



# Managing DHCP Server

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This chapter describes how to set up some of the DHCP server parameters. Before clients can use DHCP for address assignment, you must add at least one scope to the server. This is described in [Managing Scopes, Prefixes, Links, and Networks](#).

Cisco Prime IP Express failover protocol is designed to allow a backup DHCP server to take over for a main server if the main server is taken offline for any reason. To set up DHCP failover, read [Managing DHCP Failover](#).

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## Configuring DHCP Servers

When configuring a DHCP server, you must configure the server properties, policies, and associated DHCP options. Cisco Prime IP Express needs:

- The DHCP server IP address.
- One or more scopes (see the [Managing Scopes](#)) and/or prefixes.

## General Configuration Guidelines

Here are some guidelines to consider before configuring a DHCP server:

- **Separate the DHCP server from secondary DNS servers used for DNS updating**—To ensure that the DHCP server is not adversely affected during large zone transfers, it should run on a different cluster than your secondary DNS servers.
- **Lease times**—See the [Guidelines for Lease Times](#).

## Configuring DHCP Server Interfaces

To configure the DHCP server, accept the Cisco Prime IP Express defaults or supply the data explicitly:

- **Network interface**—Ethernet card IP address, which must be static and not assigned by DHCP.
- **Subnet mask**—Identifies the interface network membership. The subnet mask is usually based on the network class of the interface address, in most cases 255.255.255.0.

By default, the DHCP server uses the operating system support to automatically enumerate the active interfaces on the machine and listens on all of them. You can also manually configure the server interface. You should statically configure all the IP addresses assigned to NIC cards on the machine where the DHCP server resides. The machine should not be a BOOTP or DHCP client.



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**Note** Unless you have a specific need to restrict the interfaces used for DHCP, it is recommended that you do not configure specific DHCP Server interfaces. Allow the server to automatically discover the available interfaces.

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### Local Advanced Web UI

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- Step 1** From the Operate menu, choose **Manage Servers** under the **Servers** submenu to open the Manage Servers page.
  - Step 2** Select the Local DHCP server on the Manager Servers pane.
  - Step 3** Click the Network Interfaces tab to view the available network interfaces that you can configure for the server. By default, the server uses all of them.
  - Step 4** To configure an interface, click the Edit icon in the Configure column for the interface. This adds the interface to the Configured Interfaces table, where you can edit or delete it.
  - Step 5** Clicking the name of the configured interface opens the Edit DHCP Server Network Interface page, where you can change the address and ports (in Expert mode) of the interface.
  - Step 6** Click **Save** when you are done editing.
  - Step 7** Click **Revert** to return to the Manage Servers page.
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### CLI Commands

Use **dhcp-interface** to manually control which network interface cards' IP addresses the DHCP server will listen on for DHCP clients. By default, the DHCP server automatically uses all your server network interfaces, so use this command to be more specific about which ones to use.

To troubleshoot and confirm validity of the configuration changes.

- Reload the DHCP server.
- Check the dhcp\_startup\_log and/or name\_dhcp\_1\_log file.

For information on Log Settings, see [Tuning the DHCP Server, on page 17](#)

## Defining Advanced Server Attributes

You can set advanced DHCP server attributes, including custom DHCP options.

To set up the DHCP server.

1. Configure a scope or prefix.
2. Reload the server.

## Related Topics

[Setting Advanced DHCP Server Attributes, on page 3](#)

[Enabling BOOTP for Scopes, on page 27](#)

[Moving or Decommissioning BOOTP Clients, on page 28](#)

[Using Dynamic BOOTP, on page 28](#)

[BOOTP Relay, on page 28](#)

## Setting Advanced DHCP Server Attributes

The table below describes the advanced DHCP server attributes that you can set in the local cluster web UI and CLI.

**Table 1: DHCP Advanced Attributes**

Advanced Parameter	Action	Description
<i>max-dhcp-requests</i>	set/ unset	<p>Controls the number of buffers that the DHCP server allocates for receiving packets from DHCP clients and failover partners. If this setting is too large, a burst of DHCP activity can clog the server with requests that become stale before being processed. This results in an increasing processing load that can severely degrade performance as clients try to obtain a new lease, and affects the ability to handle bursts. A low buffer setting throttles requests and could affect server throughput. If the server runs out of buffers, packets are dropped.</p> <p>A good rule of thumb is to increase the buffers if you expect a high load (in a steady state or when experiencing frequent stress times) or you have a fast multiprocessor system.</p>

Advanced Parameter	Action	Description
		<p>In a nonfailover deployment, the default setting (500) is sufficient. In a failover deployment, you can increase it to 1000 if the DHCP logs indicate a consistently high number of request buffers. You should then also modify the number of DHCP responses (see the <i>max-dhcp-responses</i> parameter) to four times the request buffers.</p> <p>When using LDAP client lookups, buffers should not exceed the LDAP lookup queue size defined by the total number of LDAP connections and the maximum number of requests allowed for each connection. Set the LDAP queue size to match the capacity of the LDAP server to service client lookups.</p> <p>If the following logs messages occur frequently and are not related to short term traffic spikes (such as after a power recovery), you may want to consider increasing the value of the attribute:</p> <pre> 4493 DHCP ERROR "DHCP has used xx of its YY request buffers: the server is dropping a request." 4494 DHCP WARNING "DHCP has used xx of yy request packets. Requests will be ignored if no packet buffers are available." 5270 DHCP WARNING "DHCP has used xx of its YY request buffers: the server is congested -- will not keep the client last-transaction-time to within value but will keep it to within value seconds." </pre> <p>Required. The default is 500.</p>

Advanced Parameter	Action	Description
<i>max-dhcp-responses</i>	set/ unset	<p>Controls the number of response buffers that the DHCP server allocates for responding to DHCP clients and performing failover communication between DHCP partners.</p> <p>In a non-failover deployment, the default setting of twice the number of request buffers is sufficient. In a failover deployment, you can increase this so that it is four times the number of request buffers. In general, increasing the number of response buffers is not harmful, while reducing it to below the previously recommended ratios might be harmful to server responsiveness.</p> <p>If the following logs messages occur frequently and are not related to short term traffic spikes (such as after a power recovery), you may want to consider increasing the value of the attribute:</p> <pre>4721 DHCP ERROR "DHCP has used all xx response packets. A request was dropped and they will continue to be dropped if no responses are available." 5289 DHCP WARNING "DHCP has used xx of yy response packets. Requests will be dropped if no responses are available."</pre> <p>Required. The default is 1000.</p>
<i>max-ping-packets</i>	set/ unset	<p>Controls the number of buffers that the server has available to initiate Ping requests to clients. If you enable the <i>Ping address before offering it</i> option at the scope level, packet buffers are used to send and receive ICMP messages. If you enable pinging, you should have enough ping packets allocated to handle the peak load of possible ping requests. The default is 500 ping packets.</p>
<i>hardware-unicast</i>	enable/ disable	<p>Controls whether the DHCP server sends unicast rather than broadcast responses when a client indicates that it can accept a unicast. This feature is only available on Windows platform; other operating systems broadcast instead. The default is enabled.</p>

Advanced Parameter	Action	Description
<i>defer-lease-extensions</i>	enable/ disable	Controls whether the DHCP server extends leases that are less than half expired. This is a performance tuning attribute that helps minimize the number of disk writes to the lease state database. The default is checked or true. This means that a client renewing a lease less than halfway through can get the remaining part of it only and not be extended. See <a href="#">Deferring Lease Extensions, on page 8</a> .
<i>last-transaction-time-granularity</i>	set/ unset	<p>The default value of the last-transaction-time-granularity attribute has changed from 60 seconds to one week. This new default means that the client-last-transaction-time may not accurately reflect the last time the client communicated with the server.</p> <p>If your deployment depended on this attribute being updated whenever the client communicated with the server, you need to explicitly set the last-transaction-time-granularity attribute to a value appropriate for the deployment.</p> <p>The last-transaction-time-granularity attribute is effectively not used when you have disabled defer-lease-extensions. Therefore, if you have disabled defer-lease-extensions, this change in the default value does not impact you.</p> <p>When the server is heavily loaded and has run low on request or response buffers, the server temporarily sets the last-transaction-time-granularity value to one year to reduce its load.</p>

Advanced Parameter	Action	Description
discover-queue-limit	set/ unset	<p>Specifies the percentage limit of the request buffers that may be used for DHCPDISCOVER and SOLICIT client requests at any time. Once the configured percentage of the request buffers is exceeded, additional DHCPDISCOVER and SOLICIT client requests are discarded. By restricting the requests buffers that can be used by DHCPDISCOVER/SOLICIT requests, the server assures it has request buffers available to process DHCPREQUEST/REQUEST requests and this can greatly reduce the time needed to get clients online during spikes in activity, such as after a power recovery or CMTS reboot.</p> <p>The <b>DRL</b> (Discriminating Rate Limiter) attribute controls the discriminating rate limiter capability. The Discriminating Rate Limiter is enabled by default and assures that the DHCP server prefers completing DHCP transaction over starting too many new ones. In many situations, this should expedite bringing all clients online. If activity summary logging is enabled, the number of DHCPDISCOVER (DHCPv4) and SOLICIT (DHCPv6) packets dropped because of rate limiting is reported as DRL:number.</p> <p>The DHCPv4 statistics includes a new queue-limited-discovers-dropped counter and the DHCPv6 statistics includes a new queue-limited-solicits-dropped counter. These counters are used to monitor the packets that are dropped.</p>

## Local Basic or Advanced Web UI

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- Step 1** From the **Deploy** menu, choose **DHCP Server** under the DHCP submenu to open the Manage DHCP Server page.
  - Step 2** Select the server from the DHCP Server pane.
  - Step 3** Add or modify attributes on the Edit Local DHCP Server page.
  - Step 4** Click **Save** after making the changes.
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## CLI Commands

Use **dhcp show** and **dhcp get** to show the current server parameters, then use **dhcp set**, **dhcp unset**, **dhcp enable**, and **dhcp disable** to change them (see the table above).

## Deferring Lease Extensions

Enabling the *defer-lease-extensions* attribute (which is its preset value) allows the DHCP server to optimize response to a sudden flood of DHCP traffic. An example of a network event that could result in such a traffic spike is a power failure at a cable internet service provider (ISP) data center that results in all of its cable modem termination systems (CMTS) rebooting at once. If this happens, the devices attached to the CMTSs produce a flood of DHCP traffic as they quickly come back online.

With the *defer-lease-extensions* attribute enabled, the DHCP server might defer extending the lease expiration time for a client's renewal request, which typically occurs before T1 (usually before halfway through the lease). Instead of giving the client the full configured lease time, the server grants the remaining time on the existing lease. Because the absolute lease expiration time does not change, the server can avoid database updates that result in a significantly higher server throughput. Another benefit is avoiding having to update the failover partner with an extended lease expiration time.

If a client is at or beyond T1 (typically halfway to its expiration), enabling or disabling this attribute has no effect, and the server always tries to extend the lease expiration time. However, failover and other protocol restrictions can prevent the server from extending the lease for the full configured time.



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**Note** Deferring lease extensions significantly increases the server performance while remaining in compliance with the DHCP RFC, which stipulates that client binding information is committed to persistent storage when the lease changes.

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When deferring lease extensions, it is advisable to leave the policy attribute *allow-lease-time-override* to its default of disabled, or to change it to disabled if it is enabled.

These three specific situations are described from the server point of view:

- **Client retries**—When the server gets behind, it is possible for a client to retransmit requests. The DHCP server does not maintain enough information to recognize these as retransmissions, and processes each to completion, granting a full lease duration again and updating the database. When the server is already behind, doing extra work worsens the situation. To prevent this, the DHCP server does not extend leases that are less than 30 seconds old, regardless of the state of the *defer-lease-extensions* attribute.
- **Client reboots**—The effective renew time for a client lease is really the minimum of the configured renew time and the time between client reboots. In many installations this may mean that clients get fresh leases one (in a typical enterprise) or two (in a typical cable network) times per day, even if the renew time is set for many days. Setting the *defer-lease-extensions* attribute can prevent these early renews from causing database traffic.
- **Artificially short renewal times**—Because there is no way for a DHCP server to proactively contact a DHCP client with regard to a lease, you might configure short lease times on the DHCP server to provide a means of doing network renumbering, address reallocation, or network reconfiguration (for example, a change in DNS server address) in a timely fashion. The goal is to allow you to do this without incurring unacceptable database update overhead.

As a complication, the server also keeps track of the time when it last heard from the client. Known as the last transaction time, sites sometimes use this information as a debugging aid. Maintaining this time robustly requires a write to the database on every client interaction. The *last-transaction-time-granularity* attribute is the one to set. (See the attribute description in [Table 1: DHCP Advanced Attributes](#).) Because it is primarily a debugging aid, the value need not be entirely accurate. Furthermore, because the in-memory copy is always accurate, you can use **export leases –server** to display the current information, even if the data is not up to date in the database.

## Setting DHCP Forwarding

The Cisco Prime IP Express DHCP server supports forwarding DHCP packets to another DHCP server on a per-client basis. For example, you might want to redirect address requests from certain clients, with specific MAC address prefixes, to another DHCP server. This can be useful and important in situations where the server being forwarded to is not one that you manage. This occurs in environments where multiple service providers supply DHCP services for clients on the same virtual LAN.

Enabling DHCP forwarding requires implementing an extension script. The DHCP server intercepts the specified clients and calls its forwarding code, which checks the specified list of forwarded server addresses. It then forwards the requests rather than processing them itself. You attach and detach extensions to and from the DHCP server by using **dhcp attachExtension** and **dhcp detachExtension**.

The DHCP forwarding feature works like this:

1. When DHCP is initialized, the server opens a UDP socket, which it uses to send forwarded packets. To support servers with multiple IP addresses, the socket address pair consists of `INADDR_ANY` and any port number. This enables clients to use any one of the server IP addresses.
2. When the DHCP server receives a request from a client, it processes these extension point scripts:
  - **post-packet-decode**
  - **pre-client-lookup**
  - **post-client-lookup**

As the DHCP server processes these scripts, it checks the environment dictionary for this string:

```
cnr-forward-dhcp-request
```

3. When it finds that string and it has the value *true* (enabled), the server calls its forwarding code.
4. The forwarding code checks the environment dictionary for a string with this key:

```
cnr-request-forward-address-list
```

It expects a list of comma-separated IP addresses with an optional colon-delimited port number, as in this example:

```
192.168.168.15:1025,  
192.168.169.20:  
1027
```

By default, the server forwards to `server-port` for DHCPv4 and `v6-server-port` for DHCPv6. It sends a copy of the entire client request to each IP address and port in turn. If any element in the list is invalid, the server stops trying to parse the list.

5. After the forwarding code returns, the server stops processing the request. In the `post-client-lookup` extension point script, however, this action might create an optional log message with client-entry details.

The following example of a portion of a TCL extension script tells the DHCP server to forward a request to another server based on the information in the request. You can use such a script if there are multiple device provisioning systems in the same environment. In this case, you would run the extension script on the DHCP server to which routers forward broadcast requests. The script would determine which (if any) other server or servers should handle the request, and tell the original server to forward the request.

The sample script uses a static mapping of MAC address prefix to send modems from a specific vendor to a specific system:

```
proc postPktDecode {req resp env} {
  set mac [$req get chaddr]
  set addrs ""
  ;# Very simple, static classifier that forwards all requests from devices
  ;# with a vendor-id of 01:0c:10 to the DHCP servers at 10.1.2.3 and 10.2.2.3:
  switch -glob -- $mac {
    01:0c:10* {

      set addrs "10.1.2.3,10.2.2.3"
    }
  }
  ;# If we decide to forward the packet, the $addrs var will have the IP addresses
  ;# where to forward the packet:
  if {$addrs != ""} {
    ;# Tell the DHCP server to forward the packet...
    $env put cnr-forward-dhcp-request true
    ;# ...and where to forward it:
    $env put cnr-request-forward-address-list $addrs
    ;# No more processing is required.
    return
  }
}
```

A more flexible script could use a per-client configuration object, such as the Cisco Prime IP Express client entry, to indicate which DHCP server should get the request.

## Editing DHCPv6 Server Attributes

You can edit DHCP server attributes related to DHCPv6. These attributes are:

- **v6-client-class-lookup-id**—Expression that determines a client-class based on the DHCPv6 client request and returns a string with either the name of a configured client-class or <none> (if the expression does not wish to provide a client-class). The attribute has no preset value.
- **max-client-leases**—Maximum number of leases a DHCPv6 client can have on a link. Do not use this attribute to limit clients to one lease only. The preset is 50.

## Local Basic or Advanced Web UI

From the Deploy menu, choose **DHCP Server** under the DHCP submenu to open the Manage DHCP Server page. Click the Local DHCP Server link to open the Edit DHCP Server page, modify the aforementioned DHCPv6 attribute values, then click **Save**.

## CLI Commands

Use **dhcp** to show the aforementioned DHCPv6 server attributes, then modify them by using **dhcp set**.

# Integrating Windows System Management Servers

You can have the DHCP server interact with the Microsoft System Management Server (SMS) so that SMS is current with DHCP changes. Normally, SMS pulls updated data through a DHCPDISCOVER request from the server about any new clients that joined the network. Cisco Prime IP Express, however, pushes these updates to SMS when you use **dhcp updateSms**. Before you do, verify that:

- SMS client installation and initialization step is complete.
- Cisco Prime IP Express Server Agent is set to run under a login account with sufficient privileges.
- SMS site ID is correct and matches that of the SMS server.

These steps describe how to integrate Windows SMS into Cisco Prime IP Express.

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- Step 1** Install the Microsoft BackOffice 4.5 Resource Kit on the same machine as the Cisco Prime IP Express DHCP server. Follow the installation instructions and choose the default settings.
- Step 2** After the installation, modify the User Variable search path on the Environment tab of the System control panel to:
- ```
\program files\ResourceKit\SMS\diagnose
```
- Step 3** If the DHCP and SMS servers are on different machines, install the SMS client on the same machine as the DHCP server. The SMS library has the necessary API calls to communicate with the SMS server. You must assign the correct site code from the DHCP server machine. In your Network Neighborhood, go to the path `\\SMS-servername\SMSLOGON\x86.bin\00000409\smsman.exe`.
- Run the program and follow the instructions, using the default settings. The program creates two icons that you can use later from the control panel, marked SMS and Remote Control.
- Step 4** Stop and then restart the Cisco Prime IP Express server agent under a trusted domain account with sufficient privileges. Both the DHCP and SMS servers must be aware of this account. Use this short procedure:
- a) Stop the local cluster server agent process.
  - b) Configure the account under which the Cisco Prime IP Express services run. Create an account name that is a member of both the trusted SMS site server group and a member of the DHCP server administrator group, with the corresponding password.
  - c) Restart the local cluster server agent process.
- Step 5** Use **dhcp set sms-library-path** (or the *sms-library-path* attribute under the Microsoft Systems Management Server category on the Edit DHCP Server page) to configure the DHCP server to push lease information to SMS. Include the full path to the SMSRsGen.dll. If you omit a value, the path defaults to the internal server default location of this file. For example:

```
nrcmd> dhcp set sms-library-path /conf/dll
```

When you install the Microsoft BackOffice Resource Kit, the system path is not updated to reflect the location of the SMS data link library (DLL). Use one of these methods to configure this attribute:

- a) Set the *sms-library-path* attribute to a relative path:
  - First, modify the system PATH variable to append the path of the directory where the DLL is installed:  
`sms-install-directory\diagnose`

- Then, set *sms-library-path* to the name of the DLL, such as *smsrsgen.dll*. You can also accept the system default by unsetting the attribute.
- b) Set *sms-library-path* to an absolute path. If you do not want to change the system path, set this attribute to the absolute path of the DLL location:

```
"\\Program Files\\Resource Kit\\sms\\diagnose\\smsrsgen.dll"
```

**Step 6** Set the *sms-network-discovery* DNS attribute to 1 to turn SMS network discovery on.

If you use the default of 0, you disable SMS network discovery.

**Step 7** Set the *sms-site-code* DHCP server attribute by entering the SMS site code from **Step 3**.

The default string is empty, but for data discovery to be successful, you must provide the site code.

**Step 8** Set the *sms-lease-interval* attribute to the SMS lease interval.

The lease interval is the time between sending addresses to SMS, or how long, in milliseconds, the DHCP server should wait before pushing the next lease to the SMS server when you run **server dhcp updateSms**. Early versions of the *SMSRsGen.dll* file (SMS Version 2.0) did not allow SMS to reliably receive multiple updates within a one-second window (1000 ms); the default value, therefore, was set to 1.1 second (1100 ms). If you install a future version of the Microsoft BackOffice Resource Kit, which might contain an enhanced version of the *SMSRsGen.dll* file, then reduce this interval or set it to 0 to increase performance.

**Step 9** Reload the DHCP server and check the *dhcp\_startup\_log* and/or *name\_dhcp\_1\_log* file.

**Step 10** In the CLI, use **server dhcp updateSms** to initiate SMS processing. (This command can take an optional **all** keyword to send all leased addresses from the DHCP server to SMS. If you omit this keyword, the DHCP server sends only new leases activated since the last time the command ran.) Then, verify that both the DHCP and SMS logs indicate successful completion. Note that a server reload during SMS updating interrupts the process, but the process resumes (or restarts) after the server is back up.

## Using Extensions to Affect DHCP Server Behavior

Cisco Prime IP Express provides the ability to alter and customize the operation of the DHCP server through *extensions*, programs that you can write in TCL or C/C++. Extensions interact with the server in two ways: by modifying request or response packets, and through environment variables stored in the environment dictionary (see [Using Extension Points](#) for details).

For example, you might have an unusual routing hub that uses BOOTP configuration. This device issues a BOOTP request with an Ethernet hardware type (1) and MAC address in the *chaddr* field. It then sends out another BOOTP request with the same MAC address, but with a hardware type of Token Ring (6). The DHCP server normally distinguishes between a MAC address with hardware type 1 and one with type 6, and considers them to be different devices. In this case, you might want to write an extension that prevents the DHCP server from handing out two different addresses to the same device.

You can solve the problem of the two IP addresses by writing either of these extensions:

- One that causes the DHCP server to drop the Token Ring (6) hardware type packet.

- One that changes the Token Ring packet to an Internet packet and then switches it back again on exit. Although this extension would be more complex, the DHCP client could thereby use either return from the DHCP server.

## Related Topics

[Writing Extensions, on page 13](#)

[Preventing Chatty Clients by Using an Extension, on page 14](#)

## Writing Extensions

You can write extensions in TCL or C/C++:

- **TCL**—Makes it a bit easier and quicker to write an extension. If the extension is short, the interpreted nature of TCL does not have a serious effect on performance. When you write an extension in TCL, you are less likely to introduce a bug that can crash the server.
- **C/C++**—Provides the maximum possible performance and flexibility, including communicating with external processes. However, the complexity of the C/C++ API is greater and the possibility of a bug in the extension crashing the server is more likely than with TCL.

You create extensions at specific extension points. Extension points include three types of dictionaries—request, response, and environment. One or more of these dictionaries are available for each of the following extension points:

1. **init-entry**—Extension point that the DHCP server calls when it configures or unconfigures the extension. This occurs when starting, stopping, or reloading the server. This entry point has the same signature as the others for the extension. It is required for DHCPv6 processing. Dictionary: environment only.
2. **pre-packet-decode**—First extension point that the DHCP server encounters when a request arrives, and calls it before decoding the packet. Dictionaries: request and environment.
3. **post-packet-decode**—Rewrites the input packet. Dictionaries: request and environment.
4. **post-class-lookup**—Evaluates the result of a *client-class-lookup-id* operation on the client-class. Dictionaries: request and environment.
5. **pre-client-lookup**—Affects the client being looked up, possibly by preventing the lookup or supplying data that overrides the existing data. Dictionaries: request and environment.
6. **post-client-lookup**—Reviews the operation of the client-class lookup process, such as examining the internal server data structures filled in from the client-class processing. You can also use it to change any data before the DHCP server does additional processing. Dictionaries: request and environment.
7. **generate-lease**—Generates and controls a DHCPv6 address or prefix. Dictionaries: request, response, and environment.
8. **check-lease-acceptable**—Changes the results of the lease acceptability test. Do this only with extreme care. Dictionaries: request, response, and environment.
9. **lease-state-change**—Determines when the lease state changes this only with extreme care. Dictionaries: response and environment.
10. **pre-packet-encode**—Changes the data sent back to the DHCP client in the response, or change the address to which to send the DHCP response. Dictionaries: request, response, and environment.
11. **post-packet-encode**—Allows the server to examine and alter the packet before it sends the packet to the client, or drops the packet. Dictionaries: request, response, and environment.
12. **pre-dns-add-forward**—Alters the name used for the DNS forward (A record) request. Dictionary: environment only.

13. **post-send-packet**—Used after sending a packet for processing that you want to perform outside of the serious time constraints of the DHCP request-response cycle. Dictionaries: request, response, and environment.
14. **environment-destructor**—Allows an extension to clean up any context that it might be holding. Dictionary: environment.

To extend the DHCP server, do the following:

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**Step 1** Write the extension in Tcl, C or C++ and install it in the server extensions directory, on:

- **UNIX:**
  - **Tcl**—/opt/nwreg2/extensions/DHCP/tcl
  - **C or C++**—/opt/nwreg2/extensions/DHCP/dex
- **Windows:**
  - **Tcl**—\program files\Cisco Prime IP Express\extensions\dhcp\tcl
  - **C or C++**—\program files\Cisco Prime IP Express\extensions\dhcp\dex

It is best to place these extensions in the appropriate directory for TCL or C/C++ extensions. Then, when configuring the filename, just enter the filename itself, without slash (/) or backslash (\).

If you want to place extensions in subdirectories, enter the filename with a path separator. These are different depending on the operating system on which your DHCP server is running.

**Note** When entering a filename that contains a backslash (\) character in Windows, you must enter it with a double-backslash (\\), because backslash (\) is an escape character in the CLI. For example, enter the filename debug\myextension.tcl as **debug\\myextension.tcl**.

**Step 2** Use the List/Add DHCP Extensions page in the web UI (In the Advanced mode, from the Deploy menu, choose **Extensions** from the DHCP submenu to open the List/Add DHCP Extensions page) or the **extension** command in the CLI to configure the DHCP server to recognize this extension.

**Step 3** Attach the configured extension to one or more DHCP extension points by using **dhcp attachExtension**.

**Step 4** Reload the server.

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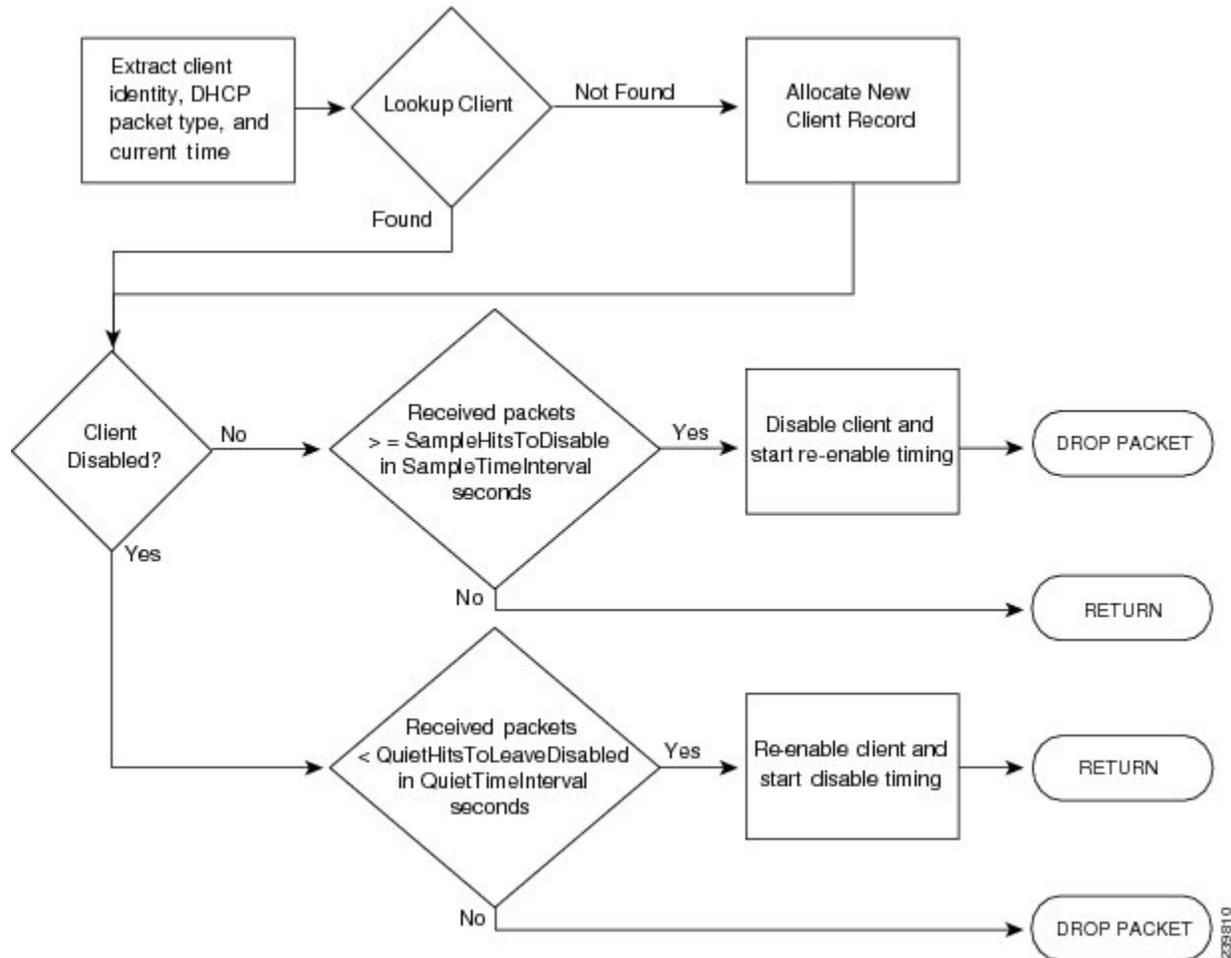
## Preventing Chatty Clients by Using an Extension

One example of an effective use of an extension is to protect against clients flooding the server with unnecessary traffic. You can use the ChattyClientFilter extension to keep the server from having to do much of the work of processing these chatty client packets. If you have large numbers of clients in your network, you might want to consider implementing this extension.

The ChattyClientFilter extension is available in the /examples/dhcp/dex directory of the Cisco Prime IP Express installation, and compiled and ready to use in /extensions/dhcp/dex/dexextension.so or /extensions/dhcp/dex/dexextension.dll. The extension monitors client requests, based on the MAC address, and disables the client if it generates more than a certain number of packets in a time interval. Disabling a client means that the server discards packets from it. However, the server does not ignore the client entirely,

because it continues to monitor traffic from it. If the server detects that the client starts to generate fewer than a certain number of packets in a time interval, it reenables the client and begins to allow packets from it again.

Figure 1: Chatty Client Filter Flow



The criteria for disabling and reenabling are set through arguments to the ChattyClientFilter extension. By default, the server disables a client when it receives more than 15 packets within 30 seconds; the server reenables the client when it sends fewer than 5 packets within 10 seconds. Note that these defaults are conservative and do not protect against all situations. For example, the server does not disable a client that sends packets every three seconds. Even allowing for a few retransmissions, a client should never need to send more than a half dozen packets in a short interval.

If you suspect chatty clients, review the DHCP server logs to determine incoming rates, then set the arguments described in the table below in the ChattyClientFilter code appropriately.

Table 2: ChattyClientFilter Arguments

| ChattyClientFilter Argument | Description                                                                                                             |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| -c                          | Ignores the packets when the “drop” attribute of the environment dictionary is set to “true”; default is not to ignore. |

| ChattyClientFilter Argument    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -d <i>packet-count seconds</i> | Drops DHCPRELEASE packets if more than the specified count are received in the specified time interval; default disabled.<br><br>The server keeps dropping DHCPRELEASE packets until the client suspends sending them for the <i>specified</i> interval. (DHCPv4 clients only.)<br><br>The basic formula is that the time interval should be at least ( <i>packet-count + 2</i> ) * 30 seconds.                                                                                                                                                                      |
| -h <i>packet-count</i>         | SampleHitsToDisable; default 15 packets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| -i <i>seconds</i>              | SampleTimeInterval; default 30 seconds.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| -l <i>packet-count</i>         | QuietHitsToLeaveDisabled; default 5 packets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| -m <i>seconds</i>              | Sets the maximum time a client is disabled, in seconds; default 0 - unlimited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| -n                             | NAKs the client if renewing or rebinding; default off. If the client exceeding the SampleHitsToDisable rate does a DHCPREQUEST, the server sends it a DHCPNAK instead of discarding the packet.<br><br>This can resolve problems with clients (such as cable modems) that cannot renew leases for some reason. Sending the DHCPNAK causes the client to restart its DHCP state machine and send a DHCPDISCOVER.<br><br>If you use this argument, you must attach the ChattyClientFilter to the <b>check-lease-acceptable</b> extension point. (DHCPv4 clients only.) |
| -q <i>seconds</i>              | QuietTimeInterval; default 10 seconds.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| -r <i>seconds</i>              | StatisticsInterval; default 300 seconds (5 minutes). This argument controls the frequency of periodic logging of the number of clients disabled and reenabled.                                                                                                                                                                                                                                                                                                                                                                                                       |
| -s                             | Silently discards dropped packets; default off.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| -w port                        | Enables web access on specified port (only enabled over IPv4; specify negative port to not bind to 127.0.0.1).                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



**Note** The -h, -i, -l, and -q defaults are unlikely to be appropriate to most situations as these were designed to address a single type of misbehaving client. Using a longer interval and packet hit count for normal conditions will produce reasonable results. Values such as -i 120 -h 8 -q 120 -l 8 would allow a client 8 packets over a 120 second period. A normal DHCPDISCOVER/OFFER/REQUEST/ACK is only 2 packets from a client. That is, the proper use of the ChattyClientFilter requires tuning these values for your particular network conditions. Use of the logscan tool which is available from the Cisco Prime IP Express download section on the Cisco website can help in analyzing client activity.

Review the comments in the ChattyClientFilter.cpp file for details on setting the arguments and enabling the extension. In most cases, you would attach it to the **post-packet-decode** extension point (along with **check-lease-acceptable** if you use the -n argument).

A sample use for the ChattyClientFilter is to drop DHCPRELEASE packets sent from a DHCPv4 client to prevent the lease history database from growing out of bounds, which can be the case with certain router configurations.

This scenario uses the `-d` argument. The setup on a Linux system might be:

```
nrcmd> extension dexChattyClientFilter create dex libdexextension.so
dexChattyClientFilter
init-entry=dexChattyClientFilterInitEntry
init-args="-d 2 120"
```

```
nrcmd> dhcp attachextension post-packet-decode dexChattyClientFilter
```

For Windows, replace `libdexextension.so` with `dexextension.dll`.

This setup results in the server dropping DHCPRELEASE packets if it receives more than two of these packets from the same client in a 120-second interval, and resuming DHCPRELEASEs processing when the client does not send a DHCPRELEASE for at least 120 seconds.

Cisco Prime IP Express 8.2 or later supports the mini-web server that can be used to obtain information about the clients being monitored or disabled (traffic being dropped) by the Chatty Client Filter. A typical request might be `http://127.0.0.1:<port>/report` entered in a web browser.

The web server supports the following requests:

- **status**—Returns a statistics report.
- **report**—Returns a statistics report and a full client report. The client report includes all clients currently being monitored and those that are disabled.
- **disabled-report**—Same as report except only the disabled clients are returned.
- **flush**—Same as report but all clients are REMOVED from the internal monitored and disabled list.
- **csv-client-list**—Returns the client list using CSV format (includes monitored and disabled clients).
- **csv-disabled-client-list**—Same as csv-client-list but only includes clients currently disabled.
- **xml-client-list**—Returns the client list using XML (includes monitored and disabled clients).
- **xml-disabled-client-list**—Returns the disabled client list using XML.




---

**Note** This web server is a very basic server implementation. It only supports the requests mentioned above.

---

## Tuning the DHCP Server

Other helpful hints in tuning your DHCP performance include:

- Set the request (*max-dhcp-requests*) and response (*max-dhcp-responses*) buffers for optimal throughput. See [Table 1: DHCP Advanced Attributes](#) for details.
- Keep the *defer-lease-extensions* attribute enabled. This reduces writes to the database.
- Set the *last-transaction-time-granularity* attribute to at least 60 seconds, optimally a value greater than half your lease interval.
- Disable the *allow-lease-time-override* attribute for policies offering production leases.
- Minimize your logging and debugging settings. If you require logging, use the *log-settings* attribute for the DHCP server with a controlled number of attributes, as described in the table below.

Table 3: DHCP Log Settings

| Log Setting (Numeric Equivalent) | Description                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| default (1)                      | Displays basic DHCP activity logging (the default setting).                                                                                                                                                                                                                                                                                       |
| incoming-packets (2)             | Logs a separate line for each incoming DHCP packet (the default).                                                                                                                                                                                                                                                                                 |
| missing-options (3)              | Displays missing policy options expected by a client (the default).                                                                                                                                                                                                                                                                               |
| incoming-packet-detail (4)       | The same as <i>incoming-packets</i> , but in human-readable form.                                                                                                                                                                                                                                                                                 |
| outgoing-packet-detail (5)       | Logs each incoming DHCP packet in a human-readable form.                                                                                                                                                                                                                                                                                          |
| unknown-criteria (6)             | Logs whenever a client entry has a <i>selection-criteria</i> or <i>selection-criteria-excluded</i> that is not found in any scope appropriate for the current network location of that client.                                                                                                                                                    |
| dns-update-detail (7)            | Logs each sent and replied DNS update.                                                                                                                                                                                                                                                                                                            |
| client-detail (8)                | After every client-class client lookup operation, logs the composite of the data found for the client and its client-class. Useful when setting a client-class configuration and debugging problems in client-class processing.                                                                                                                   |
| client-criteria-processing (9)   | Logs whenever a scope is examined to find an available lease or to determine if a lease is still acceptable for a client who already has one. Can be very useful when configuring or debugging client-class scope criteria processing. (Causes moderate amount of information to be logged and should not be left enabled as a matter of course.) |
| failover-detail (10)             | Logs detailed failover activity.                                                                                                                                                                                                                                                                                                                  |
| ldap-query-detail (11)           | Logs whenever the DHCP server initiates a query to an LDAP server, receives a response, and retrieves a result or error messages.                                                                                                                                                                                                                 |
| ldap-update-detail (12)          | Logs whenever the DHCP server initiates an update lease state to the LDAP server, receives a response, and retrieves a result or error messages.                                                                                                                                                                                                  |
| ldap-create-detail (13)          | Logs whenever the DHCP server initiates a lease state entry create to the LDAP server, receives a response, and retrieves a result or error messages.                                                                                                                                                                                             |
| leasequery (14)                  | Logs a message for every ACK- or NAK-responded lease query packet.                                                                                                                                                                                                                                                                                |
| dropped-waiting-packets (15)     | If the value of <i>max-waiting-packets</i> is non-zero, packets can be dropped if the queue length for any IP address exceeds the value. If <i>dropped-waiting-packets</i> is set, the server logs whenever it drops a waiting packet from the queue for an IP address.                                                                           |
| no-success-messages (16)         | Inhibits logging successful outgoing response packets.                                                                                                                                                                                                                                                                                            |
| no-dropped-dhcp-packets (17)     | Inhibits logging dropped DHCP packets.                                                                                                                                                                                                                                                                                                            |

| Log Setting (Numeric Equivalent) | Description                                                                                                                                                                                                                           |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| no-dropped-bootp-packets (18)    | Inhibits logging dropped BOOTP packets.                                                                                                                                                                                               |
| no-failover-activity (19)        | Inhibits logging normal activity and some warning messages logged for failover. However, serious error log messages continue to appear.                                                                                               |
| activity-summary (20)            | Enables logging a summary message every five minutes (useful if the following no- type flags are set), showing the activity in the previous interval (you can adjust this interval using <b>dhcp set activity-summary-interval</b> ). |
| no-invalid-packets (21)          | Inhibits logging invalid packets.                                                                                                                                                                                                     |
| no-reduce-logging-when-busy (22) | Inhibits reducing logging when receive buffers reach 66%.                                                                                                                                                                             |
| no-timeouts (23)                 | Inhibits logging timeouts of leases and offers.                                                                                                                                                                                       |
| minimal-config-info (24)         | Reduces the number of configuration messages in the log.                                                                                                                                                                              |
| no-failover-conflict (25)        | Logs conflicts between failover partners.                                                                                                                                                                                             |
| atul-detail (26)                 | Logs messages when the DHCP server receives Address-to-User Lookup (ATUL) packets from an ATUL protocol server.                                                                                                                       |

- Consider setting client caching (see [Setting Client Caching Parameters](#)).
- Check the server statistics to aid in monitoring server performance (see the *"Displaying Statistics" section in Cisco Prime IP Express 8.3 Administrator Guide*).
- Consider setting the scope allocation priority (see [Configuring Multiple Scopes Using Allocation Priority](#)).
- If pinging hosts before offering addresses, consider adjusting the ping timeout period (see [Pinging Hosts Before Offering Addresses](#)).
- To boost performance, consider limiting the number of selection tags.
- If using Lightweight Directory Access Protocol (LDAP) servers, consider the performance issues described in [Configuring Cisco Prime IP Express to Use LDAP](#).
- If using DHCP failover, consider using the load balancing feature (see [Setting Load Balancing](#)).



**Tip** Be sure to follow any DHCP server attribute changes with a server reload.

## Configuring Virtual Private Networks and Subnet Allocation

This section describes how to configure the Cisco Prime IP Express DHCP server to support virtual private networks (VPNs) and subnet allocation for on-demand address pools.

Configuring VPNs involves an adjustment to the usual DHCP host IP address designation. VPNs use private address spaces that might not be unique across the Internet. Because of this, Cisco Prime IP Express supports IP addresses that are distinguished by a VPN identifier. Relay agents on routers must support this capability as well. The VPN identifier selects the VPN to which the client belongs. VPN for DHCP is currently only supported by Cisco IOS software, the newest versions of which can include VPN IDs in the relayed DHCP messages.

Subnet allocation is a way of leasing subnets to clients (usually routers or edge devices) so that they can, in turn, provide DHCP services. This can occur along with or instead of managing individual client addresses. Subnet allocation can vastly improve IP address provisioning, aggregation, characterization, and distribution by relying on the DHCP infrastructure to dynamically manage subnets. Subnet allocation through DHCP is currently only supported by Cisco IOS software, the newest versions of which incorporate the on-demand address pools feature.

## Related Topics

[Configuring Virtual Private Networks Using DHCP, on page 20](#)

[Configuring DHCP Subnet Allocation, on page 24](#)

[VPN and Subnet Allocation Tuning Parameters, on page 26](#)

## Configuring Virtual Private Networks Using DHCP

VPNs that you create provide a filtering mechanism for:

- Viewing the unified address space (see [Viewing Address Space](#))
- Listing address blocks (see [Adding Address Blocks](#))
- Listing subnets (see [Address Blocks and Subnets](#))
- Querying lease history (see [Running IP Lease Histories](#))

If you do not configure a VPN, Cisco Prime IP Express uses the global VPN of 0 on each scope.

To configure a VPN whereby a client can request IP addresses from a DHCP server using a relay agent, you must define the VPN and associate a scope with it. Specifically:

1. Ensure that the relay agents that handle DHCP VPN traffic are configured with a version of Cisco IOS software that supports the *vpn-id* suboption of the *relay-agent-info* option (82) in DHCP.
2. Coordinate with the Cisco IOS relay agent administrator that the VPN is identified either by a VPN ID or a VPN Routing and Forwarding instance (VRF) name.
3. Create a scope for the VPN.

## Related Topics

[Typical Virtual Private Networks, on page 20](#)

[Creating and Editing Virtual Private Networks, on page 21](#)

[VPN Usage, on page 23](#)

## Typical Virtual Private Networks

[Figure 4](#) shows a typical VPN scenario with DHCP client 1 as part of VPN blue and DHCP client 2 in VPN red. For example, both DHCP client 1 in VPN blue and client 2 in VPN red have the same private network address: 192.168.1.0/24. The DHCP relay agent has gateway addresses that are in the two VPNs as well as a global one (172.27.180.232). There are two failover DHCP servers, both of which know the relay agent through its external gateway address.

Here is the processing that takes place for the server to issue a VPN-supported address to a client:

1. DHCP client 1 broadcasts a DHCPDISCOVER packet, including its MAC address, hostname, and any requested DHCP options.

2. DHCP relay agent at address 192.168.1.1 picks up the broadcast packet. It adds a *relay-agent-info* option (82) to the packet and includes the *subnet-selection* suboption that identifies 192.168.1.0 as the subnet. The packet also includes the *vpn-id* suboption that identifies the VPN as *blue* . Because the DHCP server cannot communicate directly with the requesting client, the *server-id-override* suboption contains the address of the relay agent as known by the client (192.168.1.1). The relay agent also includes in the packet its external gateway address (*giaddr* ), 172.27.180.232.
3. The relay agent unicasts the DHCPDISCOVER packet to the configured DHCP server on its subnet.
4. DHCP server 1 receives the packet and uses the *vpn-id* and *subnet-selection* suboptions to allocate an IP address from the proper VPN address space. It finds the available address 192.168.1.37 in the subnet and VPN, and places it in the *yiaddr* field of the packet (the address offered to the client).
5. The server unicasts a DHCPOFFER packet to the relay agent that is identified by the *giaddr* value.
6. The relay agent removes the *relay-agent-info* option and sends the packet to DHCP client 1.
7. DHCP client 1 broadcasts a DHCPREQUEST message requesting the same IP address that it was offered. The relay agent receives this broadcast message.
8. The relay agent forwards the DHCPREQUEST packet to DHCP server 1, which replies with a unicast DHCPACK packet to the client.
9. For a lease renewal, the client unicasts a DHCPRENEW packet to the IP address found in the *dhcp-server-identifier* option of the DHCPACK message. This is 192.168.1.1, the address of the relay agent. The relay agent unicasts the packet to the DHCP server. The server does its normal renewal processing, without necessarily knowing whether it was the server that gave out the original address in the first place. The server replies in a unicast DHCPACK packet. The relay agent then forwards the DHCPACK packet to the client IP address identified by the *ciaddr* field value.

If the *server-id-override* suboption of the *relay-agent-info* option (82) exists, the DHCP server uses its value to compare to that of the *dhcp-server-identifier* option in the reply packet. Any packet that the DHCP client unicasts then goes directly to the relay agent and not to the server (which may, in fact, be inaccessible from the client). Both partners in a failover environment can renew a lease if the packet includes the *server-id-override* suboption.

## Creating and Editing Virtual Private Networks

To set up the VPN and its index:

- 
- Step 1** Coordinate with the Cisco IOS relay agent administrator that the VPNs are configured either by VPN ID or VRF name on the relay agent. This will determine how to identify the VPN in Cisco Prime IP Express.
- Step 2** Create a VPN to allow provisioning DHCP clients onto the VPN that is configured in the IOS switch or router.
- Step 3** Enter a VPN index, which can be any unique text string except the reserved words **all** or **global** . Its associated ID must also be unique.

To add an index at the:

- **Local cluster (Advanced)**—From the **Design** menu, choose **VPNs** under the DHCP Settings submenu to open the List/Add VPNs page. Give the VPN a numerical key identifier and a unique name in the cluster.
- **Regional cluster**—Add the local cluster containing the VPN (from the **Operate** menu, choose **Manage Clusters under the Servers** submenu ). Then choose **VPNs** from the **Design** menu . This opens the List/Add VPNs page. You can create the VPN on this page or pull the VPN from the local clusters:
  - If creating the VPN, give it a numerical key identifier and a unique name.

- If pulling the VPN from the local clusters, click the **Pull Replica** icon in the VPNs pane on the List/Add VPNs page, then pull a specific VPN or all the VPNs from the selected cluster.

You can also push VPNs to the clusters by clicking the **Push** or **Push All** icon in the List/Add VPNs page. Then choose the synchronization mode and the clusters to which to push the VPNs on the Push VPN Data to Local Clusters page.

- **In the CLI**—Use `vpn name create key`. For example:

```
nrcmd> vpn blue create 99
```

**Step 4** Specify the appropriate VPN identifier, either by VPN ID or VRF name. It is rarely both.

- If you use a VPN ID, set the `vpn-id` attribute value for the VPN. The value is usually in hexadecimal, in the form `oui:index`, per IETF RFC 2685. It consists of a three-octet VPN Organizationally Unique Identifier (OUI) that corresponds to the VPN owner or ISP, followed by a colon. It is then followed by a four-octet index number of the VPN itself. Add the VPN ID value to the List/Add VPNs page. In the CLI, set the `vpn-id` attribute. For example:

```
nrcmd> vpn blue set vpn-id=a1:3f6c
```

- If you use a VPN Routing and Forwarding (VRF) instance name, set the `vrf-name` attribute value for the VPN. Cisco routers frequently use VRF names. Add the VRF Name value to the List/Add VPNs page. In the CLI, set the `vrf-name` attribute. For example:

```
nrcmd> vpn blue set vrf-name=framus
```

**Step 5** Add a description for the VPN (optional).

**Step 6** Click **Add VPN**. You can edit the VPN to change the values on the Edit VPN page.

**Step 7** Create a scope for the VPN.

You must keep the VPN name and scope name as similar as possible for identification purposes.

1. In the web UI, from the **Design** menu, choose **Scopes** under the DHCPv4 submenu to open the List/Add DHCP Scopes page.
2. Choose the VPN from the username drop-down list on the top right of the window. You cannot change the VPN once you set it at the time of creation of the scope

In the CLI, identify to which VPN the scope belongs in one of three ways:

- Its VPN name, through the `vpn` attribute (which applies the VPN ID to the scope).
- The VPN ID itself, through the `vpn-id` attribute.
- The current session VPN name, by omitting the VPN or its ID on the command line.

You set the default VPN for the current session using `session set current-vpn`. You can then set the usual address range and necessary option properties for the scope. For example:

```
nrcmd> scope blue-1921681 create 192.168.1.0 255.255.255.0 vpn=blue
```

Or

```
nrcmd> scope blue-1921681 create 192.168.1.0 255.255.255.0 vpn-id=99
```

Or

```
nrcmd> session set current-vpn=blue
nrcmd> scope blue-1921681 create 192.168.1.0 255.255.255.0
```

Then

```
nrcmd> scope blue-1921681 addRange 192.168.1.101 192.168.1.200
nrcmd> scope-policy blue-1921681 setOption routers 192.168.1.1
```

If you are in the staged `dhcp` edit mode, reload the DHCP server after you create all the VPNs and scopes.

## VPN Usage

The VPN name is used to qualify many DHCP objects in Cisco Prime IP Express, such as IP addresses (leases), scopes, and subnets. For example, lease names can have this syntax:

*vpn/ipaddress*

For example, `red/192.168.40.0`

A VPN can be any unique text string except the reserved words **global** and **all**. You can use **global** and **all** when you lease data. The **global** VPN maps to the [none] VPN; the **all** VPN maps to both the specific VPN and the [none] VPN.

In the CLI, if you omit the VPN or its ID in defining an object, the VPN defaults to the value set by **session set current-vpn**. In the web UI, if the current VPN is not defined, it defaults to the [none] VPN, which includes all addresses outside of any defined VPNs.

These objects have associated VPN properties:

- **Address blocks**—Define the VPN for an address block. Choose **Address Blocks** from the **Design > DHCPv4** menu to open the List/Add DHCP Address Blocks page. Choose the VPN from the username > VPN menu at the top right of the window. In the CLI, use the **dhcp-address-block** creation and attribute setting commands. For example:

```
nrcmd> dhcp-address-block red create 192.168.50.0/24
```

```
nrcmd> dhcp-address-block red set vpn=blue
```

```
nrcmd> dhcp-address-block red set vpn-id=99
```

- **Clients and client-classes**—In some cases it is best to provision a VPN inside of Cisco Prime IP Express instead of externally, where it might have to be configured for every Cisco IOS device. To support this capability, you can specify a VPN for a client or client-class. Two attributes are provided:
  - *default-vpn* —VPN that the packet gets if it does not already have a *vpn-id* or *vrf-name* value in the incoming packet. You can use the attribute with clients and client-classes.
  - *override-vpn* —VPN the packet gets no matter what is provided for a *vpn-id* or *vrf-name* value in the incoming packet. You can use the attribute with clients and client-classes. Note that if you specify an override VPN on the client-class, and a default VPN for the client, the override VPN on the client-class takes precedence over the default VPN on the client.

At the local cluster—Choose **Client-Classes** or **Clients** from the **Design > DHCP Settings** menu. Create or edit a client-class or client and enter the *default-vpn* and *override-vpn* attribute values.

At the regional cluster—Choose **Client-Classes** from the **Design > DHCP Settings** menu. Create or pull, and then edit a client-class to enter the *default-vpn* and *override-vpn* attribute values.

In the CLI—Use the **client-class** creation and attribute setting commands. For example:

```
nrcmd> client 1,6,00:d0:ba:d3:bd:3b set default-vpn=blue
nrcmd> client-class CableModem set override-vpn=blue
```

In a cable modem deployment, for example, you can use the *override-vpn* attribute to provision the cable modems. The client-class would determine the scope for the cable modem, and the scope would determine the VPN for the uBR. User traffic through the cable modem would then have the *vpn-id* suboption set and use the specific VPN. The *override-vpn* value also overrides any *default-vpn* set for the client.

- **Leases**—List leases, show a lease, or get lease attributes.

In the CLI—To import leases, use **import leases filename**. Each lease entry in the file can include the VPN at the end of the line. If it is missing, Cisco Prime IP Express assigns the [none] VPN. (See also [Importing and Exporting Lease Data](#).)

```
nrcmd> import leases leaseimport.txt
```

To export the address or lease data to include the VPN, use **export addresses** with the *vpn* attribute, or **export leases** with the **-vpn** option. The VPN value can be the reserved word **global** or **all**:

- **Global**—Any addresses outside the defined VPNs (the [none] VPN).
- **All**—All VPNs, including the [none] VPN.

If you omit the VPN, the export uses the current VPN as set by **session set current-vpn**. If the current VPN is not set, the server uses the [none] VPN.

```
nrcmd> export addresses file=addrlexport.txt vpn=red
```

```
nrcmd> export leases -server -vpn red leaseexport.txt
```

- **Scopes**—Scopes can include the VPN name or its ID, as described in [Configuring Virtual Private Networks Using DHCP, on page 20](#)




---

**Note** You cannot change the VPN once you set it at the time of creation of the scope.

---

- **Subnets**—Listing subnets, showing a subnet, or getting the *vpn* or *vpn-id* attribute for a subnet shows the VPN. See [Configuring DHCP Subnet Allocation, on page 24](#).
- **DHCP server**—If the *vpn-communication* attribute is enabled (which it is by default), the DHCP server can communicate with DHCP clients that are on a different VPN from that of the DHCP server by using an enhanced DHCP relay agent capability. This capability is indicated by the *server-id-override* suboption in the relay agent information option (82).

## Configuring DHCP Subnet Allocation

The following section provides an example of setting up subnet allocation using the DHCP server. [Figure 5](#) shows a sample subnet allocation configuration with subnets assigned to provisioning devices, along with the conventional DHCP client/server configuration.

Before allocating subnets, the DHCP server first determines what VPN the client is on, in the following order:

1. The server looks for incoming VPN options and uses the value for the VPN.

2. If no VPN options are found, the server uses the relay agent suboption value, then combines the VPN with the subnet address to form the unique identifier.
3. If no relay agent suboption is found, the server looks for client-class information (selection tags).

To configure DHCP subnet allocation:

### Step 1

Create a DHCP address block for a subnet, set the initial subnet mask and its increment, and set other subnet allocation request attributes. Also, associate a policy or define an embedded policy.

- If you use VPNs, you can specify a *vpn* or *vpn-id* attribute (see [Configuring Virtual Private Networks Using DHCP, on page 20](#)).

**Note** Unsetting the VPN ID in the CLI reverts the value to the current session VPN.

- The server uses the presence of the *subnet-alloc* DHCP option (220) in the request packet to determine that the packet is a subnet allocation request. You can configure the server to use the *subnet-name* suboption (3) as a selection tag if you set the *addr-blocks-use-selection-tags* attribute for the server or VPN.
- You can optionally set a default selection tag by setting the *addr-blocks-default-selection-tags* attribute for the DHCP server or VPN object. This identifies one or more subnets from which to allocate the addresses. If the relay agent sends a VPN string (via a VPN option or relay agent suboption), associated with a subnet, any address block with that string as one of its *addr-blocks-default-selection-tags* values uses that subnet.
- The default behavior on the server and for VPNs is that the DHCP server tries to allocate subnets to clients using address blocks that the clients already used. Disabling the *addr-blocks-use-client-affinity* attribute causes the server to supply subnets from any suitable address block, based on other selection data in the clients' messages.
- If you want to support configurations of multiple address blocks on a single LAN segment (analogous to using primary and secondary scopes), add a *segment-name* attribute string value to the DHCP address block. When the relay agent sends a single subnet selection address, it selects address blocks tagged with that *segment-name* string value. However, you must also explicitly enable the LAN segment capability (*addr-blocks-use-lan-segments*) at the server or VPN level.
- Instead of associating a policy, you can set properties for the address block embedded policy. As in embedded policies for clients, client-classes, and scopes, you can enable, disable, set, unset, get, and show attributes for an address block policy. You can also set, unset, get, and list any DHCP options for it, as well as set, unset, and list vendor options. Note that deleting an address block embedded policy unsets all the embedded policy properties.

### Step 2

Note that the server allocates subnets based on the relay agent request. If not requested, the default subnet size is a 28-bit address mask. You can change this default, if necessary, by setting the *default-subnet-size* attribute for the DHCP address block.

For example:

```
nrcmd> dhcp-address-block red set default-subnet-size=25
```

### Step 3

You can control any of the subnets the DHCP server creates from the address blocks. Identify the subnet in the form *vpn-name/netipaddress/mask*, with the *vpn-name* optional. Subnet control includes activating and deactivating the subnet as you would a lease. Likewise, you can force a subnet to be available, with the condition that before you do so, that you check that the clients assigned the subnet are no longer using it. First, show any subnets created.

### Step 4

Reload the DHCP server.

## VPN and Subnet Allocation Tuning Parameters

Consider these tuning parameters for VPNs and on-demand address pools.

- **Keep orphaned leases that have nonexistent VPNs**—Cisco Prime IP Express usually maintains leases that do not have an associated VPN in the Cisco Prime IP Express state database. You can change this by enabling the DHCP attribute *delete-orphaned-leases*. The server maintains a lease state database that associates clients with leases. If a scope modification renders the existing leases invalid, the lease database then has orphaned lease entries. These are typically not removed even after the lease expires, because the server tries to use this data in the future to reassociate a client with a lease. One downside to this is that the lease database may consume excessive disk space. When you enable the *delete-orphaned-leases* attribute, such lease database entries are removed during the next server reload. However, be cautious when enabling this attribute, because rendering leases invalid can result in clients using leases that the server believes to be free. This can compromise network stability.
- **Keep orphaned subnets that have nonexistent VPNs or address blocks**—This is the default behavior, although you can change it by enabling the DHCP attribute *dhcp enable delete-orphaned-subnets*. As the DHCP server starts up, it reads its database of subnets and tries to locate the parent VPN and address block of each subnet. With the attribute enabled, if a subnet refers to a VPN that is no longer configured in the server, or if the server cannot locate a parent address block that contains the subnet, the server permanently deletes the subnet from the state database.
- **Keep the VPN communication open**—This is the default behavior, although you can change it by disabling the DHCP attribute *vpn-communication*. The server can communicate with clients that reside on a different VPN from that of the server by using an enhanced DHCP relay agent capability. This is signaled by the appearance of the *vpn-id* suboption of the *relay-agent-info* option (82). You can disable the *vpn-communication* attribute if the server is not expected to communicate with clients on a different VPN than the server. The motivation is typically to enhance network security by preventing unauthorized DHCP client access.

## Configuring BOOTP

BOOTP (the BOOTstrap Protocol) was originally created for loading diskless computers. It was later used to allow a host to obtain all the required TCP/IP information to use the Internet. Using BOOTP, a host can broadcast a request on the network and get information required from a BOOTP server. The BOOTP server is a computer that listens for incoming BOOTP requests and generates responses from a configuration database for the BOOTP clients on that network. BOOTP differs from DHCP in that it has no concept of lease or lease expiration. All IP addresses that a BOOTP server allocates are permanent.

You can configure Cisco Prime IP Express to act like a BOOTP server. In addition, although BOOTP normally requires static address assignments, you can choose to either reserve IP addresses (and, therefore, use static assignments) or have IP addresses dynamically allocated for BOOTP clients.

## Related Topics

[About BOOTP, on page 27](#)

[Enabling BOOTP for Scopes, on page 27](#)

[Moving or Decommissioning BOOTP Clients, on page 28](#)

[Using Dynamic BOOTP, on page 28](#)

[BOOTP Relay, on page 28](#)

## About BOOTP

When you configure the DHCP server to return a BOOTP packet, be aware that BOOTP requires information in the DHCP packet in fields other than the option space. BOOTP devices often need information in the boot file (*file*), server IP address (*siaddr*), and server hostname (*sname*) fields of the DHCP packet (see RFC 2131).

Every Cisco Prime IP Express DHCP policy has attributes with which you can configure the information you want returned directly in the *file*, *siaddr*, or *sname* fields. The Cisco Prime IP Express DHCP server also supports a configuration parameter with which you can configure the policy options and determine which of the *file*, *sname*, or *siaddr* values you want returned to the BOOTP device.

Cisco Prime IP Express supports an analogous configuration parameter with which you can configure the options and *file*, *sname*, or *siaddr* values you want returned to the DHCP client. This is in addition to any options requested by the DHCP clients in the *dhcp-parameter-request* option in the DHCP request. Thus, you can configure both the BOOTP and DHCP response packets appropriately for your devices.

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**Step 1** Decide which values you want for the BOOTP attributes:

- *file*—Name of the boot file
- *siaddr*—Server IP address
- *sname*—Optional server hostname

**Step 2** Decide the list of options and their values that you want returned to the BOOTP client.

**Step 3** Set these values in the policy you want associated with the BOOTP request:

- Attributes (*packet-siaddr*, *packet-file-name*, *packet-server-name*) to send to the BOOTP client.
- Option values, such as the server addresses and domain name to return to the BOOTP client.
- List of fields and options you want returned to the BOOTP client.

**Step 4** Enable the associated scope or scopes for BOOTP processing.

**Step 5** Enable dynamic BOOTP processing if you want to have this scope provide an address for any BOOTP client that requests one. If you do not enable dynamic BOOTP, you must make reservations for each BOOTP client for which you want this scope to provide an address.

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## Enabling BOOTP for Scopes

You can enable BOOTP processing for a scope. Set certain attributes and BOOTP reply options for a created policy in the local cluster web UI, or use **policy name create** and **policy name set** in the CLI, to configure BOOTP. Set the policy attributes and options as a comma-separated list. The attributes are entities to use in a client boot process:

- *packet-siaddr*—IP address of the next server
- *packet-file-name*—Name of the boot file
- *packet-server-name*—Hostname of the server

The server looks through the policy hierarchy for the first instances of these attribute values.

In the CLI, **policy name setOption** requires spaces (not equal signs) before values.

Also, enable BOOTP and dynamic BOOTP, if desired, and ensure that the DHCP server updates the DNS server with BOOTP requests. The options are:

- Set the option *dhcp-lease-time* .
- Enable the *dynamic-bootp* attribute.
- Enable the *update-dns-for-bootp* attribute.
- Enable the *update-dns-for-bootp* attribute.

## Moving or Decommissioning BOOTP Clients

When you move or decommission a BOOTP client, you can reuse its lease. To decommission a BOOTP client, you must remove its lease reservation from the scope and force its lease to be available.

Force the lease to be available in the local cluster web UI, or set **scope name removeReservation** and **lease ipaddr force-available** in the CLI.

## Using Dynamic BOOTP

When you use dynamic BOOTP, there are additional restrictions placed on the address usage in scopes, because BOOTP clients are allocated IP addresses permanently and receive leases that never expire.

If you are using DHCP failover, when a server whose scope does not have the *dynamic-bootp* option enabled goes into PARTNER-DOWN state, it can allocate any available IP address from that scope, no matter whether it was initially available to the main or backup server. However, when the *dynamic-bootp* option is enabled, the main server and backup servers can only allocate their own addresses. Consequently scopes that enable the *dynamic-bootp* option require more addresses to support failover.

When using dynamic BOOTP:

1. Segregate dynamic BOOTP clients to a single scope. Disable DHCP clients from using that scope. In the local cluster web UI, under the BOOTP attributes for the scope, disable the *dhcp* attribute. In the CLI, use **scope name disable dhcp**.
2. If you are using DHCP failover, set the *failover-dynamic-bootp-backup-percentage* attribute for the DHCP server to allocate a greater percentage of addresses to the backup server for this scope. This percentage can be as much as 50 percent higher than a regular backup percentage.

## BOOTP Relay

Any router that supports BOOTP relay usually has an address that points to the DHCP server. For example, if you are using a Cisco router, it uses the term *IP helper-address* , which contains an address for a specific machine. In this case, use this address to forward all BOOTP (and therefore DHCP) broadcast packets. Be sure that you configure this address on the router closest to your host.



### Tip

If your DHCP clients are not receiving addresses from the DHCP server, check the network configuration, particularly the router or relay agent configuration, to verify that your network devices are set up to point to your Cisco Prime IP Express DHCP server address.