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Extension of the MLD proxy functionality to support multiple upstream interfaces
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Abstract

This document presents different scenarios of applicability for an MLD proxy running more than one upstream interface. Since those scenarios impose different requirements on the MLD proxy with multiple upstream interfaces, it is important to ensure that the proxy functionality address all of them for compatibility.

The purpose of this document is to define the requirements in an MLD proxy with multiple interfaces covering a variety of applicability scenarios, and to specify the proxy functionality to satisfy all of them.

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1 Introduction

The aim of this document is to specify the functionality that an MLD proxy with multiple upstream interfaces should have in order to support a set of different scenarios of applicability that have been identified on the MULTIMOB working group. Such functional specification is required to ensure the compatibility of the MLD proxy instances deployed in PMIPv6 domains.

To do that, a set of requirements are firstly identified to satisfy the different scenarios where an MLD proxy instance with multiple upstream interfaces can be potentially applied.

2. Terminology

<To be completed>.

3. Problem statement

The concept of MLD proxy with several upstream interfaces has emerged within the MULTIMOB working group as a way of optimizing (and in some cases enabling) service delivery scenarios in both multicast listener and source mobility cases.

Since those scenarios can motivate distinct needs in terms of 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 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

The use of an MLD proxy supporting multiple upstream interfaces can improve the performance and the scalability of multicast-capable PMIPv6 domains.

4.1 Applicability to multicast listener mobility

Three sub-cases can be identified for the multicast listener mobility.

4.1.1 Single MLD proxy instance on MAG

The base solution for multicast service in PMIPv6 [2] assumes that any MN subscribed to multicast services receive the multicast traffic through the associated LMA, as in the unicast case. As standard MLD proxy functionality only supports one upstream interface, the MAG should implement several separated MLD proxy instances, one per LMA, in order to serve the multicast traffic to the MNs, according to any particular LMA-MN association.

A way of avoiding the multiplicity of MLD proxy instance in a MAG is to deploy a unique MLD proxy instance with multiple upstream interfaces, one per LMA, without any change in the multicast traffic distribution.

4.1.1.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of delivering the multicast control messages sent by the MNs to the associated LMA.

- The MLD proxy should be able of delivering the multicast control messages sent by each of the connected LMAs to the corresponding MN.

- The MLD proxy should be able of routing the multicast data coming from different LMAs to the corresponding MNs according to the MN to LMA association.

- The MLD proxy should be able of maintaining a 1:1 association between an MN and LMA (or downstream to upstream).

4.1.2 Remote and local multicast subscription

Standard MLD proxy definition, with a unique upstream interface per proxy, does not allow the reception of multicast traffic from distinct upstream multicast routers. In other words, all the multicast traffic being sent to the MLD proxy in downstream traverses a concrete, unique router before reaching the MAG. There are, however, situations where different multicast content could reach the MLD proxy through distinct next-hop routers.

For instance, the solution adopted to avoid the tunnel convergence problem in basic multicast PMIPv6 deployments [3] considers the possibility of subscription to a multicast source local to the PMIPv6 domain. In that situation, some multicast content will be accesses remotely, through the home network via the multicast tree mobility anchor, while some other multicast content will reach the proxy

directly, via a local router in the domain.

4.1.2.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of delivering the multicast control messages sent by the MNs to the associated upstream interface based on the location of the source, remote or local, for a certain multicast group.

- The MLD proxy should be able of delivering the multicast control messages sent either local or remotely to the corresponding MNs.

- The MLD proxy should be able of routing the multicast data coming from different upstream interfaces to a certain MN according to the MN subscription, either local or remote. Note that it is assumed that a multicast group can be subscribed either locally or remotely, but not simultaneously. However more than one subscription could happen, being local or remote independently.

- The MLD proxy should be able of maintaining a 1:N association between an MN and the remote and local multicast router (or downstream to upstream).

- The MLD proxy should be able of switching between local or remote subscription for per multicast group according to specific configuration parameters (out of the scope of this document).

4.1.3 Dual subscription to multicast groups during handover

In the event of an MN handover, once an MN moves from a previous MAG (pMAG) to a new MAG (nMAG), the nMAG needs to set up the multicast status for the incoming MN, and subscribe the multicast channels it was receiving before the handover event. The MN will then experience a certain delay until it receives again the subscribed content.

A generic solution is being defined in [4] to speed up the knowledge of the ongoing subscription by the nMAG. However, for the particular case that the underlying radio access technology supports layer-2 triggers (thus requiring extra capabilities on the mobile node), there could be inter-MAG cooperation for handover support if pMAG and nMAG are known in advance.

This could be the case, for instance for those contents not already arriving to the nMAG, where the nMAG temporally subscribes the multicast groups of the ongoing MN's subscription via the pMAG, while the multicast delivery tree among the nMAG and the mobility anchor is

being established.

A similar approach is followed in [5] despite the solution proposed there differs from this approach (i.e., there is no consideration of an MLD proxy with multiple interfaces).

4.1.3.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of delivering the multicast control messages sent by the MNs to the associated upstream interface based on the handover specific moment, for a certain multicast group.

- The MLD proxy should be able of delivering the multicast control messages sent either from pMAG or the multicast anchor to the corresponding MNs, based on the handover specific moment.

- The MLD proxy should be able of handle the incoming packet flows from the two simultaneous upstream interfaces, in order to not duplicate traffic delivered on the point-to-point link to the MN.

- The MLD proxy should be able of maintaining a 1:N association between an MN and both the remote multicast router and the pMAG (or downstream to upstream).

- The MLD proxy should be able of switching between local or remote subscription for all the multicast groups (from pMAG to multicast anchor) according to specific configuration parameters (out of the scope of this document).

4.2 Applicability to multicast source mobility

A couple of sub-cases can be identified for the multicast source mobility.

4.2.1 Support of remote and direct subscription in basic source mobility

In the basic case of source mobility, the multicast source is connected to one of the downstream interfaces of an MLD proxy. According to the standard specification [1] every packet sent by the multicast source will be forwarded towards the root of the multicast tree.

However, linked to the mobility listener problem, there could be the case of simultaneous remote subscribers, subscribing to the multicast

content through the home network, and local subscribers, requesting the contents directly via a multicast router residing on the same PMIPv6 domain where the source is attached to.

Then, in order to provide the co-existence of both types of subscribers, an MLD proxy with two upstream interfaces could simultaneously serve all kind of multicast subscribers.

Basic source mobility is being defined in [6] but the solution proposed there does not allow simultaneous co-existence of remote and local subscribers (i.e., the content sent by the source is either distributed locally to a multicast router in the PMIPv6 domain, or remotely by using the bi-directional tunnel towards the mobility anchor, but not both simultaneously).

4.2.1.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of forwarding (replicating) the multicast content to both upstream interfaces, in case of simultaneous remote and local distribution.

- The MLD proxy should be able of handling control information incoming through any of the two upstream interfaces, providing the expected behavior for each of the multicast trees.

- The MLD proxy should be able of routing the multicast data towards different upstream interfaces for both remote and local subscriptions that could happen simultaneously.

- The MLD proxy should be able of maintaining a 1:N association between an MN and both the remote and local multicast router (or downstream to upstream).

4.2.2 Direct communication between source and listener associated with distinct LMAs but on the same MAG

In a certain PMIPv6 domain can be MNs associated to distinct LMAs using the same MAG to get access to their corresponding home networks. For multicast communication, according to the base solution [2], each MN <-> LMA association implies a distinct MLD proxy instance to be invoked in the MAG.

In these conditions, when a mobile source is serving multicast content to a mobile listener, both attached to the same MAG but each of them associated to different LMAs, the multicast flow must

traverse the PMIPv6 domain from the MAG to the LMA where the source maintains an association, then from that LMA to the LMA where the listener is associated to, and finally come back to the same MAG from where the flow departed. This routing is extremely inefficient.

An MLD proxy with multiple upstream interfaces avoids this behavior since it allows to invoke a unique MLD proxy instance in the MAG. In this case, the multicast source can directly communicate with the multicast listener, without need for delivering the multicast traffic to the LMAs.

4.2.3.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of forwarding (replicating) the multicast content to different upstream or downstream interfaces where subscribers are present.

- The MLD proxy should be able of handling control information incoming through any of the upstream or downstream interfaces requesting a multicast flow being injected in another downstream interface.

- The MLD proxy should be able of maintaining a 1:N association between an MN and any of the upstream or downstream interfaces demanding the multicast content.

4.2.3 Route optimization support in source mobility for remote subscribers

Even in a scenario of remote subscription, there could be the case where both the source and the listener are attached to the same PMIPv6-Domain (for instance, no possibility of direct routing within the PMIPv6, or source and listener pertaining to distinct home networks). In this situation there is a possibility of route optimization if inter-MAG communication is enabled, in such a way that the listeners in the PMIPv6 domain are served through the tunnels between MAGs, while the rest of remote listeners are served through the mobility anchor.

A multi-upstream MLD proxy would allow the simultaneous delivery of traffic to such kind of remote listeners.

A similar route optimization approach is proposed in [7].

4.2.3.1 Requirements

These are the requirements identified so far:

- The MLD proxy should be able of forwarding (replicating) the multicast content to both kinds of upstream interfaces, inter-MAG tunnel interfaces and MAG to mobility anchor tunnel interface.

- The MLD proxy should be able of handling control information incoming through any of the two types of upstream interfaces, providing the expected behavior for each of the multicast trees (e.g., no forwarding traffic on one inter-MAG link once there are not more listeners requesting the content).

- The MLD proxy should be able of routing the multicast data towards different upstream interfaces for both remote and route optimized subscriptions that could happen simultaneously.

- The MLD proxy should be able of maintaining a 1:N association between an MN and both the remote and local MAGs (or downstream to upstream).

4.3 Summary of the requirements needed

After the previous analysis, a number of different requirements can be identified by the MLD proxy to support multiple upstream interfaces. The following table summarizes these requirements.

	Scenarios						
	Mulicast Listener			Mulicast Source			
Functionality	Single MLD Proxy (4.1.1)	Remote & local subscr. (4.1.2)	Dual subscr. in HO (4.1.3)	Direct & remote subscr. (4.2.1)	Listener & source on MAG (4.2.2)	Route optimi. (4.2.3)	
Upstream Control Delivery	X	X	X	X	X	X	
Downstr. Control Delivery	X	X	X		X		
Upstream Data Delivery				X		X	
Downstr. Data Delivery	X	X	X		X		
1:1 MN to upstream assoc.	X						
1:N MN to upstream assoc.		X	X	X	X	X	
Upstr i/f selection per group		X					
Upstr i/f selection all group			X				
Upstream traffic replicat.				X		X	

Table I. Functionality needed on MLD proxy with multiple upstream interfaces per application scenario

5 Functional specification of an MLD proxy with multiple interfaces

<To be completed>.

6 Security Considerations

<To be completed>.

7 IANA Considerations

<IANA considerations text>.

8 Conclusions

Through this document several scenarios of applicability of an MLD proxy with multiple upstream interfaces have been presented.

<To be completed>.

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10 References

10.1 Normative References

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