

Internet Engineering Task Force (IETF)
Request for Comments: 6656
Category: Informational
ISSN: 2070-1721

R. Johnson
K. Kinnear
M. Stapp
Cisco Systems, Inc.
July 2012

Description of Cisco Systems' Subnet Allocation Option for DHCPv4

Abstract

This memo documents a DHCPv4 option that currently exists and was previously privately defined for the operation and usage of the Cisco Systems' Subnet Allocation Option for DHCPv4. The option is passed between the DHCPv4 Client and the DHCPv4 Server to request dynamic allocation of a subnet, give specifications of the subnet(s) allocated, and report usage statistics. This memo documents the current usage of the option in agreement with RFC 3942, which declares that any preexisting usages of option numbers in the range 128-223 should be documented and that the working group will try to officially assign those numbers to those options.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <http://www.rfc-editor.org/info/rfc6656>.

Copyright Notice

Copyright (c) 2012 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

This document may contain material from IETF Documents or IETF Contributions published or made publicly available before November 10, 2008. The person(s) controlling the copyright in some of this material may not have granted the IETF Trust the right to allow modifications of such material outside the IETF Standards Process. Without obtaining an adequate license from the person(s) controlling the copyright in such materials, this document may not be modified outside the IETF Standards Process, and derivative works of it may not be created outside the IETF Standards Process, except to format it for publication as an RFC or to translate it into languages other than English.

Table of Contents

| | | |
|-------------|---|----|
| 1. | Introduction | 4 |
| 2. | Conventions | 4 |
| 3. | Subnet Allocation Option Format | 5 |
| 3.1. | Subnet-Request Suboption Format | 5 |
| 3.2. | Subnet-Information Suboption Format | 7 |
| 3.2.1. | Subnet Prefix Information Block Format | 8 |
| 3.3. | Subnet-Name Suboption Format | 9 |
| 3.4. | Suggested-Lease-Time Suboption Format | 10 |
| 4. | Requesting Allocation of a Subnet | 10 |
| 4.1. | Client DHCPDISCOVER Message | 11 |
| 4.2. | Server DHCPOFFER Message | 11 |
| 4.3. | Client DHCPREQUEST Message | 12 |
| 4.4. | Server DHCPACK Message | 13 |
| 5. | Client Renewal of Subnet Lease | 13 |
| 5.1. | Client RENEW DHCPREQUEST Message | 13 |
| 5.2. | Server RENEW DHCPREQUEST Response | 14 |
| 5.3. | Client DHCPRELEASE Message | 14 |
| 5.4. | Server DHCPFORCERENEW Message | 15 |
| 6. | Client Requesting Previously Allocated Subnet Information | 15 |
| 6.1. | Initial Client DHCPDISCOVER Message | 15 |
| 6.2. | Initial Server DHCPOFFER Response | 16 |
| 6.3. | Additional Client DHCPDISCOVER Messages | 16 |
| 6.4. | Additional Server DHCPOFFER Responses | 16 |
| 7. | DHCP Server Subnet Allocation Method | 17 |
| 8. | Examples | 17 |
| 8.1. | Example 1 | 17 |
| 8.2. | Example 2 | 19 |
| 9. | Differences from DHCPv6 Prefix Delegation | 21 |
| 10. | Security Considerations | 22 |
| 11. | IANA Considerations | 22 |
| 12. | References | 23 |
| 12.1. | Normative References | 23 |
| 12.2. | Informative References | 23 |
| Appendix A. | Acknowledgments | 23 |

1. Introduction

This memo documents a DHCP option [RFC2132], the Subnet Allocation option, that was developed by Cisco and allows a DHCP Client to allocate a subnet given information from a DHCP Server. This protocol makes use of DHCP option number 220, one of the option numbers reclassified by [RFC3942]. That RFC specifies in Section 4, procedure 2, "Vendors that currently use one or more of the reclassified options have 6 months following this RFC's publication date to notify the DHC WG and IANA that they are using particular options numbers and agree to document that usage in an RFC". This memo serves as that documentation. The DHC WG has had no input into any of the details of the protocol operation and makes no statement about the correctness or any other aspect of the protocol. The WG also has seen no interest in further implementation or deployment of this protocol other than privately, and therefore has decided to publish this document solely for informational purposes.

The Subnet Allocation option provides a straightforward way to allocate a subnet from DHCP, useful for a simple Dial-in Aggregation box, or to implement a Hierarchical chain of DHCP Servers, each one in turn leasing one or more subnets to the next DHCP Server down the chain. This option is specified in such a way as to use one DHCP option number, while using suboption numbers for each function.

2. Conventions

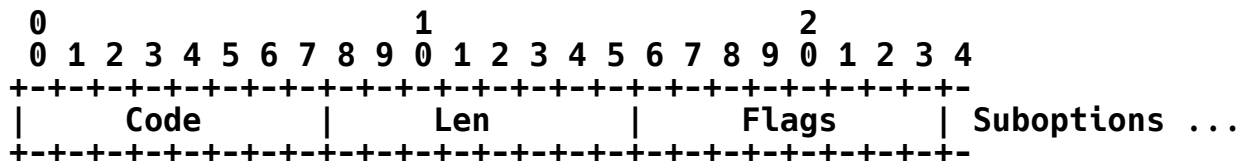
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

This document also uses the following terms:

DHCP Client: DHCP Client or "Client" is an Internet host using DHCP to obtain configuration parameters such as a network address.

DHCP Server: A DHCP Server or "Server" is an Internet host that returns configuration parameters to DHCP Clients.

3. Subnet Allocation Option Format



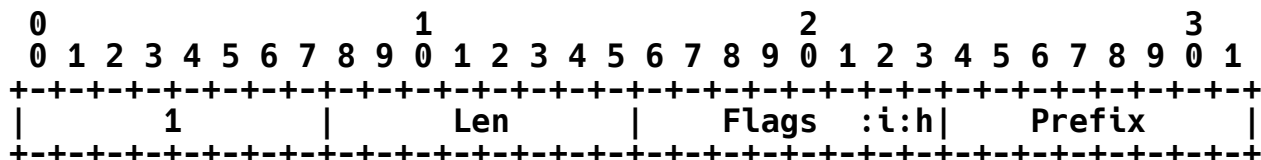
Code = Subnet Allocation option code (1 octet): 220

Len = Length of the entire option including all suboptions (1 octet)

Flags = Various flags: (None currently defined)

One or more suboptions may be specified as described below.

3.1. Subnet-Request Suboption Format



Len = Length of the suboption (always 2 for this suboption) (1 octet)

Flags = Flags field. (all unused bits must be zero)

'h' = Hierarchical flag

1 : Client will be allocating addresses from this subnet.
0 : Client will be relaying DHCP requests to the Server from this subnet.

'i' = Information flag

1 : Client is seeking information about previously allocated subnets.
0 : Client is seeking a new subnet allocation.

Prefix = Network prefix length requested

(0 means no suggested length is given) (1 octet)

The DHCP Server SHOULD NOT include the Subnet Request suboption in any replies to the DHCP Client. Enough information will be present in the Subnet-Information suboption, such that the Subnet Request suboption is not needed in replies to the Client.

The DHCP Server SHOULD allocate a subnet with prefix length [RFC4632] less than or equal to the "Prefix" field length specified in the request. In other words, a subnet containing a number of addresses at least the size indicated by the prefix length requested and

possibly more. The DHCP Server MAY allocate a subnet with a prefix length greater than that specified in the request (or a subnet with a number of addresses less than requested), but this is not encouraged.

A "Prefix" field size of 0 MAY be specified by the DHCP Client. In this case, no suggested prefix length is given.

Multiple Subnet-Request suboptions in a DHCP packet indicate that multiple subnets are being requested. Note that multiple occurrences of this suboption MUST NOT be concatenated in the sense of [RFC3396].

Each Subnet-Request suboption MUST result in no more than one Subnet-Information suboption in the DHCP OFFER message from the Server, and may result in no Subnet-Information suboptions.

The Client MAY also include the Subnet-Information suboption in order to request a particular subnet. In this case, the Client SHOULD only include one Subnet-Request suboption, since it would otherwise be unclear which Subnet-Information suboption referred to which Subnet-Request suboption. Multiple subnet requests can be made by sending multiple DHCPDISCOVER packets.

Setting the 'h' flag to 1 indicates the Client will be allocating addresses from the allocated subnet(s) itself. This can be thought of as a "Hierarchical DHCP" design in that control of allocation for the subnet(s) will be passed to the Client.

Setting the 'h' flag to 0 indicates the Client wants the DHCP Server to retain control over allocation of addresses from the subnet(s). Any address allocation requests on the subnet will be relayed back to the DHCP Server.

Setting the 'i' flag to 1 indicates the Client is NOT seeking allocation of any subnets, but is simply seeking information from the Server as to what subnet(s) have been allocated (or reserved) for this Client. If the 'i' flag is set to 1, then the "Prefix" field SHOULD be set to 0 and MUST be ignored by the Server. In this case, the conversation between the Client and the Server will only progress to the DHCP OFFER packet from the Server, giving the information, as described in Section 6 below.

Any undefined flags (those other than 'i' and 'h', mentioned above) should be ignored by the DHCP Server.

3.2. Subnet-Information Suboption Format

```

      0               1               2
      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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           2           |      Len      |  Flags      :c:s| SP1, SP2, ...
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Len = Length of the suboption (min. length of 8) (1 octet)

Flags = Various flags that apply to ALL Subnet Prefix
Information fields specified in this suboption.
Unused flags must be zero.

'c' : Client flag (explained below)

1 : This information is in response to a Client request
(or has been echoed back by the Client, when asking
for the next previously allocated subnet from the
Server).

0 : Otherwise.

's' : Server flag (explained below)

1 : Server has additional subnet information for this
Client.

0 : Otherwise.

SP1, SP2, ... Subnet Prefix Information blocks as specified below
(variable size)

Setting the 'c' flag to 1 indicates this Subnet-Information suboption is in response to a Client request for information from the Server as to what subnet(s) have been allocated. This flag is used in response to a Subnet-Request suboption with the 'i' flag set and should be 0 in other Server responses. Note, the flag is echoed back from the Client to the Server when requesting the "next previously allocated subnet". Another way to think of the 'c' bit would be that it indicates that the subnet information contained in this suboption does not represent a new allocation by the Server or a new request for allocation by the Client, but instead represents previously allocated subnet information.

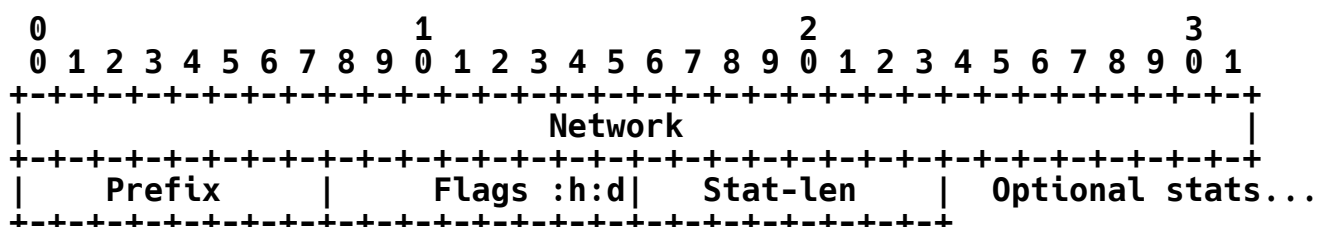
Setting the 's' flag to 1 indicates the Server has additional subnet information for the Client.

Any undefined flags (those other than 'c' and 's', mentioned above) should be ignored by the DHCP Server.

The Subnet-Information suboption is used by the DHCP Server in order to return information as to what subnets are offered (in the case of a DHCP OFFER packet) or allocated (in the case of a DHCP ACK packet). As is indicated above, multiple subnets may be returned in one Subnet-Information suboption.

The Subnet-Information suboption is also used by the DHCP Client in order to request allocation of specific subnets in a DHCP REQUEST packet. In this case, the "Network", "Prefix", and "Flags" fields contained in the associated Subnet Prefix Information blocks MUST NOT be changed from the information that was received in the DHCP OFFER packet from the Server. The Client MAY, however, use multiple Subnet-Information suboptions in order to request subnets that were originally specified by the Server inside one Subnet-Information suboption.

3.2.1. Subnet Prefix Information Block Format



Network = IPv4 network number (4 octets)

Prefix = Prefix length (1 octet)

Flags = Flags field (Undefined bits must be zero) (1 octet)

'd' = Deprecate flag (explained below)

1 : Deprecation of this subnet is requested.

0 : No deprecation is needed.

'h' = Hierarchical flag (explained below)

1 : Client will be allocating addresses from this subnet.

0 : Client will be relaying DHCP requests to the Server from this subnet.

Stat-len = Length of the optional statistics information field
(zero if no statistics are included) (1 octet)

The 'd' flag may only be returned by the Server to the Client (inside a DHCP ACK packet, in response to a DHCP RENEW). Its presence means that the Client should prepare to give up the subnet. For example, if the Client is assigning addresses from this subnet to other Clients, it should cease doing so immediately and should not renew

any leases when Clients ask for renewal. As soon as all addresses in the subnet are unallocated, the Client should send a DHCPRELEASE message to the Server, including a Subnet Prefix Information block for the subnet in order to release the subnet. The format of this message is described farther below.

The 'h' flag tells the Client how the Server intends for the Client to use the allocated subnet. It is interpreted in the same manner as that in the Subnet-Request suboption. In response to a Subnet-Request, the Server should normally specify the 'h' flag in the same manner as it was in the Subnet-Request suboption from the Client. The Server MAY, however, change the 'h' flag from that specified in the Subnet-Request suboption if it has been configured to override the Client's request.

Any undefined flags (those other than 'd' and 'h', mentioned above) should be ignored by the DHCP Server.

If any usage statistics information is to be included, then the "Stat-len" field specifies the number of bytes of statistics information that is included. See below for more information. If no statistics information is included, then this byte MUST be zero. The "Stat-len" field SHOULD always be zero when this suboption is sent by the DHCP Server. The usage statistics information is intended for use only to report usage statistics from the Client to the Server.

3.2.1.1. Subnet Usage Statistics

The Subnet-Information suboption may also include usage statistics information. If this information is included, then the "Stat-len" (Statistics length) field MUST be set to the number of bytes of statistics information that is being included. The statistics information MUST be in the following form and order:

| 0 | | | | | | | | | | 1 | | | | | | | | | |
|------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|--|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | | | | |
| High water | | | | | | | | | | | | | | | | | | | |
| Currently in use | | | | | | | | | | | | | | | | | | | |
| Unusable | | | | | | | | | | | | | | | | | | | |

"High water" refers the to "high-water mark" of allocated addresses within the subnet. That is, the largest number of addresses that were ever allocated at one time from the subnet.

"Currently in use" refers to the number of addresses currently allocated in the subnet.

"Unusable" refers to the number of addresses that are currently unusable for any reason (such as a Client returning a DHCPDECLINE, or finding the address already in use).

Additional statistics may be added to this option in the future. If so, they MUST be appended immediately after the already defined statistics fields. All statistics fields MUST remain in the same order. Use the all ones value (0xffff) in order to skip reporting a number for a particular field. Fewer fields may be included than what is specified above; for example, if "Stat-len" is "4", then the "Unusable" field has not been included. All fields that are included MUST remain in order specified here.

3.3. Subnet-Name Suboption Format

```

      0                               1
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           3           |      Len      | Name ...
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Len = length of the suboption (min. length of 1) (1 octet)

The Subnet-Name suboption may be used in order to pass a subnet name to the Server for use during allocation. This name may be used for any purpose but is intended to tell the Server something extra about the needed subnet; for example, "sales department", "customer 1002", "address pool F00", or some such. The "name" should NOT be NULL terminated since the "len" field already specifies the length of the name. The "Name" in this suboption MUST be given using UTF-8 [RFC3629].

3.4. Suggested-Lease-Time Suboption Format

```

      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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           4           |      Len (4)      |      t1      |      t2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           t3           |      t4           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Len = length of the suboption (always 4 for this suboption) (1 octet)

The Suggested-Lease-Time suboption MAY be included by the Server in order to suggest the lease time to be used by the Client when allocating addresses from the subnet allocated. The 4-octet value of the lease time is in the same format as that of the "IP Address Lease Time" option (option 51), as described in [RFC2132].

If included, this suboption MUST appear only once. (Inclusion of multiple such suboptions would result in ambiguity as to which applied to which subnet.) If different suggested lease times are needed, the Server SHOULD, instead, reply with only one offered subnet and should set the "Server flag" in the Subnet-Information suboption to indicate to the Client that it should send another subnet request to gather the others.

The Client SHOULD use a lease time, when allocating addresses from the subnet, that is the lesser of the remaining lease time of the subnet itself and the Suggested-Lease-Time suboption.

4. Requesting Allocation of a Subnet

4.1. Client DHCPDISCOVER Message

The DHCP Client creates a DHCPDISCOVER message including the Subnet Allocation option, and its set of suboptions, to request allocation of a subnet. The DHCP Client should include the Subnet-Request suboption, specifying the prefix length of the subnet requested. The 'h' bit should be set to 1 if the Client intends to control allocation of addresses within the subnet itself, or 0 if the Server should retain control of addresses within the subnet. More than one Subnet Allocation option may appear in a DHCPDISCOVER message; however, the Client SHOULD limit the number of requests, noting that the DHCP replies will need to include the Subnet-Information suboption, which takes up more space than the Subnet-Request suboption.

If more than one subnet is being requested, multiple Subnet-Request suboptions MAY be included or multiple DHCPDISCOVER messages MAY be sent instead. The prefix length field of each Subnet-Request suboption MUST be either 0, or in the range of 1 to 30 inclusive.

The DHCP "IP address lease time" option (code 51) MAY be included in the DHCPDISCOVER message to specify the lease time the Client is requesting for the subnet. If not present, no suggested lease time is given.

The DHCP "Client ID" option (code 61) MAY be included in the DHCPDISCOVER message as it may be used by the Server in performing the subnet allocation.

4.2. Server DHCPOFFER Message

Upon receiving a DHCPDISCOVER containing the Subnet Allocation option, the DHCP Server SHOULD respond with a DHCPOFFER message including the Subnet-Information suboption in order to specify the subnet(s) that it is willing to allocate to the Client in order to fulfill the request(s).

The Server need not reserve the subnets that are being offered, but SHOULD not offer the same subnets to another DHCP Client until a reasonable time period (implementation dependent) has passed. (This is similar to normal DHCP address allocation.)

The Server MUST NOT include the Subnet-Request suboption in the DHCPOFFER. The same information is already present in the Subnet Information suboption(s) that SHOULD be included in the DHCPOFFER.

The Server SHOULD also include the IP address lease time option (option 51) in the DHCPOFFER message. This gives the lease time for all subnets given in all Subnet-Request suboptions contained in the DHCPOFFER message. The Server MAY also include the Renewal and/or Rebinding options in order to further control the "T1" and "T2" lease timers of the Client. There MUST be exactly one IP address lease time (and optionally one Rebinding and/or one Renewal option) in the DHCPOFFER message.

The Server MAY set the "Server flag" ('s') to 1 to indicate that it would like to allocate one or more additional subnet(s) to the Client. This indicates that the Client should send another DHCPDISCOVER message specifying a prefix length field, P, of zero in order to request the additional subnet allocation(s) information. This may be necessary if the subnets are to be allocated with different lease times, for example.

The "Client flag" ('c') MUST be set to 0 to indicate this is a Server response to a Client request for a new subnet allocation and not a response to a request for information about already allocated subnets.

If the packet contains a Subnet Allocation option, the Server SHOULD set the DHCP yiaddr value to all zeros (0.0.0.0) and the Client MUST ignore fields having to do with address assignment. In other words, a DHCP packet exchange cannot provide subnet allocation and address assignment simultaneously.

4.3. Client DHCPREQUEST Message

When sending a DHCPREQUEST, the Client MUST NOT modify any fields of any Subnet-Information suboptions received from the Server. However, the Client MAY choose not to include some Subnet-Information suboptions when issuing the DHCPREQUEST. Subnet-Request suboptions MUST NOT be included in the DHCPREQUEST message; only the Subnet-Information suboption(s) should be included.

4.4. Server DHCPACK Message

The DHCP Server, upon receipt of the Client's DHCPREQUEST message, MAY refuse allocation of any subnets (for example, if they have been allocated elsewhere in the meantime); however, since the Server should have set aside the subnets offered for a short period of time, and since the Client should have requested the subnets within a short period of time after receiving the offer(s) from the Server(s), this last minute rejection should be rare. The DHCP Server MUST NOT change the network number(s) or prefix length(s); however, it MAY remove some Subnet-Information suboptions from the list.

The Server SHOULD include the IP address lease time option specifying the lease period for all subnet(s) in the DHCPACK. All subnets allocated in one DHCP message will have the same lease time, and only one IP address lease time option must appear in the DHCP message.

If the Server has internal information that states that the Client should be allocated more subnets than were requested, the Server MAY set the 's' bit in the last Subnet-Information suboption to indicate that the Client needs to request more subnets (as described above).

The allocable unit is the tuple (network number, prefix length). Multiple subnets may be allocated in one DHCPACK; however, since there can be only one Lease-time option, each subnet allocated is assigned the same lease time. Each subnet lease tuple (network number, prefix length) MAY be renewed or released individually.

5. Client Renewal of Subnet Lease

5.1. Client RENEW DHCPREQUEST Message

The Client MUST renew all subnets allocated with a lease time in much the same manner as renewing an allocated IP address. Renewal timers need not be set in exactly the same manner, however. If Renewal and/or Rebinding options were included in the DHCPACK of the subnet allocation, then these "T1" and "T2" timers should be used just as they would be in the case of address allocation timers.

The DHCPREQUEST message MUST include a Subnet-Information suboption for which the Client is seeking renewal of the lease. This Subnet-Information suboption may optionally include subnet usage statistics, as described above in Section 3.2 ("Subnet-Information Suboption Format").

The subnet network number field ("Network") and subnet prefix length field ("Prefix") MUST agree with the values as they were originally allocated to the Client by the Server. In any of the statistics fields (High water, Currently in use, Unusable), a value of all ones (0xffff) SHOULD be used if the Client has no information to report for a statistic.

5.2. Server RENEW DHCPREQUEST Response

The Server MAY respond to a subnet RENEW with either a DHCPACK or DHCPNAK response. If a DHCPNAK response is given, the Client MUST immediately stop using the subnet(s) specified and, if possible, notify all Clients with addresses allocated from this subnet that their addresses are no longer valid. The Client MAY, of course, send a DHCPDISCOVER message containing the Subnet Allocation option and the Subnet-Request suboption in order to acquire another subnet for use. In general, the Server should ask the Client to deprecate subnets by using the 'd' bit of the Subnet-Information suboption in a DHCPACK message (see below).

If a DHCPACK response is given, the "Deprecate" ('d') bit of the Flags field in the Subnet-Information suboption may also be set. This indicates the DHCP Client should prepare to stop using this subnet. If the Client is allocating IP addresses for other Clients from this subnet (e.g., via DHCP), the Client SHOULD immediately stop allocating such addresses. Once all allocated addresses in the subnet have been released, the Client SHOULD send a DHCPRELEASE message, including the Subnet-Information suboption (with optional usage statistics) in order to release the subnet(s) back to the Server.

5.3. Client DHCPRELEASE Message

The DHCP Client SHOULD send a DHCPRELEASE message in order to release allocated subnet(s) back to the Server when it is finished using them. This message MUST NOT include the Subnet-Request suboption, but MUST include one or more Subnet-Information suboptions, and may optionally include usage statistics.

The Client MUST release the same subnet(s) of the same prefix length ("Prefix"), as were originally allocated. The Client MAY release a subset of the subnets that were allocated originally. In other

words, the allocable unit is the tuple (network number, prefix length). Multiple subnets may be allocated in one DHCPACK; however, each subnet MAY be released individually.

5.4. Server DHCPFORCERENEW Message

The DHCP Server MAY issue a DHCPFORCERENEW [RFC3203] message containing the Subnet Allocation option and the Subnet-Information suboption. Upon receiving this message, the DHCP Client MUST issue a DHCPREQUEST message to the DHCP Server in order to renew the lease on the subnet mentioned. No other subnets allocated to the Client are affected. As is the case with all DHCP RENEW messages, the Client may include subnet usage information in the Subnet-Information suboption in order to report subnet usage statistics, or set the "Stat-len" field to 0 if no statistics are to be reported.

If the Server responds to this DHCPREQUEST with a DHCPNAK message, then the Client MUST immediately stop using the subnet(s) and, if possible, notify all Clients with addresses allocated from this/these subnet(s) that their addresses are no longer valid. The Client MAY, of course, send a DHCPDISCOVER message containing the Subnet Allocation option and the Subnet-Request suboption in order to acquire another subnet for use.

6. Client Requesting Previously Allocated Subnet Information

A DHCP Client MAY request from the DHCP Server a list of what subnets are currently allocated to the Client. This may be used to recover from a restart if the Client does not have local storage in order to retain the information itself. (For an example of this, see Section 8.2 below.)

6.1. Initial Client DHCPDISCOVER Message

The DHCP Client DHCPDISCOVER message, when used to discover already allocated subnet information, SHOULD contain a Subnet-Request suboption with the "Prefix" field set to 0 and with the 'i' flag set to 1 to indicate that the Client is seeking already allocated subnet information from the Server. No Subnet-Information suboptions should be included in this message. Note, no Subnet-Information suboption is included in this message, since the Client would not know of any subnet to request at that point.

This DHCPDISCOVER message MAY be unicast to a particular DHCP Server, or broadcast in the normal fashion.

6.2. Initial Server DHCPPOFFER Response

Any DHCP Server that has allocated subnets to the Client SHOULD respond to the DHCPDISCOVER message with a DHCPPOFFER message. The DHCPPOFFER message should contain one or more Subnet-Information suboption(s) telling the prefix of the subnet(s) allocated to the Client.

The Server SHOULD, internally, retain an ordered list of subnets that are allocated to each Client. In response to an initial DHCPDISCOVER message requesting allocated subnet information (i.e., one with the 'i' flag set to 1, but not carrying a Subnet-Information suboption), the Server returns in the DHCPPOFFER message the subnet information for the first subnet(s) from this list. If the end of the list has been reached, then the 's' bit of the last Subnet-Information suboption included in the message MUST be set to 0. If there are more subnets in the list, the 's' bit MUST be set to 1 to indicate to the Client that more information is available. Since this information is in response to a Client request for previously allocated subnet information, the 'c' bit MUST be set to 1.

6.3. Additional Client DHCPDISCOVER Messages

The Client, upon receiving any Server DHCPPOFFER messages containing Subnet Information suboption information with the 'c' ("Client") bit set, SHOULD gather the network number ("Network") and prefix length ("Prefix") information from the message.

If the 's' bit is set in the last of the Subnet-Information suboptions included in the message, then the Client SHOULD construct a new DHCPDISCOVER message containing the Subnet Allocation option and the last Subnet-Information suboption from the Server's message. This message SHOULD then be sent back to the same DHCP Server originating the DHCPPOFFER message. The 'c' and 's' bits MUST retain the same settings they had from the Server's DHCPPOFFER message and the network number ("Network") and prefix length ("Prefix") fields MUST be unaltered as well.

If the 's' bit in all of the Subnet-Information suboptions from the Server was 0, then it indicates the Server has no more information about subnets allocated to the Client.

6.4. Additional Server DHCPPOFFER Responses

The Server, upon receiving from a Client an additional DHCPDISCOVER message for allocated subnet information retrieval, with the 'i' flag set to 1 and containing one or more Subnet Information suboptions with the 'c' and the 's' bits set, MUST use the network number

("Network") and prefix length ("Prefix") fields contained in the last such Subnet Information suboption. This is in order to locate the position in the internal table of allocated subnets for this Client. Then, the Server MUST return an DHCP OFFER message containing a Subnet-Information suboption giving information about the next set of subnets allocated to this Client. If this finishes the list in the table for this Client, then the 's' bit MUST be set to 0 to indicate there is no more information. Any Subnet Information suboptions encountered without both the 'c' and 's' bits set should be ignored by the Server.

7. DHCP Server Subnet Allocation Method

The actual method of allocating subnets on the DHCP Server, as well as the configuration of what networks may be subnetted and how, is left up to the implementation.

8. Examples

Only the Subnet Allocation option and accompanying suboptions are displayed in these examples. All other fields in the DHCP messages are described in [RFC2131].

8.1. Example 1

A DHCP Client requesting a subnet with prefix length 24 from which the Client will allocate addresses to other Clients. The Server responds with an allocation of exactly the size requested:

The Client sends a DHCP DISCOVER message including a Subnet Allocation option with the Subnet-Request suboption:

```

+-----+-----+-----+-----+-----+-----+-----+-----+
|      220      |      5      |      0      |      1      |
+-----+-----+-----+-----+-----+-----+-----+-----+
|      2      |      0      | 0|0|      24      |
+-----+-----+-----+-----+-----+-----+-----+

```

The Server responds with a DHCP OFFER message including a Subnet Allocation option with a Subnet-Information suboption, offering the subnet 10.0.1.0/24.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      0      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      1      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

The Client sends a DHCPREQUEST including a Subnet Allocation option with a Subnet-Information suboption:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      0      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      1      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

The Server responds with a DHCPACK message including a Subnet Allocation option with a Subnet-Information suboption:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      0      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      1      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

Later, the Client sends a DHCPRELEASE message including a Subnet Allocation option with a Subnet-Information suboption:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      0      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      1      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

8.2. Example 2

A DHCP Client requesting two subnets, each with prefix length 24:

The Client sends a DHCPDISCOVER message including a Subnet Allocation option with a Subnet-Request suboption:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      9      |      0      |      1      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      | 0|0|      24      |      1      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      | 0|0|      24      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Server responds with a DHCPOFFER message including a Subnet Allocation option with a Subnet-Information suboption:

The DHCPOFFER specifies one subnet of size 24 and one subnet of size 28.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      18      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      15      |      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |      10      |      0      |      3      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |      28      |      | 0|0|      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Client sends a DHCPREQUEST message including a Subnet Allocation option with a Subnet-Information suboption:

The Client decides that the subnet of size 28 is not sufficient so it doesn't include that subnet in the DHCPREQUEST message.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      | 0|0|      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24      |      | 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Server responds with a DHCPACK message including a Subnet Allocation option with a Subnet-Information suboption:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      | 0 | 0 |      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24      |      | 0 | 0 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

Later, the Client sends a DHCPREQUEST message in order to renew the lease on the one subnet and includes subnet usage information. It reports that a maximum of 10 addresses were allocated from the subnet since the last report, 7 addresses are currently allocated, and 2 addresses were found to be unusable.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      17      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      14      |      | 0 | 0 |      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24      |      | 0 | 0 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      6      |      0      |      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      7      |      0      |      2      |
+---+---+---+---+---+---+

```

The Server responds with a DHCPACK message; however, it signals to the Client that the subnet should be deprecated.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11      |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      | 0 | 0 |      10      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24      |      | 0 | 1 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+

```

The Client reloads at this point and, upon completion of the reload, sends a DHCPDISCOVER asking for information about all subnets that were allocated to it.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      5      |      0      |      1      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      |1|0|      |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Server responds with a DHCP OFFER, giving the subnet information about the one subnet that is allocated to the Client. Also, the Server specifies that the one allocated subnet should be immediately deprecated. Note that the 's' ("Server") bit is 0, thus indicating that there is no more information available for this Client.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11     |      0      |      2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      |1|0|      |      10     |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24     |      |0|1|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Client responds with a DHCP RELEASE message after having deprecated the subnet:

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      220      |      11     |      0      |      SIS     |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      8      |      |0|0|      |      10     |      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      |      0      |      24     |      |0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      0      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

9. Differences from DHCPv6 Prefix Delegation

The following differences may be noticed between Subnet Allocation as described in this document and DHCPv6 Prefix Delegation as described in [RFC3633]:

- o This option does not use anything like an "IA_PD" as is used in DHCPv6.
- o If the Server cannot allocate a subnet, it remains silent, instead of returning a special response saying nothing is available.

- o DHCPv6 Prefix Delegation has no mechanism for returning subnet/prefix usage statistics.
- o DHCPv6 has no equivalent to the "subnet deprecation" flag as described here.
- o DHCPv6 Prefix Delegation makes no mention of what Client actions should result from receiving a DHCPNAK during a RENEW of a delegation.
- o DHCPv6 has no equivalent of the subnet allocation "Network name" suboption, which may be used by the Server for various purposes, such as to specify a pool to use when allocating a subnet.
- o DHCPv6 Prefix Delegation corresponds to "Hierarchical Subnet Allocation" (setting the 'h' flag in the Prefix Information block). There is no v6 equivalent of clearing the 'h' flag, in which the Server retains authority over allocation of addresses from the subnet.
- o DHCPv6 Prefix Delegation has nothing to correspond to the Suggested-Lease-Time suboption.

10. Security Considerations

Potential exposures to attack are discussed in Section 7 of the DHCP protocol specification [RFC2131]. The Subnet Allocation option can be used to hoard all allocable subnets on a network.

Implementations should consider using the DHCP Authentication option [RFC3118] in order to provide a higher level of security if it is deemed necessary in their environment.

11. IANA Considerations

IANA has assigned DHCP option number 220 for this option, in accordance with [RFC3942].

No assignment of values for the suboption codes need be made at this time. New values may only be defined by IETF Consensus, as described in [RFC5226]. Basically, this means that they are defined by RFCs approved by the IESG.

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.
- [RFC2131] Droms, R., "Dynamic Host Configuration Protocol", RFC 2131, March 1997.
- [RFC2132] Alexander, S. and R. Droms, "DHCP Options and BOOTP Vendor Extensions", RFC 2132, March 1997.
- [RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, RFC 3629, November 2003.
- [RFC3942] Volz, B., "Reclassifying Dynamic Host Configuration Protocol version 4 (DHCPv4) Options", RFC 3942, November 2004.
- [RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

12.2. Informative References

- [RFC3118] Droms, R. and W. Arbaugh, "Authentication for DHCP Messages", RFC 3118, June 2001.
- [RFC3203] T'Joens, Y., Hublet, C., and P. De Schrijver, "DHCP reconfigure extension", RFC 3203, December 2001.
- [RFC3396] Lemon, T. and S. Cheshire, "Encoding Long Options in the Dynamic Host Configuration Protocol (DHCPv4)", RFC 3396, November 2002.
- [RFC3633] Troan, O. and R. Droms, "IPv6 Prefix Options for Dynamic Host Configuration Protocol (DHCP) version 6", RFC 3633, December 2003.
- [RFC4632] Fuller, V. and T. Li, "Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan", BCP 122, RFC 4632, August 2006.

Appendix A. Acknowledgments

The authors gratefully acknowledge the contributions of Jay Kumarasamy.

Authors' Addresses

Richard A. Johnson
Cisco Systems, Inc.
170 W. Tasman Dr.
San Jose, CA 95134
US

Phone: +1 408 526 4000
EMail: raj@cisco.com

Kim Kinnear
Cisco Systems, Inc.
170 W. Tasman Dr.
San Jose, CA 95134
US

Phone: +1 408 526 4000
EMail: kkinnear@cisco.com

Mark Stapp
Cisco Systems, Inc.
170 W. Tasman Dr.
San Jose, CA 95134
US

Phone: +1 408 526 4000
EMail: mjs@cisco.com