DHCP Services

DHCP is an addressing service responsible for dynamic configuration and management of IP parameters. DHCP server supports allocation of dynamic addressing to clients that include hosts and network devices. DHCP also manages the renewal of IP addressing from an address pool. DHCP address pool is defined on the DHCP server along with the lease time period. The DHCP address pool is a range of IP addresses reserved for dynamic assignment to clients. DHCP server assigns IP address, default gateway address and DNS server address as a minimum. That is required for basic network connectivity. Optionally, TFTP server address is configurable to download IP phone settings.

DHCP Features

- Assign and renew IP addresses from a designated pool
- Configure TCP/IP address settings on hosts
- IP address is assigned to each host for a fixed lease time
- DHCP client sends periodic request to renew same IP address
- Ping or Gratuitous ARP is used to detect IP address conflicts
- IP address is removed from pool when a conflict is resolved

The host IP address renewal is based on lease time setting. The host will typically keep using the same IP address assigned. The lease renewal request is sent to the DHCP server when the lease time expires. The DHCP server will extend the lease again for the lease time setting. The network address and broadcast address should not be included with the DHCP pool for dynamic assignment.

DHCP Client

DHCP server is responsible for dynamic configuration of host endpoint IP settings. DHCP must first be enabled on each client. That prompts the host to send a DHCP request to DHCP server on startup. The clients do not know the address of the nearest DHCP server. It could be an IOS DHCP server or a third party DHCP server. As a result, there is a broadcast sent initially from a host to locate the nearest DHCP server.

Automatic Private IP Addressing (APIPA)

APIPA private addressing is initially assigned to all DHCP enabled Windows clients. It is a self-configured host address that is only advertised within a local subnet. DHCP clients are temporarily assigned APIPA addressing while waiting for a dynamic address to be allocated.

The range is from 169.254.0.1 - 169.254.255.254 with class B subnet mask. The host client checks for a DHCP server at regular intervals and replaces it with DHCP addressing.

Client IP parameters can be displayed from a Windows command prompt with **ipconfig /all** command. The current TCP/IP settings include at least an IP address for the network interface and default gateway. There also could be DNS server address and TFTP server address. The MAC address assigned to local network adapter is displayed as well. The equivalent host command is **ipv6config /all** to display IPv6 address parameters. Linux is more popular today and IP settings are listed with **ifconfig -a** equivalent command.

To request a new IP address manually, issue **ipconfig /release /renew** host command. That will release the current IP address assigned to a host interface and request a new IP address. The DHCP server would assign a random IP address from the pool. Never include network address or broadcast address in DHCP pool.

DHCP Client Request

DHCP request from a DHCP client starts with DHCP server discovery. DHCP server replies with an IP address lease offer. The DHCP client replies with an IP lease request for the proposed IP address. The DHCP server confirms the IP address with a lease acknowledgement to the client. The DHCP server will send the lease time and any additional IP parameters as well. It should be noted that when multiple DHCP servers exist, the client accepts the first offer received. The following are standard DHCP message types.

Figure 1 DHCP Client and DHCP Server Message Exchange
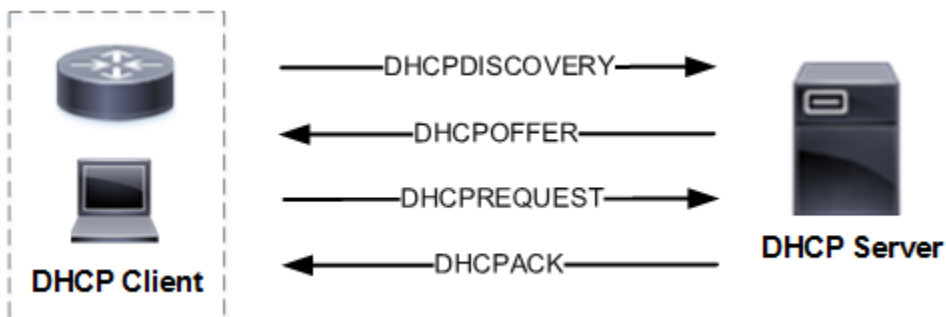
Cisco IOS Client

Cisco network devices can be configured as DHCP server. There is support for enabling network interfaces as DHCP clients. The common practice is to assign static IP addresses to network devices. Some router interfaces, for example receive IP address dynamically from an ISP. When configured as DHCP client, the network interface on a router for example, sends request for IP address to nearest DHCP server. It works the same as if request originated from a host PC. The following IOS command will enable a router interface as a DHCP client.

> router(config)# **interface gigabitethernet1/0**
> router(config-if)# **ip address dhcp**

TFTP Server

There is an option to communicate the IP address of a TFTP server via DHCP option 150. It is a Cisco proprietary feature that enables a host or IP phone to request the TFTP server IP address on bootup. There is support as well for a list of TFTP servers. Cisco IP phones require either manual configuration or DHCP option 150 to obtain the TFTP server IP address. The Cisco IP phone device configuration file is downloaded from TFTP server. DHCP option 66 is the IEEE open standard for multi-vendor equipment.

DHCP Bindings

DHCP binding table is comprised of entries with host IP address and MAC (hardware) address. That could include network devices configured as a DHCP client as well. The following command lists the bindings for all DHCP clients assigned from an IOS DHCP server.

> router# **show ip dhcp binding**

IP Address	Hardware Address	Lease Expire	Type
172.16.1.1	0000.000a.aaaa	Aug 16 2021 17:00 PM	Auto
172.16.1.2	0000.000b.bbbb	Aug 16 2021 17:00 PM	Auto
172.16.1.3	0000.000c.cccc	Aug 16 2021 17:00 PM	Auto
172.16.1.4	0000.000d.dddd	Aug 16 2021 17:00 PM	Auto

DHCP Relay

It is common practice to centralize network addressing services where possible. That would apply to DHCP and DNS where there are often multiple redundant servers. They respond to client requests from across the enterprise. The advantage of centralized management is to minimize addressing errors and ease of deployment. DHCP servers are often not located on the same subnet (or VLAN) as a client.

Figure 2 Router Default Gateway
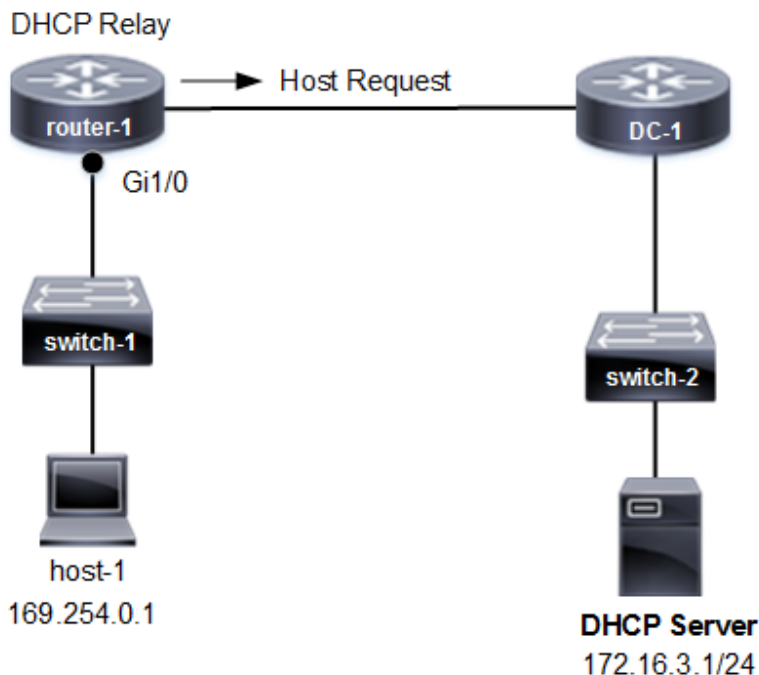
DHCP relay is a feature configured on a Cisco network device. It forwards DHCP requests from clients to a DHCP server located on a different subnet than client. It is actually an IOS command configured on a network interface that points to the IP address of a DHCP server.

The IOS command used to configure DHCP relay is **ip helper-address.** All DHCP requests for IP address settings are then forwarded to the DHCP server. DHCP relay agent is not required when a DHCP server is on the same subnet as client. There is the option of enabling DHCP relay on a physical interface or logical interface. The network interface is the default gateway for clients. The following IOS commands is an example of DHCP relay on a router interface.

The default gateway for clients is router-1 interface Gi1/0 and DHCP
server is 172.16.3.1 where requests are sent.

> router(config)# **interface gigabitethernet1/0**
> router(config-if)# **ip helper-address 172.16.3.1**

Layer 3 Switch Default Gateway

There is support as well for configuring DHCP relay on a logical interface.
This is more typical considering that multiple VLANs exist on access
switches. Each VLAN is assigned a default gateway configured as an SVI
on a Layer 3 switch. The SVI is a VLAN interface with an IP address.

Figure 3 Layer 3 Switch Default Gateway
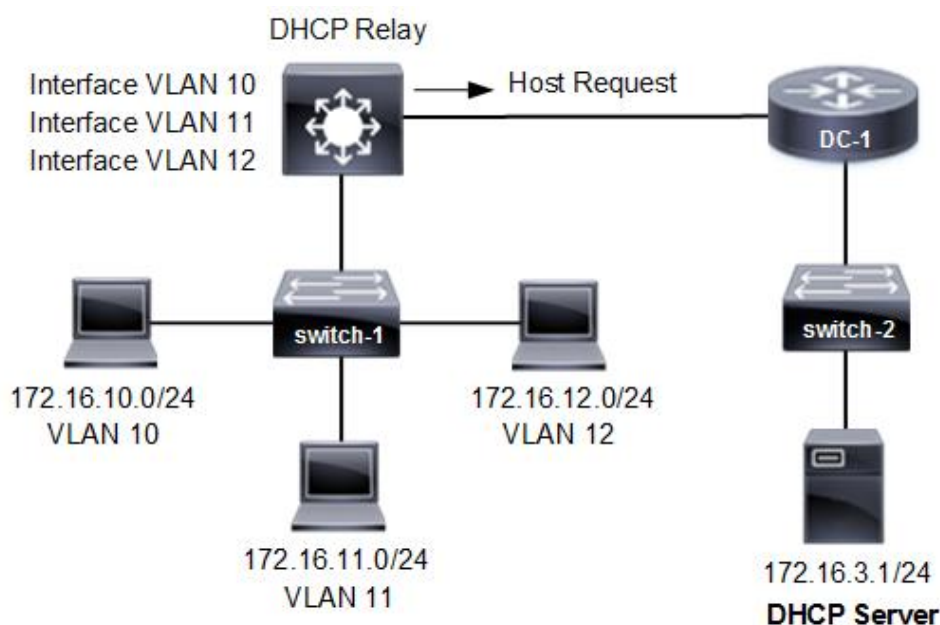
The following IOS commands configure DHCP relay agent for hosts on
VLAN 10, 11 and 12. They all point to the same DHCP server for address
requests. DHCP server would dynamically configure the correct IP
address, subnet mask and other IP parameters. The default gateways
(VLAN interfaces) are excluded from the dynamic address pool since they
are allocated on the Layer 3 switch.

> L3-Switch(config)# **interface vlan 10**
> L3-Switch(config-if)# **ip address 172.16.10.254 255.255.255.0**
> L3-Switch(config-if)# **ip helper-address 172.16.3.1**

```
L3-Switch(config)# interface vlan 11
L3-Switch(config-if)# ip address 172.16.11.254  255.255.255.0
L3-Switch(config-if)# ip helper-address 172.16.3.1

L3-Switch(config)# interface vlan 12
L3-Switch(config-if)# ip address 172.16.12.254  255.255.255.0
L3-Switch(config-if)# ip helper-address 172.16.3.1
```