Internet Engineering Task Force (IETF)
Request for Comments: 8191
Category: Standards Track
ISSN: 2070-1721

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August 2017

Home Network Prefix Renumbering in Proxy Mobile IPv6 (PMIPv6)

Abstract

In the basic Proxy Mobile IPv6 (PMIPv6) specification, a Mobile Node (MN) is assigned with a Home Network Prefix (HNP) during its initial attachment, and the MN configures its Home Address (HoA) with the HNP. During the movement of the MN, the HNP remains unchanged to keep ongoing communications associated with the HoA. However, the current PMIPv6 specification does not specify related operations when HNP renumbering has occurred (e.g., due to change of service provider or site topology, etc.). In this document, a solution to support HNP renumbering is proposed, as an optional extension of the PMIPv6 specification.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

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1. Introduction

At the time of writing, network managers prefer Provider-Independent (PI) addressing for IPv6 to attempt to minimize the need for future possible renumbering. However, a widespread use of PI addresses will cause Border Gateway Protocol (BGP) scaling problems [RFC7010]. It is thus desirable to develop tools and practices that make IPv6 renumbering a simpler process to reduce demand for IPv6 PI space [RFC6879]. In this document, we aim to support HNP renumbering when the HNP in PMIPv6 [RFC5213] is not a PI prefix.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Usage Scenarios

There are a number of reasons why HNP renumbering support in PMIPv6 is useful, and some scenarios are identified below:

Scenario 1: the HNP set used by a PMIPv6 service provider is assigned by a different Internet Service Provider (ISP), and then HNP renumbering MAY occur if the PMIPv6 service provider switches to a different ISP.

Scenario 2: multiple Local Mobility Anchors (LMAs) MAY be deployed by the same PMIPv6 service provider, and then each LMA MAY serve for a specific HNP set. In this case, the HNP of an MN MAY change if the serving LMA is changed to another LMA that does not inherit the assigned HNP set [RFC6463].

Scenario 3: PMIPv6 HNP renumbering MAY be caused by the rebuilding of the network architecture as the companies split, merge, grow, relocate, or reorganize. For example, the PMIPv6 service provider MAY reorganize its network topology.

In Scenario 1, we assume that only the HNP is renumbered, while the serving LMA remains unchanged; this is the basic scenario considered in this document. In Scenarios 2 and 3, more complex situations MAY result; for example, HNP renumbering MAY occur due to the switchover of a serving LMA.

In the Mobile IPv6 (MIPv6) protocol, when an HNP changes, the Home Agent (HA) will actively notify its MN about the new prefix, and then the renumbering of the Home Network Address (HoA) can be well supported [RFC6275]. In basic PMIPv6, the PMIPv6 binding is triggered by a Mobile Access Gateway (MAG), which detects the attachment of the MN. A scheme is also needed for the LMA to immediately initiate the PMIPv6 binding state refreshment during the HNP renumbering process. Although this issue is also mentioned in Section 6.12 of [RFC5213], the related solution has not been specified.

3. HNP Renumbering Procedure

When HNP renumbering happens in PMIPv6, the LMA MUST notify the MAG about the new HNP, and then the MAG MUST announce the new HNP to the attached MN accordingly. Also, the LMA and the MAG MUST update the routing states for the HNP and the related addresses. To support this procedure, [RFC7077] can be adopted; it specifies an asynchronous update from the LMA to the MAG about specific session parameters. This document considers the following two cases:

(1) HNP is renumbered under the same LMA

In this case, the LMA remains unchanged as in Scenarios 1 and 3. The steps are shown in Figure 1.

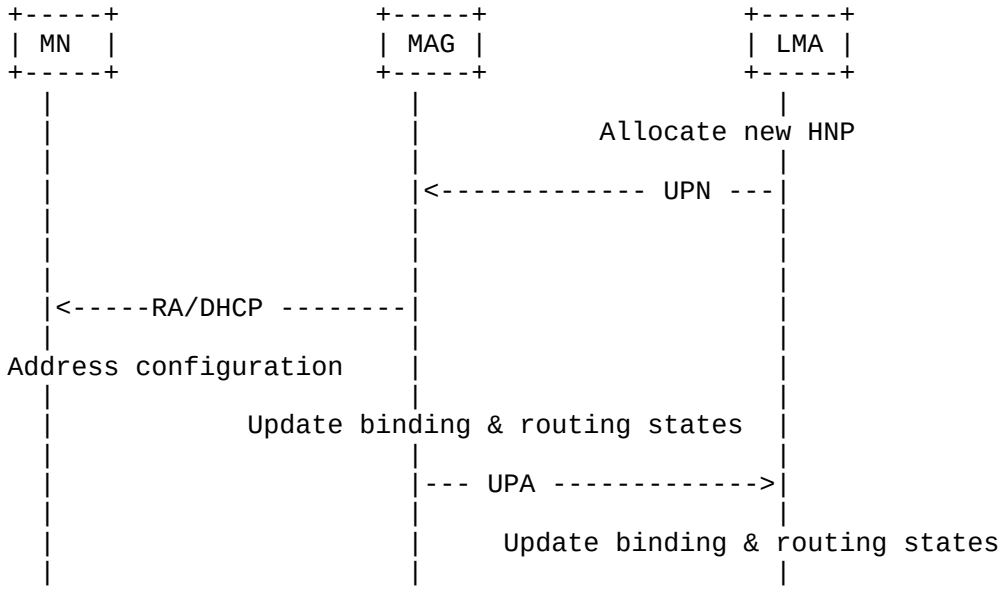

Figure 1: Signaling Call Flow for HNP Renumbering

- When a PMIPv6 service provider renumbers the HNP set under the same LMA, the serving LMA SHOULD initiate the HNP renumbering operation. The LMA allocates a new HNP for the related MN.

- The LMA sends the Update Notification (UPN) message to the MAG to update the HNP information. If the Dynamic Host Configuration Protocol (DHCP) is used to allocate the address, the DHCP infrastructure MUST also be notified about the new HNP.

- Once the MAG receives this UPN message, it recognizes that the related MN has the new HNP. Then, the MAG MUST notify the MN about the new HNP with a Router Advertisement (RA) message or allocate a new address within the new HNP through a DHCP procedure.

- After the MN obtains the HNP information through the RA message, it deletes the old HoA and configures a new HoA with the newly allocated HNP.

- When the new HNP is announced or the new address is configured to the MN successfully, the MAG MUST update the related binding and routing states. Then, the MAG sends back the Update Notification Acknowledgement (UPA) message to the LMA for the notification of successful update of the HNP, related binding state, and routing state. Then, the LMA updates the routing and binding information corresponding to the MN in order to replace the old HNP with the new one.

(2) HNP renumbering is caused by the LMA switchover

Since the HNP is assigned by the LMA, HNP renumbering MAY be caused by the LMA switchover, as in Scenarios 2 and 3.

The LMA information is the basic configuration information of the MAG. When the LMA changes, the related profile SHOULD be updated by the service provider. In this way, the MAG initiates the binding registration to the MN’s new LMA as specified in [RFC5213]. When HNP renumbering is caused in this case, the new HNP information is sent by the LMA during the new binding procedure. Accordingly, the MAG withdraws the old HNP of the MN and announces the new HNP to the MN, similar to the case when the HNP is renumbered under the same LMA.

4. Session Connectivity

HNP renumbering MAY cause the disconnection of the ongoing communications of the MN. Basically, there are two modes to manage the session connectivity during HNP renumbering.

(1) Soft mode

The LMA will temporarily maintain the state of the old HNP during the HNP renumbering (after the UPA reception) in order to redirect the packets to the MN before the MN reconnects the ongoing session and notifies the Correspondent Node (CN) about its new HoA. This mode is aiming to reduce packet loss during HNP renumbering, but the binding state corresponding to the old HNP SHOULD be marked, for example, as transient binding [RFC6058]. Also, the LMA MUST stop broadcasting the routing information about the old HNP if the old HNP is no longer anchored at this LMA.

(2) Hard mode

If HNP renumbering happens with the switchover of the LMA, hard mode is RECOMMENDED to keep the protocol simple. In this mode, the LMA deletes the binding state of the old HNP after it receives the UPA message from the MAG, and the LMA silently discards the packets destined to the old HNP.

5. Message Format

(1) UPN message

In the UPN message sent from the LMA to the MAG, the notification reason is set to 2 (UPDATE-SESSION-PARAMETERS). Besides, the HNP Option [RFC5213] containing the new HNP and the Mobile Node Identifier Option [RFC4283] (which identifies the MN) are contained as Mobility Options of UPN. The order of the HNP Option and Mobile Node Identifier Option in the UPN message is not mandated here.

(2) UPA message

The MAG sends this message in order to acknowledge that it has received an UPN message with the (A) flag set and to indicate the status after processing the message. If the MAG did not successfully renumber the HNP, which is required in the UPN message, the UPA message has the Status Code set to 128 (FAILED-TO-UPDATE-SESSION-PARAMETERS), and the subsequent operation of the LMA is PMIPv6 service provider specific.

(3) RA message

When the RA message is used by the MAG to advise the new HNP, it contains two Prefix Information Options [RFC4861] [RFC4862]. In the first Prefix Information Option, the old HNP is carried, and the related Preferred Lifetime is set to 0. In the second Prefix Information Option, the new HNP is carried with the Valid Lifetime, and Preferred Lifetime set to larger than 0.

(4) DHCP message

When the DHCP is used in PMIPv6 to configure the addresses for the MN, new IPv6 address or addresses (e.g., the HoA) will be generated based on the new HNP, and the related DHCP procedure is also triggered by the reception of the UPN message [RFC3315].

6. Other Issues

In order to maintain the reachability of the MN, the Domain Name System (DNS) resource record corresponding to this MN MAY need to be updated when the HNP of the MN changes [RFC3007]. However, this is beyond the scope of this document.

7. Security Considerations

The UPN and UPA messages in this document MUST be protected using end-to-end security association(s) offering integrity and data origin authentication as specified in [RFC5213] and [RFC7077].

When HNP renumbering is triggered, a new HNP SHOULD be allocated to the MN. The LMA MUST follow the procedure of PMIPv6 to make sure that only an authorized HNP can be assigned for the MN. In this way, the LMA is ready to be the topological anchor point of the new HNP, which is for that MN’s exclusive use.

Per [RFC4862], if the Valid Lifetime in a Prefix Information Option is set to less than 2 hours in an unauthenticated RA, it is ignored. Thus, when the old HNP that is being deprecated is included in an RA from the MAG, the Valid Lifetime SHOULD be set to 2 hours (and the Preferred Lifetime set to 0) for an unauthenticated RA. However, if the legality of the signaling messages exchanged between MAG and MN can be guaranteed, it MAY be acceptable to also set the Valid Lifetime to 0 for an unauthenticated RA.

8. IANA Considerations

This document does not require any IANA actions.

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Acknowledgements

The work of Jong-Hyouk Lee was supported by 'The Cross-Ministry Giga KOREA Project' grant from the Ministry of Science, ICT and Future Planning, Korea.

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