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Multicast address allocation extensions to the

Dynamic Host Configuration Protocol

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Abstract

The Dynamic Host Configuration Protocol (DHCP) provides a framework
for passing configuration information to hosts on a TCP/IP network.
The multicast extensions to DHCP add additional capability of
dynamic allocation of the multicast addresses and additional
configuration options.

1. Introduction

The multicast extensions to DHCP (MDHCP) provide configuration
parameters to the multicast applications. MDHCP is built on a
client-server model, where designated DHCP server allocates
multicast addresses and delivers parameters associated with the
address to dynamically configured hosts. Throughout the remainder

of this document, the term "server" refers to a host providing
multicast address(es) and parameters through DHCP, and the term
"client" refers to a host requesting multicast address(es) and
parameters from a DHCP server. MDHCP server is used at times, to
indicate a DHCP server capable of handling MDHCP extensions to the
DHCP protocol and the MDHCP client is used to indicate the MDHCP
capable DHCP client. MDHCP is not a separate protocol, but is
simply an extension to the DHCP protocol.

Like DHCP, MDHCP should be a mechanism rather than a policy. MDHCP
must allow local system administrators control over configuration
parameters where desired; e.g., local system administrators should
be able to enforce local policies concerning allocation and access
to local resources where desired.

The MDHCP client is not required to obtain IP address from a DHCP
server in order to use MDHCP protocol.

The design goals specified in the DHCP RFC also apply to MDHCP.

[1.1](). **Requirements**

Throughout this document, the words that are used to define the
significance of particular requirements are capitalized. These
words are:

      o "MUST"

        This word or the adjective "REQUIRED" means that the
        item is an absolute requirement of this specification.

      o "MUST NOT"

        This phrase means that the item is an absolute prohibition
        of this specification.

o "SHOULD"

This word or the adjective "RECOMMENDED" means that there
may exist valid reasons in particular circumstances to
ignore this item, but the full implications should be
understood and the case carefully weighed before choosing a
different course.

o "SHOULD NOT"

This phrase means that there may exist valid reasons in
particular circumstances when the listed behavior is
acceptable or even useful, but the full implications should

be understood and the case carefully weighed before
implementing any behavior described with this label.

o "MAY"

This word or the adjective "OPTIONAL" means that this item
is truly optional. One vendor may choose to include the
item because a particular marketplace requires it or because
it enhances the product, for example; another vendor may
omit the same item.

1.2. Terminology

This document uses the following terms[1]:

o "DHCP client"

A DHCP client is an Internet host that obtains configuration
parameters (e.g., network address) using DHCP protocol

o "DHCP server"

A DHCP server is an Internet host that provides
configuration parameters to DHCP clients.

o "MDHCP client"

A MDHCP client is a DHCP client that supports MDHCP
extensions.

o "MDHCP server"

   A MDHCP server is a DHCP server that supports MDHCP
   extensions.

[1.3](#). Motivation and protocol requirements.

For multicast applications to be ubiquitous, there is a need to
standardize on a protocol to allocate multicast addresses to an
application. Following are the set of requirements on such a
protocol.

Conflict Free Allocation: When two applications obtain a multicast
address (using a common multicast address allocation protocol), both
applications may be allocated identical addresses only if it can be
guaranteed that no hosts will receive multicasts using same address
from both the applications on the same network interface provided
that the multicast scoping is implemented correctly.

 Quick response: The application should not have to wait for a long
 time before it able to determine if it can use a multicast address.
 The response time should primarily be a function of network and
 system delays only and should not be in the order of several
 minutes.

 Low network load: The multicast address allocation protocol is a
 control protocol. Therefore, it should impose minimal load on the
 network. Specifically, the address allocation protocol should not
 overload a modem line when used by a dial-in user.

 Work with power managed systems: System may be in on, off or low
 power state between the address allocation and usage period.

 Multicast address scopes: The protocol must be able to allocate both
 the administratively scoped and global addresses.

 Efficient use of address space: The multicast address space is
 smaller then IP address space. Moreover, a host or application may
 require multiple addresses. Therefore, efficient use of address
 space is a design goal of multicast address allocation protocol.

 From the protocol standpoint, MDHCP is an extension of the DHCP. As
 in normal DHCP protocol, a MDHCP client requests multicast
 address(es) from the MDHCP server for a specified multicast scope.
 The MDHCP servers assigns multicast address(es) to the hosts to be
 used within the requested scope, and valid over a specific period.
 The DHCP server MUST provide TTL value of the address. The client,
 when using the assigned address should not use the TTL value larger
 than the one provided. The lease period is defined by the duration
 of the lease and the time at which the lease becomes effective. The
 DHCP server MUST NOT allocate the same address to different clients
 with overlapping lease period and scope. The protocol also allows
 client to request more than one address at a time.

 Before requesting a multicast address, a client needs to obtain the
 list of multicast scopes available on the MDHCP server. The
 multicast scope-list is one of the MDHCP configuration parameters.
 The scope list may be obtained through the DHCP option described in
 [3], or may be obtained by some other means. Similarly, the MDHCP
 server address (multicast) may also be obtained by the option
 described in [3] or can be configured on the client.

 The MDHCP server is not required to be co-located with a DHCP
 server. Therefore, in a typical deployment, there may be fewer MDHCP
 servers then the DHCP servers.

 The MDHCP protocol uses M flag and a set of options defined below.

 2.   MDHCP messages and options.

 The following options and flags are used by MDHCP extensions.

 A new flag (M) is defined to differentiate the MDHCP messages from
 DHCP messages. All the messages (DHCPDISCOVER, DHCPOFFER etc.) use
 M flag defined below to indicate multicast address negotiations. The
 second bit of the flag field (bit 1) defines M (multicast) flag.

The M bit must be set for all the message exchanges pertinent to the multicast address assignment. The client MUST obtain an IP address prior to requesting a multicast address. Therefore, B flag MUST not be set when M flag is set.

```
                            1 1 1 1 1 1

                0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5

               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

               |B|M|           MBZ             |

               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+


               B:   BROADCAST flag

               M:   Multicast address request flag.


               MBZ:   MUST BE ZERO (reserved for future use)
```

2.2. Multicast Scope Option

This option is used by the client to indicate the multicast scope for the requested multicast address(es). It is also used to indicate the scope of the assigned address by the DHCP server. If this option is not specified, the DHCP server MAY allocate an address from a DEFAULT scope or reject the request.

```
     Code   Len       Scope Id

    +-----+-----+-----+-----+-----+-----+
    | 101 | 4   | i1  | i2  | i3  | i4  |
    +-----+-----+-----+-----+-----+-----+
```

The client may obtain the scope list through the option described in [3] or using some other means. The scope id is the numeric representation of the scope as described in [3]. The 'code' for this option is 101 and the length is 4.

2.3. Start time Option

The start time is used in a client request (DHCPDISCOVER or
DHCPREQUEST) to allow the client to request the starting time for
the use of the assigned address. This option allows client to
request a multicast address for use at a future time.

```
    Code  Len      Time

    +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
    | 102 | 8   | t1  | t2  | t3  | t4  | t5  | t6  | t7  | t8  |
    +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

The time value is the decimal representation of Network Time
Protocol (NTP) time values in seconds [5].

The 'code' for this option is 102 and the length is 8.

If IP Address Lease Time option specifies [2] the duration of the
lease beginning at Start Time option value.

2.4. Multicast TTL Option

This option specifies the TTL value to be used with the multicast
address. The TTL is specified as an octet with a value between 1
and 255. The implied value of this option is 255 when not included.

```
    Code  Len    Multicast TTL

    +-----+-----+-----+
    | 103 | 1   | n   |
    +-----+-----+-----+
```

The 'code' for this option is 103 and the length is 1.

2.5. Number of Addresses Requested Option

This option specifies the number of addresses requested by the
client. The client MAY obtain more than one address either by
repeating the protocol for every address or by requesting all the
addresses at the same time via this option. The server MAY use this
option to indicate to the client the number of addresses it has
allocated to the client. When the client is requesting only one
address, this option need not be included.

```
     Code  Len    Number of Addresses

   +-----+-----+-----+-----+

   | 104 | 2   | n         |

   +-----+-----+-----+-----+
```

The 'code' for this option is 104 and the length is 2.

2.6. Client Port Option

In order to facilitate implementations outside the operating system
kernel, and to allow two separate client implementations: one for
DHCP and one for MDHCP, if this option is specified, the MDHCP server
MUST use the source port number used in the DHCPDISCOVER,
DHCPREQUEST, DHCPINFORM, and DHCPRESEASE as the destination port
number in the response messages.

```
     Code  Len    Port

   +-----+-----+-----+

   | 105 | 1   | n   |

   +-----+-----+-----+
```

The 'code' for this option is 105 and the length is 1.

[2.7](). List of Address Ranges Allocated

This option is used by the server to provide the list of all the address ranges allocated to the client when client requests more than one addresses. When a client requests only one address, the server uses the yiaddr field specify the allocated address. When a client requests more than one address, additional address ranges are listed via this option.

```
     Code   Len      Address Range List

    +-----+-----+-----+-----+-...-+-----+

    | 105 | n   | L1  | L2  |     | Ln  |

    +-----+-----+-----+-----+-----+-----+
```

 Where the Address Range List is of the follwing format.

```
    StartAddress1  BlockSize1 StartAddress2 BlockSize2 ...

    +---+---+---+---+---+---+---+---+---+---+---+---+--...--+

    |S11|S12|S13|S14|B11|B12|S21|S22|S23|S24|B21|B22|       |

    +---+---+---+---+---+---+---+---+---+---+---+---+-------+
```

 The 'code' for this option is TBD and the minimum length is 6.

[3](). MDHP protocol

The client first needs to know the group multicast address of the MDHCP servers, and the multicast scope list. This address and the scope list may be obtained by requesting the options specified in [[3]()] from DHCP servers via DHCPINFORM or from other repository of network configurations.

At this point, client has two ways of obtaining the multicast address(es) from the server.

 In the first method [see Figure 1], the client is requesting

address(es) from any of the MDHCP servers configured to hand out
addresses from a given scope. The client selects a scope and sends
out a DHCPDISCOVER
message to the multicast address of the MDHCP servers. The server
responds by sending DHCPOFFER message directly to the client. The
client then sends DHCPREQUEST messages to the multicast address.
of the MDHCP servers. The selected server responds by sending
DHCPACK message directly to the client as in normal DHCP protocol.
The multicast DHCPDICOVER and DHCPREQUEST messages are received by
only the multicast capable DHCP servers, and therefore, there is no
conflict between the MDHCP and DHCP messages. Further, the messages
for renewing and releasing lease are sent directly to the MDHCP
servers only, and therefore, there is conflict between DHCP and
MDHCP message interpretation by a non-MDHCP capable server. The
fields and options that are different from the normal DHCP message
exchange are summarized in Table 1 to 3. For details on rest of the
fields, please refer DHCP RFC [1].

The client can later renew or release the multicast address by using
DHCPREQUEST and DHCPRELEASE message exchanges as defined in the DHCP
RFC [1].

At any time, if the MDHCP server is unable to satisfy the
DHCPREQUEST message (e.g., the requested address has been
allocated), the server MUST respond with a DHCPNAK message.

Note that all the messages in this exchange have their M flag set
and B flag not set.

In the second method [see Figure 2] the client is requesting
address(es) directly from a specific MDHCP server. When a client
knows the IP address of the MDHCP server from which it can obtain a
multicast address(es) from a give scope, it MAY skip the discover
phase (i.e. DHCPDISCOVER and DHCPOFFER message exchange) and
directly start with unicasting DHCPREQUEST message to the server. If
this fails, the client SHOULD revert back to the first method.

The MDHCP client may need to be deployed on the client machines
where DHCP client implementation is not capable of filtering out the
MDHCP messages. In that case, the MDHCP client MUST use a port
number different from DHCP client port(68) . The MDHCP client MUST
specify this port in the DHCPDISCOVER and DHCPREQUEST messages via
 Client Port Option .

The MDHCP Client MUST provide client identifier option when sending
messages for multicast address assignment. The client generates a
unique key and uses that as a client identifier in the DHCPDISCOVER
message. The client identifier is the key to distinguish the client
request and to avoid duplicate address allocation.

Each client may be running several different multicast enabled

applications, and each application may require separate multicast
address(es). Client MUST use separate unique client identifier when

requesting separate multicast address(es) for each request. A client
implementation may choose to use hardware address, application
instance and time of request to generate unique client identifiers.

The following tables [Table 1, Table 2] describes the fields and
options that are relavent to MDHCP protocol but are different from
the normal DHCP protocol [1]

Field	DHCPOFFER	DHCPACK	DHCPNAK
'flags'	Set 'M' Bit. BROADCAST bit 0	set 'M' Bit BROADCAST bit 0	set 'M' bit BROADCAST bit 0
'ciaddr'	'ciaddr' from DHCPDISCOVER or 0	'ciaddr' from DHCPREQUEST or 0	0
'yiaddr'	Multicast address assigned to client	Multicast address assigned to client	
'siaddr'	Server's IP address reachable from the client.	Server's IP address reachable from the client.	0
'chaddr'	'chaddr' from client DHCPDISCOVER message	'chaddr' from client DHCPREQUEST message	'chaddr' from client DHCPREQUEST message
'file'	may contain options	may contain options	(unused)
'options'	options	options	

Option	DHCPOFFER	DHCPACK	DHCPNAK

Field			
IP address lease time	MUST	MUST	MUST NOT
Lease Start Time	MUST	MUST	MUST NOT
Server identifier	MUST	MUST	MUST
Multicast Scope	MUST	MUST	MUST NOT

Table 1: Fields and options that are different in
            multicast DHCP server messages.

                         MDHCP   11/20/97

Field	DHCPDISCOVER	DHCPREQUEST	DHCPRELEASE
'flags'	Set 'M' Bit.	set 'M' Bit	set 'M' bit
	BROADCAST bit 0	BROADCAST bit 0	BROADCAST bit 0
'ciaddr'	0 or client's	0 or client's	0
	network addr	network addr	
'chaddr'	ignored	ignored	ignored
'options'	options	options	(unused)

Option	DHCPDISCOVER	DHCPREQUEST	DHCPRELEASE
Start time	MAY	MAY	MUST NOT

Client identifier	MUST	MUST	MAY
Multicast Scope	SHOULD	SHOULD	MAY
Client Port	MUST(if using a different port)	MUST (if using a different port)	MUST NOT

Table 2: Fields and options that are different in
multicast DHCP client messages

Server   Client   Server

```
       (not selected)                    (selected)


             v                 v                   v

             |                 |                   |

             |      Obtain IP address              |

             |                 |                   |

             |Begin multicast address request|

             |                 |                   |

             | _____/|_____ |

             |/ DHCPDISCOVER | DHCPDISCOVER \|

             |                 |                   |

        Determines            |            Determines

        address(es)           |            address(es)

             |                 |                   |

             |\                |  _____/|

             | _____      | /DHCPOFFER      |

             |   DHCPOFFER\    |/                |

             |            \  |                   |

             |        Collects replies            |

             |                \|                   |

             |      Selects Address(es)           |

             |                 |                   |

             | _____/|_____ |

             |/ DHCPREQUEST  |  DHCPREQUEST \|

             |                 |                   |

             |                 |       Commits address(es)

             |                 |                   |

             |                 | _____/|
```

```
       |                    |/ DHCPACK       |

       |                    |                |

       | assignment complete                |

       |                    |                |

       .                    .                .

       |                    |                |

       |          Graceful release          |

       |                    |                |

       |                    |_____ |

       |                    | DHCPRELEASE \|

       |                    |                |

       |                    |      Discards lease

       |                    |                |

       v                    v                v
```
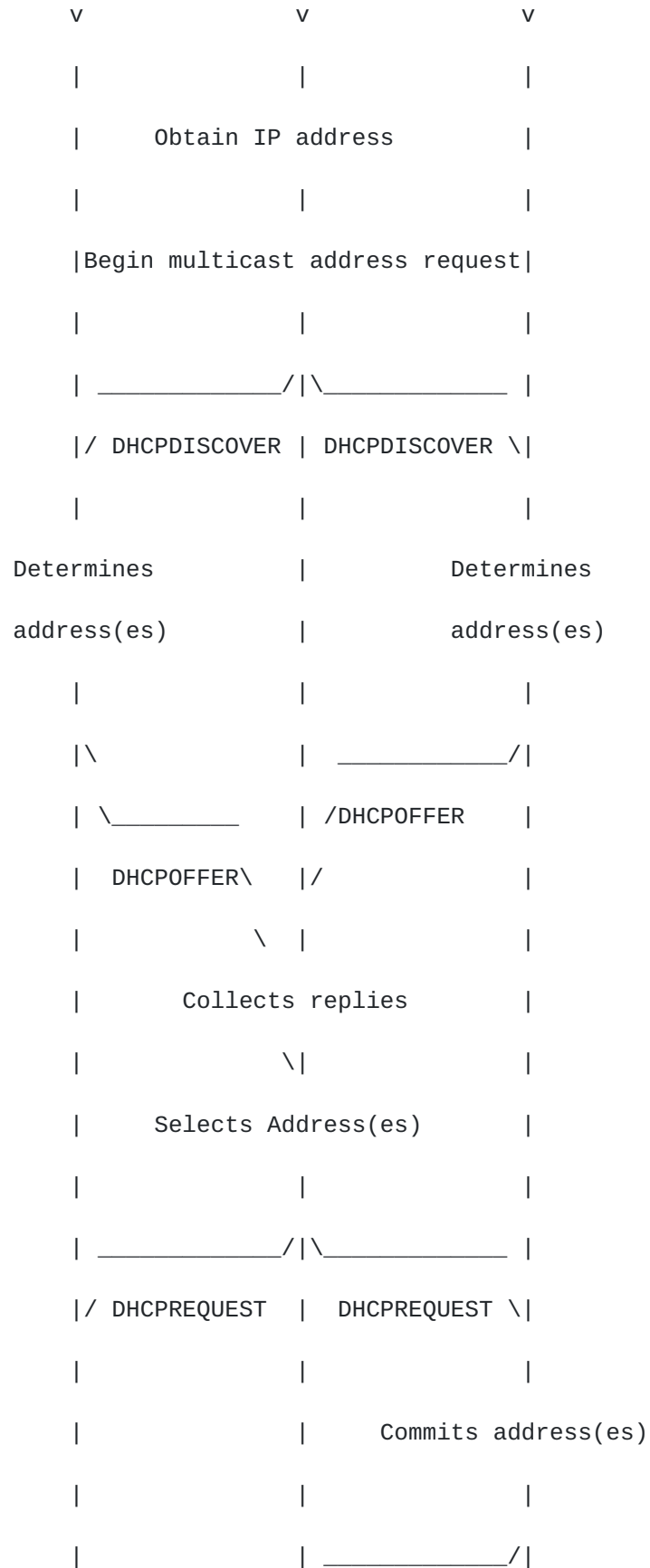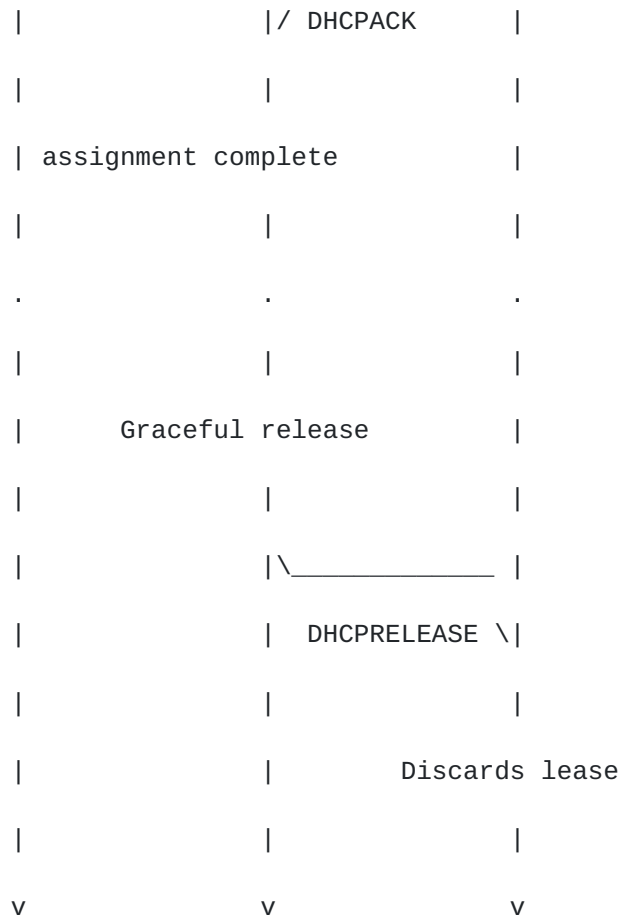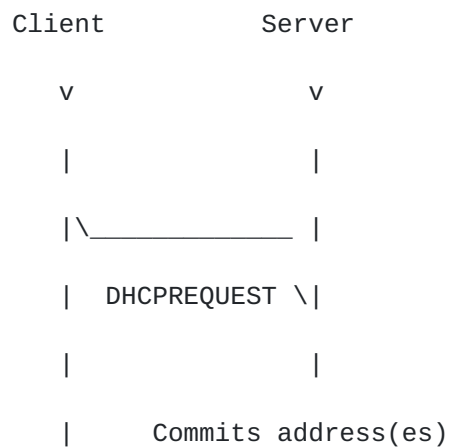
Figure 1: Timeline diagram of messages exchanged between MDHCP
client and servers using group multicast address for MDHCP
capable servers.

```
          Client          Server

           v               v

           |               |

          |_____ |

           |   DHCPREQUEST \|

           |               |

           |      Commits address(es)
```
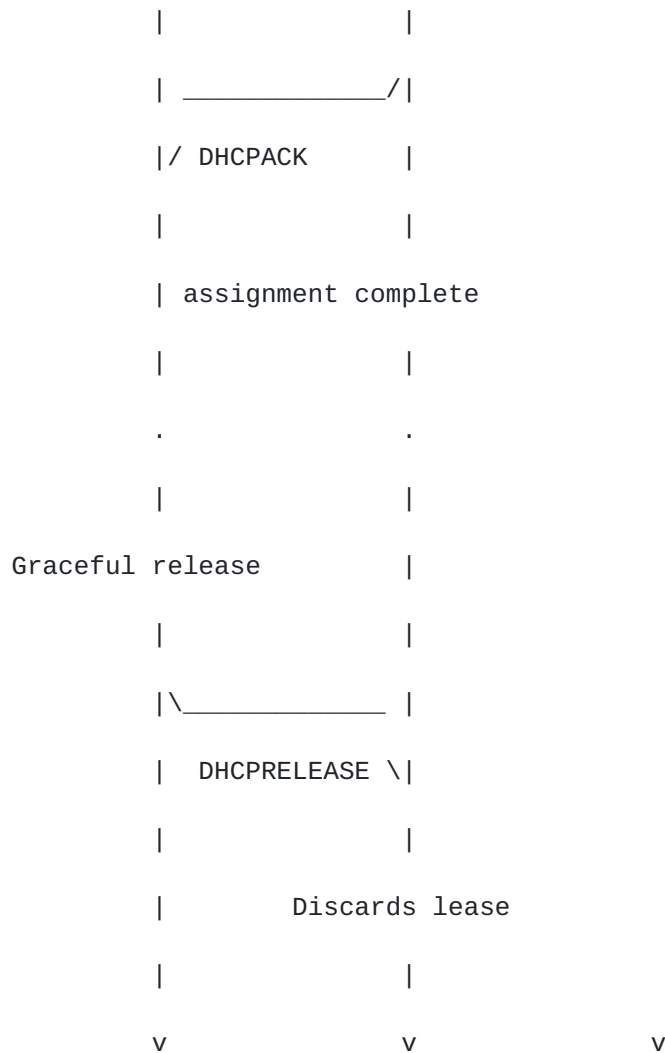
```
             |                   |

             | _____/|

             |/ DHCPACK         |

             |                   |

             | assignment complete

             |                   |

             .                   .

             |                   |

   Graceful release             |

             |                   |

             |_____  |

             |   DHCPRELEASE \|

             |                   |

             |         Discards lease

             |                   |

             v            v              v
```

Figure 2: Timeline diagram of messages exchanged between MDHCP
         client and servers when MDHCP server has already been
         selected

4. MDHCP Protocol properties

Conflict free address allocation: In the intranet case, each MDHCP
server MAY be allocated part of the administratively scoped address
space. As long as the address space managed by MDHCP servers is
non-overlapping for a given administrative scope, the protocol
will allocate conflict free addresses. MDHCP protocol does not
directly address the mechanisms for determining address allocation
outside Intranet. However, we propose to use MDHCP as a front end
to any future address allocation protocol for the Internet. The DHCP
protocol will preserve conflict free address allocation property of
the internet multicast address allocation protocol.

Small response time: The response time for MDHCP protocol is strictly based on the network propagation delay and the load on the MDHCP server.

The MDHCP protocol does not require a client system to be on all the time. Thus, it poses no additional requirements on power managed systems.

Multicast address scopes: The administratively scoped multicast address may be directly allocated by MDHCP server. However, it is envisioned that the MDHCP protocol will be indirectly used for Internet wide Multicast addresses allocation. In such deployment, the MDHCP server will act as a front-end to future Internet multicast address allocation protocols.

Efficient use of address space: The multicast address space may be statically partitioned between MDHCP servers to provide sufficient reliability and load management on servers. However, the multicast based address request will be able to obtain addresses from any of the available servers.

5.   Security Considerations

This document does not explicitly address security considerations to avoid redundant effort with the work in progress in DHC working group of IETF on securing DHCP.

6.   Acknowledgements

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