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Distributed Mobility Management Approaches with IPv6 Prefix Properties
draft-luo-dmm-ipv6-prefix-properties-00

Abstract

This document proposes a potential distributed mobility management solution by taking advantage of the feature with IPv6 Prefix Mobility Management. Solutions for extending properties to IPv6 prefixes are introduced by defining an extension to the IPv6 Neighbor Discovery protocol and its Prefix Information Option (PIO). In the case of Distributed Mobility Management, this idea can also be leveraged to describe the mobility management properties associated to the IPv6 prefix.

Requirements Language

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 [RFC2119].

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1. Introduction

Centralized mobility anchoring imposes some limitations to the system such as single point of failure, non optimal routing and etc. which are discussed in [I-D.ietf-dmm-requirements] [I-D.liu-mext-distributed-mobile-ip]. Given the exponential grow of smart-phone devices (e.g. iPhone) with mobile service applications, and the uprising social media trend driving the peer-to-peer communications, centralized mobility anchoring magnifies these issues and is no long a good fit to handle the new traffic pattern that is happening in the internet and in private networks. The design intent of Distributed Mobility Management is to mitigate those drawbacks, various solutions are introduced in current DMM working group.

Solutions for extending properties to IPv6 prefixes are introduced in[I-D.korhonen-6man-prefix-properties] by defining an extension to the IPv6 Neighbor Discovery protocol and its Prefix Information Option (PIO). For a specific use case, this idea can also be leveraged to describe the mobility management properties associated

to the IPv6 prefix. This document proposes a potential distributed mobility management solution by taking advantage of the feature with IPv6 Prefix Mobility Management.

2. Solution Overview

The proposed solution in this draft introduces two new logic functions for the distributed mobility management which is quite similar with [I-D.luo-dmm-pmip-based-dmm-approach] :

1. Location Management Function (LMF), maintaining the mappings between IP addresses and location of terminals

2. Distributed Anchoring Function (DAF), which is composed of Distributed Routing sub-Function (DRF) and Distributed Mobility sub-Function (DMF). The DRF operates as the distributed tunnel end-point at the first hop router of the mobile node or the corresponding node to support the optimized routing between two end-points, whereas the DMF supports the mobile node's mobility handover operation with minimal packet loss during the optimized route establishment

The distributed anchor is referred as enhanced LMA (eLAM) which is a RFC[5213] specified LMA integrated with the DAF function and is supposed to be the mobile node's first router as described in [I-D.luo-dmm-pmip-based-dmm-approach] section 7.

The[I-D.korhonen-6man-prefix-properties] specifies a mechanism for delivering property of IPv6 prefixes to terminal nodes (i.e. the 'C' flag in Prefix Information Option). As one specific use case, the mechanism can be re-used for delivering mobility management property of IPv6 prefix by the distributed anchor to mobile node for distributed mobility management.

When distributed anchor detects an initial attachment of a mobile node, it will send a RA message to that mobile node. The RA includes IPv6 prefixes, and each prefix is tagged with its properties which includes its mobility management property. According to the mobility management property, the IPv6 prefix can be distinguished by the mobile node into two categories, i.e. global prefix vs. local prefix defined as following:

- Global Prefix: if an IPv6 address derived from a global prefix is used as source address for a session, this session will be provided with fully mobility support by using the mobility management mechanism specified in this draft. That means, the address always remains valid even the point of attachment is changed.

o Local Prefix: if an IPv6 address derived from a local prefix is used as source address for a session, no or limited mobility support will be provided for this session. The address may not be valid when the point of attachment is changed.

Based on the acquired mobility management property, mobile node can distinguish the two categories. If application on mobile requires mobility support, the mobile will derive an IPv6 address from the global prefix by having the application to invoke an appropriate socket API extension. Otherwise, the application on the mobile that requires no or limited mobility support will derive IPv6 address from local prefix by invoking another appropriate socket API extension.

The network doesn't provide mobility for those local IPv6 prefixes, which means IPv6 address which is derived from local prefixes is treated as a plain IPv6 address and generic IPv6 routing mechanism is applied. When mobile node changes its point of attachment, e.g. from previous distributed anchor to next distributed anchor, the local prefix assigned by previous distributed anchor will be deprecated\invalidated, and the applications which are based on those prefixes will suffer an IPv6 addresses change. When attaching to next distributed anchor, the mobile node can be advertised with new local prefix by the next distributed anchor.

Mechanisms used for maintaining mobility for those global IPv6 prefixes are quite similar with the mechanisms specified in [I-D.luo-dmm-pmip-based-dmm-approach] which mainly includes three aspects as following:

a. Initial Attachment: as described above, during the initial attachment, the distributed anchor sends RA message with one or more local and global prefixes which can be distinguished by the mobile node according to their mobility management property. Distributed anchor only updates the location information to the LMF for those global prefixes. Section 3.1 provides more detailed description.

b. Data Forwarding: if the application on the mobile node requires mobility support (such as VOIP), it will ask an IPv6 address which is derived from a global prefix and establish a session based on this global address as its source address with its correspondent node. When distributed anchor of the correspondent node receives traffic send to that global address, it will query the LMF for the location information of that global address and forward the traffic based on the location information (e.g. IP in IP tunnel). Section 3.2 provides more detailed description.

c. Handoff: when mobile node changes its point of attachment from previous distributed anchor to next distributed anchor, the next distributed anchor will advertise the same global prefix to the mobile node on the new link and update new location information for that global prefix to the LMF for the purpose of maintaining the reachability of mobile node's global prefix. Section 3.3 provides more detailed description.

3. Detailed Scenarios and Approaches

As described above, the distributed anchor in this draft is referred as eLMA as shown in figures below. Note that, although the MAG as defined in RFC[5213] is not shown in the figures below, one should aware that, the MAG could be co-located with the eLMA.

3.1. Initial Attachment

```
   Internet
      |           +-----+
      |           | LMF |
Border Router     +-----+
      |
      +-----------------+---------
                        |
                    +---+---+
                    | eLMA1 |
                    | (DAF) |
                    +--+----+
         Global Prefix |  |Local Prefix
             (PreB)    |  |  (PreA)
                       V  V
                      +----+
                      | MN |
                      +----+
      IP1: From PreA (Local, without mobility)
      IP2: From PreB (Global, with mobility)
```

Figure 1. Initial Attach

When eLMA1 detects an initial attachment of a mobile node, it sends a RA message to that mobile. The RA includes two categories of prefixes, local prefix (PreA) and global prefix (PreB). The eLMA should set PreA (i.e. local prefix) with high priority and PreB (i.e. global prefix) with low priority as according to [I-D.korhonen-6man-prefix-properties].

The mobile node will derive its IPv6 addresses based on these two categories of IPv6 prefixes provided by the RA message. The derived IPv6 addresses include local IPv6 address (IP1 in figure 1) and global IPv6 address (IP2 in figure 1). Applications on the mobile node could select an appropriate IPv6 address as its source address as described in section 4 in [I-D.korhonen-6man-prefix-properties].

Furthermore, the eLMA1 needs to perform the location update for the MN based on the MN's global prefix-to-location mapping info, i.e. {MN's global prefix, eLMA's IPv6 address}, for this particular mobile node to the LMF based on the mechanism introduced in section 7.2 of[I-D.luo-dmm-pmip-based-dmm-approach]. Note that, the distributed anchor performs the location update only for the MN's global prefix.

3.2. Data forwarding

```
                                IP1 as destination:
                                common routing
                          |             +--------+       +----+
                          |             | eLMA3 |_______| CN |
       +-----+            +-------------+ (DAF) |       +----+
       | LMF |            |             +--------+
       +-----+            |     IP2 as destination:
                          |     Routing based on location
       -------------+-----+     (e.g. IP in IP tunnel)
                    |
                 +---+---+
                 | eLMA1 |
                 | (DAF) |
                 +--+----+
      Global Prefix |  |Local Prefix
          (PreB)    |  |  (PreA)
                    V  V
                   +----+
                   | MN |
                   +----+
   IP1: From PreA (Local, without mobility)
   IP2: From PreB (Global, with mobility)
```

Figure 2.1 Data forwarding mechanism

When correspondent node (CN) sends traffic to the mobile node, the traffic arrives at CN's distributed anchor first (i.e. eLMA3 in figure 2.1). Depending on the category of the destination IPv6 address, eLMA3 should operate accordingly:

a. If the destination IPv6 address with local IPv6 prefix (IP1 in figure 2.1), eLMA3 will route the IP packet by using the generic IPv6 routing mechanism.

b. Otherwise, if the destination IPv6 address with global IPv6 prefix (IP2 in figure 2.1), then eLMA3 will route this IP packet using routing mechanism as specified in section 7.2 of [I-D.luo-dmm-pmip-based-dmm-approach].

```
                +-------+               +-----+
                | eLMA3 |<--------------+ CN |
                | (DAF) |               +-----+
                +-------+   Destination IP (IP2)is
   Tunneled        ||       global IPv6 address
   forwarding      ||       configured on MN
   based on MN's   ||
   location        ||
                   VV
                +-------+               +-----+
                | eLMA1 +-------------->| MN |
                | (DAF) |               +-----+
                +-------+
```

Figure 2.2 traffic between CN and MN, when destination is global IPv6 address of MN, routing is optimized.

As shown in figure 2.2, if the traffic from CN is sent to the mobile node's global IPv6 address (i.e. IP2), the routing will be: CN-->eLMA3==>eLMA1-->MN which is based on optimized route.

Note that, the tunnel between eLMA1 and eLMA3 is not per MN-CN pair, rather, it is a single tunnel between two distributed anchor peers. Any traffic between the MNs which are attached to these two peers will be routed over the same tunnel of which the tunnel is over an optimal routing path between the peers.

3.3. Handoff Scenario

```
                                              IP1 as destination:
                                              can not be reachable
                                              after handoff
        Internet                              IP3 as destination:
            |                                 common routing
            |                                     +-------+       +-----+
            |                              |      | eLMA3 |_______| CN |
            |          +-----+             +------+ (DAF) |       +-----+
      Border Router    | LMF |             |      +-------+
```

```
         |          +-----+             |  IP2 as destination:
         |                              |  Routing based on location
         +-----+---------------------+--+
               |                     |
           +---+---+             +---+---+
           | eLMA2 |             | eLMA1 |
           | (DAF) |             | (DAF) |
           +-------+             +--+----+
   Local Prefix |  |   Global Prefix   |  |Local Prefix
     (PreC)     |  |       (PreB)      |  |  (PreA)
               V  V                   V  V
              +----+                +----+
              | MN |   <------------ | MN |
              +----+                +----+
    IP3: From PreC               IP1: From PreA
    (Local, without mobility)    (Local, without mobility)
    IP2:Keep unchanged           IP2: From PreB
    (Global, with mobility)      (Global, with mobility)
```

Figure 3.1 Handover Scenario.

The handover between distributed anchors happens when the mobile node switches to a new distributed anchor, i.e. switching its anchor from eLMA1 to eLMA2 as shown in figure 3.1. Once eLMA2 detects the attachment from the MN, it will send a RA which includes local prefix(es) and global prefix(es) to the mobile node and the handover operation is described as follows:

a. MN's local prefix assigned by the previous distributed anchor (PreA in figure 3.1) will be deprecated\invalidated. In this case, the traffic which is sent to IP1 (configured from PreA) from CN will be discarded by the IPv6 routing system automatically; unless, a temporary tunnel between the previous and the next distributed anchors is setup to maintain the reachability to the previous local prefix. Applications which rely on those local prefixes may suffer a change of source IP address.

b. New local prefix(es) (i.e. PreC in figure 3.1) carried in the RA message and is assigned by eLMA2 is now have high priority. The MN will derive a new IPv6 local address (IP3 in figure 3.1) for the PreC.

c. The global prefix(es) (i.e.PreB in figure 3.1) in the RA message remain the same global prefix(es) as assigned by eLMA1 which is the distributed anchor of this MN during its initial attachment. The eLMA2 shall perform the location update for the global

prefixes of this MN based on the IPv6 address of eLMA2 to LMF to maintain the reachability of those global prefix(es). The details for the handover can be reviewed in section 7.2 of [I-D.luo-dmm-pmip-based-dmm-approach].

Thus, after the handover, the mobile node can be reached either via its new local IPv6 address (i.e. IP3) or via its global IPv6 address (i.e. IP2); and if a temporary tunnel is present between eLMA1 and eLMA2, also be researchable via its previous local IPv6 address (i.e.IP1).

It is the network policy to decide to maintain the reachability to the previous local prefix via a temporary tunnel between the previous distributed anchor and the next distributed anchor as described in section 4.4.2 of Korhonen-draft[I-D.korhonen-6man-prefix-properties] (Note that the distributed anchor refers to MAG in Korhonen-draft and eLMA in this draft). Never-the-less, the purpose for such temporary tunnel to support service continuity when employing the local prefix is similar to the tunnel used by the global prefix for the mobility management purpose.

```
             +-------+               +----+
             | eLMA3 |<--------------+ CN |
             | (DAF) |               +----+
             +-------+   Destination IP (IP2) is
Tunneled        ||       global IPv6 address
forwarding      ||       configured on MN
based on MN's   ||
new location    ||
                VV
             +-------+               +----+
             | eLMA2 +-------------->| MN |
             | (DAF) |               +----+
             +-------+
(New Distributed anchor after handoff)
```

Figure 3.2 traffic between CN and MN after the handover, when destination is global IPv6 address of MN, routing is also optimized..

As shown in figure 3.2, if the traffic from CN is sent to the mobile node's global IPv6 address (i.e. IP2) after the handover, the routing will be: CN-->eLMA3==>eLMA2-->MN. The routing is still optimized.

4. IANA Considerations

This document makes no request of IANA.

5. References

5.1. Normative References

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5.2. Informative References

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