Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) Options for
IEEE 802.21 Mobility Services (MoS) Discovery

Abstract

   This document defines new Dynamic Host Configuration Protocol (DHCPv4
   and DHCPv6) options that contain a list of IP addresses and a list of
   domain names that can be mapped to servers providing IEEE 802.21 type
   of Mobility Service (MoS) (see RFC 5677). These Mobility Services
   are used to assist a mobile node (MN) in handover preparation
   (network discovery) and handover decision (network selection). The
   services addressed in this document are the Media Independent
   Handover Services defined in IEEE 802.21.

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

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1. Introduction

   IEEE 802.21 [IEEE802.21] defines three distinct service types to
   facilitate link layer handovers across heterogeneous technologies:

   a) Information Services (IS)
      IS provides a unified framework to the higher-layer entities
      across the heterogeneous network environment to facilitate
      discovery and selection of multiple types of networks existing
      within a geographical area. The objective is to help the higher-
      layer mobility protocols acquire a global view of heterogeneous
      networks and perform seamless handover across these networks.

   b) Event Services (ES)
      Events may indicate changes in state and transmission behavior of
      the physical, data link, and logical link layers, or predict state
      changes of these layers. The Event Service may also be used to
      indicate management actions or command status on the part of the
      network or some management entity.

   c) Command Services (CS)
      The command service enables higher layers to control the physical,
      data link, and logical link layers. The higher layers may control
      the reconfiguration or selection of an appropriate link through a
      set of handover commands.

In IEEE terminology, these services are called Media Independent
Handover (MIH) services. While these services may be co-located, the
different pattern and type of information they provide do not
necessitate the co-location.

A mobile node (MN) may make use of any of these MIH service types
separately or any combination of them [RFC5677]. In practice, a
Mobility Server may not necessarily host all three of these MIH
services together; thus, there is a need to discover the MIH service
types separately.

This document defines new DHCPv4 and DHCPv6 options and sub-options
called the MoS IP Address and Domain Name List Options, which allow
the MN to locate a Mobility Server that hosts the desired service
type (i.e., IS, ES, or CS) as defined in [IEEE802.21]. Apart from
manual configuration, this is one of the possible solutions for
locating a server providing Mobility Services.

1.1. Conventions Used in This Document

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].

1.2. Terminology

Mobility Services: a set of services provided by the network to
mobile nodes to facilitate handover preparation and handover
decision. In this document, Mobility Services refer to the services
defined in IEEE 802.21 specifications [IEEE802.21]

Mobility Server: a network node providing Mobility Services.

MIH: Media Independent Handover, as defined in [IEEE802.21].

MIH Service: IS, ES, or CS type of service, as defined in
[IEEE802.21].

2. MoS IPv4 Address Option for DHCPv4

This section describes the MoS IPv4 Address Option for DHCPv4.
Whether the MN receives a MoS address from the local or home network
will depend on the actual network deployment [RFC5677]. The MoS IPv4
Address Option begins with an option code followed by a length and
sub-options. The value of the length octet does not include itself
or the option code. The option layout is depicted below:

```
 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 Code   |    Length     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Sub-Option 1                           |
   .                                                              .
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           ...                                |
   .                                                              .
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Sub-Option n                           |
   .                                                              .
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
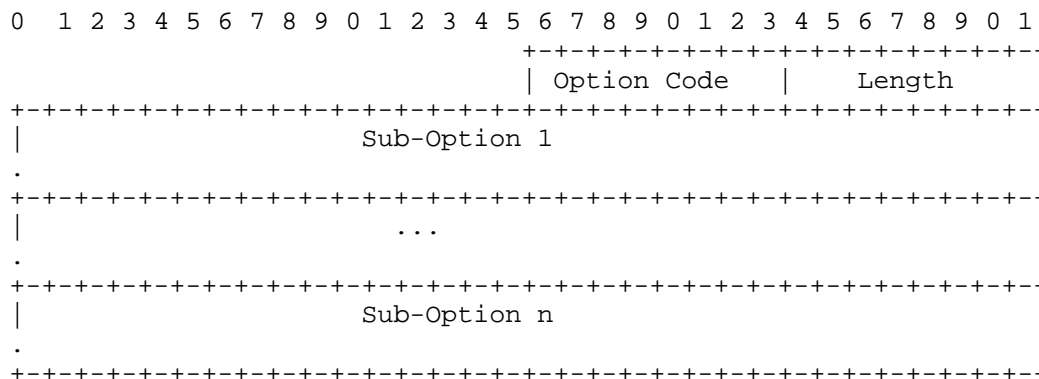
   Option Code

      OPTION-IPv4_Address-MoS (139) - 1 byte

   Length

      An 8-bit field indicating the length of the option excluding
      the 'Option Code' and the 'Length' fields

   Sub-options

      A series of DHCPv4 sub-options

When the total length of a MoS IPv4 Address Option exceeds 254
octets, the procedure outlined in [RFC3396] MUST be employed to split
the option into multiple, smaller options.

A sub-option begins with a sub-option code followed by a length and
one or more IPv4 addresses. The sub-option layout is depicted below:

```
  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
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  | Sub-opt Code  |    Length     |   IP Address . . . . .
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  .                                                              .
  .                                                              |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The sub-option codes are summarized below.

```
+--------------+---------------+
|   Sub-opt    | Service       |
|    Code      | Name          |
+==============+===============+
|     1        |   IS          |
+--------------+---------------+
|     2        |   CS          |
+--------------+---------------+
|     3        |   ES          |
+--------------+---------------+
```

If the length is followed by a list of IPv4 addresses indicating
appropriate MIH servers available to the MN for a requested option,
servers MUST be listed in order of preference and the client should
process them in decreasing order of preference. In the case that
there is no MIH server available, the length is set to 0; otherwise,
it is a multiple of 4.

The sub-option has the following format:

```
      Code Len    IPv4 Address 1      IPv4 Address 2
     +-----+---+---+----+----+----+----+----+---
     |1..3 | n |a1 | a2 |a3  | a4 | a1 |  ...
     +-----+---+---+----+----+----+-----+----+--
```

3. MoS Domain Name List Option for DHCPv4

   This section describes the MoS Domain Name List Option for DHCPv4.
   The general format of this option is depicted below:

```
   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 Code   |    Length     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Sub-Option 1                              |
 .                                                              .
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                          ...                                 |
 .                                                              .
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Sub-Option n                             |
 .                                                              .
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Option Code

      OPTION-IPv4_FQDN-MoS (140) - 1 byte
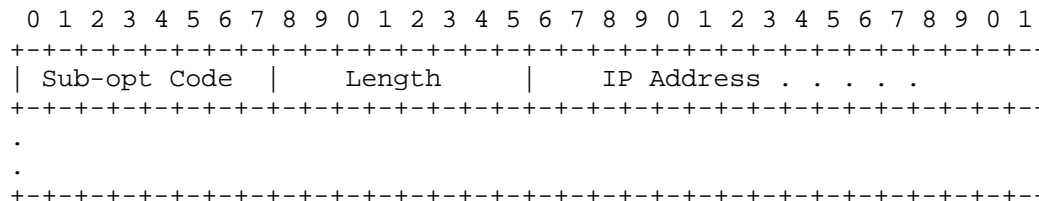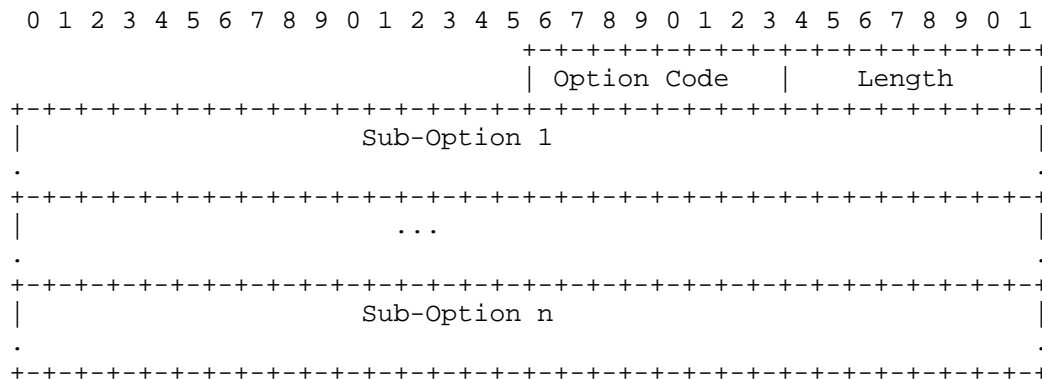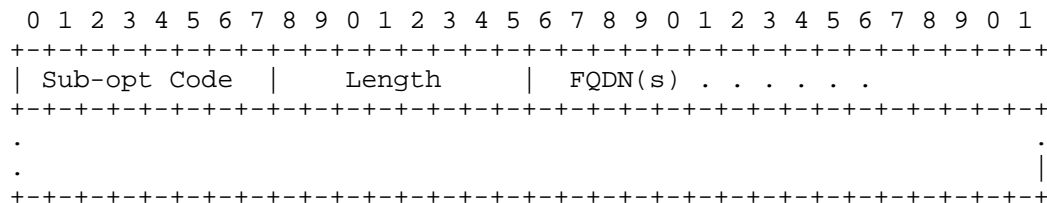
   Length

      An 8-bit field indicating the length of the option excluding
      the 'Option Code' and the 'Length' fields

   Sub-options

      A series of DHCPv4 sub-options.

When the total length of a MoS Domain Name List Option exceeds 254
octets, the procedure outlined in [RFC3396] MUST be employed to split
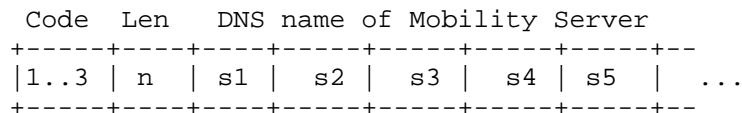the option into multiple, smaller options.

A sub-option begins with a sub-option code followed by a length and
one or more Fully Qualified Domain Names (FQDNs). The sub-option
layout is depicted below:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Sub-opt Code  |     Length    | FQDN(s) . . . . . .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                                                              .
.                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The sub-option codes are summarized below.

```
        +--------------+---------------+
        |  Sub-opt     |  Service      |
        |  Code        |  Name         |
        +==============+===============+
        |    1         |  IS           |
        +--------------+---------------+
        |    2         |  CS           |
        +--------------+---------------+
        |    3         |  ES           |
        +--------------+---------------+
```

Thus, the sub-option for this encoding has the following format:

```
        Code  Len   DNS name of Mobility Server
       +-----+----+----+-----+-----+-----+-----+--
       |1..3 | n  | s1 | s2  | s3  | s4  | s5  | ...
       +-----+----+----+-----+-----+-----+-----+--
```

The sub-option begins with a sub-option code followed by a length and
a sequence of labels that are encoded according to Section 8 of
[RFC3315].

The sub-option MAY contain multiple domain names, but these should
refer to the NAPTR records of different providers, rather than
different A records within the same provider. That is, the use of
multiple domain names is not meant to replace NAPTR and SRV records,
but rather to allow a single DHCP server to indicate MIH servers
operated by multiple providers.

The client MUST try the records in the order listed, applying the
mechanism described in [RFC5679] for each. The client only resolves
the subsequent domain names if attempts to contact the first one
failed or yielded no common transport protocols between the MN and
the server.

As an example, consider the case where the server wants to offer two
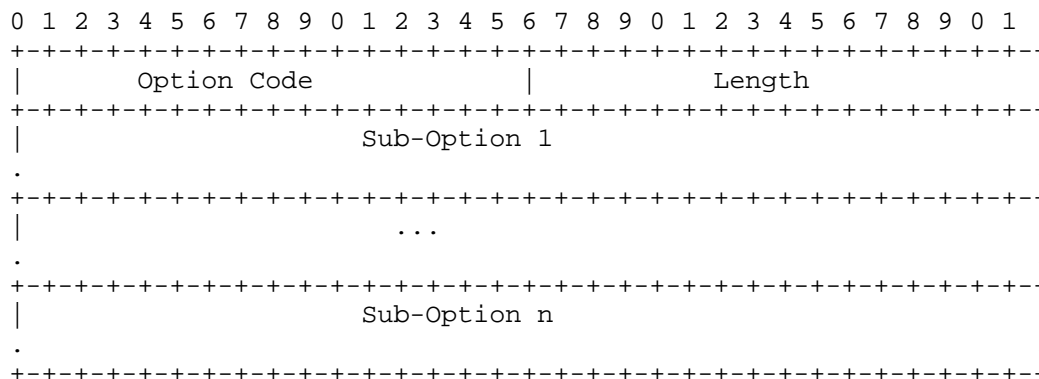MIH IS servers, "example.com" and "example.net". These would be
encoded as follows:

```
+-----+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1..3 |26 | 7 |'e'|'x'|'a'|'m'|'p'|'l'|'e'| 3 |'c'|'o'|'m'| 0 |
+-----+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| 7 |'e'|'x'|'a'|'m'|'p'|'l'|'e'| 3 |'n'|'e'|'t'| 0 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

4. MoS IPv6 Address Option for DHCPv6

   This section describes the MoS IPv6 Address Option for DHCPv6.
   Whether the MN receives a MoS address from the local or home network
   will depend on the actual network deployment [RFC5677]. The MoS
   Discovery Option begins with an option code followed by a length and
   sub-options. The value of the length octet does not include itself
   or the option code. The option layout is depicted below:

```
 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 Code           |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sub-Option 1                             |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         ...                                   |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Sub-Option n                             |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Option Code

      OPTION-IPv6_Address-MoS (54) - 2 bytes
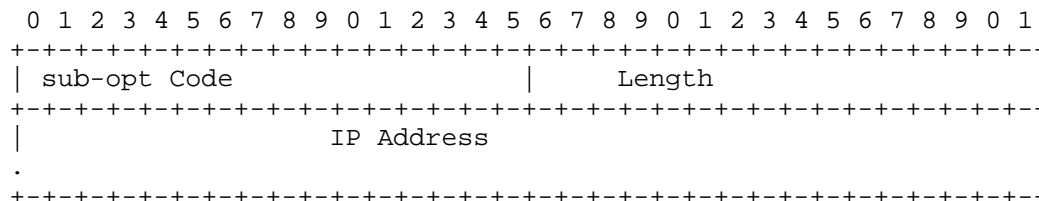
   Length

      A 16-bit field indicating the length of the option excluding
      the 'Option Code' and the 'Length' fields.

   Sub-options

      A series of DHCPv6 sub-options

The sub-options follow the same format (except the Sub-opt Code and
Length value) as described in Section 2. The value of the Sub-opt
Code and Length is 2 octets, and the Length does not include itself
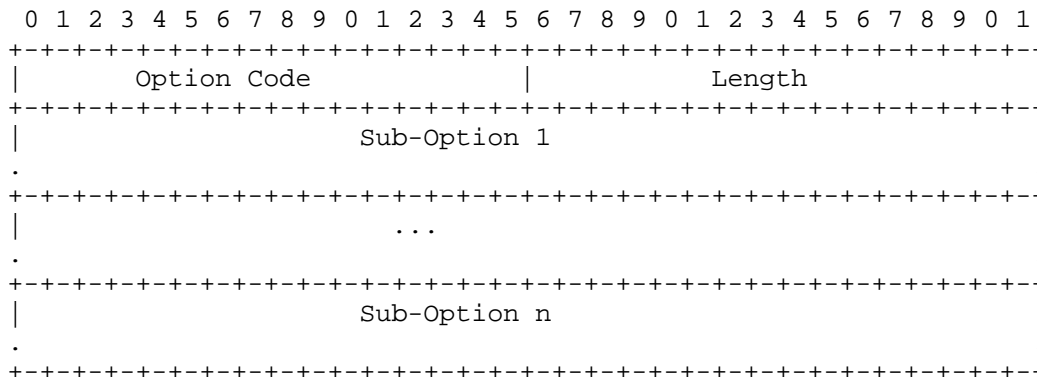or the Sub-opt Code field. The sub-option layout is depicted below:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| sub-opt Code                   |        Length                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       IP Address                             |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The sub-option codes are summarized below.

```
+---------------+--------------+
| Sub-opt Code  | Service Name |
+===============+==============+
|      1        |     IS       |
+---------------+--------------+
|      2        |     CS       |
+---------------+--------------+
|      3        |     ES       |
+---------------+--------------+
```

If the length is followed by a list of IPv6 addresses indicating
appropriate MIH servers available to the MN for a requested option,
servers MUST be listed in order of preference and the client should

process them in decreasing order of preference. In the case where
there is no MIH server available, the length is set to 0; otherwise,
it is a multiple of 16.

5. MoS Domain Name List Option for DHCPv6

    This section describes the MoS Domain List Option for DHCPv6. The
    general format of this option is depicted below:

```
 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 Code          |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Sub-Option 1                          |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            ...                                |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Sub-Option n                          |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
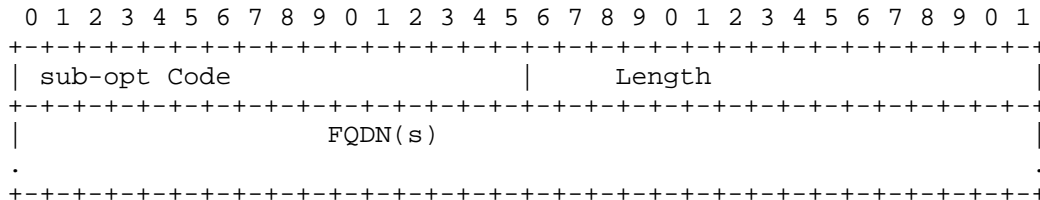
    Option Code

        OPTION-IPv6_FQDN-MoS (55) - 2 bytes

    Length

        A 16-bit field indicating the length of the option excluding
        the 'Option Code' and the 'Length' fields

Sub-options

A series of DHCPv6 sub-options

The sub-options follow the same format (except the Sub-opt Code and
Length value) as described in Section 3. The value of the Sub-opt
Code and Length is 2 octets, and the Length does not include itself
or the Sub-opt Code field. The sub-option layout is depicted below:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| sub-opt Code                  |           Length              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     FQDN(s)                                    |
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The sub-option codes are summarized below.

```
+----------------+---------------+
|  Sub-opt Code  | Service Name  |
+================+===============+
|      1         |     IS        |
+----------------+---------------+
|      2         |     CS        |
+----------------+---------------+
|      3         |     ES        |
+----------------+---------------+
```

The semantics and content of the DHCPv6 encoding of this option are
exactly the same as the encoding described in Section 3, except the
Option Code and Length value.

6. Option Usage

6.1. Usage of MoS Options for DHCPv4

The requesting and sending of the proposed DHCPv4 options follow the
rules for DHCP options in [RFC2131].

6.1.1. Mobile Node Behavior

The mobile node may perform a MoS discovery either during initial
association with a network or when the mobility service is required.
It may also try to perform the MoS discovery when it lacks the
network information for MoS or needs to change the MoS for some
reasons, for instance, to recover from the single point of failure of
the existing MoS.

In order to discover the IP address or FQDN of a MoS, the mobile node
(DHCP client) MUST include either a MoS IPv4 Address Option or a MoS
Domain Name List Option in the Parameter Request List (PRL) in the
respective DHCP messages as defined in [RFC2131].

The client MAY include a MoS IPv4 Address Option or a MoS Domain Name
List Option that includes one or more sub-option(s) with the Sub-opt
Code or Codes that represent the service(s) the mobile node is
interested in. However, a client SHOULD be prepared to accept a
response from a server that includes other sub-option(s) or does not
include the requested sub-option(s).

6.1.2. DHCP Server Behavior

When the DHCP server receives either a MoS IPv4 Address Option or a
MoS Domain Name List Option in the PRL, the DHCP server MUST include
the option in its response message as defined in [RFC2131].

A server MAY use the sub-options in the received MoS IPv4 Address
Option or MoS Domain Name List Option from the client's message to
restrict its response to the client requested sub-options. In the
case when the server cannot find any Mobility Server satisfying a
requested sub-option, the server SHOULD return the MoS Option with
that sub-option and the length of the sub-option set to 0.

6.2. Usage of MoS Options for DHCPv6

The requesting and sending of the proposed DHCPv6 options follow the
rules for DHCP options in [RFC3315].

6.2.1. Mobile Node Behavior

The mobile node may perform the MoS discovery either during initial
association with a network or when the mobility service is required.
It may also try to perform the MoS discovery when it lacks the
network information for MoS or needs to change the MoS for some
reasons, for instance, to recover from the single point of failure of
the existing MoS.

In order to discover the IP address or FQDN of a MoS, the mobile node
(DHCP client) MUST include either a MoS IPv6 Address Option or a MoS
Domain Name List Option in the Option Request Option (ORO) in the
respective DHCP messages as defined in [RFC3315].

The client MAY include a MoS IPv6 Address Option or a MoS Domain Name
List Option that includes one or more sub-option(s) with the Sub-opt
Code or Codes that represent the service(s) the mobile node is

   interested in. However, a client SHOULD be prepared to accept a
   response from a server that includes other sub-option(s) or does not
   include the requested sub-option(s).

6.2.2. DHCP Server Behavior

   When the DHCP server receives either a MoS IPv6 Address Option or a
   MoS Domain Name List Option in the ORO, the DHCP server MUST include
   the option in its response message as defined in [RFC3315].

   A server MAY use the sub-options in the received MoS IPv6 Address
   Option or MoS Domain Name List Option from the client's message to
   restrict its response to the client-requested sub-options. In the
   case when the server cannot find any Mobility Server satisfying a
   requested sub-option, the server SHOULD return the MoS Option with
   that sub-option and the length of the sub-option set to 0.

7. Security Considerations

   The security considerations in [RFC2131] apply. If an adversary
   manages to modify the response from a DHCP server or insert its own
   response, an MN could be led to contact a rogue Mobility Server,
   possibly one that then would provide wrong information, event or
   command for handover.

   It is recommended to use either DHCP authentication option described
   in [RFC3118] where available. This will also protect the denial-of-
   service attacks to DHCP servers. [RFC3118] provides mechanisms for
   both entity authentication and message authentication.

   In deployments where DHCP authentication is not available, lower-
   layer security services may be sufficient to protect DHCP messages.

   Regarding domain name resolution, it is recommended to consider the
   usage of DNSSEC [RFC4033] and the aspects of DNSSEC Operational
   Practices [RFC4641]. Security considerations described in [RFC5679]
   also apply.

8. IANA Considerations

   This document defines two new DHCPv4 options as described in Sections
   2 and 3.

   MoS IPv4 Address Option for DHCPv4 (OPTION-IPv4_Address-MoS)   139

   MoS Domain Name List option for DHCPv4 (OPTION-IPv4_FQDN-MoS)   140

This document creates a new registry for the Sub-Option fields in the
MoS DHCPv4 Address and FQDN options called the "IEEE 802.21 Service
Type" (Section 2 and 3).

        IS   1
        CS   2
        ES   3

The values '0' and '255' are reserved. Values '1' through '3' are
allocated as above, and the rest are available for allocation. New
values can be allocated via Standards Action as defined in [RFC5226].

This document also defines two DHCPv6 options as described in
Sections 4 and 5.

MoS IPv6 Address Option for DHCPv6 (OPTION-IPv6_Address-MoS)   54

MoS Domain Name List option for DHCPv6 (OPTION-IPv6_FQDN-MoS) 55

This document creates a new registry for the sub-option field in the
MoS DHCPv6 Address and FQDN options called the "IEEE 802.21 IPv6
Service Type" (Sections 4 and 5).

        IS   1
        CS   2
        ES   3

The values '0' and '65535' are reserved. Values '1' through '3' are
allocated as above, and the rest are available for allocation. New
values can be allocated via Standards Action as defined in [RFC5226].

9. Acknowledgements

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their valuable comments: Alfred Hoenes, Bernie Volz, David W.
Hankins, Jari Arkko, Telemaco Melia, Ralph Droms, Ted Lemon, Vijay
Devarapalli, and Yoshihiro Ohba.

10. References

10.1. Normative References

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   [RFC2131]   Droms, R., "Dynamic Host Configuration Protocol", RFC
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                DHCP Messages", RFC 3118, June 2001.

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                C., and M. Carney, "Dynamic Host Configuration Protocol
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                Dynamic Host Configuration Protocol (DHCPv4)", RFC 3396,
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   [RFC4033]   Arends, R., Austein, R., Larson, M., Massey, D., and S.
                Rose, "DNS Security Introduction and Requirements", RFC
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   [RFC5226]   Narten, T. and H. Alvestrand, "Guidelines for Writing an
                IANA Considerations Section in RFCs", BCP 26, RFC 5226,
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                Zuniga, "IEEE 802.21 Mobility Services Framework Design
                (MSFD)", RFC 5677, December 2009.

   [RFC5679]   Bajko, G., "Locating IEEE 802.21 Mobility Services Using
                DNS", RFC 5679, December 2009.

10.2. Informative References

   [RFC4641]   Kolkman, O. and R. Gieben, "DNSSEC Operational
                Practices", RFC 4641, September 2006.

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                - Part 21: Media Independent Handover Services", IEEE
                LAN/MAN Std 802.21-2008, January 2009,
                http://www.ieee802.org/21/private/Published%20Spec/
                802.21-2008.pdf (access to the document requires
                membership).

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