Dynamic Host Configuration Protocol (DHCP)

DHCP Overview

Dynamic Host Configuration Protocol, or DHCP. This protocol is a means of automatically distributing IP address information and configuration across a network. You need to go through a lot of configuration for each end node in a given environment. DHCP's role is to do this more efficiently. When a device comes up with no IP information present, it grabs what it needs from a Dynamic Host Configuration Protocol scope, also called a DHCP pool.

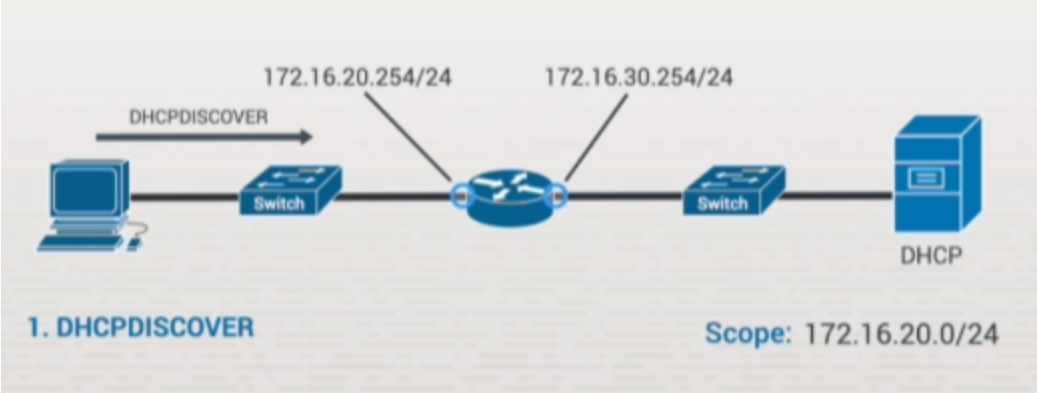
With DHCP configured to handle all the subnets, you don't need to manually configure an end node again.

DHCP Servers

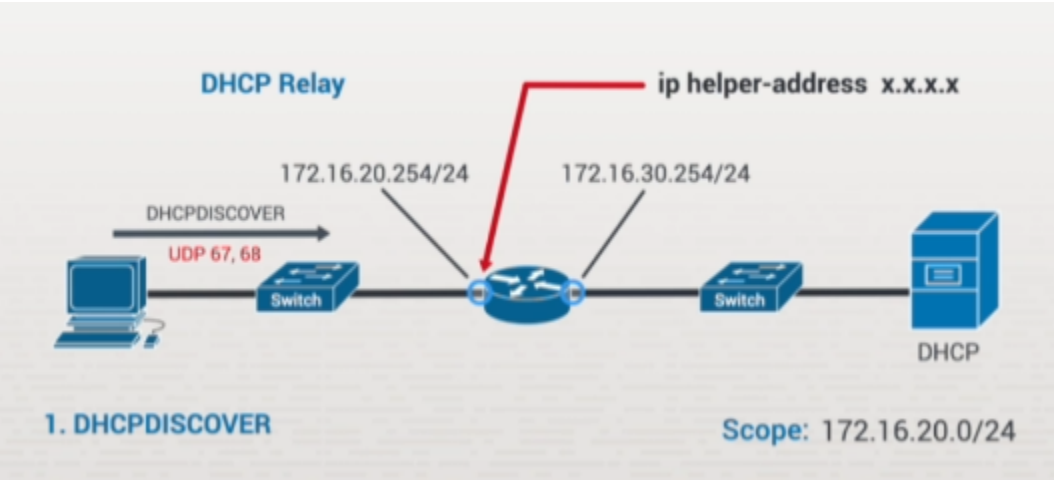
A DHCP client uses the following process to obtain an IP address using a 4-way handshake.:

1. Lease Request. The client initializes a limited version of TCP/IP and broadcasts a DHCPDISCOVER packet requesting the location of a DHCP server.
2. Lease Offer. All DHCP servers with available IP addresses send DHCPOFFER packets to the client. These include the client's hardware address, the IP address the server is offering, the subnet mask, the duration of the IP lease, and the IP address of the DHCP server making the offer.
3. Lease Selection. The client selects the IP address from the first offer it receives and broadcasts a DHCPREQUEST packet requesting to lease the IP address in that offer.
4. IP Lease Acknowledgment. The DHCP server that made the offer responds, and all other DHCP servers withdraw their offers. The IP addressing information is assigned to the client, and the offering DHCP server sends a DHCPACK (acknowledgement) packet directly to the client. The client finishes initializing and binding the TCP/IP protocol.

This DHCP server could be any device you choose, like a Windows or Cisco device. But this is typically done on a device in your data center that's well protected and has redundant power supplies. DHCP serves need protection because of the important role they play.

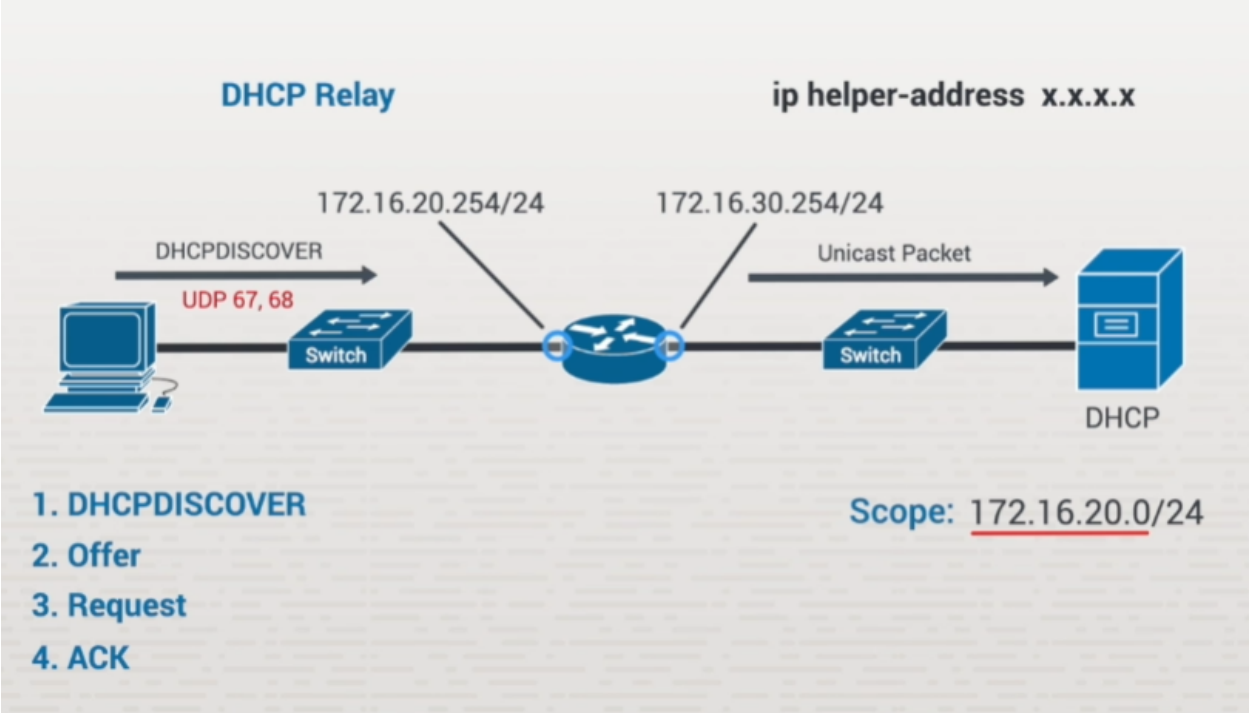


1. **DHCPDISCOVER Packet** - The workstation on the left is going through the DHCP process. The process has four steps. The first step is DHCP discover. The workstation sends out a broadcast called DHCP discover packet. DHCP uses the User Datagram Protocol, or UDP, in ports 67 and 68.
    a. There's a problem in this environment because the broadcast comes out out of that workstation and then goes to the local switch. The local switch copies it everywhere and then hits the router.
    b. Routers drop broadcast frames because they're what define broadcast domains. To get this broadcast past the router and towards the DHCP server, you add a command on the router interface to make it accept any UDP 67 and 68 requests.
    c. **Ip helper address:** Use the 'ip helper-address' command to do this and then the DHCP server's IP address. You enter this command on this router interface, and the DHCP relay activates. The next time that workstation sends out a discover broadcast, the router sends it over with a unicast packet intended for XXXX, which goes over to the DHCP server. The packet also indicates the which network the request came from.



2. **Offer -** The second step is the DHCP server tries to find a valid number in that range. It sees an accurate scope for that subnet, so it offers up the next open number in that pool to the workstation.

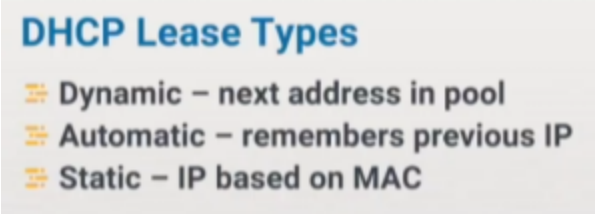
3. **Request -** The third step is the workstation sends a request to reserve the config offered by the DHCP server.
4. **ACK** - In the fourth and final step, the DHCP server provides the workstation's acceptance acknowledgement. When the acknowledgement comes back, the IP address in that scope has been reserved. Now the workstation is a functional endpoint on the network.



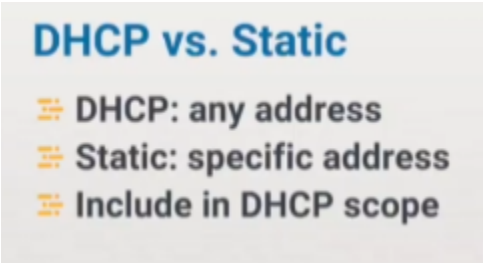
DHCP Leases

It’s important to know about a config you'll be given called a DHCP lease. The typical term is about three days and it's your job to renew the lease periodically. If you don't, you could lose your IP config at the end of this period. But you can reconfigure lease terms to whatever length of time you want.

You also need to know that there are three basic lease types. They're dynamic, automatic, and static.



Dynamic - Everything we just talked about was dynamic. That's DHCP's default nature. If a workstation comes up and needs an address, it'll find the next available address in a pool and assign that number.
Automatic - An automatic lease is pretty much the same thing. The difference is that the DHCP server keeps a local table and remembers the IP configuration given to you. If you shut the workstation down and then bring it up later, you'll get the same IP address as before.
Static - A static lease is when you program Media Access Control addresses, or MAC addresses, into the DHCP server. When the DHCP server sees a certain host requesting an IP address, it gives you a specific IP address based on its MAC address.



But devices you want to have consistent and static numbers shouldn't depend on DHCP. DHCP is for endpoints whose IP address doesn't really matter. But servers, web servers, file servers, network infrastructure equipment, switches, and routers all need consistent static IP addresses. In these cases, configure them manually yourself.

Lastly, for all the statically assigned IP addresses you have in your network, put excluded addresses into your DHCP scopes. This makes sure those numbers won't be leased.

DHCP Facts

Dynamic Host Configuration Protocol (DHCP) is a protocol used by hosts to obtain various parameters necessary for the clients to operate in a network. You can configure DHCP on a Cisco device through the command-line interface (CLI) or the Security Device Manager (SDM).

DHCP Configuration

DHCP configuration parameters include the following:

Component	Description
Address pool	The *address pool* is the range of addresses that can be assigned to requesting hosts. The DHCP server assigns only addresses within the address pool. The DHCP server can also be configured with *exclusions*, which are specific addresses in the range that should not be assigned.
Lease	The *lease* is the length of time for which the assignment is valid. It contains the assigned IP address and other information for the client. Periodically, and when the client reboots, the DHCP server is contacted to renew the lease on the IP address.
DHCP options	In addition to the IP address and subnet mask, the DHCP server can also deliver the following: ● Domain Name Server (DNS) server address(es) ● Default router (or default gateway) address ● Windows Internet Name Service (WINS) server addresses ● Additional TCP/IP configuration parameters
Binding	A *binding* is an association of a MAC address with a specific IP address. When you create a binding, the client with the specified MAC address is assigned the same IP address each time it requests an address. For example, if you have servers that need to be accessible from outside the local network, the IP addresses of the servers should remain the same. A binding is also known as *DHCP reservation*.
Interface	The interface that responds to DHCP requests is identified automatically according to the IP address assigned to the interface. When you configure the DHCP service on a Cisco device, it compares the subnet address specified in the address pool with the IP addresses assigned to the router interfaces. If an interface has been assigned an IP address in the address pool, that interface will listen for and respond to DHCP requests. Be aware that: ● To allow an interface to listen and respond to DHCP requests, assign it an IP address within the address pool. If the interface does not have an IP address, or if the IP address is not within the address pool, client DHCP requests will be ignored. ● You should exclude the interface IP address from the DHCP address pool.

DHCP Client Process

A DHCP client uses the following process to obtain an IP address:

1. Lease Request. The client initializes a limited version of TCP/IP and broadcasts a DHCPDISCOVER packet requesting the location of a DHCP server.
2. Lease Offer. All DHCP servers with available IP addresses send DHCPOFFER packets to the client. These include the client's hardware address, the IP address the server is offering, the subnet mask, the duration of the IP lease, and the IP address of the DHCP server making the offer.
3. Lease Selection. The client selects the IP address from the first offer it receives and broadcasts a DHCPREQUEST packet requesting to lease the IP address in that offer.
4. IP Lease Acknowledgment. The DHCP server that made the offer responds and all other DHCP servers withdraw their offers. The IP addressing information is assigned to the client and the offering DHCP server sends a DHCPACK (acknowledgement) packet directly to the client. The client finishes initializing and binding the TCP/IP protocol.

DHCP Across Subnets

The DHCP lease process uses frame-level broadcasts. For this reason, DHCP requests typically do not pass through routers to other subnets. To enable DHCP across subnets:

- Enable BOOTP (DHCP broadcast) requests through the router.
- Configure a computer for BOOTP forwarding to request IP information on behalf of other clients.

Address Resolution Protocols

You should be familiar with the following protocols that can perform address resolution:

Protocol	Description
Address Resolution Protocol (ARP)	Used by hosts to discover the MAC address of a computer from its IP address.
Reverse Address Resolution Protocol (RARP)	Used by a host to discover the IP address of a computer from its MAC address.

Bootstrap Protocol (BOOTP)	Used by a host (such as a diskless workstation) to query a bootstrap computer and receive an IP address assignment. A BOOTP server has a static list of MAC addresses and their corresponding IP addresses.
Dynamic Host Configuration Protocol (DHCP)	An improvement on BOOTP, DHCP is used to dynamically assign IP address and other TCP/IP configuration parameters. A DHCP server can use a static list to assign a specific IP address to a specific host. More commonly, however, the DHCP server automatically assigns an IP address from a preset range of possible addresses.

DHCP Configuration Facts

When configuring a Cisco router as a DHCP server, be aware that the router uses the DHCPDISCOVER packet to obtain the IP subnet in which the DHCP client resides. The router can assign an IP address from a pool of valid IP addresses in that subnet.

Pre-Configuration Steps

Before discussing the configuration steps, be aware of the following preparation steps:

1. Identify an external database agent with a URL.
2. Identify the IP address range to be assigned by the DHCP server. This may include:
    - The subnet address and mask
    - IP address exclusions (addresses you don't want assigned)
3. Identify DHCP options where necessary. This may include:
    - The default gateway
    - DNS server addresses
    - NetBIOS name server
    - VoIP options, such as option 150
4. Identify the DNS domain name.

Configuration Commands

The following table lists commands you can use to configure the DHCP service on a Cisco router:

Command	Action

Router(config)**#service dhcp**	Enables DHCP features on the router. This is enabled by default.
Router(config)**#no ip dhcp conflict logging**	Forces the DHCP server not to log IP address conflicts.
Router(config)**#ip dhcp excluded-address *[address]*** Router(config)**#ip dhcp excluded-address *[start_ip] [end_ip]***	Prevents an address from being assigned by the DHCP server. If there is a range of addresses that needs to be excluded, identify the start and ending addresses. Typically, you will exclude the DHCP server's own IP address from the range. This command is a global configuration command; it is not issued as part of the pool.
Router(config)**#ip dhcp pool *[VLAN_ID]***	Configures a DHCP address pool on the specified VLAN. Pools are used to define a range of addresses to assign, as well as to create bindings.
Router(dhcp-config)**#network *[address] [mask]***	Sets the network address and subnet mask for a DHCP address pool. Clients are assigned IP addresses starting from the lowest possible IP address in the network.
Router(dhcp-config)**#domain-name *[domain]***	Sets the domain name to be delivered to DHCP clients.
Router(dhcp-config)**#dns-server *[server1_ip] [server2_ip]***	Sets the DNS server address to be delivered to DHCP clients. You can configure multiple DNS server addresses. To do this, you include multiple addresses separated by a space. You can specify up

	to 8 server addresses. Servers should be listed in order of preference.
Router(dhcp-config)#**default-router** ***[router_ip]***	Default gateway - Sets the default router address to be delivered to DHCP clients. This address should be inside the address pool. You can identify up to 8 addresses. However, most hosts can accept only a single default gateway address.
Router(dhcp-config)#**lease** ***[days]***	Sets the lease duration (in days) for a DHCP address pool. You can specify a value between **0** and **365**. Use the **infinite** keyword for a lease that does not expire.
Router(dhcp-config)#**host** ***[address] [mask]*** Router(dhcp-config)#**client-identifier** ***[mac_address]***	Manually binds a specific IP address and mask to a host. When you create a binding, you create a separate pool that is different than the pool that identifies the subnet. This pool must have a unique name. Observe the following guidelines: ● You configure the IP address and mask that will be assigned to the host. ● Only one manual binding can be configured per host pool. ● Bindings for DHCP clients require the client-identifier command. The unique identification of the client is specified in dotted hexadecimal notation; for example, 01aa.bbcc.ddee.ff, where 01 represents the Ethernet media type. Media types are: ○ 1:Ethernet

	○ 5:IEEE 802 Networks ○ 17:HDLC ○ 20:Serial Line ● Devices using a BOOTP request should have their MAC address identified using the hardware-address command. ● The host DHCP pool configuration command can use the prefix notation (e.g., /24) or subnet address representation (e.g., 255.255.255.0) to identify the client network mask.
Router(config-subif)**#ip helper-address *[address]***	Enables the DHCP relay agent feature.
Router(config)**#no ip forward-protocol udp *[port]***	Controls which broadcast packets and protocols are forwarded by a DHCP relay agent. The value is either a port number or name, such as the following well-known UDP broadcast ports: ● 37: Time ● 49: TACACS ● 53: DNS ● 67: BOOTP/DHCP Server ● 68: BOOTP/DHCP Client ● 69: TFTP ● 137: NetBIOS Name Service ● 138: NetBIOS Datagram Service
Router**#show ip dhcp binding**	Displays information about each IP address lease.

Router#**show ip dhcp pool *[pool_name]***	Displays information about the DHCP address pools, including the following: ● Pool name ● High and low utilization level for the pool ● Size of the requested subnets ● Total number of addresses in the pool ● Number of leased addresses in the pool ● Number of allocated subnets to the address pool ● IP address range of the subnets ● Number of leased addresses from each subnet ● Number of excluded addresses ● Number of reserved addresses in the pool and the reserved addresses ● Short name of the interface connected to the client using the reserved address
Router#**show ip dhcp server statistics**	Displays DHCP server statistics.
Router#**show ip dhcp conflict**	Displays IP addresses with conflicts as well as the method used to identify them: ● Gratuitous ARP (detected by the client) ● Ping (detected by the server) If an address conflict is detected, the address is removed from the pool and the address is not assigned until an administrator resolves the conflict.

Router#**clear ip dhcp conflict**	Clears the address conflict list.
Router#**show ip dhcp database**	Displays DHCP server database agent information, including the following: ● Remote file used to store automatic DHCP bindings ● Last date and time bindings were read and written from the server ● Whether the last read or write of host bindings was successful ● Number of failed and successful file transfers
Router#**show hosts**	Displays the default domain name, the style of name lookup service, a list of name server hosts, and the cached list of hostnames and addresses.
Router(config)#**interface vlan 1** Router(config-if)#**ip address dhcp**	Configures an interface on a Cisco device to get its IP address from the DHCP server. Most routers and servers have static IP addresses and do not use DHCP for obtaining an IP address. If you choose to use DHCP, then create a binding to make sure the same address is always assigned to network infrastructure devices, such as servers, switches, and routers.

Example 1 - Configure a DHCP pool

The following commands configure a DHCP pool on VLAN2 that distributes addresses to DHCP clients from the 172.17.0.0/16 address range using a lease time of 5 days. The IP addresses between 172.17.0.1 and 172.17.0.25 are excluded. The default router and DNS server addresses are also distributed to DHCP clients:

- Router(config)**#ip dhcp excluded-address 172.17.0.1**
- Router(config)**#ip dhcp excluded-address 172.17.0.25**
- Router(config)**#ip dhcp pool VLAN2**

- Router(config-if)**#interface fa0/1.1**
- Router(dhcp-config)**#network 172.17.0.0 255.255.0.0**
- Router(dhcp-config)**#domain-name westsim.com**
- Router(dhcp-config)**#dns-server 172.17.0.2 8.8.8.8**
- Router(dhcp-config)**#default-router 172.17.0.1**
- Router(dhcp-config)**#lease 5**

Example 2 - Forward DHCP Broadcast Messages

In the following example, the router's Fast Ethernet 0/0 interface is configured with an IP address in the 172.16.10.0 network and will forward DHCP broadcast messages to a DHCP server that has an IP address of 172.31.1.1. It will also not forward packets sent to the NetBIOS ports:

- Router(config)**#int fa 0/0**
- Router(config-if)**#ip address 172.16.10.254 255.255.255.0**
- Router(config-if)**#ip helper-address 172.31.1.1**
- Router(config-if)**#no ip forward-protocol udp 137**
- Router(config-if)**#no ip forward-protocol udp 138**