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Prefix Delegation for Proxy Mobile IPv6
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Abstract

Proxy Mobile IPv6 enables IP mobility for a host without requiring its participation in any mobility signaling, being the network responsible for managing IP mobility on behalf of the host. However, Proxy Mobile IPv6 does not support assigning a prefix to a router and managing its IP mobility. This document specifies an extension to Proxy Mobile IPv6 protocol for supporting network mobility using DHCPv6-based Prefix Delegation.

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1. Introduction

Proxy Mobile IPv6 [RFC5213] enables network-based mobility management support for an IP host without requiring its participation in any IP mobility signaling. The mobility elements in the network allow the IP host to obtain an IPv4 address and/or a set of IPv6 addresses and be able to obtain IP mobility support for those IP addresses. However, this network-based mobility management support is specific to an IP host and currently there is no such network-based mobility management support for a mobile router with a cluster of IP hosts behind it. This specification defines extensions to Proxy Mobile IPv6 protocol for allowing a mobile router to be able to obtain one or more delegated IPv4/IPv6 prefixes for its inside networks using DHCP Prefix Delegation extensions [RFC3633]. The mobility entities in the network will provide network-based mobility management support for these delegated prefixes just as how that is supported for Home Network prefixes.

2. Convention and 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].

All the mobility related terms used in this document are to be interpreted as defined in Mobile IPv6 (MIPv6) [RFC6275], Proxy Mobile IPv6 specifications [RFC5213], [RFC5844], DHCPv6-PD for NEMO [RFC6276], DHCPv6-PD [RFC3633] and Mobility Related Terminology [RFC3753]. This document also provides a context-specific explanation to the following terms used in this document.

Mobile Router (MR)

Throughout this document, the term mobile router is used to refer to an IP router whose mobility is managed by the network while being attached to a Proxy Mobile IPv6 domain. The mobile router is not required to participate in any IP mobility related signaling for achieving mobility for an IPv4/IPv6 prefix that is obtained in that Proxy Mobile IPv6 domain.

Delegated Mobile Network Prefix (DMNP)

The DMNP is an IPv4 or an IPv6 prefix delegated to a mobile router and advertised in the mobile network. More than one Delegated Mobile Network Prefix could be assigned to a mobile router. The DMNP is topologically anchored on the local mobility anchor. While used by the mobile router, the mobile access gateway and local mobility anchor provide mobility service to the mobile router for the DMNP(s).

3. DHCPv6 Prefix Delegation Support for Proxy Mobile IPv6

3.1. Assumptions

This specification extends Proxy Mobile IPv6 (PMIPv6) to assign a (delegated) mobile network prefix to a mobile router (MR) for supporting network mobility. The specification assumes that a mobile router is a regular IPv6 router without any capability for mobility management. The mobile router forwards outgoing packets from its mobile network to the mobile access gateway (MAG), and the MAG delivers the incoming packets to the mobile network via the MR.

In order to use DHCPv6-PD as delegated mobile network prefix assignment mechanism in a PMIPv6-Domain, this specification makes the following assumptions.

- The mobile router MUST be able to function as a requesting router (RR), as specified in [RFC3633].
- The delegating router (DR) function, as specified in [RFC3633], MUST be co-located with the LMA.
- A DHCPv6 Relay Agent (DRA) function MUST be used by the mobile access gateway to be able to intercept the related DHCPv6 message sourced from the mobile router.
- The mobile router MUST have obtained an IPv6 address from its home network prefix (HNP) before initiating DHCPv6-PD procedures for obtaining delegated IPv4 or IPv6 prefixes for its ingress networks. This IPv6 address is on the interface attached to the MN-MAG access link as specified in [RFC3633].
- The MR (acting as a RR) SHOULD support Prefix Exclude Option for DHCPv6-PD as described in [RFC6603]. It essentially allows the home network prefix on the MN-MAG link and the delegated prefix can be part of the same aggregated block. This simplies address pool management aspects

3.2. Network Mobility Service

The network mobility service of a mobile router is indicated by the policy profile defined in [RFC5213]. During the mobile router's initial attachment procedure, the mobile access gateway MUST identify the mobile router and SHOULD acquire the policy profile to determine whether the network mobility service is offered to the mobile router. If the network mobility service needs to be offered to the mobile router, the mobile access gateway MUST set the Mobile Router Flag (R) when sending the Proxy Binding Update (PBU) message to the local

mobility anchor.

3.3. Binding association with the delegated prefix

3.3.1. Mobile Router initiated prefix delegation in PMIPv6

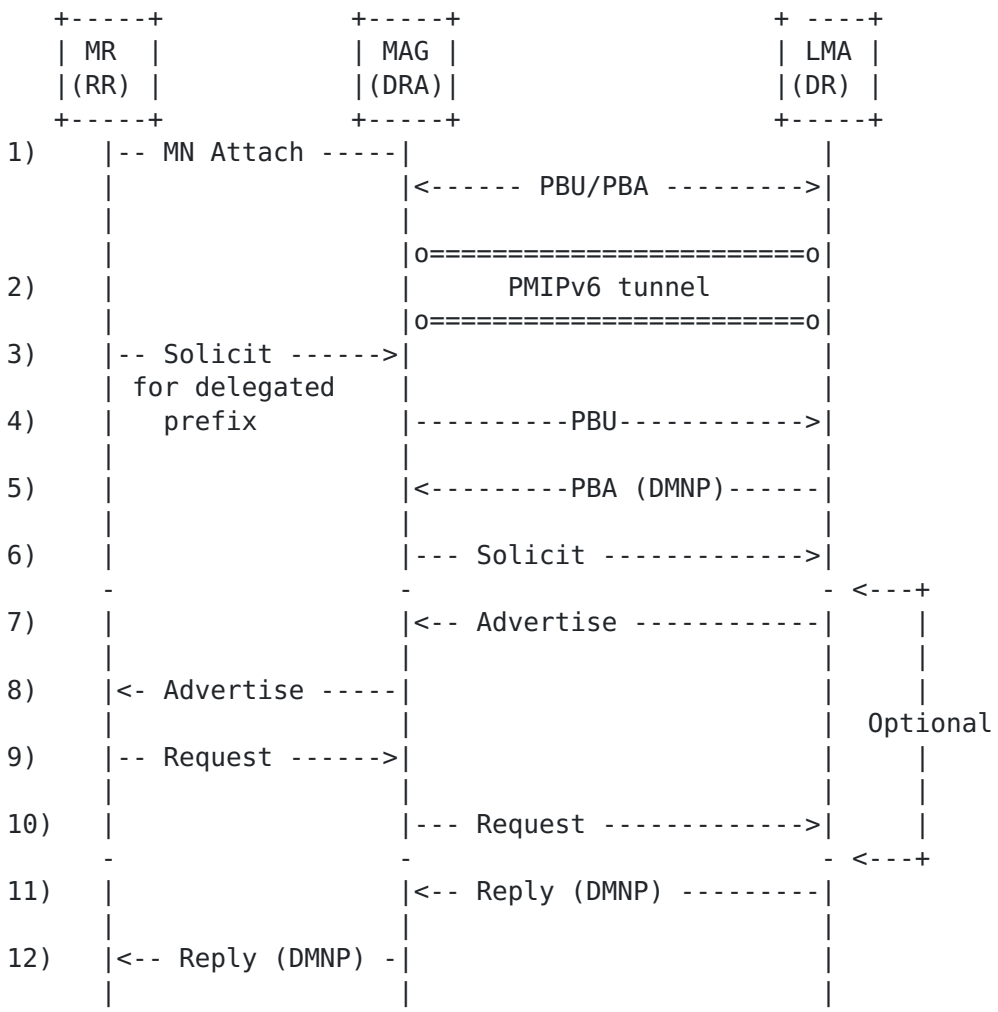


Figure 1: Prefix Delegation in PMIPv6 during the initial attachment to the PMIPv6 Domain

The steps required to complete the delegation of IPv6 prefix(es) to a mobile router that is provided with network mobility service are the following (see Figure 1):

1. MAG after detecting the mobile node's attachment to the access link initiates the signaling with the LMA.

2. The PMIPv6 tunnel is set up between the MAG and the LMA as described in [RFC5213]. This requires the MAG to send a regular PBU to the LMA to register the location of the mobile router and set-up the bi-directional tunnel. The LMA binds the allocated home network prefix (HNP) to the Proxy-CoA of the mobile router (i.e., the address of the mobile access gateway where the MR is attached to).

3. The mobile router, acting as a "Requesting Router" as described in [RFC3633], sends a DHCPv6 SOLICIT message including one or more IA_PD option(s) to the mobile access gateway (which has a "DHCPv6 Relay Agent" function) to acquire the delegated prefix(es).

4. Upon receiving the DHCPv6 SOLICIT message, the mobile access gateway sends a proxy binding update (PBU) message to the local mobility anchor, including one (or more) Delegated Mobile Network Prefix (DMNP) mobility options. All the considerations from Section 5.3.1 of [RFC5213] MUST be applied on the encapsulated Proxy Binding Update message. If the mobile access gateway does not know the delegated prefix(es), then the delegated mobile network prefix in the DMNP option(s) MUST be set to the unspecified IPv6 address "::", or an IPv4 address of 0.0.0.0 with the prefix length of 0. The local mobility anchor either assigns the MR a new set of delegated IPv4/IPv6 prefix(es) or returns the existing one(s) that are associated with that mobility session.

5. On reception of the proxy binding update, the local mobility anchor returns the assigned prefix(es) in the DMNP option(s) conveyed in a proxy binding acknowledgment (PBA) message sent to the mobile access gateway, unless the prefix(es) included in the PBU was the IPv6 unspecified address "::". The assigned prefix(es) MUST be the same one(s) which will be assigned via DHCPv6PD in step 6. The prefix(es) MUST be added to the delegated prefix(es) in the local mobility anchor binding cache which is extended as described in Section 3.5.1. The LMA must set up forwarding for the delegated prefixes as reachable through the PMIPv6 tunnel.

6. The DHCPv6 Relay Agent function on the mobile access gateway relays the DHCPv6 SOLICIT message to the delegating router (as described in [RFC3633]). The delegating router inserts one or more IA_PD option(s) including the delegated prefix(es) in the reply message.

   Note: steps 6 to 9 are not present if DHCPv6 Rapid Commit is used.

7. The delegating router sends the delegated prefix(es) in one or more IA_PD(s) to the mobile access gateway (acting as "DHCPv6 Relay Agent") inside the DHCPv6 ADVERTISE message.

8. The mobile access gateway relays the DHCPv6 ADVERTISE message to the mobile router.

9. The mobile router sends the DHCPv6 REQUEST message with the IA_PD option(s) received from previous message to the mobile access gateway (which is acting as "DHCPv6 Relay Agent").

10. The DRA function on the mobile access gateway relays the DHCPv6 REQUEST message to the DR.

11. The DR function on the local mobility anchor responds to the REQUEST from the mobile access gateway with a DHCPv6 REPLY message.

12. The RR function on the mobile router receives one or more IA_PD prefix(es) in the DHCPv6 REPLY message sent by the mobile access gateway.

13. The MAG sets up the forwarding for the delegated prefixes. The delegated prefixes are reachable over the MN-MAG interface with the MR's link-local address, or home address as the next-hop destination.

3.3.2. Refreshing the Delegated Prefix in Proxy Mobile IPv6

When the mobile router sends DHCPv6 Renew messages to extend the lifetime of the delegated prefix, these messages are also intercepted by the mobile access gateway (acting as "DHCPv6 Relay Agent") and are relayed to the local mobility anchor (which is acting as "Delegating Router").

3.3.3. Deletion of the Delegated Prefix in Proxy Mobile IPv6

If the lifetime of the delegated prefix (included in the IA_PD Prefix Option carried by the DHCPv6 Reply message) is set to zero, the mobile access gateway MUST send a proxy binding update message to remove the binding for that delegated mobile network prefix.

3.4. Mobile Access Gateway Operation

3.4.1. Extension to Binding Update List Entry Data Structure

In order to support this specification, the conceptual Binding Update List Entry (BULE) data structure needs to be extended with a new

prefix information field. This field is used to store the delegated IPv4/IPv6 mobile network prefix assigned to the mobile router, which is included in the proxy binding acknowledgment.

3.4.2. Forwarding

Forwarding packets sent to the MR's delegated mobile network prefix:

- On receiving a packet from the bi-directional tunnel established with the local mobility anchor, the mobile access gateway MUST first decapsulate the packet (removing the outer header) and then use the destination address of the (inner) packet to forward it on the interface through which the destination delegated mobile network prefix is reachable.

Forwarding packets sent by the mobile router:

- On receiving packets from a mobile router connected to one access link, the mobile access gateway MUST ensure that there is an established binding for the mobile router and the local mobility anchor for the source delegated mobile network prefix before tunneling the packet to the MR's local mobility anchor.

Other considerations from Section 6.10.5 of [RFC5213] also apply here.

3.4.3. Handover

When the mobile router moves from the previously attached mobile access gateway to the target MAG, the newly attached mobile access gateway MAY know the delegated mobile network prefix(es) which were assigned to the mobile router during the previous attachment. It is out of scope of this specification how the new mobile access gateway could obtain the previously assigned delegated mobile network prefix(es) (e.g., from some network element such as the previous MAG). After moving to the new MAG, a proxy binding update message including the assigned delegated mobile network prefix(es) (if available) MUST be sent by the MAG to the LMA. The local mobility anchor MUST check the delegated mobile network prefix(es) included in the PBU message and return the same assigned delegated mobile network prefix(es) in the proxy binding acknowledgment message. If the previously assigned mobile network prefix(es) are not known by new MAG, the mobile network prefix(es) MUST be set to unspecified address "::" and the prefix length MUST be set to 0 in the proxy binding update message sent by the new mobile access gateway to the local mobility anchor. In this case, the local mobility anchor MUST return the same previously assigned mobile network prefix(es) in proxy binding acknowledgment message.

3.5. Local Mobility Anchor Operation

3.5.1. Extension to Binding Cache Entry Data Structure

In order to support this specification, the conceptual Binding Cache Entry (BCE) data structure needs to be extended with a new prefix information field. This field is used to store the IPv4/IPv6 delegated mobile network prefix(es) assigned to the mobile router and included in the proxy binding update (as described in Section 3.2).

3.5.2. Forwarding

Intercepting packets sent to the MR's delegated mobile network prefix:

- When the local mobility anchor is serving the mobile router, it MUST be able to receive/intercept packets destined to the network behind the mobile router. In order to receive these packets, the local mobility anchor MUST be the topological anchor of the MR's delegated mobile network prefix(es).

Forwarding packets to the mobile router:

- On receiving a packet from a correspondent node with the destination address matching the MR's delegated mobile network prefix(es), the local mobility anchor MUST forward the packet through the bi-directional tunnel set up with the mobile router.

Other considerations from Section 5.6.2 of [RFC5213] also apply here.

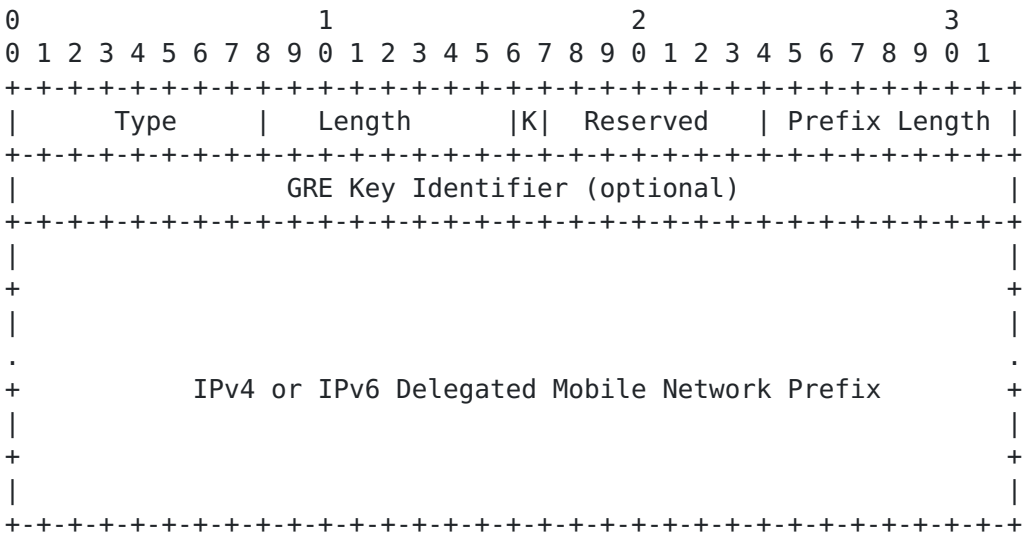
4. Message formats

This section defines extensions to Proxy Mobile IPv6 [RFC5213] protocol messages.

4.1. Delegated Mobile Network Prefix Option

A new Delegated Mobile Network Prefix option is defined for use with the Proxy Binding Update and Proxy Binding Acknowledgment messages exchanged between a local mobility anchor and a mobile access gateway. This option is used for exchanging the mobile router's IPv4/IPv6 delegated mobile network prefix information. There can be multiple Delegated Mobile Network Prefix options present in the message.

The Delegated Mobile Network Prefix option has an alignment requirement of 8n+2. Its format is as follows:



Type

To be assigned by IANA.

Length

8-bit unsigned integer indicating the length of the option in octets, excluding the type and length fields.

Key present (K)

If the Key Present bit is set to 1, then it indicates that the GRE Key Identifier field includes a valide GRE Key. Otherwise, the value of the GRE Key Identifier field MUST be ignored by the receiver.

Reserved

This field is unused for now. The value MUST be initialized to 0 by the sender and MUST be ignored by the receiver.

Prefix Length

8-bit unsigned integer indicating the prefix length of the prefix contained in the option.

Generic Routing Encapsulation (GRE) key tag

A four-byte optional field containing the GRE key tag as specified in [RFC2890]. If the Key Present flag is set to 0, this field MUST be initialized to 0 by the sender and MUST be ignored by the receiver. This option MAY be used by the LMA to provide differentiated service to different clients attached to the same mobile router.

Delegated Mobile Network Prefix

Contains a mobile router's 4-byte IPv4 or a 16-byte IPv6 Delegated Mobile Network Prefix.

5. Security Considerations

This document describes extensions to the Proxy Mobile IPv6 protocol for supporting network mobility using DHCPv6-based Prefix Delegation. The security considerations for DHCPv6 described in the "Security Considerations" section of the DHCPv6 base specification [RFC3315], the "Security Considerations" of the DHCPv6 Prefix Delegation specification [RFC3633], and the security considerations from the base Proxy Mobile IPv6 [RFC5213] apply when using the extensions defined in this document.

The use of DHCPv6, as described in this document, requires message integrity protection and source authentication. The IPsec security mechanism mandated by Proxy Mobile IPv6 [RFC5213] MUST be used to secure the DHCPv6 signaling between the mobile access gateway and the local mobility anchor. In the following, we describe the Security Policy Database (SPD) and Security Association Database (SAD) entries necessary to protect the DHCPv6 signaling. We use the same format used by [RFC4877]. The SPD and SAD entries are only example configurations. A particular mobile access gateway implementation and a local mobility anchor implementation could configure different SPD and SAD entries as long as they provide the required security of the DHCPv6 signaling messages.

For the examples described in this document, a mobile access gateway with address "mag_address_1", and a local mobility anchor with address "lma_address_1" are assumed.

```
mobile access gateway SPD-S:
  - IF local_address = mag_address_1 &
       remote_address = lma_address_1 & proto = UDP &
       local_port = any & remote_port = DHCP
    Then use SA1 (OUT) and SA2 (IN)

mobile access gateway SAD:
  - SA1(OUT, spi_a, lma_address_1, ESP, TRANSPORT):
        local_address = mag_address_1 &
        remote_address = lma_address_1 &
        proto = UDP & remote_port = DHCP
  - SA2(IN, spi_b, mag_address_1, ESP, TRANSPORT):
        local_address = lma_address_1 &
        remote_address = mag_address_1 &
        proto = UDP & local_port = DHCP

local mobility anchor SPD-S:
  - IF local_address = lma_address_1 &
       remote_address = mag_address_1 & proto = UDP &
       local_port = DHCP & remote_port = any
```

```
          Then use SA2 (OUT) and SA1 (IN)

      local mobility anchor SAD:
        - SA2(OUT, spi_b, mag_address_1, ESP, TRANSPORT):
            local_address = lma_address_1 &
            remote_address = mag_address_1 &
            proto = UDP & local_port = DHCP
        - SA1(IN, spi_a, lma_address_1, ESP, TRANSPORT):
            local_address = mag_address_1 &
            remote_address = lma_address_1 &
            proto = UDP & remote_port = DHCP
```

6. IANA Considerations

This document requires the following IANA action.

- Action-1: This specification defines a new Mobility Header option, Delegated Mobile Network Prefix option. This mobility option is described in Section 4.1. The Type value for this option needs to be assigned from the same numbering space as allocated for the other mobility options, as defined in [RFC6275].

7. Acknowledgments

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8. References

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