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Multiple Upstream Interface Support for IGMP/MLD Proxy draft-asaeda-pim-multiif-igmpmldproxy-00

Abstract

This document describes the way of supporting multiple upstream interfaces for an IGMP/MLD proxy device. The proposed extension enables an IGMP/MLD proxy device to receive multicast sessions/ channels through the different upstream interfaces. The upstream interface is selected based on the pre-configured supported address prefixes and interface priority value. A mechanism for upstream interface takeover that switches from an inactive upstream interface to an active upstream interface is also described.

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1. Introduction

The Internet Group Management Protocol (IGMP) [2][4] for IPv4 and the Multicast Listener Discovery Protocol (MLD) [3][4] for IPv6 are the standard protocols for hosts to initiate joining or leaving of multicast sessions. A proxy device performing IGMP/MLD-based forwarding (as known as IGMP/MLD proxy) [5] maintains multicast membership information by IGMP/MLD protocols on the downstream interfaces and sends IGMP/MLD membership report messages via the upstream interface to the upstream multicast routers when the membership information changes (e.g., by receiving solicited/ unsolicited report messages). The proxy device forwards appropriate multicast packets received on its upstream interface to each downstream interface based on the downstream interface's subscriptions.

According to the specification of [5], an IGMP/MLD proxy has *a single* upstream interface and one or more downstream interfaces. The multicast forwarding tree must be manually configured by designating upstream and downstream interfaces on an IGMP/MLD proxy device, and the root of the tree is expected to be connected to a wider multicast infrastructure. An IGMP/MLD proxy device hence performs the router portion of the IGMP or MLD protocol on its downstream interfaces, and the host portion of IGMP/MLD on its

upstream interface. The proxy device must not perform the router portion of IGMP/MLD on its upstream interface.

On the other hand, there is a scenario in which an IGMP/MLD proxy device enables multiple upstream interfaces and receives multicast packets through these interfaces. For example, a proxy device having more than one interface may want to access to different networks, such as a global network like the Internet and local-scope networks. Or, a proxy device having wired link (e.g., ethernet) and high-speed wireless link (e.g., WiMAX or LTE) may want to have the capability to connect to the Internet through both links. These proxy devices shall receive multicast packets from the different upstream interfaces and forward to the downstream interface(s).

This document describes the mechanism that makes an IGMP/MLD proxy device enable to receive multicast sessions/channels through the different upstream interfaces. The mechanism is configured with either "channel-based upstream selection" or "subscriber-based upstream selection", or both of them. By channel-based upstream selection, an IGMP/MLD proxy device selects one or multiple upstream interface(s) from pre-configured candidate upstream interfaces "per channel/session". By subscriber-based upstream selection, an IGMP/MLD proxy device selects one or multiple upstream interface(s) from pre-configured candidate upstream interfaces "per subscriber/receiver".

When a proxy device transmits an IGMP/MLD report message, it examines the source and multicast addresses in the IGMP/MLD records of the report message. It then transmits the appropriate IGMP/MLD report message(s) from the selected upstream interface(s). When a proxy device selects "one" upstream interface from the candidate upstream interfaces per session/channel, it enables load balancing per session/channel. When a proxy device selects "more than two" upstream interfaces from the candidate upstream interfaces per session/channel, it potentially receives duplicate (redundant) packets for the session/channel from the different upstream interfaces simultaneously and improves the robustness of data reception.

A mechanism for "upstream interface takeover" is also described in this document; when the selected upstream interface is going down or the state of the link attached to the upstream interface is inactive, one of the other active candidate upstream interfaces takes over the upstream interface (if configured). The potential timer values to switch from an inactive upstream interface to an active upstream interface from a list of candidate upstream interfaces are discussed in this document as well.

2. 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 RFC 2119 [1].

In addition, the following terms are used in this document.

Selected upstream interface (or simply, upstream interface):
A proxy device's interface in the direction of the root of the multicast forwarding tree. A proxy device performs the host portion of IGMP/MLD on its upstream interfaces. An upstream interface is selected from a list of candidate upstream interfaces.

Default upstream interface:
A default upstream interface is the upstream interface for multicast sessions/channels for which a proxy device cannot choose other interfaces as the upstream interface. A default upstream interface is manually configured.

Active upstream interface:
An active upstream interface is the upstream interface that has been receiving packets for specific multicast sessions/channels during the pre-defined active interval.

Inactive upstream interface:
An inactive upstream interface is the interface that has not received packets for specific multicast sessions/channels during the pre-defined active interval.

Downstream interface:
Each of a proxy device's interfaces that is not in the direction of the root of the multicast forwarding tree. A proxy device performs the router portion of IGMP/MLD on its downstream interfaces.

Candidate upstream interface:
An interface that potentially becomes an upstream interface of the proxy device. A list of candidate upstream interfaces with supported address prefixes is manually configured on an IGMP/MLD proxy device.

Supported address prefix:
The supported address prefix is the address prefix for which a candidate upstream interface supposes to be an upstream interface for specified multicast sessions/channels. The supported source address prefix and the supported multicast address prefix an IGMP/MLD proxy device can configure.

3. Upstream Selection Mechanism

3.1. Channel-Based Upstream Selection

Channel-based upstream selection enables a proxy device to use one or multiple upstream interface(s) per session/channel from the "candidate upstream interfaces" based on the "supported address prefix" configuration (as will be in Section 5.1).

A proxy device selects a candidate upstream interface having supported source and multicast address prefixes that include both source and multicast address, rather than the other one whose supported source and multicast address prefixes includes either source or multicast address.

When more than one candidate upstream interfaces are configured with the same source and multicast addresses as the supported address prefixes and the interface priority values are identical, these candidate upstream interfaces act as the upstream interfaces for the sessions/channels and receive the packets simultaneously. This multiple upstream interface selection implements duplicate packet reception from redundant paths. It may improve data reception quality or robustness for a session/channel, as the same multicast data packets can come from different upstream interfaces simultaneously. However, this configuration does not guarantee that the packets come from disjoint paths. It only configures that the adjacent upstream routers are different.

3.2. Subscriber-Based Upstream Selection

Subscriber-based upstream selection enables a proxy device to use one or multiple upstream interface(s) per session/channel from the "candidate upstream interfaces" based on the "subscriber address prefix" configuration (as will be in Section 5.1).

It is also possible to configure both supported address prefix (described in Section 3.1) and subscriber address prefix. If both prefixes are configured, the configuration of subscriber address prefix is prioritized.

4. Upstream Interface Takeover

If a selected upstream interface is going down or inactive, or an adjacent upstream router is not working, the upstream interface can be disabled and the other active upstream interface listed in the candidate upstream interfaces covering the same supported address prefix can act as a new upstream interface. It recursively examines the list of the candidate upstream interfaces (except the disabled

interface) and decides a new upstream interface from them. If no active candidate upstream interfaces exist, the default upstream interface takes its role.

This function called "upstream interface takeover" is a default function for a proxy device that enables multiple upstream interface support. If a proxy device simultaneously uses more than two upstream interfaces per session/channel, and one or some of these upstream interface(s) is/are inactive, the proxy device acts either of the following behaviors based on the configuration; (1) it only uses the active upstream interface(s) and does not add (i.e., complement) other upstream interfaces, (2) it uses the active upstream interface(s) and another candidate upstream interface whose priority is highest among the configured upstream interfaces, or (3) it uses the active upstream interface(s) and the default upstream interface.

The condition whether the upstream adjacent router is active or not can be decided by checking the link/interface condition on the proxy device or detected by monitoring IGMP/MLD Query or PIM [6] Hello message reception on the link. There are the cases that PIM is not running on the link or IGMP/MLD Query messages are not transmitted by the upstream router (e.g., because of enabling the explicit tracking function [7]). Therefore, network operators MUST configure either; (1) the proxy device disables the upstream interface takeover, (2) the proxy device triggers upstream interface takeover by detecting no IGMP/MLD Query message within the active interval, or (3) the proxy device triggers upstream interface takeover by detecting no PIM Hello message within the active interval, for each candidate upstream interface.

Network operators may want to keep out of use for the inactive upstream interface(s). This causes, for example, when subscriber-based upstream selection is configured, according to their accounting policy (because the specific subscribers are planned to use the specific upstream interface and cannot receive packets from other upstream interfaces.) In that case, this upstream interface takeover must be disabled, and the proxy device keeps using that interface as the upstream interface for them (and waits for working the interface later again).

5. Candidate Upstream Interface Configuration

Candidate upstream interfaces are the interfaces from which an IGMP/MLD proxy device selects as an upstream interface. The upstream interface selection works with the configurations of "subscriber address prefix and supported address prefix" and "interface priority" value.

5.1. Subscriber Address Prefix and Supported Address Prefix

An IGMP/MLD proxy device can configure the "subscriber address prefix" and "supported address prefix" for each candidate upstream interface. A proxy selects an upstream interface from its candidate upstream interfaces based on the configuration below:

> (subscriber address prefix, source address prefix, multicast address prefix)

If network operators want to select specific upstream interface(s) without depending on subscriber address prefix, subscriber address prefix in this record is "null". If network operators want to assign a specific upstream interface for specific subscribers without depending on source and multicast address prefixes, both source and multicast addresses in this record is "null".

The default values of subscriber address prefix and both source and multicast address prefixes are "null". If the default value is set up on a candidate upstream interface, the decision whether the candidate upstream interface is selected as the upstream interface or not is made by the "interface priority" value described in Section 5.2.

The wildcard multicast address prefix is represented by the entire multicast address range (i.e., '224.0.0.0/4' for IPv4 or 'ff00::/8' for IPv6). The wildcard source address prefix is represented by any host. If the default value is set up on a candidate upstream interface, the decision whether the candidate upstream interface is selected as the upstream interface or not is made by the "interface priority" value.

The same address prefix may be configured on different candidate upstream interfaces. As well as the above-mentioned default configuration, when the same address prefix is configured on different candidate upstream interfaces, an upstream interface for that address prefix is selected based on each interface priority value described in Section 5.2.

For upstream interface selection, source address prefix takes priority over multicast address prefix. This avoids conflict of upstream interface selection. For example, consider the case that an IGMP/MLD proxy device has a configuration with source address prefix S_p for the candidate upstream interface A and multicast address prefix G_p for the candidate upstream interface B. When it deals with an IGMP/MLD record whose source address, let's say S, is in the range of S_p, and whose multicast address, let's say G, is in the range of G_p, the proxy device selects the candidate upstream

interface A, which supports the source address prefix, as the upstream interface, and transmits the (S,G) record via the interface A.

5.2. Interface Priority

An IGMP/MLD proxy device can configure the "interface priority" value for each candidate upstream interface. It is an integer value and manually configured. The default value of the interface priority is the lowest value.

The interface priority value effects only when either of the following conditions is satisfied.

- None of the candidate upstream interfaces configure the supported address prefix.
- Both source and multicast addresses are included in the supported address prefixes for more than one candidate upstream interface.
- Neither source nor multicast address is included in the supported address prefixes for any of the candidate upstream interfaces.
- The supported source address prefix is not configured or does not include the source address, but (on the other hand) the multicast address is included in the supported multicast address prefix for more than one candidate upstream interface.

In these conditions, the candidate upstream interface with the highest priority is chosen as the upstream interface. And as stated in Section 3.1, if the priority values for candidate upstream interfaces are identical, all of these interfaces act as the upstream interfaces for the supported address prefix and may receive duplicate packets.

5.3. Active Interval

Active interval is a period, after which a proxy device recognizes that the selected upstream interface is inactive. Active interval for each candidate upstream interface SHOULD be configured. The active interval values are different in the situation whether the network operators want to trigger by either IGMP/MLD or PIM messages. The default active interval to detect an inactive upstream interface is around twice of IGMP/MLD General Query interval and PIM Hello interval. [TBD]

5.4. Default Upstream Interface

An IGMP/MLD proxy device SHOULD configure "a default upstream interface" for all incoming sessions/channels. A default upstream interface is selected as the upstream interface, when none of the candidate upstream interfaces configure the supported address prefix and interface priority value, or with either of the following conditions.

- Neither source nor multicast address is included in the supported address prefixes for any of the candidate upstream interfaces, and all candidate upstream interfaces' priorities are identical.

- The supported source address prefix is not configured or does not include the source address, and the multicast address is included in the supported multicast address prefix for more than one candidate upstream interface, yet these candidate upstream interfaces' priorities are identical.

If a default upstream interface is not configured on an IGMP/MLD proxy device, the candidate upstream interface whose IPv4/v6 address is the highest of others is configured as the default upstream interface for the proxy device.

6. IANA Considerations

This document has no actions for IANA.

7. Security Considerations

This document neither provides new functions nor modifies the standard functions defined in [2][3][4]; hence there is no additional security consideration provided for these protocols themselves. On the other hand, it may be possible to encounter DoS attacks to make the function for upstream interface takeover stop if attackers illegally sends IGMP/MLD Query or PIM Hello messages on a LAN within a shorter period (i.e., before expiring the active interval for the upstream interface). To bypass such threats, it is recommended to capture the source addresses of IGMP/MLD Query or PIM Hello message senders and check whether the addresses correspond to the correct adjacent upstream routers.

8. References

8.1. Normative References

[1] Bradner, S., "Key words for use in RFCs to indicate requirement levels", RFC 2119, March 1997.

[2] Cain, B., Deering, S., Kouvelas, I., Fenner, B., and A. Thyagarajan, "Internet Group Management Protocol, Version 3", RFC 3376, October 2002.

[3] Vida, R. and L. Costa, "Multicast Listener Discovery Version 2 (MLDv2) for IPv6", RFC 3810, June 2004.

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[5] Fenner, B., He, H., Haberman, B., and H. Sandick, "Internet Group Management Protocol (IGMP) / Multicast Listener Discovery (MLD)-Based Multicast Forwarding ("IGMP/MLD Proxying")", RFC 4605, August 2006.

[6] Fenner, B., Handley, M., Holbrook, H., and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 4601, August 2006.

8.2. Informative References

[7] Asaeda, H., "IGMP/MLD-Based Explicit Membership Tracking Function for Multicast Routers", draft-ietf-pim-explicit-tracking-11 (work-in-progress), March 2015.

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