4

Configuring Controller Settings

This chapter describes how to configure settings on the controller. It contains these sections:

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Installing and Configuring Licenses

Note All features included in a WPlus license are now included in the base license in controller releases 6.0.195.0 and later. These WPlus license features are included in the base license:
- Office Extend AP
- Enterprise Mesh
- CAPWAP Data Encryption
This licensing change can affect features on your wireless LAN when you upgrade or downgrade software releases, so you should be aware of these guidelines:
- If you have a WPlus license and you upgrade from 6.0.18x to 6.0.195.0 or later: Your license file contains both Basic and WPlus license features. You won't see any disruption in feature availability and operation.
- If you have a WPlus license and you downgrade from 6.0.195.0 to 6.0.188 or 6.0.182: The license file in 6.0.195.0 contains both Basic and WPlus license features, so you won't see any disruption in feature availability and operation.
- If you have a base license and you downgrade from 6.0.195.0 to 6.0.188 or 6.0.182: When you downgrade, you lose all WPlus features.

Note Some references to WPlus licenses remain in the controller CLI and GUI in release 6.0.195.0. However, WPlus license features have been included in the Base license, so you can ignore those references.

Two types of licenses are required in order to use the 5500 series controllers in releases 6.0.188.0 and earlier:

- An image-based license (base or wplus), which determines the feature set that the controller uses
- An ap-count license (base-ap-count or wplus-ap-count), which determines the number of access points that the controller supports (12, 25, 50, 100, or 250)

Note These controller platforms do not require licenses: 2100 and 4400 series controllers, Cisco WiSMs, Controller Network Modules, and Catalyst 3750G Integrated Wireless LAN Controller Switches.

The base license supports the standard base software set, and the wplus license supports the premium wireless plus (wplus) software set. The wplus software set provides the standard base feature set as well as this functionality:

- Datagram Transport Layer Security (DTLS) data encryption for added security across remote WAN and LAN links

  Note Refer to the "Configuring Data Encryption" section on page 4 for more information on data encryption.

- Support for OfficeExtend access points, which are used for secure mobile teleworking

  Note Refer to the "OfficeExtend Access Points" section on page 50 for more information on OfficeExtend access points.

- Support for the 1130AG and 1240AG series indoor mesh access points, which dynamically establish wireless connections in locations where it might be difficult to connect to the wired network

Note Cisco Aironet 1520 series outdoor mesh access points can be used with the 5500 series controller without a wplus license.

Note Refer to the *Controlling Mesh Access Points* chapter for more information about mesh access points.

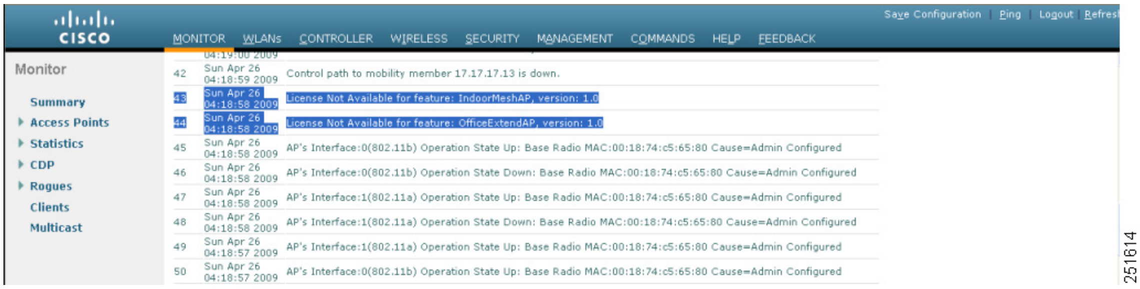
Data-encrypted, OfficeExtend, and indoor mesh access points can join a 5500 series controller only if the wplus license is installed on the controller. If the wplus license is not installed, the access points cannot join the controller, and one of the following messages appears in the controller trap log:

- "Data DTLS: AP Configured for Data DTLS but license not available"
- "License Not Available for feature: IndoorMeshAP"
- "License Not Available for feature: OfficeExtendAP"

To view the controller trap log, choose **Monitor** and click **View All** under "Most Recent Traps" on the controller GUI (see Figure 1).

Note You can also view traps by using SNMP-based management tools.

Figure 1 Trap Logs Page



```
    04:19:00 2009
42  Sun Apr 26      Control path to mobility member 17.17.17.13 is down.
    04:18:59 2009
43  Sun Apr 26      License Not Available for feature: IndoorMeshAP, version: 1.0
    04:18:58 2009
44  Sun Apr 26      License Not Available for feature: OfficeExtendAP, version: 1.0
    04:18:58 2009
45  Sun Apr 26      AP's Interface:0(802.11b) Operation State Up: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:58 2009
46  Sun Apr 26      AP's Interface:0(802.11b) Operation State Down: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:58 2009
47  Sun Apr 26      AP's Interface:1(802.11a) Operation State Up: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:58 2009
48  Sun Apr 26      AP's Interface:1(802.11a) Operation State Down: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:58 2009
49  Sun Apr 26      AP's Interface:1(802.11a) Operation State Up: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:57 2009
50  Sun Apr 26      AP's Interface:0(802.11b) Operation State Up: Base Radio MAC:00:18:74:c5:65:80 Cause=Admin Configured
    04:18:57 2009
```

The ap-count licenses and their corresponding image-based licenses are installed together. For example, the base-ap-count license is installed with the base license, and the wplus-ap-count license is installed with the wplus license. The controller keeps track of the licensed access point count and does not allow more than that number of access points to associate to it.

The 5500 series controller is shipped with both permanent and evaluation base and base-ap-count licenses, evaluation wplus and wplus-ap-count licenses, and if you ordered the wplus software set, permanent wplus and wplus-ap-count licenses. It is configured to use the permanent base or permanent wplus licenses, depending on the feature set ordered. If desired, you can activate the evaluation licenses, which are designed for temporary use and set to expire after 60 days.

Note Refer to the "Choosing the Licensed Feature Set" section on page 15 for instructions on activating an image-based evaluation license and the "Activating an AP-Count Evaluation License" section on page 18 for instructions on activating an ap-count evaluation license.

No licensing steps are required after you receive your 5500 series controller because the licenses you ordered are installed at the factory. In addition, licenses and product authorization keys (PAKs) are pre-registered to serial numbers. However, as your wireless network evolves, you might want to add support for additional access points or upgrade from the standard software set to the wplus software set. To do so, you need to obtain and install an upgrade license.

Obtaining an Upgrade License

A certificate with a product authorization key (PAK) is required before you can obtain an upgrade license for either the standard or wplus software.

You can upgrade your controller's access point count only to one of the approved tiers (25, 50, 100, or 250), and you must upgrade from one tier to the next without skipping any tiers. For example, if you have a base-ap-count or wplus-ap-count license with a 12-access-point count and want to upgrade to 100 access point support, you need to buy a -25U, -50U, and -100U upgrade license. The license with the greatest access point count represents the total number of access points supported by your controller. In the previous example, the -100U upgrade license is the license with the greatest access point count, so the controller would support up to 100 access points.

Note If you skip any tiers when upgrading (for example, if you do not install the -25U and -50U licenses along with the -100U), the license registration fails.

For a single controller, you can order different upgrade licenses in one transaction (for example, -25U, -50U, -100U, and -250U), for which you receive one PAK with one license. Then you have only one license (instead of four) to install on your controller.

If you have multiple controllers and want to upgrade all of them, you can order multiple quantities of each upgrade license in one transaction (for example, you can order 10 each of the -25U, -50U, -100U, and -250 upgrade licenses), for which you receive one PAK with one license. You can continue to register the PAK for multiple controllers until it is exhausted.

Note You cannot install a wplus license that has an access point count greater than the controller's base license. For example, you cannot apply a wplus-ap-count 100 license to a controller with an existing base-ap-count 12 license. If you attempt to register for such a license, an error message appears indicating that the license registration has failed. Before upgrading to a wplus-ap-count 100 license, you would first have to upgrade the controller to a base-ap-count 100 or 250 license.

Follow these steps to obtain and register a PAK certificate.

Step 1 Order the PAK certificate for an upgrade license through your Cisco channel partner or your Cisco sales representative, or order it online at this URL:

http://www.cisco.com/go/ordering

Step 2 If you are ordering online, begin by choosing the primary upgrade SKU **L-LIC-CT5508-UPG**. Then choose any number of the following options to upgrade one or more controllers under one PAK:

- **L-LIC-CT5508-25U**—5500 series controller 12 to 25 access point upgrade license.
- **L-LIC-CT5508-50U**—5500 series controller 25 to 50 access point upgrade license.
- **L-LIC-CT5508-100U**—5500 series controller 50 to 100 access point upgrade license.
- **L-LIC-CT5508-250U**—5500 series controller 100 to 250 access point upgrade license.

- **L-LIC-WPLUS-12**—wplus feature license for up to 12 Cisco access points.
- **L-LIC-WPLUS-25**—wplus feature license for up to 25 Cisco access points.
- **L-LIC-WPLUS-50**—wplus feature license for up to 50 Cisco access points.
- **L-LIC-WPLUS-100**—wplus feature license for up to 100 Cisco access points.
- **L-LIC-WPLUS-250**—wplus feature license for up to 250 Cisco access points.
- **L-LIC-WPLUS-25U**—wplus feature license upgrade for 12 to 25 Cisco access points.
- **L-LIC-WPLUS-50U**—wplus feature license upgrade for 25 to 50 Cisco access points.
- **L-LIC-WPLUS-100U**—wplus feature license upgrade for 50 to 100 Cisco access points.
- **L-LIC-WPLUS-250U**—wplus feature license upgrade for 100 to 250 Cisco access points.

When you use these SKUs, your certificate is delivered to you by email.

Note If you require a paper certificate for Customs, order it without the “L-” in the SKU (for example, LIC-WPLUS-250U) and choose to ship it using US mail.

Step 3 After you receive the certificate, use one of two methods to register the PAK:

- **Cisco License Manager (CLM)**—This method automates the process of obtaining licenses and deploying them on Cisco devices. For deployments with more than five controllers, Cisco recommends using CLM to register PAKs and install licenses. You can also use CLM to rehost or RMA a license.

  Note You cannot use CLM to change the licensed feature set or activate an ap-count evaluation license. To perform these operations, you must follow the instructions in the "Choosing the Licensed Feature Set" section on page 15 and the "Activating an AP-Count Evaluation License" section on page 18. Because you can use CLM to perform all other license operations, you can disregard the remaining licensing information in this chapter except these two sections and the "Configuring the License Agent" section on page 27 if you want your controller to use HTTP to communicate with CLM.

  Note You can download the CLM software and access user documentation at this URL:

  http://www.cisco.com/go/clm

- **Licensing portal**—This alternative method enables you to manually obtain and install licenses on your controller. If you want to use the licensing portal to register the PAK, follow the instructions in Step 4.

Step 4 To use the licensing portal to register the PAK, follow these steps:

a. Go to http://www.cisco.com/go/license

b. On the main Product License Registration page, enter the PAK mailed with the certificate in the Product Authorization Key (PAK) field and click **Submit**.

c. On the Validate Features page, enter the number of licenses that you want to register in the Qty field and click **Update**.

d. To determine the controller's product ID and serial number, choose **Controller > Inventory** on the controller GUI or enter the **show license udi** command on the controller CLI.

Information similar to the following appears on the controller CLI:

```
Device# PID                     SN                       UDI
------- -------------------- ----------------------- ---------------------------------
*0      AIR-CT5508-K9         FCW1308L030             AIR-CT5508-K9:FCW1308L030
```

e. On the Designate Licensee page, enter the product ID and serial number of the controller on which you plan to install the license, read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Submit**.

f. On the Finish and Submit page, verify that all information is correct and click **Submit**.

g. When a message appears indicating that the registration is complete, click **Download License**. The license is emailed within 1 hour to the address you specified.

h. When the email arrives, follow the instructions provided.

i. Copy the license file to your TFTP server.

j. Follow the instructions in the "Installing a License" section below to install the license on your controller.

Installing a License

You can use the controller GUI or CLI to install a license on a 5500 series controller.

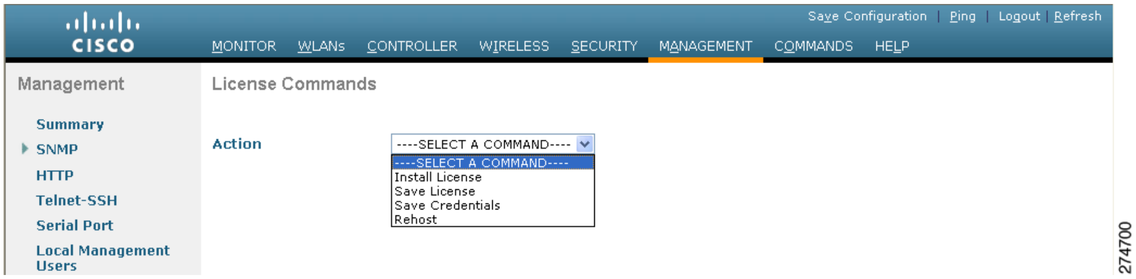
Note Cisco recommends that the access point count be the same for the base-ap-count and wplus-ap-count licenses installed on your controller. If your controller has a base-ap-count license of 100 and you install a wplus-ap-count license of 12, the controller supports up to 100 access points when the base license is in use but only a maximum of 12 access points when the wplus license is in use.

Using the GUI to Install a License

Using the controller GUI, follow these steps to install a license on the controller.

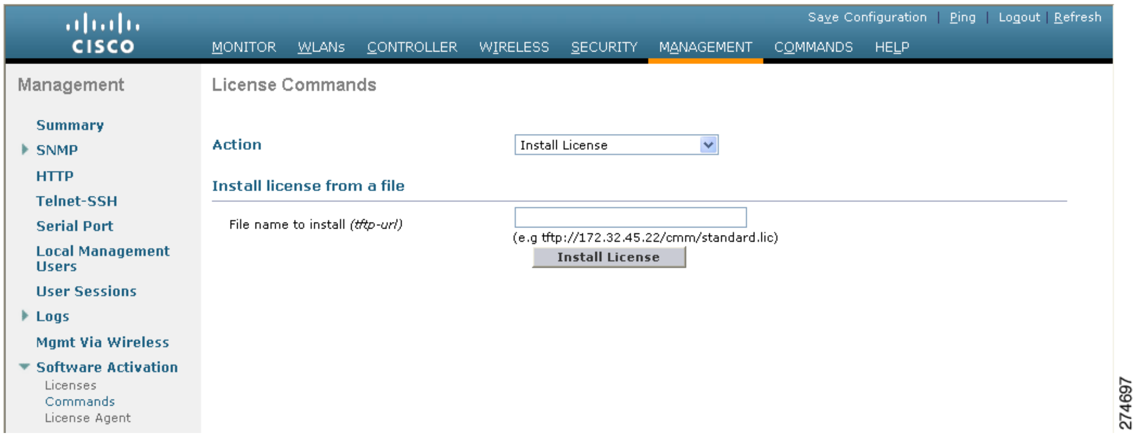
Step 1 Choose **Management** > **Software Activation** > **Commands** to open the License Commands page (see Figure 2).

Figure 2 License Commands Page



Step 2 From the Action drop-down box, choose **Install License**. The Install License from a File section appears (see Figure 3).

Figure 3 License Commands (Install License) Page



Action: Install License

File name to install *(tftp-url)*
(e.g tftp://172.32.45.22/cmm/standard.lic)

Step 3 In the File Name to Install field, enter the path to the license (*.lic) on the TFTP server.

Step 4 Click **Install License**. A message appears to show whether the license was installed successfully. If the installation fails, the message provides the reason for the failure, such as the license is an existing license, the path was not found, the license does not belong to this device, you do not have correct permissions for the license, and so on.

Step 5 If the end-user license agreement (EULA) acceptance window appears, read the agreement and click **Accept** to accept the terms of the agreement.

Note Typically you are prompted to accept the EULA for evaluation, extension, and rehost licenses. The EULA is also required for permanent licenses, but it is accepted during license generation.

Step 6 To save a backup copy of all installed licenses, follow these steps:

a. From the Action drop-down box, choose **Save License**.

b. In the File Name to Save field, enter the path on the TFTP server where you want the licenses to be saved.

Note You cannot save evaluation licenses.

c. Click **Save Licenses**.

Step 7 Reboot the controller.

Step 8 Follow the instructions in the "Viewing Licenses" section on page 10 to see the status of the license that you installed.

Step 9 If the desired license is not being used by the controller, follow the instructions in the "Choosing the Licensed Feature Set" section on page 15 or the "Activating an AP-Count Evaluation License" section on page 18 to change the license that is used by the controller.

Using the CLI to Install a License

Using the controller CLI, follow these steps to install a license on the controller.

Step 1 To install a license on the controller, enter this command:

license install *url*

where *url* is tftp://*server_ip*/*path*/*filename*.

Note To remove a license from the controller, enter this command: **license clear** *license_name*. For example, you might want to delete an expired evaluation license or any unused license. You cannot delete unexpired evaluation licenses, the permanent base image license, or licenses that are in use by the controller.

Step 2 If you are prompted to accept the end-user license agreement (EULA), read and accept the terms of the agreement.

> **Note** Typically you are prompted to accept the EULA for evaluation, extension, and rehost licenses. The EULA is also required for permanent licenses, but it is accepted during license generation.

Step 3 To add comments to a license or delete comments from a license, enter this command:

license comment {**add** | **delete**} *license_name comment_string*

Step 4 To save a backup copy of all installed licenses, enter this command:

license save *url*

where *url* is tftp://*server_ip*/*path*/*filename*.

Step 5 To reboot the controller, enter this command:

reset system

Step 6 Follow the instructions in the "Viewing Licenses" section on page 10 to see the status of the license you installed.

Step 7 If the desired license is not being used by the controller, follow the instructions in the "Choosing the Licensed Feature Set" section on page 15 or the "Activating an AP-Count Evaluation License" section on page 18 to change the license that is used by the controller.

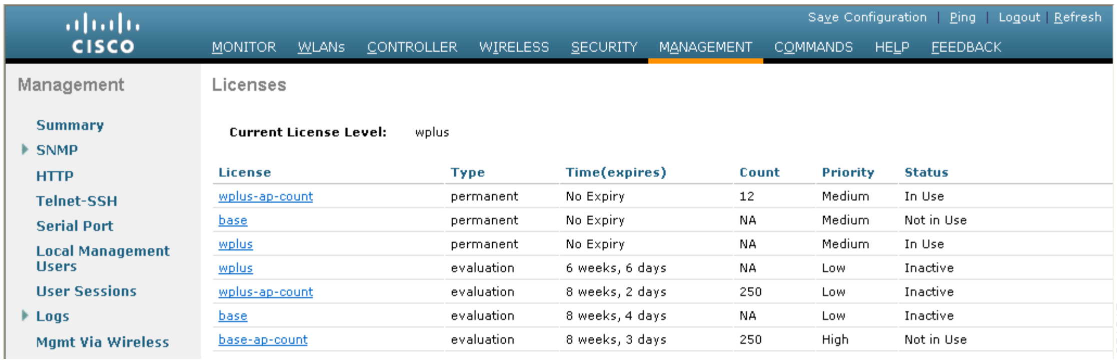
Viewing Licenses

Using the GUI to View Licenses

Using the controller GUI, follow these steps to view licenses on the controller.

Step 1 Choose **Management** > **Software Activation** > **Licenses** to open the Licenses page (see Figure 4).

Figure 4 Licenses Page



Licenses

Current License Level: wplus

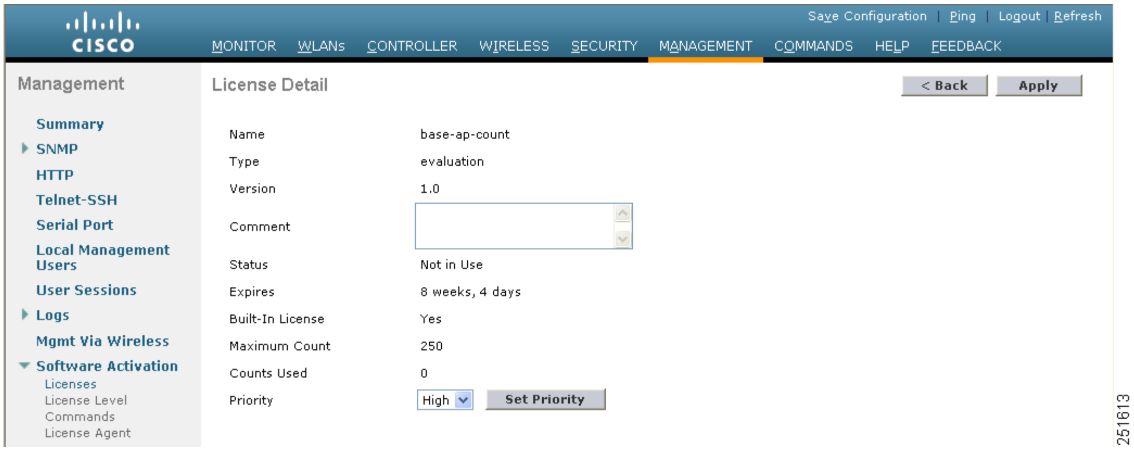
License	Type	Time(expires)	Count	Priority	Status
wplus-ap-count	permanent	No Expiry	12	Medium	In Use
base	permanent	No Expiry	NA	Medium	Not in Use
wplus	permanent	No Expiry	NA	Medium	In Use
wplus	evaluation	6 weeks, 6 days	NA	Low	Inactive
wplus-ap-count	evaluation	8 weeks, 2 days	250	Low	Inactive
base	evaluation	8 weeks, 4 days	NA	Low	Inactive
base-ap-count	evaluation	8 weeks, 3 days	250	High	Not in Use

This page lists all of the licenses installed on the controller. For each license, it shows the license type (permanent, evaluation, or extension), expiration, count (the maximum number of access points allowed for this license), priority (low, medium, or high), and status (in use, not in use, inactive, or EULA not accepted).

Note If you ever want to remove a license from the controller, hover your cursor over the blue drop-down arrow for the license and click **Remove**. For example, you might want to delete an expired evaluation license or any unused license. You cannot delete unexpired evaluation licenses, the permanent base image license, or licenses that are in use by the controller.

Step 2 To view more details for a particular license, click the link for the desired license. The License Detail page appears (see Figure 5).

Figure 5 License Detail Page



License Detail

Name	base-ap-count
Type	evaluation
Version	1.0
Comment	
Status	Not in Use
Expires	8 weeks, 4 days
Built-In License	Yes
Maximum Count	250
Counts Used	0
Priority	High

This page shows the following additional information for the license:

- The license type (permanent, evaluation, or extension)
- The license version
- The status of the license (in use, not in use, inactive, or EULA not accepted)
- The length of time before the license expires

  Note Permanent licenses never expire.

- Whether the license is a built-in license
- The maximum number of access points allowed for this license
- The number of access points currently using this license

Step 3 If you want to enter a comment for this license, type it in the Comment field and click **Apply**.

Step 4 Click **Save Configuration**.

Using the CLI to View Licenses

Enter these CLI commands to view licenses on the controller.

- To see the license level, license type, and number of access points licensed on the controller, enter this command:

  show sysinfo

  Information similar to the following appears:

  ```
  Product Name................................... Cisco Controller
  Product Version................................ 6.0.118.0
  ...
  Current Boot License Level...................... wplus
  Current Boot License Type....................... Permanent
  Next Boot License Level......................... wplus
  Next Boot License Type.......................... Permanent
  ...
  Power Supply 1................................. Not Available
  Power Supply 2................................. Not Available
  Maximum number of APs supported............... 250
  ```

- To see a brief summary of all active licenses installed on the controller, enter this command:

  show license summary

  Information similar to the following appears:

  ```
  Index 1 Feature: wplus
          Period left: Life time
          License Type: Permanent
          License State: Active, In Use
          License Count: Non-Counted
          License Priority: Medium
  Index 2 Feature: wplus-ap-count
          Period left: Life time
          License Type: Permanent
          License State: Active, In Use
          License Count: 12/12/0
          License Priority: Medium
  Index 3 Feature: base
          Period left: Life time
          License Type: Permanent
          License State: Active, Not in Use
          License Count: Non-Counted
          License Priority: Medium
  Index 4 Feature: base-ap-count
          Period left:  8 weeks  3 days
          License Type: Evaluation
          License State: Active, Not in Use, EULA accepted
           License Count: 250/0/0
          License Priority: High
  ```

- To see all of the licenses installed on the controller, enter this command:

  show license all

  Information similar to the following appears:

  ```
  License Store: Primary License Storage
  StoreIndex:  0  Feature: wplus-ap-count   Version: 1.0
          License Type: Permanent
          License State: Active, In Use
          License Count: 12/12/0
          License Priority: Medium
  ```

```
StoreIndex:  1  Feature: base   Version: 1.0
        License Type: Permanent
        License State: Active, Not in Use
        License Count: Non-Counted
        License Priority: Medium
StoreIndex:  2  Feature: wplus   Version: 1.0
        License Type: Permanent
        License State: Active, In Use
        License Count: Non-Counted
        License Priority: Medium
License Store: Evaluation License Storage
StoreIndex:  0  Feature: wplus   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  6 weeks  6 days
         License Count: Non-Counted
        License Priority: Low
StoreIndex:  1  Feature: wplus-ap-count   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  2 days
        License Count: 250/0/0
        License Priority: Low
StoreIndex:  2  Feature: base   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  4 days
        License Count: Non-Counted
        License Priority: Low
StoreIndex:  3  Feature: base-ap-count   Version: 1.0
        License Type: Evaluation
        License State: Active, Not in Use, EULA accepted
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  3 days
        License Count: 250/0/0
        License Priority: High
```

- To see the details for a particular license, enter this command:

  show license detail *license_name*

  Information similar to the following appears:

```
Index:  1       Feature: base-ap-count   Version: 1.0
        License Type: Permanent
        License State: Active, Not in Use
        License Count: 12/0/0
        License Priority: Medium
        Store Index: 0
        Store Name: Primary License Storage
Index:  2       Feature: base-ap-count   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  4 days
        License Count: 250/0/0
        License Priority: Low
        Store Index: 3
        Store Name: Evaluation License Storage
```

- To see all expiring, evaluation, permanent, or in-use licenses, enter this command:

  show license {**expiring | evaluation | permanent | in-use**}

  Information similar to the following appears for the **show license in-use** command:

```
StoreIndex:  2  Feature: wplus-ap-count   Version: 1.0
        License Type: Permanent
        License State: Active, In Use
        License Count: 12/12/0
        License Priority: Medium
StoreIndex:  3  Feature: wplus   Version: 1.0
        License Type: Permanent
        License State: Active, In Use
        License Count: Non-Counted
        License Priority: Medium
```

- To see the maximum number of access points allowed for this license on the controller, the number of access points currently joined to the controller, and the number of access points that can still join the controller, enter this command:

  show license capacity

  Information similar to the following appears:

```
Licensed Feature    Max Count         Current Count     Remaining Count
----------------- --------------- ------------------- --------------------
AP Count            250                47                203
```

- To see statistics for all licenses on the controller, enter this command:

  show license statistics

  Information similar to the following appears:

```
Administrative statistics
        Install success count:       2
        Install failure count:       0
        Install duplicate count:     0
        Comment add count:           0
        Comment delete count:        0
        Clear count:                 0
        Save count:                  2
        Save cred count:             0
Client status
        Request success count     2
        Request failure count     0
        Release count             0
        Global Notify count     6
```

- To see a summary of license-enabled features, enter this command:

  show license feature

  Information similar to the following appears:

```
       Feature name    Enforcement  Evaluation  Clear Allowed  Enabled
               wplus         yes         yes            yes      yes
      wplus-ap-count         yes         yes            yes      yes
                base          no         yes            yes      no
       base-ap-count         yes         yes            yes      no
```

Choosing the Licensed Feature Set

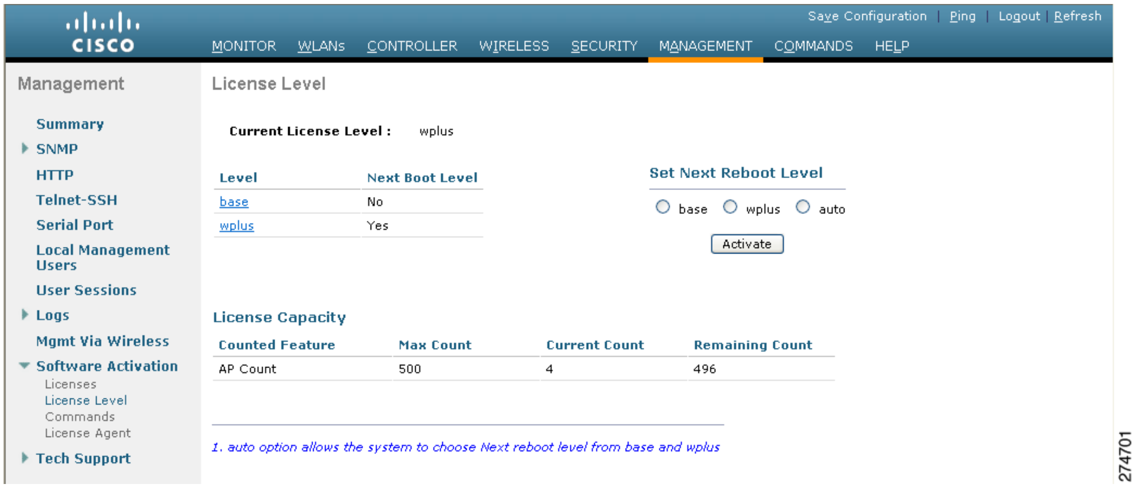
You can configure the controller to specify which feature set it uses (base or wplus). Only the base or wplus license can be active at a time. The currently active license determines the feature set and number of access points supported on the controller.

Using the GUI to Choose the Licensed Feature Set

Using the controller GUI, follow these steps to specify which feature set the controller uses.

Step 1 Choose **Management** > **Software Activation** > **License Level** to open the License Level page (see Figure 6).

Figure 6 License Level Page



License Level

Current License Level : wplus

Level	Next Boot Level
base	No
wplus	Yes

Set Next Reboot Level

○ base ○ wplus ○ auto

Activate

License Capacity

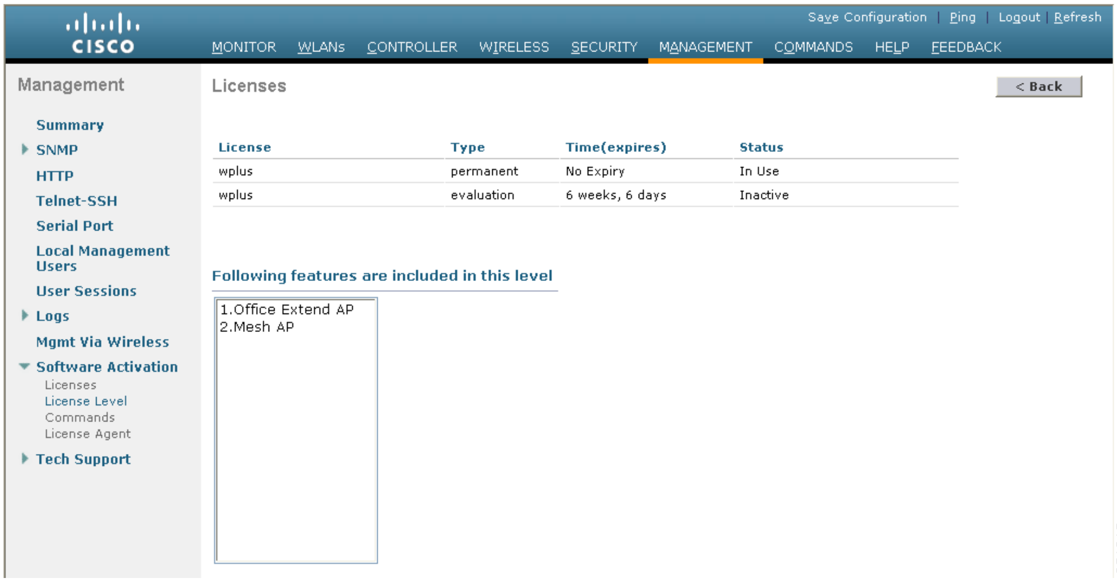
Counted Feature	Max Count	Current Count	Remaining Count
AP Count	500	4	496

1. auto option allows the system to choose Next reboot level from base and wplus

This page shows the current license level (base or wplus) and the level to be used after the next controller reboot. It also shows the maximum number of access points allowed by the license on the controller, the number of access points currently joined to the controller, and the number of access points that can still join the controller.

Step 2 To learn more about the available license levels, click the **base** or **wplus** license level link to open the Licenses page (see Figure 7).

Figure 7 Licenses Page



Licenses

License	Type	Time(expires)	Status
wplus	permanent	No Expiry	In Use
wplus	evaluation	6 weeks, 6 days	Inactive

Following features are included in this level

1.Office Extend AP
2.Mesh AP

This page shows the licenses applicable to this level and the list of features supported.

Step 3 Click **Back** to return to the License Level page.

Step 4 If you want to change the license level, follow these steps:

a. Choose the license level to be used on the next reboot: **base**, **wplus**, or **auto**. If you choose **auto**, the licensing software automatically chooses the license level to use on the next reboot. It chooses permanent licenses over evaluation licenses and wplus licenses over base licenses.

Note If you are considering upgrading from a base license to a wplus license, you can try an evaluation wplus license before upgrading to a permanent wplus license. To activate the evaluation license, you need to set the image level to **wplus** in order for the controller to use the wplus evaluation license instead of the base permanent license.

Note To prevent disruptions in operation, the controller does not switch licenses when an evaluation license expires. You must reboot the controller in order to return to a permanent license. Following a reboot, the controller defaults to the same feature set level as the expired evaluation license. If no permanent license at the same feature set level is installed, the controller uses a permanent license at another level or an unexpired evaluation license. If no valid licenses are installed, the controller can always operate in base level.

b. Click **Activate**.

c. Click **OK** when prompted to confirm your decision to change the license level on the next reboot.

d. If you are prompted to accept the end-user license agreement (EULA), read and accept the terms of the agreement and then click **Accept**.. The Next Boot Level field now shows the license level that you specified as the level to be used after the next controller reboot.

e. Reboot the controller so that the specified license level takes effect.

Using the CLI to Choose the Licensed Feature Set

Using the controller CLI, follow these steps to specify the feature set that the controller uses.

Step 1 To see the current license level (base or wplus) and the level to be used after the next controller reboot, enter this command:

show sysinfo

Information similar to the following appears:

```
Product Name..................................... Cisco Controller
Product Version.................................. 6.0.118.0
...
Current Boot License Level....................... wplus
Current Boot License Type........................ Permanent
Next Boot License Level.......................... wplus
Next Boot License Type........................... Permanent
...
```

Step 2 To specify the license level to be used on the next reboot, enter this command:

config license boot {**base** | **wplus** | **auto**}

If you choose **auto**, the licensing software automatically chooses the license level to use on the next reboot. It chooses permanent licenses over evaluation licenses and wplus licenses over base licenses.

Note If you are considering upgrading from a base license to a wplus license, you can try an evaluation wplus license before upgrading to a permanent wplus license. To activate the evaluation license, you need to set the image level to **wplus** in order for the controller to use the wplus evaluation license instead of the base permanent license.

Note To prevent disruptions in operation, the controller does not switch licenses when an evaluation license expires. You must reboot the controller in order to return to a permanent license. Following a reboot, the controller defaults to the same feature set level as the expired evaluation license. If no permanent license at the same feature set level is installed, the controller uses a permanent license at another level or an unexpired evaluation license.

Step 3 If you are prompted to accept the end-user license agreement (EULA), read and accept the terms of the agreement. The EULA appears if no permanent licenses are installed at the specified boot level and the evaluation license has not yet been activated. In this case, the **config license boot** command changes the license level and activates the evaluation license following a reboot.

Step 4 To see the license level to be used after the next controller reboot, enter this command:

show sysinfo

Step 5 To reboot the controller in order to have your changes take effect, enter this command:

reset system

Activating an AP-Count Evaluation License

If you are considering upgrading to a license with a higher access point count, you can try an evaluation license before upgrading to a permanent version of the license. For example, if you are using a permanent license with a 50-access-point count and want to try an evaluation license with a 100-access-point count, you can try out the evaluation license for 60 days.

AP-count evaluation licenses are set to low priority by default so that the controller uses the ap-count permanent license. If you want to try an evaluation license with an increased access point count, you must change its priority to high. If you no longer want to have this higher capacity, you can lower the priority of the ap-count evaluation license, thereby forcing the controller to use the permanent license.

Note If the ap-count evaluation license is a wplus license and the ap-count permanent license is a base license, you must also change the feature set to wplus. See the "Choosing the Licensed Feature Set" section on page 15 for instructions.

Note To prevent disruptions in operation, the controller does not switch licenses when an evaluation license expires. You must reboot the controller in order to return to a permanent license. Following a reboot, the controller defaults to the same feature set level as the expired evaluation license. If no permanent license at the same feature set level is installed, the controller uses a permanent license at another level or an unexpired evaluation license.

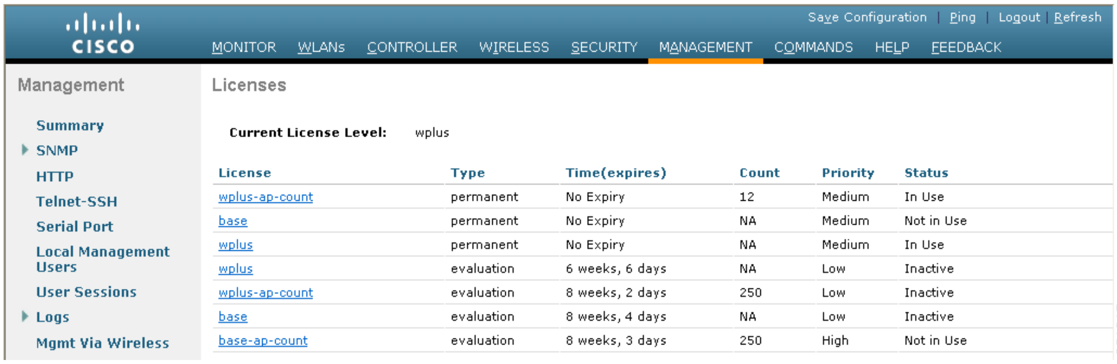
You can activate ap-count evaluation licenses using the controller GUI or CLI.

Using the GUI to Activate an AP-Count Evaluation License

Using the controller GUI, follow these steps to activate an ap-count evaluation license.

Step 1 To see the current status of all the licenses on your controller, choose **Management** > **Software Activation** > **Licenses** to open the Licenses page (see Figure 8).

Figure 8 Licenses Page



Licenses

Current License Level: wplus

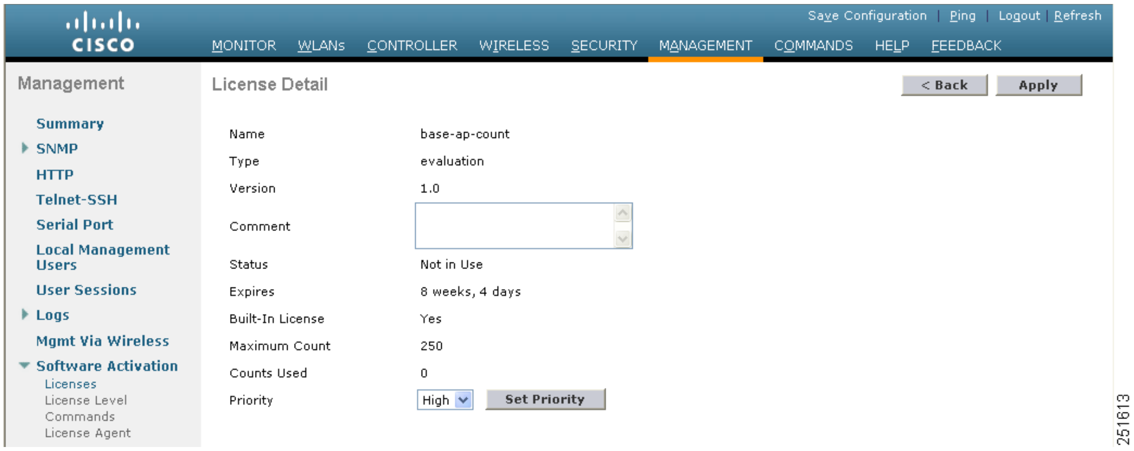
License	Type	Time(expires)	Count	Priority	Status
wplus-ap-count	permanent	No Expiry	12	Medium	In Use
base	permanent	No Expiry	NA	Medium	Not in Use
wplus	permanent	No Expiry	NA	Medium	In Use
wplus	evaluation	6 weeks, 6 days	NA	Low	Inactive
wplus-ap-count	evaluation	8 weeks, 2 days	250	Low	Inactive
base	evaluation	8 weeks, 4 days	NA	Low	Inactive
base-ap-count	evaluation	8 weeks, 3 days	250	High	Not in Use

The Status column shows which licenses are currently in use, and the Priority column shows the current priority of each license.

Step 2 To activate an ap-count evaluation license, follow these steps:

a. Click the link for the ap-count evaluation license that you want to activate. The License Detail page appears (see Figure 9).

Figure 9 License Detail Page



License Detail

Name	base-ap-count
Type	evaluation
Version	1.0
Comment	
Status	Not in Use
Expires	8 weeks, 4 days
Built-In License	Yes
Maximum Count	250
Counts Used	0
Priority	High

b. Choose **High** from the Priority drop-down box and click **Set Priority**.

Note You can set the priority only for ap-count evaluation licenses. AP-count permanent licenses always have a medium priority, which cannot be configured.

c. Click **OK** when prompted to confirm your decision about changing the priority of the license.

d. When the EULA appears, read the terms of the agreement and then click **Accept**.

e. When prompted to reboot the controller, click **OK**.

f. Reboot the controller in order for the priority change to take effect.

g. Click **Licenses** to open the Licenses page and verify that the ap-count evaluation license now has a high priority and is in use. You can use the evaluation license until it expires.

Step 3 If you decide to stop using the ap-count evaluation license and want to revert to using an ap-count permanent license, follow these steps:

a. On the Licenses page, click the link for the ap-count evaluation license that is in use.

b. Choose **Low** from the Priority drop-down box and click **Set Priority**.

Note You can set the priority only for ap-count evaluation licenses. AP-count permanent licenses always have a medium priority, which cannot be configured.

c. Click **OK** when prompted to confirm your decision about changing the priority of the license.

d. When the EULA appears, read the terms of the agreement and then click **Accept**.

e. When prompted to reboot the controller, click **OK**.

f. Reboot the controller in order for the priority change to take effect.

g. Click **Licenses** to open the Licenses page and verify that the ap-count evaluation license now has a low priority and is not in use. Instead, the ap-count permanent license should be in use.

Using the CLI to Activate an AP-Count Evaluation License

Using the controller CLI, follow these steps to activate an ap-count evaluation license.

Step 1 To see the current status of all the licenses on your controller, enter this command:

show license all

Information similar to the following appears:

```
License Store: Primary License Storage
StoreIndex:  0  Feature: base-ap-count   Version: 1.0
        License Type: Permanent
        License State: Active, In Use
        License Count: 12/0/0
        License Priority: Medium
StoreIndex:  1  Feature: base   Version: 1.0
        License Type: Permanent
        License State: Active, In Use
        License Count: Non-Counted
        License Priority: Medium
StoreIndex:  2  Feature: wplus-ap-count   Version: 1.0
        License Type: Permanent
        License State: Active, Not in Use
        License Count: 12/12/0
        License Priority: Medium
StoreIndex:  3  Feature: wplus   Version: 1.0
        License Type: Permanent
        License State: Active, Not in Use
        License Count: Non-Counted
        License Priority: Medium
License Store: Evaluation License Storage
StoreIndex:  0  Feature: wplus  Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  6 weeks  6 days
        License Count: Non-Counted
        License Priority: Low
StoreIndex:  1  Feature: wplus-ap-count   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  7 weeks  0 day
        License Count: 250/0/0
        License Priority: Low
StoreIndex:  2  Feature: base   Version: 1.0
        License Type: Evaluation
        License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  4 days
        License Count: Non-Counted
        License Priority: Low
```

```
StoreIndex:  3  Feature: base-ap-count   Version: 1.0
        License Type: Evaluation
       License State: Inactive
            Evaluation total period:  8 weeks  4 days
            Evaluation period left:  8 weeks  4 days
        License Count: 250/0/0
       License Priority: Low
```

The License State field shows the licenses that are in use, and the License Priority field shows the current priority of each license.

Step 2 To activate an ap-count evaluation license, follow these steps:

a. To raise the priority of the base-ap-count or wplus-ap-count evaluation license, enter this command:

license modify priority *license_name* **high**

Note You can set the priority only for ap-count evaluation licenses. AP-count permanent licenses always have a medium priority, which cannot be configured.

b. To reboot the controller in order for the priority change to take effect, enter this command:

reset system

c. To verify that the ap-count evaluation license now has a high priority and is in use, enter this command:

show license all

You can use the evaluation license until it expires.

Step 3 If you decide to stop using the ap-count evaluation license and want to revert to using an ap-count permanent license, follow these steps:

a. To lower the priority of the ap-count evaluation license, enter this command:

license modify priority *license_name* **low**

b. To reboot the controller in order for the priority change to take effect, enter this command:

reset system

c. To verify that the ap-count evaluation license now has a low priority and is not in use, enter this command:

show license all

Instead, the ap-count permanent license should be in use.

Rehosting a License

Revoking a license from one controller and installing it on another is called *rehosting*. You might want to rehost a license in order to change the purpose of a controller. For example, if you want to move your OfficeExtend or indoor mesh access points to a different controller, you could transfer the wplus license from one controller to another.

In order to rehost a license, you must generate credential information from the controller and use it to obtain a permission ticket to revoke the license from the Cisco licensing site. Next, you must obtain a rehost ticket and use it to obtain a license installation file for the controller on which you want to install the license.

Evaluation licenses and the permanent base image license cannot be rehosted.

Note A revoked license cannot be reinstalled on the same controller.

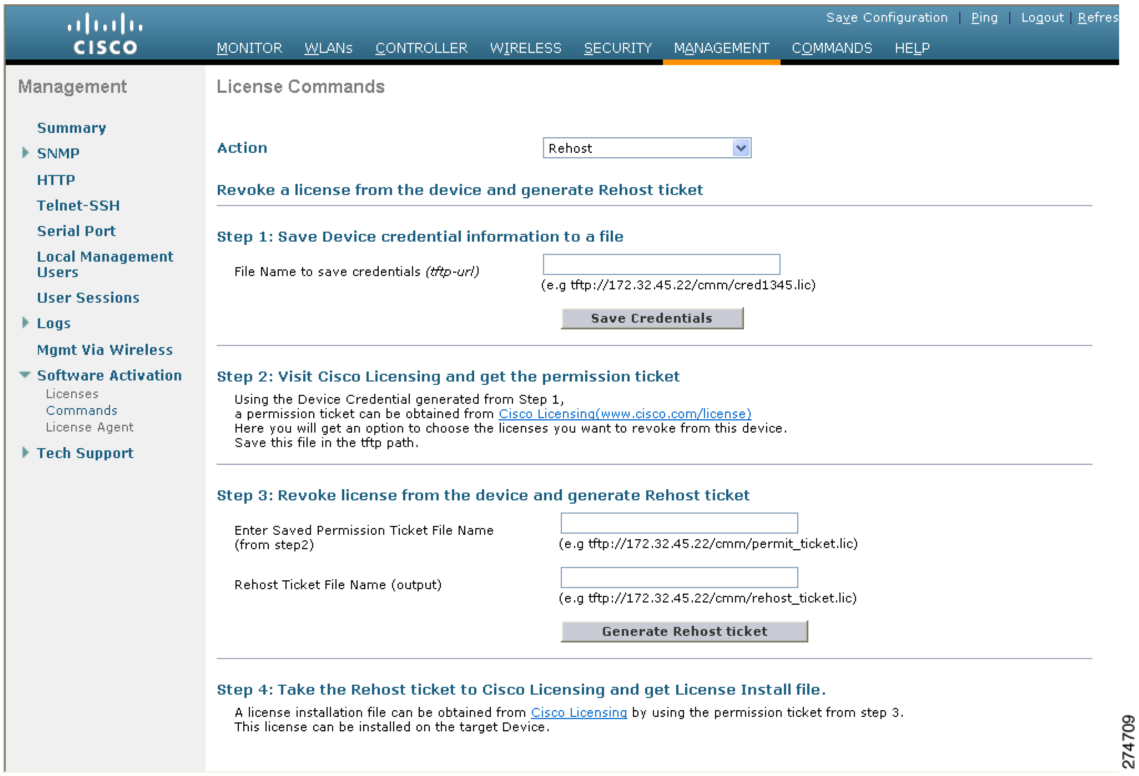
Using the GUI to Rehost a License

Using the controller GUI, follow these steps to rehost a license.

Step 1 Choose **Management** > **Software Activation** > **Commands** to open the License Commands page.

Step 2 From the Action drop-down box, choose **Rehost**. The Revoke a License from the Device and Generate Rehost Ticket section appears (see Figure 10).

Figure 10 License Commands (Rehost) Page



License Commands

Action: Rehost

Revoke a license from the device and generate Rehost ticket

Step 1: Save Device credential information to a file

File Name to save credentials *(tftp-url)*

(e.g tftp://172.32.45.22/cmm/cred1345.lic)

Step 2: Visit Cisco Licensing and get the permission ticket

Using the Device Credential generated from Step 1,
a permission ticket can be obtained from Cisco Licensing(www.cisco.com/license)
Here you will get an option to choose the licenses you want to revoke from this device.
Save this file in the tftp path.

Step 3: Revoke license from the device and generate Rehost ticket

Enter Saved Permission Ticket File Name (from step2)

(e.g tftp://172.32.45.22/cmm/permit_ticket.lic)

Rehost Ticket File Name (output)

(e.g tftp://172.32.45.22/cmm/rehost_ticket.lic)

Step 4: Take the Rehost ticket to Cisco Licensing and get License Install file.

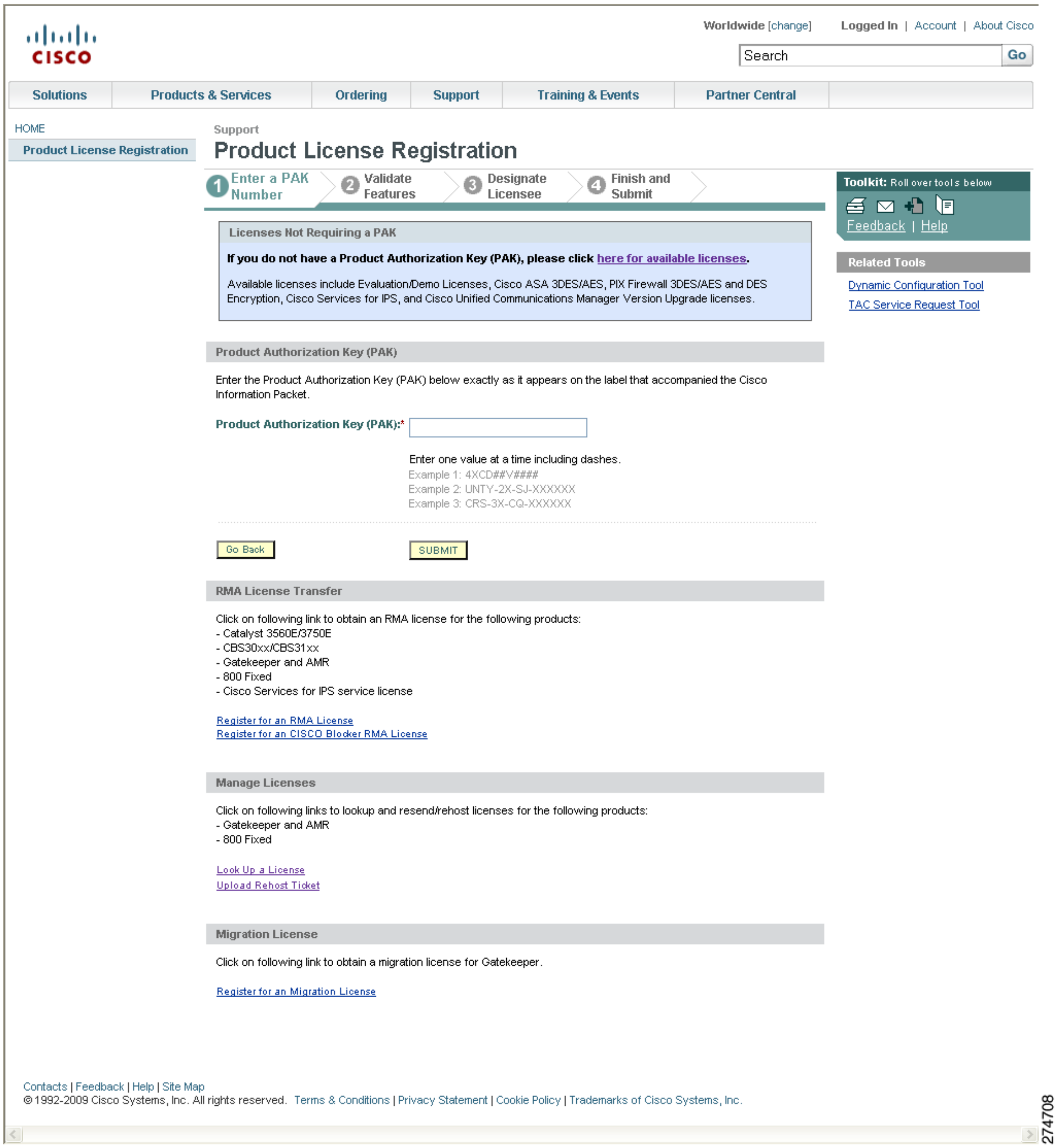
A license installation file can be obtained from Cisco Licensing by using the permission ticket from step 3.
This license can be installed on the target Device.

Step 3 In the File Name to Save Credentials field, enter the path on the TFTP server where you want the device credentials to be saved and click **Save Credentials**.

Step 4 To obtain a permission ticket to revoke the license, follow these steps:

a. Click **Cisco Licensing** (http://www.cisco.com/go/license). The Product License Registration page appears (see Figure 11).

Figure 11 Product License Registration Page



Product License Registration

Licenses Not Requiring a PAK

If you do not have a Product Authorization Key (PAK), please click here for available licenses.

Available licenses include Evaluation/Demo Licenses, Cisco ASA 3DES/AES, PIX Firewall 3DES/AES and DES Encryption, Cisco Services for IPS, and Cisco Unified Communications Manager Version Upgrade licenses.

Product Authorization Key (PAK)

Enter the Product Authorization Key (PAK) below exactly as it appears on the label that accompanied the Cisco Information Packet.

Product Authorization Key (PAK):*

Enter one value at a time including dashes.
Example 1: 4XCD##V####
Example 2: UNTY-2X-SJ-XXXXXX
Example 3: CRS-3X-CQ-XXXXXX

RMA License Transfer

Click on following link to obtain an RMA license for the following products:
- Catalyst 3560E/3750E
- CBS30xx/CBS31xx
- Gatekeeper and AMR
- 800 Fixed
- Cisco Services for IPS service license

Register for an RMA License
Register for an CISCO Blocker RMA License

Manage Licenses

Click on following links to lookup and resend/rehost licenses for the following products:
- Gatekeeper and AMR
- 800 Fixed

Look Up a License
Upload Rehost Ticket

Migration License

Click on following link to obtain a migration license for Gatekeeper.

Register for an Migration License

Contacts | Feedback | Help | Site Map
©1992-2009 Cisco Systems, Inc. All rights reserved. Terms & Conditions | Privacy Statement | Cookie Policy | Trademarks of Cisco Systems, Inc.

b. Under Manage Licenses, click **Look Up a License**.

c. Enter the product ID and serial number for your controller.

> **Note** To find the controller’s product ID and serial number, choose **Controller > Inventory** on the controller GUI.

d. Open the device credential information file that you saved in Step 3 and copy and paste the contents of the file into the Device Credentials field.

e. Enter the security code in the blank box and click **Continue**.

f. Choose the licenses that you want to revoke from this controller and click **Start License Transfer**.

g. On the Rehost Quantities page, enter the number of licenses that you want to revoke in the To Rehost field and click **Continue**.

h. On the Designate Licensee page, enter the product ID and serial number of the controller for which you plan to revoke the license, read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Continue**.

i. On the Review and Submit page, verify that all information is correct and click **Submit**.

j. When a message appears indicating that the registration is complete, click **Download Permission Ticket**. The rehost permission ticket is emailed within 1 hour to the address you specified.

k. After the email arrives, copy the rehost permission ticket to your TFTP server.

Step 5 To use the rehost permission ticket to revoke the license from this controller and generate a rehost ticket, follow these steps on the controller GUI:

a. In the Enter Saved Permission Ticket File Name field, enter the TFTP path and filename (*.lic) for the rehost permission ticket that you generated in Step 4.

b. In the Rehost Ticket File Name field, enter the TFTP path and filename (*.lic) for the ticket that will be used to rehost this license on another controller.

c. Click **Generate Rehost Ticket**.

d. When the end-user license agreement (EULA) acceptance window appears, read the agreement and click **Accept** to accept the terms of the agreement.

Step 6 To use the rehost ticket generated in Step 5 to obtain a license installation file, which can then be installed on another controller, follow these steps:

a. Click **Cisco Licensing**.

b. On the Product License Registration page, click **Upload Rehost Ticket** under Manage Licenses.

c. On the Upload Ticket page, enter the rehost ticket that you generated in Step 5 in the Enter Rehost Ticket field and click **Continue**.

d. On the Validate Features page, verify that the license information for your controller is correct, enter the rehost quantity, and click **Continue**.

e. On the Designate Licensee page, enter the product ID and serial number of the controller on which you plan to use the license, read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Continue**.

f. On the Review and Submit page, verify that all information is correct and click **Submit**.

g. When a message appears indicating that the registration is complete, click **Download License**. The rehost license key is emailed within 1 hour to the address you specified.

h. After the email arrives, copy the rehost license key to your TFTP server.

i. Follow the instructions in the "Installing a License" section on page 8 to install this license on another controller.

Using the CLI to Rehost a License

Using the controller CLI, follow these steps to rehost a license.

Step 1 To save device credential information to a file, enter this command:

license save credential *url*

where *url* is tftp://*server_ip*/*path*/*filename*.

Step 2 To obtain a permission ticket to revoke the license, follow these steps:

a. Go to http://www.cisco.com/go/license. The Product License Registration page appears (see Figure 11).

b. Under Manage Licenses, click **Look Up a License**.

c. Enter the product ID and serial number for your controller.

Note To find the controller's product ID and serial number, enter the **show license udi** command on the controller CLI.

d. Open the device credential information file that you saved in Step 1 and copy and paste the contents of the file into the Device Credentials field.

e. Enter the security code in the blank box and click **Continue**.

f. Choose the licenses that you want to revoke from this controller and click **Start License Transfer**.

g. On the Rehost Quantities page, enter the number of licenses that you want to revoke in the To Rehost field and click **Continue**.

h. On the Designate Licensee page, enter the product ID and serial number of the controller for which you plan to revoke the license, read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Continue**.

i. On the Review and Submit page, verify that all information is correct and click **Submit**.

j. When a message appears indicating that the registration is complete, click **Download Permission Ticket**. The rehost permission ticket is emailed within 1 hour to the address you specified.

k. After the email arrives, copy the rehost permission ticket to your TFTP server.

Step 3 To use the rehost permission ticket to revoke the license from this controller and generate a rehost ticket, follow these steps on the controller CLI:

a. To revoke the license from the controller, enter this command:

license revoke *permission_ticket_url*

where *permission_ticket_url* is tftp://*server_ip*/*path*/*filename*.

b. To generate the rehost ticket, enter this command:

license revoke rehost *rehost_ticket_url*

where *rehost_ticket_url* is tftp://*server_ip*/*path*/*filename*.

c. If prompted, read and accept the terms of the end-user license agreement (EULA).

Step 4 To use the rehost ticket generated in Step 3 to obtain a license installation file, which can then be installed on another controller, follow these steps:

a. Go to http://www.cisco.com/go/license.

b. On the Product License Registration page, click **Upload Rehost Ticket** under Manage Licenses.

c. On the Upload Ticket page, enter the rehost ticket that you generated in Step 3 in the Enter Rehost Ticket field and click **Continue**.

d. On the Validate Features page, verify that the license information for your controller is correct, enter the rehost quantity, and click **Continue**.

e. On the Designate Licensee page, enter the product ID and serial number of the controller on which you plan to use the license, read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Continue**.

f. On the Review and Submit page, verify that all information is correct and click **Submit**.

g. When a message appears indicating that the registration is complete, click **Download License**. The rehost license key is emailed within 1 hour to the address you specified.

h. After the email arrives, copy the rehost license key to your TFTP server.

i. Follow the instructions in the "Installing a License" section on page 8 to install this license on another controller.

Transferring Licenses to a Replacement Controller after an RMA

If you return a 5500 series controller to Cisco as part of the Return Material Authorization (RMA) process, you must transfer that controller's licenses within 60 days to a replacement controller that you receive from Cisco.

Replacement controllers come preinstalled with the following licenses: permanent base and evaluation base, base-ap-count, wplus, and wplus-ap-count. No other permanent licenses are installed. The SKU for replacement controllers is AIR-CT5508-CA-K9.

Because licenses are registered to the serial number of a controller, you can use the licensing portal on Cisco.com to request that the license from your returned controller be revoked and authorized for use on the replacement controller. After your request is approved, you can install the old license on the replacement controller. Before you begin, you need the product ID and serial number of both the returned controller and the replacement controller. This information is included in your purchase records.

Note The evaluation licenses on the replacement controller are designed for temporary use and expire after 60 days. To prevent disruptions in operation, the controller does not switch licenses when an evaluation license expires. You must reboot the controller in order to return to a permanent license. If the evaluation licenses expire before you transfer the permanent licenses from your defective controller to your replacement controller, the replacement controller remains up and running using the permanent base license, but access points are no longer able to join the controller.

Step 1 Go to http://www.cisco.com/go/license.

Step 2 On the main Product License Registration page, click **Register for an RMA License** under RMA License Transfer.

Step 3 In the Select a Product drop-down box, choose **Cisco 5500 Series Wireless Controllers**.

Step 4 Enter the security code in the blank box and click **Go to RMA Portal**.

Step 5 On the RMA License Transfer page, enter the product ID and serial number of the controller that you returned and your RMA service contract number. Then click **Continue**.

Step 6 On the Validate Features page, verify that the license information for your controller is correct, and click **Continue**.

Step 7 On the Designate Licensee page, enter the product ID and serial number of the replacement controller.

Step 8 Read and accept the conditions of the end-user license agreement (EULA), complete the rest of the fields on this page, and click **Submit**.

Step 9 On the Review and Submit page, verify that all information is correct and click **Submit**. A message appears indicating that your registration request has been submitted, and you receive an email containing your RMA request ID.

Step 10 To check the status of your RMA registration request, follow the instructions provided in the email.

Step 11 After you receive another email notifying you that your RMA registration request is approved (usually within 1 hour), follow the instructions in the "Installing a License" section on page 8 to install the license on the replacement controller.

Configuring the License Agent

If your network contains various Cisco licensed devices, you might want to consider using the Cisco License Manager (CLM) to manage all of the licenses using a single application. CLM is a secure client/server application that manages Cisco software licenses network wide.

The license agent is an interface module that runs on the controller and mediates between CLM and the controller's licensing infrastructure. CLM can communicate with the controller using various channels, such as HTTP, Telnet, and so on. If you want to use HTTP as the communication method, you must enable the license agent on the controller.

The license agent receives requests from CLM and translates them into license commands. It also sends notifications to CLM. It uses XML messages over HTTP or HTTPS to receive the requests and send the notifications. For example, CLM sends a **license install** command, and the agent notifies CLM after the license expires.

Note You can download the CLM software and access user documentation at this URL:

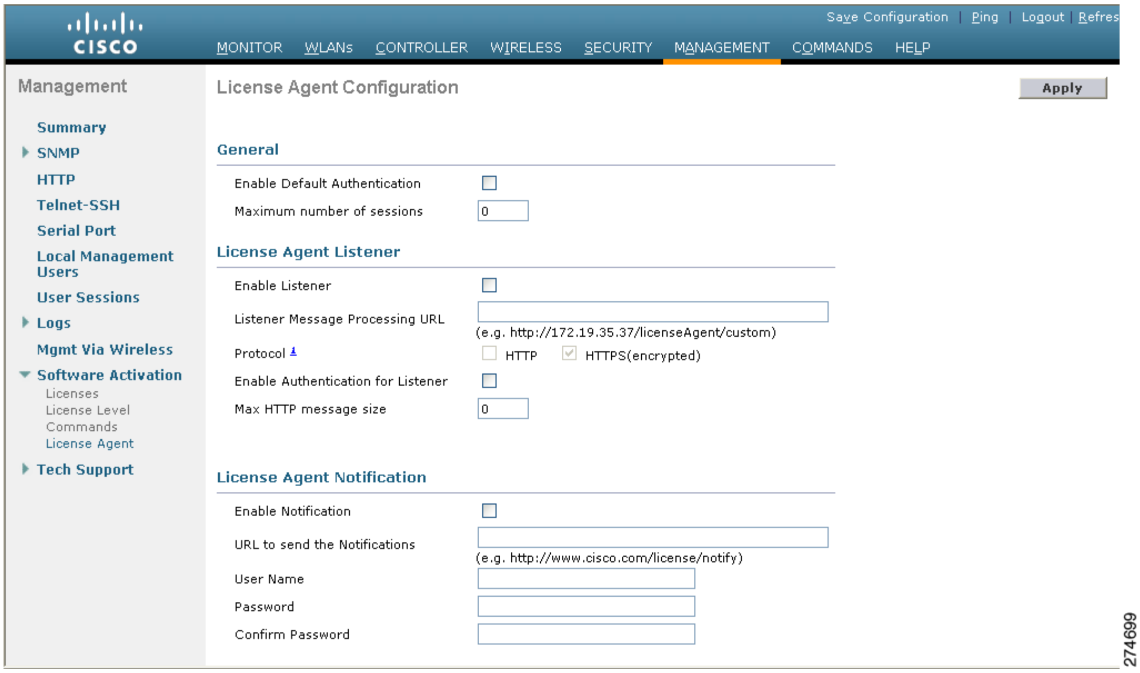
http://www.cisco.com/go/clm

Using the GUI to Configure the License Agent

Using the controller GUI, follow these steps to configure the license agent on the controller.

Step 1 Choose **Management > Software Activation > License Agent** to open the License Agent Configuration page (see Figure 12).

Figure 12 License Agent Configuration Page



License Agent Configuration

General

Enable Default Authentication □

Maximum number of sessions 0

License Agent Listener

Enable Listener □

Listener Message Processing URL

(e.g. http://172.19.35.37/licenseAgent/custom)

Protocol □ HTTP ☑ HTTPS(encrypted)

Enable Authentication for Listener □

Max HTTP message size 0

License Agent Notification

Enable Notification □

URL to send the Notifications

(e.g. http://www.cisco.com/license/notify)

User Name

Password

Confirm Password

Step 2 Check the **Enable Default Authentication** check box to enable the license agent, or leave it unchecked to disable this feature. The default value is unchecked.

Step 3 In the Maximum Number of Sessions field, enter the maximum number of sessions for the license agent. The valid range is 1 to 25 sessions (inclusive).

Step 4 To configure the license agent to listen for requests from the CLM, follow these steps:

a. Check the **Enable Listener** check box to enable the license agent to receive license requests from the CLM, or uncheck this check box to disable this feature. The default value is unchecked.

b. In the Listener Message Processing URL field, enter the URL where the license agent receives license requests (for example, http://172.19.35.37/licenseAgent/custom). The Protocol parameter indicates whether the URL requires HTTP or HTTPS.

Note You can specify the protocol to use on the HTTP Configuration page. Refer to the "Enabling Web and Secure Web Modes" section on page 18 for more information.

c. Check the **Enable Authentication for Listener** check box to enable authentication for the license agent when it is receiving license requests, or uncheck this check box to disable this feature. The default value is unchecked.

d. In the Max HTTP Message Size field, enter the maximum size for license requests. The valid range is 0 to 9999 bytes, and the default value is 0.

Step 5 To configure the license agent to send license notifications to the CLM, follow these steps:

a. Check the **Enable Notification** check box to enable the license agent to send license notifications to the CLM, or uncheck this check box to disable this feature. The default value is unchecked.

b. In the URL to Send the Notifications field, enter the URL where the license agent sends the notifications (for example, http://www.cisco.com/license/notify).

c. In the User Name field, enter the username required in order to view the notification messages at this URL.

d. In the Password and Confirm Password fields, enter the password required in order to view the notification messages at this URL.

Step 6 To commit your changes, click **Apply**.

Step 7 To save your changes, click **Save Configuration**.

Using the CLI to Configure the License Agent

Using the controller CLI, follow these steps to configure the license agent on the controller.

Step 1 To enable the license agent, enter one of these commands:

- **config license agent default authenticate**—Enables the license agent default listener with authentication.
- **config license agent default authenticate none**—Enables the license agent default listener without authentication.

Note To disable the license agent default listener, enter **config license agent default disable**. The default value is disabled.

Step 2 To specify the maximum number of sessions for the license agent, enter this command:

config license agent max-sessions *sessions*

The valid range for the *sessions* parameter is 1 to 25 (inclusive), and the default value is 9.

Step 3 To enable the license agent to receive license requests from the CLM and to specify the URL where the license agent receives the requests, enter this command:

config license agent listener http {**plaintext** | **encrypt**} *url* **authenticate** [**none**] [**max-message** *size*] [**acl** *acl*]

The valid range for the *size* parameter is 0 to 65535 bytes, and the default value is 0.

Note To prevent the license agent from receiving license requests from the CLM, enter **config license agent listener http disable**. The default value is disabled.

Step 4 To configure the license agent to send license notifications to the CLM and to specify the URL where the license agent sends the notifications, enter this command:

config license agent notify *url username password*

Note To prevent the license agent from sending license notifications to the CLM, enter **config license agent notify disable** *username password*. The default value is disabled.

Step 5 To save your changes, enter this command:

save config

Step 6 To see statistics for the license agent's counters or sessions, enter this command:

show license agent {**counters** | **sessions**}

Information similar to the following appears for the **show license agent counters** command:

```
License Agent Counters
Request Messages Received:10: Messages with Errors:1
Request Operations Received:9: Operations with Errors:0
Notification Messages Sent:12: Transmission Errors:0: Soap Errors:0
```

Information similar to the following appears for the **show license agent sessions** command:

```
License Agent Sessions: 1 open, maximum is 9
```

Note To clear the license agent's counter or session statistics, enter **clear license agent** {**counters** | **sessions**}.

Configuring 802.11 Bands

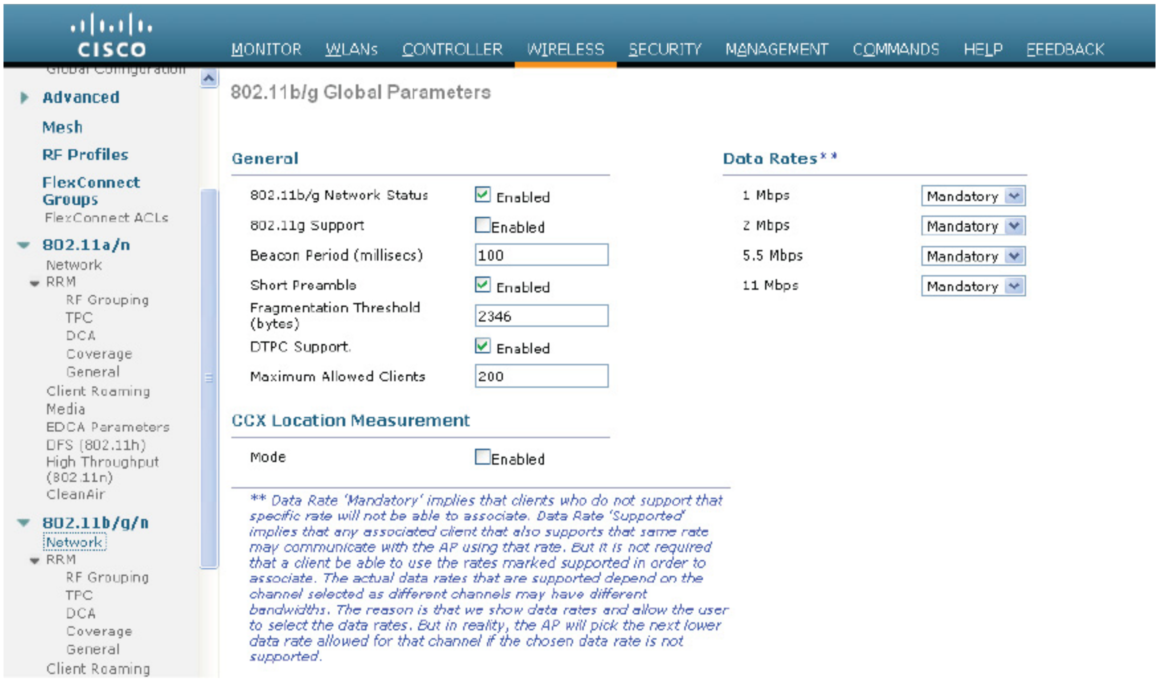
You can configure the 802.11b/g/n (2.4-GHz) and 802.11a/n (5-GHz) bands for the controller to comply with the regulatory requirements in your country. By default, both 802.11b/g/n and 802.11a/n are enabled.

Using the GUI to Configure 802.11 Bands

Using the controller GUI, follow these steps to configure 802.11 bands.

Step 1 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **Network** to open the 802.11a (or 802.11b/g) Global Parameters page (see Figure 13).

Figure 13 802.11a Global Parameters Page



802.11b/g Global Parameters

General

802.11b/g Network Status	☑ Enabled
802.11g Support	□ Enabled
Beacon Period (millisecs)	100
Short Preamble	☑ Enabled
Fragmentation Threshold (bytes)	2346
DTPC Support.	☑ Enabled
Maximum Allowed Clients	200

CCX Location Measurement

Mode	□ Enabled

Data Rates**

1 Mbps	Mandatory
2 Mbps	Mandatory
5.5 Mbps	Mandatory
11 Mbps	Mandatory

*** Data Rate 'Mandatory' implies that clients who do not support that specific rate will not be able to associate. Data Rate 'Supported' implies that any associated client that also supports that same rate may communicate with the AP using that rate. But it is not required that a client be able to use the rates marked supported in order to associate. The actual data rates that are supported depend on the channel selected as different channels may have different bandwidths. The reason is that we show data rates and allow the user to select the data rates. But in reality, the AP will pick the next lower data rate allowed for that channel if the chosen data rate is not supported.*

Step 2 To enable the 802.11a or 802.11b/g band, check the **802.11a** (or **802.11b/g**) **Network Status** check box. To disable the band, uncheck the check box. The default value is enabled. You can enable both the 802.11a and 802.11b/g bands.

Step 3 If you enabled the 802.11b/g band in Step 2, check the **802.11g Support** check box if you want to enable 802.11g network support. The default value is enabled. If you disable this feature, the 802.11b band is enabled without 802.11g support.

Step 4 To specify the rate at which the SSID is broadcast by the access point, enter a value between 100 and 600 milliseconds (inclusive) in the Beacon Period field. The default value is 100 milliseconds.

Step 5 To specify the size at which packets are fragmented, enter a value between 256 and 2346 bytes (inclusive) in the Fragmentation Threshold field. Enter a low number for areas where communication is poor or where there is a great deal of radio interference.

Step 6 To make access points advertise their channel and transmit power level in beacons and probe responses, check the **DTPC Support** check box. Otherwise, uncheck this check box. The default value is enabled.

Client devices using dynamic transmit power control (DTPC) receive the channel and power level information from the access points and adjust their settings automatically. For example, a client device used primarily in Japan could rely on DTPC to adjust its channel and power settings automatically when it travels to Italy and joins a network there.

Note On access points that run Cisco IOS software, this feature is called *world mode*.

Note DTPC and 801.11h power constraint cannot be enabled simultaneously.

Step 7 Use the Data Rates options to specify the rates at which data can be transmitted between the access point and the client. These data rates are available:

- 802.11a—6, 9, 12, 18, 24, 36, 48, and 54 Mbps
- 802.11b/g—1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, or 54 Mbps

For each data rate, choose one of these options:

- **Mandatory**—Clients must support this data rate in order to associate to an access point on the controller.
- **Supported**—Any associated clients that support this data rate may communicate with the access point using that rate. However, the clients are not required to be able to use this rate in order to associate.
- **Disabled**—The clients specify the data rates used for communication.

Step 8 Click **Apply** to commit your changes.

Step 9 Click **Save Configuration** to save your changes.

Using the CLI to Configure 802.11 Bands

Using the controller CLI, follow these steps to configure 802.11 bands.

Step 1 To disable the 802.11a band, enter this command:

config 802.11a disable network

Note The 802.11a band must be disabled before you can configure the 802.11a network parameters in this section.

Step 2 To disable the 802.11b/g band, enter this command:

config 802.11b disable network

Note The 802.11b band must be disabled before you can configure the 802.11b network parameters in this section.

Step 3 To specify the rate at which the SSID is broadcast by the access point, enter this command:

config {**802.11a** | **802.11b**} **beaconperiod** *time_unit*

where *time_unit* is the beacon interval in time units (TU). One TU is 1024 micro seconds. You can configure the access point to send a beacon every 20 to 1000 milliseconds.

Step 4 To specify the size at which packets are fragmented, enter this command:

config {**802.11a** | **802.11b**} **fragmentation** *threshold*

where *threshold* is a value between 256 and 2346 bytes (inclusive). Specify a low number for areas where communication is poor or where there is a great deal of radio interference.

Step 5 To make access points advertise their channel and transmit power level in beacons and probe responses, enter this command:

config {**802.11a** | **802.11b**} **dtpc** {**enable** | **disable**}

The default value is enabled. Client devices using dynamic transmit power control (DTPC) receive the channel and power level information from the access points and adjust their settings automatically. For example, a client device used primarily in Japan could rely on DTPC to adjust its channel and power settings automatically when it travels to Italy and joins a network there.

Note On access points that run Cisco IOS software, this feature is called *world mode*.

Step 6 To specify the rates at which data can be transmitted between the controller and the client, enter this command:

config {**802.11a** | **802.11b**} **rate** {**disabled** | **mandatory** | **supported**} *rate*

where

- **disabled**—The clients specify the data rates used for communication.
- **mandatory**—Specifies that clients support this data rate in order to associate to an access point on the controller.
- **supported**—Any associated clients that support this data rate may communicate with the access point using that rate. However, the clients are not required to be able to use this rate in order to associate.
- *rate*—The rate at which data is transmitted:
  - 6, 9, 12, 18, 24, 36, 48, and 54 Mbps (802.11a)
  - 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, or 54 Mbps (802.11b/g)

Step 7 To enable the 802.11a band, enter this command:

config 802.11a enable network

The default value is enabled.

Step 8 To enable the 802.11b band, enter this command:

config 802.11b enable network

The default value is enabled.

Step 9 To enable or disable 802.11g network support, enter this command:

config 802.11b 11gSupport {**enable** | **disable**}

The default value is enabled. You can use this command only if the 802.11b band is enabled. If you disable this feature, the 802.11b band is enabled without 802.11g support.

Step 10 To save your changes, enter this command:

save config

Step 11 To view the configuration settings for the 802.11a or 802.11b/g band, enter this command:

show {**802.11a** | **802.11b**}

Information similar to the following appears:

```
802.11a Network............................... Enabled
11nSupport.................................... Enabled
    802.11a Low Band.......................... Enabled
    802.11a Mid Band.......................... Enabled
    802.11a High Band......................... Enabled
802.11a Operational Rates
  802.11a 6M Rate............................. Mandatory
  802.11a 9M Rate............................. Supported
  802.11a 12M Rate............................ Mandatory
  802.11a 18M Rate............................ Supported
  802.11a 24M Rate............................ Mandatory
  802.11a 36M Rate............................ Supported
  802.11a 48M Rate............................ Supported
  802.11a 54M Rate............................ Supported
...
Beacon Interval.................................. 100
...
Default Channel.............................. 36
Default Tx Power Level....................... 1
DTPC Status.................................. Enabled
Fragmentation Threshold...................... 2346
...
```

Configuring 802.11n Parameters

This section provides instructions for managing 802.11n devices such as the Cisco Aironet 1140 and 1250 Series Access Points on your network. The 802.11n devices support the 2.4- and 5-GHz bands and offer high-throughput data rates.

Note The 802.11n high-throughput rates are available only on 1140 and 1250 series access points for WLANs using WMM with no Layer 2 encryption or with WPA2/AES encryption enabled.

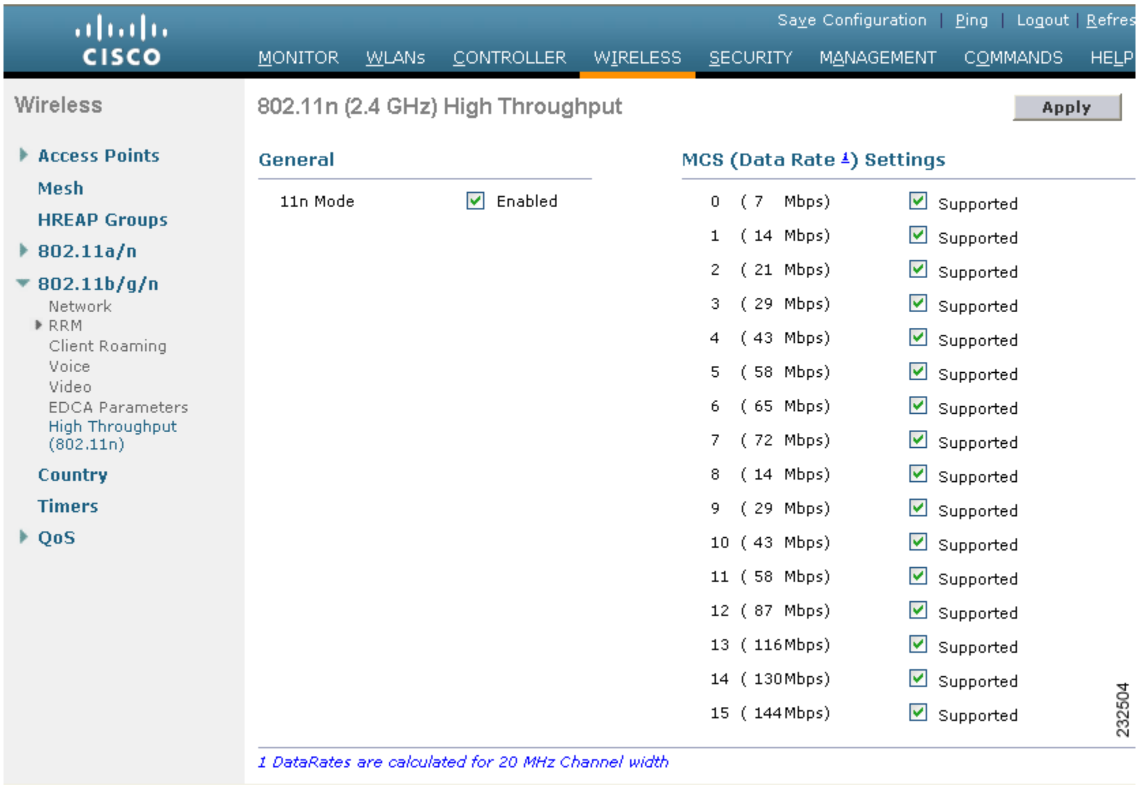
Note For information on configuring radio resource management (RRM) parameters or statically assigning radio parameters for 802.11n access points, refer to the *Configuring Radio Resource Management* chapter.

Using the GUI to Configure 802.11n Parameters

Using the controller GUI, follow these steps to configure 802.11n parameters.

Step 1 Choose **Wireless > 802.11a/n** or **802.11b/g/n > High Throughput (802.11n)** to open the 802.11n (5 GHz or 2.4 GHz) High Throughput page (see Figure 14).

Figure 14 802.11n (2.4 GHz) High Throughput Page



802.11n (2.4 GHz) High Throughput

General

11n Mode ☑ Enabled

MCS (Data Rate [1]) Settings

0	(7 Mbps)	☑ Supported
1	(14 Mbps)	☑ Supported
2	(21 Mbps)	☑ Supported
3	(29 Mbps)	☑ Supported
4	(43 Mbps)	☑ Supported
5	(58 Mbps)	☑ Supported
6	(65 Mbps)	☑ Supported
7	(72 Mbps)	☑ Supported
8	(14 Mbps)	☑ Supported
9	(29 Mbps)	☑ Supported
10	(43 Mbps)	☑ Supported
11	(58 Mbps)	☑ Supported
12	(87 Mbps)	☑ Supported
13	(116Mbps)	☑ Supported
14	(130Mbps)	☑ Supported
15	(144Mbps)	☑ Supported

[1] DataRates are calculated for 20 MHz Channel width

Step 2 Check the **11n Mode** check box to enable 802.11n support on the network. The default value is enabled.

Step 3 To specify the modulation and coding scheme (MCS) rates at which data can be transmitted between the access point and the client, check the check boxes of the desired rates. These data rates, which are calculated for a 20-MHz channel width using a short guard interval, are available:

- 0 (7 Mbps)
- 1 (14 Mbps)
- 2 (21 Mbps)
- 3 (29 Mbps)
- 4 (43 Mbps)
- 5 (58 Mbps)
- 6 (65 Mbps)
- 7 (72 Mbps)
- 8 (14 Mbps)
- 9 (29 Mbps)
- 10 (43 Mbps)
- 11 (58 Mbps)
- 12 (87 Mbps)
- 13 (116 Mbps)

- 14 (130 Mbps)
- 15 (144 Mbps)

Any associated clients that support the selected rates may communicate with the access point using those rates. However, the clients are not required to be able to use this rate in order to associate. The MCS settings determine the number of spatial streams, the modulation, the coding rate, and the data rate values that are used.

Step 4 Click **Apply** to commit your changes.

Step 5 To use the 802.11n data rates that you configured, you need to enable WMM on the WLAN. Follow these steps to do so:

a. Choose **WLANs** to open the WLANs page.

b. Click the ID number of the WLAN for which you want to configure WMM mode.

c. When the WLANs > Edit page appears, choose the **QoS** tab to open the WLANs > Edit (Qos) page.

d. From the WMM Policy drop-down box, choose **Required** or **Allowed** to require or allow client devices to use WMM. Devices that do not support WMM cannot join the WLAN.

e. Click **Apply** to commit your changes.

Step 6 Click **Save Configuration** to save your changes.

Note To determine if an access point supports 802.11n, look at the 11n Supported field on either the 802.11a/n (or 802.11b/g/n) Cisco APs > Configure page or the 802.11a/n (or 802.11b/g/n) AP Interfaces > Details page.

Using the CLI to Configure 802.11n Parameters

Using the controller CLI, follow these steps to configure 802.11n parameters.

Step 1 To enable 802.11n support on the network, enter this command:

config {**802.11a** | **802.11b**} **11nsupport** {**enable** | **disable**}

Step 2 To specify the modulation and coding scheme (MCS) rates at which data can be transmitted between the access point and the client, enter this command:

config {**802.11a** | **802.11b**} **11nsupport mcs tx** {**0-15**} {**enable** | **disable**}

See the descriptions of the 0 through 15 MCS data rates in the "Using the GUI to Configure 802.11n Parameters" section on page 34.

Step 3 To use the 802.11n data rates that you configured, you need to enable WMM on the WLAN. Enter this command to do so:

config wlan wmm required *wlan_id*

The **required** parameter requires client devices to use WMM. Devices that do not support WMM cannot join the WLAN.

Step 4 To specify the aggregation method used for 802.11n packets, follow these steps:

a. To disable the network, enter this command:

config {**802.11a** | **802.11b**} **disable network**

b. To specify the aggregation method, enter this command:

config {**802.11a** | **802.11b**} **11nsupport a-mpdu tx priority {0-7 | all} {enable | disable**}

Aggregation is the process of grouping packet data frames together rather than transmitting them separately. Two aggregation methods are available: Aggregated MAC Protocol Data Unit (A-MPDU) and Aggregated MAC Service Data Unit (A-MSDU). A-MPDU is performed in the software whereas A-MSDU is performed in the hardware.

You can specify the aggregation method for various types of traffic from the access point to the clients. Table 1 defines the priority levels (0-7) assigned per traffic type.

Table 1 Traffic Type Priority Levels

User Priority	Traffic Type
0	Best effort
1	Background
2	Spare
3	Excellent effort
4	Controlled load
5	Video, less than 100-ms latency and jitter
6	Voice, less than 10-ms latency and jitter
7	Network control

You can configure each priority level independently, or you can use the **all** parameter to configure all of the priority levels at once. When you use the **enable** command, the traffic associated with that priority level uses A-MPDU transmission. When you use the **disable** command, the traffic associated with that priority level uses A-MSDU transmission. Configure the priority levels to match the aggregation method used by the clients. By default, only priority level 0 is enabled.

c. To re-enable the network, enter this command:

config {**802.11a** | **802.11b**} **enable network**

Step 5 To save your changes, enter this command:

save config

Step 6 To view the configuration settings for the 802.11a/n or 802.11b/g/n band, enter this command:

show {**802.11a** | **802.11b**}

Information similar to the following appears:

```
802.11a Network.............................. Enabled
11nSupport.................................... Enabled
    802.11a Low Band.......................... Enabled
    802.11a Mid Band.......................... Enabled
    802.11a High Band......................... Enabled
802.11a Operational Rates
   802.11a 6M Rate............................ Mandatory
   802.11a 9M Rate............................ Supported
   802.11a 12M Rate........................... Mandatory
   802.11a 18M Rate............................ Supported
   802.11a 24M Rate............................ Mandatory
   802.11a 36M Rate............................ Supported
   802.11a 48M Rate............................ Supported
   802.11a 54M Rate............................ Supported
802.11n MCS Settings:
MCS 0...................................... Supported
   MCS 1.................................... Supported
   MCS 2.................................... Supported
   MCS 3.................................... Supported
   MCS 4.................................... Supported
   MCS 5.................................... Supported
  MCS 6.................................... Supported
   MCS 7.................................... Supported
   MCS 8.................................... Supported
   MCS 9.................................... Supported
   MCS 10................................... Supported
   MCS 11................................... Supported
   MCS 12................................... Supported
   MCS 13................................... Supported
   MCS 14................................... Supported
  MCS 15..................................... Supported
802.11n Status:
   A-MPDU Tx ................................ Enabled
      Priority 0............................. Enabled
      Priority 1............................. Enabled
      Priority 2............................. Enabled
      Priority 3............................. Enabled
      Priority 4............................. Enabled
      Priority 5............................. Disabled
      Priority 6............................. Disabled
      Priority 7............................. Enabled
   A-MSDU Tx ................................ Enabled
    Rifs Tx ................................. Enabled
   Guard Interval ........................... Short
Beacon Interval.............................. 100
CF Pollable mandatory........................ Disabled
CF Poll Request mandatory.................... Disabled
CFP Period....................................... 4
CFP Maximum Duration........................... 60
Default Channel................................ 36
Default Tx Power Level......................... 1
DTPC Status.................................Enabled
Fragmentation Threshold...................... 2346
Long Retry Limit................................ 4
Maximum Rx Life Time......................... 512
Max Tx MSDU Life Time.......................... 512
Medium Occupancy Limit......................... 100
Pico-Cell Status............................... Disabled
Pico-Cell-V2 Status............................ Disabled
RTS Threshold.................................. 2347
Short Retry Limit.............................. 7
TI Threshold................................... -50
Traffic Stream Metrics Status.................. Enabled
Expedited BW Request Status.................... Disabled
EDCA profile type.............................. default-wmm
Voice MAC optimization status.................. Disabled
Call Admission Control (CAC) configuration
   Voice AC - Admission control (ACM)........... Enabled
   Voice max RF bandwidth....................... 75
   Voice reserved roaming bandwidth............. 6
   Voice load-based CAC mode.................... Disabled
   Voice tspec inactivity timeout............... Disabled
   Video AC - Admission control (ACM)........... Enabled
```

```
Voice Stream-Size............................ 84000
Voice Max-Streams............................ 2
Video max RF bandwidth....................... Infinite
Video reserved roaming bandwidth........... 0
```

Configuring 802.11h Parameters

802.11h informs client devices about channel changes and can limit the transmit power of those client devices. You can configure the 802.11h parameters using the controller GUI or CLI.

Using the GUI to Configure 802.11h Parameters

Using the controller GUI, follow these steps to configure 802.11h parameters.

Step 1 To disable the 802.11a band, follow these steps:

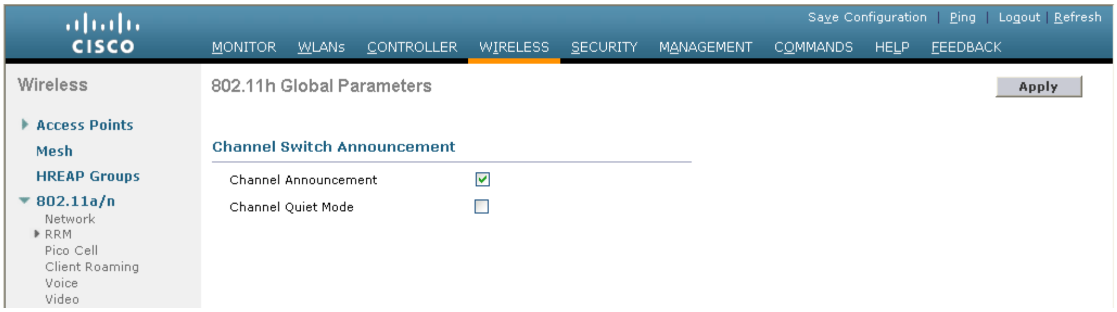
a. Choose **Wireless** > **802.11a/n** > **Network** to open the 802.11a Global Parameters page.

b. Uncheck the **802.11a Network Status** check box.

c. Click **Apply** to commit your change.

Step 2 Choose **Wireless** > **802.11a/n** > **DFS (802.11h)** to open the 802.11h Global Parameters page (see Figure 15).

Figure 15 802.11h Global Parameters Page



802.11h Global Parameters

Channel Switch Announcement

Channel Announcement ☑

Channel Quiet Mode □

Step 3 Check the **Channel Announcement** check box if you want the access point to announce when it is switching to a new channel and the new channel number, or uncheck this check box to disable channel announcement. The default value is disabled.

Step 4 If you enabled channel announcement in Step 3, the Channel Quiet Mode check box appears. Check this check box if you want the access point to stop transmitting on the current channel, or uncheck this check box to disable quiet mode. The default value is disabled.

Step 5 Click **Apply** to commit your changes.

Step 6 To re-enable the 802.11a band, follow these steps:

- **a.** Choose **Wireless** > **802.11a/n** > **Network** to open the 802.11a Global Parameters page.
- **b.** Check the **802.11a Network Status** check box.
- **c.** Click **Apply** to commit your change.

Step 7 Click **Save Configuration** to save your changes.

Using the CLI to Configure 802.11h Parameters

Using the controller CLI, follow these steps to configure 802.11h parameters.

Step 1 To disable the 802.11a network, enter this command:

config 802.11a disable network

Step 2 To enable or disable the access point to announce when it is switching to a new channel and the new channel number, enter this command:

config 802.11h channelswitch {**enable** | **disable**} *switch_mode*

You can enter a 0 or 1 for the *switch_mode* parameter to specify whether transmissions are restricted until the actual channel switch (0) or are not restricted (1). The default value is disabled.

Step 3 To configure a new channel using the 802.11h channel announcement, enter this command:

config 802.11h setchannel channel *channel*

Step 4 To configure the 802.11h power constraint value, enter this command:

config 802.11h powerconstraint *value*

The default value for the *value* parameter is 3 dB.

Step 5 To re-enable the 802.11a network, enter this command:

config 802.11a enable network

Step 6 To see the status of 802.11h parameters, enter this command:

show 802.11h

Information similar to the following appears:

```
Power Constraint................................ 0
Channel Switch.................................. Disabled
Channel Switch Mode............................. 0
```

Configuring DHCP Proxy

When DHCP proxy is enabled on the controller, the controller unicasts DHCP requests from the client to the configured servers. Consequently, at least one DHCP server must be configured on either the interface associated with the WLAN or the WLAN itself.

When DHCP proxy is disabled on the controller, those DHCP packets transmitted to and from the clients are bridged by the controller without any modification to the IP portion of the packet. Packets received from the client are removed from the CAPWAP tunnel and transmitted on the upstream VLAN. DHCP packets directed to the client are received on the upstream VLAN, converted to 802.11, and transmitted through a CAPWAP tunnel toward the client. As a result, the internal DHCP server cannot be used when DHCP proxy is disabled. The ability to disable DHCP proxy allows organizations to use DHCP servers that do not support Cisco's native proxy mode of operation. It should be disabled only when required by the existing infrastructure.

You can use the controller GUI or CLI to enable or disable DHCP proxy on a global basis, rather than on a WLAN basis. DHCP proxy is enabled by default.

Note DHCP proxy must be enabled in order for DHCP option 82 to operate correctly. Refer to the "Configuring DHCP Option 82" section on page 55 for information on DHCP option 82.

Note All controllers that will communicate must have the same DHCP proxy setting.

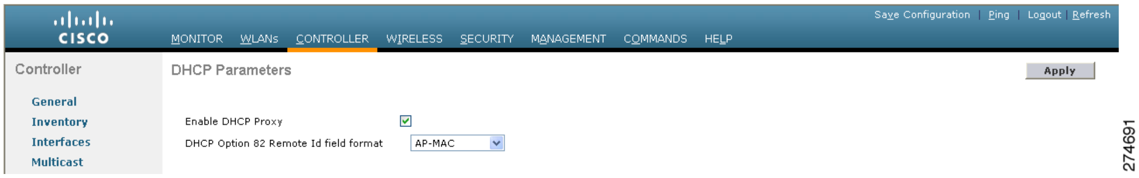
Note Refer to the *Configuring WLANs* chapter for information on configuring DHCP servers.

Using the GUI to Configure DHCP Proxy

Using the controller GUI, follow these steps to configure DHCP proxy.

Step 1 Choose **Controller** > **Advanced** > **DHCP** to open the DHCP Parameters page (see Figure 16).

Figure 16 DHCP Parameters Page



DHCP Parameters

Enable DHCP Proxy ☑

DHCP Option 82 Remote Id field format: AP-MAC

Step 2 To enable DHCP proxy on a global basis, check the **Enable DHCP Proxy** check box. Otherwise, uncheck the check box. The default value is checked.

Step 3 Click **Apply** to commit your changes.

Step 4 Click **Save Configuration** to save your changes.

Using the CLI to Configure DHCP Proxy

Using the controller CLI, follow these steps to configure DHCP proxy.

Step 1 To enable or disable DHCP proxy, enter this command:

config dhcp proxy {**enable** | **disable**}

Step 2 To view the DHCP proxy configuration, enter this command:

show dhcp proxy

Information similar to the following appears:

```
DHCP Proxy Behavior: enabled
```

Configuring Administrator Usernames and Passwords

You can configure administrator usernames and passwords to prevent unauthorized users from reconfiguring the controller and viewing configuration information. This section provides instructions for initial configuration and for password recovery.

Configuring Usernames and Passwords

Using the controller CLI, follow these steps to configure administrator usernames and passwords:

Step 1 To configure a username and password, enter one of these commands:

- **config mgmtuser add** *username password* **read-write**—Creates a username-password pair with read-write privileges.
- **config mgmtuser add** *username password* **read-only**—Creates a username-password pair with read-only privileges.

Usernames and passwords are case-sensitive and can contain up to 24 ASCII characters. Usernames and passwords cannot contain spaces.

Note If you ever need to change the password for an existing username, enter this command: **config mgmtuser password** *username new_password*

Step 2 To list configured users, enter this command:

show mgmtuser

Restoring Passwords

If you ever forget your password, follow these steps to configure a new username and password at boot-up using the CLI from the controller's serial console:

Step 1 After the controller boots up, enter **Restore-Password** at the User prompt.

> **Note** For security reasons, the text that you enter does not appear on the controller console.

Step 2 At the Enter User Name prompt, enter a new username.

Step 3 At the Enter Password prompt, enter a new password.

Step 4 At the Re-enter Password prompt, re-enter the new password. The controller validates and stores your entries in the database.

Step 5 When the User prompt reappears, enter your new username.

Step 6 When the Password prompt appears, enter your new password. The controller logs you in with your new username and password.

Configuring SNMP

Cisco recommends that you use the GUI to configure SNMP settings on the controller. To use the CLI, follow these steps:

Step 1 Enter **config snmp community create** *name* to create an SNMP community name.

Step 2 Enter **config snmp community delete** *name* to delete an SNMP community name.

Step 3 Enter **config snmp community accessmode ro** *name* to configure an SNMP community name with read-only privileges. Enter **config snmp community accessmode rw** *name* to configure an SNMP community name with read-write privileges.

Step 4 Enter **config snmp community ipaddr** *ip-address ip-mask name* to configure an IP address and subnet mask for an SNMP community.

> **Note** This command behaves like an SNMP access list. It specifies the IP address from which the device accepts SNMP packets with the associated community. The requesting entity's IP address is ANDed with the subnet mask before being compared to the IP address. If the subnet mask is set to 0.0.0.0, an IP address of 0.0.0.0 matches to all IP addresses. The default value is 0.0.0.0.

> **Note** The controller can use only one IP address range to manage an SNMP community.

Step 5 Enter **config snmp community mode enable** to enable a community name. Enter **config snmp community mode disable** to disable a community name.

Step 6 Enter **config snmp trapreceiver create** *name ip-address* to configure a destination for a trap.

Step 7 Enter **config snmp trapreceiver delete** *name* to delete a trap.

Step 8 Enter **config snmp trapreceiver ipaddr** *old-ip-address name new-ip-address* to change the destination for a trap.

Step 9 Enter **config snmp trapreceiver mode enable** to enable traps. Enter **config snmp trapreceiver mode disable** to disable traps.

Step 10 Enter **config snmp syscontact** *syscontact-name* to configure the name of the SNMP contact. Enter up to 31 alphanumeric characters for the contact name.

Step 11 Enter **config snmp syslocation** *syslocation-name* to configure the SNMP system location. Enter up to 31 alphanumeric characters for the location.

Step 12 Use the **show snmpcommunity** and **show snmptrap** commands to verify that the SNMP traps and communities are correctly configured.

Step 13 Use the **show trapflags** command to see the enabled and disabled trapflags. If necessary, use the **config trapflags** commands to enable or disable trapflags.

Changing the Default Values of SNMP Community Strings

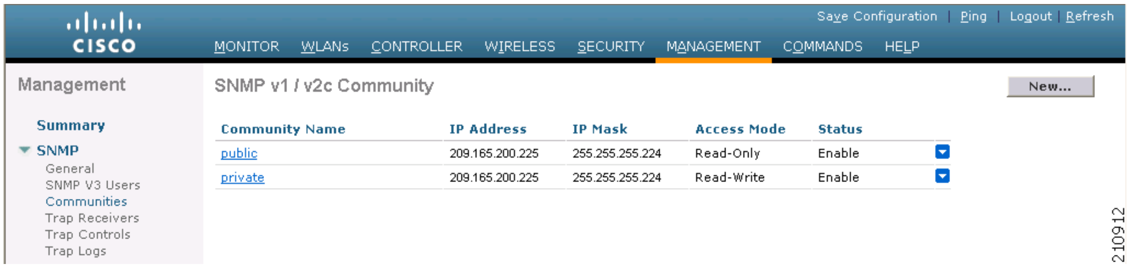
The controller has commonly known default values of “public” and “private” for the read-only and read-write SNMP community strings. Using these standard values presents a security risk. Therefore, Cisco strongly advises that you change these values.

Using the GUI to Change the SNMP Community String Default Values

Follow these steps to change the SNMP community string default values through the controller GUI.

Step 1 Choose **Management** and then **Communities** under SNMP. The SNMP v1 / v2c Community page appears (see Figure 17).

Figure 17 SNMP v1 / v2c Community Page



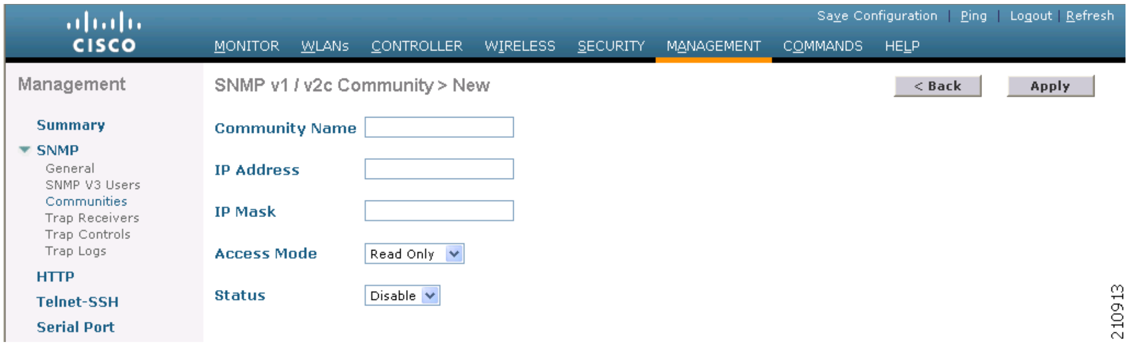
SNMP v1 / v2c Community

Community Name	IP Address	IP Mask	Access Mode	Status
public	209.165.200.225	255.255.255.224	Read-Only	Enable
private	209.165.200.225	255.255.255.224	Read-Write	Enable

Step 2 If “public” or “private” appears in the Community Name column, hover your cursor over the blue drop-down arrow for the desired community and choose **Remove** to delete this community.

Step 3 Click **New** to create a new community. The SNMP v1 / v2c Community > New page appears (see Figure 18).

Figure 18 SNMP v1 / v2c Community > New Page



SNMP v1 / v2c Community > New

Community Name

IP Address

IP Mask

Access Mode: Read Only

Status: Disable

Step 4 In the Community Name field, enter a unique name containing up to 16 alphanumeric characters. Do not enter “public” or “private.”

Step 5 In the next two fields, enter the IP address from which this device accepts SNMP packets with the associated community and the IP mask.

Step 6 Choose **Read Only** or **Read/Write** from the Access Mode drop-down box to specify the access level for this community.

Step 7 Choose **Enable** or **Disable** from the Status drop-down box to specify the status of this community.

Step 8 Click **Apply** to commit your changes.

Step 9 Click **Save Configuration** to save your settings.

Step 10 Repeat this procedure if a “public” or “private” community still appears on the SNMP v1 / v2c Community page.

Using the CLI to Change the SNMP Community String Default Values

Follow these steps to change the SNMP community string default values through the controller CLI.

Step 1 To see the current list of SNMP communities for this controller, enter this command:

show snmp community

Step 2 If “public” or “private” appears in the SNMP Community Name column, enter this command to delete this community:

config snmp community delete *name*

The *name* parameter is the community name (in this case, “public” or “private”).

Step 3 To create a new community, enter this command:

config snmp community create *name*

Enter up to 16 alphanumeric characters for the *name* parameter. Do not enter “public” or “private.”

Step 4 To enter the IP address from which this device accepts SNMP packets with the associated community, enter this command:

config snmp community ipaddr *ip_address ip_mask name*

Step 5 To specify the access level for this community, enter this command, where **ro** is read-only mode and **rw** is read/write mode:

config snmp community accessmode {**ro** | **rw**} *name*

Step 6 To enable or disable this SNMP community, enter this command:

config snmp community mode {**enable** | **disable**} *name*

Step 7 To save your changes, enter **save config**.

Step 8 Repeat this procedure if you still need to change the default values for a "public" or "private" community string.

Changing the Default Values for SNMP v3 Users

The controller uses a default value of "default" for the username, authentication password, and privacy password for SNMP v3 users. Using these standard values presents a security risk. Therefore, Cisco strongly advises that you change these values.

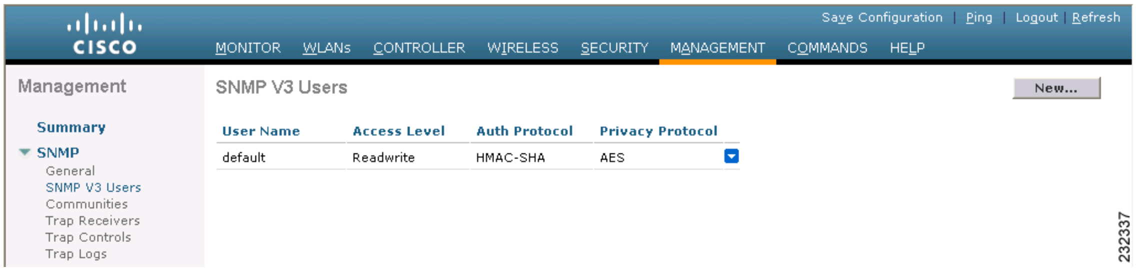
Note SNMP v3 is time sensitive. Make sure that you have configured the correct time and time zone on your controller.

Using the GUI to Change the SNMP v3 User Default Values

Follow these steps to change the SNMP v3 user default values through the controller GUI.

Step 1 Choose **Management > SNMP > SNMP V3 Users** to open the SNMP V3 Users page (see Figure 19).

Figure 19 SNMP V3 Users Page



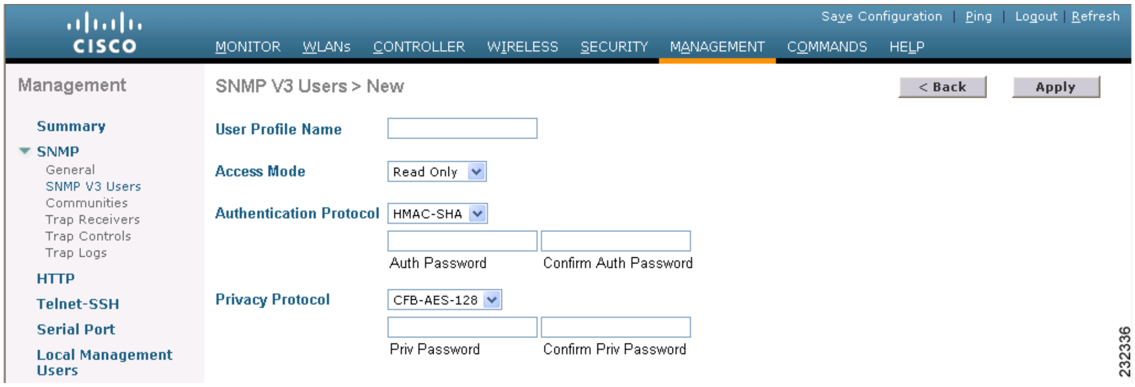
SNMP V3 Users

User Name	Access Level	Auth Protocol	Privacy Protocol
default	Readwrite	HMAC-SHA	AES

Step 2 If "default" appears in the User Name column, hover your cursor over the blue drop-down arrow for the desired user and choose **Remove** to delete this SNMP v3 user.

Step 3 Click **New** to add a new SNMP v3 user. The SNMP V3 Users > New page appears (see Figure 20).

Figure 20 SNMP V3 Users > New Page



User Profile Name

Access Mode: Read Only

Authentication Protocol: HMAC-SHA

Auth Password | Confirm Auth Password

Privacy Protocol: CFB-AES-128

Priv Password | Confirm Priv Password

Step 4 In the User Profile Name field, enter a unique name. Do not enter "default."

Step 5 Choose **Read Only** or **Read Write** from the Access Mode drop-down box to specify the access level for this user. The default value is Read Only.

Step 6 From the Authentication Protocol drop-down box, choose the desired authentication method: **None**, **HMAC-MD5** (Hashed Message Authentication Coding-Message Digest 5), or **HMAC-SHA** (Hashed Message Authentication Coding-Secure Hashing Algorithm). The default value is HMAC-SHA.

Step 7 In the Auth Password and Confirm Auth Password fields, enter the shared secret key to be used for authentication. You must enter at least 12 characters.

Step 8 From the Privacy Protocol drop-down box, choose the desired encryption method: **None**, **CBC-DES** (Cipher Block Chaining-Digital Encryption Standard), or **CFB-AES-128** (Cipher Feedback Mode-Advanced Encryption Standard-128). The default value is CFB-AES-128.

Note In order to configure CBC-DES or CFB-AES-128 encryption, you must have selected either HMAC-MD5 or HMAC-SHA as the authentication protocol in Step 6.

Step 9 In the Priv Password and Confirm Priv Password fields, enter the shared secret key to be used for encryption. You must enter at least 12 characters.

Step 10 Click **Apply** to commit your changes.

Step 11 Click **Save Configuration** to save your settings.

Step 12 Reboot the controller so that the SNMP v3 user that you added takes effect.

Using the CLI to Change the SNMP v3 User Default Values

Follow these steps to change the SNMP v3 user default values through the controller CLI.

Step 1 To see the current list of SNMP v3 users for this controller, enter this command:

show snmpv3user

Step 2 If "default" appears in the SNMP v3 User Name column, enter this command to delete this user:

config snmp v3user delete *username*

The *username* parameter is the SNMP v3 username (in this case, "default").

Step 3 To create a new SNMP v3 user, enter this command:

config snmp v3user create *username* {**ro** | **rw**} {**none** | **hmacmd5** | **hmacsha**} {**none** | **des** | **aescfb128**} *auth_key encrypt_key*

where

- *username* is the SNMP v3 username;
- **ro** is read-only mode and **rw** is read-write mode;
- **none**, **hmacmd5**, and **hmacsha** are the authentication protocol options;
- **none**, **des**, and **aescfb128** are the privacy protocol options;
- *auth_key* is the authentication shared secret key; and
- *encrypt_key* is the encryption shared secret key.

Do not enter "default" for the *username*, *auth_key*, and *encrypt_key* parameters.

Step 4 To save your changes, enter **save config**.

Step 5 To reboot the controller so that the SNMP v3 user that you added takes effect, enter **reset system**.

Configuring Aggressive Load Balancing

Enabling aggressive load balancing on the controller allows lightweight access points to load balance wireless clients across access points. You can enable aggressive load balancing using the controller GUI or CLI.

Note Clients are load balanced between access points on the same controller. Load balancing does not occur between access points on different controllers.

When a wireless client attempts to associate to a lightweight access point, association response packets are sent to the client with an 802.11 response packet including status code 17. This code indicates whether the access point can accept any more associations. If the access point is too busy, the client attempts to associate to a different access point in the area. The system determines if an access point is relatively more busy than its neighbor access points that are also accessible to the client.

For example, if the number of clients on AP1 is more than the number of clients on AP2 plus the load-balancing window, then AP1 is considered to be busier than AP2. When a client attempts to associate to AP1, it receives an 802.11 response packet with status code 17, indicating that the access point is busy, and the client attempts to associate to a different access point.

In previous software releases, the controller denies a client only once and allows the client to associate to the access point on a second attempt. In software release 6.0.188.0, you can configure the controller to deny client associations up to 10 times. In addition, you can now enable or disable load balancing on a particular WLAN, which is useful if you want to disable load balancing for a select group of clients (such as time-sensitive voice clients).

Note These new aggressive load-balancing options in software release 6.0 are available only in the controller CLI.

Note Load-balancing-enabled WLANs do not support time-sensitive applications like voice and video because of roaming delays.

Note When you use Cisco 7921 and 7920 Wireless IP Phones with controllers, make sure that aggressive load balancing is disabled on the voice WLANs for each controller. Otherwise, the initial roam attempt by the phone might fail, causing a disruption in the audio path.

Using the CLI to Configure Aggressive Load Balancing

Using the controller CLI, follow these steps to configure aggressive load balancing.

Step 1 To globally enable or disable aggressive load balancing on the controller, enter this command:

config load-balancing aggressive {**enable** | **disable**}

The default value is disabled.

Step 2 To set the load-balancing window for aggressive load balancing, enter this command:

config load-balancing window *clients*

You can enter a value between 1 and 20 for the *clients* parameter. The load-balancing window becomes part of the algorithm that determines whether an access point is too heavily loaded to accept more client associations:

load-balancing window + client associations on AP with lightest load = load-balancing threshold

In the group of access points accessible to a client device, each access point has a different number of client associations. The access point with the lowest number clients has the lightest load. The load-balancing window plus the number of clients on the access point with the lightest load forms the threshold. Access points with more client associations than this threshold is considered busy, and clients can associate only to access points with client counts lower than the threshold.

Step 3 To set the maximum number of association denials during load balancing, enter this command:

config load-balancing denial *denials*

You can enter a value between 0 and 10 for the *denials* parameter.

Step 4 To save your changes, enter this command:

save config

Step 5 To verify your settings, enter this command:

show load-balancing

Information similar to the following appears:

```
Aggressive Load Balancing........................ Enabled
Aggressive Load Balancing Window................. 0 clients
Aggressive Load Balancing Denial Count........... 3

Statistics
Total Denied Count............................... 10 clients
Total Denial Sent................................ 20 messages
```

```
Exceeded Denial Max Limit Count................. 0 times
None 5G Candidate Count......................... 0 times
None 2.4G Candidate Count....................... 0 times
```

Step 6 If client load balancing is enabled globally, you can enable or disable this feature on a per-WLAN basis using the following command:

config wlan load-balance allow {**enable** | **disable**} *wlan_id*

By default, load balancing is allowed on all WLANs.

Step 7 To save your changes, enter this command:

save config

Configuring Band Selection

The 2.4-GHz band is often congested. Clients on this band typically experience interference from Bluetooth devices, microwave ovens, and cordless phones as well as co-channel interference from other access points because of the 802.11b/g limit of three non-overlapping channels. To combat these sources of interference and improve overall network performance, controller software release 6.0 enables you to configure band selection on the controller. This feature enables client radios that are capable of dual-band (2.4- and 5-GHz) operation to move to a less congested 5-GHz access point.

Band selection works by regulating probe responses to clients. It makes 5-GHz channels more attractive to clients by delaying probe responses to clients on 2.4-GHz channels.

Using the controller CLI, you can globally enable band selection on the controller, or you can enable or disable band selection for a particular WLAN, which is useful if you want to disable it for a select group of clients (such as time-sensitive voice clients).

Note Band-selection-enabled WLANs do not support time-sensitive applications like voice and video because of roaming delays.

Guidelines for Using Band Selection

Follow these guidelines when using band selection on your controller:

- Band selection can be used only with Cisco Aironet 1140 and 1250 series access points.
- Band selection operates only on access points that are connected to a controller. A hybrid-REAP access point without a controller connection does not perform band selection after a reboot.
- The band-selection algorithm directs dual-band clients only from the 2.4-GHz radio to the 5-GHz radio of the same access point, and it only runs on an access point when both the 2.4-GHz and 5-GHz radios are up and running.
- You can enable both band selection and aggressive load balancing on the controller. They run independently and do not impact one another.

Using the CLI, follow these steps to configure band selection on the controller:

Step 1 To globally enable or disable band selection on the controller, enter this command:

config band-select probe-response {**enable** | **disable**}

The default value is disabled.

Step 2 To set the number of suppression cycles for a new client, enter this command:

config band-select cycle-count *cycles*

You can enter a value between 1 and 10 for the *cycles* parameter. The default cycle count is 2.

Step 3 To set the time threshold during which new probe requests from a client come from a new scanning cycle, enter this command:

config band-select cycle-threshold *milliseconds*

You can enter a value between 1 and 1000 for the *milliseconds* parameter. The default cycle threshold is 200 milliseconds.

Step 4 To set the expiration time for pruning previously known 802.11b/g clients, enter this command:

config band-select expire suppression *seconds*

You can enter a value between 10 and 200 for the *seconds* parameter. The default value is 20 seconds. After this time elapses, clients become new and are subject to probe response suppression.

Step 5 To set the expiration time for pruning previously known dual-band clients, enter this command:

config band-select expire dual-band *seconds*

You can enter a value between 10 and 300 for the *seconds* parameter. The default value is 60 seconds. After this time elapses, clients become new and are subject to probe response suppression.

Step 6 To set the minimum RSSI for a client to respond to a probe, enter this command:

config band-select client-rssi *dBm*

You can enter a value between –20 and –90 for the *dBm* parameter. The default value is –80 dBm.

Step 7 To save your changes, enter this command:

save config

Step 8 If band select is enabled globally, you can enable or disable this feature on a per-WLAN basis using the following command.

config wlan band-select allow {enable | disable} *wlan_ID*

You can enter a value between 1 and 512 for *wlan_ID* parameter.

Step 9 To see a summary of dual-band clients and suppressed clients, enter this command:

show ap stats {**802.11a** | **802.11b**} *Cisco_AP*

Information similar to the following appears:

```
Band Select Stats
  Num of dual band client ...................... 10
  Num of dual band client added................. 0
  Num of dual band client expired .............. 4
  Num of dual band client replaced.............. 0
  Num of dual band client detected ............. 9
  Num of suppressed client ..................... 8
  Num of suppressed client expired.............. 8
  Num of suppressed client replaced.......... 0
```

Note These counters return to 0 when the access point radio is reset or shut down because all the clients are disconnected.

Step 10 To override the global configuration and enable or disable band selection on a particular WLAN, enter this command:

config wlan band-select allow {**enable** | **disable**} *wlan_id*

By default, band selection is allowed on all WLANs.

Step 11 To save your changes, enter this command:

save config

Configuring Fast SSID Changing

When fast SSID changing is enabled, the controller allows clients to move between SSIDs. When the client sends a new association for a different SSID, the client entry in the controller connection table is cleared before the client is added to the new SSID. When fast SSID changing is disabled, the controller enforces a delay before clients are allowed to move to a new SSID.

Using the GUI to Configure Fast SSID Changing

Using the controller GUI, follow these steps to configure fast SSID changing for mobile clients.

Step 1 Choose **Controller** to open the General page.

Step 2 From the Fast SSID Change drop-down box, choose **Enabled** to enable this feature or **Disabled** to disable it. The default value is disabled.

Step 3 Click **Apply** to commit your changes.

Step 4 Click **Save Configuration** to save your changes.

Using the CLI to Configure Fast SSID Changing

Using the controller CLI, follow these steps to configure fast SSID changing for mobile clients.

Step 1 To enable or disable fast SSID changing, enter this command:

config network fast-ssid-change {**enable** | **disable**}

Step 2 To save your changes, enter this command:

save config

Enabling 802.3X Flow Control

802.3X Flow Control is disabled by default. To enable it, enter **config switchconfig flowcontrol enable**.

Configuring 802.3 Bridging

The controller supports 802.3 frames and the applications that use them, such as those typically used for cash registers and cash register servers. However, to make these applications work with the controller, the 802.3 frames must be bridged on the controller.

Support for raw 802.3 frames allows the controller to bridge non-IP frames for applications not running over IP. Only this raw 802.3 frame format is currently supported:

```
+-------------------+---------------------+-----------------+------------------------+

| Destination      | Source             | Total packet | Payload .....
| MAC address    | MAC address     | length           |

+-------------------+----------------------+-----------------+------------------------
```

You can configure 802.3 bridging through the controller GUI in software release 4.1 or later and through the controller CLI in software release 4.0 or later.

Note In controller software release 5.2 or later, the software-based forwarding architecture for 2100-series-based controllers is being replaced with a new forwarding plane architecture. As a result, 2100 series controllers and the Cisco Wireless LAN Controller Network Module for Cisco Integrated Services Routers (as well as 5500 series controllers) bridge 802.3 packets by default. Therefore, 802.3 bridging can now be disabled only on 4400 series controllers, the Cisco WiSM, and the Catalyst 3750G Wireless LAN Controller Switch.

Note By default, 2100-series-based controllers running software release 5.2 or later and 5500 series controllers bridge all non-IPv4 packets (such as Appletalk, IPv6, and so on). If desired, you can use ACLs to block the bridging of these protocols.

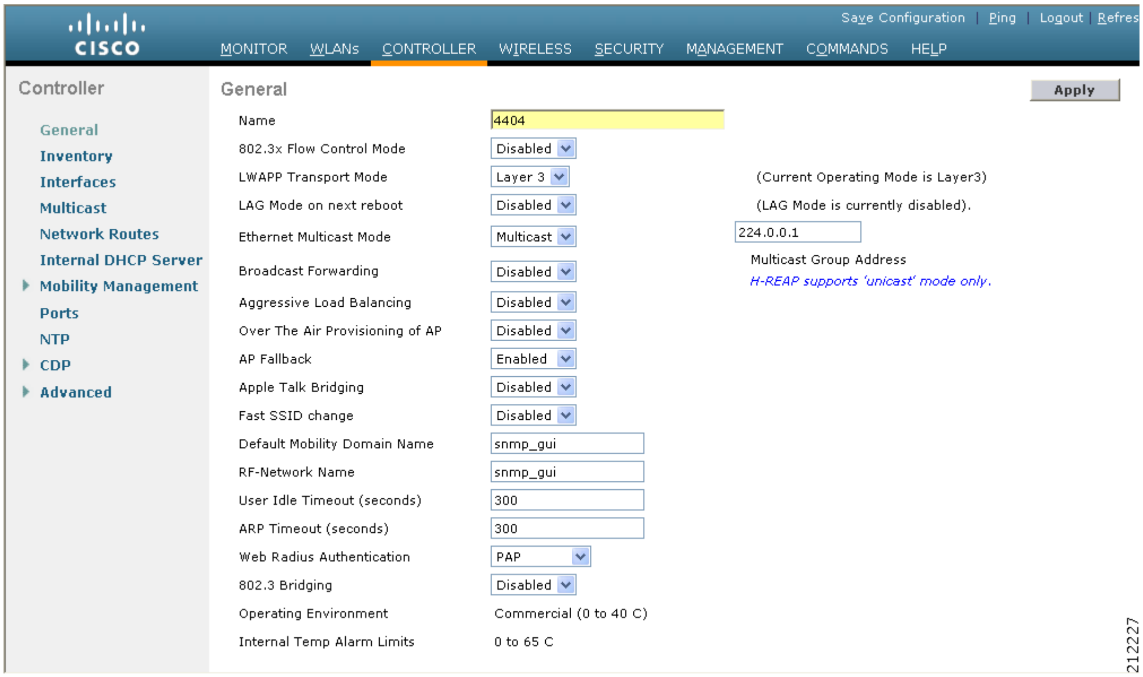
Note You can also configure 802.3 bridging using the Cisco Wireless Control System (WCS). Refer to the *Cisco Wireless Control System Configuration Guide* for instructions.

Using the GUI to Configure 802.3 Bridging

Follow these steps to configure 802.3 bridging using the controller GUI.

Step 1 Choose **Controller** > **General** to open the General page (see Figure 21).

Figure 21 General Page



General

Name	4404	
802.3x Flow Control Mode	Disabled	
LWAPP Transport Mode	Layer 3	(Current Operating Mode is Layer3)
LAG Mode on next reboot	Disabled	(LAG Mode is currently disabled).
Ethernet Multicast Mode	Multicast	224.0.0.1 Multicast Group Address *H-REAP supports 'unicast' mode only.*
Broadcast Forwarding	Disabled	
Aggressive Load Balancing	Disabled	
Over The Air Provisioning of AP	Disabled	
AP Fallback	Enabled	
Apple Talk Bridging	Disabled	
Fast SSID change	Disabled	
Default Mobility Domain Name	snmp_gui	
RF-Network Name	snmp_gui	
User Idle Timeout (seconds)	300	
ARP Timeout (seconds)	300	
Web Radius Authentication	PAP	
802.3 Bridging	Disabled	
Operating Environment	Commercial (0 to 40 C)	
Internal Temp Alarm Limits	0 to 65 C	

Step 2 From the 802.3 Bridging drop-down box, choose **Enabled** to enable 802.3 bridging on your controller or **Disabled** to disable this feature. The default value is Disabled.

Note In controller software release 5.2 or later, you can disable 802.3 bridging only for 4400 series controllers, the Cisco WiSM, and the Catalyst 3750G Wireless LAN Controller Switch.

Step 3 Click **Apply** to commit your changes.

Step 4 Click **Save Configuration** to save your changes.

Using the CLI to Configure 802.3 Bridging

Follow these steps to configure 802.3 bridging using the controller CLI.

Step 1 To see the current status of 802.3 bridging for all WLANs, enter this command:

show network

Step 2 To enable or disable 802.3 bridging globally on all WLANs, enter this command:

config network 802.3-bridging {**enable** | **disable**}

The default value is disabled.

Note In controller software release 5.2 or later, you can disable 802.3 bridging only for 4400 series controllers, the Cisco WiSM, and the Catalyst 3750G Wireless LAN Controller Switch.

Step 3 To save your settings, enter this command:

save config

Configuring Multicast Mode

If your network supports packet multicasting, you can configure the multicast method that the controller uses. The controller performs multicasting in two modes:

- **Unicast mode**—In this mode, the controller unicasts every multicast packet to every access point associated to the controller. This mode is inefficient but might be required on networks that do not support multicasting.
- **Multicast mode**—In this mode, the controller sends multicast packets to a CAPWAP multicast group. This method reduces overhead on the controller processor and shifts the work of packet replication to your network, which is much more efficient than the unicast method.

You can enable multicast mode using the controller GUI or CLI.

Understanding Multicast Mode

When you enable multicast mode and the controller receives a multicast packet from the wired LAN, the controller encapsulates the packet using CAPWAP and forwards the packet to the CAPWAP multicast group address. The controller always uses the management interface for sending multicast packets. Access points in the multicast group receive the packet and forward it to all the BSSIDs mapped to the interface on which clients receive multicast traffic. From the access point perspective, the multicast appears to be a broadcast to all SSIDs.

In controller software release 4.2 or later, Internet Group Management Protocol (IGMP) snooping is introduced to better direct multicast packets. When this feature is enabled, the controller gathers IGMP reports from the clients, processes them, creates unique multicast group IDs (MGIDs) from the IGMP reports after checking the Layer 3 multicast address and the VLAN number, and sends the IGMP reports to the infrastructure switch. The controller sends these reports with the source address as the interface address on which it received the reports from the clients. The controller then updates the access point MGID table on the access point with the client MAC address. When the controller receives multicast traffic for a particular multicast group, it forwards it to all the access points, but only those access points that have active clients listening or subscribed to that multicast group send multicast traffic on that particular WLAN. IP packets are forwarded with an MGID that is unique for an ingress VLAN and the destination multicast group. Layer 2 multicast packets are forwarded with an MGID that is unique for the ingress interface.

When IGMP snooping is disabled, the following is true:

- The controller always uses Layer 2 MGID when it sends multicast data to the access point. Every interface created is assigned one Layer 2 MGID. For example, the management interface has an MGID of 0, and the first dynamic interface created is assigned an MGID of 8, which increments as each dynamic interface is created.
- The IGMP packets from clients are forwarded to the router. As a result, the router IGMP table is updated with the IP address of the clients as the last reporter.

When IGMP snooping is enabled, the following is true:

- The controller always uses Layer 3 MGID for all Layer 3 multicast traffic sent to the access point. For all Layer 2 multicast traffic, it continues to use Layer 2 MGID.
- IGMP report packets from wireless clients are consumed or absorbed by the controller, which generates a query for the clients. After the router sends the IGMP query, the controller sends the IGMP reports with its interface IP address as the listener IP address for the multicast group. As a result, the router IGMP table is updated with the controller IP address as the multicast listener.
- When the client that is listening to the multicast groups roams from one controller to another, the first controller transmits all the multicast group information for the listening client to the second controller. As a result, the second controller can immediately create the multicast group information for the client. The second controller sends the IGMP reports to the network for all multicast groups to which the client was listening. This process aids in the seamless transfer of multicast data to the client.
- If the listening client roams to a controller in a different subnet, the multicast packets are tunneled to the anchor controller of the client to avoid the reverse path filtering (RPF) check. The anchor then forwards the multicast packets to the infrastructure switch.

Note The MGIDs are controller specific. The same multicast group packets coming from the same VLAN in two different controllers may be mapped to two different MGIDs.

Note If Layer 2 multicast is enabled, a single MGID is assigned to all the multicast addresses coming from an interface (see Figure 23).

Guidelines for Using Multicast Mode

Follow these guidelines when you enable multicast mode on your network:

- The Cisco Unified Wireless Network solution uses some IP address ranges for specific purposes, and you should keep these ranges in mind when configuring a multicast group:
  - 224.0.0.0 through 224.0.0.255—Reserved link local addresses
  - 224.0.1.0 through 238.255.255.255—Globally scoped addresses
  - 239.0.0.0 through 239.255.x.y /16—Limited scope addresses
- When you enable multicast mode on the controller, you also must configure a CAPWAP multicast group address. Access points subscribe to the CAPWAP multicast group using IGMP.
- Cisco 1100, 1130, 1200, 1230, and 1240 access points use IGMP versions 1, 2, and 3.
- Access points in monitor mode, sniffer mode, or rogue detector mode do not join the CAPWAP multicast group address.
- The CAPWAP multicast group configured on the controllers should be different for different controllers.
- Multicast mode does not operate across intersubnet mobility events such as guest tunneling. It does, however, operate with interface overrides using RADIUS (but only when IGMP snooping is enabled) and with site-specific VLANs (access point group VLANs).

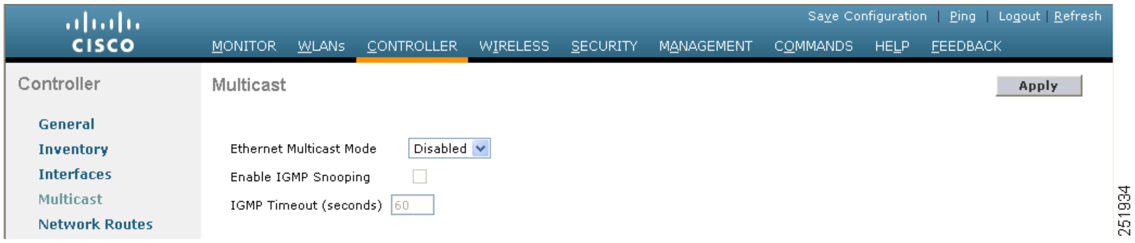
- For LWAPP, the controller drops multicast packets sent to UDP control port 12223. For CAPWAP, the controller drops multicast packets sent to UDP control and data ports 5246 and 5247, respectively. Therefore, you may want to consider not using these port numbers with the multicast applications on your network.
- Cisco recommends that any multicast applications on your network not use the multicast address configured as the CAPWAP multicast group address on the controller.
- 2100 series controllers do not support multicast-unicast mode. They do, however, support multicast-multicast mode, except when access points are connected directly to the local port of a 2100 series controller.

Using the GUI to Enable Multicast Mode

Follow these steps to enable multicast mode using the controller GUI.

Step 1 Choose **Controller** > **Multicast** to open the Multicast page (see Figure 22).

Figure 22 Multicast Page



Ethernet Multicast Mode: Disabled

Enable IGMP Snooping ☐

IGMP Timeout (seconds): 60

Step 2 Choose one of the following options from the Ethernet Multicast Mode drop-down box:

- **Disabled**—Disables multicasting on the controller. This is the default value.
- **Unicast**—Configures the controller to use the unicast method to send multicast packets.
- **Multicast**—Configures the controller to use the multicast method to send multicast packets to a CAPWAP multicast group.

Note Hybrid REAP supports unicast mode only.

Step 3 If you chose Multicast in Step 2, enter the IP address of the multicast group in the Multicast Group Address field.

Step 4 If you want to enable IGMP snooping, check the **Enable IGMP Snooping** check box. If you want to disable IGMP snooping, leave the check box unchecked. The default value is disabled.

Step 5 To set the IGMP timeout, enter a value between 30 and 7200 seconds in the **IGMP Timeout** field. The controller sends three queries in one timeout value at an interval of *timeout*/3 (if the timeout value is more than 360 seconds, controller sends one query every 120 seconds, irrespective of the value configured) to see if any clients exist for a particular multicast group. If the controller does not receive a response through an IGMP report from the client, the controller times out the client entry from the MGID table. When no clients are left for a particular multicast group, the controller waits for the IGMP timeout value (if the timeout value is more than 360 seconds, controller waits for 360 seconds irrespective of the value configured) to expire and then deletes the MGID entry from the controller. The controller always generates a general IGMP query (that is, to destination address 224.0.0.1) and sends it on all WLANs with an MGID value of 1.

Step 6 Click **Apply** to commit your changes.

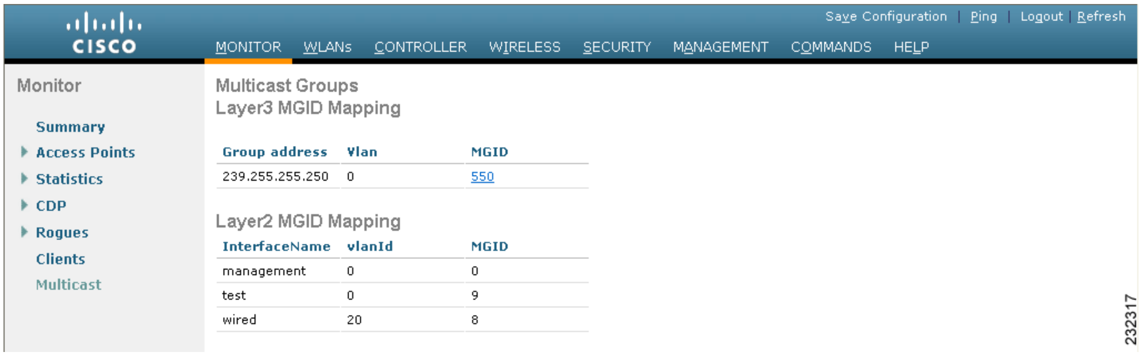
Step 7 Click **Save Configuration** to save your changes.

Using the GUI to View Multicast Groups

Follow these steps to view multicast groups using the controller GUI.

Step 1 Choose **Monitor** > **Multicast**. The Multicast Groups page appears (see Figure 23).

Figure 23 Multicast Groups Page



Multicast Groups

Layer3 MGID Mapping

Group address	Vlan	MGID
239.255.255.250	0	550

Layer2 MGID Mapping

InterfaceName	vlanId	MGID
management	0	0
test	0	9
wired	20	8

This page shows all the multicast groups and their corresponding MGIDs.

Step 2 Click the link for a specific MGID (such as MGID 550) to see a list of all the clients joined to the multicast group in that particular MGID.

Using the CLI to Enable Multicast Mode

Follow these steps to enable multicast mode using the controller CLI.

Step 1 To enable or disable multicasting on the controller, enter this command:

config network multicast global {**enable** | **disable**}

The default value is disabled.

Note The **config network broadcast** {**enable** | **disable**} command allows you to enable or disable broadcasting without enabling or disabling multicasting as well. This command uses the multicast mode currently on the controller to operate.

Step 2 Perform one of the following:

a. To configure the controller to use the unicast method to send multicast packets, enter this command:

config network multicast mode unicast

b. To configure the controller to use the multicast method to send multicast packets to a CAPWAP multicast group, enter this command:

config network multicast mode multicast *multicast_group_ip_address*

Step 3 To enable or disable IGMP snooping, enter this command:

config network multicast igmp snooping {**enable** | **disable**}

The default value is disabled.

Step 4 To set the IGMP timeout value, enter this command:

config network multicast igmp timeout *timeout*

You can enter a *timeout* value between 30 and 300 seconds. The controller sends three queries in one timeout value at an interval of *timeout*/3 to see if any clients exist for a particular multicast group. If the controller does not receive a response through an IGMP report from the client, the controller times out the client entry from the MGID table. When no clients are left for a particular multicast group, the controller waits for the IGMP timeout value to expire and then deletes the MGID entry from the controller. The controller always generates a general IGMP query (that is, to destination address 224.0.0.1) and sends it on all WLANs with an MGID value of 1.

Step 5 To save your changes, enter this command:

save config

Using the CLI to View Multicast Groups

Use these commands to view multicast groups using the controller CLI.

- To see all the multicast groups and their corresponding MGIDs, enter this command:

  show network multicast mgid summary

  Information similar to the following appears:

```
Layer2 MGID Mapping:
-------------------
InterfaceName                    vlanId   MGID
-------------------------------- ------   ----
management                       0        0
test                             0        9
wired                            20       8

Layer3 MGID Mapping:
-------------------
Number of Layer3 MGIDs.......................... 1

 Group address    Vlan  MGID
 ---------------  ----  ----
 239.255.255.250  0     550
```

- To see all the clients joined to the multicast group in a specific MGID, enter this command:

  show network multicast mgid detail *mgid_value* where the *mgid_value* parameter is a number between 550 and 4095.

Information similar to the following appears:

```
Mgid....................................... 550
Multicast Group Address.................... 239.255.255.250
Vlan....................................... 0
Rx Packet Count............................ 807399588
No of clients.............................. 1
Client List................................
        Client MAC             Expire Time (mm:ss)
        00:13:02:23:82:ad      0:20
```

Using the CLI to View an Access Point's Multicast Client Table

To help troubleshoot roaming events, you can view an access point's multicast client table from the controller by performing a remote debug of the access point. Follow these steps to do so using the controller CLI:

Step 1 To initiate a remote debug of the access point, enter this command:

debug ap enable *Cisco_AP*

Step 2 To see all of the MGIDs on the access point and the number of clients per WLAN, enter this command:

debug ap command "**show capwap mcast mgid all**" *Cisco_AP*

Step 3 To see all of the clients per MGID on the access point and the number of clients per WLAN, enter this command:

debug ap command "**show capwap mcast mgid id** *mgid_value*" *Cisco_AP*

Configuring Client Roaming

The Cisco UWN Solution supports seamless client roaming across lightweight access points managed by the same controller, between controllers in the same mobility group on the same subnet, and across controllers in the same mobility group on different subnets. Also, in controller software release 4.1 or later, client roaming with multicast packets is supported.

You can adjust the default RF settings (RSSI, hysteresis, scan threshold, and transition time) to fine-tune the operation of client roaming using the controller GUI or CLI.

Intra-Controller Roaming

Each controller supports same-controller client roaming across access points managed by the same controller. This roaming is transparent to the client as the session is sustained, and the client continues using the same DHCP-assigned or client-assigned IP address. The controller provides DHCP functionality with a relay function. Same-controller roaming is supported in single-controller deployments and in multiple-controller deployments.

Inter-Controller Roaming

Multiple-controller deployments support client roaming across access points managed by controllers in the same mobility group and on the same subnet. This roaming is also transparent to the client because the session is sustained and a tunnel between controllers allows the client to continue using the same DHCP- or client-assigned IP address as long as the session remains active. The tunnel is torn down, and the client must reauthenticate when the client sends a DHCP Discover with a 0.0.0.0 client IP address or a 169.254.*.* client auto-IP address or when the operator-set session timeout is exceeded.

Inter-Subnet Roaming

Multiple-controller deployments support client roaming across access points managed by controllers in the same mobility group on different subnets. This roaming is transparent to the client because the session is sustained and a tunnel between the controllers allows the client to continue using the same DHCP-assigned or client-assigned IP address as long as the session remains active. The tunnel is torn down, and the client must reauthenticate when the client sends a DHCP Discover with a 0.0.0.0 client IP address or a 169.254.*.* client auto-IP address or when the operator-set user timeout is exceeded.

Voice-over-IP Telephone Roaming

802.11 voice-over-IP (VoIP) telephones actively seek out associations with the strongest RF signal to ensure the best quality of service (QoS) and the maximum throughput. The minimum VoIP telephone requirement of 20-millisecond or shorter latency time for the roaming handover is easily met by the Cisco UWN Solution, which has an average handover latency of 5 or fewer milliseconds when open authentication is used. This short latency period is controlled by controllers rather than allowing independent access points to negotiate roaming handovers.

The Cisco UWN Solution supports 802.11 VoIP telephone roaming across lightweight access points managed by controllers on different subnets, as long as the controllers are in the same mobility group. This roaming is transparent to the VoIP telephone because the session is sustained and a tunnel between controllers allows the VoIP telephone to continue using the same DHCP-assigned IP address as long as the session remains active. The tunnel is torn down, and the VoIP client must reauthenticate when the VoIP telephone sends a DHCP Discover with a 0.0.0.0 VoIP telephone IP address or a 169.254.*.* VoIP telephone auto-IP address or when the operator-set user timeout is exceeded.

CCX Layer 2 Client Roaming

The controller supports five CCX Layer 2 client roaming enhancements:

- **Access point assisted roaming**—This feature helps clients save scanning time. When a CCXv2 client associates to an access point, it sends an information packet to the new access point listing the characteristics of its previous access point. Roaming time decreases when the client recognizes and uses an access point list built by compiling all previous access points to which each client was associated and sent (unicast) to the client immediately after association. The access point list contains the channels, BSSIDs of neighbor access points that support the client's current SSID(s), and time elapsed since disassociation.
- **Enhanced neighbor list**—This feature focuses on improving a CCXv4 client's roam experience and network edge performance, especially when servicing voice applications. The access point provides its associated client information about its neighbors using a neighbor-list update unicast message.

- **Enhanced neighbor list request (E2E)**—The End-2-End specification is a Cisco and Intel joint program that defines new protocols and interfaces to improve the overall voice and roaming experience. It applies only to Intel clients in a CCX environment. Specifically, it enables Intel clients to request a neighbor list at will. When this occurs, the access point forwards the request to the controller. The controller receives the request and replies with the current CCX roaming sublist of neighbors for the access point to which the client is associated.

  Note To see whether a particular client supports E2E, choose **Wireless** > **Clients** on the controller GUI, click the **Detail** link for the desired client, and look at the E2E Version field under Client Properties.

- **Roam reason report**—This feature enables CCXv4 clients to report the reason why they roamed to a new access point. It also allows network administrators to build and monitor a roam history.
- **Directed roam request**—This feature enables the controller to send directed roam requests to the client in situations when the controller can better service the client on an access point different from the one to which it is associated. In this case, the controller sends the client a list of the best access points that it can join. The client can either honor or ignore the directed roam request. Non-CCX clients and clients running CCXv3 or below must not take any action. No configuration is required for this feature.

Controller software release 4.2 or later supports CCX versions 1 through 5. CCX support is enabled automatically for every WLAN on the controller and cannot be disabled. The controller stores the CCX version of the client in its client database and uses it to generate and respond to CCX frames appropriately. Clients must support CCXv4 or v5 (or CCXv2 for access point assisted roaming) in order to utilize these roaming enhancements. See the "Configuring Cisco Client Extensions" section on page 49 for more information on CCX.

The roaming enhancements mentioned above are enabled automatically, with the appropriate CCX support.

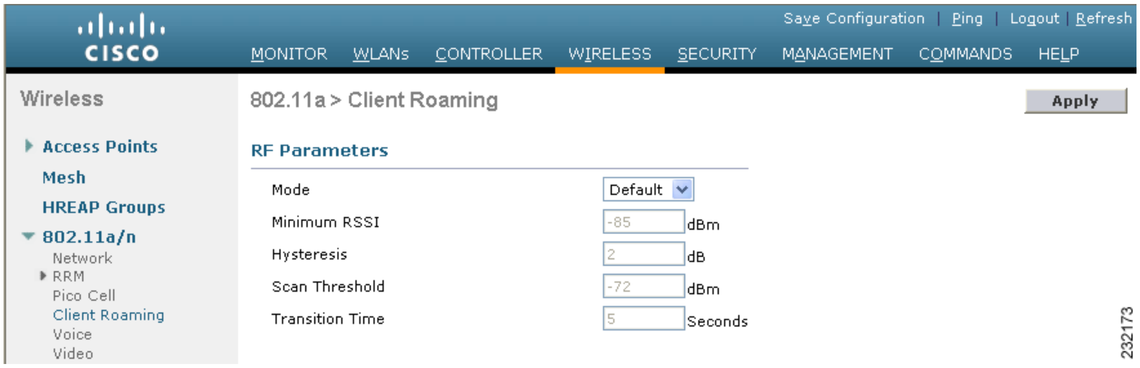
Note Hybrid-REAP access points in standalone mode do not support CCX Layer 2 roaming.

Using the GUI to Configure CCX Client Roaming Parameters

Follow these steps to configure CCX client roaming parameters using the GUI.

Step 1 Choose **Wireless** > **802.11a/n** (or **802.11b/g/n**) > **Client Roaming**. The 802.11a (or 802.11b) > Client Roaming page appears (see Figure 24).

Figure 24 802.11a > Client Roaming Page



802.11a > Client Roaming

RF Parameters

Mode	Default
Minimum RSSI	-85 dBm
Hysteresis	2 dB
Scan Threshold	-72 dBm
Transition Time	5 Seconds

Step 2 If you want to fine-tune the RF parameters that affect client roaming, choose **Custom** from the Mode drop-down box and go to Step 3. If you want to leave the RF parameters at their default values, choose **Default** and go to Step 8.

Step 3 In the Minimum RSSI field, enter a value for the minimum received signal strength indicator (RSSI) required for the client to associate to an access point. If the client's average received signal power dips below this threshold, reliable communication is usually impossible. Therefore, clients must already have found and roamed to another access point with a stronger signal before the minimum RSSI value is reached.

Range: –80 to –90 dBm

Default: –85 dBm

Step 4 In the Hysteresis field, enter a value to indicate how much greater the signal strength of a neighboring access point must be in order for the client to roam to it. This parameter is intended to reduce the amount of roaming between access points if the client is physically located on or near the border between two access points.

Range: 2 to 4 dB

Default: 2 dB

Step 5 In the Scan Threshold field, enter the minimum RSSI that is allowed before the client should roam to a better access point. When the RSSI drops below the specified value, the client must be able to roam to a better access point within the specified transition time. This parameter also provides a power-save method to minimize the time that the client spends in active or passive scanning. For example, the client can scan slowly when the RSSI is above the threshold and scan more rapidly when below the threshold.

Range: –70 to –77 dBm

Default: –72 dBm

Step 6 In the Transition Time field, enter the maximum time allowed for the client to detect a suitable neighboring access point to roam to and to complete the roam, whenever the RSSI from the client's associated access point is below the scan threshold.

The Scan Threshold and Transition Time parameters guarantee a minimum level of client roaming performance. Together with the highest expected client speed and roaming hysteresis, these parameters make it possible to design a wireless LAN network that supports roaming simply by ensuring a certain minimum overlap distance between access points.

Range: 1 to 10 seconds

Default: 5 seconds

Step 7 Click **Apply** to commit your changes.

Step 8 Click **Save Configuration** to save your changes.

Step 9 Repeat this procedure if you want to configure client roaming for another radio band (802.11a or 802.11b/g).

Using the CLI to Configure CCX Client Roaming Parameters

To configure CCX Layer 2 client roaming parameters, enter this command:

config {**802.11a** | **802.11b**} **l2roam rf-params** {**default** | **custom** *min_rssi roam_hyst scan_thresh trans_time*}

Note See the description, range, and default value of each RF parameter in the "Using the GUI to Configure CCX Client Roaming Parameters" section on page 63.

Using the CLI to Obtain CCX Client Roaming Information

Use these commands to view information about CCX Layer 2 client roaming.

1. To view the current RF parameters configured for client roaming for the 802.11a or 802.11b/g network, enter this command:

   show {**802.11a** | **802.11b**} **l2roam rf-param**

2. To view the CCX Layer 2 client roaming statistics for a particular access point, enter this command:

   show {**802.11a** | **802.11b**} **l2roam statistics** *ap_mac*

   This command provides the following information:

   - The number of roam reason reports received
   - The number of neighbor list requests received
   - The number of neighbor list reports sent
   - The number of broadcast neighbor updates sent

3. To view the roaming history for a particular client, enter this command:

   show client roam-history *client_mac*

   This command provides the following information:

   - The time when the report was received
   - The MAC address of the access point to which the client is currently associated
   - The MAC address of the access point to which the client was previously associated
   - The channel of the access point to which the client was previously associated
   - The SSID of the access point to which the client was previously associated
   - The time when the client disassociated from the previous access point
   - The reason for the client roam

Using the CLI to Debug CCX Client Roaming Issues

If you experience any problems with CCX Layer 2 client roaming, enter this command:

debug l2roam [**detail** | **error** | **packet** | **all]** {**enable** | **disable**}

Configuring IP-MAC Address Binding

In controller software release 5.2 or later, the controller enforces strict IP address-to-MAC address binding in client packets. The controller checks the IP address and MAC address in a packet, compares them to the addresses that are registered with the controller, and forwards the packet only if they both match. In previous releases, the controller checks only the MAC address of the client and ignores the IP address.

Note If the IP address or MAC address of the packet has been spoofed, the check does not pass, and the controller discards the packet. Spoofed packets can pass through the controller only if both the IP and MAC addresses are spoofed together and changed to that of another valid client on the same controller.

Using the controller CLI, follow these steps to configure IP-MAC address binding.

Step 1 To enable or disable IP-MAC address binding, enter this command:

config network ip-mac-binding {**enable** | **disable**}

The default value is enabled.

Note You might want to disable this binding check if you have a routed network behind a workgroup bridge (WGB).

Note You must disable this binding check in order to use an access point in sniffer mode if the access point is joined to a 5500 series controller, a 2100 series controller, or a controller network module running software release 6.0.

Step 2 To save your changes, enter this command:

save config

Step 3 To view the status of IP-MAC address binding, enter this command:

show network summary

Information similar to the following appears:

```
RF-Network Name............................ ctrl4404
Web Mode................................... Disable
Secure Web Mode............................ Enable
Secure Web Mode Cipher-Option High.......... Disable
Secure Web Mode Cipher-Option SSLv2......... Enable
...
IP/MAC Addr Binding Check ............... Enabled
...
```

Configuring Quality of Service

Quality of service (QoS) refers to the capability of a network to provide better service to selected network traffic over various technologies. The primary goal of QoS is to provide priority including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics.

The controller supports four QoS levels:

- Platinum/Voice—Ensures a high quality of service for voice over wireless.
- Gold/Video—Supports high-quality video applications.
- Silver/Best Effort—Supports normal bandwidth for clients. This is the default setting.
- Bronze/Background—Provides the lowest bandwidth for guest services.

Note VoIP clients should be set to Platinum.

You can configure the bandwidth of each QoS level using QoS profiles and then apply the profiles to WLANs. The profile settings are pushed to the clients associated to that WLAN. In addition, you can create QoS roles to specify different bandwidth levels for regular and guest users. Follow the instructions in this section to configure QoS profiles and QoS roles.

Configuring Quality of Service Profiles

You can use the controller GUI or CLI to configure the Platinum, Gold, Silver, and Bronze QoS profiles.

Using the GUI to Configure QoS Profiles

Follow these steps to configure QoS profiles using the controller GUI.

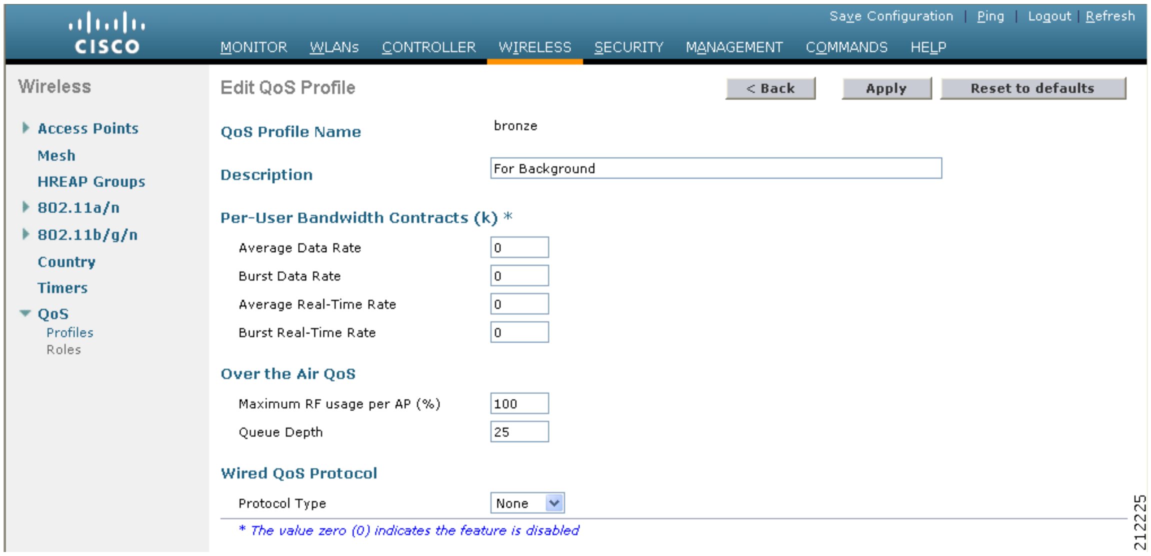
Step 1 Disable the 802.11a and 802.11b/g networks so that you can configure the QoS profiles.

To disable the radio networks, choose **Wireless > 802.11a/n** or **802.11b/g/n > Network**, uncheck the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 2 Choose **Wireless** > **QoS > Profiles** to open the QoS Profiles page.

Step 3 Click the name of the profile that you want to configure to open the Edit QoS Profile page (see Figure 25).

Figure 25 Edit QoS Profile Page



Edit QoS Profile

QoS Profile Name	bronze
Description	For Background
Per-User Bandwidth Contracts (k) *	
Average Data Rate	0
Burst Data Rate	0
Average Real-Time Rate	0
Burst Real-Time Rate	0
Over the Air QoS	
Maximum RF usage per AP (%)	100
Queue Depth	25
Wired QoS Protocol	
Protocol Type	None

* The value zero (0) indicates the feature is disabled

Step 4 To change the description of the profile, modify the contents of the Description field.

Step 5 To define the average data rate for TCP traffic per user, enter the rate in Kbps in the Average Data Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the profile.

Step 6 To define the peak data rate for TCP traffic per user, enter the rate in Kbps in the Burst Data Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the profile.

Note The Burst Data Rate should be greater than or equal to the Average Data Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

Step 7 To define the average real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Average Real-Time Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the profile.

Step 8 To define the peak real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Burst Real-Time Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the profile.

Note The Burst Real-Time Rate should be greater than or equal to the Average Real-Time Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

Step 9 In the Maximum RF Usage Per AP field, enter the maximum percentage of bandwidth given to a user class.

For example, if you set 50% for Bronze QoS, all the Bronze WLAN users combined will not get more than 50% of the available RF bandwidth. Actual throughput could be less than 50%, but it will never be more than 50%.

Step 10 In the Queue Depth field, enter the maximum number of packets that access points keep in their queues. Any additional packets are dropped.

Step 11 To define the maximum value (0–7) for the priority tag associated with packets that fall within the profile, choose **802.1p** from the Protocol Type drop-down box and enter the maximum priority value in the 802.1p Tag field.

The tagged packets include CAPWAP data packets (between access points and the controller) and packets sent toward the core network.

Note If a QoS profile has 802.1p tagging configured and if this QoS profile is assigned to a WLAN that uses an untagged interface on the controller, the client traffic will be blocked.

Step 12 Click **Apply** to commit your changes.

Step 13 Click **Save Configuration** to save your changes.

Step 14 Re-enable the 802.11a and 802.11b/g networks.

To enable the radio networks, choose **Wireless > 802.11a/n** or **802.11b/g/n > Network**, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 15 Follow the instructions in the "Assigning a QoS Profile to a WLAN" section on page 35 to assign a QoS profile to a WLAN.

Using the CLI to Configure QoS Profiles

Follow these steps to configure the Platinum, Gold, Silver, and Bronze QoS profiles using the CLI.

Step 1 To disable the 802.11a and 802.11b/g networks so that you can configure the QoS profiles, enter these commands:

config 802.11a disable network

config 802.11b disable network

Step 2 To change the profile description, enter this command:

config qos description {bronze | silver | gold | platinum} *description*

Step 3 To define the average data rate in Kbps for TCP traffic per user, enter this command:

config qos average-data-rate {bronze | silver | gold | platinum} *rate*

Note For the *rate* parameter, you can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS profile.

Step 4 To define the peak data rate in Kbps for TCP traffic per user, enter this command:

config qos burst-data-rate {bronze | silver | gold | platinum} *rate*

Step 5 To define the average real-time rate in Kbps for UDP traffic per user, enter this command:

config qos average-realtime-rate {bronze | silver | gold | platinum} *rate*

Step 6 To define the peak real-time rate in Kbps for UDP traffic per user, enter this command:

config qos burst-realtime-rate {bronze | silver | gold | platinum} *rate*

Step 7 To specify the maximum percentage of RF usage per access point, enter this command:

config qos max-rf-usage {bronze | silver | gold | platinum} *usage_percentage*

Step 8 To specify the maximum number of packets that access points keep in their queues, enter this command:

config qos queue_length {bronze | silver | gold | platinum} *queue_length*

Note If a QoS profile has 802.1p tagging configured and if this QoS profile is assigned to a WLAN that uses an untagged interface on the controller, the client traffic will be blocked.

Step 9 To define the maximum value (0–7) for the priority tag associated with packets that fall within the profile, enter these commands:

config qos protocol-type {bronze | silver | gold | platinum} dot1p

config qos dot1p-tag {bronze | silver | gold | platinum} *tag*

The tagged packets include CAPWAP data packets (between access points and the controller) and packets sent toward the core network.

Step 10 To re-enable the 802.11a and 802.11b/g networks so that you can configure the QoS profiles, enter these commands:

config 802.11a enable network

config 802.11b enable network

Step 11 Follow the instructions in the "Assigning a QoS Profile to a WLAN" section on page 35 to assign a QoS profile to a WLAN.

Configuring Quality of Service Roles

After you configure a QoS profile and apply it to a WLAN, it limits the bandwidth level of clients associated to that WLAN. Multiple WLANs can be mapped to the same QoS profile, which can result in bandwidth contention between regular users (such as employees) and guest users. In order to prevent guest users from using the same level of bandwidth as regular users, you can create QoS roles with different (and presumably lower) bandwidth contracts and assign them to guest users.

You can use the controller GUI or CLI to configure up to ten QoS roles for guest users.

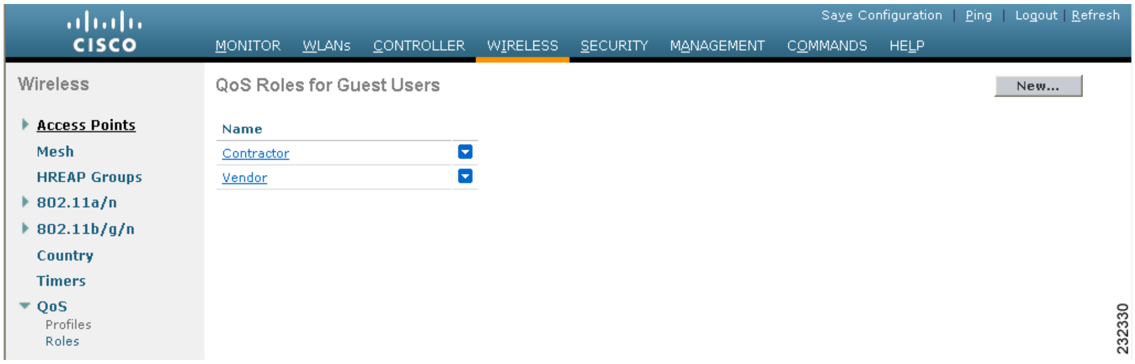
Note If you choose to create an entry on the RADIUS server for a guest user and enable RADIUS authentication for the WLAN on which web authentication is performed rather than adding a guest user to the local user database from the controller, you need to assign the QoS role on the RADIUS server itself. To do so, a "guest-role" Airespace attribute needs to be added on the RADIUS server with a datatype of "string" and a return value of "11." This attribute is sent to the controller when authentication occurs. If a role with the name returned from the RADIUS server is found configured on the controller, the bandwidth associated to that role is enforced for the guest user after authentication completes successfully.

Using the GUI to Configure QoS Roles

Follow these steps to configure QoS roles using the controller GUI.

Step 1 Choose **Wireless > QoS > Roles** to open the QoS Roles for Guest Users page (see Figure 26).

Figure 26 QoS Roles for Guest Users Page


CISCO
Save Configuration | Ping | Logout | Refresh
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP
Wireless
Access Points
Mesh
HREAP Groups
802.11a/n
802.11b/g/n
Country
Timers
QoS
Profiles
Roles
New...
232330

QoS Roles for Guest Users

Name
Contractor
Vendor

This page shows any existing QoS roles for guest users.

Note If you want to delete a QoS role, hover your cursor over the blue drop-down arrow for that role and choose **Remove**.

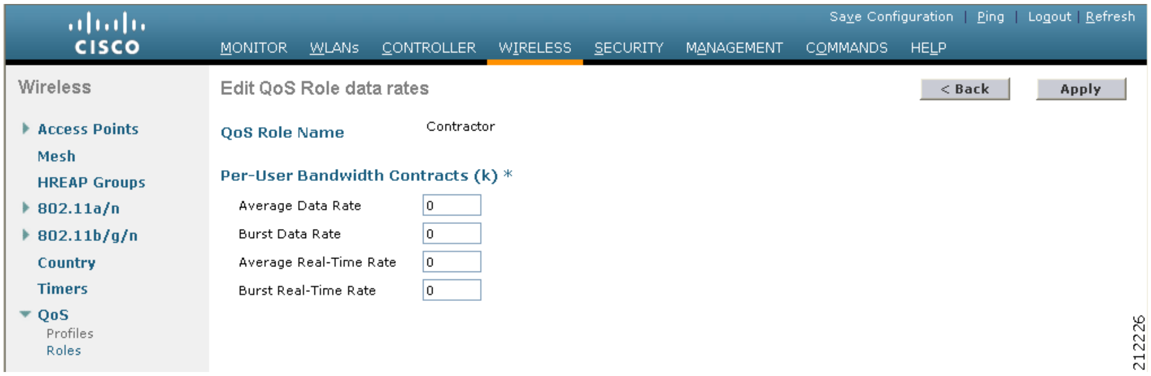
Step 2 To create a new QoS role, click **New**. The QoS Role Name > New page appears.

Step 3 In the Role Name field, enter a name for the new QoS role. The name should uniquely identify the role of the QoS user (such as Contractor, Vendor, and so on).

Step 4 Click **Apply** to commit your changes.

Step 5 To edit the bandwidth of a QoS role, click the name of the QoS role. The Edit QoS Role Data Rates page appears (see Figure 27).

Figure 27 Edit QoS Role Data Rates Page


CISCO
Save Configuration | Ping | Logout | Refresh
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP
Wireless
Access Points
Mesh
HREAP Groups
802.11a/n
802.11b/g/n
Country
Timers
QoS
Profiles
Roles
< Back
Apply
212226

Edit QoS Role data rates

QoS Role Name Contractor

Per-User Bandwidth Contracts (k) *

Average Data Rate	0
Burst Data Rate	0
Average Real-Time Rate	0
Burst Real-Time Rate	0

Note The values that you configure for the per-user bandwidth contracts affect only the amount of bandwidth going downstream (from the access point to the wireless client). They do not affect the bandwidth for upstream traffic (from the client to the access point).

Step 6 To define the average data rate for TCP traffic on a per user basis, enter the rate in Kbps in the Average Data Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS role.

Step 7 To define the peak data rate for TCP traffic on a per user basis, enter the rate in Kbps in the Burst Data Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS role.

Note The Burst Data Rate should be greater than or equal to the Average Data Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

Step 8 To define the average real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Average Real-Time Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS role.

Step 9 To define the peak real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Burst Real-Time Rate field. You can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS role.

Note The Burst Real-Time Rate should be greater than or equal to the Average Real-Time Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

Step 10 Click **Apply** to commit your changes.

Step 11 Click **Save Configuration** to save your changes.

Step 12 To apply a QoS role to a guest user, follow the steps in the "Using the GUI to Configure Local Network Users" section on page 32.

Using the CLI to Configure QoS Roles

Follow these steps to configure QoS roles using the controller CLI.

Step 1 To create a QoS role for a guest user, enter this command:

config netuser guest-role create *role_name*

Note If you want to delete a QoS role, enter this command:
config netuser guest-role delete *role_name*

Step 2 To configure the bandwidth contracts for a QoS role, enter these commands:

- **config netuser guest-role qos data-rate average-data-rate** *role_name rate*—Configures the average data rate for TCP traffic on a per user basis.
- **config netuser guest-role qos data-rate burst-data-rate** *role_name rate*—Configures the peak data rate for TCP traffic on a per user basis.

  Note The Burst Data Rate should be greater than or equal to the Average Data Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

- **config netuser guest-role qos data-rate average-realtime-rate** *role_name rate*—Configures the average real-time rate for UDP traffic on a per user basis.

- **config netuser guest-role qos data-rate burst-realtime-rate** *role_name rate*—Configures the peak real-time rate for UDP traffic on a per user basis.

  Note The Burst Real-Time Rate should be greater than or equal to the Average Real-Time Rate. Otherwise, the QoS policy may block traffic to and from the wireless client.

Note For the *role_name* parameter in each of these commands, enter a name for the new QoS role. The name should uniquely identify the role of the QoS user (such as Contractor, Vendor, and so on). For the *rate* parameter, you can enter a value between 0 and 60,000 Kbps (inclusive). A value of 0 imposes no bandwidth restriction on the QoS role.

Step 3 To apply a QoS role to a guest user, enter this command:

config netuser guest-role apply *username role_name*

For example, the role of *Contractor* could be applied to guest user *jsmith*.

Note If you do not assign a QoS role to a guest user, the Role field in the User Details shows the role as “default.” The bandwidth contracts for this user are defined in the QoS profile for the WLAN.

Note If you want to unassign a QoS role from a guest user, enter this command: **config netuser guest-role apply** *username* **default**. This user now uses the bandwidth contracts defined in the QoS profile for the WLAN.

Step 4 To save your changes, enter this command:

save config

Step 5 To see a list of the current QoS roles and their bandwidth parameters, enter this command:

show netuser guest-roles

Information similar to the following appears:

```
Role Name........................................ Contractor
     Average Data Rate........................... 10
     Burst Data Rate............................. 10
     Average Realtime Rate....................... 100
     Burst Realtime Rate......................... 100

Role Name........................................ Vendor
     Average Data Rate........................... unconfigured
     Burst Data Rate............................. unconfigured
     Average Realtime Rate....................... unconfigured
     Burst Realtime Rate...................... unconfigured
```

Configuring Voice and Video Parameters

Three parameters on the controller affect voice and/or video quality:

- Call admission control
- Expedited bandwidth requests
- Unscheduled automatic power save delivery

Each of these parameters is supported in Cisco Compatible Extensions (CCX) v4 and v5. See the "Configuring Cisco Client Extensions" section on page 49 for more information on CCX.

Note CCX is not supported on the AP1030.

Traffic stream metrics (TSM) can be used to monitor and report issues with voice quality.

Call Admission Control

Call admission control (CAC) enables an access point to maintain controlled quality of service (QoS) when the wireless LAN is experiencing congestion. The Wi-Fi Multimedia (WMM) protocol deployed in CCXv3 ensures sufficient QoS as long as the wireless LAN is not congested. However, in order to maintain QoS under differing network loads, CAC in CCXv4 is required. Two types of CAC are available: bandwidth-based CAC and load-based CAC.

Bandwidth-Based CAC

Bandwidth-based, or static, CAC enables the client to specify how much bandwidth or shared medium time is required to accept a new call and in turn enables the access point to determine whether it is capable of accommodating this particular call. The access point rejects the call if necessary in order to maintain the maximum allowed number of calls with acceptable quality.

The QoS setting for a WLAN determines the level of bandwidth-based CAC support. To use bandwidth-based CAC with voice applications, the WLAN must be configured for Platinum QoS. To use bandwidth-based CAC with video applications, the WLAN must be configured for Gold QoS. Also, make sure that WMM is enabled for the WLAN. See the "Configuring 802.3 Bridging" section on page 54 for QoS and WMM configuration instructions.

Note You must enable admission control (ACM) for CCXv4 clients that have WMM enabled. Otherwise, bandwidth-based CAC does not operate properly.

Load-Based CAC

Load-based CAC incorporates a measurement scheme that takes into account the bandwidth consumed by all traffic types (including that from clients), co-channel access point loads, and co-located channel interference, for voice applications. Load-based CAC also covers the additional bandwidth consumption resulting from PHY and channel impairment.

In load-based CAC, the access point continuously measures and updates the utilization of the RF channel (that is, the percentage of bandwidth that has been exhausted), channel interference, and the additional calls that the access point can admit. The access point admits a new call only if the channel has enough unused bandwidth to support that call. By doing so, load-based CAC prevents over-subscription of the channel and maintains QoS under all conditions of WLAN loading and interference.

Note Load-based CAC is supported only on lightweight access points. If you disable load-based CAC, the access points start using bandwidth-based CAC.

Expedited Bandwidth Requests

The expedited bandwidth request feature enables CCXv5 clients to indicate the urgency of a WMM traffic specifications (TSPEC) request (for example, an e911 call) to the WLAN. When the controller receives this request, it attempts to facilitate the urgency of the call in any way possible without potentially altering the quality of other TSPEC calls that are in progress.

You can apply expedited bandwidth requests to both bandwidth-based and load-based CAC. Expedited bandwidth requests are disabled by default. When this feature is disabled, the controller ignores all expedited requests and processes TSPEC requests as normal TSPEC requests.

See Table 2 for examples of TSPEC request handling for normal TSPEC requests and expedited bandwidth requests.

Table 2 TSPEC Request Handling Examples

CAC Mode	Reserved bandwidth for voice calls[1]	Usage[2]	Normal TSPEC Request	TSPEC with Expedited Bandwidth Request
Bandwidth-based CAC	75% (default setting)	Less than 75%	Admitted	Admitted
		Between 75% and 90% (reserved bandwidth for voice calls exhausted)	Rejected	Admitted
		More than 90%	Rejected	Rejected
Load-based CAC		Less than 75%	Admitted	Admitted
		Between 75% and 85% (reserved bandwidth for voice calls exhausted)	Rejected	Admitted
		More than 85%	Rejected	Rejected

[1] For bandwidth-based CAC, the voice call bandwidth usage is per access point and does not take into account co-channel access points. For load-based CAC, the voice call bandwidth usage is measured for the entire channel.

[2] Bandwidth-based CAC (consumed voice and video bandwidth) or load-based CAC (channel utilization [Pb]).

Note Controller software release 6.0 supports admission control for TSPEC g711-40ms codec type.

Note When video ACM is enabled, the controller rejects a video TSPEC if the Nom-MSDU size in the TSPEC is greater than 149 or the mean data rate is greater than 1 Kb/s.

U-APSD

Unscheduled automatic power save delivery (U-APSD) is a QoS facility defined in IEEE 802.11e that extends the battery life of mobile clients. In addition to extending battery life, this feature reduces the latency of traffic flow delivered over the wireless media. Because U-APSD does not require the client to poll each individual packet buffered at the access point, it allows delivery of multiple downlink packets by sending a single uplink trigger packet. U-APSD is enabled automatically when WMM is enabled.

Traffic Stream Metrics

In a voice-over-wireless LAN (VoWLAN) deployment, traffic stream metrics (TSM) can be used to monitor voice-related metrics on the client-access point air interface. It reports both packet latency and packet loss. An administrator can isolate poor voice quality issues by studying these reports.

The metrics consist of a collection of uplink (client side) and downlink (access point side) statistics between an access point and a client device that supports CCX v4 or later. If the client is not CCX v4 or CCXv5 compliant, only downlink statistics are captured. The client and access point measure these metrics. The access point also collects the measurements every 5 seconds, prepares 90-second reports, and then sends the reports to the controller. The controller organizes the uplink measurements on a client basis and the downlink measurements on an access point basis and maintains an hour's worth of historical data. To store this data, the controller requires 32 MB of additional memory for uplink metrics and 4.8 MB for downlink metrics.

TSM can be configured through either the GUI or the CLI on a per radio-band basis (for example, all 802.11a radios). The controller saves the configuration in flash memory so that it persists across reboots. After an access point receives the configuration from the controller, it enables TSM on the specified radio band.

Note Access points support TSM in both local and hybrid-REAP modes.

Using the GUI to Configure Voice Parameters

Follow these steps to configure voice parameters using the GUI.

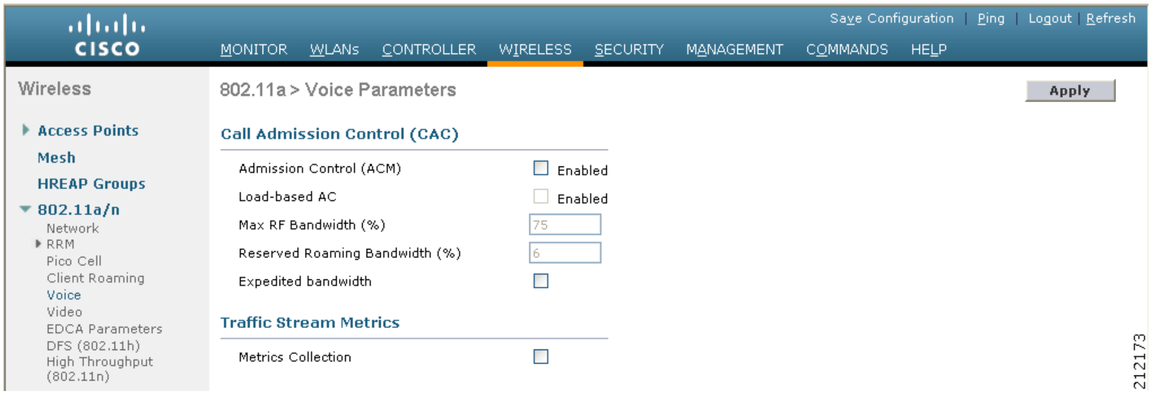
Step 1 Make sure that the WLAN is configured for WMM and the Platinum QoS level.

Step 2 Disable all WLANs with WMM enabled and click **Apply**.

Step 3 To disable the radio network, choose **Wireless** and then **Network** under 802.11a/n or 802.11b/g/n, uncheck the 802.11a (or 802.11b/g) Network Status check box, and click **Apply**.

Step 4 Choose **Voice** under 802.11a/n or 802.11b/g/n. The 802.11a (or 802.11b) > Voice Parameters page appears (see Figure 28).

Figure 28 802.11a > Voice Parameters Page


cisco
Save Configuration | Ping | Logout | Refresh
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP
Wireless
Access Points
Mesh
HREAP Groups
802.11a/n
Network
RRM
Pico Cell
Client Roaming
Voice
Video
EDCA Parameters
DFS (802.11h)
High Throughput (802.11n)
Apply
212173

802.11a > Voice Parameters

Call Admission Control (CAC)

Admission Control (ACM) □ Enabled

Load-based AC □ Enabled

Max RF Bandwidth (%) 75

Reserved Roaming Bandwidth (%) 6

Expedited bandwidth □

Traffic Stream Metrics

Metrics Collection □

Step 5 To enable bandwidth-based CAC for this radio band, check the **Admission Control (ACM)** check box. The default value is disabled.

Step 6 To enable load-based CAC for this radio band, check both the **Admission Control (ACM)** check box and the **Load-based AC** check box. The default value for both check boxes is disabled.

Step 7 In the Max RF Bandwidth field, enter the percentage of the maximum bandwidth allocated to clients for voice applications on this radio band. Once the client reaches the value specified, the access point rejects new calls on this radio band.

Range: 40 to 85%

Default: 75%

Step 8 In the Reserved Roaming Bandwidth field, enter the percentage of maximum allocated bandwidth reserved for roaming voice clients. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming voice clients.

Range: 0 to 25%

Default: 6%

Step 9 To enable expedited bandwidth requests, check the **Expedited Bandwidth** check box. The default value is disabled.

Step 10 To enable TSM, check the **Metrics Collection** check box. The default value is disabled.

Step 11 Click **Apply** to commit your changes.

Step 12 Re-enable all WMM WLANs and click **Apply**.

Step 13 To re-enable the radio network, choose **Network** under 802.11a/n or 802.11b/g/n, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 14 Click **Save Configuration** to save your changes.

Step 15 Repeat this procedure if you want to configure voice parameters for another radio band (802.11a or 802.11b/g).

Using the GUI to Configure Video Parameters

Follow these steps to configure video parameters using the GUI.

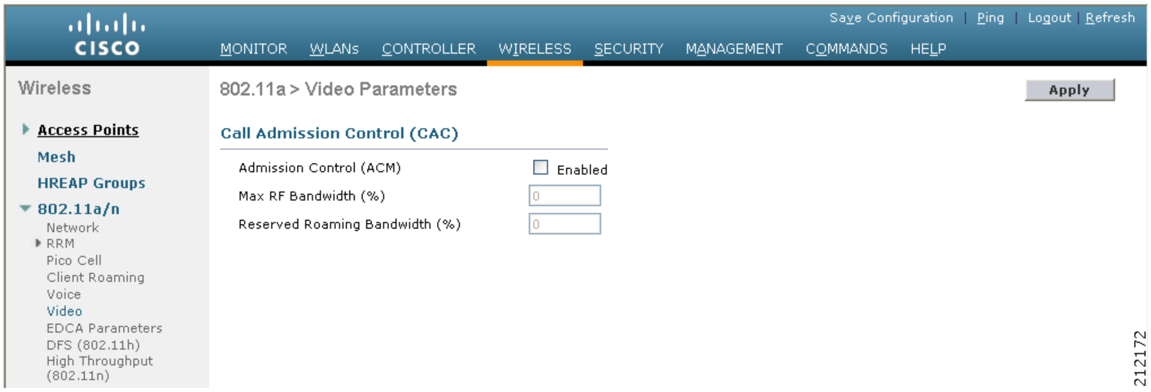
Step 1 Make sure that the WLAN is configured for WMM and the Gold QoS level.

Step 2 Disable all WLANs with WMM enabled and click **Apply**.

Step 3 To disable the radio network, choose **Wireless** and then **Network** under 802.11a/n or 802.11b/g/n, uncheck the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 4 Choose **Video** under 802.11a/n or 802.11b/g/n. The 802.11a (or 802.11b) > Video Parameters page appears (see Figure 28).

Figure 29 ***802.11a > Video Parameters Page***



802.11a > Video Parameters

Call Admission Control (CAC)

Admission Control (ACM) □ Enabled

Max RF Bandwidth (%) 0

Reserved Roaming Bandwidth (%) 0

Step 5 To enable video CAC for this radio band, check the **Admission Control (ACM)** check box. The default value is disabled.

Step 6 In the Max RF Bandwidth field, enter the percentage of the maximum bandwidth allocated to clients for video applications on this radio band. Once the client reaches the value specified, the access point rejects new requests on this radio band.

Range: 0 to 100% (However, the maximum RF bandwidth cannot exceed 100% for voice + video.)

Default: 0%

Note If this parameter is set to zero (0), the controller assumes that the operator does not want to do any bandwidth allocation and, therefore, allows all bandwidth requests.

Step 7 In the Reserved Roaming Bandwidth field, enter the percentage of maximum allocated bandwidth reserved for roaming video clients. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming video clients.

Range: 0 to 25%

Default: 0%

Step 8 Click **Apply** to commit your changes.

Step 9 Re-enable all WMM WLANs and click **Apply**.

Step 10 To re-enable the radio network, choose **Network** under 802.11a/n or 802.11b/g/n, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 11 Click **Save Configuration** to save your changes.

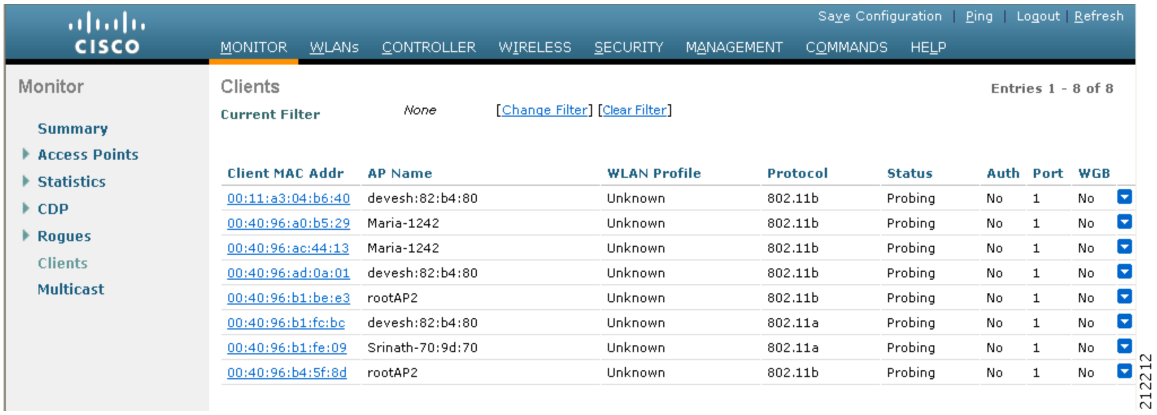
Step 12 Repeat this procedure if you want to configure video parameters for another radio band (802.11a or 802.11b/g).

Using the GUI to View Voice and Video Settings

Follow these steps to view voice and video settings using the GUI.

Step 1 Choose **Monitor** > **Clients** to open the Clients page (see Figure 30).

Figure 30 Clients Page



Clients

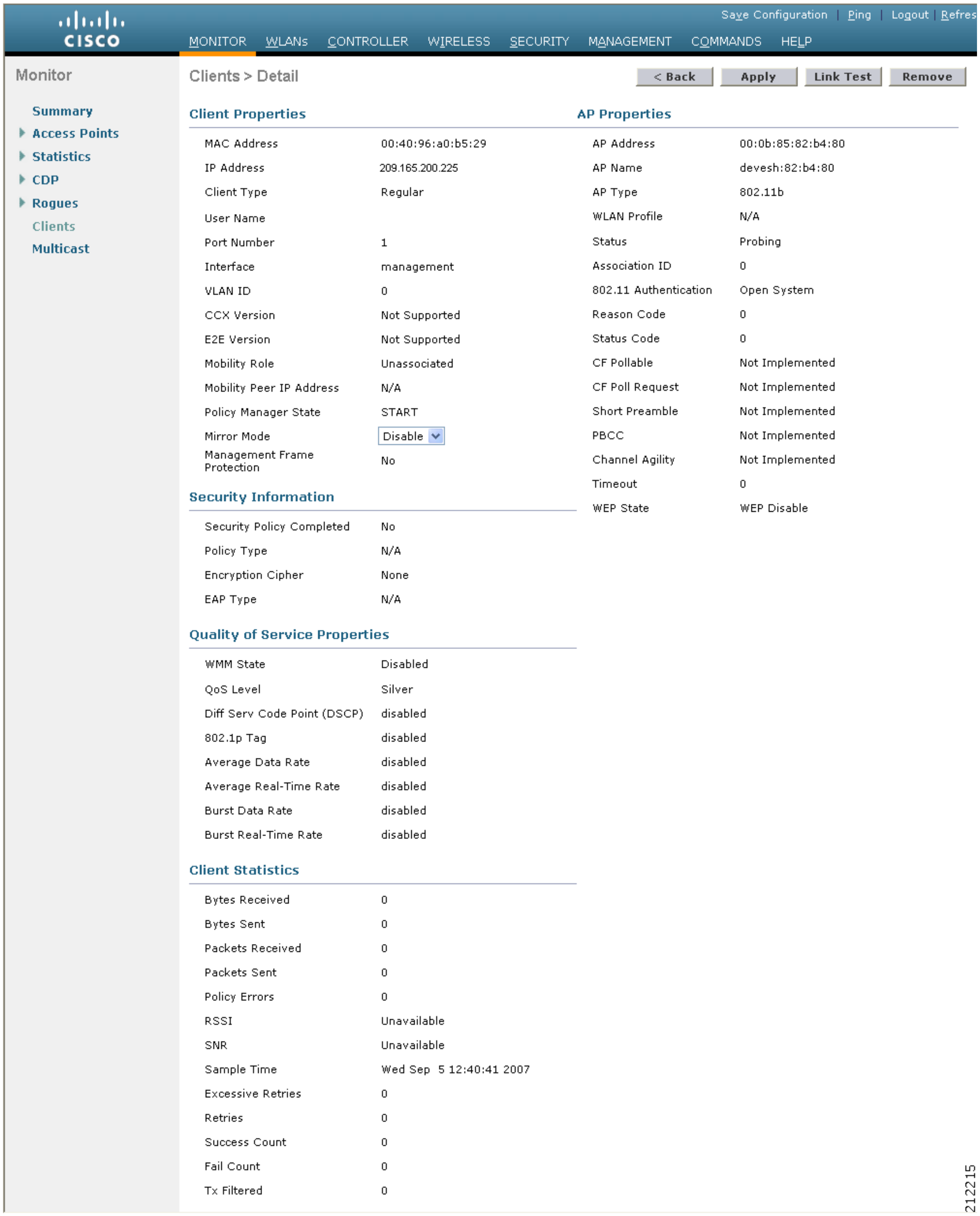
Entries 1 - 8 of 8

Current Filter None [Change Filter] [Clear Filter]

Client MAC Addr	AP Name	WLAN Profile	Protocol	Status	Auth	Port	WGB
00:11:a3:04:b6:40	devesh:82:b4:80	Unknown	802.11b	Probing	No	1	No
00:40:96:a0:b5:29	Maria-1242	Unknown	802.11b	Probing	No	1	No
00:40:96:ac:44:13	Maria-1242	Unknown	802.11b	Probing	No	1	No
00:40:96:ad:0a:01	devesh:82:b4:80	Unknown	802.11b	Probing	No	1	No
00:40:96:b1:be:e3	rootAP2	Unknown	802.11b	Probing	No	1	No
00:40:96:b1:fc:bc	devesh:82:b4:80	Unknown	802.11a	Probing	No	1	No
00:40:96:b1:fe:09	Srinath-70:9d:70	Unknown	802.11a	Probing	No	1	No
00:40:96:b4:5f:8d	rootAP2	Unknown	802.11b	Probing	No	1	No

Step 2 Click the MAC address of the desired client to open the Clients > Detail page (see Figure 31).

Figure 31 Clients > Detail Page



Clients > Detail

Client Properties

MAC Address	00:40:96:a0:b5:29
IP Address	209.165.200.225
Client Type	Regular
User Name	
Port Number	1
Interface	management
VLAN ID	0
CCX Version	Not Supported
E2E Version	Not Supported
Mobility Role	Unassociated
Mobility Peer IP Address	N/A
Policy Manager State	START
Mirror Mode	Disable
Management Frame Protection	No

AP Properties

AP Address	00:0b:85:82:b4:80
AP Name	devesh:82:b4:80
AP Type	802.11b
WLAN Profile	N/A
Status	Probing
Association ID	0
802.11 Authentication	Open System
Reason Code	0
Status Code	0
CF Pollable	Not Implemented
CF Poll Request	Not Implemented
Short Preamble	Not Implemented
PBCC	Not Implemented
Channel Agility	Not Implemented
Timeout	0
WEP State	WEP Disable

Security Information

Security Policy Completed	No
Policy Type	N/A
Encryption Cipher	None
EAP Type	N/A

Quality of Service Properties

WMM State	Disabled
QoS Level	Silver
Diff Serv Code Point (DSCP)	disabled
802.1p Tag	disabled
Average Data Rate	disabled
Average Real-Time Rate	disabled
Burst Data Rate	disabled
Burst Real-Time Rate	disabled

Client Statistics

Bytes Received	0
Bytes Sent	0
Packets Received	0
Packets Sent	0
Policy Errors	0
RSSI	Unavailable
SNR	Unavailable
Sample Time	Wed Sep 5 12:40:41 2007
Excessive Retries	0
Retries	0
Success Count	0
Fail Count	0
Tx Filtered	0

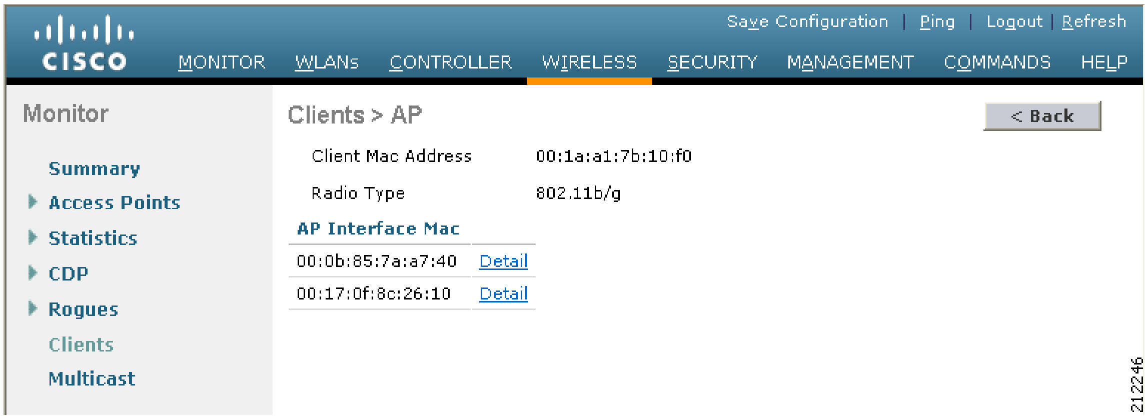
This page shows the U-APSD status (if enabled) for this client under Quality of Service Properties.

Step 3 Click **Back** to return to the Clients page.

Step 4 Follow these steps to see the TSM statistics for a particular client and the access point to which this client is associated.

a. Hover your cursor over the blue drop-down arrow for the desired client and choose **802.11aTSM** or **802.11b/gTSM**. The Clients > AP page appears (see Figure 32).

Figure 32 Clients > AP Page


Save Configuration | Ping | Logout | Refresh
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP
Monitor
Summary
Access Points
Statistics
CDP
Rogues
Clients
Multicast
< Back
212246

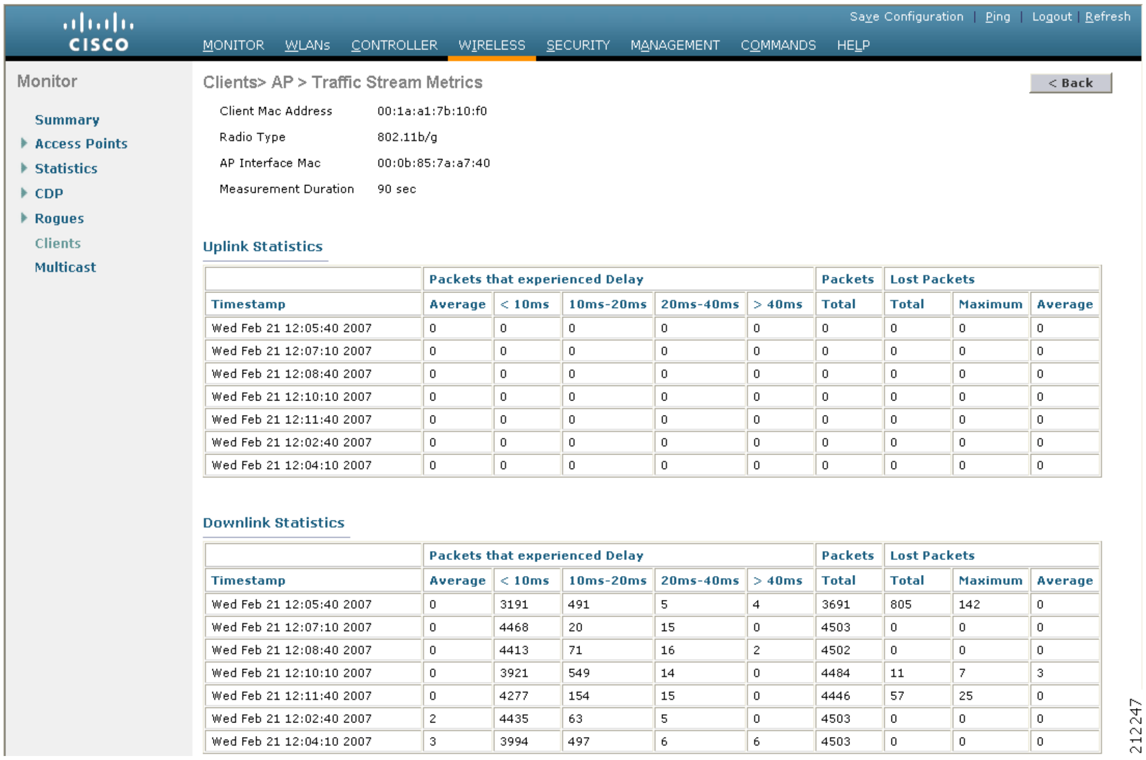
Clients > AP

Client Mac Address	00:1a:a1:7b:10:f0
Radio Type	802.11b/g

AP Interface Mac	
00:0b:85:7a:a7:40	Detail
00:17:0f:8c:26:10	Detail

b. Click the **Detail** link for the desired access point to open the Clients > AP > Traffic Stream Metrics page (see Figure 33).

Figure 33 Clients > AP > Traffic Stream Metrics Page


Save Configuration | Ping | Logout | Refresh
MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS HELP
Monitor
Summary
Access Points
Statistics
CDP
Rogues
Clients
Multicast
< Back
212247

Clients> AP > Traffic Stream Metrics

Client Mac Address	00:1a:a1:7b:10:f0
Radio Type	802.11b/g
AP Interface Mac	00:0b:85:7a:a7:40
Measurement Duration	90 sec

Uplink Statistics

	Packets that experienced Delay					Packets	Lost Packets		
Timestamp	Average	< 10ms	10ms-20ms	20ms-40ms	> 40ms	Total	Total	Maximum	Average
Wed Feb 21 12:05:40 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:07:10 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:08:40 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:10:10 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:11:40 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:02:40 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:04:10 2007	0	0	0	0	0	0	0	0	0

Downlink Statistics

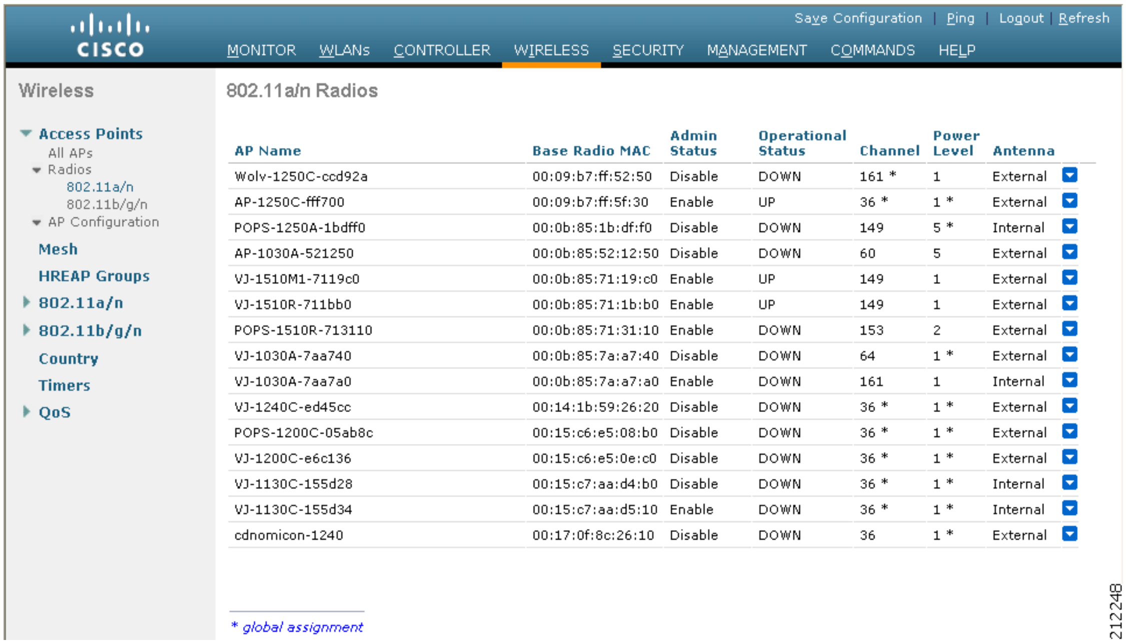
	Packets that experienced Delay					Packets	Lost Packets		
Timestamp	Average	< 10ms	10ms-20ms	20ms-40ms	> 40ms	Total	Total	Maximum	Average
Wed Feb 21 12:05:40 2007	0	3191	491	5	4	3691	805	142	0
Wed Feb 21 12:07:10 2007	0	4468	20	15	0	4503	0	0	0
Wed Feb 21 12:08:40 2007	0	4413	71	16	2	4502	0	0	0
Wed Feb 21 12:10:10 2007	0	3921	549	14	0	4484	11	7	3
Wed Feb 21 12:11:40 2007	0	4277	154	15	0	4446	57	25	0
Wed Feb 21 12:02:40 2007	2	4435	63	5	0	4503	0	0	0
Wed Feb 21 12:04:10 2007	3	3994	497	6	6	4503	0	0	0

This page shows the TSM statistics for this client and the access point to which it is associated. The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Step 5 Follow these steps to see the TSM statistics for a particular access point and a particular client associated to this access point.

a. Choose **Wireless** > **Access Points** > **Radios** > **802.11a/n** or **802.11b/g/n**. The 802.11a/n Radios or 802.11b/g/n Radios page appears (see Figure 34).

Figure 34 802.11a/n Radios Page



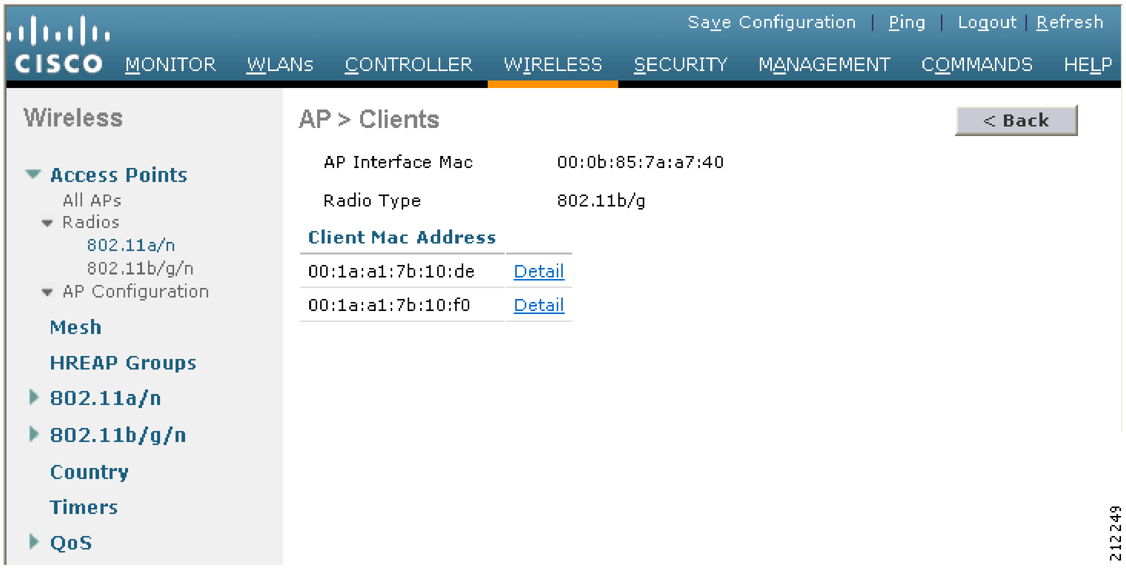
802.11a/n Radios

AP Name	Base Radio MAC	Admin Status	Operational Status	Channel	Power Level	Antenna
Wolv-1250C-ccd92a	00:09:b7:ff:52:50	Disable	DOWN	161 *	1	External
AP-1250C-fff700	00:09:b7:ff:5f:30	Enable	UP	36 *	1 *	External
POPS-1250A-1bdff0	00:0b:85:1b:df:f0	Disable	DOWN	149	5 *	Internal
AP-1030A-521250	00:0b:85:52:12:50	Disable	DOWN	60	5	External
VJ-1510M1-7119c0	00:0b:85:71:19:c0	Enable	UP	149	1	External
VJ-1510R-711bb0	00:0b:85:71:1b:b0	Enable	UP	149	1	External
POPS-1510R-713110	00:0b:85:71:31:10	Enable	DOWN	153	2	External
VJ-1030A-7aa740	00:0b:85:7a:a7:40	Disable	DOWN	64	1 *	External
VJ-1030A-7aa7a0	00:0b:85:7a:a7:a0	Enable	DOWN	161	1	Internal
VJ-1240C-ed45cc	00:14:1b:59:26:20	Disable	DOWN	36 *	1 *	External
POPS-1200C-05ab8c	00:15:c6:e5:08:b0	Disable	DOWN	36 *	1 *	External
VJ-1200C-e6c136	00:15:c6:e5:0e:c0	Disable	DOWN	36 *	1 *	External
VJ-1130C-155d28	00:15:c7:aa:d4:b0	Disable	DOWN	36 *	1 *	Internal
VJ-1130C-155d34	00:15:c7:aa:d5:10	Enable	DOWN	36 *	1 *	Internal
cdnomicon-1240	00:17:0f:8c:26:10	Disable	DOWN	36	1 *	External

* global assignment

b. Hover your cursor over the blue drop-down arrow for the desired access point and choose **802.11aTSM** or **802.11b/gTSM**. The AP > Clients page appears (see Figure 35).

Figure 35 AP > Clients Page



AP > Clients

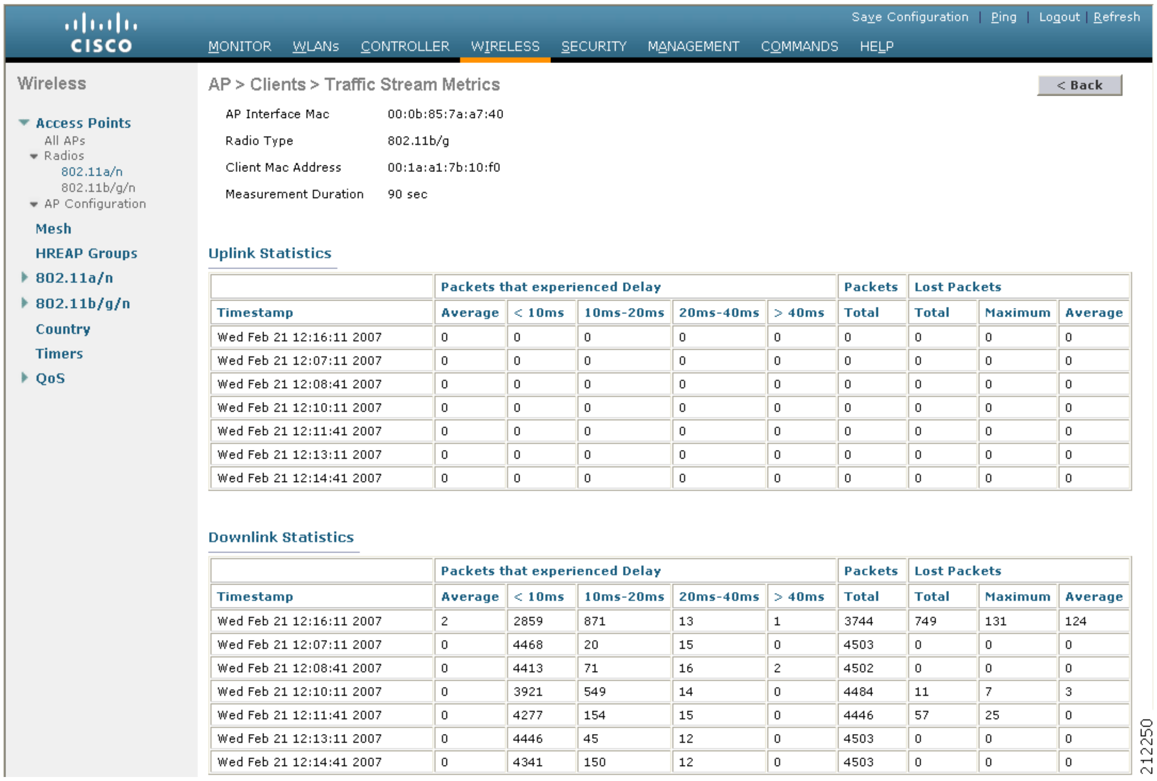
AP Interface Mac 00:0b:85:7a:a7:40

Radio Type 802.11b/g

Client Mac Address	
00:1a:a1:7b:10:de	Detail
00:1a:a1:7b:10:f0	Detail

c. Click the **Detail** link for the desired client to open the AP > Clients > Traffic Stream Metrics page (see Figure 36).

Figure 36 AP > Clients > Traffic Stream Metrics Page



AP > Clients > Traffic Stream Metrics

AP Interface Mac 00:0b:85:7a:a7:40

Radio Type 802.11b/g

Client Mac Address 00:1a:a1:7b:10:f0

Measurement Duration 90 sec

Uplink Statistics

	Packets that experienced Delay					Packets	Lost Packets		
Timestamp	Average	< 10ms	10ms-20ms	20ms-40ms	> 40ms	Total	Total	Maximum	Average
Wed Feb 21 12:16:11 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:07:11 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:08:41 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:10:11 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:11:41 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:13:11 2007	0	0	0	0	0	0	0	0	0
Wed Feb 21 12:14:41 2007	0	0	0	0	0	0	0	0	0

Downlink Statistics

	Packets that experienced Delay					Packets	Lost Packets		
Timestamp	Average	< 10ms	10ms-20ms	20ms-40ms	> 40ms	Total	Total	Maximum	Average
Wed Feb 21 12:16:11 2007	2	2859	871	13	1	3744	749	131	124
Wed Feb 21 12:07:11 2007	0	4468	20	15	0	4503	0	0	0
Wed Feb 21 12:08:41 2007	0	4413	71	16	2	4502	0	0	0
Wed Feb 21 12:10:11 2007	0	3921	549	14	0	4484	11	7	3
Wed Feb 21 12:11:41 2007	0	4277	154	15	0	4446	57	25	0
Wed Feb 21 12:13:11 2007	0	4446	45	12	0	4503	0	0	0
Wed Feb 21 12:14:41 2007	0	4341	150	12	0	4503	0	0	0

This page shows the TSM statistics for this access point and a client associated to it. The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Using the CLI to Configure Voice Parameters

Follow these steps to configure voice parameters using the CLI.

Step 1 To see all of the WLANs configured on the controller, enter this command:

show wlan summary

Step 2 To make sure that the WLAN you are planning to modify is configured for WMM and the QoS level is set to Platinum, enter this command:

show wlan *wlan_id*

Step 3 To disable all WLANs with WMM enabled prior to changing the voice parameters, enter this command:

config wlan disable *wlan_id*

Step 4 To disable the radio network, enter this command:

config {**802.11a** | **802.11b**} **disable network**

Step 5 To save your settings, enter this command:

save config

Step 6 To enable or disable bandwidth-based voice CAC for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac voice acm** {**enable** | **disable**}

Step 7 To set the percentage of maximum bandwidth allocated to clients for voice applications on the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac voice max-bandwidth** *bandwidth*

The *bandwidth* range is 40 to 85%, and the default value is 75%. Once the client reaches the value specified, the access point rejects new calls on this network.

Step 8 To set the percentage of maximum allocated bandwidth reserved for roaming voice clients, enter this command:

config {**802.11a** | **802.11b**} **cac voice roam-bandwidth** *bandwidth*

The *bandwidth* range is 0 to 25%, and the default value is 6%. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming voice clients.

Step 9 To process or ignore the TSPEC inactivity timeout received from an access point, enter this command:

config {**802.11a** | **802.11b**} **cac voice tspec-inactivity-timeout** {**enable** | **ignore**}

Step 10 To enable or disable load-based CAC for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac voice load-based** {**enable** | **disable**}

Step 11 To configure the number of aggregated voice WMM traffic specification (TSPEC) streams at a specified data rate for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac voice stream-size** *number* **max-streams** *mean_datarate*

The *number* range is 1 to 5 voice streams, and the default value is 2. The *mean_datarate* range is 84 to 91.2 Kbps, and the default value is 84 Kbps.

Step 12 To enable or disable expedited bandwidth requests for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **exp-bwreq** {**enable** | **disable**}

Step 13 To enable or disable TSM for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **tsm** {**enable** | **disable**}

Step 14 To re-enable all WLANs with WMM enabled, enter this command:

config wlan enable *wlan_id*

Step 15 To re-enable the radio network, enter this command:

config {**802.11a** | **802.11b**} **enable network**

Step 16 To save your settings, enter this command:

save config

Using the CLI to Configure Video Parameters

Follow these steps to configure video parameters using the CLI.

Step 1 To see all of the WLANs configured on the controller, enter this command:

show wlan summary

Step 2 To make sure that the WLAN you are planning to modify is configured for WMM and the QoS level is set to Gold, enter this command:

show wlan *wlan_id*

Step 3 To disable all WLANs with WMM enabled prior to changing the video parameters, enter this command:

config wlan disable *wlan_id*

Step 4 To disable the radio network, enter this command:

config {**802.11a** | **802.11b**} **disable network**

Step 5 To save your settings, enter this command:

save config

Step 6 To enable or disable video CAC for the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac video acm** {**enable** | **disable**}

Step 7 To set the percentage of maximum bandwidth allocated to clients for video applications on the 802.11a or 802.11b/g network, enter this command:

config {**802.11a** | **802.11b**} **cac video max-bandwidth** *bandwidth*

The *bandwidth* range is 0 to 100%, and the default value is 0%. However, the maximum RF bandwidth cannot exceed 100% for voice + video. Once the client reaches the value specified, the access point rejects new calls on this network.

Note If this parameter is set to zero (0), the controller assumes that the operator does not want to do any bandwidth allocation and, therefore, allows all bandwidth requests.

Step 8 To set the percentage of maximum allocated bandwidth reserved for roaming video clients, enter this command:

config {**802.11a** | **802.11b**} **cac video roam-bandwidth** *bandwidth*

The *bandwidth* range is 0 to 25%, and the default value is 0%. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming video clients.

Step 9 To process or ignore the TSPEC inactivity timeout received from an access point, enter this command:

config {**802.11a** | **802.11b**} **cac video tspec-inactivity-timeout** {**enable** | **ignore**}

Step 10 To re-enable all WLANs with WMM enabled, enter this command:

config wlan enable *wlan_id*

Step 11 To re-enable the radio network, enter this command:

config {**802.11a** | **802.11b**} **enable network**

Step 12 To save your settings, enter this command:

save config

Using the CLI to View Voice and Video Settings

Use these commands to view voice and video settings using the CLI.

1. To see the CAC configuration for the 802.11a or 802.11b/g network, enter this command:

   show {**802.11a** | **show 802.11b**}

2. To see the CAC statistics for a particular access point, enter this command:

   show ap stats {**802.11a** | **802.11b**} *ap_name*

   Information similar to the following appears:

```
Call Admission Control (CAC) Stats
  Voice Bandwidth in use(% of config bw)......... 0
    Total channel MT free........................ 0
    Total voice MT free.......................... 0
    Na Direct.................................... 0
    Na Roam...................................... 0
  Video Bandwidth in use(% of config bw)......... 0
  Total num of voice calls in progress........... 0
  Num of roaming voice calls in progress......... 0
  Total Num of voice calls since AP joined....... 0
  Total Num of roaming calls since AP joined..... 0
  Total Num of exp bw requests received.......... 5
  Total Num of exp bw requests admitted.......... 2

Num of voice calls rejected since AP joined...... 0
  Num of roam calls rejected since AP joined..... 0
  Num of calls rejected due to insufficient bw....0
  Num of calls rejected due to invalid params.... 0
  Num of calls rejected due to PHY rate.......... 0
  Num of calls rejected due to QoS policy..... 0
```

In the example above, “MT” is medium time, “Na” is the number of additional calls, and “exp bw” is expedited bandwidth.

3. To see the U-APSD status for a particular client, enter this command:

   show client detail *client_mac*

4. To see the TSM statistics for a particular client and the access point to which this client is associated, enter this command:

   show client tsm {**802.11a** | **802.11b**} *client_mac* {*ap_ma*c | **all**}

   The optional **all** command shows all access points to which this client has associated. Information similar to the following appears:

```
AP Interface Mac:                   00:0b:85:01:02:03
Client Interface Mac:               00:01:02:03:04:05
Measurement Duration:               90 seconds

  Timestamp                           1st Jan 2006, 06:35:80
    UpLink Stats
    ================
       Average Delay (5sec intervals)............................35
       Delay less than 10 ms.....................................20
       Delay bet 10 - 20 ms......................................20
       Delay bet 20 - 40 ms......................................20
       Delay greater than 40 ms..................................20
      Total packet Count.........................................80
      Total packet lost count (5sec).............................10
      Maximum Lost Packet count(5sec).............................5
      Average Lost Packet count(5secs)............................2
    DownLink Stats
    ================
       Average Delay (5sec intervals)............................35
       Delay less than 10 ms.....................................20
       Delay bet 10 - 20 ms......................................20
       Delay bet 20 - 40 ms......................................20
       Delay greater than 40 ms..................................20
      Total packet Count.........................................80
      Total packet lost count (5sec).............................10
      Maximum Lost Packet count(5sec).............................5
      Average Lost Packet count(5secs)............................2
```

Note The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Note To clear the TSM statistics for a particular access point or all the access points to which this client is associated, enter this command: **clear client tsm** {**802.11a** | **802.11b**} *client_mac* {*ap_ma*c | **all**}.

5. To see the TSM statistics for a particular access point and a particular client associated to this access point, enter this command:

   show ap stats {**802.11a** | **802.11b**} *ap_name* **tsm** {*client_mac* | **all**}

   The optional **all** command shows all clients associated to this access point. Information similar to the following appears:

```
AP Interface Mac:                   00:0b:85:01:02:03
Client Interface Mac:               00:01:02:03:04:05
Measurement Duration:               90 seconds

  Timestamp                           1st Jan 2006, 06:35:80
    UpLink Stats
    ================
       Average Delay (5sec intervals)............................35
       Delay less than 10 ms.....................................20
       Delay bet 10 - 20 ms......................................20
       Delay bet 20 - 40 ms......................................20
       Delay greater than 40 ms..................................20
      Total packet Count.........................................80
      Total packet lost count (5sec).............................10
      Maximum Lost Packet count(5sec)............................5
      Average Lost Packet count(5secs)...........................2
    DownLink Stats
    ================
       Average Delay (5sec intervals)............................35
       Delay less than 10 ms.....................................20
       Delay bet 10 - 20 ms......................................20
       Delay bet 20 - 40 ms......................................20
       Delay greater than 40 ms..................................20
      Total packet Count.........................................80
      Total packet lost count (5sec).............................10
      Maximum Lost Packet count(5sec)............................5
      Average Lost Packet count(5secs)...........................2
```

Note The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

6. To enable or disable debugging for call admission control (CAC) messages, events, or packets, enter this command:

   debug cac {**all** | **event** | **packet**}{**enable** | **disable**}

   where **all** configures debugging for all CAC messages, **event** configures debugging for all CAC events, and **packet** configures debugging for all CAC packets.

Configuring EDCA Parameters

Enhanced distributed channel access (EDCA) parameters are designed to provide preferential wireless channel access for voice, video, and other quality-of-service (QoS) traffic. Follow the instructions in this section to configure EDCA parameters using the controller GUI or CLI.

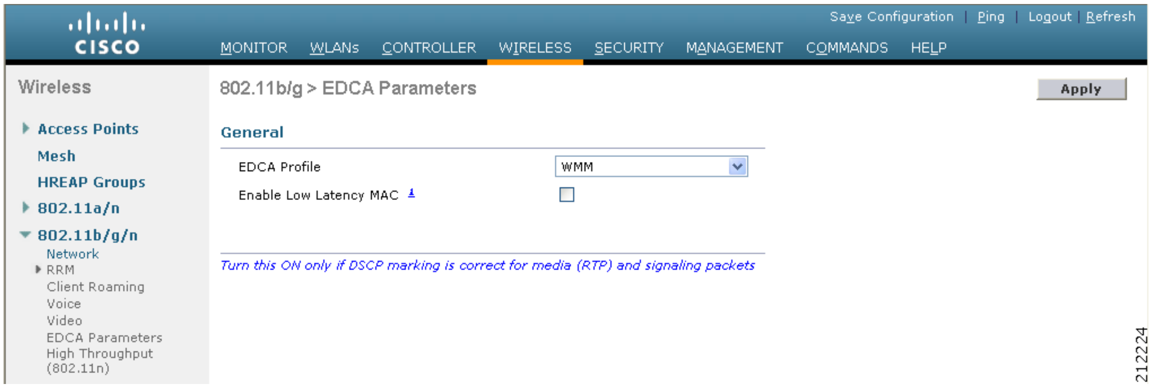
Using the GUI to Configure EDCA Parameters

Follow these steps to configure EDCA parameters using the controller GUI.

Step 1 To disable the radio network, choose **Wireless** and then **Network** under 802.11a/n or 802.11b/g/n, uncheck the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 2 Choose **EDCA Parameters** under 802.11a/n or 802.11b/g/n. The 802.11a (or 802.11b/g) > EDCA Parameters page appears (see Figure 37).

Figure 37 802.11a > EDCA Parameters Page



802.11b/g > EDCA Parameters

General

EDCA Profile: WMM

Enable Low Latency MAC [1] ☐

[1] *Turn this ON only if DSCP marking is correct for media (RTP) and signaling packets*

Step 3 Choose one of the following options from the EDCA Profile drop-down box:

- **WMM**—Enables the Wi-Fi Multimedia (WMM) default parameters. This is the default value. Choose this option when voice or video services are not deployed on your network.
- **Spectralink Voice Priority**—Enables SpectraLink voice priority parameters. Choose this option if SpectraLink phones are deployed on your network to improve the quality of calls.
- **Voice Optimized**—Enables EDCA voice-optimized profile parameters. Choose this option when voice services other than SpectraLink are deployed on your network.
- **Voice & Video Optimized**—Enables EDCA voice- and video-optimized profile parameters. Choose this option when both voice and video services are deployed on your network.

Note If you deploy video services, admission control (ACM) must be disabled.

Step 4 If you want to enable MAC optimization for voice, check the **Enable Low Latency MAC** check box. Otherwise, leave this check box unchecked, which is the default value. This feature enhances voice performance by controlling packet retransmits and appropriately aging out voice packets on lightweight access points, thereby improving the number of voice calls serviced per access point.

Note You should enable low latency MAC only if the WLAN allows WMM clients. If WMM is enabled, then low latency MAC can be used with any of the EDCA profiles. Refer to the "Configuring QoS Enhanced BSS" section on page 37 for instructions on enabling WMM.

Caution We recommend that you not use the low latency MAC feature if you are using the 1140, 1250, 1260, and 3500 series access points that are based on the Marvell platform. If used, the data packets are retried at the data rate specified multiple times without downshifting the rates.
We also recommend that you not use the low latency MAC feature if you are using the 1120, 1130, 1230, and 1240 series access points (not based on the Marvell platform). If used, the number of retries is reduced to 3 with the first retry at the initial rate.

Step 5 Click **Apply** to commit your changes.

Step 6 To re-enable the radio network, choose **Network** under 802.11a/n or 802.11b/g/n, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 7 Click **Save Configuration** to save your changes.

Using the CLI to Configure EDCA Parameters

Follow these steps to configure EDCA parameters using the CLI.

Step 1 To disable the radio network, enter this command:

config {**802.11a** | **802.11b**} **disable network**

Step 2 To save your settings, enter this command:

save config

Step 3 To enable a specific EDCA profile, enter this command:

config advanced {**802.11a** | **802.11b**} **edca-parameters** *?*

where *?* is one of the following:

- **wmm-default**—Enables the Wi-Fi Multimedia (WMM) default parameters. This is the default value. Choose this option when voice or video services are not deployed on your network.
- **svp-voice**—Enables SpectraLink voice priority parameters. Choose this option if SpectraLink phones are deployed on your network to improve the quality of calls.
- **optimized-voice**—Enables EDCA voice-optimized profile parameters. Choose this option when voice services other than SpectraLink are deployed on your network.
- **optimized-video-voice**—Enables EDCA voice- and video-optimized profile parameters. Choose this option when both voice and video services are deployed on your network.

Note If you deploy video services, admission control (ACM) must be disabled.

Step 4 To view the current status of MAC optimization for voice, enter this command:

show {**802.11a** | **802.11b**}

Information similar to the following appears:

```
Voice-mac-optimization...................Disabled
```

Step 5 To enable or disable MAC optimization for voice, enter this command:

config advanced {**802.11a** | **802.11b**} **voice-mac-optimization** {**enable** | **disable**}

This feature enhances voice performance by controlling packet retransmits and appropriately aging out voice packets on lightweight access points, thereby improving the number of voice calls serviced per access point. The default value is disabled.

Step 6 To re-enable the radio network, enter this command:

config {**802.11a** | **802.11b**} **enable network**

Step 7 To save your settings, enter this command:

save config

Configuring Cisco Discovery Protocol

Cisco Discovery Protocol (CDP) is a device discovery protocol that runs on all Cisco-manufactured equipment. A device enabled with CDP sends out periodic interface updates to a multicast address in order to make itself known to neighboring devices.

The default value for the frequency of periodic transmissions is 60 seconds, and the default advertised time-to-live value is 180 seconds. The second and latest version of the protocol, CDPv2, introduces new time-length-values (TLVs) and provides a reporting mechanism that allows for more rapid error tracking, thereby reducing down time.

CDPv1 and CDPv2 are supported on the following devices:

- 5500, 4400, and 2100 series controllers

  Note CDP is not supported on the controllers that are integrated into Cisco switches and routers, including those in the Catalyst 3750G Integrated Wireless LAN Controller Switch, the Cisco WiSM, and the Cisco 28/37/38xx Series Integrated Services Router. However, you can use the **show ap cdp neighbors detail** {*Cisco_AP* | **all**} command on these controllers in order to see the list of CDP neighbors for the access points that are connected to the controller.

- CAPWAP- enabled access points
- An access point connected directly to a 5500, 4400, or 2100 series controller

This support enables network management applications to discover Cisco devices.

These TLVs are supported by both the controller and the access point:

- **Device-ID TLV: 0x0001**—The host name of the controller, the access point, or the CDP neighbor.

- **Address TLV: 0x0002**—The IP address of the controller, the access point, or the CDP neighbor.
- **Port-ID TLV: 0x0003**—The name of the interface on which CDP packets are sent out.
- **Capabilities TLV: 0x0004**—The capabilities of the device. The controller sends out this TLV with a value of Host: 0x10, and the access point sends out this TLV with a value of Transparent Bridge: 0x02.

- **Version TLV: 0x0005**—The software version of the controller, the access point, or the CDP neighbor.
- **Platform TLV: 0x0006**—The hardware platform of the controller, the access point, or the CDP neighbor.

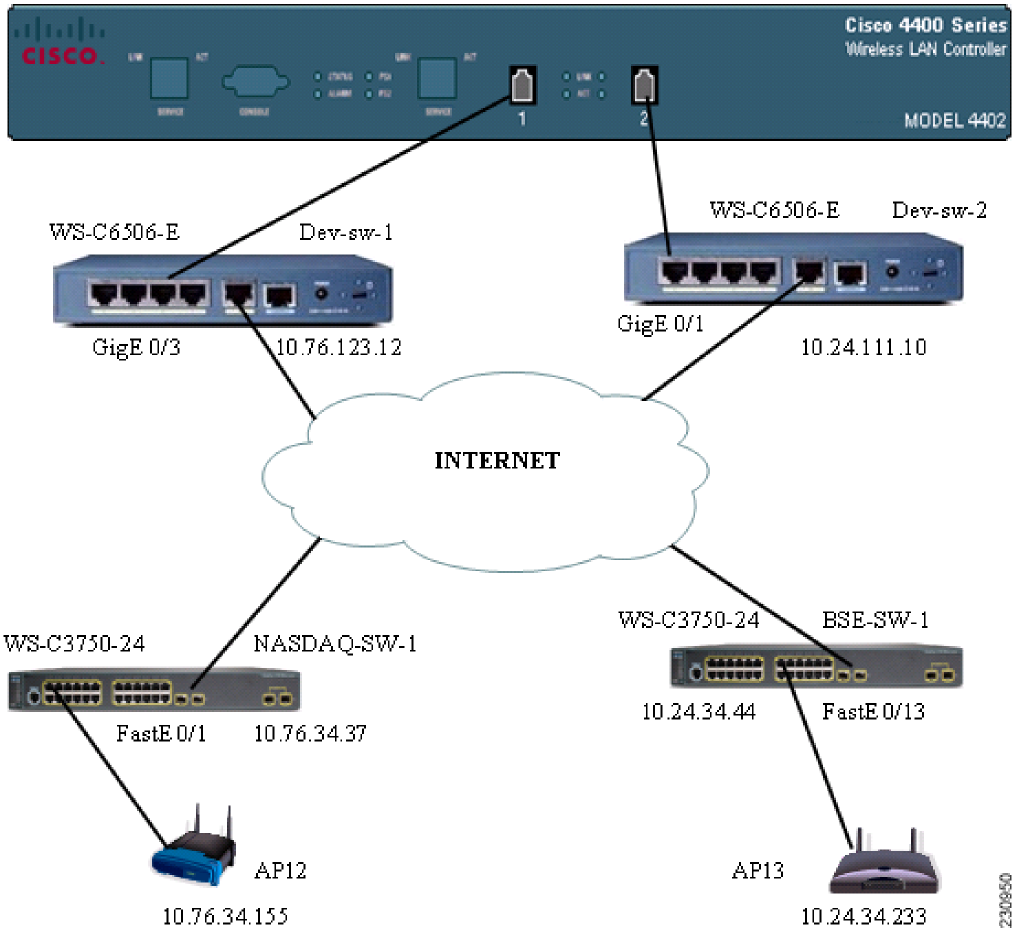
These TLVs are supported only by the access point:

- **Full/Half Duplex TLV: 0x000b**—The full- or half-duplex mode of the Ethernet link on which CDP packets are sent out. This TLV is not supported on access points that are connected directly to a 5500, 4400, or 2100 series controller.
- **Power Consumption TLV: 0x0010**—The maximum amount of power consumed by the access point. This TLV is not supported on access points that are connected directly to a 5500, 4400, or 2100 series controller.

You can configure CDP and view CDP information using the GUI in controller software release 4.1 or later or the CLI in controller software release 4.0 or later. Figure 38 shows a sample network that you can use as a reference when performing the procedures in this section.

Note Changing the CDP configuration on the controller does not change the CDP configuration on the access points connected to the controller. You must enable and disable CDP separately for each access point.

Figure 38 Sample Network Illustrating CDP

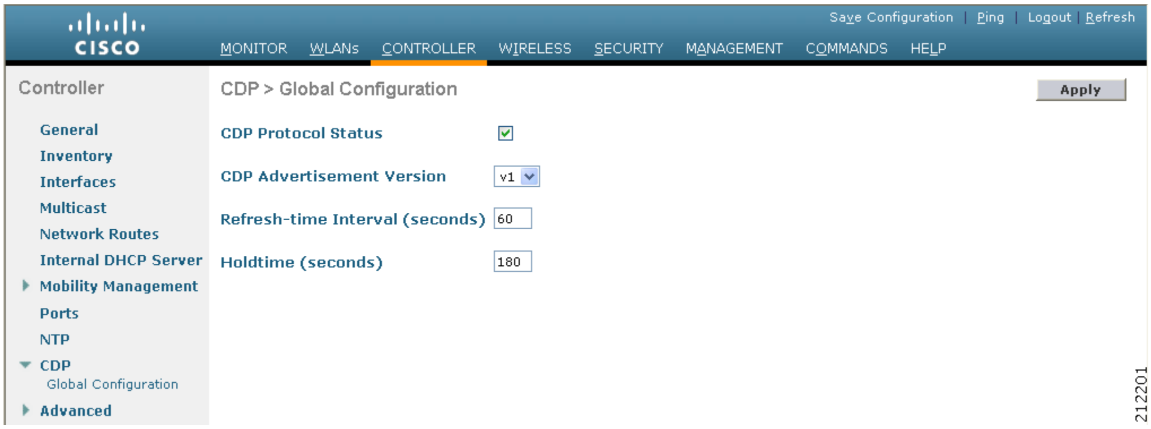


Using the GUI to Configure Cisco Discovery Protocol

Follow these steps to configure CDP using the controller GUI.

Step 1 Choose **Controller** > **CDP** > **Global Configuration** to open the CDP > Global Configuration page (see Figure 39).

Figure 39 CDP > Global Configuration Page



CDP > Global Configuration

CDP Protocol Status ☑

CDP Advertisement Version v1

Refresh-time Interval (seconds) 60

Holdtime (seconds) 180

Step 2 Check the **CDP Protocol Status** check box to enable CDP on the controller or uncheck it to disable this feature. The default value is checked.

Step 3 From the CDP Advertisement Version drop-down box, choose **v1** or **v2** to specify the highest CDP version supported on the controller. The default value is v1.

Step 4 In the Refresh-time Interval field, enter the interval at which CDP messages are to be generated. The range is 5 to 254 seconds, and the default value is 60 seconds.

Step 5 In the Holdtime field, enter the amount of time to be advertised as the time-to-live value in generated CDP packets. The range is 10 to 255 seconds, and the default value is 180 seconds.

Step 6 Click **Apply** to commit your changes.

Step 7 Click **Save Configuration** to save your changes.

Step 8 Perform one of the following:

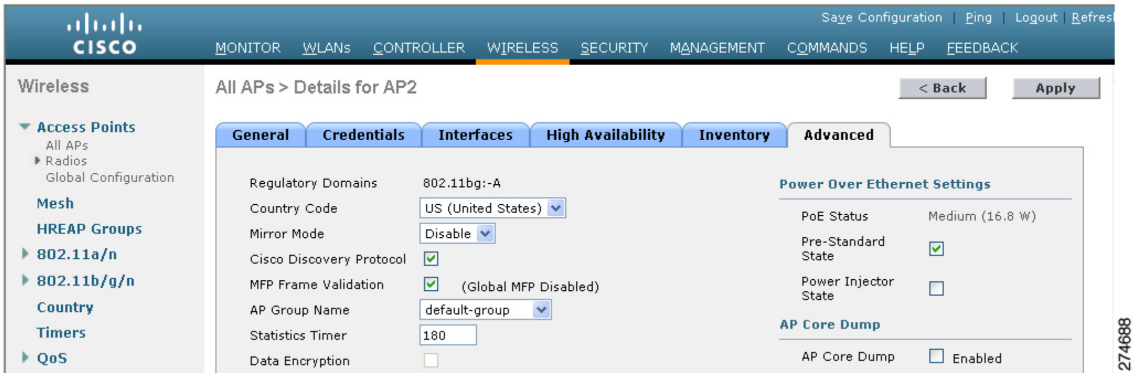
- To enable or disable CDP on a specific access point, follow these steps:

  a. Choose **Wireless** > **Access Points** > **All APs** to open the All APs page.

  b. Click the link for the desired access point.

  c. Choose the **Advanced** tab to open the All APs > Details for (Advanced) page (see Figure 40).

Figure 40 All APs > Details for (Advanced) Page



All APs > Details for AP2

Regulatory Domains	802.11bg:-A
Country Code	US (United States)
Mirror Mode	Disable
Cisco Discovery Protocol	☑
MFP Frame Validation	☑ (Global MFP Disabled)
AP Group Name	default-group
Statistics Timer	180
Data Encryption	□

Power Over Ethernet Settings

PoE Status	Medium (16.8 W)
Pre-Standard State	☑
Power Injector State	□

AP Core Dump

AP Core Dump	□ Enabled

- d. Check the **Cisco Discovery Protocol** check box to enable CDP on this access point or uncheck it to disable this feature. The default value is enabled.
- e. Click **Apply** to commit your changes.

- To enable or disable CDP on all access points currently associated to the controller, follow these steps:
  - a. Choose **Wireless** > **Access Points** > **Global Configuration** to open the Global Configuration page.
  - b. Check the **CDP State** check box to enable CDP on all access points associated to the controller or uncheck it to disable CDP on all access points. The default value is checked.
  - c. Click **Apply** to commit your changes.

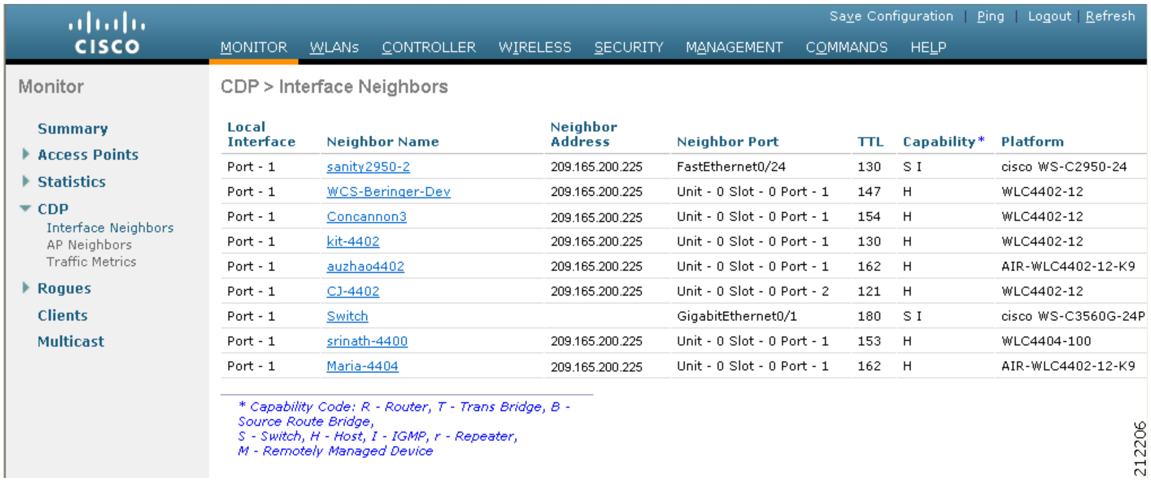
Step 9 Click **Save Configuration** to save your changes.

Using the GUI to View Cisco Discovery Protocol Information

Follow these steps to view CDP information using the controller GUI.

Step 1 To see a list of all CDP neighbors on all interfaces, choose **Monitor** > **CDP** > **Interface Neighbors**. The CDP > Interface Neighbors page appears (see Figure 41).

Figure 41 CDP > Interface Neighbors Page



CDP > Interface Neighbors

Local Interface	Neighbor Name	Neighbor Address	Neighbor Port	TTL	Capability*	Platform
Port - 1	sanity2950-2	209.165.200.225	FastEthernet0/24	130	S I	cisco WS-C2950-24
Port - 1	WCS-Beringer-Dev	209.165.200.225	Unit - 0 Slot - 0 Port - 1	147	H	WLC4402-12
Port - 1	Concannon3	209.165.200.225	Unit - 0 Slot - 0 Port - 1	154	H	WLC4402-12
Port - 1	kit-4402	209.165.200.225	Unit - 0 Slot - 0 Port - 1	130	H	WLC4402-12
Port - 1	auzhao4402	209.165.200.225	Unit - 0 Slot - 0 Port - 1	162	H	AIR-WLC4402-12-K9
Port - 1	CJ-4402	209.165.200.225	Unit - 0 Slot - 0 Port - 2	121	H	WLC4402-12
Port - 1	Switch		GigabitEthernet0/1	180	S I	cisco WS-C3560G-24P
Port - 1	srinath-4400	209.165.200.225	Unit - 0 Slot - 0 Port - 1	153	H	WLC4404-100
Port - 1	Maria-4404	209.165.200.225	Unit - 0 Slot - 0 Port - 1	162	H	AIR-WLC4402-12-K9

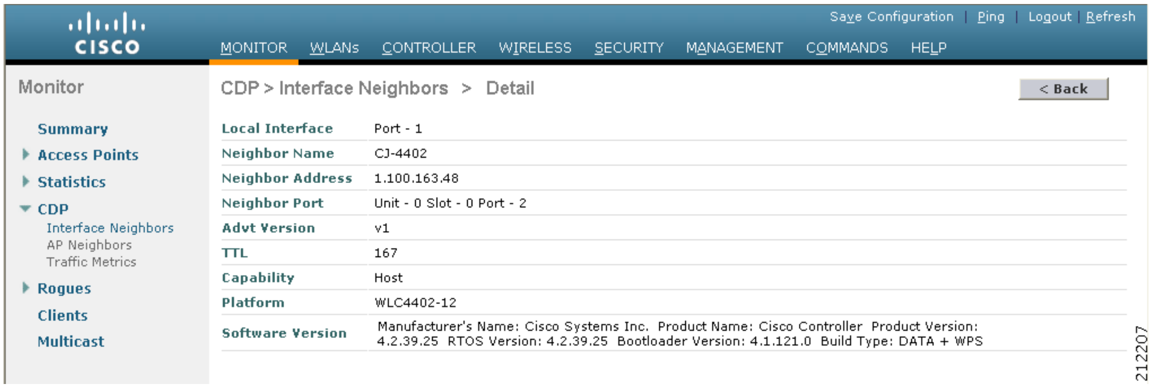
** Capability Code: R - Router, T - Trans Bridge, B - Source Route Bridge,*
S - Switch, H - Host, I - IGMP, r - Repeater,
M - Remotely Managed Device

This page shows the following information:

- The controller port on which the CDP packets were received
- The name of each CDP neighbor
- The IP address of each CDP neighbor
- The port used by each CDP neighbor for transmitting CDP packets
- The time left (in seconds) before each CDP neighbor entry expires
- The functional capability of each CDP neighbor, defined as follows: R - Router, T - Trans Bridge, B - Source Route Bridge, S - Switch, H - Host, I - IGMP, r - Repeater, or M - Remotely Managed Device
- The hardware platform of each CDP neighbor device

Step 2 To see more detailed information about each interface's CDP neighbor, click the name of the desired interface neighbor. The CDP > Interface Neighbors > Detail page appears (see Figure 42).

Figure 42 CDP > Interface Neighbors > Detail Page



CDP > Interface Neighbors > Detail

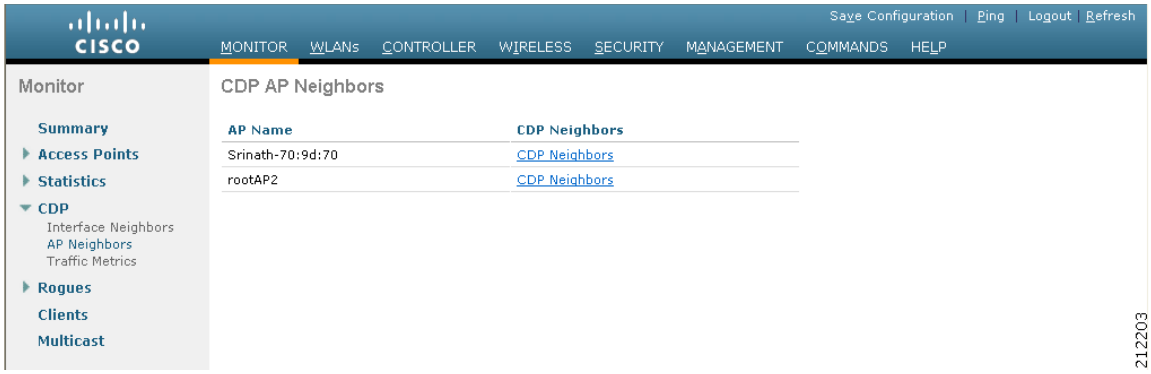
Local Interface	Port - 1
Neighbor Name	CJ-4402
Neighbor Address	1.100.163.48
Neighbor Port	Unit - 0 Slot - 0 Port - 2
Advt Version	v1
TTL	167
Capability	Host
Platform	WLC4402-12
Software Version	Manufacturer's Name: Cisco Systems Inc. Product Name: Cisco Controller Product Version: 4.2.39.25 RTOS Version: 4.2.39.25 Bootloader Version: 4.1.121.0 Build Type: DATA + WPS

This page shows the following information:

- The controller port on which the CDP packets were received
- The name of the CDP neighbor
- The IP address of the CDP neighbor
- The port used by the CDP neighbor for transmitting CDP packets
- The CDP version being advertised (v1 or v2)
- The time left (in seconds) before the CDP neighbor entry expires
- The functional capability of the CDP neighbor, defined as follows: Router, Trans Bridge, Source Route Bridge, Switch, Host, IGMP, Repeater, or Remotely Managed Device
- The hardware platform of the CDP neighbor device
- The software running on the CDP neighbor

Step 3 To see a list of CDP neighbors for all access points connected to the controller, choose **AP Neighbors**. The CDP AP Neighbors page appears (see Figure 43).

Figure 43 CDP AP Neighbors Page

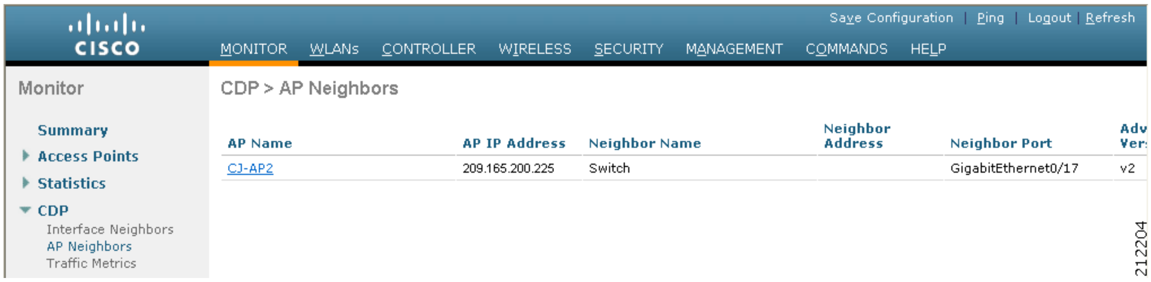


CDP AP Neighbors

AP Name	CDP Neighbors
Srinath-70:9d:70	CDP Neighbors
rootAP2	CDP Neighbors

Step 4 To see a list of CDP neighbors for a specific access point, click the **CDP Neighbors** link for the desired access point. The CDP > AP Neighbors page appears (see Figure 45).

Figure 44 CDP > AP Neighbors Page



CDP > AP Neighbors

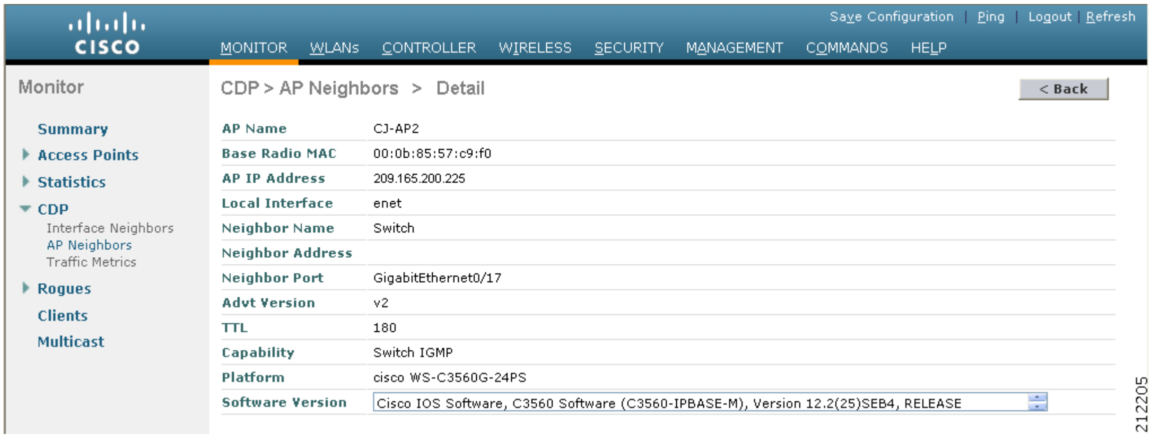
AP Name	AP IP Address	Neighbor Name	Neighbor Address	Neighbor Port	Adv Ver:
CJ-AP2	209.165.200.225	Switch		GigabitEthernet0/17	v2

This page shows the following information:

- The name of each access point
- The IP address of each access point
- The name of each CDP neighbor
- The IP address of each CDP neighbor
- The port used by each CDP neighbor
- The CDP version being advertised (v1 or v2)

Step 5 To see detailed information about an access point's CDP neighbors, click the name of the desired access point. The CDP > AP Neighbors > Detail page appears (see Figure 45).

Figure 45 CDP > AP Neighbors > Detail Page



CDP > AP Neighbors > Detail

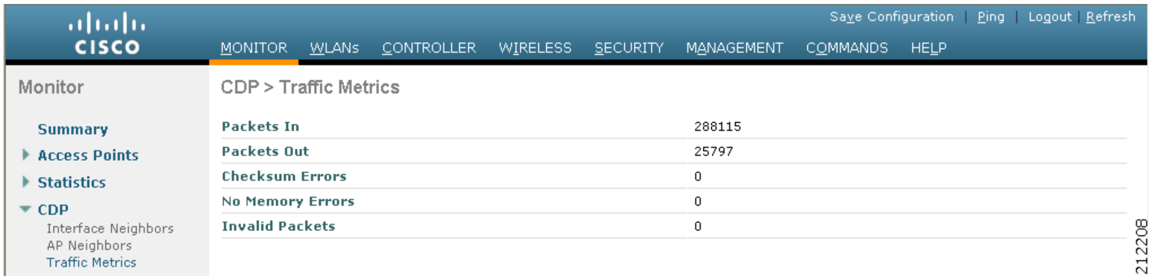
AP Name	CJ-AP2
Base Radio MAC	00:0b:85:57:c9:f0
AP IP Address	209.165.200.225
Local Interface	enet
Neighbor Name	Switch
Neighbor Address	
Neighbor Port	GigabitEthernet0/17
Advt Version	v2
TTL	180
Capability	Switch IGMP
Platform	cisco WS-C3560G-24PS
Software Version	Cisco IOS Software, C3560 Software (C3560-IPBASE-M), Version 12.2(25)SEB4, RELEASE

This page shows the following information:

- The name of the access point
- The MAC address of the access point's radio
- The IP address of the access point
- The interface on which the CDP packets were received
- The name of the CDP neighbor
- The IP address of the CDP neighbor
- The port used by the CDP neighbor
- The CDP version being advertised (v1 or v2)
- The time left (in seconds) before the CDP neighbor entry expires
- The functional capability of the CDP neighbor, defined as follows: R - Router, T - Trans Bridge, B - Source Route Bridge, S - Switch, H - Host, I - IGMP, r - Repeater, or M - Remotely Managed Device
- The hardware platform of the CDP neighbor device
- The software running on the CDP neighbor

Step 6 To see CDP traffic information, choose **Traffic Metrics**. The CDP > Traffic Metrics page appears (see Figure 46).

Figure 46 CDP > Traffic Metrics Page



Packets In	288115
Packets Out	25797
Checksum Errors	0
No Memory Errors	0
Invalid Packets	0

This page shows the following information:

- The number of CDP packets received by the controller
- The number of CDP packets sent from the controller
- The number of packets that experienced a checksum error
- The number of packets dropped due to insufficient memory
- The number of invalid packets

Using the CLI to Configure Cisco Discovery Protocol

Use these commands to configure CDP using the controller CLI.

1. To enable or disable CDP on the controller, enter this command:

   config cdp {**enable** | **disable**}

   CDP is enabled by default.

2. To specify the interval at which CDP messages are to be generated, enter this command:

   config cdp timer *seconds*

   The range is 5 to 254 seconds, and the default value is 60 seconds.

3. To specify the amount of time to be advertised as the time-to-live value in generated CDP packets, enter this command:

   config cdp holdtime *seconds*

   The range is 10 to 255 seconds, and the default value is 180 seconds.

4. To specify the highest CDP version supported on the controller, enter this command:

   config cdp advertise {**v1** | **v2**}

   The default value is v1.

5. To enable or disable CDP on all access points that are joined to the controller, enter this command:

   config ap cdp {**enable** | **disable**} **all**

   The **config ap cdp disable all** command disables CDP on all access points that are joined to the controller and all access points that join in the future. CDP remains disabled on both current and future access points even after the controller or access point reboots. To enable CDP, enter **config ap cdp enable all**.

Note After you enable CDP on all access points joined to the controller, you may disable and then re-enable CDP on individual access points using the command in #6 below. After you disable CDP on all access points joined to the controller, you may not enable and then disable CDP on individual access points.

6. To enable or disable CDP on a specific access point, enter this command:

   config ap cdp {**enable** | **disable**} *Cisco_AP*

7. To save your settings, enter this command:

   save config

Using the CLI to View Cisco Discovery Protocol Information

Use these commands to obtain information about CDP neighbors on the controller.

1. To see the status of CDP and to view CDP protocol information, enter this command:

   show cdp

2. To see a list of all CDP neighbors on all interfaces, enter this command:

   show cdp neighbors [**detail**]

   The optional **detail** command provides detailed information for the controller's CDP neighbors.

   Note This command shows only the CDP neighbors of the controller. It does not show the CDP neighbors of the controller's associated access points. Additional commands are provided below to show the list of CDP neighbors per access point.

3. To see all CDP entries in the database, enter this command:

   show cdp entry all

4. To see CDP traffic information on a given port (for example, packets sent and received, CRC errors, and so on), enter this command:

   show cdp traffic

5. To see the CDP status for a specific access point, enter this command:

   show ap cdp ap-name *Cisco_AP*

6. To see the CDP status for all access points that are connected to the controller, enter this command:

   show ap cdp all

7. To see a list of all CDP neighbors for a specific access point, enter these commands:

   show ap cdp neighbors ap-name *Cisco_AP*

   show ap cdp neighbors detail *Cisco_AP*

   Note The access point sends CDP neighbor information to the controller only when the information changes.

8. To see a list of all CDP neighbors for all access points connected to the controller, enter these commands:

   show ap cdp neighbors all

   show ap cdp neighbors detail all

   Information similar to the following appears when you enter **show ap cdp neighbors all**:

```
AP Name            AP IP          Neighbor Name  Neighbor IP    Neighbor Port
--------           --------       -------------  -----------    -------------
AP0013.601c.0a0    10.76.108.123        6500-1   10.76.108.207  GigabitEthernet1/26
AP0013.601c.0b0    10.76.108.111        6500-1   10.76.108.207  GigabitEthernet1/27
AP0013.601c.0c0   10.76.108.125        6500-1    10.76.108.207  GigabitEthernet1/28
```

   Information similar to the following appears when you enter **show ap cdp neighbors detail all**:

```
AP Name: AP0013.601c.0a0
AP IP Address: 10.76.108.125
----------------------------------
Device ID: 6500-1
Entry address(es): 10.76.108.207
Platform: cisco WS-C6506-E,  Capabilities: Router Switch IGMP
Interface: Port - 1,  Port ID (outgoing port): GigabitEthernet1/26
Holdtime: 157 sec

Version:
Cisco Internetwork Operating System Software  IOS (tm) s72033_rp Software
(s72033_rp-PSV-M), Version 12.2(18)SXD5, RELEASE SOFTWARE (fc3) Technical Support:
http://www.cisco.com/techsupport Copyright (c) 1986-2005 by cisco Systems, Inc.
Compiled Fri 13-Ma
```

Note The access point sends CDP neighbor information to the controller only when the information changes.

Use these commands to obtain CDP debug information for the controller.

1. To obtain debug information related to CDP packets, enter this command:

   debug cdp packets

2. To obtain debug information related to CDP events, enter this command:

   debug cdp events

Configuring RFID Tag Tracking

The controller enables you to configure radio-frequency identification (RFID) tag tracking. RFID tags are small wireless devices that are affixed to assets for real-time location tracking. They operate by advertising their location using special 802.11 packets, which are processed by access points, the controller, and the location appliance.

The controller supports tags from AeroScout, WhereNet, and Pango (an InnerWireless company). Some of the tags from these vendors comply with Cisco Compatible Extensions for RFID Tags. See Table 3 for details. The location appliance receives telemetry and chokepoint information from tags that are compliant with this CCX specification.

Table 3 Cisco Compatible Extensions for RFID Tags Summary

Partners	AeroScout		WhereNet	Pango (InnerWireless)
Product Name	T2	T3	Wheretag IV	V3
Telemetry				
Temperature	X	X		X
Pressure				
Humidity				
Status				
Fuel				
Quantity				
Distance				
Motion Detection	X	X		X
Number of Panic Buttons	1	2	0	1
Tampering		X	X	X
Battery Information	X	X	X	X
Multiple-Frequency Tags[1]	X	X	X	

[1] For chokepoint systems, note that the tag can work only with chokepoints coming from the same vendor.

Note Network Mobility Services Protocol (NMSP) runs on location appliance software release 3.0 or later. In order for NMSP to function properly, the TCP port (16113) over which the controller and location appliance communicate must be open (not blocked) on any firewall that exists between these two devices. Refer to the *Cisco Location Appliance Configuration Guide* for additional information on NMSP and RFID tags.

The Cisco-approved tags support these capabilities:

- **Information notifications**—Enable you to view vendor-specific and emergency information.
- **Information polling**—Enables you to monitor battery status and telemetry data. Many telemetry data types provide support for sensory networks and a large range of applications for RFID tags.
- **Measurement notifications**—Enable you to deploy chokepoints at strategic points within your buildings or campuses. Whenever an RFID tag moves to within a defined proximity of a chokepoint, the tag begins transmitting packets that advertise its location in relation to the chokepoint.

The number of tags supported varies depending on controller platform. Table 4 lists the number of tags supported per controller.

Table 4 RFID Tags Supported per Controller

Controller	Number of RFID Tags Supported
5508	2500
Cisco WiSM	5000
4404	2500
4402	1250
Catalyst 3750G Integrated Wireless LAN Controller Switch	1250
2106	500
Controller Network Module within the Cisco 28/37/38xx Series Integrated Services Routers	500

You can configure and view RFID tag tracking information through the controller CLI.

Using the CLI to Configure RFID Tag Tracking

Follow these steps to configure RFID tag tracking parameters using the CLI.

Step 1 To enable or disable RFID tag tracking, enter this command:

config rfid status {**enable** | **disable**}

The default value is enabled.

Step 2 To specify a static timeout value (between 60 and 7200 seconds), enter this command:

config rfid timeout *seconds*

The static timeout value is the amount of time that the controller maintains tags before expiring them. For example, if a tag is configured to beacon every 30 seconds, Cisco recommends that you set the timeout value to 90 seconds (approximately three times the beacon value). The default value is 1200 seconds.

Step 3 To enable or disable RFID tag mobility for specific tags, enter these commands:

- **config rfid mobility** *vendor_name* **enable**—Enables client mobility for a specific vendor's tags. When you enter this command, tags are unable to obtain a DHCP address for client mode when attempting to check and/or download a configuration.
- **config rfid mobility** *vendor_name* **disable**—Disables client mobility for a specific vendor's tags. When you enter this command, tags can obtain a DHCP address. If a tag roams from one subnet to another, it obtains a new address rather than retaining the anchor state.

Note These commands can be used only for Pango tags. Therefore, the only valid entry for *vendor_name* is "pango" in all lowercase letters.

Using the CLI to View RFID Tag Tracking Information

Use these commands to view RFID tag tracking information using the controller CLI.

1. To see the current configuration for RFID tag tracking, enter this command:

   show rfid config

   Information similar to the following appears:

```
RFID Tag data Collection......................... Enabled
RFID timeout..................................... 1200 seconds
RFID mobility................................. Oui:00:14:7e : Vendor:pango
                                                 State:Disabled
```

2. To see detailed information for a specific RFID tag, enter this command:

   show rfid detail *mac_address*

   where *mac_address* is the tag's MAC address.

   Information similar to the following appears:

```
RFID address..................................... 00:12:b8:00:20:52
Vendor........................................... G2
Last Heard....................................... 51 seconds ago
Packets Received................................. 2
Bytes Received................................... 324
Cisco Type.......................................

Content Header
=================
Version.......................................... 1
Tx Power......................................... 12 dBm
Channel.......................................... 1
Reg Class........................................ 12
Burst Length..................................... 1

CCX Payload
===========
Last Sequence Control............................ 0
Payload length................................... 127
Payload Data Hex Dump

01 09 00 00 00 00 0b 85 52 52 52 02 07 4b ff ff
7f ff ff ff 03 14 00 12 7b 10 48 53 c1 f7 51 4b
50 ba 5b 97 27 80 00 67 00 01 03 05 01 42 34 00
00 03 05 02 42 5c 00 00 03 05 03 42 82 00 00 03
05 04 42 96 00 00 03 05 05 00 00 00 55 03 05 06
42 be 00 00 03 02 07 05 03 12 08 10 00 01 02 03
04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 03 0d 09 03
08 05 07 a8 02 00 10 00 23 b2 4e 03 02 0a 03

Nearby AP Statistics:
      lap1242-2(slot 0, chan 1) 50 seconds ag.... -76 dBm
      lap1242(slot 0, chan 1) 50 seconds ago..... -65 dBm
```

3. To see a list of all RFID tags currently connected to the controller, enter this command:

   show rfid summary

   Information similar to the following appears:

```
Total Number of RFID   : 24
----------------- -------- ------------------ ------ ---------------------
     RFID ID      VENDOR       Closest AP      RSSI  Time Since Last Heard
----------------- -------- ------------------ ------ ---------------------
00:04:f1:00:00:03 Wherenet HReap               -70      151 seconds ago
00:04:f1:00:00:05 Wherenet HReap               -66      251 seconds ago
00:0c:cc:5b:f8:1e Aerosct  HReap               -40        5 seconds ago
00:0c:cc:5c:05:10 Aerosct  HReap               -68       25 seconds ago
00:0c:cc:5c:06:69 Aerosct  HReap               -54        7 seconds ago
00:0c:cc:5c:06:6b Aerosct  HReap               -68      245 seconds ago
00:0c:cc:5c:06:b5 Aerosct  cisco1242           -67       70 seconds ago
00:0c:cc:5c:5a:2b Aerosct  cisco1242           -68       31 seconds ago
00:0c:cc:5c:87:34 Aerosct  HReap               -40        5 seconds ago
00:14:7e:00:05:4d Pango    cisco1242           -66      298 seconds ago
```

4. To see a list of RFID tags that are associated to the controller as clients, enter this command:

   show rfid client

   When the RFID tag is in client mode, information similar to the following appears:

```
------------------ -------- --------- ----------------- ------ ----------------
                              Heard
   RFID Mac         VENDOR   Sec Ago    Associated AP    Chnl    Client State
------------------ -------- --------- ----------------- ------ ----------------

00:14:7e:00:0b:b1   Pango      35    AP0019.e75c.fef4   1      Probing
```

   When the RFID tag is not in client mode, the above fields are blank.

Using the CLI to Debug RFID Tag Tracking Issues

If you experience any problems with RFID tag tracking, use these debug commands.

- To configure MAC address debugging, enter this command:

  debug mac addr *mac_address*

  Note Cisco recommends that you perform the debugging on a per-tag basis. If you enable debugging for all of the tags, the console or Telnet screen is inundated with messages.

- To enable or disable RFID debug options, enter this command:

  debug rfid {**all** | **detail** | **error** | **nmsp** | **receive**} {**enable** | **disable**}

  where

  – **all** configures debugging of all RFID messages,

  – **detail** configures debugging of RFID detailed messages,

  – **error** configures debugging of RFID error messages,

  – **nmsp** configures debugging of RFID NMSP messages, and

  – **receive** configures debugging of incoming RFID tag messages.

Configuring and Viewing Location Settings

This section provides instructions for configuring and viewing location settings from the controller CLI.

Note Access points in monitor mode should not be used for location purposes.

Installing the Location Appliance Certificate

A self-signed certificate (SSC) is required on the location appliance. This certificate, which is comprised of the location appliance MAC address and a 20-byte key hash, must be present on the controller. Otherwise, the controller cannot authenticate the location appliance, and they can never establish a connection. WCS usually pushes the certificate to the controller automatically, but you can install the certificate on the controller using the controller CLI if necessary (for example, if the controller is not connected to WCS or if an error or certificate mismatch occurs on WCS).

Note If an error occurs on WCS and prevents the location appliance certificate from being pushed to the controller, make sure that the time zone has been synchronized on the controller and the location appliance before following this procedure. Follow the instructions in the "Viewing Location Settings" section on page 109 to do so.

Follow these steps to install the location appliance certificate on the controller.

Step 1 To obtain the key hash value of the location appliance certificate, enter this command:

debug pm pki enable

Information similar to the following appears:

```
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Calculate SHA1 hash on Public Key Data
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Key Data  30820122 300d0609 2a864886
f70d0101
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Key Data  01050003 82010f00 3082010a
02820101
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Key Data  009a98b5 d2b7c77b 036cdb87
5bd20e5a
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Key Data  894c66f4 df1cbcfb fe2fcf01
09b723aa
Thu Oct 11 08:52:26 2007: sshpmGetIssuerHandles: Key Data  5c0917f1 ec1d5061 2d386351
573f2c5e
Thu Oct 11 08:52:30 2007: sshpmGetIssuerHandles: Key Data  b9020301 0001
Thu Oct 11 08:52:30 2007: sshpmGetIssuerHandles: SSC Key Hash is
4869b32638c00ffca88abe9b1a8e0525b9344b8b
```

Step 2 To install the location appliance certificate on the controller, enter this command:

config auth-list add lbs-ssc *lbs_mac lbs_key*

where

- *lbs_mac* is the MAC address of the location appliance, and
- *lbs_key* is the 20-byte key hash value of the certificate.

Step 3 To save your changes, enter this command:

save config

Step 4 To verify that the location appliance certificate is installed on the controller, enter this command:

show auth-list

Information similar to the following appears:

```
Authorize APs against AAA ....................... disabled
Allow APs with Self-Signed Certificate (SSC) .... disabled

Mac Addr                  Cert Type    Key Hash
-----------------------   ----------   --------------------------------------------
00:16:36:91:9a:27          LBS-SSC     593f34e7cb151997a28cc7da2a6cac040b329636
```

Synchronizing the Controller and Location Appliance

For controller software release 4.2 or later, if a location appliance (release 3.1 or later) is installed on your network, the time zone must be set on the controller to ensure proper synchronization between the two systems. Also, the times must be in sync on the two devices. Cisco highly recommends that the time be set even for networks that do not have location appliances. Refer to the "Configuring 802.11 Bands" section on page 30 for instructions on setting the time and date on the controller.

Note The time zone can be different for the controller and the location appliance, but the time zone delta must be configured accordingly, based on GMT.

Configuring Location Settings

The controller determines the location of client devices by gathering received signal strength indication (RSSI) measurements from access points all around the client of interest. The controller can obtain location reports from up to 16 access points for clients, RFID tags, and rogue access points.

To improve location accuracy by configuring the path loss measurement (S60) request for normal clients or calibrating clients, enter this command:

config location plm *?*

where *?* is one of the following:

- **client** {**enable** | **disable**} *burst_interval*—Enables or disables the path loss measurement request for normal, non-calibrating clients. The valid range for the *burst_interval* parameter is 1 to 3600 seconds, and the default value is 60 seconds.

- **calibrating** {**enable** | **disable**} {**uniband** | **multiband**}—Enables or disables the path loss measurement request for calibrating clients on the associated 802.11a or 802.11b/g radio or on the associated 802.11a/b/g radio.

If a client does not send probes often or sends them only on a few channels, its location cannot be updated or cannot be updated accurately. The **config location plm** command forces clients to send more packets on all channels. When a CCXv4 (or higher) client associates, the controller sends it a path loss measurement request, which instructs the client to transmit on the bands and channels that the access points are on (typically channels 1, 6, and 11 for 2.4-GHz-only access points) at a configurable interval (such as 60 seconds) indefinitely.

These four additional location CLI commands are available; however, they are set to optimal default values, so Cisco does not recommend that you use or modify them.

1. To configure the RSSI timeout value for various devices, enter this command:

   config location expiry *?*

   where *?* is one of the following:

   - **client** *timeout*—Configures the RSSI timeout value for clients. The valid range for the *timeout* parameter is 5 to 3600 seconds, and the default value is 5 seconds.
   - **calibrating-client** *timeout*—Configures the RSSI timeout value for calibrating clients. The valid range for the *timeout* parameter is 0 to 3600 seconds, and the default value is 5 seconds.
   - **tags** *timeout*—Configures the RSSI timeout value for RFID tags. The valid range for the *timeout* parameter is 5 to 300 seconds, and the default value is 5 seconds.
   - **rogue-aps** *timeout*—Configures the RSSI timeout value for rogue access points. The valid range for the *timeout* parameter is 5 to 3600 seconds, and the default value is 5 seconds.

   Ensuring that recent, strong RSSIs are retained by the CPU is critical to location accuracy. The **config location expiry** command enables you to specify the length of time after which old RSSI averages expire.

   Note Cisco recommends that you do not use or modify the **config location expiry** command.

2. To configure the RSSI half life for various devices, enter this command:

   config location rssi-half-life *?*

   where *?* is one of the following:

   - **client** *half_life*—Configures the RSSI half life for clients. The valid range for the *half_life* parameter is 0, 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, or 300 seconds, and the default value is 0 seconds.
   - **calibrating-client** *half_life*—Configures the RSSI half life for calibrating clients. The valid range for the *half_life* parameter is 0, 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, or 300 seconds, and the default value is 0 seconds.
   - **tags** *half_life*—Configures the RSSI half life for RFID tags. The valid range for the *half_life* parameter is 0, 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, or 300 seconds, and the default value is 0 seconds.
   - **rogue-aps** *half_life*—Configures the RSSI half life for rogue access points. The valid range for the *half_life* parameter is 0, 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, or 300 seconds, and the default value is 0 seconds.

Some client devices transmit at reduced power immediately after changing channels, and RF is variable, so RSSI values might vary considerably from packet to packet. The **config location rssi-half-life** command increases accuracy by averaging non-uniformly arriving data using a configurable forget period (or half life).

Note Cisco recommends that you do not use or modify the **config location rssi-half-life** command.

3. To configure the NMSP notification threshold for RSSI measurements, enter this command:

   config location notify-threshold *?*

   where *?* is one of the following:

   - **client** *threshold*—Configures the NMSP notification threshold (in dB) for clients and rogue clients. The valid range for the *threshold* parameter is 0 to 10 dB, and the default value is 0 dB.
   - **tags** *threshold*—Configures the NMSP notification threshold (in dB) for RFID tags. The valid range for the *threshold* parameter is 0 to 10 dB, and the default value is 0 dB.
   - **rogue-aps** *threshold*—Configures the NMSP notification threshold (in dB) for rogue access points. The valid range for the *threshold* parameter is 0 to 10 dB, and the default value is 0 dB.

   Note Cisco recommends that you do not use or modify the **config location notify-threshold** command.

4. To configure the algorithm used to average RSSI and signal-to-noise ratio (SNR) values, enter this command:

   config location algorithm *?*

   where *?* is one of the following:

   - **simple**—Specifies a faster algorithm that requires low CPU overhead but provides less accuracy.
   - **rssi-average—**Specifies a more accurate algorithm but requires more CPU overhead.

   Note Cisco recommends that you do not use or modify the **config location algorithm** command.

Viewing Location Settings

Use these CLI commands to view location information.

1. To view the current location configuration values, enter this command:

   show location summary

Information similar to the following appears:

```
Location Summary

Algorithm used:                         Average
Client
        RSSI expiry timeout:             5 sec
        Half life:                       0 sec
        Notify Threshold:                0 db
Calibrating Client
        RSSI expiry timeout:             5 sec
        Half life:                       0 sec
Rogue AP
        RSSI expiry timeout:             5 sec
        Half life:                       0 sec
        Notify Threshold:                0 db
RFID Tag
        RSSI expiry timeout:             5 sec
        Half life:                       0 sec
        Notify Threshold:                0 db
```

2. To see the RSSI table for a particular client, enter this command:

   show location detail *client_mac_addr*

   Information similar to the following appears:

```
...
[11] AP 00:00:00:00:00:00 :  Slot 0 inUse 0, expired 0, Timestamp (antenna-A 0)
(antenna-B 0), band 0  rssi (antenna-A 0) (antenna-B 0), snr 0, acceptable 0
[12] AP 00:00:00:00:00:00 :  Slot 0 inUse 0, expired 0, Timestamp (antenna-A 0)
(antenna-B 0), band 0  rssi (antenna-A 0) (antenna-B 0), snr 0, acceptable 0
[13] AP 00:00:00:00:00:00 :  Slot 0 inUse 0, expired 0, Timestamp (antenna-A 0)
(antenna-B 0), band 0  rssi (antenna-A -1) (antenna-B 0), snr 0, acceptable 0
[14] AP 00:00:00:00:00:00 :  Slot 0 inUse 0, expired 0, Timestamp (antenna-A 0)
(antenna-B 0), band 0  rssi (antenna-A 0) (antenna-B 0), snr 0, acceptable 0
[15] AP 00:00:00:00:00:00 :  Slot 0 inUse 0, expired 0, Timestamp (antenna-A 0)
(antenna-B 0), band 0  rssi (antenna-A 0) (antenna-B 0), snr 0, acceptable 0
```

3. To see the location-based RFID statistics, enter this command:

   show location statistics rfid

   Information similar to the following appears:

```
RFID Statistics

Database Full :         0        Failed Delete:         0
Null Bufhandle:         0        Bad Packet:            0
Bad LWAPP Data:         0        Bad LWAPP Encap:       0
Off Channel:            0        Bad CCX Version:       0
Bad AP Info :           0
Above Max RSSI:         0        Below Max RSSI:        0
Invalid RSSI:           0        Add RSSI Failed:       0
Oldest Expired RSSI:  0        Smallest Overwrite:  0
```

4. To clear the location-based RFID statistics, enter this command:

   clear location statistics rfid

5. To clear a specific RFID tag or all of the RFID tags in the entire database, enter this command:

   clear location rfid {*mac_address* | **all**}

6. To see whether location presence (S69) is supported on a client, enter this command:

   show client detail *client_mac*

   When location presence is supported by a client and enabled on a location appliance, the location appliance can provide the client with its location upon request. Location presence is enabled automatically on CCXv5 clients.

   Information similar to the following appears:

```
Client MAC Address.............................. 00:40:96:b2:a3:44
Client Username ................................ N/A
AP MAC Address.................................. 00:18:74:c7:c0:90
Client State.................................... Associated
Wireless LAN Id................................. 1
BSSID........................................... 00:18:74:c7:c0:9f
Channel......................................... 56
IP Address...................................... 192.168.10.28
Association Id.................................. 1
Authentication Algorithm........................ Open System
Reason Code..................................... 0
Status Code..................................... 0
Session Timeout................................. 0
Client CCX version.............................. 5
Client E2E version.............................. No E2E support
Diagnostics Capability.......................... Supported
S69 Capability.................................. Supported
Mirroring....................................... Disabled
QoS Level....................................... Silver
...
```

Note See the *Cisco Wireless Control System Configuration Guide* or the *Cisco Location Appliance Configuration Guide* for instructions on enabling location presence on a location appliance.

Modifying the NMSP Notification Interval for Clients, RFID Tags, and Rogues

The Network Mobility Services Protocol (NMSP) manages communication between the location appliance and the controller for incoming and outgoing traffic. If your application requires more frequent location updates, you can modify the NMSP notification interval (to a value between 1 and 180 seconds) for clients, active RFID tags, and rogue access points and clients.

Note The TCP port (16113) that the controller and location appliance communicate over must be open (not blocked) on any firewall that exists between the controller and the location appliance for NMSP to function.

Using the controller CLI, follow these steps to modify the NMSP notification interval value on the controller.

Step 1 To set the NMSP notification interval value for clients, RFID tags, and rogue clients and access points, enter these commands, where *interval* is a value between 1 and 180 seconds:

- **config nmsp notification interval rssi clients** *interval*
- **config nmsp notification interval rssi rfid** *interval*
- **config nmsp notification interval rssi rogues** *interval*

Step 2 To see the NMSP notification intervals, enter this command:

show nmsp notification interval

Information similar to the following appears:

```
NMSP Notification Interval Summary

RSSI Interval:
 Client.......................................... 2 sec
 RFID............................................ 0 sec
 Rogue AP........................................ 2 sec
 Rogue Client.................................... 2 sec
```

Viewing NMSP Settings

Use these CLI commands to view NMSP information.

1. To see the status of active NMSP connections, enter this command:

   show nmsp status

   Information similar to the following appears:

```
MSE IP Address    Tx Echo Resp    Rx Echo Req    Tx Data    Rx Data
--------------    ------------    -----------    -------    -------
171.71.132.107      39046           39046        103742         1
```

2. To see the NMSP capabilities, enter this command:

   show nmsp capability

   Information similar to the following appears:

```
Service                  Subservice
-------                  ----------
RSSI                     Mobile Station, Tags, Rogue,
Info                     Mobile Station, Rogue,
Statistics               Mobile Station, Tags,
IDS Services           WIPS
```

3. To see the NMSP counters, enter this command:

   show nmsp statistics {**summary** | **connection**}

   where

   – **summary** shows the common NMSP counters, and

   – **connection** shows the connection-specific NMSP counters.

   Information similar to the following appears for the **show nmsp statistics summary** command:

```
NMSP Global Counters

Client Measure Send Fail......................... 0
Send RSSI with no entry.......................... 0
APP msg too big.................................. 0
Failed Select on Accept Socket................... 0
Failed SSL write................................. 0
Partial SSL write................................ 0
SSL write returned zero.......................... 0
SSL write attempts to want read.................. 0
SSL write attempts to want write................. 0
SSL write got default error...................... 0
SSL write max data length sent................... 0
SSL write max attempts to write in loop.......... 0
SSL read returned zero........................... 0
SSL read attempts to want read................... 0
SSL read attempts to want write.................. 0
SSL read got default error....................... 0
Failed SSL read - Con Rx buf freed............... 0
Failed SSL read - Con/SSL freed.................. 0
Max records read before exiting SSL read......... 0
Normal Prio Tx Q full............................ 0
Highest Prio Tx Q count.......................... 0
Normal Prio Tx Q count........................... 0
Messages sent by APPs to Highest Prio TxQ........ 0
Max Measure Notify Msg........................... 0
Max Info Notify Msg.............................. 0
Max Highest Prio Tx Q Size....................... 0
Max Normal Prio Tx Q Size........................ 0
Max Rx Size...................................... 1
Max Info Notify Q Size........................... 0
Max Client Info Notify Delay..................... 0
Max Rogue AP Info Notify Delay................... 0
Max Rogue Client Info Notify Delay............... 0
Max Client Measure Notify Delay.................. 0
Max Tag Measure Notify Delay..................... 0
Max Rogue AP Measure Notify Delay................ 0
Max Rogue Client Measure Notify Delay............ 0
Max Client Stats Notify Delay.................... 0
Max Client Stats Notify Delay.................... 0
RFID Measurement Periodic........................ 0
RFID Measurement Immediate....................... 0
SSL Handshake failed............................. 0
NMSP Rx detected con failure..................... 0
NMSP Tx detected con failure..................... 0
NMSP Tx buf size exceeded........................ 0
Reconnect Before Conn Timeout................. 0
```

Information similar to the following appears for each active connection when you enter the **show nmsp statistics connection** command:

```
NMSP Connection Counters

MSE IP: 171.71.132.107
 Connection status:     UP
 Tx message count                       Rx message count
 ----------------                       ----------------
 WLC Capability:        1               MSE Capability:         0
 Service Subscr Rsp:    1               Service Subscr Req:     1
 Measure Rsp:           0               Measure Req:            0
 Measure Notify:        0
 Info Rsp:              0               Info Req:               0
 Info Notify:           0
 Stats Rsp:             0               Stats Req:              0
 Stats Notify:          0
 Loc Req:               0               Loc Rsp:                0
 Loc Subscr Req:        0               Loc Subscr Rsp:         0
                                        Loc Notify:             0
 Loc Unsubscr Req:      0               Loc Unsubscr Rsp:       0
 AP Monitor Rsp:        0               AP Monitor Req:         0
 AP Monitor Notify:     64677
 IDS Get Rsp:           0               IDS Get Req:            0
IDS Notif:             0
 IDS Set Rsp:           0               IDS Set Req:            0
```

4. To see the mobility services that are active on the controller, enter this command:

   show nmsp subscription {**summary** | **detail** | **detail** *ip_addr*}

   where

   - **summary** shows all of the mobility services to which the controller is subscribed,
   - **detail** shows details for all of the mobility services to which the controller is subscribed, and
   - **detail** *ip_addr* shows details only for the mobility services subscribed to by a specific IP address.

   Information similar to the following appears for the **show nmsp subscription summary** command:

```
Mobility Services Subscribed:

 Server IP              Services
 ---------              --------
 1.4.93.31              RSSI, Info, Statistics
```

   Information similar to the following appears for the **show nmsp subscription detail** *ip_addr* command:

```
Mobility Services Subscribed by 1.4.93.31

Services                Sub-services
--------                ------------
RSSI                    Mobile Station, Tags,
Info                    Mobile Station,
Statistics            Mobile Station, Tags,
```

5. To clear all NMSP statistics, enter this command:

   clear nmsp statistics

Debugging NMSP Issues

Use these CLI commands if you experience any problems with NMSP.

- To configure NMSP debug options, enter this command:

  debug nmsp *?*

  where *?* is one of the following:

  - **all** {**enable** | **disable**}—Enables or disables debugging for all NMSP messages.
  - **connection** {**enable** | **disable**}—Enables or disables debugging for NMSP connection events.
  - **detail** {**enable** | **disable**}—Enables or disables debugging for NMSP detailed events.
  - **error** {**enable** | **disable**}—Enables or disables debugging for NMSP error messages.
  - **event** {**enable** | **disable**}—Enables or disables debugging for NMSP events.
  - **message** {**tx** | **rx**} {**enable** | **disable**}—Enables or disables debugging for NMSP transmit or receive messages.
  - **packet** {**enable** | **disable**}—Enables or disables debugging for NMSP packet events.

- To enable or disable debugging for IAPP NMSP events, enter this command:

  debug iapp nmsp {**enable** | **disable**}

- To enable or disable debugging for RFID NMSP messages, enter this command:

  debug rfid nmsp {**enable** | **disable**}

- To enable or disable debugging for access point monitor NMSP events, enter this command:

  debug service ap-monitor nmsp {**enable** | **disable**}

- To enable or disable debugging for wIPS NMSP events, enter this command:

  debug wips nmsp {**enable** | **disable**}

Configuring the Supervisor 720 to Support the WiSM

When you install a WiSM in a Cisco Catalyst 6500 switch or a Cisco 7600 series router, you must configure the Supervisor 720 to support the WiSM. When the supervisor detects the WiSM, the supervisor creates ten Gigabit Ethernet interfaces, ranging from Gig*slot*/1 to Gig*slot*/8. For example, if the WiSM is in slot 9, the supervisor creates interfaces Gig9/1 through Gig9/8. The first eight Gigabit Ethernet interfaces must be organized into two Etherchannel bundles of four interfaces each. The remaining two Gigabit Ethernet interfaces are used as service-port interfaces, one for each controller on the WiSM. You must manually create VLANs to communicate with the ports on the WiSM.

Note The WiSM is supported on Cisco 7600 series routers running only Cisco IOS Release 12.2(18)SXF5.

General WiSM Guidelines

Keep these general guidelines in mind when you add a WiSM to your network:

- The switch or router ports leading to the controller service port are automatically configured and cannot be manually configured.
- The switch or router ports leading to the controller data ports should be configured as edge ports to avoid sending unnecessary BPDUs.
- The switch or router ports leading to the controller data ports should not be configured with any additional settings (such as port channel or SPAN destination) other than settings necessary for carrying data traffic to and from the controllers.

Note Refer to the *Configuring Ports and Interfaces* chapter for information on configuring the WiSM's ports and interfaces.

Configuring the Supervisor

Log into the switch or router CLI and, beginning in Privileged Exec mode, follow these steps to configure the supervisor to support the WiSM:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *vlan*	Create a VLAN to communicate with the data ports on the WiSM and enter interface config mode.
Step 3	**ip address** *ip-address gateway*	Assign an IP address and gateway to the VLAN.
Step 4	**ip helper-address** *ip-address*	Assign a helper address to the VLAN.
Step 5	**end**	Return to global config mode.
Step 6	**wism module** *module_number* **controller** { **1** | **2**} **allowed-vlan** *vlan_number*	Create Gigabit port-channel interfaces automatically for the specified WiSM controller and configure the port-channel interfaces as trunk ports. Also, specify the VLAN you created earlier as the allowed VLAN on the port-channel trunk. VLAN traffic is carried on the trunk between the WiSM controller and the supervisor. **Note** Services might be temporarily interrupted (for approximately two pings) after you enter this command.
Step 7	**wism module** *module_number* **controller** { **1** | **2**} **native-vlan** *vlan_number*	For the native VLAN on the ports, specify the VLAN that you created earlier to communicate with the WiSM data ports.
Step 8	**interface** *vlan*	Create a VLAN to communicate with the service ports on the WiSM.
Step 9	**ip address** *ip_address gateway*	Assign an IP address and gateway to the VLAN.
Step 10	**end**	Return to global config mode.
Step 11	**wism service-vlan** *vlan*	Configure the VLAN that you created in steps 8 through 10 to communicate with the WiSM service ports.
Step 12	**end**	Return to global config mode.
Step 13	**show wism status**	Verify that the WiSM is operational.

Note The commands used for communication between the Cisco WiSM, the Supervisor 720, and the 4404 controllers are documented in *Configuring a Cisco Wireless Services Module and Wireless Control System* at this URL:

http://www.cisco.com/c/en/us/td/docs/wireless/technology/wism/technical/reference/appnote.html#wp39498

Using the Wireless LAN Controller Network Module

Keep these guidelines in mind when using a wireless LAN controller network module (CNM) installed in a Cisco Integrated Services Router:

- The CNM does not support IPSec. To use IPSec with the CNM, configure IPSec on the router in which the CNM is installed. Click this link to browse to IPSec configuration instructions for routers:

  http://www.cisco.com/c/en/us/tech/security-vpn/ipsec-negotiation-ike-protocols/tech-configuration-guides-list.html
- The CNM does not have a battery and cannot save a time setting. It must receive a time setting from an external NTP server when it powers up. When you install the module, the configuration wizard prompts you for NTP server information.
- To access the CNM bootloader, Cisco recommends that you reset the CNM from the router. If you reset the CNM from a CNM user interface, the router might reset the CNM while you are using the bootloader.

  When you reset the CNM from a CNM interface, you have 17 minutes to use the bootloader before the router automatically resets the CNM. The CNM bootloader does not run the Router Blade Configuration Protocol (RBCP), so the RBCP heartbeat running on the router times out after 17 minutes, triggering a reset of the CNM.

  If you reset the CNM from the router, the router stops the RBCP heartbeat exchange and does not restart it until the CNM boots up. To reset the CNM from the router, enter one of these commands on the router CLI:

  service-module wlan-controller 1/0 reset (for Fast Ethernet CNM versions)

  service-module integrated-service-engine 1/0 reset (for Gigabit Ethernet CNM versions)
- Gigabit Ethernet versions of the Controller Network Module are supported on Cisco 28/37/38xx Series Integrated Services Routers running Cisco IOS Release 12.4(11)T2 or later.

Resetting the Controller to Default Settings

If you want to return the controller to its original configuration, you can use the controller GUI or CLI to reset the controller to factory default settings.

Using the GUI to Reset the Controller to Default Settings

Using the GUI, follow these steps to return the controller to factory default settings.

Step 1 Open your Internet browser.

Step 2 Enter the controller IP address in the browser address line and press **Enter**. An Enter Network Password window appears.

Step 3 Enter your username in the User Name field. The default username is *admin*.

Step 4 Enter the wireless device password in the Password field and press **Enter**. The default password is *admin*.

Step 5 Choose **Commands > Reset to Factory Default**.

Step 6 Click **Reset**.

Step 7 When prompted, confirm the reset.

Step 8 Reboot the controller without saving the configuration.

Step 9 Use the configuration wizard to enter configuration settings. Refer to the "Using the Configuration Wizard" section on page 2 for instructions.

Using the CLI to Reset the Controller to Default Settings

Using the CLI, follow these steps to return the controller to factory default settings.

Step 1 Enter **reset system**. At the prompt that asks whether you need to save changes to the configuration, enter **N**. The unit reboots.

Step 2 When you are prompted for a username, enter **recover-config** to restore the factory default configuration. The controller reboots and displays this message:

```
Welcome to the Cisco WLAN Solution Wizard Configuration Tool
```

Step 3 Use the configuration wizard to enter configuration settings. Refer to the "Using the Configuration Wizard" section on page 2 for instructions.