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H. Zhao
Ericsson
X. Liu
IBM Corporation
Y. Liu
China Mobile
M. Panchanathan
Cisco Systems
M. Sivakumar
Juniper

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A YANG Data Model for IGMP/MLD Proxy
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Abstract

This document defines a YANG data model that can be used to configure and manage Internet Group Management Protocol (IGMP) or Multicast Listener Discovery (MLD) proxy devices. The YANG module in this document conforms to Network Management Datastore Architecture (NMDA).

Status of this Memo

This Internet-Draft will expire on July 04, 2023.

Table of Contents

1. Introduction

This document defines a YANG [RFC7950] data model for the management of Internet Group Management Protocol (IGMP) or Multicast Listener Discovery (MLD) Proxy [RFC4605] devices. The YANG module in this document conforms to the Network Management Datastore Architecture defined in [RFC8342].

1.1. Terminology

The terminology for describing YANG data models is found in [RFC6020] and [RFC7950], including:

* augment
* data model
* data node
* identity
* module

The following abbreviations are used in this document and defined model:

IGMP: Internet Group Management Protocol [RFC3376].
MLD: Multicast Listener Discovery [RFC3810].
PIM: Protocol Independent Multicast [RFC7761].

1.2. Tree Diagrams

Tree diagrams used in this document follow the notation defined in

[RFC8340].

1.3. Prefixes in Data Node Names

In this document, names of data nodes, and other data model objects are often used without a prefix, as long as it is clear from the context in which YANG module each name is defined. Otherwise, names are prefixed using the standard prefix associated with the corresponding YANG module, as shown in Table 1.

Prefix	YANG module	Reference

inet	ietf-inet-types	[RFC6991]
if	ietf-interfaces	[RFC8343]
rt	ietf-routing	[RFC8349]
rt-types	ietf-routing-types	[RFC8294]
pim-base	ietf-pim-base	[RFC9128]

Table 1: Prefixes and Corresponding YANG Modules

2. Design of Data Model

The model covers Internet Group Management Protocol (IGMP) / Multicast Listener Discovery (MLD) - Based Multicast Forwarding ("IGMP/MLD Proxying") [RFC4605]. The goal of this document is to define a data model that provides a common user interface to IGMP/MLD Proxy.

2.1. Overview

The model defined in this document has all the common building blocks for the IGMP/MLD Proxy devices. It can be used to configure IGMP/MLD Proxy. The operational state data and statistics can also be retrieved by it.

2.2. Optional Features

This model is designed to represent the basic capability subsets of IGMP / MLD Proxy. The main design goals of this document are that the basic capabilities described in the model are supported by any major now-existing implementation, and that the configuration of all implementations meeting the specifications is easy to express through some combination of the optional features in the model and simple vendor augmentations.

This model declares two features representing capabilities that not all deployed devices support. One feature is igmp-proxy, and the other feature is mld-proxy. Either or both features could be implemented, which could provide more choices for vendors.

2.3. Position of Address Family in Hierarchy

IGMP Proxy only supports IPv4, while MLD Proxy only supports IPv6. The data model defined in this document can be used for both IPv4 and IPv6 address families.

This document defines IGMP Proxy and MLD Proxy as separate schema branches in the structure. The benefits are:

* The model can support IGMP Proxy (IPv4), MLD Proxy (IPv6), or both optionally and independently. Such flexibility cannot be achieved cleanly with a combined branch.

* The structure is consistent with other YANG data models such as [RFC8652], which uses separate branches for IPv4 and IPv6.

* Having separate branches for IGMP Proxy and MLD Proxy allows minor differences in their behavior to be modelled more simply and cleanly. The two branches can better support different features and node types.

3. Module Structure

This model augments the core routing data model specified in [RFC8349].

```
      +--rw routing
         +--rw router-id?
         +--rw control-plane-protocols
         |  +--rw control-plane-protocol* [type name]
         |     +--rw type
         |     +--rw name
         |     +--rw igmp-proxy <= Augmented by this Model
                     ...
         |     +--rw mld-proxy  <= Augmented by this Model
```

The "igmp-proxy" container instantiates IGMP Proxy. The "mld-proxy" container instantiates MLD Proxy.

3.1. IGMP Proxy Configuration and Operational State

The YANG module augments /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol to add the igmp-proxy container.

All the IGMP Proxy related attributes are defined in the igmp-proxy container. The read-write attributes represent configurable data. The read-only attributes represent state data.

The igmp-version represents the version of IGMP protocol, and the default value is 2. If the value of enabled is true, it means IGMP Proxy is enabled.

The interface list under igmp-proxy contains upstream interfaces for IGMP proxy. There is also a constraint to make sure the upstream interface for IGMP proxy is not configured to use PIM.

To configure a downstream interface for IGMP proxy, it is needed to enable IGMP on that interface. This is defined in the YANG Data Model

for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) [RFC8652].

```
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol:
    +--rw igmp-proxy! {igmp-proxy}?
       +--rw interfaces
          +--rw interface* [name]
             +--rw name                     if:interface-ref
             +--rw igmp-version?            uint8
             +--rw enabled?                 boolean
             +--rw sender-source-address?   inet:ipv4-address-no-zone
             +--ro group* [group-address]
                +--ro group-address
                |       rt-types:ipv4-multicast-group-address
                +--ro up-time?         uint32
                +--ro filter-mode      enumeration
                +--ro source* [source-address]
                   +--ro source-address
                   |       inet:ipv4-address-no-zone
                   +--ro up-time?               uint32
                   +--ro downstream-interface* [name]
                      +--ro name    if:interface-ref
```

3.2. MLD Proxy Configuration and Operational State

The YANG module augments /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol to add the mld-proxy container.

All the MLD Proxy related attributes are defined in the mld-proxy container. The read-write attributes represent configurable data. The read-only attributes represent state data.

The mld-version represents the version of MLD protocol, and default value is 2. If the value of enabled is true, it means MLD Proxy is enabled.

The interface list under mld-proxy contains upstream interfaces for MLD proxy. There is also a constraint to make sure the upstream interface for MLD proxy is not configured to use PIM.

To configure a downstream interface for MLD proxy, enable MLD on that interface. This is defined in the YANG Data Model for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) [RFC8652].

```
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol:
     +--rw mld-proxy! {mld-proxy}?
       +--rw interfaces
          +--rw interface* [name]
```

```
            +--rw name                     if:interface-ref
            +--rw mld-version?             uint8
            +--rw enabled?                 boolean
            +--rw sender-source-address?   inet:ipv6-address-no-zone
            +--ro group* [group-address]
               +--ro group-address
               |       rt-types:ipv6-multicast-group-address
               +--ro up-time?         uint32
               +--ro filter-mode      enumeration
               +--ro source* [source-address]
                  +--ro source-address
                  |       inet:ipv6-address-no-zone
                  +--ro up-time?               uint32
                  +--ro downstream-interface* [name]
                     +--ro name    if:interface-ref
```

4. IGMP/MLD Proxy YANG Module

This module references [RFC4605], [RFC6991], [RFC8294], [RFC8343], [RFC8349] and [RFC9128].

```
<CODE BEGINS> file ietf-igmp-mld-proxy@2022-12-07.yang
module ietf-igmp-mld-proxy {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy";
  // replace with IANA namespace when assigned
  prefix igmp-mld-proxy;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-interfaces {
    prefix if;
    reference
      "RFC 8343: A YANG Data Model for Interface Management";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-pim-base {
    prefix pim-base;
```

```
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent Multicast
      (PIM)";
  }

  organization
    "IETF PIM Working Group";

  contact
    "WG Web:   <https://datatracker.ietf.org/wg/pim/about/>
     WG List:  <mailto:pim@ietf.org>

     Editors:  Hongji Zhao
               <mailto:hongji.zhao@ericsson.com>

               Xufeng Liu
               <mailto:xufeng.liu.ietf@gmail.com>

               Yisong Liu
               <mailto:liuyisong@chinamobile.com>

               Mani Panchanathan
               <mailto:mapancha@cisco.com>

               Mahesh Sivakumar
               <mailto:sivakumar.mahesh@gmail.com>

    ";

  description
    "The module defines a collection of YANG definitions common for
     all Internet Group Management Protocol (IGMP) and Multicast
     Listener Discovery (MLD) Proxy devices.

     Copyright (c) 2022 IETF Trust and the persons identified as
     authors of the code.  All rights reserved.

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     without modification, is permitted pursuant to, and subject to
     the license terms contained in, the Revised 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 2022-12-07 {
    description
      "Initial revision.";
    reference
```

```
      "RFC XXXX: A YANG Data Model for IGMP and MLD Proxy";
  }

  /*
   * Features
   */

  feature igmp-proxy {
    description
      "Support IGMP Proxy protocol.";
    reference
      "RFC 4605";
  }

  feature mld-proxy {
    description
      "Support MLD Proxy protocol.";
    reference
      "RFC 4605";
  }

  /*
   * Identities
   */

  identity igmp-proxy {
    base rt:control-plane-protocol;
    description
      "IGMP Proxy protocol";
  }

  identity mld-proxy {
    base rt:control-plane-protocol;
    description
      "MLD Proxy protocol";
  }

  /*
   * Groupings
   */

  grouping per-interface-config-attributes {
    description "Config attributes under interface view";
    leaf enabled {
      type boolean;
      default true;
      description
        "Set the value to true to enable IGMP/MLD proxy";
    }
  } // per-interface-config-attributes
```

```
  grouping state-group-attributes {
    description
      "State group attributes";
    leaf up-time {
      type uint32;
      units seconds;
      description
        "The elapsed time for (S,G) or (*,G).";
    }
    leaf filter-mode {
      type enumeration {
        enum "include" {
          description
            "In include mode, reception of packets sent
             to the specified multicast address is requested
             only from those IP source addresses listed in the
             source-list parameter";
        }
        enum "exclude" {
          description
            "In exclude mode, reception of packets sent
             to the given multicast address is requested
             from all IP source addresses except those
             listed in the source-list parameter.";
        }
      }
      mandatory true;
      description
        "Filter mode for a multicast group,
         may be either include or exclude.";
    }
  } // state-group-attributes


 /* augments */

  augment "/rt:routing/rt:control-plane-protocols"+
        "/rt:control-plane-protocol" {
    when
      "derived-from-or-self(rt:type, 'igmp-mld-proxy:igmp-proxy')" {
        description
          "This augmentation is only valid for IGMP Proxy.";
    }
    description
      "IGMP Proxy augmentation to routing control plane protocol
       configuration and state.";
    container igmp-proxy {
      if-feature "igmp-proxy";
      presence "IGMP Proxy configuration.";
      description "IGMP Proxy instance configuration.";
      container interfaces {
```

```
        description
          "Containing a list of upstream interfaces.";
        list interface {
          key "name";
          description
            "List of upstream interfaces.";
          leaf name {
            type if:interface-ref;
            must "not( current() = /rt:routing"+
              "/rt:control-plane-protocols/pim-base:pim"+
              "/pim-base:interfaces/pim-base:interface"+
              "/pim-base:name )" {
              description
                "The upstream interface for IGMP proxy
                 must not be configured to use PIM.";
            }
            description "The upstream interface name.";
          }
          leaf igmp-version {
            type uint8 {
              range "1..3";
            }
            default 2;
            description "IGMP version.";
          }
          uses per-interface-config-attributes;
          leaf sender-source-address {
            type inet:ipv4-address-no-zone;
            description
              "The sender source address of
               IGMP membership report message or leave message.";
          }
          list group {
            key "group-address";
            config false;
            description
              "Multicast group membership information
              that joined on the interface.";
            leaf group-address {
              type rt-types:ipv4-multicast-group-address;
              description
                "Multicast group address.";
            }
            uses state-group-attributes;
            list source {
              key "source-address";
              description
                "List of multicast source information
                 of the multicast group.";
              leaf source-address {
                type inet:ipv4-address-no-zone;
```

```
                description
                  "Multicast source address";
              }
              leaf up-time {
                type uint32;
                units seconds;
                description
                  "The elapsed time for (S,G) or (*,G).";
              }
              list downstream-interface {
                key "name";
                description "The downstream interfaces list.";
                leaf name {
                  type if:interface-ref;
                  description
                    "Downstream interfaces
                     for each upstream-interface";
                }
              }
            } // list source
          } // list group
        } // interface
      } // interfaces
    }
  }

  augment "/rt:routing/rt:control-plane-protocols"+
        "/rt:control-plane-protocol" {
    when
     "derived-from-or-self(rt:type, 'igmp-mld-proxy:mld-proxy')" {
        description
          "This augmentation is only valid for MLD Proxy.";
    }
    description
      "MLD Proxy augmentation to routing control plane protocol
       configuration and state.";
    container mld-proxy {
      if-feature "mld-proxy";
      presence "MLD Proxy configuration.";
      description "MLD Proxy instance configuration.";
      container interfaces {
        description
          "Containing a list of upstream interfaces.";
        list interface {
          key "name";
          description
            "List of upstream interfaces.";
          leaf name {
            type if:interface-ref;
            must "not( current() = /rt:routing"+
              "/rt:control-plane-protocols/pim-base:pim"+
```

```
              "/pim-base:interfaces/pim-base:interface"+
              "/pim-base:name )" {
              description
                "The upstream interface for MLD proxy
                 must not be configured to use PIM.";
            }
            description "The upstream interface name.";
          }
          leaf mld-version {
            type uint8 {
              range "1..2";
            }
            default 2;
            description "MLD version.";
          }
          uses per-interface-config-attributes;
          leaf sender-source-address {
            type inet:ipv6-address-no-zone;
            description
              "The sender source address of
               MLD membership report message or leave message.";
          }
          list group {
            key "group-address";
            config false;
            description
              "Multicast group membership information
              that joined on the interface.";
            leaf group-address {
              type rt-types:ipv6-multicast-group-address;
              description
                "Multicast group address.";
            }
            uses state-group-attributes;
            list source {
              key "source-address";
              description
                "List of multicast source information
                 of the multicast group.";
              leaf source-address {
                type inet:ipv6-address-no-zone;
                description
                  "Multicast source address";
              }
              leaf up-time {
                type uint32;
                units seconds;
                description
                  "The elapsed time for (S,G) or (*,G).";
              }
              list downstream-interface {
```

```
                key "name";
                description "The downstream interfaces list.";
                leaf name {
                  type if:interface-ref;
                  description
                    "Downstream interfaces
                     for each upstream-interface";
                }
              }
            } // list source
          } // list group
        } // interface
      } // interfaces
    }
  }
}
<CODE ENDS>
```

5. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this YANG module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

Under /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/igmp-mld-proxy:igmp-proxy,

igmp-mld-proxy:interfaces
  This subtree specifies the interface list for IGMP Proxy. Modifying the configuration may cause IGMP Proxy interface to be deleted or changed.

igmp-mld-proxy:interfaces/interface
This subtree specifies the configuration for the IGMP Proxy attributes at the interface level. Modifying the configuration may cause IGMP Proxy to be deleted or changed on a specific interface.

Under /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/igmp-mld-proxy:mld-proxy,

igmp-mld-proxy:interfaces
This subtree specifies the interface list for MLD Proxy. Modifying the configuration may cause MLD Proxy interface to be deleted or changed.

igmp-mld-proxy:interfaces/interface
This subtree specifies the configuration for the MLD Proxy attributes at the interface level. Modifying the configuration may cause MLD Proxy to be deleted or changed on a specific interface.

Unauthorized access to any data node of these subtrees can adversely affect the IGMP / MLD Proxy subsystem of both the local device and the network. This may lead to network malfunctions, delivery of packets to inappropriate destinations, and other problems.

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

Under /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol:/igmp-mld-proxy:igmp-proxy
igmp-mld-proxy:mld-proxy

Unauthorized access to any data node of these subtrees can disclose the operational state information of IGMP / MLD Proxy on this device. The group/source information may expose multicast group memberships.

6. IANA Considerations

RFC Ed.: In this section, replace all occurrences of 'XXXX' with the actual RFC number (and remove this note).

6.1. XML Registry

This document registers the following namespace URIs in the IETF XML registry [RFC3688]:

```
---------------------------------------------------------------------
URI: urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
---------------------------------------------------------------------
```

6.2. YANG Module Names Registry

This document registers the following YANG modules in the YANG Module Names registry [RFC7950]:

```
---------------------------------------------------------------------
name:         ietf-igmp-mld-proxy
namespace:    urn:ietf:params:xml:ns:yang:ietf-igmp-mld-proxy
prefix:       igmp-mld-proxy
reference:    RFC XXXX
---------------------------------------------------------------------
```

7. References

7.1. Normative References

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[RFC8652] X. Liu, F. Guo, M. Sivakumar, P. McAllister, A. Peter, "A YANG Data Model for the Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD)", RFC 8652, November 2019.

[RFC9128] X. Liu, P. McAllister, A. Peter, M. Sivakumar, Y. Liu, F. Hu, "A YANG Data Model for Protocol Independent Multicast (PIM)", RFC 9128, May 2018.

7.2. Informative References

[RFC7761] B. Fenner, M. Handley, H. Holbrook, I. Kouvelas, R. Parekh, Z. Zhang, L. Zheng, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 7761, March 2016.

[RFC7951] L. Lhotka, "JSON Encoding of Data Modeled with YANG", RFC 7951, August 2016.

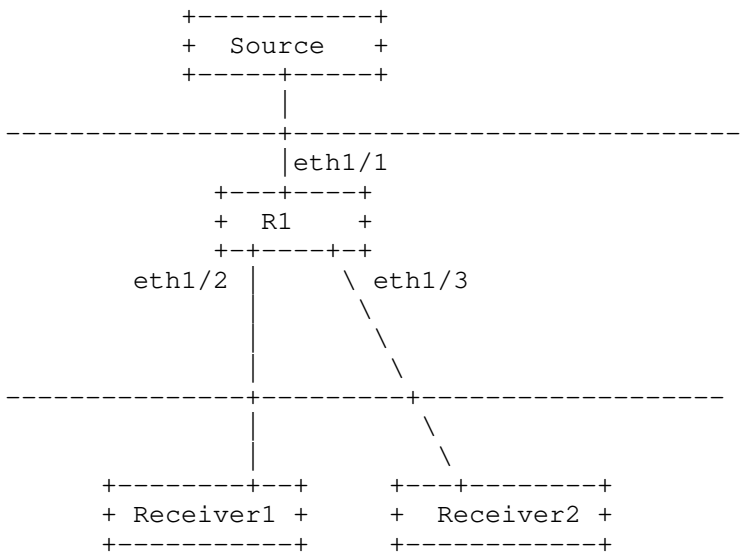
[RFC8340] M. Bjorklund, and L. Berger, Ed., "YANG Tree Diagrams", RFC 8340, March 2018.

[RFC8407] A. Bierman, "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", RFC 8407, October 2018.

Appendix. Data Tree Example

This section contains an example for IGMP Proxy in the JSON encoding [RFC7951], containing both configuration and state data. In the example IGMP Proxy is enabled on interface eth1/1.

It is also needed to enable IGMP on eth1/2 and eth1/3. The configuration details are omitted here because this document is focused on IGMP/MLD Proxy.



The configuration data for R1 in the above figure could be as follows:

```
{
    "ietf-interfaces:interfaces": {
      "interface": [
        {
          "name": "eth1/1",
          "type": "iana-if-type:ipForward",
          "ietf-ip:ipv4": {
            "address": [
              {
                "ip": "203.0.113.1",
                "prefix-length": 24
              }
            ]
          }
        }
      ]
    },
```

```
   "ietf-routing:routing": {
      "control-plane-protocols": {
        "control-plane-protocol": [
          {
            "type": "ietf-igmp-mld-proxy:igmp-proxy",
            "name": "proxy1",
            "ietf-igmp-mld-proxy:igmp-proxy": {
              "interfaces": {
                "interface": [
                  {
                    "name": "eth1/1",
                    "igmp-version": 3,
                    "enabled": true
                  }
                ]
              }
            }
          }
        ]
      }
    }
  }
```

The corresponding operational state data for R1 could be as follows:

```
{
    "ietf-interfaces:interfaces": {
      "interface": [
        {
          "name": "eth1/1",
          "type": "iana-if-type:ipForward",
          "admin-status": "up",
          "oper-status": "up",
          "if-index": 25678136,
          "statistics": {
            "discontinuity-time": "2021-05-23T10:34:56-06:00"
          },
          "ietf-ip:ipv4": {
            "address": [
              {
                "ip": "203.0.113.1",
                "prefix-length": 24
              }
            ]
          }
        }
      ]
    },
   "ietf-routing:routing": {
      "control-plane-protocols": {
```

```
        "control-plane-protocol": [
          {
            "type": "ietf-igmp-mld-proxy:igmp-proxy",
            "name": "proxy1",
            "ietf-igmp-mld-proxy:igmp-proxy": {
              "interfaces": {
                "interface": [
                  {
                    "name": "eth1/1",
                    "igmp-version": 3,
                    "enabled": true,
                    "group": [
                      {
                        "group-address": "233.252.0.23",
                        "filter-mode": "include",
                        "source": [
                          {
                            "source-address": "192.0.2.1",
                            "downstream-interface": [
                              {
                                "name": "eth1/2"
                              },
                              {
                                "name": "eth1/3"
                              }
                            ]
                          }
                        ]
                      }
                    ]
                  }
                ]
              }
            }
          }
        ]
      }
    }
  }
```

Authors' Addresses

Hongji Zhao
Ericsson (China) Communications Company Ltd.
Ericsson Tower, No. 5 Lize East Street,
ChaoYANG District Beijing 100102, China
Email: hongji.zhao@ericsson.com

Xufeng Liu
IBM Corporation
2300 Dulles Station Blvd.
Herndon, VA 20171
United States of America
EMail: Xufeng.liu.ietf@gmail.com

Yisong Liu
China Mobile
China
Email: liuyisong@chinamobile.com

Mani Panchanathan
Cisco Systems
India
Email: mapancha@cisco.com

Mahesh Sivakumar
Juniper Networks
1133 Innovation Way
Sunnyvale, California
USA
EMail: sivakumar.mahesh@gmail.com