Dynamic Host Configuration Protocol (DHCP)

Is a network protocol that is used to configure devices which are connected to a network so that they can communicate on an IP network. It involves clients and a server operating in a client-server model. In a typical personal home local area network (LAN), a router is the server while clients are personal computers or printers. The router receives this information through a modem from an internet service provider which also operate DHCP servers where the modems are clients. The clients request configuration settings using the DHCP protocol such as an IP address, a default route and one or more DNS server addresses. Once the client implements these settings, the host is able to communicate on that internet.

The DHCP server maintains a database of available IP addresses and configuration information. When the server receives a request from a client, the DHCP server determines the network to which the DHCP client is connected, and then allocates an IP address or prefix that is appropriate for the client, and sends configuration information appropriate for that client. DHCP servers typically grant IP addresses to clients only for a limited interval (lease). DHCP clients are responsible for renewing their IP address before that interval has expired, and must stop using the address once the interval has expired, if they have not been able to renew it.

DHCP was first defined as a standards track protocol in RFC 1531 in October 1993. DHCP is often used together with network address translation (NAT). Network address translation separates public (external) and private (internal) IP addresses. In home networks, the ISP server may assign a globally unique external IP address to a home router or modem and this IP address is used in internet communications. The router will then assign internal IP addresses to the clients connected to it, allowing the clients to broadcast only the external IP address. This improves security by limiting access to devices and also helps to conserve IPv4 addresses.

Technical Overview

Dynamic Host Configuration Protocol automates network-parameter assignment to network devices from one or more DHCP servers. Even in small networks, DHCP is useful because it makes it easy to add new machines to the network.

When a DHCP-configured client (a computer or any other network-aware device) connects to a network, the DHCP client sends a broadcast query requesting necessary information to a DHCP server. The DHCP server manages a pool of IP addresses and information about client configuration parameters such as default gateway, domain name, the name servers, other servers such as time servers, and so forth. On receiving a valid request, the server assigns the computer an IP address, a lease (length of time the allocation is valid), and other IP configuration parameters, such as the subnet mask and the default gateway. The query is typically initiated immediately after booting, and must complete before the client can initiate IP-based communication with other hosts. Upon disconnecting, the IP address is returned to the pool for use by another computer. This way, many other computers can use the same IP address within minutes of each other.

Depending on implementation, the DHCP server may have three methods of allocating IP addresses:
1. **dynamic allocation**: A network administrator assigns a range of IP addresses to DHCP, and each client computer on the LAN is configured to request an IP address from the DHCP server during network initialization. The request-and-grant process uses a lease concept with a controllable time period, allowing the DHCP server to reclaim (and then reallocate) IP addresses that are not renewed.

2. **automatic allocation**: The DHCP server permanently assigns a free IP address to a requesting client from the range defined by the administrator. This is like dynamic allocation, but the DHCP server keeps a table of past IP address assignments, so that it can preferentially assign to a client the same IP address that the client previously had.

3. **static allocation**: The DHCP server allocates an IP address based on a table with MAC address/IP address pairs, which are manually filled in (perhaps by a network administrator). Only clients with a MAC address listed in this table will be allocated an IP address.

DHCP uses two ports: destination UDP port 67 for sending data to the server, and UDP port 68 for data to the client. DHCP communications are connectionless in nature.

DHCP operations fall into four basic phases: **IP discovery**, **IP lease offer**, **IP request**, and **IP lease acknowledgment**. These points are often abbreviated as DORA (Discovery, Offer, Request, Acknowledgment).

DHCP clients and servers on the same subnet communicate via UDP broadcasts, initially. If the client and server are on different subnets, a DHCP Helper or DHCP Relay Agent may be used. Clients requesting renewal of an existing lease may communicate directly via UDP unicast, since the client already has an established IP address at that point.

1. **DHCP discovery** - The client broadcasts messages on the physical subnet to discover available DHCP servers by creating a User Datagram Protocol (UDP) packet with the broadcast destination of 255.255.255.255 or the specific subnet broadcast address. A DHCP client can also request its last-known IP address.

2. **DHCP offer** - When a DHCP server receives an IP lease request from a client, it reserves an IP address for the client and extends an IP lease offer by sending a DHCPOFFER message to the client. This message contains the client's MAC address, the IP address that the server is offering, the subnet mask, the lease duration, and the IP address of the DHCP server making the offer. The server determines the configuration based on the client's hardware address as specified in the CHADDR (Client Hardware Address) field. Here the server, 192.168.1.1, specifies the client's IP address in the YIADDR (Your IP Address) field.

3. **DHCP request** - In response to the DHCP offer, the client replies with a DHCP request, unicast to the server, requesting the offered address. Based on the Transaction ID field in the request, the server is informed which client has accepted.

4. **DHCP acknowledgment** - When the DHCP server receives the DHCPREQUEST message from the client, the configuration process enters its final phase. The acknowledgment phase involves sending a DHCPACK packet to the client. This packet includes the lease duration and any other configuration information that the client might have requested. At this point, the IP configuration process is completed. The protocol expects the DHCP client to configure its network interface with the negotiated parameters.