**DHCPv6 Options for configuration of Softwire Address and Port Mapped
Clients**
draft-ietf-softwire-map-dhcp-04

Abstract

   This document specifies DHCPv6 options, termed Softwire46 options,
   for the provisioning of Softwire46 Customer Edge (CE) devices.
   Softwire46 is a collective term used to refer to architectures based
   on the notion of IPv4 Address+Port (A+P) for providing IPv4
   connectivity across an IPv6 network, as specified by the IETF
   Softwires Working Group, including those where the IPv4 A+P
   parameters are optionally derived from the CE's IPv6 network prefix
   by algorithmic means.

Status of this Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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1. Introduction

A number of architectural solution proposals formed in the IETF
Softwires Working Group use Address and Port (A+P) [RFC6346] as their
technology base in providing IPv4 connectivity service to end users
using CE devices and doing so across a service provider's IPv6
network, while also allowing for shared or dedicated IPv4 addressing
of the CEs. This document specifies DHCPv6 options for the
provisioning of such Softwire A+P based Customer Edge (CE) devices,
referred to collectively as Softwire46 options.

Examples of such proposals are those of Mapping of Address and Port
(MAP) defined in [I-D.ietf-softwire-map], [I-D.ietf-softwire-map-t],
and [I-D.ietf-softwire-lw4over6]. In all cases the solution
architecture consists of one or more domain gateways (e.g. a MAP
Border Relay or lw46 AFTR), responsible for forwarding between an
IPv6 network domain and external public IPv4 network, and one or more
Customer Edge (CE) routers, responsible for forwarding between a
user's private IPv4 network and the IPv6 network domain.
Collectively the CE and domain router form a domain when configured
with common service parameters. These parameters consist primarily
of the IPv4 address and the transport layer port-range(s) that each
CE should use in the domain, as well as the parameters for the IPv6
network transport mode (e.g. Encapsulation or translation, address
of the domain gateway, etc). Depending on the characteristics of the
domain, the IPv4 address and port parameters can be optionally
algorithmically derived from the CE's native end-user IPv6 prefix.
Networks with numerous CEs require dynamic configuration of these
parameters on CEs, which forms the requirement for a dynamic
provisioning mechanism using DHCPv6 [RFC3315] options that are the
subject of this document. The means of configuration of the domain's
gateway is outside the scope of this document.

2. Conventions

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].

3. Softwire46 Service Information

The following presents the information parameters that are used to
configure a Softwire46 CE and defined in this document:
o A Basic Rule (BR). This rule governs the A+P configuration of the
   CE in terms of deriving the CEs IPv4 address and port range(s) as
   well as completing the CE's IPv6 address for the S46 service when

      needed. Key parameters of a BR include: i) The IPv4 Prefix - Used
      to derive the CE's IPv4 address; ii) The Embedded Address bit
      length - Used to derive how many, if any, of the CE's end-user
      IPv6 prefix are to be mapped to its IPv4 address and port-set.
      iii) The IPv6 prefix - used to scope the CE's IPv6 domain for the
      S46 service

   o A Forwarding Rule (FR). This rule governs the forwarding
      behaviour to destinations covered by the rule expressed in terms
      of an IPv4 prefix.

   o Port Parameters: The specification allows flexibility in the level
      of automation a CE uses to derive its transport layer port-ranges,
      ranging from full derivation of this parameter from the CE's IPv6
      prefix, to full parametrization of configuration independent of
      the CE's IPv6 prefix.

4. DHCPv6 Softwire46 Options

   The DHCPv6 protocol is used for Softwire46 CE provisioning following
   regular DHCPv6 notions, with the CE assuming the role of a DHCPv6
   client, and the DHCPv6 server providing options following typical
   DHCPv6 server side policies. The format and usage of the options is
   defined in the following sub-sections. Examples of use of the option
   as are presented in Section 8.

4.1. Softwire46 Options Cardinality

   When requested by clients by means of an DHCPv6 Option Request Option
   a server SHOULD return one Softwire46 Container Option for each
   Softwire46 domain that a given CPE is determined to belong to.
   Typically a CE will belong to only one domain, multiple CEs can also
   be part of a single domain and thus share their Softwire46 service
   configuration. The means of determining the domain of a given client
   is by following typical DHCPv6 server policies and not specified by
   this document.

   A returned Softwire46 Container Option MAY include one or more Rule
   Options.

4.2. Softwire46 Container Option

   This S46 Container Option specifies the container used to group all
   rules and optional port parameters for a specified domain.

```
 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_S46            |          option-length        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+            encapsulated-options (variable length)            .
.                                                               .
+---------------------------------------------------------------+
```
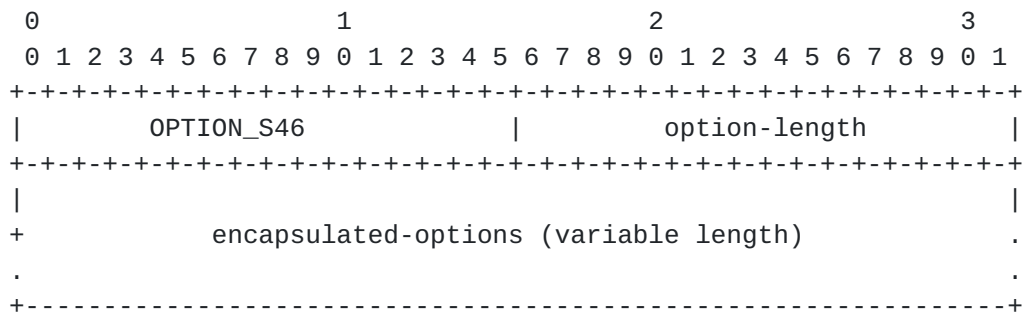
Figure 1: MAP Container Option

o option-code: OPTION_S46 (TBD1)
o option-length: Length of encapsulated options
o encapsulated-options: options associated with this Softwire46
   domain.

Currently there are two options that MAY appear encapsulated as sub-
options in the Container Option: OPTION_S46_BRULE and
OPTION_S46_FRULE. Other options suitable for a domain may be defined
in the future. A DHCP message MAY include multiple S46 Container
Options (representing multiple domains), but typically it will have
only one.

4.3. S46 Basic Rule Option

Figure 2 shows the format of the S46 Rule option used for conveying
the Basic Rule that is used for determining the key A+P
characteristics intended for the client.

A server MAY send more than one S46 Basic Rule Option, if it is
configured to do so. Clients MUST NOT send a S46 Rule Option.

```
    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_S46_BRULE         |         option-length         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |  prefix4-len  |               rule-ipv4-prefix                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | (continued)   |    ea-len     |   prefix6-len  |               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+               |
   |                        rule-ipv6-prefix                        |
   |                        (variable length)                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   .             encapsulated-options (variable length)            .
   .                                                               .
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

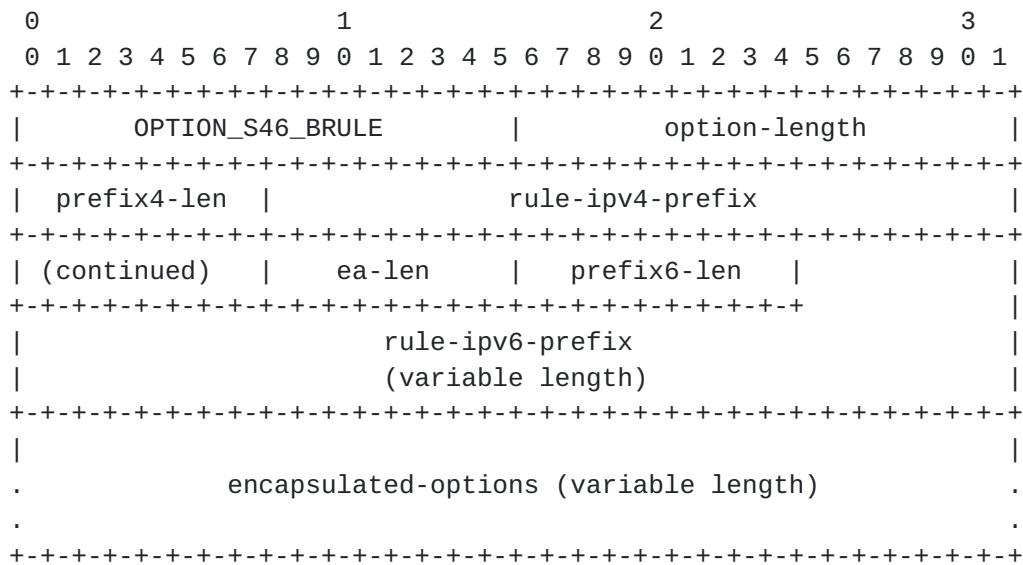   Figure 2: S46 Basic Rule Option

   o option-code: OPTION_S46_BRULE (TBD2)
   o option-length: length of the option, excluding option-code and
      option-length fields, including length of all encapsulated
      options, expressed in bytes.
   o prefix4-len: 8 bits long field expressing the bit mask length of
      the IPv4 prefix specified in the rule-ipv4-prefix field. Allowed
      values are 0 to 32.
   o rule-ipv4-prefix: a fixed length 32 bit field that specifies the
      IPv4 prefix for the S46 rule.
   o ea-len: 8 bits long field that specifies the Embedded-Address (EA)
      bit length. Values allowed range from 0 to 48. A value of 0
      signifies no embedded address.
   o prefix6-len: 8 bits long field expressing the bit mask length of
      the IPv6 prefix specified in the rule-ipv6-prefix field. Allowed
      values are 0 to 128.
   o rule-ipv6-prefix: a variable length field that specifies the IPv6
      domain prefix for the S46 rule. The field is padded with follow
      up zero bits up to the nearest octet boundary when prefix6-len is
      not divisible by 8.
   o encapsulated options: a variable field that may contain zero or
      more options that specify additional parameters for this S46 rule,
      e.g. a Port Parameter Option.

4.4. S46 Forwarding Rule Option

   Figure 3 shows the format of the S46 Forwarding Rule option used for
   conveying a Forwarding Rule that governs the IPv4 forwarding
   behaviour for destinations covered by the rule.

A server MAY send more than one S46 Forwarding Rule Option, if it is
configured to do so. Clients MUST NOT send a S46 Rule Option.

```
     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_S46_FRULE        |          option-length        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |  prefix4-len  |               rule-ipv4-prefix                |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | (continued)   |    ea-len     |   prefix6-len   |             |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+             |
    |                         rule-ipv6-prefix                      |
    |                         (variable length)                     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    .               encapsulated-options (variable length)        .
    .                                                               .
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                   Figure 3: S46 Forwarding Rule Option

o option-code: OPTION_S46_FRULE (TBD2)
o option-length: length of the option, excluding option-code and
   option-length fields, including length of all encapsulated
   options, expressed in bytes.
o prefix4-len: 8 bits long field expressing the bit mask length of
   the IPv4 prefix specified in the rule-ipv4-prefix field. Valid
   values 0 to 32.
o rule-ipv4-prefix: a fixed length 32 bit field that specifies the
   IPv4 prefix for the S46 rule.
o ea-len: 8 bits long field that specifies the Embedded-Address (EA)
   bit length. Values allowed range from 0 to 48. A value of 0
   signifies no embedded address.
o prefix6-len: 8 bits long field expressing the bit mask length of
   the IPv6 prefix specified in the rule-ipv6-prefix field. Allowed
   values are 0 to 128.
o rule-ipv6-prefix: a variable length field that specifies the IPv6
   domain prefix for the S46 rule. The field is padded with follow
   up zero bits up to the nearest octet boundary when prefix6-len is
   not divisible by 8.
o encapsulated options: a variable field that may contain zero or
   more options that specify additional parameters for this S46 rule,
   e.g. a Port Parameter Option.

4.5. **S46 Port Parameters Option**

   The S46 Port parameters Option conveys information used for
   determining the transport port-range(s) to be used by the client.
   The port-range is generally represented by an index, the Port Set
   Identifier (PSID), that pertains to a given port-indexing reversible
   algorithm.

   When used, the option MUST appear as encapsulated option in S46 Basic
   or Forwarding Rule options and it MUST NOT appear directly in a
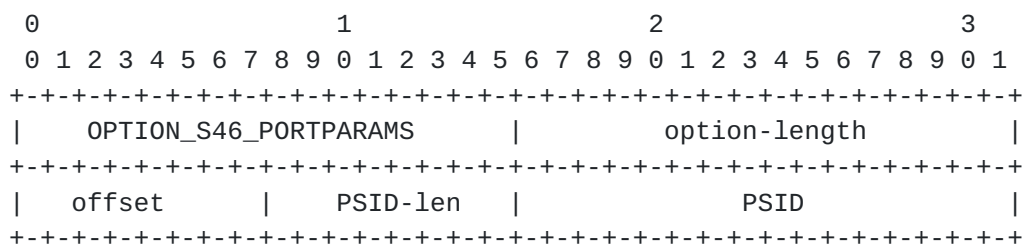   message.

```
 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_S46_PORTPARAMS      |         option-length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   offset     |   PSID-len     |             PSID              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                   Figure 4: S46 Port Parameters Option

   o option-code: OPTION_S46__PORTPARAMS (TBD4)
   o option-length: 4
   o offset: (PSID offset) 8 bits long field that specifies the numeric
      value for the S46 algorithm's excluded port range/offset bits
      (a-bits), as per section 5.1.1 in [I-D.ietf-softwire-map].
      Allowed values are between 0 and 15. 0 means no exclusion.
   o PSID-len: 8 bits long field expressing the bit length value of the
      number of significant bits in the PSID field (also known as 'k'
      bits). When set to 0, the PSID field is to be ignored.
   o PSID: Explicit 16-bit (unsigned word) PSID value. The first
      k-bits on the left of this 2-octets field is the PSID value. The
      remaining (16-k) bits on the right are padded with zeros.
   The numeric sum of offset and PSID-len MUST NOT exceed 16.

4.6. **Definition of Alternative Port Paramaters Option**

   Given that all the S46 options in this document are regular DHCPv6
   options (with global option codes), alternative port parameters
   options relating to alternative port-indexing methods and intended
   for use along with the S46 options can be defined following DHCPv6
   extension procedures [I-D.ietf-dhc-option-guidelines].

5. DHCPv6 Server Behavior

   RFC 3315 Section 17.2.2 [RFC3315] describes how a DHCPv6 client and
   server negotiate configuration values using the ORO. As a
   convenience to the reader, we mention here that a server will by
   default not reply with a S46 Rule Option if the client has not
   explicitly enumerated it on its Option Request Option.

   A Server following this specification MUST allow the configuration of
   one or more S46 Rule Options, and optional Port Parameters Option and
   SHOULD send such options grouped under a single S46 Container Option.
   The server SHOULD allow the S46 Rule Options to be part of a wider
   set of options returned to a client.

   The DHCPv6 Server MUST use a S46 Container Option, which encapsulates
   all S46 Basic and Forwarding Rules, as well as Port parameters
   Options, when sending responses to clients that requested S46
   configuration.

   A DHCPv6 server that is enabled to provision requesting CE's with
   Softwire46 options MUST include exactly one OPTION_S46 option in a
   REPLY message for each domain the CE is determined to be part of - by
   default this is one domain.

6. DHCPv6 Client Behavior

   A CE acting as DHCPv6 client will request S46 configuration to be
   assigned from a DHCPv6 server located in the IPv6 network. Such a
   client SHOULD request OPTION_S46 option in its ORO in SOLICIT,
   REQUEST, RENEW, REBIND and INFORMATION-REQUEST messages. The other
   S46 options MAY also be included as options in the ORO.

   When processing received S46 options the following behaviour is
   expected:
   o A client MUST support processing multiple received
      OPTION_S46_FRULE options in a container OPTION_S46 option.
   o A client MUST use the contents of the OPTION_S46_BRULE rule-ipv6-
      prefix parameter to determine the IPv6 interface prefix to select
      for the S46 service, for example by performing a longest match
      between the rule-ipv6-prefix and the locally configured
      interfaces. A null rule-ipv6-prefix (rule6-prefix-len = 0)
      communicates to the client that any IPv6 prefix can be used from
      the interface as used by the DHCPv6 client receiving this option.
   o The contents of the OPTION_S46_FRULE convey information about the
      mode that the client should use for transporting IPv4 traffic
      across the IPv6 network. A client receiving an OPTION_S46_FRULE
      with an 0/0 IPv4 prefix (i.e. prefix4-len parameter = 0) and

prefix6-len length of 128 SHOULD assume encapsulation mode
[RFC2473] of IPv6 transport. Conversely, when the received option
has a prefix length shorter than 128, the client SHOULD assume a
stateless NAT46 [RFC6145] translation mode of IPv6 transport.
Clients not supporting the intended mode of transport SHOULD
discard the option and log an "DHCP S46 FRule Option received
requires form of IPv6 transport not supported by this device"
message, or similar.

o   The presence of a OPTION_S46_BRULE option indicates to the CE that
    NAPT44 mode of operation is to be used, and the conveyed A+P
    parameters applied. Conversely, the absence of an
    OPTION_S46_BRULE option indicates that NAPT44 mode is not required
    and SHOULD be disabled. This allows the client to be compatible
    for use with [RFC6333] architectures*.

o   The processed contents of the OPTION_S46_FRULE and
    OPTION_S46_FRULE override any previously acquired rules for the
    domain.

*Note: An operator intending to use the client in a [RFC6877]
architecture, can provision all clients with the same
OPTION_S46_BRULE passing in the rule-ipv4-prefix any suitable RFC1918
IPv4 address. This would be sufficient to allow a NAT64 capable
client (e.g. a MAP-T CE) to be used in stateful core NAT64
deployments, besides stateless NAT64.

6.1. Processing of information by clients supporting MAP

Clients using the MAP algorithm MUST be capable of applying the
received S46 option parameters for the configuration of the local MAP
service: The MAP Base Mapping Rule (BMR) and Forward Mapping Rule
(FMR) parameters are to be derived from the OPTION_S46_BRULE and
OPTION_S46_FRULE Options respectively and MUST be used to configure
the CE's MAP service characteristics as per Section 5 of
[I-D.ietf-softwire-map], including the CE's MAP interface address.

When processing OPTION_S46_FRULE containing an parameter of prefix4-
len = 0, a MAP CE client SHOULD determine the MAP BR's address or
prefix [I-D.ietf-softwire-map-t], from the OPTION_S46_FRULE as
follows:

o   If the prefix6-len parameter is 128, the BR's address is contained
    in the rule-ipv6-prefix parameter. This forms the MAP BR address
    for MAP-E.

o   If the prefix6-len parameter is <128, the BR's prefix is contained
    in the rule-ipv6-prefix parameter. This forms the Default Mapping
    Rule (DMR) for MAP-T.

o   In either of the above cases, the determined parameter MUST
    override the MAP BR's address or prefix parameter that was
    determined using other** means.

**Note: The MAP CE's BR's address or prefix, as well as implicit
encapsulating or translating mode of operation may be derived using
other means, such as [RFC6334] or
[I-D.ietf-behave-nat64-discovery-heuristic]. This allows for the
deployment of MAP CEs in existing DS-Lite or 464xlat deployments. If
the operator prefers to utilize these other means, then the
Forwarding Rule Option with the 0/0 IPv4 parameter is simply not
distributed.

The MAP algorithm, as per Section 5.1 [I-D.ietf-softwire-map], allows
the port-indexing algorithm to be paramaterized in terms of an
excluded port range (a-bits) and an explicit Port Set ID (PSID)
value, which can be conveyed via the S46 Port Paramaters Option .
The following behaviour is expected when processing this option by
MAP clients: A client receiving a S46 Port parameters Option in an
OPTION_S46_BRULE or OPTION_S46_FRULE whose derived IPv4 address is
not 32 bit-long MUST discard the option. The formula for this check
is "prefix4-len + ea-len == 32". This is to ensure that the explicit
PSID is only applied to configurations with a completely formed IPv4
address.

When received in an OPTION_S46_BRULE, the MAP CE client MUST use the
contents of S46 Port Option for configuring its MAP Basic Mapping
Rule (BMR), and similarly, it MUST use the contents for configuring
its MAP Forward Mapping Rule (FMR) when received in an
OPTION_S46_FRULE.

7. DHCPv6 Deployment Considerations

The usage of the S46 Option(s) is intended for stateless server
operation, whereby for any given client, the server establishes no
dynamic state regarding the S46 options that are sent to the client.
For cases that require per client configuration, the DHCPv6 server
needs to have means to access a per-client option configuration
store. This is commonly realized and utilized DHCPv6 server
platforms servers using back-end mechanisms such as [RFC4510] for
example. This type of DHCP server and configuration store deployment
is recommended when the intent is to utilize full IPv4-IPv6 address
independence of any given CE, by issuing unique options to each CE.

In typical MAP deployments, many clients will belong to one of a few
MAP domains, with the same MAP domain level configuration applicable
to of its clients. The DHCPv6 server is then expected to provide the
same set of MAP Option(s) to all clients in a given domain, governed
by a regular DHCP server policy.

Domains that require more extensive IPv4 client configuration

options, i.e. More extensive than those possible by means of DHCPv6
in conjunction with the options in this document, should consider the
use of DHCPv4 over IPv6 as specified in
[I-D.ietf-dhc-dhcpv4-over-ipv6].

8. S46 Options Examples

This section presents some examples of the use of the S46 Options.

8.1. Basic Rule with no embedded address bits and no IPv4 address sharing

Example 1 - Basic Rule:

   This example demonstrates the use of Basic Rule Option to
   convey to a client a non-shared IPv4 address 192.0.2.1/32.
   It is applicable to any S46 architecture. The end-user ipv6
   prefix is assumed to be 2001:db8:0012:3400::/56.


```
DHCPv6_S46_OPTION:
          option-length: 18
  DHCPv6_S46_BRULE_OPTION:
          option-length: 14
          prefix4-len: 32
          rule-ipv4-prefix: 192.0.2.1
          ea-len: 0
          prefix6-len: 56
          rule-ipv6-prefix: 2001:db8:0012:34
```

8.2. **Basic Rule Option Example with shared addressing and MAP**

   Example 2 - Basic Rule with MAP:

      Given an IPv6 prefix assigned to the end-user:
      2001:db8:0012:3400::/56, the following DHCPv6 S46_BRULE_OPTION
      allows a client to derive its basic A+P configuration
      for a shared address domain. The shared IPv4 subnet is
      192.0.2.0/24.

      DHCPv6_S46_OPTION:
              option-length: 14
        DHCPv6_S46_BRULE_OPTION:
              option-length: 10
              prefix4-len: 24
              rule-ipv4-prefix: 192.0.2.0
              ea-len: 16
              prefix6-len: 40
              rule-ipv6-prefix: 2001:db8:00

      Using the above a MAP CE node will determine the IPv4 address
      and port-set as shown below:

      EA bits offset: 40
      IPv4 suffix bits (p) Length of IPv4 address (32) - IPv4 prefix
         length (24) = 8
      IPv4 address 192.0.2.18 (0xc0000212)
      PSID start: 40 + p = 40 + 8 = 48
      PSID length (q): o - p = (End-user prefix len -
         rule IPv6 prefix len) - p = (56 - 40) - 8 = 8
      PSID derived from IPv6 end-user-prefix: 0x34

      Available ports (63 ranges) : 1232-1235, 2256-2259, ... ,
                                    63696-63699, 64720-64723

      IPv6 address of MAP CE: 2001:db8:0012:3400:0000:c000:0212:0034

8.3. **Forwarding Rule Option Example with MAP mesh mode**

Example 3 - Mesh mode Forwarding Rule:

Given an IPv6 prefix assigned to the end-user:
2001:db8:0012:3400::/56, the following
DHCPv6 S46_FRULE_OPTION allows the client to communicate
directly with other CEs in the domain addressed by
the 192.0.2.0/24 prefix.

DHCPv6_S46_OPTION:
            option-length: 14
   DHCPv6_S46_FRULE_OPTION:
            option-length: 10
            prefix4-len: 24
            rule-ipv4-prefix: 192.0.2.0
            ea-len: 16
            prefix6-len: 40
            rule-ipv6-prefix: 2001:db8:00

[8.4](). Basic Rule Option Example with MAP and explicit PSID

   Example 4 - Basic Rule with PSID:

      Given an IPv6 prefix assigned to the end-user:
      2001:db8:0012:3400::/56, the following DHCPv6 S46_BRULE_OPTION
      allows a client to derive its basic A+P configuration
      for a shared MAP address domain with no relation to the
      IPv6 end-user prefix.

      DHCPv6_S46_OPTION:
                option-length: 34
        DHCPv6_S46_BRULE_OPTION:
                option-length: 30
                prefix4-len: 32
                rule-ipv4-prefix: 192.0.2.1
                ea-len: 0
                prefix6-len: 56
                rule-ipv6-prefix: 2001:db8:0000:00
          DHCPv6_S46_PORTPARAMS_OPTION:
                option-length: 4
                rsv: 0
                offset: 6
                rsv: 0
                PSID-len: 8
                PSID: 0x20

      The Basic Rule information allows a MAP CE also to determine
      its full IPv6 address by combining the IPv6 prefix with the MAP
      interface identifier (that embeds the IPv4 address and PSID).

      IPv6 address of MAP CE: 2001:db8:0012:3400:0000:c000:0212:0034

      Note that the IPv4 address and PSID is not derived from the IPv6
      prefix assigned to the CE, but provisioned separately using for
      example MAP options in DHCPv6.

8.5. Forwarding Rule Option example for MAP-T DMR prefix

   Example 5 - Forwarding Rule for MAP-T:

      Given an IPv6 prefix assigned to the end-user:
      2001:db8:0012:3400::/56, the following DHCPv6 S46_FRULE_OPTION
      allows a client to derive its MAP-T's DMR prefix.

      DHCPv6_S46_OPTION:
                 option-length: 19
         DHCPv6_S46_FRULE_OPTION:
                 option-length: 15
                 prefix4-len: 0
                 rule-ipv4-prefix: 0.0.0.0
                 ea-len: 0
                 prefix6-len: 64
                 rule-ipv6-prefix: 2001:db8:ffff:0000

      Using the above a MAP CE node will install a DMR using
      prefix 2001:db8:ffff/64.

9. IANA Considerations

   IANA is kindly requested to allocate the following DHCPv6 option
   codes: TBD1 for OPTION_S46, TBD2 for OPTION_S4_BRULE, TBD3 for
   OPTION_S46_FRULE, and TBD4 for OPTION_S46_PORTPARAMS. All values
   should be added to the DHCPv6 option code space defined in Section
   24.3 of [RFC3315].

10. Security Considerations

   Implementation of this document does not present any new security
   issues, but as with all DHCPv6-derived configuration state, it is
   completely possible that the configuration is being delivered by a
   third party (Man In The Middle). As such, there is no basis to trust
   that the access over the S46 service can be trusted, and it should
   not therefore bypass any security mechanisms such as IP firewalls.

   Readers concerned with security of provisioning over DHCPv6 are
   encouraged to read [I-D.ietf-dhc-secure-dhcpv6].

   Section 23 of [RFC3315] discusses DHCPv6-related security issues.

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12. References

12.1. Normative References

[RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
            Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2473]   Conta, A. and S. Deering, "Generic Packet Tunneling in
            IPv6 Specification", RFC 2473, December 1998.

[RFC3315]   Droms, R., Bound, J., Volz, B., Lemon, T., Perkins, C.,
            and M. Carney, "Dynamic Host Configuration Protocol for
            IPv6 (DHCPv6)", RFC 3315, July 2003.

12.2. Informative References

[I-D.ietf-behave-nat64-discovery-heuristic]
            Savolainen, T., Korhonen, J., and D. Wing, "Discovery of
            the IPv6 Prefix Used for IPv6 Address Synthesis",
            draft-ietf-behave-nat64-discovery-heuristic-17 (work in
            progress), April 2013.

[I-D.ietf-dhc-dhcpv4-over-ipv6]
            Cui, Y., Wu, P., Wu, J., and T. Lemon, "DHCPv4 over IPv6
            Transport", draft-ietf-dhc-dhcpv4-over-ipv6-06 (work in
            progress), March 2013.

[I-D.ietf-dhc-option-guidelines]
            Hankins, D., Mrugalski, T., Siodelski, M., Jiang, S., and
            S. Krishnan, "Guidelines for Creating New DHCPv6 Options",
            draft-ietf-dhc-option-guidelines-12 (work in progress),
            June 2013.

   [I-D.ietf-dhc-secure-dhcpv6]
             Jiang, S. and S. Shen, "Secure DHCPv6 Using CGAs",
             draft-ietf-dhc-secure-dhcpv6-07 (work in progress),
             September 2012.

   [I-D.ietf-softwire-lw4over6]
             Cui, Y., Sun, Q., Boucadair, M., Tsou, T., Lee, Y., and I.
             Farrer, "Lightweight 4over6: An Extension to the DS-Lite
             Architecture", draft-ietf-softwire-lw4over6-00 (work in
             progress), April 2013.

   [I-D.ietf-softwire-map]
             Troan, O., Dec, W., Li, X., Bao, C., Matsushima, S.,
             Murakami, T., and T. Taylor, "Mapping of Address and Port
             with Encapsulation (MAP)", draft-ietf-softwire-map-07
             (work in progress), May 2013.

   [I-D.ietf-softwire-map-t]
             Li, X., Bao, C., Dec, W., Troan, O., Matsushima, S., and
             T. Murakami, "Mapping of Address and Port using
             Translation (MAP-T)", draft-ietf-softwire-map-t-03 (work
             in progress), July 2013.

   [RFC4510] Zeilenga, K., "Lightweight Directory Access Protocol
             (LDAP): Technical Specification Road Map", RFC 4510,
             June 2006.

   [RFC6145] Li, X., Bao, C., and F. Baker, "IP/ICMP Translation
             Algorithm", RFC 6145, April 2011.

   [RFC6333] Durand, A., Droms, R., Woodyatt, J., and Y. Lee, "Dual-
             Stack Lite Broadband Deployments Following IPv4
             Exhaustion", RFC 6333, August 2011.

   [RFC6334] Hankins, D. and T. Mrugalski, "Dynamic Host Configuration
             Protocol for IPv6 (DHCPv6) Option for Dual-Stack Lite",
             RFC 6334, August 2011.

   [RFC6346] Bush, R., "The Address plus Port (A+P) Approach to the
             IPv4 Address Shortage", RFC 6346, August 2011.

   [RFC6877] Mawatari, M., Kawashima, M., and C. Byrne, "464XLAT:
             Combination of Stateful and Stateless Translation",
             RFC 6877, April 2013.

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