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IPv6 Prefix Options for DHCPv6
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Abstract

The Prefix Delegation option and the Prefix Request option provide a mechanism for delegation of IPv6 prefixes using DHCP. This prefix delegation mechanism is intended for simple prefix delegation from a delegating router to a requesting router, across an administrative boundary, where the delegating router does not require knowledge about the topology of the links in the network to which the prefixes will be assigned.

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1. Introduction

This document describes new options for DHCP, which provide a mechanism for the delegation of IPv6 prefixes. Through these options, an authorized delegating router can delegate prefixes to requesting routers.

The prefix delegation mechanism described in this document is intended for simple delegation of prefixes from a delegating router to requesting routers. It is appropriate for situations in which the delegating router does not have knowledge about the topology of the networks to which the requesting router is attached, and the delegating router does not require other information aside from the identity of the requesting router to choose a prefix for delegation. For example, the Prefix Delegation and Prefix Request options would be used by a service provider to assign a prefix to a CPE device acting as a router between the subscriber's internal network and the service provider's core network.

2. Terminology

This document uses the terminology defined in RFC2460 [2] and the DHCP specification [5]. In addition, this document uses the following terms:

Requesting Router: The router that acts as a DHCP client and is requesting that prefix(es) be assigned.

Delegating Router: The router that acts as a DHCP server, and is responding to the prefix request.

3. Requirements

The keywords MUST, MUST NOT, REQUIRED, SHALL, SHALL NOT, SHOULD, SHOULD NOT, RECOMMENDED, MAY, and OPTIONAL, when they appear in this document, are to be interpreted as described in RFC 2119 [1].

4. Model and Applicability

The model of operation for prefix delegation is as follows. A delegating router is provided DHCPv6 prefixes to be delegated to requesting routers. Examples of ways in which the delegating router may be provided these prefixes are given in Section 11.2. A requesting router requests prefix(es) from the delegating router, as described in Section 11.1. The delegating router chooses prefix(es) for delegation, and returns the prefix(es) to the requesting router. The requesting router is then responsible for the delegated

prefix(es). For example, the requesting router might assign a delegated prefix to one of its interfaces, and begin sending router advertisements for the prefix on that link.

Each prefix has an associated lease, which constitutes an agreement about the length of time over which the requesting router is allowed to use the prefix. A requesting router can request an extension of the lease on a delegated prefix and is required to terminate the use of a delegated prefix if the lease on the prefix expires.

This prefix delegation mechanism would be appropriate for use by an ISP to delegate a prefix to a subscriber, where the delegated prefix would possibly be subnetted and assigned to the links within the subscriber's network.

Figure 1 illustrates a network architecture in which prefix delegation would be used.

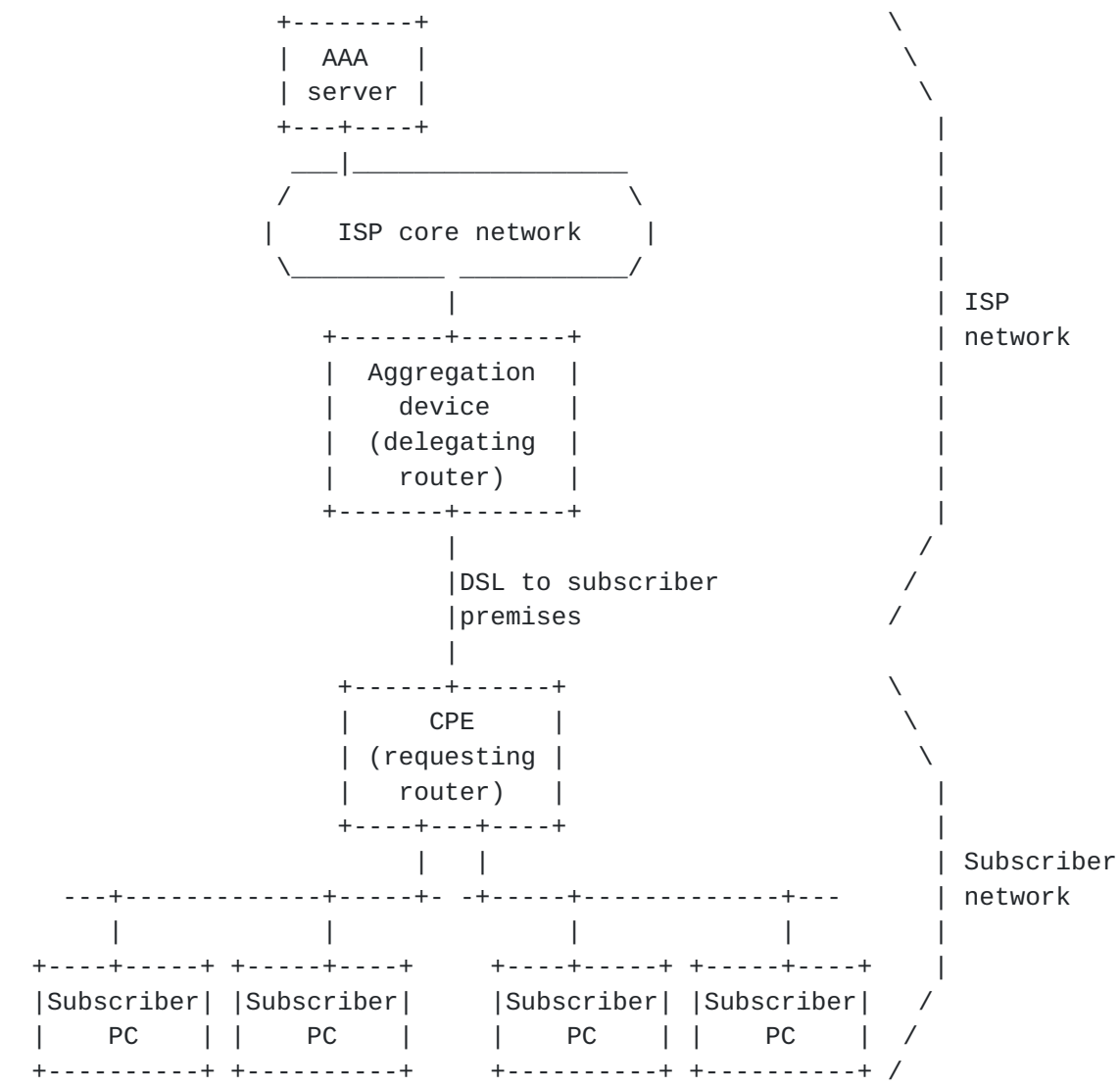


Figure 1: An example of prefix delegation.

In this example, the delegating router is configured with a prefix assigned to the customer at the time of subscription to the ISP service. The prefix delegation process begins when the requesting router requests configuration information through DHCP. The DHCP messages from the requesting router are received by the delegating router in the aggregation device. When the delegating router receives the request, it consults the AAA server to authenticate and authorize the requesting router. The AAA server returns the subscriber's prefix in an Framed-IPv6-Prefix attribute as described in RFC 3162 [6], and the delegating router returns them to the requesting router.

The requesting router assigns longer prefixes from the delegated prefix for assignment to links in the subscriber's network. In a typical scenario based on the network shown in Figure 1, the requesting router subnets a single delegated /48 prefix into /64 prefixes and assigns one /64 prefix to each of the links in the subscriber network.

The prefix delegation options can be used in conjunction with other DHCP options carrying other configuration information to the requesting router. The requesting router may, in turn, then provide DHCP service to hosts attached to the internal network. For example, the requesting router may obtain the addresses of DNS and NTP servers from the ISP delegating router, and then pass that configuration information on to the subscriber hosts through a DHCP server in the requesting router.

5. Overview of DHCP with Prefix Delegation

Prefix delegation with DHCP is independent of address assignment and other configuration information. A requesting router can use DHCP for just prefix delegation or for prefix delegation along with address assignment and configuration.

To locate a delegating router, the requesting router sends an initial Solicit message as described in the DHCP specification [5]. The responding delegating router includes a Prefix Delegation option that identifies the prefix(es) to be delegated in the Advertise message it returns to the requesting router.

When the requesting router has identified a delegating router, the requesting router sends a Request message to the delegating router. The delegating router returns a Prefix Delegation option with the prefix(es) to be delegated in the Reply message it sends to the requesting router. The requesting router records the lease duration time for the delegated prefix(es) and uses the prefix(es) as described in the previous section.

Under the conditions decsribed in the DHCPv6 specification [5], the requesting router sends a Confirm message to verify that its delegated prefix(es) are still valid. The reqeuesting router responds with a Reply message containing a Prefix Delegation option with the delegated prefix(es). The requesting router may choose to extend the lease on the delegated prefix(es) in the Reply message.

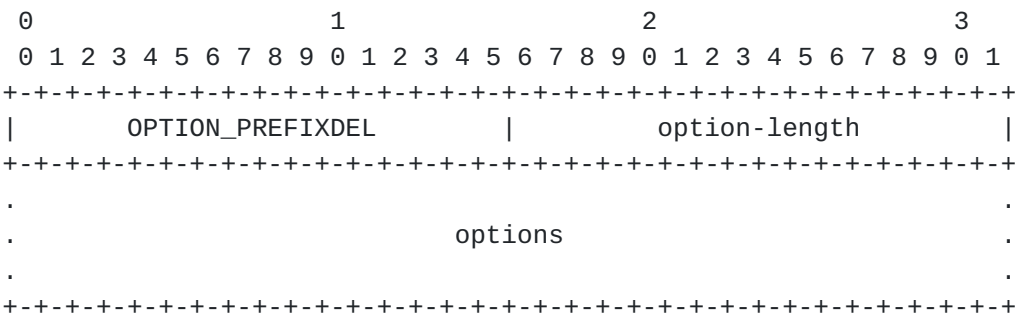
Before the lease on each delegated prefix expires, the requesting router includes the prefix in a Prefix Delegation option sent in a Renew message to the delegating router. The delegating router responds by returning the prefix with an updated lease to the

requesting router.

6. Prefix Delegation Option

The Prefix Delegation option encapsulates other options that are used for prefix delegation. The Prefix Delegation option must include at least one Prefix Information option.

The format of the Prefix Delegation option is:



option-code: OPTION_PREFIXDEL (TBD)

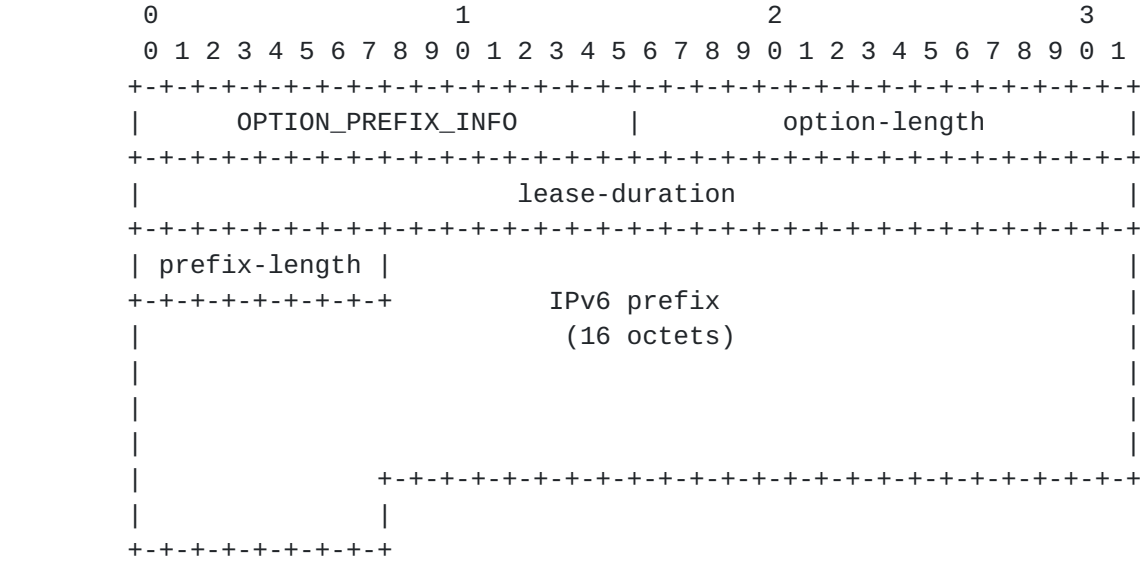
option-length: Length of the 'options' field in octets.

options: Options associated with Prefix Delegation.

7. Prefix Information option

One or more Prefix Information options are encapsulated in a Prefix Delegation option and are used by the delegating router to inform a requesting router about a prefix or prefixes.

The format of the Prefix Information option is:



option-code: OPTION_PREFIX_INFO (TBD)

option-length: 21

lease duration: The duration of the lease for the IPv6 prefix in the option

prefix-length: Length for this prefix

IPv6-prefix: An IPv6 prefix

The lease-duration is expressed in seconds, and a value of 0xFFFFFFFF indicates infinity. The prefix-length gives the number of bits in the prefix carried in this option. The IPv6-prefix field contains the delegated prefix padded on the right with additional bits to fill the field. The pad bits are set to 0 by the sender and ignored by the receiver.

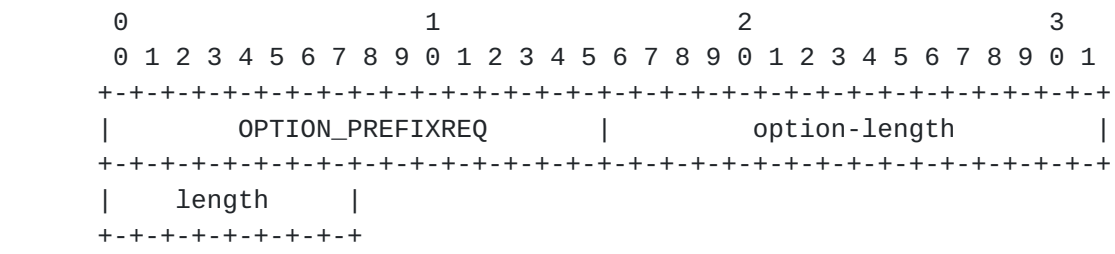
A requesting router MAY include a Prefix Delegation option in a Solicit, Request, Renew, Rebind or Confirm message to inform the delegating router about the prefixes the requesting router wants the delegating router to send.

In a message sent by a requesting router to a delegating router, the value in the lease duration field indicates the requesting router's preference. The requesting router may send a value of zero to indicate no preference.

8. Prefix Request option

The Prefix Request option is only sent by the requesting router and MAY be used to indicate properties of the prefixes it wants delegated.

The format of the Prefix Request option is:



option-code: OPTION_PREFIXREQ (TBD)

option-len: 1

length: The length of the requested prefix.

This option MUST not appear together with the Prefix Delegation option.

A requesting router MUST ignore any Prefix Request options in messages it receives.

9. Appearance of these options

The Prefix Delegation option MUST only appear in the options section of the following DHCP messages: Solicit, Advertise, Request, Confirm, Renew, Rebind, Release, Reply.

The Prefix Information option MUST be encapsulated by the Prefix Delegation option.

The Prefix request option MUST only appear in the options section of the following DHCP messages: Solicit, Request.

10. Delegating Router Solicitation

The requesting router locates and selects a delegating router in the same way as described in section "DHCP Server Solicitation" of the DHCP specification [5]. The details of the solicitation process are described in this section.

10.1 Requesting router behavior

The requesting router creates and transmits a Solicit message as described in sections "Creation of Solicit Messages" and "Transmission of Solicit Messages" of the DHCP specification [5]. The requesting router MUST include either an Option Request option specifying the Prefix Delegation option or a Prefix Request option.

The requesting router processes any received Advertise messages as described in section "Receipt of Advertise Messages" in the DHCP specification [5]. The requesting router MAY choose to consider the presence of advertised prefixes in its decision about which delegating router to respond to.

10.2 Delegating router behavior

The delegating router processes Solicit messages from requesting routers in the same way as described in section "Receipt of Solicit messages" of the DHCP specification [5]. If the message contains Prefix Request option or an Option Request option specifying the Prefix Request option, and the delegating router is configured to delegate prefix(es) to the requesting router, the delegating router selects the prefix(es) to be delegated to the requesting router. The mechanism through which the delegating router selects prefix(es) for delegation is not specified in this document. Examples of ways in which the delegating router might select prefix(es) for a requesting router include: static assignment based on subscription to an ISP; dynamic assignment from a pool of available prefixes; selection based on an external authority such as a RADIUS server using the Framed-IPv6-Prefix option.

If the requesting router includes a Prefix Request option in its Solicit message, the delegating router MAY choose to use the information in that option to select the prefix(es) to be delegated to the requesting router.

The delegating router sends an Advertise message to the requesting router in the same way as described in section "Creation and transmission of Advertise messages" in the DHCP specification [5]. The delegating router MUST include a Prefix Delegation option, identifying any prefix(es) that the delegating router will delegate to the requesting router.

11. Requesting router initiated prefix delegation

A requesting router uses the same message exchanges as described in section "DHCP Client-Initiated Configuration Exchange" of the DHCP specification [5] to obtain or update prefix(es) from a delegating

router. The requesting router and the delegating router use the Prefix Delegation option to exchange information about prefix(es) in much the same way IA Address options are used for assigned addresses.

11.1 Requesting router behavior

To obtain prefix(es) from the delegating router, the requesting router MUST include the Prefix Information option (in a Prefix Delegation option) in the Request message it sends to the delegating router identifying the prefix(es) sent from the delegating router to the requesting router in the Advertise message received by the requesting router.

The requesting router MUST include the Prefix Information options, identifying the prefix(es) that have been previously delegated by the delegating router, in any Confirm, Renew, or Rebind messages sent by the requesting router.

Each prefix has an associated lease whose duration is specified in the Prefix Information option for that prefix. The requesting router uses Renew and Rebind messages to request the extension of the lease on a delegated prefix. The recommended time to begin lease extension with a Renew message is 0.5 times the lease duration, and the recommended time to begin lease extension with a Rebind message is 0.8 times the lease duration.

The requesting router uses a Release message to return a delegated prefix to a delegating router.

The requesting router assigns a subnet from each of the delegated prefixes to each of the links to which it is attached, with the following exception: the requesting router MUST NOT assign any delegated prefixes or subnets from the delegated prefix(es) to the link through which it received the DHCP message from the delegating router.

When a requesting router subnets a delegated prefix, it must assign additional bits to the prefix to generate unique, longer prefixes. For example, if the requesting router in Figure 1 were delegated 3FFE:FFFF:0::/48, it might generate 3FFE:FFFF:0:1::/64 and 3FFE:FFFF:0:2::/64 for assignment to the two links in the subscriber network. If the requesting router were delegated 3FFE:FFFF:0::/48 and 3FFE:FFFF:1::/48, it might assign 3FFE:FFFF:0:0001::/64 and 3FFE:FFFF:1:1::/64 to one of the links, and 3FFE:FFFF:0:2::/64 and 3FFE:FFFF:1:2::/64 for assignment to the other link.

If the requesting router assigns a delegated prefix to a link to which the router is attached, and begins to send router

advertisements for the prefix on the link, the requesting router MUST set the valid lifetime and the preferred lifetime for that prefix to expire no later than the expiration of the lease on the prefix. The recommended preferred lifetime is 0.8 times the lease duration and the recommended valid lifetime is equal to the lease duration.

11.2 Delegating Router Behavior

When a delegating router receives a Request message from a requesting router that contains a Prefix Delegation option, and the delegating router is authorized to delegate prefix(es) to the requesting router, the delegating router selects the prefix(es) to be delegated to the requesting router. If the requesting router includes a Prefix Request option in its Solicit message, the delegating router MAY choose to use the information in that option to select the prefix(es) to be delegated to the requesting router. The mechanism through which the delegating router selects prefix(es) for delegation is not specified in this document. Section 10.2 gives examples of ways in which a delegating router might select the prefix to be delegated to a requesting router.

A delegating router examines the prefix(es) identified in Prefix Information options (in a Prefix Delegation option) in Confirm, Renew and Rebind messages and responds according to the current status of the prefix(es). The delegating router returns a Prefix Information option with an updated lease duration for each valid prefix in the message from the requesting router.

A delegating router may mark any prefix(es) in Prefix Information options in a Release message from a requesting router as "available", dependent on the mechanism used to acquire the prefix, e.g in the case of a dynamic pool.

The delegating router MUST include a Prefix Information option or options (in a Prefix Delegation option) in Reply messages sent to a requesting router.

12. Prefix Delegation reconfiguration

This section describes prefix delegation in Reconfigure message exchanges.

12.1 Delegating Router behavior

The delegating router initiates a configuration message exchange with a requesting router, as described in the section "DHCP Server-Initiated Configuration Exchange" of the DHCP specification [5]. The delegating router specifies the Prefix Delegation option in the

Option Request option to cause the requesting router to include a Prefix Delegation option to obtain new information about delegated prefix(es).

12.2 Requesting Router behavior

The requesting router responds to a Reconfigure message received from a delegating router as described in the DHCP specification [5]. The requesting router MUST include the Prefix Information option (in a Prefix Delegation option) for prefix(es) that have been delegated to the requesting router by the delegating router from which the Reconfigure message was received.

13. Relay agent behavior

A relay agent forwards messages containing prefix delegation options in the same way as described in section "Relay Behavior" of the DHCP specification [5].

If a delegating router communicates with a requesting router through a relay agent, the delegating router may need a protocol or other out-of-band communication to add routing information for delegated prefixes into the provider edge router.

14. Security Considerations

Security considerations in DHCP are described in the section "Security Considerations" of the DHCP specification [5].

Prefix delegation can be used to mount a denial of service attack or a man-in-the-middle attack against an organization by delegating invalid prefixes to a requesting router, causing the requesting router to forward outbound datagrams to an invalid destination or to an intruder's destination host.

An intruder requesting router may be able to mount a denial of service attack by repeated requests for delegated prefixes that exhaust the delegating router's available prefixes.

To guard against attacks through prefix delegation, requesting routers and delegating routers SHOULD use DHCP authentication as described in section "Authentication of DHCP messages" in the DHCP specification [5]. For point to point links, where one trusts that there is no man in the middle, or one trusts layer two authentication, DHCP authentication or IPsec is not necessary. Because a requesting router and delegating routers must each have at least one assigned IPv6 address, the routers may be able to use IPsec for authentication of DHCPv6 messages. The details of using IPsec

for DHCPv6 are under development.

15. IANA Considerations

IANA is requested to assign an option code to these options from the option-code space defined in section "DHCPv6 Options" of the DHCPv6 specification [5].

16. Acknowledgements

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