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DHCPv6 Prefix Delegation for Network Mobility (NEMO)

Abstract

One aspect of network mobility support is the assignment of a prefix or prefixes to a mobile router for use on the links in the mobile network. This document specifies how DHCPv6 prefix delegation can be used for this configuration task. The mobile router plays the role of requesting router, while the home agent assumes the role of delegating router. When the mobile router is outside its home network, the mobile router also assumes the role of DHCPv6 relay agent, co-located with the requesting router function.

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1. Introduction

One aspect of network mobility support is the assignment of a prefix or prefixes to a mobile router for use on the links in Network Mobility (NEMO). DHCPv6 prefix delegation (DHCPv6PD) [RFC3633] can be used for this configuration task.

The model of operation of DHCPv6PD for prefix delegation is as follows [RFC3633]. A delegating router is provided IPv6 prefixes to be delegated to requesting routers. A requesting router requests prefix(es) from the delegating router. The delegating router chooses prefix(es) for delegation, and responds with prefix(es) to the requesting router. The requesting router is then responsible for the delegated prefix(es). Note that DHCPv6 options for prefix delegation defined in [RFC3633] have been defined for general use across routers, and not only for mobile routers running the NEMO Basic Support protocol [RFC3963].

To use DHCPv6PD as a prefix assignment mechanism in mobile networks, when the mobile router is located at home, the home agent assumes the role of the delegating router and the mobile router assumes the role

of the requesting router. However, when the mobile router is away from home, in addition to the roles when the mobile router is located at home, the mobile router also assumes the role of a DHCPv6 relay agent co-located with the requesting router function.

The DHCPv6PD server running at the home agent is provisioned with prefixes to be assigned using any of the prefix assignment mechanisms described in the DHCPv6PD specification [RFC3633].

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 RFC 2119 [RFC2119].

The following terms used in this document are defined in the IPv6 Addressing Architecture document [RFC4291]:

Link-Local Unicast address

Link-Local Scope Multicast address

The following terms used in this document are defined in the Mobile IPv6 specification [RFC6275]:

Home Agent (HA)

Home Link

Home Address (HoA)

Care-of Address (CoA)

Binding Update (BU)

Binding Acknowledgement (BA)

The following terms used in this document are defined in the Mobile Network terminology document [RFC4885]:

Mobile Router (MR)

Mobile Network (NEMO)

Mobile Network Prefix (MNP)

The following terms used in this document are defined in the DHCPv6 [RFC3315] and DHCPv6 prefix delegation [RFC3633] specifications:

Delegating Router (DR; acts as a DHCPv6 server)

Requesting Router (RR; acts as a DHCPv6 client)

DHCPv6 Relay Agent (DRA)

The following acronym is used in this document:

DHCPv6PD: DHCPv6 Prefix Delegation

3. DHCPv6 Prefix Delegation of Mobile Network Prefixes

The NEMO Basic Support protocol [RFC3963] extends the Mobile IPv6 protocol [RFC6275] to enable network mobility. With the NEMO Basic Support protocol, a mobile router uses Mobile IPv6 to establish and maintain a session with its home agent and uses bidirectional tunneling between the mobile router and the home agent to provide a path through which nodes attached to links in the mobile network can maintain connectivity with nodes not in the NEMO.

The requirements for Network Mobility [RFC4885] include the ability of the mobile router to receive delegated prefixes that can then be assigned to links in the mobile network. DHCPv6PD can be used to meet this requirement for prefix delegation.

To use DHCPv6PD for mobile networks, when the mobile router is located at home, the home agent assumes the role of the delegating router and the mobile router assumes the role of the requesting router. However, when the mobile router is away from home, in addition to the roles when the mobile router is located at home, the mobile router also assumes the role of a DHCPv6 relay agent co-located with the requesting router function.

When the mobile router is not at home, the home agent and the mobile router exchange DHCPv6PD protocol messages as specified in [RFC6275]. This means that the messages sent by the mobile router MUST include the Home Address destination option and messages sent by the home agent MUST make use of a Routing Header type 2. See Figure 1 for the deployment topologies when the MR is at home and when it is visiting a foreign network.

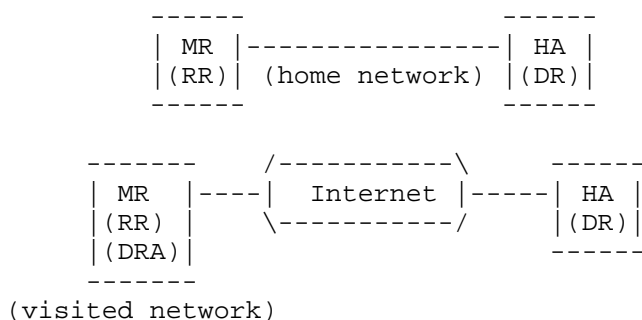


Figure 1: Deployment topologies of the use of DHCPv6PD for delegation of Mobile Network Prefixes

The DHCPv6PD server is provisioned with prefixes to be assigned using any of the prefix assignment mechanisms described in the DHCPv6PD specifications. Other updates to the home agent data structures required as a side effect of prefix delegation are specified by the particular network mobility protocol. For example, in the case of NEMO Basic Network Mobility Support [RFC3963], the HA would add an entry in its binding cache registering the delegated prefix to the mobile router to which the prefix was delegated.

3.1. Exchanging DHCPv6 Messages When the Mobile Router Is Not at Home

The case when the mobile router is away from home is described in this section. Section 3.2 describes the protocol operation for the case when the mobile router is attached to its home link.

The mobile router MUST register at the home agent (i.e., by sending a Binding Update to the home agent) before initiating a DHCPv6 message exchange for prefix delegation. The mobile router MUST use implicit BU signaling, since the mobile router may not have yet requested any prefixes.

If the mobile router does not have any active delegated prefixes (with unexpired leases), the mobile router MUST initiate a DHCPv6 message exchange with a DHCPv6 Solicit message as described in Section 17 of [RFC3315] and Section 11.1 of [RFC3633]. The delegating router at the home agent responds with an Advertise message. Then, the mobile router MUST request a set of prefixes by sending a Request message. The delegating router includes the delegated prefixes in a Reply message. Note that in this case, the mobile router has previously sent a Binding Update to the home agent without knowing yet the set of prefixes that it can use as mobile network prefixes. The home agent, upon reception of the implicit Binding Update from the mobile router, MUST select (in case this was

not pre-configured already) the prefixes that would then be delegated to the mobile router via DHCPv6PD. The home agent, once the DHCPv6 signaling has been completed, MUST add an entry in its binding cache including the delegated prefixes.

In case the mobile router has one or more active delegated prefixes -- for example, as if the mobile router reboots or the mobile network prefix(es) currently used by the mobile router is about to expire -- the mobile router MUST initiate a DHCPv6 message exchange with a DHCPv6 Rebind message as described in Section 18.1.2 of [RFC3315] and Section 12.1 of [RFC3633].

A DHCPv6 relay agent function [RFC3315] MUST be used at the mobile router. This relay agent function is co-located in the mobile router with the DHCPv6 client function (see Figure 2). The DHCPv6 signaling between the mobile router and the home agent is exchanged between the DHCPv6 relay agent in the mobile router and the DHCPv6 server on the home agent. DHCPv6 messages from the mobile router to the home agent are unicast packets sent from the unicast home address of the mobile router to the global unicast address of the home agent, and therefore the Home Address destination option MUST be used. DHCPv6 replies from the home agent to the mobile router MUST be sent using the Routing Header type 2, as specified in [RFC6275]. The DHCPv6 client in the mobile router MUST hand any outbound DHCPv6 messages to the co-located relay agent. Responses from the DHCPv6 server are delivered to the relay agent function in the mobile router, which MUST extract the encapsulated message and deliver it to the DHCPv6 client in the mobile router.

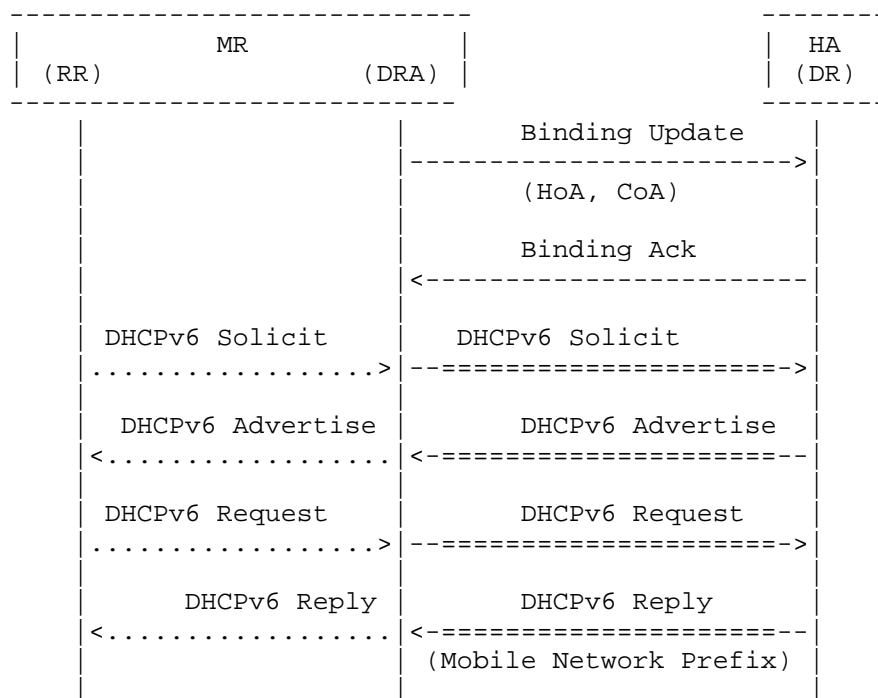


Figure 2: Signaling sequence when the mobile router is not at home

Note that a mobile router using DHCPv6PD to obtain the set of prefixes to be used as mobile network prefixes cannot derive its home address from one of its mobile network prefix(es) (as the mobile router does not know them before registering to the home agent). Therefore, the mobile router MUST assign its home address from the prefix on its Home Link.

3.1.1. Relay Agent Configuration

The use of the relay agent function in the mobile router allows the mobile router to unicast DHCPv6 messages to the DHCPv6 server. The relay agent MUST be configured with the address of the DHCPv6 server. For the purposes of this specification, the relay agent assumes that the home agent for the mobile router hosts the DHCPv6 server. Therefore, the mobile router MUST configure the DHCPv6 relay agent to forward DHCPv6 messages to the home agent.

The DHCPv6 specification supports in certain scenarios the use of unicast between the client and the server. However, its use presents some difficulties, as the client has to first receive a Server Unicast option (Section 22.12 of [RFC3315]) from the server, which

means that a Solicit/Advertise message exchange is required in advance. That signaling exchange would require the presence of a relay agent on the mobile router, and therefore little gain would be achieved in this case from the use of the Server Unicast option.

3.1.2. Transmission of DHCPv6 Messages

When the DHCPv6 client in the mobile router sends a message, it MUST hand the message to the DHCPv6 relay agent in the mobile router. The way in which the message is passed to the DHCP relay agent is beyond the scope of this document. The relay agent encapsulates the message from the client according to [RFC3315] in a Relay-forward message and sends the resulting DHCPv6 message to the home agent. The relay agent sets the fields in the Relay-forward message as follows:

msg-type	RELAY-FORW
hop-count	1
link-address	The home address of the mobile router
peer-address	The home address of the mobile router
options	MUST include a "Relay Message option" [RFC3315]; MAY include other options added by the relay agent.

3.1.3. Receipt of DHCPv6 Messages

Messages from the DHCPv6 server will be returned to the DHCPv6 relay agent, with the message for the DHCPv6 client encapsulated in the Relay Message option [RFC3315] in a Relay-reply message. The relay agent function MUST extract the message for the client from the Relay Message option and hand the message to the DHCPv6 client in the mobile router. The way in which the message is passed to the client is beyond the scope of this document.

3.2. Exchanging DHCPv6 Messages When the Mobile Router Is at Home

When the mobile router is on its home link, the home agent MUST use the home link to exchange DHCPv6PD messages with the mobile router (Figure 3). In this case, the DHCPv6 co-located relay function MUST be disabled. It is the responsibility of the implementation to determine when the mobile router is on its home link. The Home Link Detection mechanism is described in Section 11.5.2 of [RFC6275].

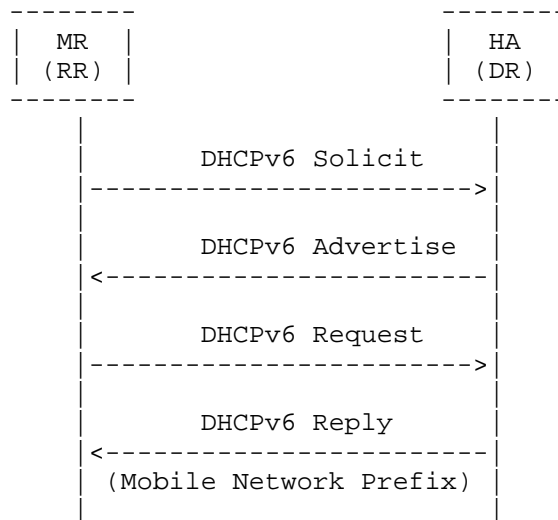


Figure 3: Signaling sequence for the case the home agent is at home

3.3. Selecting a Home Agent That Provides DHCPv6PD

Not all nodes that are willing to act as a home agent are required to provide DHCPv6PD. Therefore, when selecting a home agent, a mobile router that requires DHCPv6PD service MUST identify a home agent that will provide the service. The mobile router can determine if a home agent provides DHCPv6PD by initiating a DHCPv6 message exchange (i.e., sending a Solicit message) in which the mobile router requests delegated prefix(es). If the home agent does not respond or responds but does not delegate any prefix(es) in its response, the mobile router assumes that the home agent does not provide DHCPv6PD service. The mobile router continues to query all candidate home agents until it finds one that provides DHCPv6PD. Note that in this particular case and if the mobile router is away from home, the mobile router has to have already performed a Mobile IPv6 registration with the home agent it queries.

Querying a home agent to determine if it provides DHCPv6PD requires different operational variables than those recommended by the DHCPv6 specification. [RFC3315] recommends that under normal circumstances, a host will continue to send DHCPv6 Solicit messages until it receives a response (see Section 17 of [RFC3315]), i.e., the Maximum Retransmission Duration (MRD) and Maximum Retransmission Count (MRC) are both set to zero. However, a home agent may not respond to the Solicit messages from the mobile router because the home agent does not support DHCPv6 prefix delegation. Therefore, when querying a home agent to determine if the home agent provides DHCPv6PD service,

it is RECOMMENDED that MRD and MRC be set to non-zero values so that the mobile router discontinues sending Solicit messages to the home agent after sending 6 Solicit messages, and conclude that the home agent will not provide DHCPv6PD service. Sending 6 queries provides enough reliability for scenarios in which the wireless connectivity is lost for a short period after sending the first Binding Update message.

It is RECOMMENDED that the mobile router uses a sequential probing of the home agents for DHCPv6PD service.

3.4. Minimizing DHCPv6PD Messages

The use DHCPv6PD in a mobile network can be combined with the Rapid Commit option [RFC3315] to provide DHCPv6 prefix delegation with a two-message exchange between the mobile router and the DHCPv6PD delegating router.

3.5. Other DHCPv6 Functions

The DHCPv6 messages exchanged between the mobile router and the home agent MAY also be used for other DHCPv6 functions in addition to DHCPv6PD. For example, the home agent MAY assign global addresses to the mobile router and MAY pass other configuration information such as a list of available DNS recursive name servers [RFC3646] to the mobile router using the same DHCPv6 messages as used for DHCPv6PD.

The home agent MAY act as a DHCPv6 relay agent for mobile nodes while it acts as a delegating router for mobile routers.

4. Security Considerations

This document describes the use of DHCPv6 for prefix delegation in mobile networks. In addition to the security considerations for DHCPv6 described in the "Security Considerations" section of the DHCPv6 base specification [RFC3315] and the "Security Considerations" of the DHCPv6 Prefix Delegation specification [RFC3633], there are two aspects that need to be considered.

First, the NEMO Basic Support specification requires the home agent to prevent a mobile router from claiming mobile network prefixes belonging to another mobile router. Upon reception of an implicit Binding Update from a mobile router, the home agent MUST only add prefixes into the mobile router's Binding Cache Entry if the mobile router has a valid DHCPv6 Prefix Delegation lease for said prefixes. If the mobile router does not have a valid DHCPv6 Prefix Delegation lease, the home agent MUST NOT add any prefixes into the mobile router's Binding Cache Entry. Upon the mobile router obtaining a

valid DHCPv6 Prefix Delegation lease for a given set of prefixes, the home agent MUST add these prefixes to the mobile router's Binding Cache Entry. This avoids the home agent forwarding traffic addressed to prefixes that have not been yet delegated to the mobile router.

The use of DHCPv6, as described in this document, requires message integrity protection and source authentication. When the mobile router is at home, normal DHCPv6 operation is used between the mobile router and the home agent and therefore this specification does not add any new security issue. While the mobile router is away from home, the IPsec security mechanism mandated by Mobile IPv6 [RFC3776] MUST be used to secure the DHCPv6 signaling. 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 router implementation and a home agent 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 router with home address "home_address_1", and a home agent with address "home_agent_1" are assumed. If the home address of the mobile router changes, the SPD and SAD entries need to be re-created or updated for the new home address.

mobile router SPD-S:

- IF local_address = home_address_1 &
remote_address = home_agent_1 & proto = UDP &
local_port = any & remote_port = DHCP
Then use SA1 (OUT) and SA2 (IN)

mobile router SAD:

- SA1(OUT, spi_a, home_agent_1, ESP, TRANSPORT):
local_address = home_address_1 &
remote_address = home_agent_1 &
proto = UDP & remote_port = DHCP
- SA2(IN, spi_b, home_address_1, ESP, TRANSPORT):
local_address = home_agent_1 &
remote_address = home_address_1 &
proto = UDP & local_port = DHCP

home agent SPD-S:

- IF local_address = home_agent_1 &
remote_address = home_address_1 & proto = UDP &
local_port = DHCP & remote_port = any
Then use SA2 (OUT) and SA1 (IN)

home agent SAD:

- SA2(OUT, spi_b, home_address_1, ESP, TRANSPORT):
 local_address = home_agent_1 &
 remote_address = home_address_1 &
 proto = UDP & local_port = DHCP
- SA1(IN, spi_a, home_agent_1, ESP, TRANSPORT):
 local_address = home_address_1 &
 remote_address = home_agent_1 &
 proto = UDP & remote_port = DHCP

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