roll
Internet-Draft
Intended status: Standards Track
Expires: January 16, 2019

P. van der Stok, Ed.
consultant

July 15, 2018

A YANG model for Multicast Protocol for Low power and lossy Networks (MPL)
draft-ietf-roll-mpl-yang-02

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.

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 https://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 January 16, 2019.

Copyright Notice

Table of Contents

1. Introduction

This document defines a YANG [RFC7950] data model for management of Multicast Protocol for Low power and lossy Networks (MPL) [RFC7731] implementations. The data model covers configuration of MPL parameters per interface. It also provides information about which Multicast addresses are operationally used, and the seeds of the forwarded packets.

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:

- client
- configuration data
- server
- state data

The following terms are defined in [RFC7950] and are not redefined here:

- data model
- data node

The terminology for describing YANG data models is found in [RFC7950].

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

Terms like YANG Schema Item iDentifier (SID) and delta are defined in [I-D.ietf-core-sid].

Multiple copies of a message can be received or sent by a node.

1.1.1. Tree Diagrams

YANG tree diagrams provide a concise representation of a YANG module, and SHOULD be included to help readers understand YANG module structure. Guidelines on tree diagrams can be found in Section 3 of [I-D.ietf-netmod-yang-tree-diagrams]. Tree diagrams used in this document follow the notation defined in [RFC8340].

2. MPL model

This document defines the YANG modules "ietf-yang-mpl-xxx", which specify a data model for MPL servers. The model is separated into four modules which can be loaded independently to accommodate the storage space to the wanted functionality. The model consists of the following parts: (1) "mpl-domain", (2) "mpl-op", (3) "mpl-seeds", and (4) "mpl-statistics". The four models are discussed below accompanied by their trees.

2.1. NMDA considerations

The Network Management Data Architecture (NMDA) is specified in [RFC8342]. The MPL protocol is designed for low-resource nodes, where the hardware is fixed once and for all. The configuration of the node in the MPL context is limited to enabling the interface(s) with Multicast addresses. The interface configuration of the YANG module replaces the multicast address assignment of section 2.6.2 of [RFC7390].

Consequently, The contents of the "candidate", "startup", "running", and "intended" datastores are identical. The conceptual datastore consists of an "operational" and an "intended" datastore. The "intended" store contains the nodes of the modules: ietf-yang-mpl-domain, and ietf-yang-mpl-ops. The "running" store contains the nodes of the modules: ietf-yang-mpl-seeds, and ietf-yang-mpl-statistics. The ietf-yang-mpl-domain is necessary when any MPL management is wanted. The two modules of the "running" store need the two modules of the "intended" store, and can be loaded dependent on the management wishes and resource constraints.

The modules ietf-yang-mpl-ops, ietf-yang-mpl-seeds, and ietf-yang-mpl-statistics "augment" ietf-yang-mpl-domain.

2.2. MPL-domain tree

The "mpl-domain" module describes the MPL-domains and associated Multicast addresses and the interfaces on which the Multicast addresses are enabled. The model allow for a short single MPL-domain configuration or a multi-domain configuration that needs more storage space.

```
module: ietf-yang-mpl-domain
    +--rw domain
       +--rw (multiple)?
          +--:(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
```

2.3. MPL-ops tree

The generator node of a MPL message is called a seed that emits on a multicast address of a domain. The "mpl-ops" module describes the operational parameters settings per domain. The parameters determine the dynamics of the message reception intervals per domain [RFC7731].

```
module: ietf-yang-mpl-ops
  augment /mpl:domain:
    +--rw mpl-ops
       +--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
```

2.4. MPL-seeds tree

The "mpl-seeds" part describes the MPL buffer contents and the Trickle timer values associated with each seed and domain. Multiple seeds per domain may exist. The module exposes the state of the MPL buffer and key information about the messages in the MPL buffers at a given acquisition moment.

```
module: ietf-yang-mpl-seeds
 augment /mpl:domain:
   +--rw SE_LIFETIME?   uint16
   +--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
```

2.5. MPL-statistics tree

The "mpl-statistics" module describes the number of lost and correctly forwarded messages and its copies.

```
 module: ietf-yang-mpl-statistics
 augment /mpl:domain:
   +--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-messages-forwarded?       uint64
   |  +--ro nr-of-copies-received?          uint64
   |  +--ro nr-of-copies-forwarded?         uint64
   |  +--ro nr-of-refused-copies?           uint64
   |  +--ro nr-of-missed-messages?          uint64
   |  +--ro nr-of-notreceived-messages?     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
   |  +--ro statistics-interval?            uint64
   |  +---x reset-buffer-statistics
   +---x reset-all-statistics
```

3. SID file generation

YANG Schema Item iDentifiers (SID) are allocated to replace the relatively long YANG identifiers by the much shorter SIDs. Consequently, the payload size is considerably reduced. The assignment tool is https://comi.space/. SIDs are allocated to the identifiers specified in the four modules. Their values are:

3.1. mpl-domain

Module : ietf-yang-mpl-domain
Revision : 2018-07-06

SID	Namespace	YANG identifier
1004000	module	ietf-yang-mpl-domain
1004001	data	/ietf-yang-mpl-domain:domain
1004002	data	/ietf-yang-mpl-domain:domain/mpl-domain
1004003	data	/ietf-yang-mpl-domain:domain/mpl-domain /addresses
1004004	data	/ietf-yang-mpl-domain:domain/mpl-domain /addresses/MCaddress
1004005	data	/ietf-yang-mpl-domain:domain/mpl-domain /addresses/interfaces
1004006	data	/ietf-yang-mpl-domain:domain/mpl-domain /domains
1004007	data	/ietf-yang-mpl-domain:domain/mpl-domain /domains/MClist
1004008	data	/ietf-yang-mpl-domain:domain/mpl-domain /domains/domainID
1004009	data	/ietf-yang-mpl-domain:domain/mpl-single
1004010	data	/ietf-yang-mpl-domain:domain/mpl-single /MCaddresses

3.2. mpl-ops

```
Module : ietf-yang-mpl-ops
Revision : 2018-07-06

SID     Namespace       YANG identifier
1004050 module  ietf-yang-mpl-ops
1004051 data    /ietf-yang-mpl-domain:domain
                                    /ietf-yang-mpl-ops:mpl-ops
1004052 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/PROACTIVE_FORWARDING
1004053 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/SEED_SET_ENTRY_LIFETIME
1004054 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter
1004055 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/CONTROL_MESSAGE_IMAX
1004056 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/CONTROL_MESSAGE_IMIN
1004057 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/CONTROL_MESSAGE_K
1004058 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
          mpl-ops/mpl-parameter/CONTROL_MESSAGE_TIMER_EXPIRATIONS
1004059 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/DATA_MESSAGE_IMAX
1004060 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/DATA_MESSAGE_IMIN
1004061 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/DATA_MESSAGE_K
1004062 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/DATA_MESSAGE_TIMER_EXPIRATIONS
1004063 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-ops:
           mpl-ops/mpl-parameter/domainID
```

3.3. mpl-seeds

```
Module : ietf-yang-mpl-seeds
Revision : 2018-07-06

SID     Namespace       YANG identifier
1004100 module  ietf-yang-mpl-seeds
1004101 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:SE_LIFETIME
1004102 data    /ietf-yang-mpl-domain:domain
                           /ietf-yang-mpl-seeds:mpl-seeds
1004103 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages
1004104 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages/I
1004105 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages/c
1004106 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages/e
1004107 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages/seqno
1004108 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/buffered-messages/t
1004109 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/control-number
1004110 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/data-number
1004111 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/domainID
1004112 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/generate-seqno
1004113 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/life-time
1004114 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/local
1004115 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/min-seqno
1004116 data    /ietf-yang-mpl-domain:domain/ietf-yang-mpl-seeds:
           mpl-seeds/seedID
```

3.4. mpl-statistics

```
Module : ietf-yang-mpl-statistics
Revision : 2018-07-06

SID     Namespace       YANG identifier
1004150 module  ietf-yang-mpl-statistics
1004151 data    /ietf-yang-mpl-domain:domain/
           ietf-yang-mpl-statistics:mpl-statistics
1004152 data    /ietf-yang-mpl-domain:domain/
```

```
    ietf-yang-mpl-statistics:mpl-statistics/c-too-high
1004153 data    /ietf-yang-mpl-domain:domain/
     ietf-yang-mpl-statistics:mpl-statistics/domainID
1004154 data    /ietf-yang-mpl-domain:domain/
     ietf-yang-mpl-statistics:mpl-statistics/nr-forwarded
1004155 data    /ietf-yang-mpl-domain:domain/
     ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-consistent-control
1004156 data    /ietf-yang-mpl-domain:domain/
      ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-consistent-data
1004157 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-copies-forwarded
1004158 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-copies-received
1004159 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-inconsistent-control
1004160 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-inconsistent-data
1004161 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-messages-forwarded
1004162 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-messages-received
1004163 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-missed-messages
1004164 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-notreceived-messages
1004165 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /nr-of-refused-copies
1004166 data    /ietf-yang-mpl-domain:domain/
    ietf-yang-mpl-statistics:mpl-statistics
                              /seedID
1004167 data    /ietf-yang-mpl-domain:domain/
     ietf-yang-mpl-statistics:mpl-statistics
                              /statistics-interval
```

4. yang-mpl modules

This section describes the four yang modules. The modules are 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 [RFC8343].

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.

4.1. yang-mpl-domain module

This module 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:

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

the model specifies for larger devices "multiple" interface and "multiple" domains, a list of MC addresses for which one or more interfaces are enabled.

<CODE BEGINS>file "ietf-yang-mpl-domain@2018-07-06.yang"

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

  yang-version 1.1;

  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.

     Copyright (c) 2018 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).

     This version of this YANG module is part of RFC XXXX; see
     the RFC itself for full legal notices.";

revision "2018-07-06" {
      description "revision 3";
      reference
        "I-D:draft-ietf-roll-mpl-yang: A YANG model for Multicast
         Protocol for Low power and lossy Networks (MPL)";
    }
   container domain {
     description
        "High level container containing the choice statement
         between single domain/interface and multiple
         domains and interfaces.";

   choice multiple {
     description
        "A choice for large devices with 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 the 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 MC 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 Appendix A of [RFC8343].";
          }
       }   // addresses list
     }   // container mpl-domain
     container mpl-single {
```

```
        description
           "A choice for constrained devices  with a 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 interface.";
         }
     }   // container mpl-simple
   }   // choice simple
}  // container module
}  //module ietf-yang-mpl-domain
```

<CODE ENDS>

4.2. 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. The module augments the ietf-yang-mpl-domain module.

<CODE BEGINS>file "ietf-yang-mpl-ops@2018-07-06.yang"

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

  yang-version 1.1;

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

  import ietf-yang-mpl-domain{
     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.

         Copyright (c) 2018 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).

         This version of this YANG module is part of RFC XXXX; see
         the RFC itself for full legal notices.";

    revision "2018-07-06" {
          description "revision 3";
          reference
            "I-D:draft-ietf-roll-mpl-yang: A YANG model for Multicast
             Protocol for Low power and lossy Networks (MPL)";
        }

        augment "/mpl:domain" {
           description
              "additional MPL server settings to MPL domains";

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

          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.
              Specified in section 5.4 of [RFC7731]";
        }

        leaf SEED_SET_ENTRY_LIFETIME {
           type uint64;
           units "seconds";
           default 1800;
           description
              "The value indicates the minimum lifetime for
               an entry in the Seed set expressed in seconds.
               Default value is 30 minutes.
               Specified in section 5.4 of [RFC7731]";
         }

         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
                   for MPL Data Message transmissions.
                   mpl-ops/mpl-parameter/DATA_MESSAGE_IMIN <=
                   mpl-seeds/buffered-messages/I <=
                   mpl-ops/mpl-parameter/DATA_MESSAGE_IMAX
                   Specified in section 5.4 of [RFC7731]";
             }

             leaf DATA_MESSAGE_IMAX{
                type uint16;
                description
                   "The maximum Trickle timer interval
                    for MPL Data Message transmissions.
                    mpl-ops/mpl-parameter/DATA_MESSAGE_IMIN <=
```

```
            mpl-seeds/buffered-messages/I <=
            mpl-ops/mpl-parameter/DATA_MESSAGE_IMAX
            Specified in section 5.4 of [RFC7731]";
         }

         leaf DATA_MESSAGE_K{
            type uint16;
            default 1;
            description
               "The redundancy constant
                for MPL Data Message transmissions.
                Specified in section 5.4 of [RFC7731]";
         }

         leaf DATA_MESSAGE_TIMER_EXPIRATIONS{
            type uint16;
            default 3;
            description
                "The number of Trickle timer expirations, as
                 that occur before terminating the Trickle
                 algorithm's retransmission of a given
                 MPL Data Message.
                 Specified in section 5.4 of [RFC7731]";
          }

          leaf CONTROL_MESSAGE_IMIN{
             type uint16;
             description
                "The minimum Trickle timer interval
                 for MPL Control Message transmissions.
                 Specified in section 5.4 of [RFC7731]";
          }

          leaf CONTROL_MESSAGE_IMAX{
             type uint16;
             description
                "The maximum Trickle timer interval
                 for MPL Control Message transmissions.
                 Specified in section 5.4 of [RFC7731]";
          }

          leaf CONTROL_MESSAGE_K{
             type uint16;
             default 1;
             description
                "The redundancy constant
                 for MPL Control Message transmissions.
                 Specified in section 5.4 of [RFC7731]";
```

```
              }

              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.
                     Specified in section 5.4 of [RFC7731]";
              }

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

<CODE ENDS>

4.3. 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.

The module augments the ietf-yang-mpl-domain module.

<CODE BEGINS>file "ietf-yang-mpl-seeds@2018-07-06.yang"

```
module ietf-yang-mpl-seeds {

  yang-version 1.1;
```

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

     prefix "mplse";

     import ietf-yang-mpl-domain{
        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.

        Copyright (c) 2018 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).

        This version of this YANG module is part of RFC XXXX; see
        the RFC itself for full legal notices.";

   revision "2018-07-06" {
         description "revision 3";
         reference
           "I-D:draft-ietf-roll-mpl-yang: A YANG model for Multicast
```

```
    Protocol for Low power and lossy Networks (MPL)";
       }

   augment "/mpl:domain" {
          description "additional message buffer status to MPL
          domains";

        leaf SE_LIFETIME {
           type uint16;
           units "milliseconds/timer units";
           description
              "Conversion from clock ticks to milliseconds,
               equivalent to SEED_SET_ENTRY_LIFETIME/TUNIT as
               specified in [RFC7774].";
        }

        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 originated in this
                forwarder.
                When local == false, seed originated 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;
           units   "milliseconds";
           description
              "Minimum remaining lifetime of the seed entry in
               milliseconds.";
        }

        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 by seqno. and seed/domain";

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

            leaf I{
               type uint8;
```

```
               units  "milliseconds";
               description
                  "Current Trickle timer interval size in
                   milliseconds.
                   mpl-ops/mpl-parameter/DATA_MESSAGE_IMIN <=
                   mpl-seeds/buffered-messages/I <=
                   mpl-ops/mpl-parameter/DATA_MESSAGE_IMAX";
            }

            leaf c{
               type uint8;
               description
                  "number of times that a 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;
               units  "milliseconds";
               description
                  "Time expressed in milliseconds
                   that message will be (is) forwarded.
                   mpl-seeds/buffered-messages/t <
                   mpl-seeds/buffered-messages/I";
            }

        } // list seed-timers
      } // list MPL-seeds
    } // augment
  } // module ietf-yang-mpl-seeds
```

<CODE ENDS>

4.4. 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].

The module augments the ietf-yang-mpl-domain module.

<CODE BEGINS>file "ietf-yang-mpl-statistics@2018-07-06.yang"

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

  yang-version 1.1;

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

  prefix "mplst";

  import ietf-yang-mpl-domain{
     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.

        Copyright (c) 2018 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).

        This version of this YANG module is part of RFC XXXX; see
        the RFC itself for full legal notices.";

   revision "2018-07-06" {
         description "revision 3";
         reference
           "I-D:draft-ietf-roll-mpl-yang: A YANG model for Multicast
    Protocol for Low power and lossy Networks (MPL)";
       }

    augment "/mpl:domain" {
         description "additional MPL message statistics to MPL
         domains";

        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 received,
               must be smaller than or equal to seqno.";
        }

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

        leaf nr-of-copies-forwarded{
           type uint64;
           description
              "number of forwarded copies, can be larger than
               number-of-copies-received.";
        }
```

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

        leaf nr-of-missed-messages{
           type uint64;
           description
              "number of messages that were not received
               because seqno < min-seqno.";
        }

        leaf nr-of-notreceived-messages{
           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.";
        }

        leaf statistics-interval{
           type uint64;
           description
              "Interval, expressed in seconds, during which
```

```
                the statistics are collected.";
         }

         action reset-buffer-statistics{
            description
               "set all statistics counters and
                statistics-interval of buffer[seedID domainID}
                to zero.";
         }

      }  // list mpl statistics

      action reset-all-statistics{
         description
            "set all statistics counters and
             statistics-interval of all buffers to zero.";
      }

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

<CODE ENDS>

5. IANA Considerations

Registration of four YANG modules and corresponding SID files in the "YANG module assignment" registry is required.

```
   module: ietf-yang-mpl-domain



      .yang file: ietf-yang-mpl-domain@2018-07-06.yang

      .sid file: ietf-yang-mpl-domain@2018-07-06.sid

   module: ietf-yang-mpl-ops



      .yang file: ietf-yang-mpl-ops@2018-07-06.yang

      .sid file: ietf-yang-mpl-ops@2018-07-06.sid

   module: ietf-yang-mpl-seeds
```

.yang file: ietf-yang-mpl-seeds@2018-07-06.yang

.sid file: ietf-yang-mpl-seeds@2018-07-06.sid

module: ietf-yang-mpl-statistics

.yang file: ietf-yang-mpl-statistics@2018-07-06.yang

.sid file: ietf-yang-mpl-statistics@2018-07-06.sid

6. Acknowledgements

Andy Bierman has commented on the use of YANG for mpl. Many thanks to Radi Krejci for yang review.

7. Changelog

Changes from version 01 to version 02

- Added NMDA section.
- added module explanation in model section
- IANA considerations added

Changes from version 00 to version 01

- config false in "statistics" and "seeds" modules
- separated into 4 modules
- inserted choice in domain modules
- more explanatory text
- renamed some parameters
- Introduced section per module
- reset of statistics is added

Version ietf-00 copied from version vanderstok-02

8. References

8.1. Normative References

[I-D.ietf-core-sid]
Veillette, M. and A. Pelov, "YANG Schema Item iDentifier (SID)", draft-ietf-core-sid-04 (work in progress), June 2018.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[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, <https://www.rfc-editor.org/info/rfc6241>.

[RFC7731] Hui, J. and R. Kelsey, "Multicast Protocol for Low-Power and Lossy Networks (MPL)", RFC 7731, DOI 10.17487/RFC7731, February 2016, <https://www.rfc-editor.org/info/rfc7731>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/info/rfc7950>.

[RFC8343] Bjorklund, M., "A YANG Data Model for Interface Management", RFC 8343, DOI 10.17487/RFC8343, March 2018, <https://www.rfc-editor.org/info/rfc8343>.

8.2. Informative References

[I-D.ietf-netmod-yang-tree-diagrams]
Bjorklund, M. and L. Berger, "YANG Tree Diagrams", draft-ietf-netmod-yang-tree-diagrams-06 (work in progress), February 2018.

[RFC6206] Levis, P., Clausen, T., Hui, J., Gnawali, O., and J. Ko, "The Trickle Algorithm", RFC 6206, DOI 10.17487/RFC6206, March 2011, <https://www.rfc-editor.org/info/rfc6206>.

[RFC7390] Rahman, A., Ed. and E. Dijk, Ed., "Group Communication for the Constrained Application Protocol (CoAP)", RFC 7390, DOI 10.17487/RFC7390, October 2014, <https://www.rfc-editor.org/info/rfc7390>.

[RFC7774] Doi, Y. and M. Gillmore, "Multicast Protocol for Low-Power and Lossy Networks (MPL) Parameter Configuration Option for DHCPv6", RFC 7774, DOI 10.17487/RFC7774, March 2016, <https://www.rfc-editor.org/info/rfc7774>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

[RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/info/rfc8342>.

Author’s Address

Peter van der Stok (editor)
consultant

Phone: +31-492474673 (Netherlands), +33-966015248 (France)
Email: consultancy@vanderstok.org
URI: www.vanderstok.org