Radio Resource Management

Information About Radio Resource Management

The Radio Resource Management (RRM) software embedded in the Cisco Wireless LAN Controller acts as a built-in RF engineer to consistently provide real-time RF management of your wireless network. RRM enables Cisco WLCs to continually monitor their associated lightweight access points for the following information:

- Traffic load—The total bandwidth used for transmitting and receiving traffic. It enables wireless LAN managers to track and plan network growth ahead of client demand.
- Interference—The amount of traffic coming from other 802.11 sources.
- Noise—The amount of non-802.11 traffic that is interfering with the currently assigned channel.
- Coverage—The received signal strength (RSSI) and signal-to-noise ratio (SNR) for all connected clients.
- Other—The number of nearby access points.

Using this information, RRM can periodically reconfigure the 802.11 RF network for best efficiency. To do this, RRM performs these functions:

- Radio resource monitoring
- Transmit power control

- Dynamic channel assignment
- Coverage hole detection and correction

Radio Resource Monitoring

RRM automatically detects and configures new Cisco WLCs and lightweight access points as they are added to the network. It then automatically adjusts associated and nearby lightweight access points to optimize coverage and capacity.

Lightweight access points can simultaneously scan all valid 802.11a/b/g channels for the country of operation as well as for channels available in other locations. The access points go “off-channel” for a period not greater than 60 ms to monitor these channels for noise and interference. Packets collected during this time are analyzed to detect rogue access points, rogue clients, ad-hoc clients, and interfering access points.

Note In the presence of voice traffic (in the last 100 ms), the access points defer off-channel measurements.

Each access point spends only 0.2 percent of its time off-channel. This activity is distributed across all access points so that adjacent access points are not scanning at the same time, which could adversely affect wireless LAN performance.

Note When there are numerous rogue access points in the network, the chance of detecting rogues on channels 157 or 161 by a FlexConnect or local mode access point is small. In such cases, the monitor mode AP can be used for rogue detection.

Transmit Power Control

The Cisco WLC dynamically controls access point transmit power based on real-time wireless LAN conditions. You can choose between two versions of transmit power control: TPCv1 and TPCv2. With TPCv1, typically, power can be kept low to gain extra capacity and reduce interference. With TPCv2, transmit power is dynamically adjusted with the goal of minimum interference. TPCv2 is suitable for dense networks. In this mode, there could be higher roaming delays and coverage hole incidents.

The Transmit Power Control (TPC) algorithm both increases and decreases an access point’s power in response to changes in the RF environment. In most instances, TPC seeks to lower an access point's power to reduce interference, but in the case of a sudden change in the RF coverage—for example, if an access point fails or becomes disabled—TPC can also increase power on surrounding access points. This feature is different from coverage hole detection, which is primarily concerned with clients. TPC provides enough RF power to achieve desired coverage levels while avoiding channel interference between access points.

These documents provide more information on Transmit Power Control values for the following access points:

Cisco Aironet 3500 Series http://www.cisco.com/c/en/us/support/wireless/aironet-3500-series/products-installation-guides-list.html

Cisco Aironet 3700 Series http://www.cisco.com/c/en/us/support/wireless/aironet-3700-series/products-installation-guides-list.html

Cisco Aironet 700 Series http://www.cisco.com/c/en/us/support/wireless/aironet-700-series/products-installation-guides-list.html

Cisco Aironet 1530 Series http://www.cisco.com/c/en/us/support/wireless/aironet-1530-series/products-installation-guides-list.html

Overriding the TPC Algorithm with Minimum and Maximum Transmit Power Settings

The TPC algorithm balances RF power in many diverse RF environments. However, it is possible that automatic power control will not be able to resolve some scenarios in which an adequate RF design was not possible to implement due to architectural restrictions or site restrictions—for example, when all access points must be mounted in a central hallway, placing the access points close together, but requiring coverage out to the edge of the building.

In these scenarios, you can configure maximum and minimum transmit power limits to override TPC recommendations. The maximum and minimum TPC power settings apply to all access points through RF profiles in a RF network.

To set the Maximum Power Level Assignment and Minimum Power Level Assignment, enter the maximum and minimum transmit power used by RRM in the text boxes in the Tx Power Control page. The range for these parameters is -10 to 30 dBm. The minimum value cannot be greater than the maximum value; the maximum value cannot be less than the minimum value.

If you configure a maximum transmit power, RRM does not allow any access point attached to the controller to exceed this transmit power level (whether the power is set by RRM TPC or by coverage hole detection). For example, if you configure a maximum transmit power of 11 dBm, then no access point would transmit above 11 dBm, unless the access point is configured manually.

Dynamic Channel Assignment

Two adjacent access points on the same channel can cause either signal contention or signal collision. In a collision, data is not received by the access point. This functionality can become a problem, for example, when someone reading e-mail in a café affects the performance of the access point in a neighboring business. Even though these are completely separate networks, someone sending traffic to the café on channel 1 can disrupt communication in an enterprise using the same channel. Controllers can dynamically allocate access point channel assignments to avoid conflict and to increase capacity and performance. Channels are “reused” to avoid wasting scarce RF resources. In other words, channel 1 is allocated to a different access point far from the café, which is more effective than not using channel 1 altogether.

The controller’s Dynamic Channel Assignment (DCA) capabilities are also useful in minimizing adjacent channel interference between access points. For example, two overlapping channels in the 802.11b/g band, such as 1 and 2, cannot both simultaneously use 11/54 Mbps. By effectively reassigning channels, the controller keeps adjacent channels separated.

Note We recommend that you use only non-overlapping channels (1, 6, 11, and so on).

The controller examines a variety of real-time RF characteristics to efficiently handle channel assignments as follows:

- Access point received energy—The received signal strength measured between each access point and its nearby neighboring access points. Channels are optimized for the highest network capacity.

- Noise—Noise can limit signal quality at the client and access point. An increase in noise reduces the effective cell size and degrades user experience. By optimizing channels to avoid noise sources, the controller can optimize coverage while maintaining system capacity. If a channel is unusable due to excessive noise, that channel can be avoided.
- 802.11 Interference—Interference is any 802.11 traffic that is not part of your wireless LAN, including rogue access points and neighboring wireless networks. Lightweight access points constantly scan all channels looking for sources of interference. If the amount of 802.11 interference exceeds a predefined configurable threshold (the default is 10 percent), the access point sends an alert to the controller. Using the RRM algorithms, the controller may then dynamically rearrange channel assignments to increase system performance in the presence of the interference. Such an adjustment could result in adjacent lightweight access points being on the same channel, but this setup is preferable to having the access points remain on a channel that is unusable due to an interfering foreign access point.

  In addition, if other wireless networks are present, the controller shifts the usage of channels to complement the other networks. For example, if one network is on channel 6, an adjacent wireless LAN is assigned to channel 1 or 11. This arrangement increases the capacity of the network by limiting the sharing of frequencies. If a channel has virtually no capacity remaining, the controller may choose to avoid this channel. In very dense deployments in which all nonoverlapping channels are occupied, the controller does its best, but you must consider RF density when setting expectations.
- Load and utilization—When utilization monitoring is enabled, capacity calculations can consider that some access points are deployed in ways that carry more traffic than other access points (for example, a lobby versus an engineering area). The controller can then assign channels to improve the access point with the worst performance reported. The load is taken into account when changing the channel structure to minimize the impact on clients currently in the wireless LAN. This metric keeps track of every access point's transmitted and received packet counts to determine how busy the access points are. New clients avoid an overloaded access point and associate to a new access point. This parameter is disabled by default.

The controller combines this RF characteristic information with RRM algorithms to make system-wide decisions. Conflicting demands are resolved using soft-decision metrics that guarantee the best choice for minimizing network interference. The end result is optimal channel configuration in a three-dimensional space, where access points on the floor above and below play a major factor in an overall wireless LAN configuration.

Note Radios using 40-MHz channels in the 2.4-GHz band or or 80MHz channels are not supported by DCA.

The RRM startup mode is invoked in the following conditions:

- In a single-controller environment, the RRM startup mode is invoked after the controller is upgraded and rebooted.
- In a multiple-controller environment, the RRM startup mode is invoked after an RF Group leader is elected.

You can trigger RRM startup mode from CLI.

RRM startup mode runs for 100 minutes (10 iterations at 10-minute intervals). The duration of the RRM startup mode is independent of the DCA interval, sensitivity, and network size. The startup mode consists of 10 DCA runs with high sensitivity (making channel changes easy and sensitive to the environment) to converge to a steady state channel plan. After the startup mode is finished, DCA continues to run at the specified interval and sensitivity.

Note DCA algorithm interval is set to one hour, but DCA algorithm always runs in default interval of 10min, channel allocation happens for every 10min interval for the first 10 cycles, and channel changes as per DCA algorithm for every 10min. After that it goes back to the configured time interval. This is common for both DCA interval and Anchor time since it follows the steady state.

Note If DCA/TPC is turned off on the RF-group member, and auto is set on RF-group leader, the channel/TX power on member gets changed as per the algorithm run on the RF-group leader.

Coverage Hole Detection and Correction

The RRM coverage hole detection algorithm can detect areas of radio coverage in a wireless LAN that are below the level needed for robust radio performance. This feature can alert you to the need for an additional (or relocated) lightweight access point.

If clients on a lightweight access point are detected at threshold levels (RSSI, failed client count, percentage of failed packets, and number of failed packets) lower than those specified in the RRM configuration, the access point sends a “coverage hole” alert to the controller. The alert indicates the existence of an area where clients are continually experiencing poor signal coverage, without having a viable access point to which to roam. The controller discriminates between coverage holes that can and cannot be corrected. For coverage holes that can be corrected, the controller mitigates the coverage hole by increasing the transmit power level for that specific access point. The controller does not mitigate coverage holes caused by clients that are unable to increase their transmit power or are statically set to a power level because increasing their downstream transmit power might increase interference in the network.

Benefits of RRM

RRM produces a network with optimal capacity, performance, and reliability. It frees you from having to continually monitor the network for noise and interference problems, which can be transient and difficult to troubleshoot. RRM ensures that clients enjoy a seamless, trouble-free connection throughout the Cisco unified wireless network.

RRM uses separate monitoring and control for each deployed network: 802.11a and 802.11b/g. The RRM algorithms run separately for each radio type (802.11a and 802.11b/g). RRM uses both measurements and algorithms. RRM measurements can be adjusted using monitor intervals, but they cannot be disabled. RRM algorithms are enabled automatically but can be disabled by statically configuring channel and power assignment. The RRM algorithms run at a specified updated interval, which is 600 seconds by default.

Restrictions for Configuring RRM

- The OEAP 600 series access points do not support RRM. The radios for the 600 series OEAP access points are controlled through the local GUI of the 600 series access points and not through the Cisco WLC. Attempting to control the spectrum channel or power, or disabling the radios through the Cisco WLC will fail to have any effect on the 600 series OEAP.

Configuring RRM

The controller's preconfigured RRM settings are optimized for most deployments. However, you can modify the controller's RRM configuration parameters at any time through either the GUI or the CLI.

Note You can configure these parameters on controllers that are part of an RF group or on controllers that are not part of an RF group.

Note The RRM parameters should be set to the same values on every controller in an RF group. The RF group leader can change as a result of controller reboots or depending on which radios hear each other. If the RRM parameters are not identical for all RF group members, varying results can occur when the group leader changes.

Using the controller GUI, you can configure the following RRM parameters: RF group mode, transmit power control, dynamic channel assignment, coverage hole detection, profile thresholds, monitoring channels, and monitor intervals.

Configuring the RF Group Mode (GUI)

Step 1 Choose **Wireless** > **802.11a/n** or **802.11b/g/n > RRM > RF Grouping** to open the 802.11a (or 802.11b/g) RRM > RF Grouping page.

Step 2 From the **Group Mode** drop-down list, select the mode you want to configure for this Cisco WLC.
You can configure RF grouping in the following modes:

- auto—Sets the RF group selection to automatic update mode.

  Note This mode does not support IPv6 based configuration.

- leader—Sets the RF group selection to static mode, and sets this Cisco WLC as the group leader.

  Note Leader supports static IPv6 address.

  Note If a RF group member is configured using IPv4 address, then IPv4 address is used to communicate with the leader. The same is applicable for a RF group member configured using IPv6 too.

- off—Sets the RF group selection off. Every Cisco WLC optimizes its own access point parameters.

  Note A configured static leader cannot become a member of another Cisco WLC until its mode is set to "auto".

  Note A Cisco WLC with a lower priority cannot assume the role of a group leader if a Cisco WLC with a higher priority is available. Here priority is related to the processing power of the Cisco WLC.

  Note We recommend that Cisco WLCs participate in automatic RF grouping. You can override RRM settings without disabling automatic RF group participation.

Step 3 Click **Apply** to save the configuration and click **Restart** to restart RRM RF Grouping algorithm.

Step 4 If you configured RF Grouping mode for this Cisco WLC as a static leader, you can add group members from the RF Group Members section as follows:

1. In the Cisco WLC Name text box, enter the Cisco WLC that you want to add as a member to this group.
2. In the **IP Address (IPv4/IPv6)** text box, enter the IPv4/IPv6 address of the RF Group Member.
3. Click **Add Member** to add the member to this group.

   Note If the member has not joined the static leader, the reason of the failure is shown in parentheses.

Step 5 Click **Apply**.

Step 6 Click **Save Configuration**.

Configuring the RF Group Mode (CLI)

Step 1 Configure the RF Grouping mode by entering this command:
config advanced {802.11a | 802.11b} group-mode {*auto* | *leader*| *off* | *restart***}**

- auto—Sets the RF group selection to automatic update mode.
- leader—Sets the RF group selection to static mode, and sets this Cisco WLC as the group leader.

  Note If a group member is configured with IPv4 address, then IPv4 address is used to communicate with a leader and vice versa with IPv6 also.
- off—Sets the RF group selection off. Every Cisco WLC optimizes its own access point parameters.
- restart—Restarts the RF group selection.

  Note A configured static leader cannot become a member of another Cisco WLC until its mode is set to “auto”.

  Note A Cisco WLC with a lower priority cannot assume the role of a group leader if a Cisco WLC with higher priority is available. Here priority is related to the processing power of the Cisco WLC.

Step 2 Add or remove a Cisco WLC as a static member of the RF group (if the mode is set to “leader”) by entering the these commands:

- **config advanced {802.11a | 802.11b} group-member add** *controller_name ipv4/ipv6 _address*
- **config advanced {802.11a | 802.11b}** *group-member* **remove** *controller_nam ipv4/ipv6_address*

Note You can add RF Group Members using either IPv4 or IPv6 address.

Step 3 See RF grouping status by entering this command:
show advanced {802.11a | 802.11b} *group*

Configuring Transmit Power Control (GUI)

Step 1 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **RRM** > **TPC** to open the 802.11a/n (or 802.11b/g/n) > RRM > Tx Power Control (TPC) page.

Step 2 Choose the Transmit Power Control version from the following options:

- Interference Optimal Mode (TPCv2)—For scenarios where voice calls are extensively used. Transmit power is dynamically adjusted with the goal of minimum interference. It is suitable for dense networks. In this mode, there could be higher roaming delays and coverage hole incidents.

  Note We recommend that you use TCPv2 only in cases where RF issues cannot be resolved by using TCPv1. Please evaluate and test the use of TPCv2 with the assistance of Cisco Services.

- Coverage Optimal Mode (TPCv1)—(Default) Offers strong signal coverage and stability. In this mode, power can be kept low to gain extra capacity and reduce interference.

Step 3 Choose one of the following options from the Power Level Assignment Method drop-down list to specify the Cisco WLC's dynamic power assignment mode:

- **Automatic**—Causes the Cisco WLC to periodically evaluate and, if necessary, update the transmit power for all joined access points. This is the default value.
- **On Demand**—Causes the Cisco WLC to periodically evaluate the transmit power for all joined access points. However, the Cisco WLC updates the power, if necessary, only when you click **Invoke Power Update Now**.

  Note The Cisco WLC does not evaluate and update the transmit power immediately after you click **Invoke Power Update Now**. It waits for the next 600-second interval. This value is not configurable.

- **Fixed**—Prevents the Cisco WLC from evaluating and, if necessary, updating the transmit power for joined access points. The power level is set to the fixed value chosen from the drop-down list.

  Note The transmit power level is assigned an integer value instead of a value in mW or dBm. The integer corresponds to a power level that varies depending on the regulatory domain, channel, and antennas in which the access points are deployed.

  Note For optimal performance, we recommend that you use the Automatic setting.

Step 4 Enter the maximum and minimum power level assignment values in the Maximum Power Level Assignment and Minimum Power Level Assignment text boxes.
The range for the Maximum Power Level Assignment is –10 to 30 dBm.

The range for the Minimum Power Level Assignment is –10 to 30 dBm.

Step 5 In the Power Threshold text box, enter the cutoff signal level used by RRM when determining whether to reduce an access point's power. The default value for this parameter is –70 dBm for TPCv1 and –67 dBm for TPCv2, but can be changed when access points are transmitting at higher (or lower) than desired power levels.
The range for this parameter is –80 to –50 dBm. Increasing this value (between –65 and –50 dBm) causes the access points to operate at a higher transmit power. Decreasing the value has the opposite effect.

In applications with a dense population of access points, it may be useful to decrease the threshold to –80 or –75 dBm to reduce the number of BSSIDs (access points) and beacons seen by the wireless clients. Some wireless clients might

have difficulty processing a large number of BSSIDs or a high beacon rate and might exhibit problematic behavior with the default threshold.

This page also shows the following nonconfigurable transmit power level parameter settings:

- Power Neighbor Count—The minimum number of neighbors an access point must have for the transmit power control algorithm to run.
- Power Assignment Leader—The MAC address of the RF group leader, which is responsible for power level assignment.
- Last Power Level Assignment—The last time RRM evaluated the current transmit power level assignments.

Step 6 Click **Apply**.

Step 7 Click **Save Configuration**.

Configuring Off-Channel Scanning Defer

Information About Off-Channel Scanning Defer

In deployments with certain power-save clients, you sometimes need to defer the Radio Resource Management's (RRM) normal off-channel scanning to avoid missing critical information from low-volume clients (for example, medical devices that use power-save mode and periodically send telemetry information). This feature improves the way that Quality of Service (QoS) interacts with the RRM scan defer feature.

You can use a client's Wi-Fi Multimedia (WMM) UP marking to configure the access point to defer off-channel scanning for a configurable period of time if it receives a packet marked UP.

Off-Channel Scanning Defer is essential to the operation of RRM, which gathers information about alternate channel choices such as noise and interference. Additionally, Off-Channel Scanning Defer is responsible for rogue detection. Devices that need to defer Off-Channel Scanning Defer should use the same WLAN as often as possible. If there are many of these devices (and the possibility exists that Off-Channel Defer scanning could be completely disabled by the use of this feature), you should implement an alternative to local AP Off-Channel Scanning Defer, such as monitoring access points, or other access points in the same location that do not have this WLAN assigned.

You can assign a QoS policy (bronze, silver, gold, and platinum) to a WLAN to affect how packets are marked on the downlink connection from the access point regardless of how they were received on the uplink from the client. UP=1,2 is the lowest priority, and UP=0,3 is the next higher priority. The marking results of each QoS policy are as follows:

- Bronze marks all downlink traffic to UP= 1.
- Silver marks all downlink traffic to UP= 0.
- Gold marks all downlink traffic to UP=4.
- Platinum marks all downlink traffic to UP=6.

Configuring Off-Channel Scanning Defer for WLANs

Configuring Off-Channel Scanning Defer for a WLAN (GUI)

Step 1 Choose **WLANs** to open the WLANs page.

Step 2 Click the ID number of the WLAN to which you want to configure off-channel scanning Defer.

Step 3 Choose the **Advanced** tab from the WLANs > Edit page.

Step 4 From the Off Channel Scanning Defer section, set the **Scan Defer Priority** by clicking on the priority argument.

Step 5 Set the time in milliseconds in the Scan Defer Time text box.
Valid values are 100 through 60000. The default value is 100 milliseconds.

Step 6 Click **Apply** to save your configuration.

Configuring Off Channel Scanning Defer for a WLAN (CLI)

Step 1 Assign a defer-priority for the channel scan by entering this command:
config wlan channel-scan defer-priority priority [enable | disable] *WLAN-id*

The valid range for the priority argument is 0 to 7.

The priority is 0 to 7 (this value should be set to 6 on the client and on the WLAN).

Use this command to configure the amount of time that scanning will be deferred following an UP packet in the queue.

Step 2 Assign the channel scan defer time (in milliseconds) by entering this command:
config wlan channel-scan defer-time msec *WLAN-id*

The time value is in miliseconds (ms) and the valid range is 100 (default) to 60000 (60 seconds). This setting should match the requirements of the equipment on your wireless LAN.

You can also configure this feature on the Cisco WLC GUI by selecting WLANs, and either edit an existing WLAN or create a new one.

Configuring Dynamic Channel Assignment (GUI)

You can specify the channels that the dynamic channel assignment (DCA) algorithm considers when selecting the channels to be used for RRM scanning by using the Cisco WLC GUI.

Note This functionality is helpful when you know that the clients do not support certain channels because they are legacy devices or they have certain regulatory restrictions.

Step 1 Disable the 802.11a/n or 802.11b/g/n network as follows:

a) Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **Network** to open the Global Parameters page.
b) Unselect the **802.11a** (or **802.11b/g**) **Network Status** check box.
c) Click **Apply**.

Step 2 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **RRM** > **DCA** to open the Dynamic Channel Assignment (DCA) page.

Step 3 Choose one of the following options from the **Channel Assignment Method** drop-down list to specify the Cisco WLC's DCA mode:

- **Automatic—**Causes the Cisco WLC to periodically evaluate and, if necessary, update the channel assignment for all joined access points. This is the default value.
- **Freeze—**Causes the Cisco WLC to evaluate and update the channel assignment for all joined access points, if necessary, but only when you click **Invoke Channel Update Once**.

  Note The Cisco WLC does not evaluate and update the channel assignment immediately after you click **Invoke Channel Update Once**. It waits for the next interval to elapse.

- **OFF—**Turns off DCA and sets all access point radios to the first channel of the band, which is the default value. If you choose this option, you must manually assign channels on all radios.

  Note For optimal performance, we recommend that you use the Automatic setting. See the Disabling Dynamic Channel and Power Assignment (GUI), on page 32 section for instructions on how to disable the Cisco WLC's dynamic channel and power settings.

Step 4 From the Interval drop-down list, choose one of the following options to specify how often the DCA algorithm is allowed to run: **10 minutes**, **1 hour**, **2 hours**, **3 hours**, **4 hours**, **6 hours**, **8 hours**, **12 hours**, or **24 hours**. The default value is 10 minutes.

Note If your Cisco WLC supports only OfficeExtend access points, we recommend that you set the DCA interval to 6 hours for optimal performance. For deployments with a combination of OfficeExtend access points and local access points, the range of 10 minutes to 24 hours can be used.

Step 5 From the AnchorTime drop-down list, choose a number to specify the time of day when the DCA algorithm is to start. The options are numbers between 0 and 23 (inclusive) representing the hour of the day from 12:00 a.m. to 11:00 p.m.

Step 6 Select the **Avoid Foreign AP Interference** check box to cause the Cisco WLC's RRM algorithms to consider 802.11 traffic from foreign access points (those not included in your wireless network) when assigning channels to lightweight access points, or unselect it to disable this feature. For example, RRM may adjust the channel assignment to have access points avoid channels close to foreign access points. The default value is selected.

Step 7 Select the **Avoid Cisco AP Load** check box to cause the Cisco WLC's RRM algorithms to consider 802.11 traffic from Cisco lightweight access points in your wireless network when assigning channels, or unselect it to disable this feature. For example, RRM can assign better reuse patterns to access points that carry a heavier traffic load. The default value is unselected.

Step 8 Select the **Avoid Non-802.11a (802.11b) Noise** check box to cause the Cisco WLC's RRM algorithms to consider noise (non-802.11 traffic) in the channel when assigning channels to lightweight access points, or unselect it to disable this

feature. For example, RRM may have access points avoid channels with significant interference from nonaccess point sources, such as microwave ovens. The default value is selected.

Step 9 Select the **Avoid Persistent Non-WiFi Interference** check box to enable the Cisco WLC to ignore persistent non-WiFi interference.

Step 10 From the **DCA Channel Sensitivity** drop-down list, choose one of the following options to specify how sensitive the DCA algorithm is to environmental changes such as signal, load, noise, and interference when determining whether to change channels:

- **Low—**The DCA algorithm is not particularly sensitive to environmental changes.
- **Medium—**The DCA algorithm is moderately sensitive to environmental changes.
- **High—**The DCA algorithm is highly sensitive to environmental changes.

The default value is Medium. The DCA sensitivity thresholds vary by radio band, as noted in the table below.

Table 1: DCA Sensitivity Thresholds

Option	2.4-GHz DCA Sensitivity Threshold	5-GHz DCA Sensitivity Threshold
High	5 dB	5 dB
Medium	10 dB	15 dB
Low	20 dB	20 dB

Step 11 For 802.11a/n networks only, choose one of the following channel width options to specify the channel bandwidth supported for all 802.11n radios in the 5-GHz band:

- **20 MHz—**The 20-MHz channel bandwidth (default)
- **40 MHz—**The 40-MHz channel bandwidth

Note If you choose 40 MHz, be sure to choose at least two adjacent channels from the DCA Channel List in *Step 13* (for example, a primary channel of 36 and an extension channel of 40). If you choose only one channel, that channel is not used for 40-MHz channel width.

Note If you choose 40 MHz, you can also configure the primary and extension channels used by individual access points.

Note To override the globally configured DCA channel width setting, you can statically configure an access point's radio for 20- or 40-MHz mode on the 802.11a/n Cisco APs > Configure page. if you then change the static RF channel assignment method to WLC Controlled on the access point radio, the global DCA configuration overrides the channel width configuration that the access point was previously using. It can take up to 30 minutes (depending on how often DCA is configured to run) for the change to take effect.

Note If you choose 40 MHz on the A radio, you cannot pair channels 116, 140, and 165 with any other channels.

This page also shows the following nonconfigurable channel parameter settings:

- Channel Assignment Leader—The MAC address of the RF group leader, which is responsible for channel assignment.
- Last Auto Channel Assignment—The last time RRM evaluated the current channel assignments.

Step 12 Select the **Avoid check for non-DFS** channel to enable the Cisco WLC to avoid checks for non-DFS channels. DCA configuration requires at least one non-DFS channel in the list. In the EU countries, outdoor deployments do not support non-DFS channels. Customers based in EU or regions with similar regulations must enable this option or at least have one non-DFS channel in the DCA list even if the channel is not supported by the APs.

Note This parameter is applicable only for deployments having outdoor access points such as 1522 and 1524.

Step 13 In the DCA Channel List area, the DCA Channels text box shows the channels that are currently selected. To choose a channel, select its check box in the Select column. To exclude a channel, unselect its check box.
The ranges are as follows: 802.11a—36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 132, 136, 140, 149, 153, 157, 161, 165, 190, 196 802.11b/g—1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

The defaults are as follows: 802.11a—36, 40, 44, 48, 52, 56, 60, 64, 100, 104, 108, 112, 116, 132, 136, 140, 149, 153, 157, 161 802.11b/g—1, 6, 11

Note These extended UNII-2 channels in the 802.11a band do not appear in the channel list: 100, 104, 108, 112, 116, 132, 136, and 140. If you have Cisco Aironet 1520 series mesh access points in the -E regulatory domain, you must include these channels in the DCA channel list before you start operation. If you are upgrading from a previous release, verify that these channels are included in the DCA channel list. To include these channels in the channel list, select the **Extended UNII-2 Channels** check box.

Step 14 If you are using Cisco Aironet 1520 series mesh access points in your network, you need to set the 4.9-GHz channels in the 802.11a band on which they are to operate. The 4.9-GHz band is for public safety client access traffic only. To choose a 4.9-GHz channel, select its check box in the Select column. To exclude a channel, unselect its check box.
The ranges are as follows: 802.11a—1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26

The defaults are as follows: 802.11a—20, 26

Step 15 Click **Apply**.

Step 16 Reenable the 802.11 networks as follows:

1. Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **Network** to open the Global Parameters page.
2. Select the **802.11a** (or **802.11b/g**) **Network Status** check box.
3. Click **Apply**.

Step 17 Click **Save Configuration**.

Note To see why the DCA algorithm changed channels, choose **Monitor** and then choose **View All** under Most Recent Traps. The trap provides the MAC address of the radio that changed channels, the previous channel and the new channel, the reason why the change occurred, the energy before and after the change, the noise before and after the change, and the interference before and after the change.

Configuring Coverage Hole Detection (GUI)

Step 1 Disable the 802.11 network as follows:

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

b) Unselect the **802.11a** (or **802.11b/g**) **Network Status** check box.
c) Click **Apply**.

Step 2 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **RRM** > **Coverage** to open the 802.11a (or 802.11b/g/n) > RRM > Coverage page.

Step 3 Select the **Enable Coverage Hole Detection** check box to enable coverage hole detection, or unselect it to disable this feature. If you enable coverage hole detection, the Cisco WLC automatically determines, based on data received from the access points, if any access points have clients that are potentially located in areas with poor coverage. The default value is selected.

Step 4 In the **Data RSSI** text box, enter the minimum receive signal strength indication (RSSI) value for data packets received by the access point. The value that you enter is used to identify coverage holes (or areas of poor coverage) within your network. If the access point receives a packet in the data queue with an RSSI value below the value that you enter here, a potential coverage hole has been detected. The valid range is –90 to –60 dBm, and the default value is –80 dBm. The access point takes data RSSI measurements every 5 seconds and reports them to the Cisco WLC in 90-second intervals.

Step 5 In the **Voice RSSI** text box, enter the minimum receive signal strength indication (RSSI) value for voice packets received by the access point. The value that you enter is used to identify coverage holes within your network. If the access point receives a packet in the voice queue with an RSSI value below the value that you enter here, a potential coverage hole has been detected. The valid range is –90 to –60 dBm, and the default value is –75 dBm. The access point takes voice RSSI measurements every 5 seconds and reports them to the Cisco WLC in 90-second intervals.

Step 6 In the **Min Failed Client Count per AP** text box, enter the minimum number of clients on an access point with an RSSI value at or below the data or voice RSSI threshold. The valid range is 1 to 75, and the default value is 3.

Step 7 In the **Coverage Exception Level per AP** text box, enter the percentage of clients on an access point that are experiencing a low signal level but cannot roam to another access point. The valid range is 0 to 100%, and the default value is 25%.

Note If both the number and percentage of failed packets exceed the values configured for Failed Packet Count and Failed Packet Percentage (configurable through the Cisco WLC CLI) for a 5-second period, the client is considered to be in a pre-alarm condition. The Cisco WLC uses this information to distinguish between real and false coverage holes. False positives are generally due to the poor roaming logic implemented on most clients. A coverage hole is detected if both the number and percentage of failed clients meet or exceed the values entered in the Min Failed Client Count per AP and Coverage Exception Level per AP text boxes over a 90-second period. The Cisco WLC determines if the coverage hole can be corrected and, if appropriate, mitigates the coverage hole by increasing the transmit power level for that specific access point.

Step 8 Click **Apply**.

Step 9 Reenable the 802.11 network as follows:

a) Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **Network** to open the 802.11a (or 802.11b/g) Global Parameters page.
b) Select the **802.11a** (or **802.11b/g/n**) **Network Status** check box.
c) Click **Apply**.

Step 10 Click **Save Configuration**.

Configuring RRM Profile Thresholds, Monitoring Channels, and Monitor Intervals (GUI)

Step 1 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **RRM** > **General** to open the 802.11a/n (or 802.11b/g/n) > RRM > General page.

Step 2 Configure profile thresholds used for alarming as follows:

Note The profile thresholds have no bearing on the functionality of the RRM algorithms. Lightweight access points send an SNMP trap (or an alert) to the Cisco WLC when the values set for these threshold parameters are exceeded.

a) In the **Interference** text box, enter the percentage of interference (802.11 traffic from sources outside of your wireless network) on a single access point. The valid range is 0 to 100%, and the default value is 10%.

b) In the **Clients** text box, enter the number of clients on a single access point. The valid range is 1 to 75, and the default value is 12.

c) In the **Noise** text box, enter the level of noise (non-802.11 traffic) on a single access point. The valid range is –127 to 0 dBm, and the default value is –70 dBm.

d) In the **Utilization** text box, enter the percentage of RF bandwidth being used by a single access point. The valid range is 0 to 100%, and the default value is 80%.

Step 3 From the **Channel List** drop-down list, choose one of the following options to specify the set of channels that the access point uses for RRM scanning:

- **All Channels—**RRM channel scanning occurs on all channels supported by the selected radio, which includes channels not allowed in the country of operation.
- **Country Channels—**RRM channel scanning occurs only on the data channels in the country of operation. This is the default value.
- **DCA Channels—**RRM channel scanning occurs only on the channel set used by the DCA algorithm, which by default includes all of the non-overlapping channels allowed in the country of operation. However, you can specify the channel set to be used by DCA if desired. To do so, follow instructions in the Dynamic Channel Assignment.

Step 4 Configure monitor intervals as follows:

1 In the **Channel Scan Interval** text box, enter (in seconds) the sum of the time between scans for each channel within a radio band. The entire scanning process takes 50 ms per channel, per radio and runs at the interval configured here. The time spent listening on each channel is determined by the non-configurable 50-ms scan time and the number of channels to be scanned. For example, in the U.S. all 11 802.11b/g channels are scanned for 50 ms each within the default 180-second interval. So every 16 seconds, 50 ms is spent listening on each scanned channel (180/11 = ~16 seconds). The Channel Scan Interval parameter determines the interval at which the scanning occurs.The valid range is 60 to 3600 seconds, and the default value is 60 seconds for 802.11a radios and 180 seconds for the 802.11b/g radios.

Note If your Cisco WLC supports only OfficeExtend access points, we recommend that you set the channel scan interval to 1800 seconds for optimal performance. For deployments with a combination of OfficeExtend access points and local access points, the range of 60 to 3600 seconds can be used.

2 In the **Neighbor Packet Frequency** text box, enter (in seconds) how frequently neighbor packets (messages) are sent, which eventually builds the neighbor list. The valid range is 60 to 3600 seconds, and the default value is 60 seconds.

Note If your Cisco WLC supports only OfficeExtend access points, we recommend that you set the neighbor packet frequency to 600 seconds for optimal performance. For deployments with a combination of OfficeExtend access points and local access points, the range of 60 to 3600 seconds can be used.

Note If the access point radio does not receive a neighbor packet from an existing neighbor within 60 minutes, the Cisco WLC deletes that neighbor from the neighbor list.

Step 5 Click **Apply**.

Step 6 Click **Save Configuration**.

Note Click **Set to Factory Default** if you want to return all of the Cisco WLC's RRM parameters to their factory-default values.

Configuring RRM (CLI)

Step 1 Disable the 802.11 network by entering this command:
config {**802.11a** | **802.11b**} **disable network**

Step 2 Choose the Transmit Power Control version by entering this command:
config advanced {**802.11a** | **802.11b**} **tpc-version** {**1** | **2**}

where:

- TPCv1: Coverage-optimal—(Default) Offers strong signal coverage and stability with negligent intercell interferences and sticky client syndrome.
- TPCv2: Interference-optimal—For scenarios where voice calls are extensively used. Tx power is dynamically adjusted with the goal of minimum interference. It is suitable for dense networks. In this mode, there can be higher roaming delays and coverage hole incidents.

Step 3 Perform one of the following to configure transmit power control:

- Have RRM automatically set the transmit power for all 802.11 radios at periodic intervals by entering this command:

  config {**802.11a** | **802.11b**} **txPower global auto**

- Have RRM automatically reset the transmit power for all 802.11a or 802.11b/g radios one time by entering this command:

  config {**802.11a** | **802.11b**} **txPower global once**

- Configure the transmit power range that overrides the Transmit Power Control algorithm, use this command to enter the maximum and minimum transmit power used by RRM:

  config {**802.11a** | **802.11b**} **txPower global** {**max** | **min**} *txpower*

  where *txpower* is a value from –10 to 30 dBM. The minimum value cannot be greater than the maximum value; the maximum value cannot be less than the minimum value.

  If you configure a maximum transmit power, RRM does not allow any access point to exceed this transmit power (whether the maximum is set at RRM startup, or by coverage hole detection). For example, if you configure a

maximum transmit power of 11 dBm, then no access point would transmit above 11 dBm, unless the access point is configured manually.

- Manually change the default transmit power setting by entering this command:

  config advanced {**802.11a** | **802.11b**} {**tpcv1-thresh** | **tpcv2-thresh**} *threshold*

  where *threshold* is a value from –80 to –50 dBm. Increasing this value causes the access points to operate at higher transmit power rates. Decreasing the value has the opposite effect.

  In applications with a dense population of access points, it may be useful to decrease the threshold to –80 or –75 dBm in order to reduce the number of BSSIDs (access points) and beacons seen by the wireless clients. Some wireless clients may have difficulty processing a large number of BSSIDs or a high beacon rate and may exhibit problematic behavior with the default threshold.

- Configure the Transmit Power Control Version 2 on a per-channel basis by entering this command:

  config advanced {**802.11a** | **802.11b**} **tpcv2-per-chan** {**enable** | **disable**}

Step 4 Perform one of the following to configure dynamic channel assignment (DCA):

- Have RRM automatically configure all 802.11 channels based on availability and interference by entering this command:

  config {**802.11a** | **802.11b**} **channel global auto**

- Have RRM automatically reconfigure all 802.11 channels one time based on availability and interference by entering this command:

  config {**802.11a** | **802.11b**} **channel global once**

- Disable RRM and set all channels to their default values by entering this command:

  config {**802.11a** | **802.11b**} **channel global off**

- Restart aggressive DCA cycle by entering this command:

  config {**802.11a** | **802.11b**} **channel global restart**

- To specify the channel set used for DCA by entering this command:

  config advanced {**802.11a** | **802.11b**} **channel** {**add** | **delete**} *channel_number*

  You can enter only one channel number per command. This command is helpful when you know that the clients do not support certain channels because they are legacy devices or they have certain regulatory restrictions.

Step 5 Configure additional DCA parameters by entering these commands:

- **config advanced** {**802.11a** | **802.11b**} **channel dca anchor-time** *value*—Specifies the time of day when the DCA algorithm is to start. value is a number between 0 and 23 (inclusive) representing the hour of the day from 12:00 a.m. to 11:00 p.m.
- **config advanced** {**802.11a** | **802.11b**} **channel dca interval** *value*—Specifies how often the DCA algorithm is allowed to run. value is one of the following: 1, 2, 3, 4, 6, 8, 12, or 24 hours or 0, which is the default value of 10 minutes (or 600 seconds).

  Note If your Cisco WLC supports only OfficeExtend access points, we recommend that you set the DCA interval to 6 hours for optimal performance. For deployments with a combination of OfficeExtend access points and local access points, the range of 10 minutes to 24 hours can be used.

- **config advanced** {**802.11a** | **802.11b**} **channel dca sensitivity** {**low** | **medium** | **high**}—Specifies how sensitive the DCA algorithm is to environmental changes such as signal, load, noise, and interference when determining whether to change channel.
  - **low** means that the DCA algorithm is not particularly sensitive to environmental changes.
  - **medium** means that the DCA algorithm is moderately sensitive to environmental changes.
  - **high** means that the DCA algorithm is highly sensitive to environmental changes.

The DCA sensitivity thresholds vary by radio band, as noted in following table.

Table 2: DCA Sensitivity Thresholds

Option	2.4-GHz DCA Sensitivity Threshold	5-GHz DCA Sensitivity Threshold
High	5 dB	5 dB
Medium	10 dB	15 dB
Low	20 dB	20 dB

- **config advanced 802.11a channel dca chan-width-11n** {**20** | **40**}—Configures the DCA channel width for all 802.11n radios in the 5-GHz band.

  where
  - **20** sets the channel width for 802.11n radios to 20 MHz. This is the default value.
  - **40** sets the channel width for 802.11n radios to 40 MHz.

  Note If you choose **40**, be sure to set at least two adjacent channels in the **config advanced 802.11a channel** {**add** | **delete**} *channel_number* command in *Step 4* (for example, a primary channel of 36 and an extension channel of 40). If you set only one channel, that channel is not used for 40-MHz channel width.

  Note If you choose 40, you can also configure the primary and extension channels used by individual access points.

  Note To override the globally configured DCA channel width setting, you can statically configure an access point's radio for 20-MHz or 40-MHz mode using the **config 802.11a chan_width** *Cisco_AP* {**20** | **40**} command. If you change the static configuration to global on the access point radio, the global DCA configuration overrides the channel width configuration that the access point was previously using. It can take up to 30 minutes (depending on how often DCA is configured to run) for the change to take effect.

- **config advanced {802.11a | 802.11b} channel outdoor-ap-dca {***enable* | *disable***}**—Enables or disables to the Cisco WLC to avoid checks for non-DFS channels.

  Note This parameter is applicable only for deployments having outdoor access points such as 1522 and 1524.

- **config advanced** {**802.11a** | **802.11b**} **channel foreign** {**enable** | **disable**}—Enables or disables foreign access point interference avoidance in the channel assignment.

- **config advanced** {**802.11a** | **802.11b**} **channel load** {**enable** | **disable**}—Enables or disables load avoidance in the channel assignment.
- **config advanced** {**802.11a** | **802.11b**} **channel noise** {**enable** | **disable**}—Enables or disables noise avoidance in the channel assignment.
- **config advanced** {**802.11a** | **802.11b**} **channel update**—Initiates an update of the channel selection for every Cisco access point.

Step 6 Configure coverage hole detection by entering these commands:

Note In Cisco WLC software release 5.2 or later releases, you can disable coverage hole detection on a per-WLAN basis.

- **config advanced** {**802.11a** | **802.11b**} **coverage** {**enable** | **disable**}—Enables or disables coverage hole detection. If you enable coverage hole detection, the Cisco WLC automatically determines, based on data received from the access points, if any access points have clients that are potentially located in areas with poor coverage. The default value is enabled.
- **config advanced** {**802.11a** | **802.11b**} **coverage** {**data** | **voice**} **rssi-threshold** *rssi*—Specifies the minimum receive signal strength indication (RSSI) value for packets received by the access point. The value that you enter is used to identify coverage holes (or areas of poor coverage) within your network. If the access point receives a packet in the data or voice queue with an RSSI value below the value you enter here, a potential coverage hole has been detected. The valid range is –90 to –60 dBm, and the default value is –80 dBm for data packets and –75 dBm for voice packets. The access point takes RSSI measurements every 5 seconds and reports them to the Cisco WLC in 90-second intervals.
- **config advanced** {**802.11a** | **802.11b**} **coverage level global** *clients*—Specifies the minimum number of clients on an access point with an RSSI value at or below the data or voice RSSI threshold. The valid range is 1 to 75, and the default value is 3.
- **config advanced** {**802.11a** | **802.11b**} **coverage exception global** *percent*—Specifies the percentage of clients on an access point that are experiencing a low signal level but cannot roam to another access point. The valid range is 0 to 100%, and the default value is 25%.
- **config advanced** {**802.11a** | **802.11b**} **coverage** {**data** | **voice**} **packet-count** *packets*—Specifies the minimum failure count threshold for uplink data or voice packets. The valid range is 1 to 255 packets, and the default value is 10 packets.
- **config advanced** {**802.11a** | **802.11b**} **coverage** {**data** | **voice**} **fail-rate** *percent*—Specifies the failure rate threshold for uplink data or voice packets. The valid range is 1 to 100%, and the default value is 20%.

  Note If both the number and percentage of failed packets exceed the values entered in the **packet-count** and **fail-rate** commands for a 5-second period, the client is considered to be in a pre-alarm condition. The Cisco WLC uses this information to distinguish between real and false coverage holes. False positives are generally due to the poor roaming logic implemented on most clients. A coverage hole is detected if both the number and percentage of failed clients meet or exceed the values entered in the **coverage level global** and **coverage exception global** commands over a 90-second period. The Cisco WLC determines if the coverage hole can be corrected and, if appropriate, mitigates the coverage hole by increasing the transmit power level for that specific access point.

Step 7 Enable the 802.11a or 802.11b/g network by entering this command:
config {**802.11a** | **802.11b**} **enable network**

Note To enable the 802.11g network, enter **config 802.11b 11gSupport** *enable* after the **config 802.11b enable network** command.

Step 8 Save your settings by entering this command:
save config

Viewing RRM Settings (CLI)

To see 802.11a and 802.11b/g RRM settings, use these commands:

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

where ? is one of the following:

- **ccx** {*global* | *Cisco_AP*}**—**Shows the CCX RRM configuration.
- **channel—**Shows the channel assignment configuration and statistics.
- **coverage—**Shows the coverage hole detection configuration and statistics.
- **logging—**Shows the RF event and performance logging.
- **monitor—**Shows the Cisco radio monitoring.
- **profile** {*global* | *Cisco_AP*}**—**Shows the access point performance profiles.
- **receiver—**Shows the 802.11a or 802.11b/g receiver configuration and statistics.
- **summary—**Shows the configuration and statistics of the 802.11a or 802.11b/g access points.
- **txpower—**Shows the transmit power assignment configuration and statistics.

Debug RRM Issues (CLI)

Use these commands to troubleshoot and verify RRM behavior:

debug airewave-director *?*

where *?* is one of the following:

- **all—**Enables debugging for all RRM logs.
- **channel—**Enables debugging for the RRM channel assignment protocol.
- **detail—**Enables debugging for RRM detail logs.
- **error—**Enables debugging for RRM error logs.
- **group—**Enables debugging for the RRM grouping protocol.
- **manager—**Enables debugging for the RRM manager.
- **message—**Enables debugging for RRM messages.
- **packet—**Enables debugging for RRM packets.

- **power—**Enables debugging for the RRM power assignment protocol as well as coverage hole detection.
- **profile—**Enables debugging for RRM profile events.
- **radar—**Enables debugging for the RRM radar detection/avoidance protocol.
- **rf-change—**Enables debugging for RRM RF changes.

Configuring RRM Neighbor Discovery Packets

The Cisco Neighbor Discovery Packet (NDP) is the fundamental tool for RRM and other wireless applications that provides information about the neighbor radio information. You can configure the controller to encrypt neighbor discovery packets.

This feature enables you to be compliant with the PCI specifications.

Information About RRM NDP and RF Grouping

The Cisco Neighbor Discovery Packet (NDP) is the fundamental tool for RRM and other wireless applications that provides information about the neighbor radio information. You can configure the Cisco WLC to encrypt neighbor discovery packets.

This feature enables you to be compliant with the PCI specifications.

An RF group can only be formed between Cisco WLCs that have the same encryption mechanism. That is, an access point associated to a Cisco WLC that is encrypted can not be neighbors with an access point associated to a Cisco WLC that is not encrypted. The two Cisco WLCs and their access points will not recognize each other as neighbors and cannot form an RF group. It is possible to assign two Cisco WLCs in a static RF group configuration that has mismatched encryption settings. In this case, the two Cisco WLCs do not function as a single RF group because the access points belonging to the mismatched Cisco WLCs do not recognize one another as neighbors in the group.

Configuring RRM NDP (CLI)

To configure RRM NDP using the Cisco WLC CLI, enter this command:

config advanced 802.11{**a**|**b**} **monitor ndp-mode** {**protected** | **transparent**}

This command configures NDP mode. By default, the mode is set to “transparent”. The following options are available:

- Protected—Packets are encrypted.
- Transparent—Packets are sent as is.

Use this command to see the discovery type:

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

Configuring RF Groups

Information About RF Groups

An RF group is a logical collection of Cisco WLCs that coordinate to perform RRM in a globally optimized manner to perform network calculations on a per-radio basis. An RF group exists for each 802.11 network type. Clustering Cisco WLCs into a single RF group enable the RRM algorithms to scale beyond the capabilities of a single Cisco WLC.

RF group is created based on following parameters:

- User-configured RF network name.
- Neighbor discovery performed at the radio level.
- Country list configured on MC.

RF grouping runs between MCs.

Lightweight access points periodically send out neighbor messages over the air. Access points using the the same RF group name validate messages from each other.

When access points on different Cisco WLCs hear validated neighbor messages at a signal strength of –80 dBm or stronger, the Cisco WLCs dynamically form an RF neighborhood in auto mode. In static mode, the leader is manually selected and the members are added to the RF Group. To know more about RF Group modes, RF Group Leader.

Note RF groups and mobility groups are similar in that they both define clusters of Cisco WLCs, but they are different in terms of their use. An RF group facilitates scalable, system-wide dynamic RF management while a mobility group facilitates scalable, system-wide mobility and Cisco WLC redundancy.

RF Group Leader

Starting in the 7.0.116.0 release, the RF Group Leader can be configured in two ways as follows:

- Auto Mode—In this mode, the members of an RF group elect an RF group leader to maintain a “master” power and channel scheme for the group. The RF grouping algorithm dynamically chooses the RF group leader and ensures that an RF group leader is always present. Group leader assignments can and do change (for instance, if the current RF group leader becomes inoperable or if RF group members experience major changes).
- Static Mode—In this mode, the user selects a Cisco WLC as an RF group leader manually. In this mode, the leader and the members are manually configured and are therefore fixed. If the members are unable to join the RF group, the reason is indicated. The leader tries to establish a connection with a member every 1 minute if the member has not joined in the previous attempt.

The RF group leader analyzes real-time radio data collected by the system, calculates the power and channel assignments, and sends them to each of the Cisco WLCs in the RF group. The RRM algorithms ensure

system-wide stability and restrain channel and power scheme changes to the appropriate local RF neighborhoods.

In Cisco WLC software releases prior to 6.0, the dynamic channel assignment (DCA) search algorithm attempts to find a good channel plan for the radios associated to Cisco WLCs in the RF group, but it does not adopt a new channel plan unless it is considerably better than the current plan. The channel metric of the worst radio in both plans determines which plan is adopted. Using the worst-performing radio as the single criterion for adopting a new channel plan can result in pinning or cascading problems.

Pinning occurs when the algorithm could find a better channel plan for some of the radios in an RF group but is prevented from pursuing such a channel plan change because the worst radio in the network does not have any better channel options. The worst radio in the RF group could potentially prevent other radios in the group from seeking better channel plans. The larger the network, the more likely pinning becomes.

Cascading occurs when one radio's channel change results in successive channel changes to optimize the remaining radios in the RF neighborhood. Optimizing these radios could lead to their neighbors and their neighbors' neighbors having a suboptimal channel plan and triggering their channel optimization. This effect could propagate across multiple floors or even multiple buildings, if all the access point radios belong to the same RF group. This change results in considerable client confusion and network instability.

The main cause of both pinning and cascading is the way in which the search for a new channel plan is performed and that any potential channel plan changes are controlled by the RF circumstances of a single radio. In Cisco WLC software release 6.0, the DCA algorithm has been redesigned to prevent both pinning and cascading. The following changes have been implemented:

- Multiple local searches—The DCA search algorithm performs multiple local searches initiated by different radios within the same DCA run rather than performing a single global search driven by a single radio. This change addresses both pinning and cascading while maintaining the desired flexibility and adaptability of DCA and without jeopardizing stability.
- Multiple channel plan change initiators (CPCIs)—Previously, the single worst radio was the sole initiator of a channel plan change. Now each radio within the RF group is evaluated and prioritized as a potential initiator. Intelligent randomization of the resulting list ensures that every radio is eventually evaluated, which eliminates the potential for pinning.
- Limiting the propagation of channel plan changes (Localization)—For each CPCI radio, the DCA algorithm performs a local search for a better channel plan, but only the CPCI radio itself and its one-hop neighboring access points are actually allowed to change their current transmit channels. The impact of an access point triggering a channel plan change is felt only to within two RF hops from that access point, and the actual channel plan changes are confined to within a one-hop RF neighborhood. Because this limitation applies across all CPCI radios, cascading cannot occur.
- Non-RSSI-based cumulative cost metric—A cumulative cost metric measures how well an entire region, neighborhood, or network performs with respect to a given channel plan. The individual cost metrics of all access points in that area are considered in order to provide an overall understanding of the channel plan's quality. These metrics ensure that the improvement or deterioration of each single radio is factored into any channel plan change. The objective is to prevent channel plan changes in which a single radio improves but at the expense of multiple other radios experiencing a considerable performance decline.

The RRM algorithms run at a specified updated interval, which is 600 seconds by default. Between update intervals, the RF group leader sends keepalive messages to each of the RF group members and collects real-time RF data.

Note Several monitoring intervals are also available. See the Configuring RRM section for details.

RF Group Name

A Cisco WLC is configured with an RF group name, which is sent to all access points joined to the Cisco WLC and used by the access points as the shared secret for generating the hashed MIC in the neighbor messages. To create an RF group, you configure all of the Cisco WLCs to be included in the group with the same RF group name.

If there is any possibility that an access point joined to a Cisco WLC may hear RF transmissions from an access point on a different Cisco WLC, you should configure the Cisco WLCs with the same RF group name. If RF transmissions between access points can be heard, then system-wide RRM is recommended to avoid 802.11 interference and contention as much as possible.

Controllers and APs in RF Groups

- Controller software supports up to 20 controllers and 6000 access points in an RF group.
- The RF group members are added based on the following criteria:
  - Maximum number of APs Supported: The maximum limit for the number of access points in an RF group is 6000. The number of access points supported is determined by the number of APs licensed to operate on the controller.
  - Twenty controllers: Only 20 controllers (including the leader) can be part of an RF group if the sum of the access points of all controllers combined is less than or equal to the upper access point limit.

Table 3: Controller Model Information

	8500	7500	5500	WiSM2
Maximum APs per RRM Group	6000	6000	1000	2000
Maximum AP Groups	6000	6000	500	500

Configuring RF Groups

This section describes how to configure RF groups through either the GUI or the CLI.

Note The RF group name is generally set at deployment time through the Startup Wizard. However, you can change it as necessary.

Note When the multiple-country feature is being used, all Cisco WLCs intended to join the same RF group must be configured with the same set of countries, configured in the same order.

Note You can also configure RF groups using the Cisco Prime Infrastructure.

Configuring an RF Group Name (GUI)

Step 1 Choose **Controller** > **General** to open the General page.
Step 2 Enter a name for the RF group in the RF-Network Name text box. The name can contain up to 19 ASCII characters.
Step 3 Click **Apply** to commit your changes.
Step 4 Click **Save Configuration** to save your changes.
Step 5 Repeat this procedure for each controller that you want to include in the RF group.

Configuring an RF Group Name (CLI)

Step 1 Create an RF group by entering the **config network rf-network-name name** command:
Note Enter up to 19 ASCII characters for the group name.
Step 2 See the RF group by entering the **show network** command.
Step 3 Save your settings by entering the **save config** command.
Step 4 Repeat this procedure for each controller that you want to include in the RF group.

Viewing the RF Group Status

This section describes how to view the status of the RF group through either the GUI or the CLI.

Note You can also view the status of RF groups using the Cisco Prime Infrastructure.

Viewing the RF Group Status (GUI)

Step 1 Choose **Wireless** > **802.11a/n** > **or 802.11b/g/n > RRM** > **RF Grouping** to open the 802.11a/n (or 802.11b/g/n) RRM > RF Grouping page.
This page shows the details of the RF group, displaying the configurable parameter **RF Group mode**, the **RF Group role** of this Cisco WLC, the **Update Interval** and the Cisco WLC name and IP address of the **Group Leader** to this Cisco WLC.

Note RF grouping mode can be set using the **Group Mode** drop-down list.

Tip Once a Cisco WLC has joined as a static member and you want to change the grouping mode, we recommend that you remove the member from the configured static-leader and also make sure that a member Cisco WLC has not been configured to be a member on multiple static leaders. This is to avoid repeated join attempts from one or more RF static leaders.

Step 2 (Optional) Repeat this procedure for the network type that you did not select (802.11a/n or 802.11b/g/n).

Viewing the RF Group Status (CLI)

Step 1 See which Cisco WLC is the RF group leader for the 802.11a RF network by entering this command:
show advanced 802.11a group
Information similar to the following appears:

```
Radio RF Grouping
  802.11a Group Mode.............................. STATIC
  802.11a Group Update Interval................... 600 seconds
  802.11a Group Leader............................ test (209.165.200.225)
    802.11a Group Member.......................... test (209.165.200.225)
  802.11a Last Run................................ 397 seconds ago
```

This output shows the details of the RF group, specifically the grouping mode for the Cisco WLC, how often the group information is updated (600 seconds by default), the IP address of the RF group leader, the IP address of this Cisco WLC, and the last time the group information was updated.

Note If the IP addresses of the group leader and the group member are identical, this Cisco WLC is currently the group leader.

Note A * indicates that the Cisco WLC has not joined as a static member.

Step 2 See which Cisco WLC is the RF group leader for the 802.11b/g RF network by entering this command:
show advanced 802.11b group

Overriding RRM

Information About Overriding RRM

In some deployments, it is desirable to statically assign channel and transmit power settings to the access points instead of relying on the RRM algorithms provided by Cisco. Typically, this is true in challenging RF environments and non standard deployments but not the more typical carpeted offices.

Note If you choose to statically assign channels and power levels to your access points and/or to disable dynamic channel and power assignment, you should still use automatic RF grouping to avoid spurious rogue device events.

You can disable dynamic channel and power assignment globally for a Cisco WLC, or you can leave dynamic channel and power assignment enabled and statically configure specific access point radios with a channel and power setting. While you can specify a global default transmit power parameter for each network type that applies to all the access point radios on a Cisco WLC, you must set the channel for each access point radio when you disable dynamic channel assignment. You may also want to set the transmit power for each access point instead of leaving the global transmit power in effect.

Prerequisites for Overriding RRM

We recommend that you assign different nonoverlapping channels to access points that are within close proximity to each other. The nonoverlapping channels in the U.S. are 36, 40, 44, 48, 52, 56, 60, 64, 149, 153, 157, and 161 in an 802.11a network and 1, 6, and 11 in an 802.11b/g network.

Restrictions for Overriding RRM

- Do not assign all access points that are within close proximity to each other to the maximum power level.

Statically Assigning Channel and Transmit Power Settings to Access Point Radios

Statically Assigning Channel and Transmit Power Settings (GUI)

Step 1 Choose **Wireless > Access Points > Radios > 802.11a/n** or **802.11b/g/n** to open the 802.11a/n (or 802.11b/g/n) Radios page.

This page shows all the 802.11a/n or 802.11b/g/n access point radios that are joined to the Cisco WLC and their current settings. The Channel text box shows both the primary and extension channels and uses an asterisk to indicate if they are globally assigned.

Step 2 Hover your cursor over the blue drop-down arrow for the access point for which you want to modify the radio configuration and choose **Configure**. The 802.11a/n (or 802.11b/g/n) Cisco APs > Configure page appears.

Step 3 Specify the RF Channel Assignment from the following options:

- **Global—**Choose this to specify a global value.
- **Custom—**Choose this and then select a value from the adjacent drop-down list to specify a custom value.

Step 4 Configure the antenna parameters for this radio as follows:

1. From the Antenna Type drop-down list, choose **Internal** or **External** to specify the type of antennas used with the access point radio.
2. Select and unselect the check boxes in the Antenna text box to enable and disable the use of specific antennas for this access point, where A, B, and C are specific antenna ports. The D antenna appears for the Cisco 3600 Series Access Points. A is the right antenna port, B is the left antenna port, and C is the center antenna port. For example, to enable transmissions from antenna ports A and B and receptions from antenna port C, you would select the following check boxes: Tx: A and B and Rx: C. In 3600 APs, the valid combinations are A, A+B, A+B+C or A+B+C+D. When you select a dual mode antenna, you can only apply single spatial 802.11n stream rates: MCS 0 to 7 data rates. When you select two dual mode antennae, you can apply only the two spatial 802.11n stream rates: MCS 0 to 15 data rates.
3. In the Antenna Gain text box, enter a number to specify an external antenna's ability to direct or focus radio energy over a region of space. High-gain antennas have a more focused radiation pattern in a specific direction. The antenna gain is measured in 0.5 dBi units, and the default value is 7 times 0.5 dBi, or 3.5 dBi.

   If you have a high-gain antenna, enter a value that is twice the actual dBi value (see *Cisco Aironet Antenna Reference Guide* for antenna dBi values). Otherwise, enter 0. For example, if your antenna has a 4.4-dBi gain, multiply the 4.4 dBi by 2 to get 8.8 and then round down to enter only the whole number (8). The Cisco WLC reduces the actual equivalent isotropic radiated power (EIRP) to make sure that the antenna does not violate your country's regulations.
4. Choose one of the following options from the Diversity drop-down list:

   Enabled—Enables the antenna connectors on both sides of the access point. This is the default value.

   Side A or Right—Enables the antenna connector on the right side of the access point.

   Side B or Left—Enables the antenna connector on the left side of the access point.

Step 5 In the RF Channel Assignment area, choose **Custom** for the Assignment Method under RF Channel Assignment and choose a channel from the drop-down list to assign an RF channel to the access point radio.

Step 6 In the Tx Power Level Assignment area, choose the **Custom** assignment method and choose a transmit power level from the drop-down list to assign a transmit power level to the access point radio.
The transmit power level is assigned an integer value instead of a value in mW or dBm. The integer corresponds to a power level that varies depending on the regulatory domain in which the access points are deployed. The number of available power levels varies based on the access point model. However, power level 1 is always the maximum power level allowed per country code setting, with each successive power level representing 50% of the previous power level. For example, 1 = maximum power level in a particular regulatory domain, 2 = 50% power, 3 = 25% power, 4 = 12.5% power, and so on.

Note See the hardware installation guide for your access point for the maximum transmit power levels supported per regulatory domain. Also, see the data sheet for your access point for the number of power levels supported.

Note If the access point is not operating at full power, the "Due to low PoE, radio is transmitting at degraded power" message appears under the Tx Power Level Assignment section.

Step 7 Choose **Enable** from the Admin Status drop-down list to enable this configuration for the access point.

Step 8 Click **Apply**.

Step 9 Have the Cisco WLC send the access point radio admin state immediately to Cisco Prime Infrastructure as follows:

1. Choose **Wireless > 802.11a/n** or **802.11b/g/n > Network** to open the 802.11a (or 802.11b/g) Global Parameters page.
2. Select the **802.11a** (or **802.11b/g**) **Network Status** check box.
3. Click **Apply**.

Step 10 Click **Save Configuration**.

Step 11 Repeat this procedure for each access point radio for which you want to assign a static channel and power level.

Statically Assigning Channel and Transmit Power Settings (CLI)

Step 1 Disable the radio of a particular access point on the 802.11a/n or 802.11b/g/n network by entering this command:
config {**802.11a** | **802.11b**} **disable** *Cisco_AP*

Step 2 Configure the channel width for a particular access point by entering this command:
config {**802.11a** | **802.11b**} **chan_width** *Cisco_AP* {**20** | **40**}

where

- **20** allows the radio to communicate using only 20-MHz channels. Choose this option for legacy 802.11a radios, 20-MHz 802.11n radios, or 40-MHz 802.11n radios that you want to operate using only 20-MHz channels. This is the default value.
- **40** allows 40-MHz 802.11n radios to communicate using two adjacent 20-MHz channels bonded together. The radio uses the primary channel that you choose as well as its extension channel for faster throughput. Each channel has only one extension channel (36 and 40 are a pair, 44 and 48 are a pair, and so on). For example, if you choose a primary channel of 44, the Cisco WLC would use channel 48 as the extension channel. If you choose a primary channel of 48, the Cisco WLC would use channel 44 as the extension channel.

  Note This parameter can be configured only if the primary channel is statically assigned.

  Note Statically configuring an access point's radio for 20-MHz or 40-MHz mode overrides the globally configured DCA channel width setting (configured using the **config advanced 802.11a channel dca chan-width-11n** {**20** | **40**} command). If you ever change the static configuration back to global on the access point radio, the global DCA configuration overrides the channel width configuration that the access point was previously using. It can take up to 30 minutes (depending on how often DCA is configured to run) for the change to take effect.

Note Channels 116, 120, 124, and 128 are not available in the U.S. and Canada for 40-MHz channel bonding.

Step 3 Enable or disable the use of specific antennas for a particular access point by entering this command:

config {**802.11a** | **802.11b**} **11nsupport antenna** {**tx** | **rx**} *Cisco_AP* {**A** | **B** | **C**} {**enable** | **disable**}

where A, B, and C are antenna ports. A is the right antenna port, B is the left antenna port, and C is the center antenna port. For example, to enable transmissions from the antenna in access point AP1's antenna port C on the 802.11a network, you would enter this command:

config 802.11a 11nsupport antenna tx AP1 C enable

Step 4 Specify the external antenna gain, which is a measure of an external antenna's ability to direct or focus radio energy over a region of space entering this command:
config {**802.11a** | **802.11b**} **antenna extAntGain** *antenna_gain Cisco_AP*

High-gain antennas have a more focused radiation pattern in a specific direction. The antenna gain is measured in 0.5 dBi units, and the default value is 7 times 0.5 dBi, or 3.5 dBi.

If you have a high-gain antenna, enter a value that is twice the actual dBi value (see *Cisco Aironet Antenna Reference Guide* for antenna dBi values). Otherwise, enter 0. For example, if your antenna has a 4.4-dBi gain, multiply the 4.4 dBi by 2 to get 8.8 and then round down to enter only the whole number (8). The Cisco WLC reduces the actual equivalent isotropic radiated power (EIRP) to make sure that the antenna does not violate your country's regulations.

Step 5 Specify the channel that a particular access point is to use by entering this command:
config {**802.11a** | **802.11b**} **channel ap** *Cisco_AP channe*l

For example, to configure 802.11a channel 36 as the default channel on AP1, enter the **config 802.11a channel ap AP1 36** command.

The channel you choose is the primary channel (for example, channel 36), which is used for communication by legacy 802.11a radios and 802.11n 20-MHz radios. 802.11n 40-MHz radios use this channel as the primary channel but also use an additional bonded extension channel for faster throughput, if you chose 40 for the channel width.

Note Changing the operating channel causes the access point radio to reset.

Step 6 Specify the transmit power level that a particular access point is to use by entering this command:
config {**802.11a** | **802.11b**} **txPower ap** *Cisco_AP power_level*

For example, to set the transmit power for 802.11a AP1 to power level 2, enter the **config 802.11a txPower ap AP1 2** command.

The transmit power level is assigned an integer value instead of a value in mW or dBm. The integer corresponds to a power level that varies depending on the regulatory domain in which the access points are deployed. The number of available power levels varies based on the access point model. However, power level 1 is always the maximum power level allowed per country code setting, with each successive power level representing 50% of the previous power level. For example, 1 = maximum power level in a particular regulatory domain, 2 = 50% power, 3 = 25% power, 4 = 12.5% power, and so on.

In certain cases, Cisco access points support only 7 power levels for certain channels, so that the Cisco Wireless Controller considers the 7th and 8th power levels as the same. If the 8th power level is configured on those channels, the configuration would fail since the controller considers the 7th power level as the lowest acceptable valid power level. These power values are derived based on the regulatory compliance limits and minimum hardware limitation which varies across different Cisco access points. For example, Cisco 3500, 1140, and 1250 series access points allow the configuration of last power levels because those access points report the "per path power" to the controller, whereas all next generation acess points such as Cisco 3700, 3600, 2600, and 1600 series access points report "total power value" to the controller, thereby decreasing the allowed power levels for newer generation products. For example, if the last power level in the 3600E access point has a power value of 4dbm (total power), then it actually means the power value is -2dbm (per path).

Note See the hardware installation guide for your access point for the maximum transmit power levels supported per regulatory domain. Also, see data sheet for your access point for the number of power levels supported.

Step 7 Save your settings by entering this command:
save config

Step 8 Repeat *Step 2* through *Step 7* for each access point radio for which you want to assign a static channel and power level.

Step 9 Reenable the access point radio by entering this command:
config {**802.11a** | **802.11b**} **enable** *Cisco_AP*

Step 10 Have the Cisco WLC send the access point radio admin state immediately to WCS by entering this command:
config {**802.11a** | **802.11b**} **enable network**

Step 11 Save your changes by entering this command:
save config

Step 12 See the configuration of a particular access point by entering this command:
show ap config {**802.11a** | **802.11b**} *Cisco_AP*

Information similar to the following appears:

```
Cisco AP Identifier.............................. 7
Cisco AP Name.................................... AP1
...
Tx Power
Num Of Supported Power Levels ............. 8
      Tx Power Level 1 ........................... 20 dBm
      Tx Power Level 2 ........................... 17 dBm
      Tx Power Level 3 ........................... 14 dBm
      Tx Power Level 4 ........................... 11 dBm
      Tx Power Level 5 ........................... 8 dBm
      Tx Power Level 6 ........................... 5 dBm
      Tx Power Level 7 ........................... 2 dBm
      Tx Power Level 8 ........................... -1 dBm
      Tx Power Configuration ..................... CUSTOMIZED
      Current Tx Power Level ..................... 1

Phy OFDM parameters
      Configuration .............................. CUSTOMIZED
      Current Channel ............................ 36
      Extension Channel .......................... 40
      Channel Width.............................. 40 Mhz
      Allowed Channel List....................... 36,44,52,60,100,108,116,132,
        ..........................................  149,157
      TI Threshold ............................... -50
      Antenna Type............................... EXTERNAL_ANTENNA
      External Antenna Gain (in .5 dBi units).... 7
      Diversity.................................. DIVERSITY_ENABLED

802.11n Antennas
        Tx
         A..................................... ENABLED
         B..................................... ENABLED
        Rx
         A..................................... DISABLED
         B..................................... DISABLED
         C..................................... ENABLED
```

Disabling Dynamic Channel and Power Assignment Globally for a Controller

Disabling Dynamic Channel and Power Assignment (GUI)

Step 1 Choose **Wireless** > **802.11a/n** or **802.11b/g/n** > **RRM** > **Auto RF** to open the 802.11a/n (or 802.11b/g/n) Global Parameters > Auto RF page.

Step 2 Disable dynamic channel assignment by choosing **OFF** under RF Channel Assignment.

Step 3 Disable dynamic power assignment by choosing **Fixed** under Tx Power Level Assignment and choosing a default transmit power level from the drop-down list.

Step 4 Click **Apply**.

Step 5 Click **Save Configuration**.

Step 6 If you are overriding the default channel and power settings on a per radio basis, assign static channel and power settings to each of the access point radios that are joined to the Cisco WLC.

Step 7 (Optional) Repeat this procedure for the network type that you did not select (802.11a/n or 802.11b/g/n).

Disabling Dynamic Channel and Power Assignment (CLI)

Step 1 Disable the 802.11a or 802.11b/g network by entering this command:
config {**802.11a** | **802.11b**} **disable network**

Step 2 Disable RRM for all 802.11a or 802.11b/g radios and set all channels to the default value by entering this command:
config {**802.11a** | **802.11b**} **channel global off**

Step 3 Enable the 802.11a or 802.11b/g network by entering this command:
config {**802.11a** | **802.11b**} **enable network**

Note To enable the 802.11g network, enter the **config 802.11b 11gSupport enable** command after the **config 802.11b enable network** command.

Step 4 Save your changes by entering this command:
save config

Configuring Rogue Access Point Detection in RF Groups

Information About Rogue Access Point Detection in RF Groups

After you have created an RF group of Cisco WLCs, you need to configure the access points connected to the Cisco WLCs to detect rogue access points. The access points will then select the beacon/probe-response frames in neighboring access point messages to see if they contain an authentication information element (IE) that matches that of the RF group. If the select is successful, the frames are authenticated. Otherwise, the authorized access point reports the neighboring access point as a rogue, records its BSSID in a rogue table, and sends the table to the Cisco WLC.

Configuring Rogue Access Point Detection in RF Groups

Enabling Rogue Access Point Detection in RF Groups (GUI)

Step 1 Make sure that each Cisco WLC in the RF group has been configured with the same RF group name.
Note The name is used to verify the authentication IE in all beacon frames. If the Cisco WLCs have different names, false alarms will occur.

Step 2 Choose **Wireless** to open the All APs page.

Step 3 Click the name of an access point to open the All APs > Details page.

Step 4 Choose either **local** or **monitor** from the AP Mode drop-down list and click **Apply** to commit your changes.

Step 5 Click **Save Configuration** to save your changes.

Step 6 Repeat Step 2 through Step 5 for every access point connected to the Cisco WLC.

Step 7 Choose **Security** > **Wireless Protection Policies** > **AP Authentication/MFP** to open the AP Authentication Policy page.
The name of the RF group to which this Cisco WLC belongs appears at the top of the page.

Step 8 Choose **AP Authentication** from the Protection Type drop-down list to enable rogue access point detection.

Step 9 Enter a number in the Alarm Trigger Threshold edit box to specify when a rogue access point alarm is generated. An alarm occurs when the threshold value (which specifies the number of access point frames with an invalid authentication IE) is met or exceeded within the detection period.
Note The valid threshold range is from1 to 255, and the default threshold value is 1. To avoid false alarms, you may want to set the threshold to a higher value.

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

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

Step 12 Repeat this procedure on every Cisco WLC in the RF group.
Note If rogue access point detection is not enabled on every Cisco WLC in the RF group, the access points on the Cisco WLCs with this feature disabled are reported as rogues.

Configuring Rogue Access Point Detection in RF Groups (CLI)

Step 1 Make sure that each Cisco WLC in the RF group has been configured with the same RF group name.
Note The name is used to verify the authentication IE in all beacon frames. If the Cisco WLCs have different names, false alarms will occur.

Step 2 Configure a particular access point for local (normal) mode or monitor (listen-only) mode by entering this command:
config ap mode local *Cisco_AP* or **config ap mode monitor** *Cisco_AP*

Step 3 Save your changes by entering this command:
save config

Step 4 Repeat *Step 2* and *Step 3* for every access point connected to the Cisco WLC.

Step 5 Enable rogue access point detection by entering this command:
config wps ap-authentication

Step 6 Specify when a rogue access point alarm is generated by entering this command. An alarm occurs when the threshold value (which specifies the number of access point frames with an invalid authentication IE) is met or exceeded within the detection period.
config wps ap-authentication *threshold*

Note The valid threshold range is from 1 to 255, and the default threshold value is 1. To avoid false alarms, you may want to set the threshold to a higher value.

Step 7 Save your changes by entering this command:
save config

Step 8 Repeat *Step 5* through *Step 7* on every Cisco WLC in the RF group.
Note If rogue access point detection is not enabled on every Cisco WLC in the RF group, the access points on the Cisco WLCs with this feature disabled are reported as rogues.

Configuring CCX Radio Management Features

Information About CCX Radio Management Features

You can configure two parameters that affect client location calculations:

- Radio measurement requests
- Location calibration

These parameters are supported in Cisco Client Extensions (CCX) v2 and later releases are designed to enhance location accuracy and timeliness for participating CCX clients.

For the location features to operate properly, the access points must be configured for normal, monitor, or FlexConnect mode. However, for FlexConnect mode, the access point must be connected to the Cisco WLC.

Radio Measurement Requests

When you enable the radio measurements requests feature, lightweight access points issue broadcast radio measurement request messages to clients running CCXv2 or later releases. The access points transmit these messages for every SSID over each enabled radio interface at a configured interval. In the process of performing 802.11 radio measurements, CCX clients send 802.11 broadcast probe requests on all the channels specified in the measurement request. The Cisco Location Appliance uses the uplink measurements based on these requests received at the access points to quickly and accurately calculate the client location. You do not need to specify on which channels the clients are to measure. The Cisco WLC, access point, and client automatically determine which channels to use.

The radio measurement feature enables the Cisco WLC to also obtain information on the radio environment from the client's perspective (rather than from just that of the access point). In this case, the access points issue unicast radio measurement requests to a particular CCXv4 or v5 client. The client then sends various measurement reports back to the access point and onto the Cisco WLC. These reports include information about the radio environment and data used to interpret the location of the clients. To prevent the access points and Cisco WLC from being overwhelmed by radio measurement requests and reports, only two clients per access point and up to 20 clients per Cisco WLC are supported. You can view the status of radio measurement requests for a particular access point or client as well as radio measurement reports for a particular client from the Cisco WLC CLI.

The Cisco WLC software improves the ability of the mobility services engine to accurately interpret the location of a device through a CCXv4 feature called location-based services. The Cisco WLC issues a path-loss request to a particular CCXv4 or v5 client. If the client chooses to respond, it sends a path-loss measurement report to the Cisco WLC. These reports contain the channel and transmit power of the client.

Note Non-CCX and CCXv1 clients ignore the CCX measurement requests and do not participate in the radio measurement activity.

Location Calibration

For CCX clients that need to be tracked more closely (for example, when a client calibration is performed), the Cisco WLC can be configured to command the access point to send unicast measurement requests to these clients at a configured interval and whenever a CCX client roams to a new access point. These unicast requests can be sent out more often to these specific CCX clients than the broadcast measurement requests, which are sent to all clients. When location calibration is configured for non-CCX and CCXv1 clients, the clients are forced to disassociate at a specified interval to generate location measurements.

Configuring CCX Radio Management

Configuring CCX Radio Management (GUI)

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

Step 2 Under CCX Location Measurement, select the **Mode** check box to globally enable CCX radio management. This parameter causes the access points connected to this Cisco WLC to issue broadcast radio measurement requests to clients running CCX v2 or later releases. The default value is disabled (or unselected).

Step 3 If you selected the Mode check box in the previous step, enter a value in the Interval text box to specify how often the access points are to issue the broadcast radio measurement requests.
The range is 60 to 32400 seconds.

The default is 60 seconds.

Step 4 Click **Apply**.

Step 5 Click **Save Configuration**.

Step 6 Follow the instructions in *Step 2* of the Configuring CCX Radio Management (CLI) section below to enable access point customization.

Note To enable CCX radio management for a particular access point, you must enable access point customization, which can be done only through the Cisco WLC CLI.

Step 7 If desired, repeat this procedure for the other radio band (802.11a/n or 802.11b/g/n).

Configuring CCX Radio Management (CLI)

Step 1 Globally enable CCX radio management by entering this command:
config advanced {**802.11a** | **802.11b**} **ccx location-meas global enable** *interval_seconds*

The range for the *interval_seconds* parameter is 60 to 32400 seconds, and the default value is 60 seconds. This command causes all access points connected to this Cisco WLC in the 802.11a or 802.11b/g network to issue broadcast radio measurement requests to clients running CCXv2 or later releases.

Step 2 Enable access point customization by entering these commands:

- **config advanced** {**802.11a** | **802.11b**} **ccx customize** *Cisco_AP* {**on** | **off**}

  This command enables or disables CCX radio management features for a particular access point in the 802.11a or 802.11b/g network.

- **config advanced** {**802.11a** | **802.11b**} **ccx location-meas ap** *Cisco_AP* **enable** *interval_seconds*

  The range for the *interval_seconds* parameter is 60 to 32400 seconds, and the default value is 60 seconds. This command causes a particular access point in the 802.11a or 802.11b/g network to issue broadcast radio measurement requests to clients running CCXv2 or higher.

Step 3 Save your settings by entering this command:
save config

Viewing CCX Radio Management Information (CLI)

- To see the CCX broadcast location measurement request configuration for all access points connected to this Cisco WLC in the 802.11a or 802.11b/g network, enter this command:

  show advanced {**802.11a** | **802.11b**} **ccx global**

- To see the CCX broadcast location measurement request configuration for a particular access point in the 802.11a or 802.11b/g network, enter this command:

  show advanced {**802.11a** | **802.11b**} **ccx ap** *Cisco_AP*

- To see the status of radio measurement requests for a particular access point, enter this command:

  show ap ccx rm *Cisco_AP* **status**

  Information similar to the following appears:

```
A Radio

  Beacon Request.............................. Enabled
  Channel Load Request........................ Enabled
  Frame Request............................... Disabled
  Noise Histogram Request..................... Disabled
  Path Loss Request........................... Disabled
  Interval.................................... 60
  Iteration................................... 5

B Radio

  Beacon Request.............................. Disabled
  Channel Load Request........................ Enabled
  Frame Request............................... Disabled
  Noise Histogram Request..................... Enabled
  Path Loss Request........................... Disabled
  Interval.................................... 60
  Iteration................................... 5
```

- To see the status of radio measurement requests for a particular client, enter this command:

  show client ccx rm *client_mac* **status**

  Information similar to the following appears:

```
Client Mac Address.............................. 00:40:96:ae:53:b4
Beacon Request.................................. Enabled
Channel Load Request............................ Disabled
Frame Request................................... Disabled
Noise Histogram Request......................... Disabled
Path Loss Request............................... Disabled
Interval........................................ 5
Iteration....................................... 3
```

- To see radio measurement reports for a particular client, enter these commands:

  show client ccx rm *client_mac* **report beacon—**Shows the beacon report for the specified client.

show client ccx rm *client_mac* **report chan-load—**Shows the channel-load report for the specified client.

show client ccx rm *client_mac* **report noise-hist—**Shows the noise-histogram report for the specified client.

show client ccx rm *client_mac* **report frame—**Shows the frame report for the specified client.

- To see the clients configured for location calibration, enter this command:

  show client location-calibration summary

- To see the RSSI reported for both antennas on each access point that heard the client, enter this command:

  show client detail *client_mac*

Debugging CCX Radio Management Issues (CLI)

- Debug CCX broadcast measurement request activity by entering this command:

  debug airewave-director message {**enable** | **disable**}

- Debug client location calibration activity by entering this command:

  debug ccxrm [**all** | **error** | **warning** | **message** | **packet** | **detail** {**enable** | **disable**}]

- The CCX radio measurement report packets are encapsulated in Internet Access Point Protocol (IAPP) packets. Therefore, if the previous **debug ccxrm** command does not provide any debugs, enter this command to provide debugs at the IAPP level:

  debug iapp error {**enable** | **disable**}

- Debug the output for forwarded probes and their included RSSI for both antennas by entering this command:

  debug dot11 load-balancing