Benefits of DHCP

DHCP provides many benefits for network administrators, network users, and people using consumer gadgets such as mobile phones, tablets, and laptops to connect to the network. This section focuses on the benefits for network users and network administrators.

Network users

DHCP provides network users with ‘plug and play’ networking. This means that network users can travel anywhere on the network and automatically receive an IP address when they reconnect to the network.

Network administrators

DHCP provides network administrators with quicker and more reliable IP address configuration. DHCP minimizes configuration errors caused by manual IP address configuration, such as typographical errors, or address conflicts caused by the assignment of an IP address to more than one computer at the same time.

Network administrators find DHCP useful when they want to change the IP addresses of a large number of systems. Instead of reconfiguring all the systems, they can just edit one DHCP configuration file on the server for the new set of IP addresses. If the DNS server for an organization changes, the changes are made on the DHCP server, not on the DHCP clients.

Because DHCP is easy to configure, it minimizes operational overhead and costs associated with configuration.

DHCP includes the following features to reduce network administration:

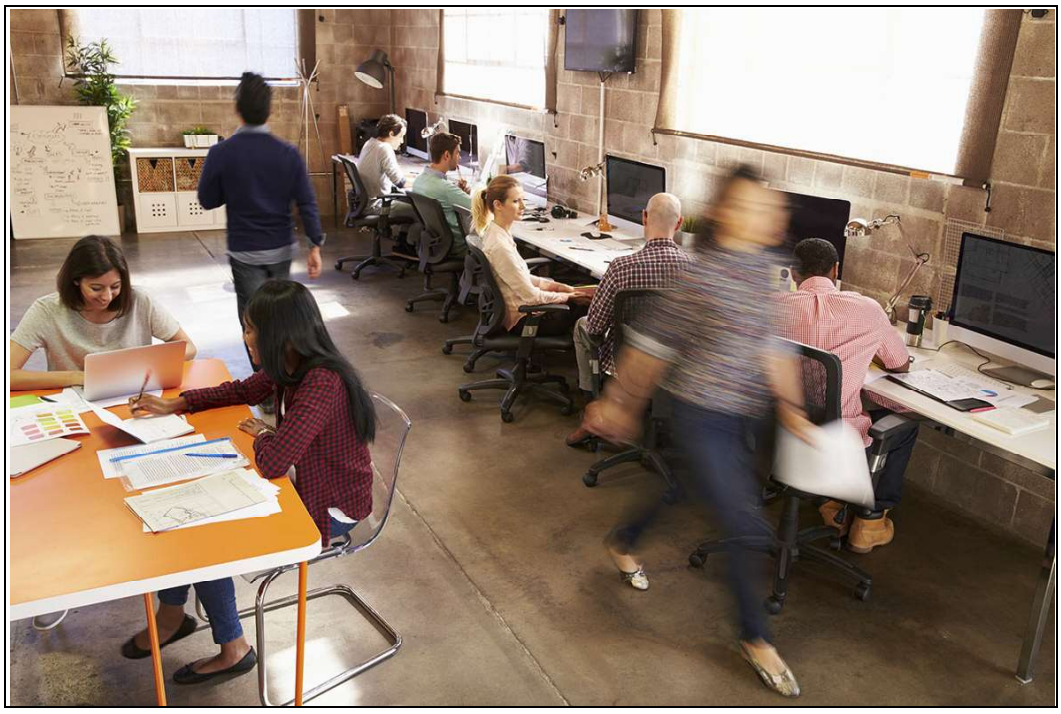
- The ability to define TCP/IP configurations from a central location.
- The ability to assign a full range of additional TCP/IP configuration values by means of DHCP options.
- The efficient handling of IP address changes for clients that must be updated frequently, such as those for portable computers that move to different locations on a wireless network.
- The forwarding of initial DHCP messages by using a DHCP relay agent, which eliminates the need for a DHCP server on every subnet.

DHCP also helps conserve limited IP address space, because IP addresses no longer need to be permanently assigned to hosts.

How does DHCP work

When you access the Internet, your computer automatically requests an IP address from the network's DHCP server. The DHCP server contains a range (or scope) of IP addresses that it is allowed to give out. If there is an address available, the DHCP server will send your computer a response containing an IP address, the default gateway address, subnet mask, and the lease time that your computer can use the address for.

You might ask, "why is the IP address leased?" This is so that the range of IP addresses can be recycled and not used up, or left as 'used' by a device that has been disconnected. Leases times are configured to suit various requirements. For example, a cafe with free wifi may have leases that last/expire in **1** day, but in an Enterprise environment such as a call center with 1000 computers using the same IP addresses from a DHCP server 'permanently', they may use a lease of **100** days. This would make sure no undue network traffic was going on simply for renewing an IP address for hosts plugged in all the time.



Clients renew their leases (generally at 50% of the lease time), and when the lease is renewed it will usually be the same IP address.

Of course, not every device on the network needs to have a dynamic IP address. Using DHCP, you can reserve addresses for devices such as printers. As each network device has a MAC address, you can assign a static IP at the server to a specific MAC address. This allows devices such as the network printer to always get the same IP address even after it reboots and without assigning the IP address at the printer.

DHCP architecture

The DHCP architecture is made up of DHCP clients, DHCP servers, and DHCP relay agents. The client interacts with servers using DHCP messages in a DHCP conversation to obtain and renew IP address leases.

Here is a brief description of the DHCP components:

DHCP client

A DHCP client is any IP device connected on the network that has been configured to act as a host requesting configuration parameters such as an IP address from a DHCP server. Configuration parameters and other control information are carried in tagged data items that are stored in the Options field of the DHCP message. DHCP uses the Options to pass additional IP settings to DHCP clients such as the default gateway IP address, DNS server address, and the DNS domain name.

For more detail about Options see "Configuring the DHCP client" on page 10.

DHCP server

The DHCP server is a device on the network with a pool of IP addresses at its disposal to automatically assign to devices as they join the network.

The DHCP server assigns the network device its:

- IP address - **dynamically** configured
- subnet mask - **statically** configured
- default gateway for the network - **statically** configured
- Primary DNS server - to match a device NAME to an IP address
- Secondary DNS server - **statically** configured for redundancy and load balancing.

DHCP relay agent

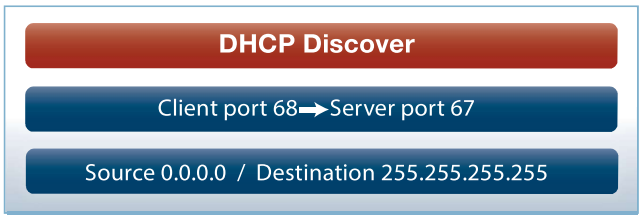
DHCP relay agents pass DHCP messages between servers and clients where the DHCP server does not reside on the same IP subnet as its clients.

For example, on large networks consisting of multiple subnets, a single DHCP server may service the entire network when aided by DHCP relay agents located on the interconnecting routers. You can configure a maximum number of 400 DHCP relay agents (one per interface) on AlliedWare Plus devices.

You can use DHCP relay agent information, Option 82, to protect your switch from spoofing attacks, where untrusted hosts send requests for IP addresses to access the network. For more information on Option 82 see, "DHCP relay agent information option (Option 82)" on page 18.

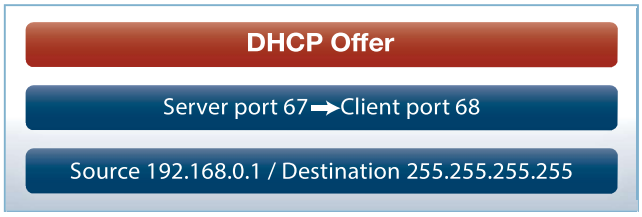
The following diagram shows the changing port numbers and the source and destination addresses used during the DHCP transaction. UDP port 68 is reserved for DHCP clients, and UDP port 67 is reserved for DHCP servers.

Step 1 **DHCP Discover**



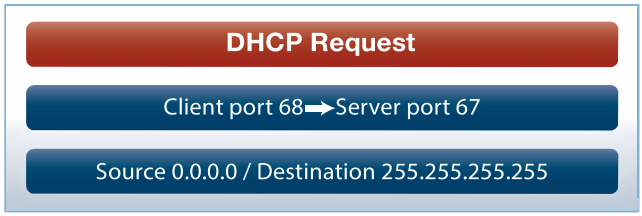
- Sent by the client looking for the IP address. The source IP is 0.0.0.0 because the client doesn't have an IP address. The destination is 255.255.255.255, which is the broadcast address, as the client doesn't know where the DHCP server is located, so it broadcasts to all devices on the network.

Step 2 **DHCP Offer**



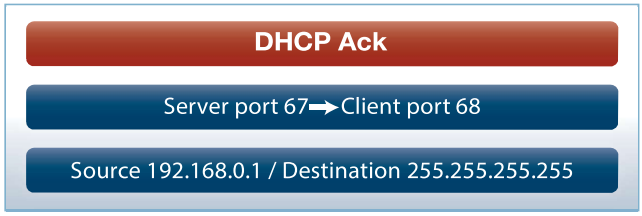
- Sent by the DHCP server offering an IP address to the client. The source address is the DHCP server address. The DHCP server doesn't know the client address yet, so it broadcasts the offer to all devices on the network.

Step 3 **DHCP Request**



- Sent by the client to the DHCP server to say "I will take that IP address, thanks." The client IP address is still 0.0.0.0 and it is again broadcast to all so that any other servers on the network that may have offered an IP address will know to stop communicating with the client for now.

Step 4 **DHCP Acknowledgment**



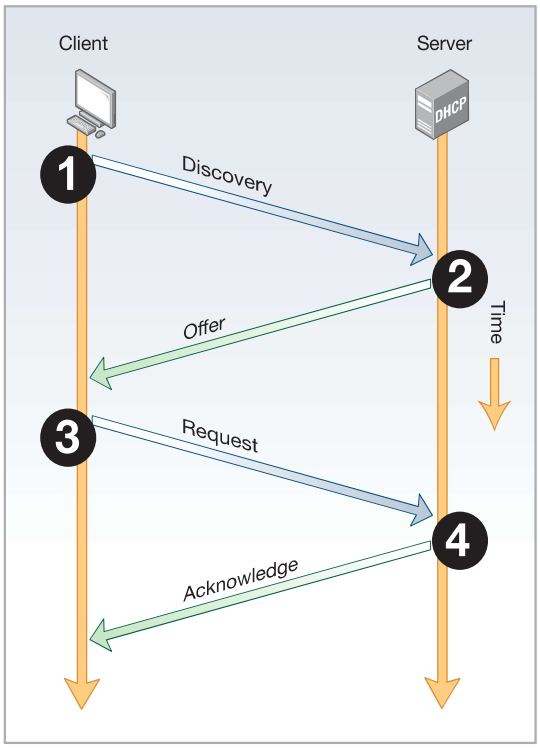
- Sent by the DHCP server to the client. It confirms the IP address and other details such as subnet mask, default gateway, and lease time with the client. The source address is the DHCP server and the destination is still the broadcast address.

The DHCP process

There are four basic steps the DHCP process follows when a client connects to the network:

1. The client broadcasts a **DHCP Discover message** to say “I need an IP address, are there any DHCP servers out there?”
2. Multiple DHCP servers may respond (via broadcast) with an **OFFER** for a leased IP address back to the client.
3. The client will choose a DHCP server offer and then broadcast a DHCP **REQUEST** back to the DHCP server(s) to say “Thanks, I have selected an offer from this DHCP server.” All servers will see which offer the client selected.
4. Finally, the selected DHCP server will send (broadcast) an **ACKNOWLEDGEMENT** back to the client to confirm the IP address, lease time, and other details.

Figure 1: Basic DHCP transaction



Lease renewal

If a clients wants to continue using its leased IP address it performs a renewal, generally at 50% of the lease time. This follows a simpler process than the initial lease acquisition. The client sends a DHCP REQUEST, requesting the address it is currently using. This time the message is unicast to the server it originally leased the address from. If the server can allow the client to continue using that address, it replies with a DHCP ACK.

Releasing an IP address

If a client no longer wishes to continue using a leased address, it sends a DHCP RELEASE message to the server. This indicates to the server that the client is no longer using the address and it is free to be allocated to another client in the future.

Port based DHCP address assignment

The DHCP Server Port-Based Address Allocation feature introduces the capability to ensure that the same IP address is always offered to a replacement device as the device being replaced.

This IP address is always offered to the same connected port even as the client identifier (client-id) or client hardware address (chaddr) changes in the DHCP messages received on that port.

This feature is enabled by substituting subscriber identifier (subscriber-id) for client-id in all DHCP server internal transactions (such as packet processing, lease management etc). And to allow port based address assignment, subscriber-id of a client needs to be associated with the physical port attachment.

Subscriber-id for remote client is included in the relay-agent information option on DHCP client packets relayed via a relay-agent, and for locally attached client, its subscriber-id is internally generated based on and associated with port interface directly attached to the DHCP client. On wire, DHCP client-id on messages used between client and server are preserved to the original client-id used by the client, this will avoid issues with interoperability with the standard DHCP client and relay implementation.

Another feature that is introduced with this enhancement is the ability for the server to make IP address reservation based on the subscriber-id.

This feature is designed to work with the following deployment scenarios:

- Direct client-server connection
  In this deployment scenario, host devices (DHCP clients) are directly attached to the switch acting as a DHCP server. The DHCP client sends DHCP messages without relay agent information option - thus without subscriber-id sub-option. Therefore we have to internally generate the subscriber-id for the client based port interface attached to the client. In this deployment scenario, only automatically generated port names can be used as subscriber-id, thus client connected to port1.0.1 of the switch acting as the server will be automatically assigned with internal subscriber-id of ‘port1.0.1’, and so on.
- Relay based client-server connection
  When host devices are connected to a switch acting either as a DHCP relay agent or running the DHCP snooping feature, the relay agent or the DHCP snooper has to be able to insert relay agent information option (option 82) with the subscriber-id sub-option (sub-option 6). The subscriber-id sub-option carried in the messages transmitted by the client will be used internally by the server as substitute for client-id for the purpose of address assignment and lease management. And to make port based assignment possible, users need to associate subscriber-id with port where the client host device is attached to.

Figure 2: Deployment scenarios for port-based IP assignment