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Abstract

The document proposes an extension to FMIPv6 to enable fast multicast handover. The mobile node in the foreign link being visited uses its care-of address (CoA) to join multicast groups via a local multicast router. During handover, PAR sends MN’s MLD state to NAR which helps NAR establish the multicast delivery trees in advance. PAR also tunnels all multicast traffic to NAR which buffers them to be delivered after the handover is completed.

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1. Introduction

Fast Mobile IPv6 (FMIPv6) [FMIPv6] extends Mobile IPv6 for reducing handover delays. However, FMIPv6 does not have any provisions for multicast communication. Mobile nodes are more and more involved in multicast communication due to recent developments such as mobile IPTV.

[MULTICASTPS] specifies the problem scope for a multicast mobility management. The attempt is made to subdivide the various challenges according to their originating aspects and to present existing proposals for solution. There are two general multicast mobility problems, that is, Multicast Source Mobility and Multicast Listener Mobility. This draft only deals with the latter.


The mobility support for IPv6 protocol [MIP] has specified two basic methods for mobile multicast:

1. via a bi-directional tunnel from a MN to its Home Agent. The MN uses its home address to send MLD (Multicast Listener Discovery) messages. The MLD messages are tunneled to its Home Agent.

2. via a local multicast router on the foreign link being visited. The MN MUST use its care-of address when sending MLD packets

[MDMA] addresses the problems of the above two methods when delivering IPv6 multicast traffic to MNs. An approach named Mobile IPv6 Multicast with Dynamic Multicast Agent is proposed.

This draft proposes an elaborate way only for the latter method, that is, using CoA to convey multicast control information. This scenario can be deployed in mobile IPTV.

In handover preparation, a previous access router informs a new access router to build related multicast deliver trees; during handover, the NAR buffers multicast traffic; after handover, the NAR sends the buffered traffic as soon as possible. These benefits can be achieved through extension of Fast Handover for Mobile IPv6 [FMIPv6]

The document continues in Section 2 to define the terminology used and then Section 3 defines the protocol operation, Section 4 introduces a new option, Section 5 discusses the security considerations. Finally, Section 6 concludes the 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 BCP 14 [STANDARDS].


DAD: Duplicate Address Detection.


Access Router (AR): The MN’s default router.

Previous Access Router (PAR): The MN’s default router prior to its handover.

New Access Router (NAR): The MN’s default router subsequent to its handover.

Previous CoA (PCoA): The MN’s Care of Address valid on PAR’s subnet.

New CoA (NCoA): The MN’s Care of Address valid on NAR’s subnet.

Router Solicitation for Proxy Advertisement (RtSolPr): A message from the MN to the PAR requesting information for a potential handover.

Proxy Router Advertisement (PrRtAdv): A message from the PAR to the MN that provides information about neighboring links facilitating expedited movement detection. The message also acts as a trigger for network-initiated handover.

Fast Binding Update (FBU): A message from the MN instructing its PAR to redirect its traffic (toward NAR).

Fast Binding Acknowledgment (FBack): A message from the PAR in response to an FBU.

Fast Neighbor Advertisement (FNA): A message from the MN to the NAR to announce attachment, and to confirm the use of NCoA when the MN has not received an FBACK.

Handover Initiate (HI): A message from the PAR to the NAR regarding an MN’s handover.

Handover Acknowledge (HAck): A message from the NAR to the PAR as a response to HI.
3. Operation of Multicast Fast Handover

In Multicast Fast Handover (MFH), the mobile node joins multicast groups such as IPTV sessions using its care-of address (CoA). MLD state consisting of the multicast group address and addresses of each sender resulting from MN’s multicast communication is kept in AR.

MFH extends FMIPv6 signalling as follows:

1. PAR sends MLD state to NAR during handover.
2. PAR tunnels all multicast packets to NAR.
3. NAR after receiving MLD state, establishes multicast delivery tree during handover.

We explain MFH operation for the predictive and reactive fast handover modes of FMIPv6.

3.1. Predictive Fast Handover

```
\begin{figure}[h]
\centering
\begin{tabular}{ccc}
\hline
MN & PAR & NAR \\
\hline
------RtSolPr------ & & \\
<------PrRtAdv------ & & \\
------FBU---------- & ------HI-------- & \\
|                    | <------HAck-------- & \\
|                    | <--FBack---|--FBack---> & \\
| disconnect         & forward & packets=============
|                   & | >
| connect            & & \\
|                   & | \\
| | | \\
| | | |--FNA -------------------------->
| | | <=================================== deliver packets
| | | |
\end{tabular}
\caption{Predictive Fast Handover}
\end{figure}
```

Figure 1 is characterized as "predictive" mode of operation in which the MN receives an FBack on the previous link.

1. With interaction of RtSolPr and PrRtAdv, the MN formulates a prospective NCoA and learns some information about the NAR.
2. The purpose of the FBU is to authorize PAR to bind PCoA to NCoA, so that arriving packets can be tunneled to the new location of MN. Upon receiving FBU, PAR sends HI message. PAR MUST include a new option called Multicast Group Information Option in HI message. The option which is defined in Section 4.1 consists of the multicast groups MN is a member of and other related information needed in [MLDv2].

3. HI with Multicast Group Information Option (MGIO) triggers the NAR:

1. to inspect MGIO. If NAR already has the state for the multicast group, no action is required.

2. to construct new multicast delivery trees for any new multicast group. For example, in PIM-SM [PIM-SM], On receiving the MN’s expression of interest, the AR then sends a PIM Join message towards a router which is the root of the non-source-specific distribution tree for a multicast group. The Join message travels hop-by-hop towards the root router for the group, and in each router it passes through, multicast tree state for the group is instantiated.

4. When HAck message is received, the PAR MUST deliver all the traffic to the NAR for buffering through an established tunnel, unicast and multicast traffic.

5. Once FNA is received, the NAR delivers all the buffered packets to the MN.

6. On finishing IPv6 network attachment on a NAR, the MN initiates multicast signaling procedure using its new CoA. At the same time, the MN receives buffered multicast traffic from the NAR and tunneled traffic from the PAR. When multicast delivery trees are constructed, the PAR stops delivering multicast traffic to MN while the NAR delivers multicast traffic directly.
3.2. Reactive Fast Handover

<table>
<thead>
<tr>
<th>MN</th>
<th>PAR</th>
<th>NAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>disconn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>connect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PrRtAdv</td>
<td></td>
<td></td>
</tr>
<tr>
<td>connect</td>
<td>FNA[FBU]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FBU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FBack</td>
<td></td>
</tr>
<tr>
<td></td>
<td>forward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>packets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>deliver packets</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Reactive Fast Handover

Figure 2 is characterized as "reactive" mode of operation. In this mode, the MN does not receive the FBack on the previous link. PAR MUST include Multicast Group Information Option in FBU which is encapsulated in FNA. Once receiving FBU, the PAR establishes a tunnel to MN and delivers related multicast traffic to the MN. At the same time, the MN initiates multicast signaling with NCoA in the visited network. Once the NAR has constructed related multicast delivery trees the NAR delivers multicast traffic directly.

3.3. Handover Latency Analysis

When an MN moves from one AR to another AR, the overall multicast handover consists of link layer (L2) delays, network layer (L3) attachment delays, and multicast signaling delays:

\[ \text{HO time} = \text{L2 delay} + \text{L3 network attachment delays} + \text{multicast signaling delays}. \]

FMIPv6 reduces HO time especially in predictive mode. L2 delay is unavoidable, while buffering related multicast traffic in an NAR can reduce the affect of a handover delay. IPv6 network attachment commonly includes activities such as default router discovery, CoA configuration and its DAD. Through RtSolPr and PrRtAdv interactions, an MN can finish the network attachment before link layer handover. Multicast signaling consists of joining multicast groups and constructing multicast delivery trees. Through tunnel between a PAR.
and a NAR, older delivery trees can be used before new delivery trees are constructed.
4. New Options

This draft introduces one new option.

4.1. Multicast Group Information Option

One or more Multicast Group Information Options can be included in the message FBU and HI.

```
+-----------------------------------------------+
<table>
<thead>
<tr>
<th>Type</th>
<th>Length</th>
<th>Record Type</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
+-----------------------------------------------+
|                                                               | +                          |
|                                                               |   Multicast Address       |
+                                                               +                          |
|                                                               +                          |
+                                                               +                          |
+                                                               +                          |
|                                                               +                          |
|                                                               +                          |
+                                                               +                          |
|                                                               +                          |
+                                                               +                          |
|                                                               +                          |
+-----------------------------------------------+
|                                                               | Source Address [1]         |
+                                                               +                          |
|                                                               +                          |
+                                                               +                          |
|                                                               | Source Address [N]         |
+                                                               +                          |
+                                                               +                          |
+-----------------------------------------------+
```

Figure 3: Multicast Group Information Option

Type: TBD

Length: The size of this option in 8 octets. The option is variable

Reserved: MUST be set to zero

Record Type: refer to section 5.2.5 in [MLDv2].

Multicast Address: the multicast group address
Source Address: a vector of N unicast addresses of the senders of this multicast group.
5. Security Considerations

This memo is based on FMIPv6, and no additional messages are defined. No additional threats are introduced. For a more analysis, see related section. [FMIPv6]
6. Conclusions

We presented a simple extension to FMIPv6 to transfer multicast state of a mobile node from the previous access router to the new access router during handover. We also defined a new option to be used in FMIPv6 messages.
7. References

7.1. Normative References


7.2. Informative References


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