DHCP - Dynamic Host Configuration Protocol

Dynamic Host Configuration Protocol (DHCP) is used to dynamically provide IP addresses and configuration information to client nodes. DHCP provides greater flexibility by leasing out IP addresses to host nodes. DHCP supports mechanisms that can be used by hosts to renew their lease.

This sequence diagram describes the DHCP interactions between a Laptop and the DHCP servers in the intranet. Four different cases are covered.

1. Laptop boots up for the first time and requests an IP address.
2. Laptop’s IP address lease is renewed.
3. Laptop reboots and confirms the IP address settings.
4. Laptop is disconnected from Subnet 1 and reconnected in Subnet 3.

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1. Laptop boots up for the first time and requests an IP address

Laptop in Subnet 1

DHCP Client starts in the Init state

DHCP Discover

Client machine comes up without an IP address. It sends out a DHCP Discover message on its subnet to identify the DHCP Servers on the subnet. The message is sent as an Ethernet broadcast, i.e. the message is sent to the Ethernet broadcast address (all Fs).

The message is received at ‘DHCP Server 1’ and the BOOTP server running on a router between Subnet 1 and Subnet2.

Now the DHCP Client is in the selecting state

DHCP Server 1 in subnet 1 makes an offer for a Subnet 1 IP address

DHCP Server 1 selects IP address A and marks it as offered. (This prevents the same IP address from being offered to another client, before DHCP Client 1 has a chance to respond.

DHCP Offer

your_ip = A

DHCP Server 2 in subnet 2 makes an offer for a subnet 1 IP address

The message is picked up by the router and forwarded to a preconfigured DHCP Server on a different subnet. This functionality utilizes the BOOTP Relay Agent support in Routers. (See the BOOTP Sequence Diagram for details)

DHCP Server 2 selects IP address B and marks it as offered.
DHCP Client has received offers with IP address A and B. It selects one of the IP addresses.

DHCP Client sends out a DHCP Request as a subnet broadcast. The selected IP address is stored in the client ip address field. In this case IP address A from DHCP Server 1 is selected.

DHCP Server 2 sees that the client has sent a DHCP Request but it has not selected the IP address it had offered, so IP address B is returned to the free pool.

DHCP Server 1 allocates IP address A and stores this binding on the disk along with the lease time.

A timer is started for the duration of the lease for the IP address.

DHCP Server 1 responds by a unicast. This requires that the ARP Cache is updated with the hardware address for the device. (This functionality is similar to BOOTP)

After DHCP Ack is received, the client validates the information provided by the DHCP server.

Timeout for a ARP Reply signals that the IP address is unique.
Manage the IP address leasing

IP address given by the DHCP server is a leased address for a given period (usually 3 days). Timer T1 and T2 are used to manage the address leasing.

- **T1**: Client starts T1 (typically 0.5 Lease Time)
- **T2**: Client starts T2 (typically 0.875 Lease Time)

**Bound**

DHCP address is now in use on this machine. This state is referred to as Bound.

(2.) Laptop's IP address lease is renewed.

Renew the IP address lease

- **T1**: T1 has expired. It's time to renew the IP address lease.
  - DHCP Request
  - client_ip = A
  - A unicast DHCP Request is sent to the DHCP Server which had assigned the IP address. In this scenario, the renewal request is lost.

- **T2**: T2 times out but DHCP Ack has not been received from the DHCP Server.
  - Rebinding
  - DHCP Request
  - client_ip = A
  - At this point, the DHCP Server would respond with DHCP Ack. In this scenario we assume that the DHCP Server does not respond to the renewal request.

LeaseTimer

- **DHCP Ack**
  - your_ip = A
  - DHCP Server sends the ack back to the client.

- **T1**
  - Client starts T1 and T2 corresponding to the new lease time

Bound

Now Client is bound.

(3.) Laptop reboots and confirms IP address setting

- **T1**
  - Laptop reboots and obtains the assigned IP address from the DHCP server.
Client does have a configured IP address, so it enters the Init-Reboot state to confirm the IP address and other configuration information.

Client sends a DHCP Request to confirm its IP address and configuration. This message is sent as a subnet broadcast.

DHCP Server 1 has leased out an IP address to the client and the lease is still active so it responds back with a DHCP Ack.

The client proceeds to Bound state after starting T1 and T2.

Laptop is disconnected from Subnet 1 and reconnected in Subnet 3.

Disconnect laptop from subnet 1.

Laptop has been disconnected from subnet 1. The lease expires as no renewal is attempted.

The IP address assigned to the laptop is freed.

Reattach the laptop to subnet 3.

DHCP Server 1 checks if the IP address is valid in the new setup.

IP Address A lease has expired. Send a negative acknowledgement to the client.

Client receives the negative ack and restarts the DHCP address request procedure by going back to the DHCP Discovery phase.
Move back to the initial state. The entire sequence of obtaining an IP address is repeated.

Init

DHCP Discover

your_ip = C

DHCP Offer

client_ip = C

DHCP Request

DHCP Ack

T1_new

T2_new

Bound

T1_new

T2_new

DHCP Release

client_ip = C

free

IP Address C

Init

IP address C is allocated

IP address C is freed

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