              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.

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 5741.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc7291.

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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.

```
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      OPTION_V6_PCP_SERVER      |          Option-length        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   |                    PCP Server IPv6 Address                    |
   |                                                               |
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                              ...                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

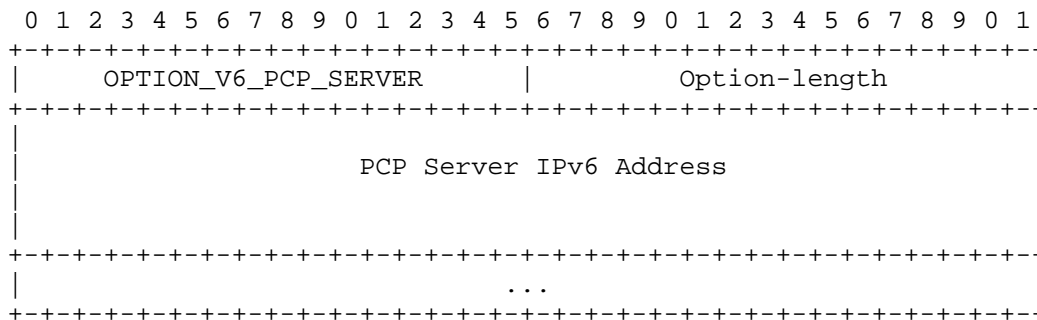   Figure 1: DHCPv6 PCP Server Option

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
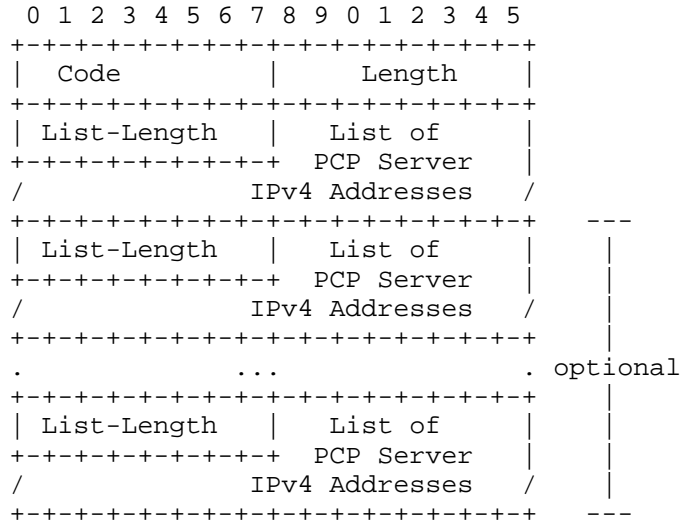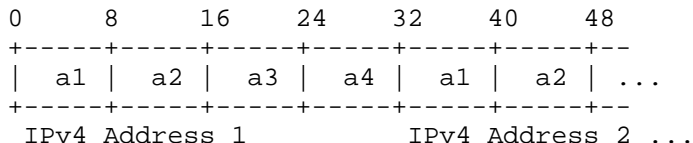   addresses of a PCP server. The format of this option is illustrated
   in Figure 2.

```
            0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
           |  Code         |    Length     |
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
           | List-Length   |    List of    |
           +-+-+-+-+-+-+-+  PCP Server     |
           /           IPv4 Addresses     /
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+   ---
           | List-Length   |    List of    |     |
           +-+-+-+-+-+-+-+-+  PCP Server    |     |
           /           IPv4 Addresses     /     |
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+     |
           .              ...              . optional
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+     |
           | List-Length   |    List of    |     |
           +-+-+-+-+-+-+-+-+  PCP Server    |     |
           /           IPv4 Addresses     /     |
           +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+   ---
```

                 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.

```
        0     8    16    24    32    40    48
        +-----+-----+-----+-----+-----+-----+--
        | a1  | a2  | a3  | a4  | a1  | a2  | ...
        +-----+-----+-----+-----+-----+-----+--
         IPv4 Address 1             IPv4 Address 2 ...
```

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;   Includes one or multiple lists
                            the minimum of PCP server IP addresses; each
                            length is   list is treated as a separate
                            5.          PCP server.
```

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11. References

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11.2. Informative References

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