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YANG Data Model for supporting multipath IGMP/MLD proxies
draft-zcl-pim-multiif-igmp-mld-proxy-yang-02

Abstract

The ability to support multiple upstream interfaces in IGMP/MLD proxies necessitates configuring different upstream interfaces for specific multicast channels or sessions. [RFC9398] defined YANG Data Model for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) Proxy Devices. Building on that foundation, this document proposes an augmentation of thet model for the support of multiple upstream interfaces in IGMP/MLD proxies.

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1. Introduction

An IGMP/MLD proxy with multiple upstream interfaces, as outlined in [I-D.ietf-pim-multipath-igmpmldproxy], enables a device to receive multicast sessions or channels through different upstream interfaces. The selection of a specific upstream interface can be determined based on various factors, including subscriber address prefixes, channel or session IDs, and interface priority values.

[I-D.ietf-pim-multipath-igmpmldproxy] explores two approaches for the automatic configuration of upstream interfaces. One approach involves a centralized controller managing the configuration, requiring the proxy to have a control and management interface to receive instructions. Alternatively, configuration can be achieved through a signaling-based mechanism using IGMP/MLD messages. While the latter approach is addressed in [I-D.contreras-pim-multiif-config], this document focuses on the former approach, defining augmentations to the model defined in [RFC9398].

2. IGMP/MLD proxy with multiple upstream interfaces

[I-D.ietf-pim-multipath-igmpmldproxy] defines the capabilities of an IGMP/MLD proxy device in receiving multicast sessions or channels through multiple upstream interfaces. The proxy can operate using either "channel-based upstream selection," "subscriber-based upstream selection," or a combination of both. In channel-based upstream selection, the proxy selects one or more upstream interfaces from the available candidates for each specific channel or session. In subscriber-based upstream selection, the proxy assigns one or more upstream interfaces for each subscriber or receiver.

By supporting content subscription through multiple upstream interfaces, the proxy can either distribute the load across sessions and channels or receive content simultaneously from multiple upstream interfaces. This enhances the reliability of content delivery. Therefore, the enablement of scenarios where a channel is subscribed to and received through more than one upstream interface simultaneously are of interest.

3. Data Model for supporting IGMP/MLD proxy with multiple upstream interfaces

The model presented in this document augments the fundamental components required for IGMP/MLD proxy devices described in [RFC9398] for allowing the configuration of multiple upstream interfaces in those devices.

3.1. YANG schema tree

The YANG schema tree intended for enabling the support of multipath for IGMP proxies is defined in the following way.

```
module: ietf-multipath-igmp-mld-proxy

  augment /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-proxy
:igmp-proxy:
    +--rw default-upstream-interface?    -> ../igmp-mld-proxy:interfaces/interface/name {
multipath-igmp-proxy}?
    +--rw upstream-interface-takeover?   boolean {multipath-igmp-proxy}?
  augment /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-proxy
:igmp-proxy/igmp-mld-proxy:interfaces/igmp-mld-proxy:interface:
    +--rw interface-priority?   uint32 {multipath-igmp-proxy}?
    +--rw active-interval?      uint32 {multipath-igmp-proxy}?
    +--rw subscriber* [address-prefix] {multipath-igmp-proxy}?
       +--rw address-prefix    inet:ipv4-address-no-zone
       +--rw group* [address-prefix]
          +--rw address-prefix    rt-types:ipv4-multicast-group-address
          +--rw source* [address-prefix]
             +--rw address-prefix    inet:ipv4-address-no-zone
```

Similarly, the YANG schema tree intended for enabling the support of multipath for MLD proxies is defined as follows.

```
module: ietf-multipath-igmp-mld-proxy

  augment /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-proxy
:mld-proxy:
    +--rw default-upstream-interface?    -> ../igmp-mld-proxy:interfaces/interface/name {
multipath-mld-proxy}?
    +--rw upstream-interface-takeover?   boolean {multipath-mld-proxy}?
  augment /rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-proxy
:mld-proxy/igmp-mld-proxy:interfaces/igmp-mld-proxy:interface:
    +--rw interface-priority?   uint32 {multipath-mld-proxy}?
    +--rw active-interval?      uint32 {multipath-mld-proxy}?
    +--rw subscriber* [address-prefix] {multipath-mld-proxy}?
       +--rw address-prefix    inet:ipv6-address-no-zone
       +--rw group* [address-prefix]
          +--rw address-prefix    rt-types:ipv6-multicast-group-address
          +--rw source* [address-prefix]
             +--rw address-prefix    inet:ipv6-address-no-zone
```

3.2. IGMP Proxy YANG Module for supporting multiple upstream interfaces

The model for IGMP is defined as follows:

```
module ietf-multipath-igmp-mld-proxy {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-multipath-igmp-mld-proxy";
  // replace with IANA namespace when assigned
  prefix multipath-igmp-mld-proxy;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  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-igmp-mld-proxy {
    prefix igmp-mld-proxy;
    reference
      "RFC 9398: A YANG Data Model for IGMP/MLD Proxy";
```

```
  }

  organization
    "IETF PIM Working Group";

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

  description
    "The module defines a collection of YANG definitions common for
     Multipath IGMP/MLD Proxy devices.

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     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 2025-03-03 {
    description
      "Initial revision.";
    reference
      "RFC XXXX: A YANG Data Model for Multipath IGMP/MLD Proxy";
  }

  /*
   * Features
   */

  feature multipath-igmp-proxy {
    description
      "Multipath Support for IGMP Proxy.";
    reference
      "draft-ietf-pim-multipath-igmpmldproxy";
  }

  feature multipath-mld-proxy {
    description
      "Multipath Support for MLD Proxy.";
```

```
    reference
      "draft-ietf-pim-multipath-igmpmldproxy";
  }


 /* augments */

  augment "/rt:routing/rt:control-plane-protocols"+
        "/rt:control-plane-protocol/igmp-mld-proxy:igmp-proxy" {
    description
      "";
    leaf default-upstream-interface {
      if-feature "multipath-igmp-proxy";
      type leafref {
            path "../igmp-mld-proxy:interfaces/igmp-mld-proxy:interface/igmp-mld-proxy:na
me";
          }
      description
        "It is used as the upstream interface when candidate
         upstream interfaces are not configured for the subscriber
         address prefix, channel/session ID, or interface priority value.";
    }
    leaf upstream-interface-takeover {
      if-feature "multipath-igmp-proxy";
      type boolean;
          default true;
      description
        "If a proxy device detects that a selected upstream interface
         is going down or inactive, it disables the current upstream
                  interface and selects another active upstream interface with
                  the highest priority among the candidate upstream interfaces
                  covering the same channel/session ID.";
    }
  }

  augment "/rt:routing/rt:control-plane-protocols"+
        "/rt:control-plane-protocol/igmp-mld-proxy:igmp-proxy"+
                "/igmp-mld-proxy:interfaces/igmp-mld-proxy:interface" {
    description
      "";

    leaf interface-priority {
      if-feature "multipath-igmp-proxy";
      type uint32;
          default 0;
      description
        "A lower value indicates a lower priority";
    }
```

```
    leaf active-interval {
      if-feature "multipath-igmp-proxy";
      type uint32;
      description
        "An active interval is a period in which the selected upstream
         interface on the proxy device remains active.";
    }

    list subscriber {
      if-feature "multipath-igmp-proxy";
          key "address-prefix";
      leaf address-prefix {
        type inet:ipv4-address-no-zone;
                description
          "Subscriber-based upstream selection involves IGMP/MLD proxy devices
           selecting one or multiple upstream interface(s) from candidate
           upstream interfaces per subscriber/receiver.
                  When setting 0.0.0.0, it indicates any host";
      }
          list group {
            key "address-prefix";
            leaf address-prefix {
          type rt-types:ipv4-multicast-group-address;
          description
            "Channel/session ID consists of source address prefix
            and multicast address prefix. This is multicast address prefix.
                        When setting 224.0.0.0, indicates the entire multicast address ra
nge";
                }
        list source {
                  key "address-prefix";
                  leaf address-prefix {
            type inet:ipv4-address-no-zone;
            description
              "Channel/session ID consists of source address prefix
               and multicast address prefix. This is source address prefix.
                           When setting 0.0.0.0, it indicates any host";
                  }
        } // source
      } // group
    } // subscriber
  }
}
```

3.3. MLD Proxy YANG Module for supporting multiple upstream interfaces

The model for IGMP is defined as follows:

```
module ietf-multipath-mld-proxy {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-multipath-mld-proxy";
  prefix multipath-mld-proxy;

  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
  }

  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-igmp-mld-proxy {
    prefix igmp-mld-proxy;
    reference
      "RFC 9398: A YANG Data Model for IGMP/MLD Proxy";
  }

  organization
    "IETF PIM Working Group";

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

  description
    "This module defines YANG augmentations to support multipath
     behavior for MLD proxy functionality in IPv6 multicast networks.";

  revision 2025-07-04 {
    description "Initial revision.";
    reference
      "RFC XXXX: A YANG Data Model for Multipath MLD Proxy";
  }

  /*
   * Features
```

```
   */

  feature multipath-mld-proxy {
    description
      "Multipath Support for MLD Proxy.";
    reference
      "draft-ietf-pim-multipath-igmpmldproxy";
  }

  /*
   * Augmentations
   */

  augment "/rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-prox
y:mld-proxy" {
    description "Add multipath support fields to MLD proxy.";

    leaf default-upstream-interface {
      if-feature multipath-mld-proxy;
      type leafref {
        path "../igmp-mld-proxy:interfaces/igmp-mld-proxy:interface/igmp-mld-proxy:name";
      }
      description
        "The default upstream interface when no candidate upstream is
         configured or applicable.";
    }

    leaf upstream-interface-takeover {
      if-feature multipath-mld-proxy;
      type boolean;
      default true;
      description
        "Indicates whether takeover of upstream interface should occur
         if the selected one becomes inactive.";
    }
  }

  augment "/rt:routing/rt:control-plane-protocols/rt:control-plane-protocol/igmp-mld-prox
y:mld-proxy/igmp-mld-proxy:interfaces/igmp-mld-proxy:interface" {
    description "Extend MLD proxy interfaces with multipath fields.";

    leaf interface-priority {
      if-feature multipath-mld-proxy;
      type uint32;
      default 0;
      description
        "Priority of the interface for upstream selection. Lower values
         indicate lower priority.";
    }
```

```
    leaf active-interval {
      if-feature multipath-mld-proxy;
      type uint32;
      units "seconds";
      description
        "Time period during which the interface is considered active.";
    }

    list subscriber {
      if-feature multipath-mld-proxy;
      key "address-prefix";
      description
        "List of IPv6 subscribers connected to this interface.";

      leaf address-prefix {
        type inet:ipv6-address-no-zone;
        description
          "IPv6 address prefix of the subscriber. A value of :: indicates any host.";
      }

      list group {
        key "address-prefix";
        description "Multicast groups associated with this subscriber.";

        leaf address-prefix {
          type rt-types:ipv6-multicast-group-address;
          description
            "Multicast group address. Value ff00::/8 indicates all multicast groups.";
        }

        list source {
          key "address-prefix";
          description "Sources for this multicast group.";

          leaf address-prefix {
            type inet:ipv6-address-no-zone;
            description
              "IPv6 source address. A value of :: indicates any source.";
          }
        }
      }
    }
  }
}
```

4. Security considerations

Same security considerations as in both [RFC9398] and [I-D.ietf-pim-multipath-igmpmldproxy] apply also to this document.

Further security considerations are under study.

5. Informative References

[I-D.contreras-pim-multiif-config]
Contreras, L. M. and H. Asaeda, "Signaling-based configuration for supporting multiple upstream interfaces in IGMP/MLD proxies", Work in Progress, Internet-Draft, draft-contreras-pim-multiif-config-02, 21 October 2024, <https://datatracker.ietf.org/doc/html/draft-contreras-pim-multiif-config-02>.

[I-D.ietf-pim-multipath-igmpmldproxy]
Asaeda, H. and L. M. Contreras, "Multipath Support for IGMP/MLD Proxy", Work in Progress, Internet-Draft, draft-ietf-pim-multipath-igmpmldproxy-01, 21 October 2024, <https://datatracker.ietf.org/doc/html/draft-ietf-pim-multipath-igmpmldproxy-01>.

[RFC9398] Zhao, H., Liu, X., Liu, Y., Panchanathan, M., and M. Sivakumar, "A YANG Data Model for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) Proxy Devices", RFC 9398, DOI 10.17487/RFC9398, May 2023, <https://www.rfc-editor.org/info/rfc9398>.

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