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Dynamic Host Configuration Protocol (DHCP) Options for Port Set Assignment
draft-wu-dhc-port-set-option-00

Abstract

   Due to the exhaustion of global IPv4 address space, there are demands
   arising for IPv4 address sharing between end users. In such context,
   different users can employ the same address, but different ports.
   This document defines two DHCP options for assigning a set of ports
   to a device. One is used for allocating continuous port set, while
   the other is designed for non-continuous port set allocation.

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[1](#). Introduction

   Due to the exhaustion of global IPv4 address space, there are demands
   arising for IPv4 address sharing between end users, especially in
   IPv4-over-IPv6 scenarios. With address sharing, different users can
   employ the same address, but different port space. In such cases,
   during the address provisioning process, the port numbers a user
   device can use should be allocated as well.

   This document defines two DHCPv4 options to carry the specific
   parameters for port set assignment. The Continuous Port Set Option
   is used for allocating continuous port set, while the Noncontinuous
   Port Set Option is designed for non-continuous port set allocation.

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. DHCP Option Format

   The format and usage of the two options are defined in the following
   sections.

3.1. Continuous Port Set Option

   This option specifies the min and max port number assigned to a DHCP
   client, which determines a continuous port range. Figure 1 shows the
   bit-representation of the option.

```
        0                               1
        0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
       +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
       |   OPTION_CON_PORT_SET   |     option-length      |
       +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
       |                Min Port Number                 |
       +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
       |                Max Port Number                 |
       +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

   Figure 1 Continuous Port Set Option Format

   o option-code: OPTION_CON_PORT_SET(TBD1)

   o option-length: An 8-bit field indicating the length of the option
      excluding the 'Option Code' and the 'Option Length' fields. In
      this option, its value is 4 octets.

   o Min Port Number: The minimum port number in the port range. The
      value of Min Port Number MUST be within 0~65535.

   o Max Port Number: The maximum port number in the port range. The
      value of Max Port Number MUST be within 0~65535, and not smaller
      than the value of Min Port Number.

   Section 4.1 further explains the above parameters with an example.

3.2. Noncontinuous Port Set Option

   There can be requests for noncontinuous port set. This option caters
   to such requirements. In this option, the PSID is short for Port-Set
   ID which identifies a set of ports exclusively assigned to a device.
   It is defined in the MAP draft
   [I-D.mdt-softwire-mapping-address-and-port], and so are PSID Offset
   and the parameters of (a,k,m) used below. Figure 2 shows the format
   of the Noncontinuous Port Set Option.

```
     0                               1
     0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
   +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
   |  OPTION_NCON_PORT_SET  |     option-length    |
   +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
   |      PSID Offset       |      PSID length     |
   +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
   |                       PSID                    |
   +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

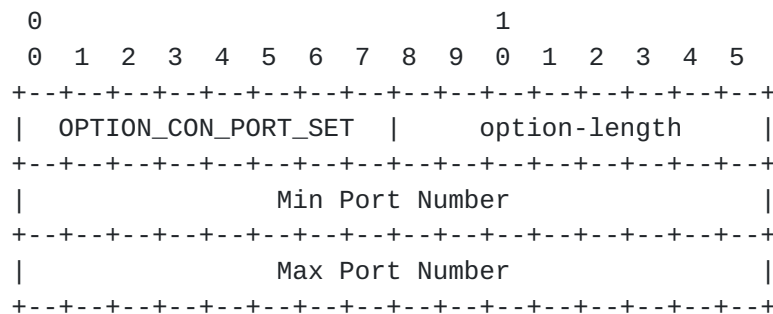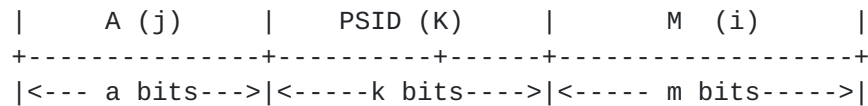Figure 2 Noncontinuous Port Set Option Format

o   option-code: OPTION_NCON_PORT_SET(TBD2)

o   option-length: An 8-bit field indicating the length of the option
    excluding the 'Option Code' and the 'Option Length' fields. In
    this option, the option-length is 4 octets.

o   PSID Offset(a): PSID Offset in MAP (also known as 'a'). The first
    'a' bits in the port number are used to exclude the well-known
    ports, as well as to represent the port range index. If 'a' is
    larger than 0, ports 0 ~ 2^(16-a)-1 are reserved from allocation,
    and a port set has 2^a-1 port ranges with different port range
    index. If 'a' is 0, the whole port range (0~65535) can be
    assigned by the server, and the port set has only one port range
    and thus becomes continuous.

o   PSID length(k): The length of PSID in bits(also known as 'k').
    After the first 'a' bits, there are k bits in the port number
    representing value of PSID. Subsequently, the address sharing
    ratio would be 2^k.

o   PSID: PSID in MAP. The PSID value algorithmically identifies a
    set of ports assigned to a CE. 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 padding zeros.

In the context of noncontinuous port set, as is defined in Section
5.1.1 of [I-D.mdt-softwire-mapping-address-and-port], the port number
consist of Port Range Index (A(j) in Figure 3, a bits), PSID (k bits)
and Continuous Port Index (M(i) in Figure 3, m bits). For the
readers' convenience, the format of the port number is included in
this draft as well. i,j, A(j) and M(i) are the same as the definition
in the GMA port mapping algorithm
[I-D.mdt-softwire-mapping-address-and-port]

```
     0                                              15
   +---------------+----------------+------------------+
```

```
        |     A (j)     |   PSID (K)   |      M  (i)       |
        +---------------+----------+------+------------------+
        |<--- a bits--->|<-----k bits---->|<----- m bits----->|
```

Figure 3 Bit Representation of a GMA port number

If PSID Offset is greater than 0(a > 0), j MUST be larger than 0, in
order to exclude the system ports ([I-D.ietf-tsvwg-iana-ports]) or
ports saved by SPs. If a = 0, j may be 0 to allow the provisioning
of the reserved ports. With a given sharing ratio (2^k) and the PSID
value, the ports assigned to a client can be calculated by increasing
i and j continuously. Section 4.2 explains the algorithm further
with an example.

4. Option Examples

4.1. Continuous Port Set Option Example

   A Continuous Port Set Option example with the assigned port range
   4096~8191 is as follows. There is no specific requirement on the
   port number format.

```
         0                           1
         0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        |   OPTION_CON_PORT_SET  |             4          |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        |                      4096                       |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        |                      8191                       |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

   Example 1 Continuous Port Set Option Example

4.2. Noncontinuous Port Set Option Example

   Here is an example of Noncontinuous Port Set Option, with PSID offset
   4, PSID length 10 and PSID value 1021 (i.e. $a = 4$, $k = 10$ and PSID =
   1021):

```
         0                           1
         0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | OPTION_NCON_PORT_SET  |             4          |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        |          4          |             10           |
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
        | 1  1  1  1  1  1  1  1  0  1  0  0  0  0  0  0|
        +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

   Example 2 Noncontinuous Port Set Option Example ($a = 4$, $k = 10$, PSID
   = 1021)

   The first 10 bits of the last two octets(11 1111 1101) are the value
   of PSID. And the allocated port ranges are:

```
              Port-range-1                   Port-range-2
    PSID=1021| 8180, 8181, 8182, 8183, | 12276, 12277, 12278, 12279,| ...
```

   All these port ranges form the full port set.

The port set calculation procedure of a client when receiving the
parameters of (a,k,PSID) follows the GMA algorithm proposed in
section 5.1 of [I-D.mdt-softwire-mapping-address-and-port]. Two
examples in [I-D.mdt-softwire-mapping-address-and-port] are
illustrated here for the readers' convenience.

For sharing ratio 1024, PSID offset a = 4 and PSID length k = 10

```
          Port-range-1                Port-range-2
PSID=0    | 4096, 4097, 4098, 4099, | 8192,  8193,  8194,  8195, | ...
PSID=1    | 4100, 4101, 4102, 4103, | 8196,  8197,  8198,  8199, | ...
PSID=2    | 4104, 4105, 4106, 4107, | 8200,  8201,  8202,  8203, | ...
PSID=3    | 4108, 4109, 4110, 4111, | 8204,  8205,  8206,  8207, | ...
...
PSID=1023| 8188, 8189, 8190, 8191, | 12284, 12285, 12286, 12287,| ...
```

Example 3: GMA calculation with a = 4, k = 10

For sharing ratio 64, PSID offset a = 0 and PSID length k = 6

```
             Port-set
   PSID=0   | [    0 - 1023]
   PSID=1   | [1024 - 2047]
   PSID=2   | [2048 - 3071]
   PSID=3   | [3072 - 4095]
   ...
   PSID=63  | [64512 - 65535]
```

Example 4: GMA calculation with a = 0, k = 6

5. **Server Behavior**

   The server will not reply with either of the two options until the
   client has explicitly listed one of them in the Parameter Request
   List(Option 55).

   Server MUST reply with Continuous Port Set Option if the client
   requested OPTION_CON_PORT_SET in its Parameter Request List. Server
   MUST reply with Noncontinuous Port Set Option if the client requested
   OPTION_NCON_PORT_SET in its Parameter Request List. The server MUST
   run an address & port-set pool which plays the same role as address
   pool in regular DHCP server. If the server supports Noncontinuous
   Port Set Option, address & port-set pool MUST follow the GMA-format
   port-set.

   The port-set assignment SHOULD be coupled with the address assignment
   process. Therefore server SHOULD assign the address and port set in
   the same DHCP messages. and the lease information for the address is
   applicable to the port-set as well.

6. **Client Behavior**

   The DHCP client applying for the a port-set MUST include either the
   OPTION_CON_PORT_SET or OPTION_NCON_PORT_SET code in the Parameter
   Request List (Option 55). If the client requests the
   OPTION_CON_PORT_SET, it will retrieve a Continuous Port Set Option
   and use the ports ranging from Min port number to Max port number.
   If the client requests OPTION_NCON_PORT_SET and retrieves a
   Noncontinuous Port Set Option, its port set follows the specific port
   number format defined in section 5.1.1 of MAP draft
   [I-D.mdt-softwire-mapping-address-and-port]. The client derives the
   PSID offset (a bits), PSID length (k bits) and the PSID from the
   option, and performs GMA to get the precise port set. The client
   renews or releases the DHCP lease with the port set.

7. Security Consideration

This specification raises no particular security issues to the DHCPv4 protocol model.

8. IANA Consideration

   IANA is kindly requested to allocate DHCP option codes to the
   OPTION_CON_PORT_SET and OPTION_NCON_PORT_SET. Both codes should be
   added to the DHCP option code space.

9. References

9.1. Normative References

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9.2. Informative References

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