                 DHCP Options for 0-RTT TCP Converters
                 draft-boucadair-tcpm-dhc-converter-02

Abstract

   Because of the lack of Multipath TCP (MPTCP) support at the server
   side, some service providers now consider a network-assisted model
   that relies upon the activation of a dedicated function called
   Converters. Network-assisted MPTCP deployment models are designed to
   facilitate the adoption of MPTCP for the establishment of multi-path
   communications without making any assumption about the support of
   MPTCP by the communicating peers. Converters located in the network
   are responsible for establishing multi-path communications on behalf
   of endpoints, thereby taking advantage of MPTCP capabilities to
   achieve different goals that include (but are not limited to)
   optimization of resource usage (e.g., bandwidth aggregation), of
   resiliency (e.g., primary/backup communication paths), and traffic
   offload management.

   This document focuses on the explicit deployment scheme where the
   identity of the Converters is explicitly configured on connected
   hosts. This document specifies DHCP (IPv4 and IPv6) options to
   configure hosts with Converters parameters.

Requirements Language

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
   "OPTIONAL" in this document are to be interpreted as described in BCP
   14 [RFC2119][RFC8174] when, and only when, they appear in all
   capitals, as shown here.

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   This Internet-Draft is submitted in full conformance with the
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Table of Contents

1. Introduction

   One of the promising deployment scenarios for Multipath TCP (MPTCP,
   [RFC6824]) is to enable a host or a Customer Premises Equipment (CPE)
   connected to multiple networks (e.g., DSL, LTE, WLAN) to optimize the
   usage of such resources. A deployment scenario relies on MPTCP
   Conversion Points (Converters). A Converter terminates the MPTCP
   sessions established from a host/CPE, before redirecting traffic into
   a legacy TCP session. Further Network-Assisted MPTCP deployment and
   operational considerations are discussed in
   [I-D.nam-mptcp-deployment-considerations].

   Figure 1 shows a deployment example of the Converters to assist
   establishing MPTCP connections.

```
    +------------+         _--------_    +----------------+
    |            |        (    LTE    )   |                |
    |    Host    +=======+              +===+  Backbone    |
    |            |        (_          _)   |   Network     |
    |            |         (_____)      |+--------------+|
    |            |        IP Network #1    ||   Converter   ||------> Internet
    |            |                         ||              ||
    |            |                         |+--------------+|
    |            |        IP Network #2    |                |
    |            |         _--------_      |                |
    |            |        (    DSL    )    |                |
    |            +=======+              +==+               |
    |            |        (_          _)   |                |
    +------------+         (_____)      +----------------+
```
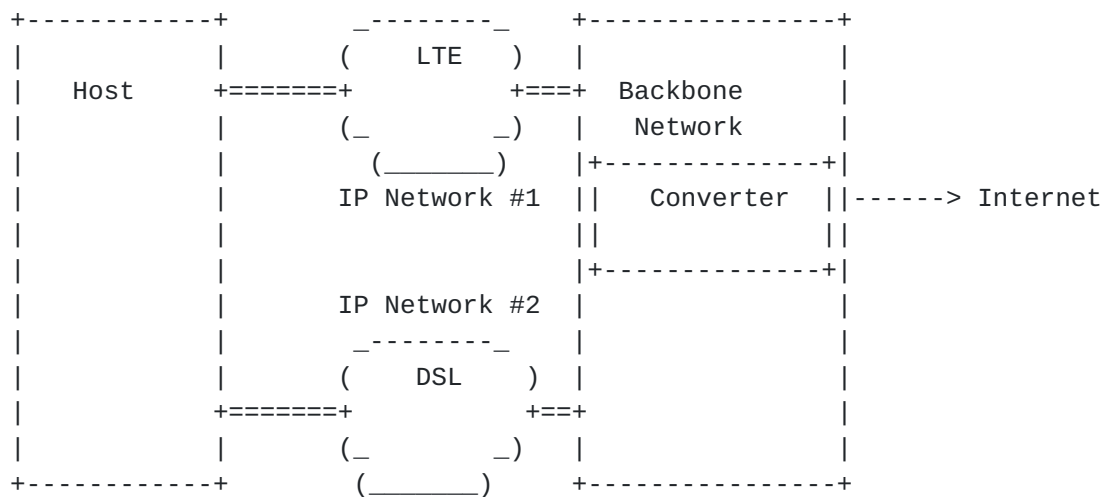
                  Figure 1: "Network-Assisted" MPTCP Design

   [I-D.ietf-tcpm-converters] specifies the Converter as a function that
   is installed by a network operator to aid the deployment of TCP
   extensions and to provide the benefits of such extensions to clients.
   A Transport Converter supports one or more TCP extensions.

   [I-D.ietf-tcpm-converters] assumes the explicit mode that consists in
   configuring explicitly the reachability information of the
   Converter(s) on a host.

   This document defines DHCPv4 [RFC2131] and DHCPv6 [RFC8415] options
   that can be used to configure hosts with Converter IP addresses.

   This specification assumes a Converter is reachable through one or
   multiple IP addresses. As such, a list of IP addresses can be
   returned in the DHCP MPTCP option. Also, it assumes the various

network attachments provided to an MPTCP-enabled host are managed by
the same administrative entity.

2. Terminology

This document makes use of the following terms:

o Converter: a function that terminates a transport flow and relays
   all data received over it over another transport flow. This
   element is located upstream in the network. One or multiple
   Converters can be deployed in the network side. The Converter
   achieves the following:

   * Listen for client sessions;
   * Receive from a client the address of the final target server;
   * Setup a session to the final server;
   * Relay control messages and data between the client and the
      server;
   * Perform access controls according to local policies.

o DHCP refers to both DHCPv4 [RFC2131] and DHCPv6 [RFC8415].
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 Converter Option

3.1. Format

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

The format of this option is shown in Figure 2. As a reminder, this
format follows the guidelines for creating new DHCPv6 options
(Section 5.1 of [RFC7227]).

```
    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_CONVERT        |          Option-length        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   |                         ipv6-address                          |
   |                                                               |
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   |                         ipv6-address                          |
   |                                                               |
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                              ...                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
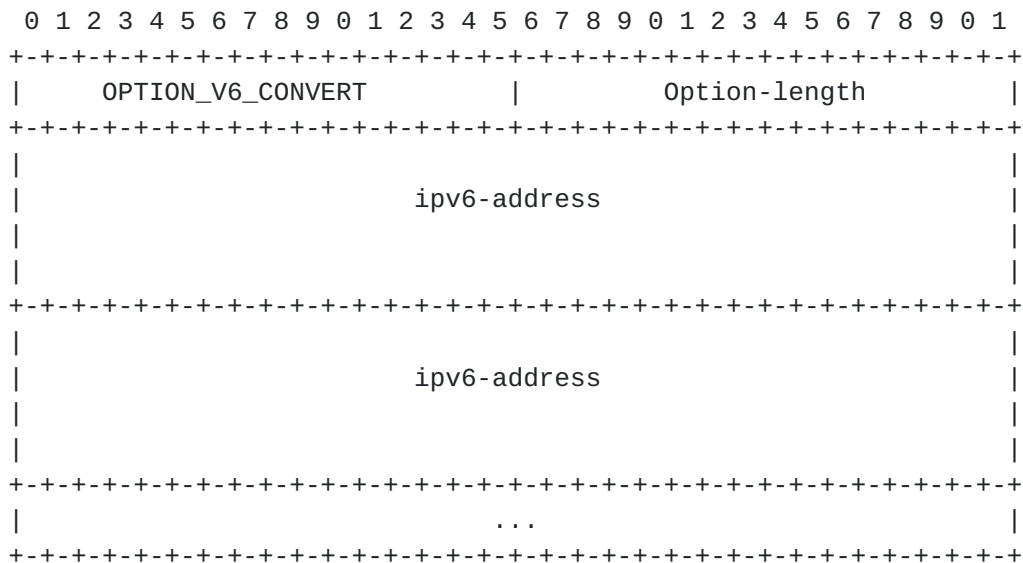
Figure 2: DHCPv6 Converter option

The fields of the option shown in Figure 2 are as follows:

o Option-code: OPTION_V6_CONVERT (TBA, see Section 6.1)
o Option-length: Length of the 'Converter IP Address(es)' field in
   octets. MUST be a multiple of 16.
o Converter IPv6 Addresses: Includes one or more IPv6 addresses
   [RFC4291] of the Converter to be used by the TCP 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 Converter to the requesting DHCPv6 client,
the DHCPv6 server returns multiple instances of OPTION_V6_CONVERT.
Some guidelines for DHCP servers are elaborated in Appendix A.

3.2. DHCPv6 Client Behavior

Clients MAY request option OPTION_V6_CONVERT, as defined in
[RFC8415], Sections 18.2.1, 18.2.2, 18.2.4, 18.2.5, 18.2.6, and 21.7.
As a convenience to the reader, we mention here that the client
includes requested option codes in the Option Request Option.

The DHCPv6 client MUST be prepared to receive multiple instances of
OPTION_V6_CONVERT; each instance is to be treated separately as it
corresponds to a given Converter: there are as many Converters as
instances of the OPTION_V6_CONVERT option.

If an IPv4-mapped IPv6 address is received in OPTION_V6_CONVERT, it
indicates that the Converter has the corresponding IPv4 address.

The DHCPv6 client MUST silently discard multicast and host loopback
addresses [RFC6890] conveyed in OPTION_V6_CONVERT.

4. DHCPv4 Converter Option

4.1. Format

The DHCPv4 Converter option can be used to configure a list of IPv4
addresses of a Converter. The format of this option is illustrated
in Figure 3.

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

              Figure 3: DHCPv4 Converter option

The fields of the option shown in Figure 3 are as follows:

o Code: OPTION_V4_CONVERT (TBA, see Section 6.2);
o Length: Length of all included data in octets. The minimum length
   is 5.
o List-Length: Length of the "List of Converter IPv4 Addresses"
   field in octets; MUST be a multiple of 4.
o List of Converter IPv4 Addresses: Contains one or more IPv4
   addresses of the Converter to be used by the TCP client. The
   format of this field is shown in Figure 4.

o OPTION_V4_CONVERT can include multiple lists of Converter IPv4
   addresses; each list is treated separately as it corresponds to a
   given Converter.

   When several lists of Converter IPv4 addresses are to be included,
   "List-Length" and "Converter IPv4 Addresses" fields are repeated.

```
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 4: Format of the List of Converter IPv4 Addresses

OPTION_V4_CONVERT is a concatenation-requiring option. As such, the
mechanism specified in [RFC3396] MUST be used if OPTION_V4_CONVERT
exceeds the maximum DHCPv4 option size of 255 octets.

Some guidelines for DHCP servers are elaborated in Appendix A.

4.2. DHCPv4 Client Behavior

To discover one or more Converters, the DHCPv4 client MUST include
OPTION_V4_CONVERT in a Parameter Request List Option [RFC2132].

The DHCPv4 client MUST be prepared to receive multiple lists of
Converter IPv4 addresses in the same OPTION_V4_CONVERT; each list is
to be treated as a separate Converter instance.

The DHCPv4 client MUST silently discard multicast and host loopback
addresses [RFC6890] conveyed in OPTION_V4_CONVERT.

5. Security Considerations

The security considerations in [RFC2131] and [RFC8415] are to be
considered.

Generic Convert security considerations are discussed in
[I-D.ietf-tcpm-converters].

MPTCP-related security considerations are discussed in [RFC6824].

Means to protect the Converter against Denial-of-Service (DoS)
attacks must be enabled. Such means include the enforcement of
ingress filtering policies at the boundaries of the network. In

order to prevent exhausting the resources of the Converter by
creating an aggressive number of simultaneous subflows for each MPTCP
connection, the administrator should limit the number of allowed
subflows per host for a given connection.

Attacks outside the domain can be prevented if ingress filtering is
enforced. Nevertheless, attacks from within the network between a
host and a Converter instance are yet another actual threat. Means
to ensure that illegitimate nodes cannot connect to a network should
be implemented.

Traffic theft is also a risk if an illegitimate Converter is inserted
in the path. Indeed, inserting an illegitimate Converter in the
forwarding path allows to intercept traffic and can therefore provide
access to sensitive data issued by or destined to a host. To
mitigate this threat, secure means to discover a Converter should be
enabled.

6. IANA Considerations

6.1. DHCPv6 Option

IANA is requested to assign the following new DHCPv6 Option Code in
the registry maintained in http://www.iana.org/assignments/
dhcpv6-parameters:

```
                 Option Name Value
                 ----------------- -----
                 OPTION_V6_CONVERT TBA
```

6.2. DHCPv4 Option

IANA is requested to assign the following new DHCPv4 Option Code in
the registry maintained in http://www.iana.org/assignments/bootp-
dhcp-parameters/:

```
      Option Name Value Data length Meaning
      ----------------- ----- ----------- ---------------------------------
      OPTION_V4_CONVERT TBA   Variable;   Includes one or multiple lists of
                              the minimum Converter IP addresses; each list
                              length is  is treated as a separate
                              5.          Converter.
```

7. Acknowledgements

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Olivier suggested to define the option as a name but that design
approach was debated several times within the dhc wg.

Thanks to Dan Seibel, Bernie Volz, Niall O'Reilly, Simon Hobson, and Ted Lemon for the feedback on the dhc wg mailing list.

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Appendix A. DHCP Server Configuration Guidelines

   DHCP servers that support the DHCP Converter option can be configured
   with a list of IP addresses of the Converter(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 Converter: the DHCP server returns multiple addresses in
       the same instance of the DHCP Converter option.

   2. distinct Converters : the DHCP server returns multiple lists of
       Converter IP addresses to the requesting DHCP client (encoded as
       multiple OPTION_V6_CONVERT or in the same OPTION_V4_CONVERT);
       each list refers to a distinct Converter.

Precisely how DHCP servers are configured to separate lists of IP
addresses according to which Converter they refer to is out of scope
for this document. However, DHCP servers MUST NOT combine the IP
addresses of multiple Converters and return them to the DHCP client
as if they were belonging to a single Converter, and DHCP servers
MUST NOT separate the addresses of a single Converter and return them
as if they were belonging to distinct Converters. For example, if an
administrator configures the DHCP server by providing a Fully
Qualified Domain Name (FQDN) for a Converter, 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 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.

Since this option requires support for IPv4-mapped IPv6 addresses, a
DHCPv6 server implementation will not be complete if it does not
query A records and represent any that are returned as IPv4-mapped
IPv6 addresses in DHCPv6 responses. 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 [RFC7969].

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