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DHCPv4 over DHCPv6 Transport
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Abstract

This document describes a mechanism for obtaining IPv4 address and other parameters in IPv6 networks by carrying DHCPv4 messages over DHCPv6 transport.

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1. Introduction

As the migration towards IPv6 continues, IPv6 only networks will become more prevalent. However, IPv4 connectivity will continue to be provided as a service over these IPv6 only networks. In addition to providing IPv4 addresses for clients of this service, other IPv4 configuration parameters may also need to be provided, (e.g. addresses of IPv4-only services).

By conveying DHCPv4 messages over DHCPv6 transport, this mechanism can achieve dynamic provisioning of IPv4 address and other configuration parameters. In addition, it is able to leverage existing infrastructure for DHCPv4, e.g. failover, DNS updates, leasequery, etc. This mechanism is suitable for stateful allocation and management of IPv4 addresses and configuration parameters across IPv6 networks.

2. 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 [RFC2119].

3. Terminology

This document makes use of the following terms:

DHCP client: The 'DHCP client' in this document consists of both DHCPv4 and DHCPv6 client engines. The client is able to request IPv6 information through DHCPv6, as well as to request IPv4 information using DHCPv4-over-DHCPv6 transport.

4o6 Server: A DHCP server capable of processing DHCPv4 packets wrapped in the BOOTP Message Option (defined below).

DHCPv4-over-DHCPv6: A protocol described in this document, which is used to carry DHCPv4 messages encapsulated in DHCPv6 messages.

4. New DHCPv6 Messages

The following new DHCPv6 Client/Server messages are defined by this document. These are formatted as specified in Section 6 of [RFC3315].

BOOTREQUESTV6 (TBD): A client sends a BOOTREQUESTV6 message to a server, which contains a BOOTP Message Option. The BOOTP Message Option contains a BOOTREQUEST message that the client uses to request IPv4 configuration parameters from the server.

BOOTREPLYV6 (TBD): A server sends a BOOTREPLYV6 message containing a BOOTP Message Option in response to a client's BOOTREQUESTV6 message. The BOOTP Message Option contains a BOOTREPLY message in response to a BOOTREQUEST received by the server in the BOOTP Message Option of a BOOTREQUESTV6 message.

5. Architecture Overview

The architecture described in this document addresses a typical use case, whereby a DHCP client's uplink supports IPv6 only and the Service Provider's network supports IPv6 and limited IPv4 services. In this scenario, the client can only use the IPv6 network to access IPv4 services and so it must configure IPv4 services using IPv6 as the underlying transport protocol.

Although the purpose of this document is to address the problem of communication between DHCPv4 client and DHCPv4 server, the mechanism it describes does not restrict the transported types of messages to DHCPv4. BOOTP messages can be transported using the same mechanism.

DHCP clients can be running on CPE devices, end hosts or any other device which supports the DHCP client function. At the time of writing, DHCP clients on CPE devices are relatively easier to modify compared to those implemented on end hosts. As a result, this document uses the CPE as an example for describing the mechanism. This doesn't preclude end hosts from implementing the mechanism in the future.

This mechanism works by carrying encapsulated DHCPv4 messages over DHCPv6 messages. Figure 1, below, illustrates one possible deployment architecture.

The DHCP client implements a new DHCPv6 message called BOOTREQUESTV6, which contains a new option called BOOTP Message Option. The format of the option is described in Section 6.1.

The DHCPv6 packet can be transmitted either via Relay Agents or directly to the 4o6 Server. The server replies with a relevant DHCPv6 packet carrying DHCPv4 response wrapped with the BOOTP Message Option.

```
                  _____________             _____________
                 /             \           /             \
                 |             |           |             |
        +--------+-+  IPv6   +-+-----------+-+  IPv6   +-+--------+
        |   DHCP   | network |     DHCP      | network |   4o6    |
        |  Client  +---------+  Relay Agent  +---------+  Server  |
        | (on CPE) |         |               |         |          |
        +--------+-+         +-+-----------+-+         +-+--------+
                 |             |           |             |
                 \_____________/           \_____________/
```

Figure 1: Architecture Overview

The DHCPv4-over-DHCPv6 is by default disabled on the client. Before client can use this protocol it MUST obtain configuration using DHCPv6 as described in [RFC3315]. During this configuration, server MAY include DHCPv4-over-DHCPv6 Enable Option in its Reply message to indicate that client SHOULD use DHCPv4-over-DHCPv6 protocol to obtain additional configuration. The format of the DHCPv4-over-DHCPv6 Enable Option is described in Section 6.2

Typically, client communicates with the 4o6 Servers using well known All_DHCP_Relay_Agents_and_Servers multicast address. If DHCPv6 server is configured to do so, it MAY send unicast addresses of the 4o6 Servers to the client during client's configuration using DHCPv6. The unicast addresses are carried in the 4o6 Server Addresses Option encapsulated in the Reply message. The 4o6 Server Addresses Option's format is defined in Section 6.3.

6. DHCPv6 Options

6.1. BOOTP Message Option Format

The BOOTP Message option carries a BOOTP message that is sent by the client or the server. Such BOOTP messages exclude any IP or UDP headers.

The format of the BOOTP Message Option is:

```
 0                   1                   2                   3
 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_BOOTP_MSG       |           option-len          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                          BOOTP-message                        .
.                                                               .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: BOOTP Message Option Format

option-code OPTION_BOOTP_MSG (TBD)

option-len Length of BOOTP message

BOOTP-message The BOOTP message sent by the client or the server. In a BOOTREQUESTV6 message it contains a BOOTREQUEST message sent by client. In a BOOTREPLYV6 message it contains a BOOTREPLY message sent by a server in response to a client.

6.2. DHCPv4-over-DHCPv6 Enable Option Format

The DHCPv4-over-DHCPv6 Enable Option indicates that the client SHOULD enable the DHCPv4-over-DHCPv6 function.

The format of the DHCPv4-over-DHCPv6 Enable Option is:

```
 0                   1                   2                   3
 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_DHCP4_O_DHCP6_ENABLE  |           option-len          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: DHCPv4-over-DHCPv6 Enable Option Format

option-code OPTION_DHCP4_O_DHCP6_ENABLE (TBD)

option-len 0

6.3. 4o6 Servers Address Option Format

The 4o6 Servers Address Option carries unicast IPv6 addresses of the 4o6 Servers.

The format of the 4o6 Servers Address Option is:

```
 0                   1                   2                   3
 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_DHCP4_O_DHCP6_SERVERS  |           option-len          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 .                        IPv6 Address(es)                       .
 .                                                               .
 .                                                               .
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: 4o6 Servers Address Option Format

option-code OPTION_DHCP4_O_DHCP6_SERVERS (TBD)

option-len Length of the IPv6 address(es), i.e. integer times of 16.

IPv6 Address The IPv6 address(es) of the 4o6 Server(s).

7. Client Behavior

The DHCP client SHOULD request the DHCPv4-over-DHCPv6 Enable Option and the 4o6 Server Addresses Option in the Option Request Option (ORO) to launch the DHCPv4-over-DHCPv6 function.

Client MUST NOT initiate communication with 4o6 Servers before it obtains configuration using DHCPv6 as described in [RFC3315]. If client supports DHCPv4-over-DHCPv6 function it SHOULD request the DHCPv4-over-DHCPv6 Enable Option and 4o6 Server Addresses Option in the Option Request Option (ORO). DHCPv6 server MAY include these options in Reply message sent to the client. The client determines how to launch the DHCPv4-over-DHCPv6 function using the presence / absence of these two options:

o If the client doesn't receive the DHCPv4-over-DHCPv6 Enable Option, it SHOULD NOT enable the DHCPv4 over DHCPv6 function.

o If the client receives the DHCPv4-over-DHCPv6 Enable Option but no 4o6 Servers Address Option, it SHOULD enable the DHCPv4-over-DHCPv6 function, but use IPv6 multicast to communicate with the servers or relays as described above.

o If the client receives both options, it SHOULD enable the DHCPv4 -over-DHCPv6 function, and send requests to all unicast addresses conveyed by the 4o6 Server Addresses Option.

If client is instructed by the DHCPv6 server to use DHCPv4-over-DHCPv6 function it MUST generate a DHCPv4 message to obtain configuration from the 4o6 Server. This message is stored verbatim in the BOOTP Message Option carried by the BOOTREQUESTV6 message. Client MUST put exactly one BOOTP Message Option into a single BOOTREQUESTV6 message.

If client did not receive a 4o6 Server Addresses Option from the DHCPv6 server, it transmits the BOOTREQUESTV6 message as specified in Section 13 of [RFC3315]. If client received this option it MUST send BOOTREQUESTV6 message to all unicast addresses listed in the received option.

When a client receives a BOOTREPLYV6 message, it MUST look for the BOOTP Message Option within this message. If this option is not found, the BOOTREPLYV6 message is discarded. If the BOOTP Message Option is found, the client extracts the DHCPv4 message it contains and processes it as described in section 4.4 of [RFC2131].

DHCP clients are responsible for the retransmission of messages. When requesting IPv4 information, the client SHOULD follow the normal DHCPv4 retransmission requirements and strategy as specified in section 4.1 of [RFC2131]. As a result there are no explicit transmission parameters associated with a BOOTPREQUESTV6 message.

As the DHCPv4 and DHCPv6 clients are running on the same host, the client MUST implement [RFC4361] to ensure that the device correctly identifies itself.

The IPv4 address allocated from the server MAY be assigned to a different interface from the IPv6 interface requesting the information. Future documents depending on this memo MUST specify which IPv6 interface is to be used by the client for that purpose.

8. Relay Agent Behavior

When a DHCPv6 relay agent receives a BOOTREQUESTV6 message, it MUST handle the message as described in section 4 of [I-D.ietf-dhc-dhcpv6-unknown-msg].

A DHCPv6 relay agent MUST implement the Relay behaviour described in section 20.1.1 of [RFC3315].

Additionally, the DHCPv6 relay agent MAY allow the configuration of dedicated DHCPv4 over DHCPv6 specific destination addresses, differing from the addresses of the DHCPv6 only server(s). To implement this function, the relay checks the received DHCPv6 message type and forwards according to the following logic:

1. If the message type is BOOTREQUESTV6, then the DHCPv6 request is relayed to the configured DHCPv4 aware 4o6 Server's address(es).

2. For any other DHCPv6 message type, forward according to section 20 of [RFC3315].

The above logic only allows for separate relay destinations configured on the relay agent closest to the client (single relay hop). Multiple relaying hops are not considered in the case of separate relay destinations.

9. Server Behavior

When server receives a BOOTREQUESTV6 message from a client, it searches for a BOOTP Message Option. If this option is missing, the server discards the packet. The server MAY notify an administrator about the receipt of a malformed packet. The mechanism for this notification is out of scope for this document

If the server finds a valid BOOTP Message Option, it extracts the original DHCPv4 message sent by the client. This message is passed to the DHCPv4 server engine, which generates a response to the client as specified in [RFC2131]. This engine can be implemented as a built-in DHCPv4 server function of the 4o6 Server, or it can be a separate DHCPv4 server instance. Discussion regarding communication between the 4o6 Server and a DHCPv4 server engine is out of scope for this document.

When appropriate DHCPv4 response is generated, 4o6 Server places it in the payload of a BOOTP Message Option, which it puts into the BOOTREPLYV6 message.

If the BOOTREQUESTV6 message was received directly by the server, the BOOTREPLYV6 message MUST be unicast from the interface on which the original message was received.

If the BOOTREQUESTV6 message was received in a Relay-forward message, the server creates a Relay-reply message with the BOOTREPLYV6 message in the payload of a Relay Message Option, and responds as described in section 20.3 of [RFC3315].

10. Security Considerations

In this specification, DHCPv4 messages are encapsulated in the newly defined option and messages. This is similar to handling the current relay agent messages. In order to bypass firewalls or network authentication gateways, a malicious attacker may leverage this feature to convey other messages using DHCPv6, i.e. use DHCPv6 as a form of encapsulation. However, the potential risk from this is no greater than that with current DHCPv4 and DHCPv6 practice.

11. IANA Considerations

IANA is kindly requested to allocate three DHCPv6 option codes to the OPTION_BOOTP_MSG, OPTION_DHCP4_O_DHCP6_ENABLE and OPTION_DHCP4_O_DHCP6_SERVERS, and two DHCPv6 message type codes to the BOOTREQUESTV6 and BOOTREPLYV6.

12. Contributors List

Many thanks to Ted Lemon, Bernie Volz, Tomek Mrugalski, Yuchi Chen and Cong Liu, for their great contributions to the draft.

13. References

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