

NETSIG 03/11/21

Dynamic Host Configuration Protocol

Where does DHCP fit in?

- DHCP provides client devices, e.g. smart phones, laptops, TVs, etc., with their network configuration or in other words – what it needs to know to connect to the Internet.
- A DHCP server typically runs as part of a WiFi router.

Why use DHCP?

- Without DHCP network IP addresses would have to be assigned manually
- On busy network, such as one of the community centers, this just not practical

What Services are provided by DHCP

- Allocation of temporary or permanent IP addresses to clients
 - Attempts to return the same network address each time the client requests an address
 - The period over which a network address is allocated to a client is referred to as a 'lease'
- Configuration parameters, such as:
 - Subnet mask
 - Domain name servers
 - Router IP address

When is DHCP used?

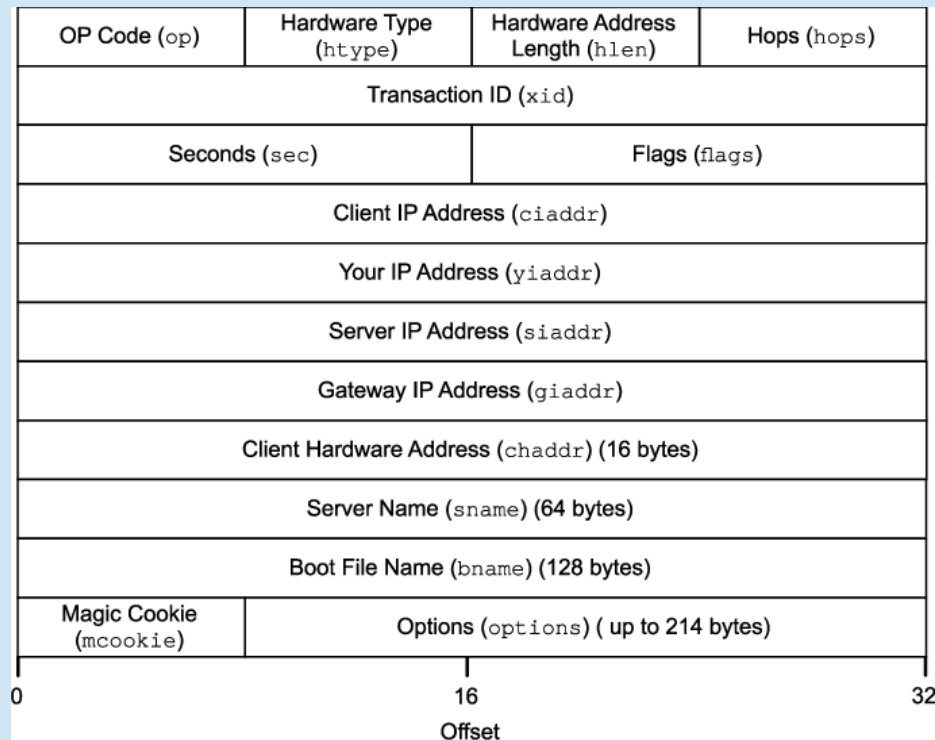
- Runs after a device establishes a wired or WiFi connection.
- When a device needs to renew its lease.
- Can also be initiated manually

3 mechanisms for IP address allocation

- 3 mechanisms for IP address allocation
 - Automatic - DHCP assigns a permanent IP address to a client
 - Dynamic - DHCP assigns an IP address to a client for a limited period of time (or until the client explicitly relinquishes the address). This is the only one of the three mechanisms that allows automatic reuse of an address that is no longer needed by the client.
 - Manual - A client's IP address is assigned by the network administrator, and DHCP is used simply to convey the assigned address to the client.

BOOTP+DHCP packet layout

- yiaddr – Your IP address
- siaddr – The address of the DHCP server
- chaddr – Client hardware address (MAC)
- options – The key to DHCP



Options are the key

- DHCP is an extension of BOOTP
- They differ in that DHCP expands on BOOTP's vendor-specific area, which becomes the options in the DHCP spec
- Options are used to request and to convey configuration parameters and other control information

Typical DHCP Options

- Domain Name Server
- Domain Name
- Subnet Mask
- Broadcast Address
- Vendor Class Identifier
- NetBIOS over TCP/IP Name Server

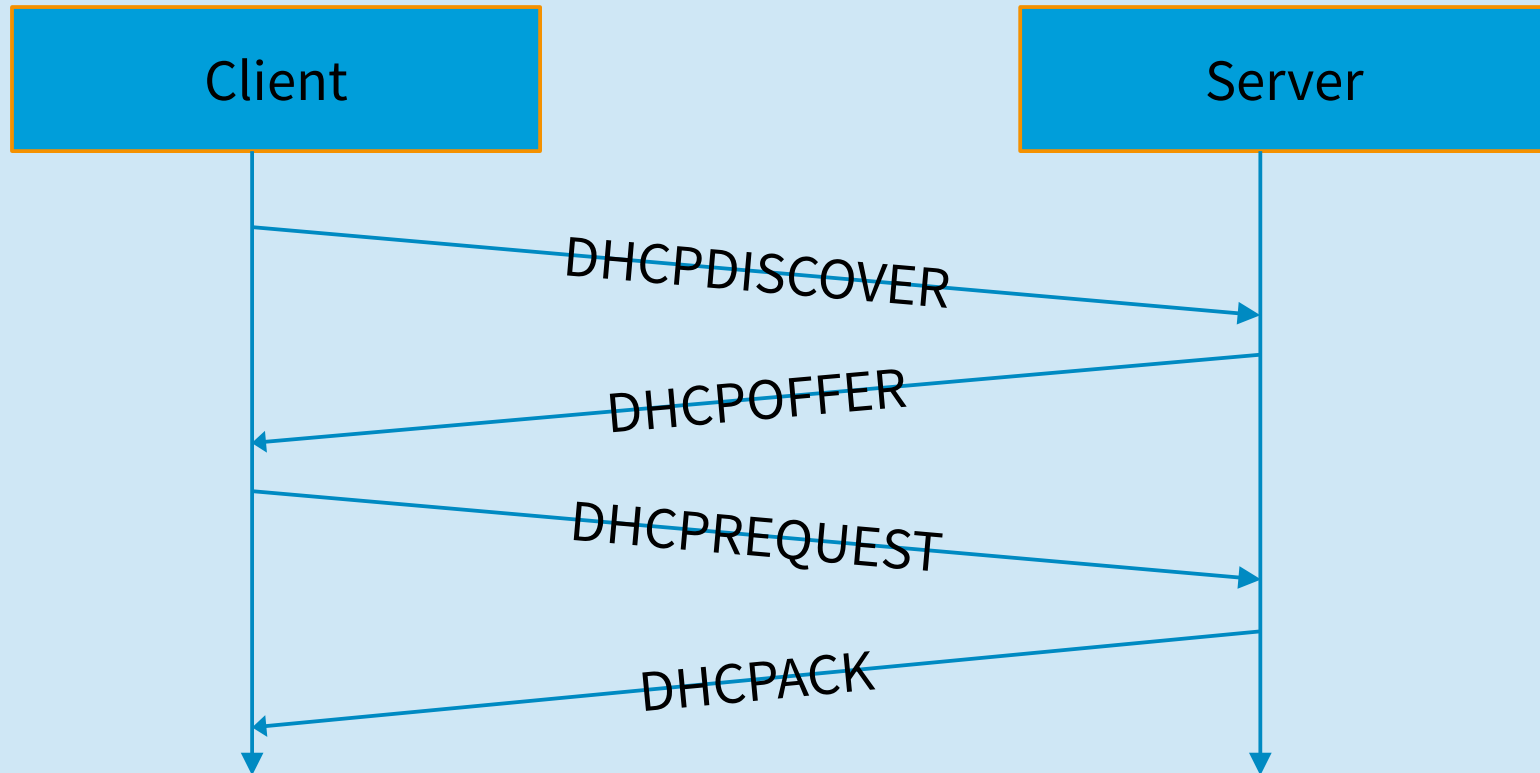
Option 53 DHCP Message Type

1. DHCPDISCOVER – Client discovering DHCP server(s)
2. DHCPOFFER – Server offering a network configuration
3. DHCPREQUEST – Client request a network configuration
4. DHCPDECLINE – Client declining a network configuration
5. DHCPACK – Server acknowledging network configuration
6. DHCPNAK – Server declining requested network configuration
7. DHCPRELEASE – Client releasing allocated IP back to server pool

Demo using GNS3

- From a Google search result:
 - GNS3 is used by hundreds of thousands of network engineers worldwide to emulate, configure, test and troubleshoot virtual and real networks. GNS3 allows you to run a small topology consisting of only a few devices on your laptop, to those that have many devices hosted on multiple servers or even hosted in the cloud.
- <https://gns3.com>

Client first time on network



DHCPDISCOVER

- Options:
 - 53 DHCP Message Type – DHCPDISCOVER
 - 61 Client Identifier – same as chaddr
 - 12 Hostname of client
 - 60 Vendor Class Identifier
 - 55 Parameter Request List

DHCPOFFER

- yiaddr is filled in with proposed IP address 192.168.1.xxx
- siaddr is also filled in with the IP address of the DHCP server
- Options
 - 53 DHCP Message Type – DHCPOFFER
 - 51 IP Address Lease Time
 - 1 Subnet Mask
 - 28 Broadcast Address
 - 6 Domain Name Server

DHCPREQUEST

- Notice the DHCPREQUEST is still using broadcast address rather than unicast, i.e. the client is still not configured
- Options:
 - 50 Requested IP address (from ciaddr of DHCPOFFER)
 - 54 DHCP Server Identifier (in case of multiple DHCP servers)
 - Same Parameter Request List (55) as the DHCPDISCOVER

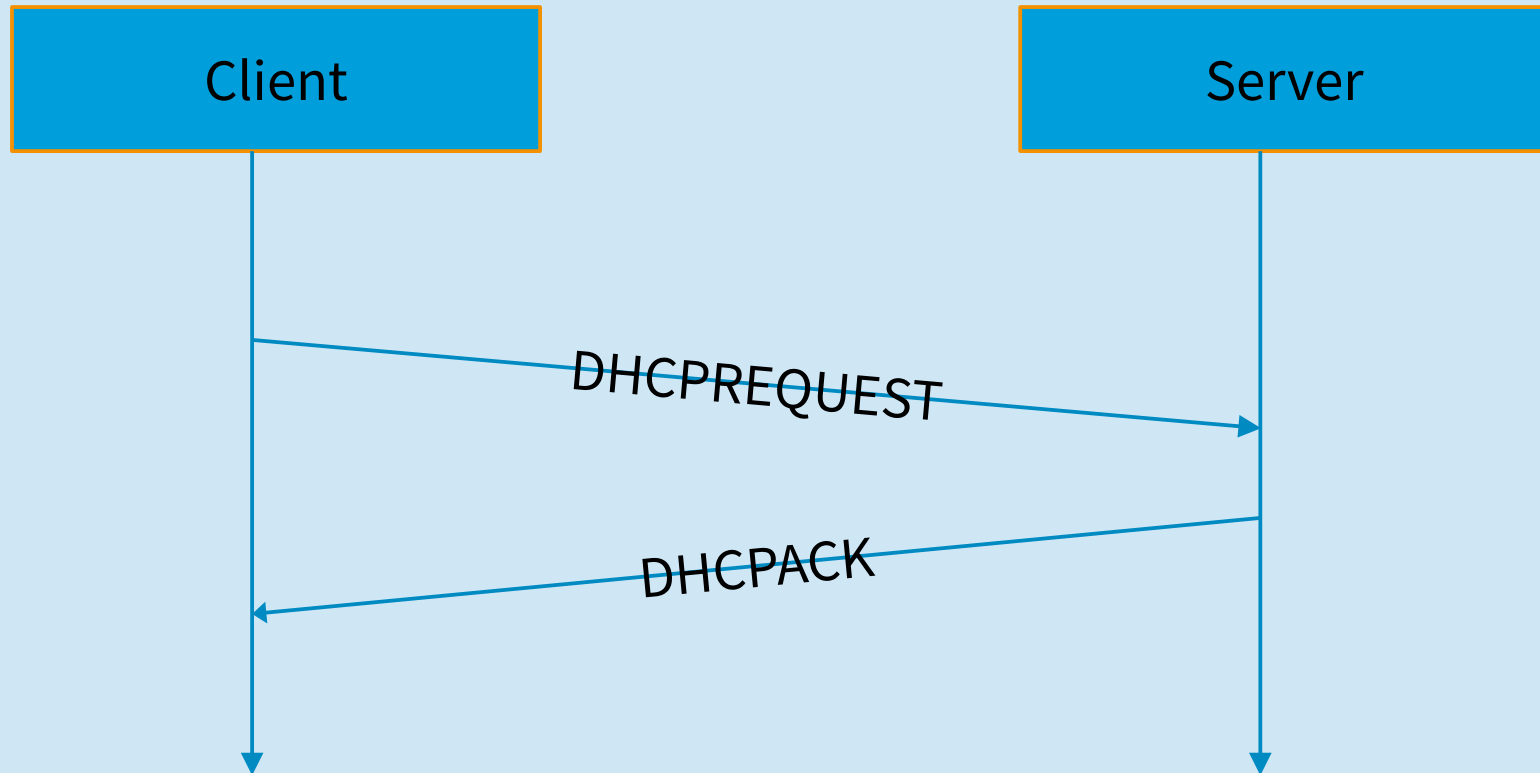
DHCPACK

- Gives the client the final configuration parameters.
- It's at this point that the client is configured or 'bound'
- Options
 - DHCP Message Type – DHCPACK
 - 81 Client Fully Qualified Domain Name

Review – First boot

- Once again – first time a client boots looks like -
 - Client - DHCPDISCOVER
 - Server - DHCPOFFER
 - Client - **DHCPREQUEST**
 - Server - **DHCPACK**

Client returning to network



DHCPREQUEST & DHCPACK

- Pretty much the same DHCPREQUEST sent in response to an acceptable DHCPOFFER with the saved IP address contained in a Requested IP Address (50) option.
- Same with DHCPACK

Lease renewal and rebinding

- When the Renewal Time Value (58) expires the client will send a **unicast** DHCPREQUEST to the server it got the IP address from.
- If the server replies with a DHCPACK, all is well and the lease is extended
- If there is no reply and the Rebinding Time Value (28) expires, the client will **broadcast** a DHCPREQUEST.
- If a server replies with a DHCPACK, all is well and the lease is extended
- If there is no reply, then the client will try another DHCPREQUEST just before the IP Address Lease Time is expires.
- After that the client stops using the network config and goes back to DHCPDISCOVER like when it first was booted.

Manual IP Address configuration

- Although DHCP attempts to make clients receive the same IP address, this is not guaranteed.
- DHCP allows for clients IP address to be manually configured.
- The actual configuration varies depending on the DHCP server software, this example will use OpenWRT.
- The server uses the chaddr (MAC) to identify the client for manual address lookup.
- Some DHCP servers require the manual address to be part of it's pool others don't
- Use `ipconfig /release` & `ipconfig /renew`

Manual Options

- Manual options are used to set to specific configuration parameters
- Options 224 – 254 are ‘private’
- Example -
 - Domain Search:
 - 119,example.com,acme.net
 - Web proxy auto discovery
 - 252,http://192.168.10.10:8080

DHCP RFCs

- RFC 951 BOOTSTRAP PROTOCOL (BOOTP)
 - <https://tools.ietf.org/html/rfc951>
- RFC 2131 Dynamic Host Configuration Protocol
 - <https://tools.ietf.org/html/rfc2131>
- RFC 2132 DHCP Options and BOOTP Vendor Extensions
 - <https://tools.ietf.org/html/rfc2132>
- IANA Dynamic Host Configuration Protocol (DHCP) and Bootstrap Protocol (BOOTP) Parameters
 - <https://www.iana.org/assignments/bootp-dhcp-parameters/bootp-dhcp-parameters.xhtml>