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Requirements for the extension of the IGMP/MLD proxy functionality to support multiple upstream interfaces
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Abstract

The purpose of this document is to define the requirements for a MLD (for IPv6) or IGMP (for IPv4) proxy with multiple interfaces covering a variety of applicability scenarios.

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1. Introduction

The aim of this document is to define the functionality that an IGMP/MLD proxy with multiple upstream interfaces should have in order to support different scenarios of applicability in both fixed and mobile networks. This compatibility is needed in order to simplify node functionality and to ensure an easier deployment of multicast capabilities in all the use cases described in this document.

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 RFC2119 [RFC2119].

This document uses the terminology defined in RFC4605 [RFC4605]. Specifically, the definition of Upstream and Downstream interfaces, which are reproduced here for completeness.

Upstream interface: A proxy device's interface in the direction of the root of the tree. Also called the "Host interface".

Downstream interface: Each of a proxy device's interfaces that is not in the direction of the root of the tree. Also called the "Router interfaces".

3. Problem statement

The concept of IGMP/MLD proxy with several upstream interfaces has emerged as a way of optimizing (and in some cases enabling) service delivery scenarios where separate multicast service providers are reachable through the same access network infrastructure. Figure 1 presents the conceptual model under consideration.

```
                      downstream        upstream
                      interface       interface A
                           |               |
                           |               |     _______________
                           |   +-------+   v    /               \
                           |   |       O-------( Multicast Set 1 )
             +----------+  v   | IGMP/ |        \_______________/
             | Listener |------|  MLD  |         _______________
             +----------+      | Proxy |        /               \
                               |       O-------( Multicast Set 2 )
                               +-------+   ^    \_______________/
                                           |
                                           |
                                     upstream
                                   interface B
```

Figure 1: Concept of IGMP/MLD proxy with multiple upstream interfaces

The current version of this document is focused on fixed network scenarios. Applicability of IGMP/MLD proxies with multiple upstream interfaces in mobile environments has been previously described in RFC7287 [RFC7287]. Mobile network scenarios will be covered in future versions of this document.

In the case of fixed networks, multicast wholesale services in a competitive residential market require an efficient distribution of multicast traffic from different operators or content providers, i.e. the incumbent operator and a number of alternative providers, on the

network infrastructure of the former. Existing proposals are based on the use of PIM routing from the metro/core network, and multicast traffic aggregation on the same tree. A different approach could be achieved with the use of an IGMP/MLD proxy with multiple upstream interfaces, each of them pointing to a distinct multicast router in the metro/core border which is part of separated multicast trees deep in the network. Figure 2 graphically describes this scenario.

```
                    downstream        upstream
                     interface       interface A
                        |                |
                        |                |     _______________
                        |   +--------+   v    /               \
                        |   |  Aggr. O-------( Multicast Set 1 )
                        |   | Switch |        \_______________/
               +----+   v   |        |     (e.g. from the Incumbent
               | AN |-------| (IGMP  |             Operator)
               +----+       |  /MLD  |         _______________
               (e.g.        | Proxy) |        /               \
               DSLAM        |        O-------( Multicast Set 2 )
               /OLT)        +--------+   ^    \_______________/
                                         | (e.g. from an Alternative
                                         |          Provider)
                                         |
                                      upstream
                                     interface B
```

Figure 2: Example of usage of an IGMP/MLD proxy with multiple upstream interfaces in a fixed network scenario

Since those scenarios can motivate distinct needs in terms of IGMP/MLD proxy functionality, it is necessary to consider a comprehensive approach, looking at the possible scenarios, and establishing a minimum set of requirements which can allow the operation of a versatile IGMP/MLD proxy with multiple upstream interfaces as a common entity to all of them (i.e., no different kinds of proxies depending on the scenario, but a common proxy applicable to all the potential scenarios).

4. Scenarios of applicability

Having multiple upstream interfaces creates a new decision space for delivering the proper multicast content to the subscriber. Basically it is now possible to implement channel-based or subscriber-based upstream selection, according to mechanisms or policies that could be defined for the multicast service provision.

This section describes in detail a number of scenarios of applicability of an IGMP/MLD proxy with multiple upstream interfaces in place. A number of requirements for the IGMP/MLD proxy functionality are identified from those scenarios.

4.1. Fixed network scenarios

Residential broadband users get access to multiple IP services through fixed network infrastructures. End user's equipment is connected to an access node, and the traffic of a number of access nodes is collected in aggregation switches.

For the multicast service, the use of an IGMP/MLD proxy with multiple upstream interfaces in those switches can provide service flexibility in a lightweight and simpler manner if compared with PIM-routing based alternatives.

4.1.1. Multicast wholesale offer for residential services

This scenario has been already introduced in the previous section, and can be seen in Figure 2. There are two different operators, the one operating the fixed network where the end user is connected (e.g., typically an incumbent operator), and the one providing the Internet service to the end user (e.g., an alternative Internet service provider). Both can offer multicast streams that can be subscribed by the end user, independently of which provider contributes with the content.

Note that it is assumed that both providers offer distinct multicast groups. However, more than one subscription to multicast channels of different providers could take place simultaneously.

4.1.1.1. Requirements

- o The IGMP/MLD proxy should be able to deliver multicast control messages sent by the end user to the corresponding provider's multicast router.

- o The IGMP/MLD proxy should be able to deliver multicast control messages sent by each of the providers to the corresponding end user.

4.1.2. Multicast resiliency

In current PIM-based solutions, the resiliency of the multicast distribution relays on the routing capabilities provided by protocols like PIM and VRRP RFC5798 [RFC5798]. A simpler scheme could be achieved by implementing different upstream interfaces on IGMP/MLD

proxies, providing path diversity through the connection to distinct leaves of a given multicast tree.

It is assumed that only one of the upstream interfaces is active in receiving the multicast content, while the other is up and in standby mode for fast switching.

4.1.2.1. Requirements

- o The IGMP/MLD proxy should be able to deliver multicast control messages sent by the end user to the corresponding active upstream interface.

- o The IGMP/MLD proxy should be able to deliver multicast control messages received in the active upstream to the end users, while ignoring the control messages of the standby upstream interface.

- o The IGMP/MLD proxy should be able of rapidly switching from the active to the standby upstream interface in case of network failure, transparently to the end user.

4.1.3. Load balancing for multicast traffic in the metro segment

A single upstream interface in existing IGMP/MLD proxy functionality typically forces the distribution of all the channels on the same path in the last segment of the network. Multiple upstream interfaces could naturally split the demand, alleviating the bandwidth requirements in the metro segment.

4.1.3.1. Requirements

- o The IGMP/MLD proxy should be able to deliver multicast control messages sent by the end user to the corresponding multicast router which provides the channel of interest.

- o The IGMP/MLD proxy should be able to deliver multicast control messages sent by each of the multicast routers to the corresponding end user.

- o The IGMP/MLD proxy should be able to decide which upstream interface is selected for any new channel request according to defined criteria (e.g., load balancing).

4.1.4. Network merging with different multicast services

In some network merging situations, the multicast services provided before in each of the merged networks are maintained for the respective customer base (usually in a temporal fashion until the

multicast service is redifined in a new single offer, but not necessarily, or not in short term, e.g. because of commercial agreements for each of the previous service offers).

In order to assists that network merging situations, IGMP/MLD proxies with multiple upstream interfaces can help in the transition simplifying the service provision and facilitating service continuity.

4.1.4.1. Requirements

- The IGMP/MLD proxy should be able to deliver multicast control messages sent by the end user to the corresponding multicast router which provides the channel of interest, according to the service subscription.

- The IGMP/MLD proxy should be able to deliver multicast control messages sent by each of the multicast routers to the corresponding end user, according to the service subscription.

- The IGMP/MLD proxy should be able to decide which upstream interface is selected for any new channel request according to defined criteria (e.g., service subscription).

4.1.5. Multicast service migration

This scenario considers the situation where a multicast service needs to be migrated from one upstream interface to another upstream interface (e.g. because of changes inside the service providers network). The migration should be "smooth" and without any service interruption. In this case the multicast content is initially offered in both upstream interfaces and the proxy dynamically switches from the first to the second upstream interface, according to certain policies, and enabling to shut down the first upstream interface once the migration is completed.

4.1.5.1. Requirements

- The IGMP/MLD proxy should be able to deliver multicast control messages sent by the end user to the corresponding multicast router before and after the service migration.

- The IGMP/MLD proxy should be able to deliver multicast control messages sent by each of the multicast routers to the corresponding end user, according to the situation of the user with respect the service migration.

o The IGMP/MLD proxy should be able to decide which upstream interface corresponds to each user, according to the situation of the user with respect the service migration.

4.1.6. Summary of the requirements needed for fixed network scenarios

Following the analysis above, a number of different requirements can be identified by the IGMP/MLD proxy to support multiple upstream interfaces in fixed network scenarios. The following table summarizes these requirements.

	Fixed Network Scenarios				
Functionality	Multicast Wholesale	Multicast Resiliency	Load Balancing	Network Merging	Network Migration
Upstream Control Delivery	X	X	X	X	X
Downstr. Control Delivery	X	X	X	X	X
Active / Standby Upstream		X			
Upstr i/f selection per group			X	X	
Upstr i/f selection all group		X			X

Figure 3: Functionality needed on IGMP/MLD proxy with multiple upstream interfaces per application scenario in fixed networks

4.2. Mobile network scenarios

To be done.

5. Security Considerations

All the security considerations in RFC4605 [RFC4605] are directly applicable to this proposal. Apart from that, if proper mechanisms (i.e., implementation practices) are in place for channel-based or subscriber-based upstream interface selection, Denial of Service attacks can be prevented.

6. IANA Considerations

To be completed

7. Acknowledgements

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