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DHCP Options for the Port Control Protocol (PCP)

Abstract

This document specifies DHCP (IPv4 and IPv6) options to configure hosts with Port Control Protocol (PCP) server IP addresses. The use of DHCPv4 or DHCPv6 depends on the PCP deployment scenarios. The set of deployment scenarios to which DHCPv4 or DHCPv6 can be applied is outside the scope of this document.

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1. Introduction

This document defines DHCPv4 [RFC2131] and DHCPv6 [RFC3315] options that can be used to configure hosts with PCP server [RFC6887] IP addresses.

This specification assumes a PCP server is reachable with one or multiple IP addresses. As such, a list of IP addresses can be returned in the DHCP PCP server option.

This specification allows returning one or multiple lists of PCP server IP addresses. This is used as a hint to guide the PCP client when determining whether to send PCP requests to one or multiple PCP servers. Concretely, the PCP client needs an indication to decide whether entries need to be instantiated in all PCP servers (e.g., multi-homing, multiple PCP-controlled devices providing distinct services, etc.) or use one IP address from the list (e.g., redundancy group scenario, proxy-based model, etc.). Refer to [PCP-DEPLOYMENT] for a discussion on PCP deployment scenarios.

For guidelines on how a PCP client can use multiple IP addresses and multiple PCP servers, see [PCP-SERVER].

1.1. 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].

2. Terminology

This document makes use of the following terms:

- o "PCP server" denotes a functional element that receives and processes PCP requests from a PCP client. A PCP server can be co-located with or be separated from the function (e.g., NAT, Firewall) it controls. Refer to [RFC6887].
- o "PCP client" denotes a PCP software instance responsible for issuing PCP requests to a PCP server. Refer to [RFC6887].
- o "DHCP" refers to both DHCPv4 [RFC2131] and DHCPv6 [RFC3315].
- o "DHCP client" denotes a node that initiates requests to obtain configuration parameters from one or more DHCP servers.
- o "DHCP server" refers to a node that responds to requests from DHCP clients.

3. DHCPv6 PCP Server Option

3.1. Format

The DHCPv6 PCP server option can be used to configure a list of IPv6 addresses of a PCP server.

The format of this option is shown in Figure 1.

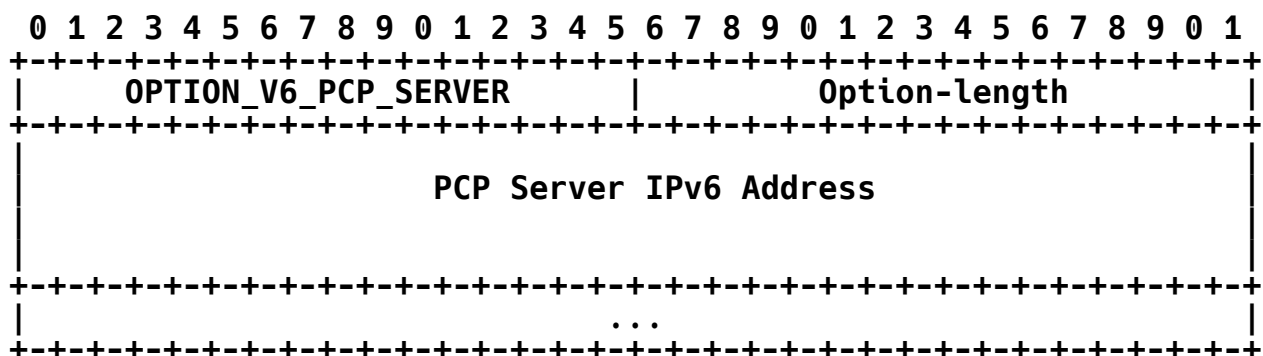


Figure 1: DHCPv6 PCP Server Option

The fields of the option shown in Figure 1 are as follows:

- o Option-code: `OPTION_V6_PCP_SERVER` (86; see Section 9.1)
- o Option-length: Length of the "PCP Server IPv6 Address(es)" field in octets. MUST be a multiple of 16.
- o PCP Server IPv6 Addresses: Includes one or more IPv6 addresses [RFC4291] of the PCP server to be used by the PCP client. Note, IPv4-mapped IPv6 addresses (Section 2.5.5.2 of [RFC4291]) are allowed to be included in this option.

To return more than one PCP server to the DHCPv6 client (as opposed to more than one address for a single PCP server), the DHCPv6 server returns multiple instances of `OPTION_V6_PCP_SERVER`.

3.2. DHCPv6 Client Behavior

To discover one or more PCP servers, the DHCPv6 client requests PCP server IP addresses by including `OPTION_V6_PCP_SERVER` in an Option Request Option (ORO), as described in Section 22.7 of [RFC3315].

The DHCPv6 client MUST be prepared to receive multiple instances of `OPTION_V6_PCP_SERVER`; each instance is to be treated as a separate PCP server.

If an IPv4-mapped IPv6 address is received in `OPTION_V6_PCP_SERVER`, it indicates that the PCP server has the corresponding IPv4 address.

Note: When presented with the IPv4-mapped prefix, current versions of Windows and Mac OS generate IPv4 packets but will not send IPv6 packets [RFC6052]. Representing IPv4 addresses as IPv4-mapped IPv6 addresses follows the same logic as in Section 5 of [RFC6887].

The DHCPv6 client MUST silently discard multicast and host loopback addresses [RFC6890] conveyed in `OPTION_V6_PCP_SERVER`.

4. DHCPv4 PCP Option

4.1. Format

The DHCPv4 PCP server option can be used to configure a list of IPv4 addresses of a PCP server. The format of this option is illustrated in Figure 2.

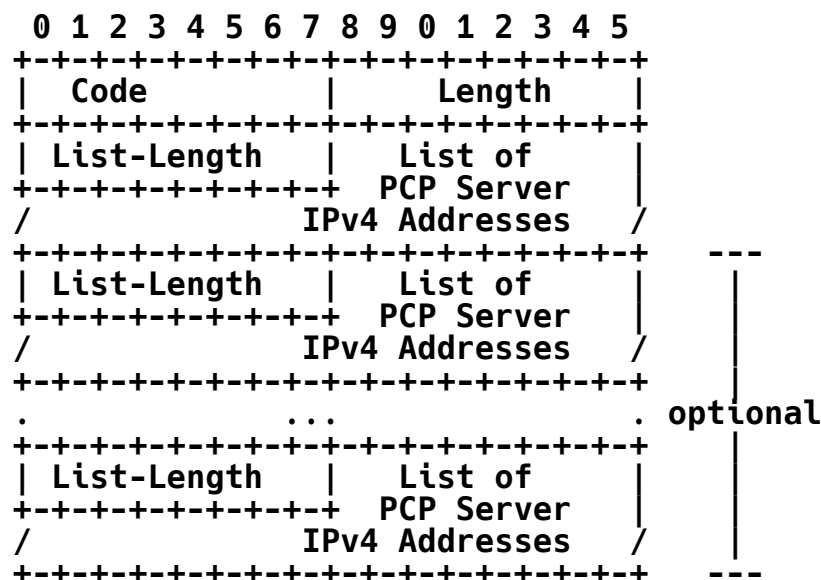
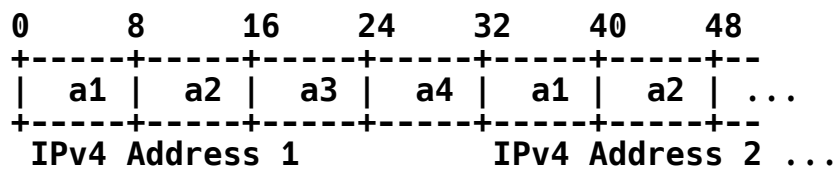


Figure 2: DHCPv4 PCP Server Option

The descriptions of the fields are as follows:

- o Code: `OPTION_V4_PCP_SERVER` (158; see Section 9.2);
- o Length: Length of all included data in octets. The minimum length is 5.
- o List-Length: Length of the "List of PCP Server IPv4 Addresses" field in octets. MUST be a multiple of 4.
- o List of PCP Server IPv4 Addresses: Contains one or more IPv4 addresses of the PCP server to be used by the PCP client. The format of this field is shown in Figure 3.



This format assumes that an IPv4 address is encoded as a1.a2.a3.a4.

Figure 3: Format of the List of PCP Server IPv4 Addresses

OPTION_V4_PCP_SERVER can include multiple lists of PCP server IPv4 addresses; each list is treated as a separate PCP server. When several lists of PCP server IPv4 addresses are to be included, the "List-Length" and "List of PCP Server IPv4 Addresses" fields are repeated.

OPTION_V4_PCP_SERVER is a concatenation-requiring option. As such, the mechanism specified in [RFC3396] MUST be used if OPTION_V4_PCP_SERVER exceeds the maximum DHCPv4 option size of 255 octets.

4.2. DHCPv4 Client Behavior

To discover one or more PCP servers, the DHCPv4 client requests PCP server IP addresses by including OPTION_V4_PCP_SERVER in a Parameter Request List option [RFC2132].

The DHCPv4 client MUST be prepared to receive multiple lists of PCP server IPv4 addresses in the same DHCPv4 PCP server option; each list is to be treated as a separate PCP server.

The DHCPv4 client MUST silently discard multicast and host loopback addresses [RFC6890] conveyed in OPTION_V4_PCP_SERVER.

5. DHCP Server Configuration Guidelines

DHCP servers supporting the DHCP PCP server option can be configured with a list of IP addresses of the PCP server(s). If multiple IP addresses are configured, the DHCP server MUST be explicitly configured whether all or some of these addresses refer to:

1. the same PCP server: the DHCP server returns multiple addresses in the same instance of the DHCP PCP server option.

2. **distinct PCP servers:** the DHCP server returns multiple lists of PCP server IP addresses to the requesting DHCP client (encoded as multiple `OPTION_V6_PCP_SERVERS` or in the same `OPTION_V4_PCP_SERVER`); each list is referring to a distinct PCP server. For example, multiple PCP servers may be configured to a PCP client in some deployment contexts such as multi-homing. It is out of the scope of this document to enumerate all deployment scenarios that require multiple PCP servers to be returned.

Precisely how DHCP servers are configured to separate lists of IP addresses according to which PCP server they address is out of the scope of this document. However, DHCP servers **MUST NOT** combine the IP addresses of multiple PCP servers and return them to the DHCP client as if they belong to a single PCP server, and DHCP servers **MUST NOT** separate the addresses of a single PCP server and return them as if they belong to distinct PCP servers. For example, if an administrator configures the DHCP server by providing a Fully Qualified Domain Name (FQDN) for a PCP server, even if that FQDN resolves to multiple addresses, the DHCP server **MUST** deliver them within a single server address block.

DHCPv6 servers that implement this option and that can populate the option by resolving FQDNs will need a mechanism for indicating whether to query for A records or only AAAA records. When a query returns A records, the IP addresses in those records are returned in the DHCPv6 response as IPv4-mapped IPv6 addresses.

Discussion: The motivation for this design is to accommodate deployment cases where an IPv4 connectivity service is provided while only DHCPv6 is in use (e.g., an IPv4-only PCP server in a Dual-Stack Lite (DS-Lite) context [RFC6333]).

Since this option requires support for IPv4-mapped IPv6 addresses, a DHCPv6 server implementation will not be complete if it does not query for A records and represent any that are returned as IPv4-mapped IPv6 addresses in DHCPv6 responses. This behavior is neither required nor suggested for DHCPv6 options in general: it is specific to `OPTION_V6_PCP_SERVER`. The mechanism whereby DHCPv6 implementations provide this functionality is beyond the scope of this document.

For guidelines on providing context-specific configuration information (e.g., returning a regional-based configuration) and information on how a DHCP server might be configured with FQDNs that get resolved on demand, see [DHC-CONFIG].

6. Dual-Stack Hosts

A dual-stack host might receive a PCP server option via both DHCPv4 and DHCPv6. For guidance on how a DHCP client can handle PCP server IP lists for the same network but obtained via different mechanisms, see [PCP-SERVER].

7. Hosts with Multiple Interfaces

A host may have multiple network interfaces (e.g., 3G, IEEE 802.11, etc.), each configured differently. Each PCP server learned **MUST** be associated with the interface via which it was learned.

Refer to [PCP-SERVER] and Section 8.4 of [RFC6887] for more discussion on multi-interface considerations.

8. Security Considerations

The security considerations in [RFC2131] and [RFC3315] are to be considered. PCP-related security considerations are discussed in [RFC6887].

The PCP server option defined here is applicable when operating under the simple threat model (Section 18.1 of [RFC6887]). Operation under the advanced threat model (Section 18.2 of [RFC6887]) may or may not be appropriate; analysis of this question is out of the scope of this document.

9. IANA Considerations

9.1. DHCPv6 Option

IANA has assigned the following new DHCPv6 Option Code in the registry maintained in
<<http://www.iana.org/assignments/dhcpv6-parameters>>:

Option Name	Value
OPTION_V6_PCP_SERVER	86

9.2. DHCPv4 Option

IANA has assigned the following new DHCPv4 Option Code in the registry maintained in
<<http://www.iana.org/assignments/bootp-dhcp-parameters>>:

Option Name	Tag	Data Length	Meaning
OPTION_V4_PCP_SERVER	158	Variable; the minimum length is 5.	Includes one or multiple lists of PCP server IP addresses; each list is treated as a separate PCP server.

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