Configuring RRM

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 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 the surrounding access points. This feature is different from coverage hole detection, which is primarily concerned with clients. TPC provides enough RF power to achieve the required 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 the access points must be mounted in a central hallway, placing the access points close together, but requiring coverage 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 the 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 fields in the **Tx Power Control** window. 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, no access point will 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 an e-mail in a café affects the performance of the access point in a neighboring business. Even though these are 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 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 simultaneously use 11 or 54 Mbps. By effectively reassigning channels, the controller keeps adjacent channels that are separated.

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

Note Channel change does not require you to shut down the radio.

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 a part of your wireless LAN, including rogue access points and neighboring wireless networks. Lightweight access points constantly scan all the 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 huge 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 that has performed the worst. The load is taken into account when changing the channel structure to minimize the impact on the clients that are 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 *Load and utilization* 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 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 the RRM startup mode from the CLI.

The 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 1 hour, but DCA algorithm always runs in default interval of 10 min, channel allocation occurs at 10-min intervals for the first 10 cycles, and channel changes occur as per the DCA algorithm every 10 min. After that the DCA algorithm goes back to the configured time interval. This is common for both DCA interval and anchor time because it follows the steady state.

Note If Dynamic Channel Assignment (DCA)/Transmit Power Control (TPC) is turned off on the RF group member, and auto is set on RF group leader, the channel or TX power on a member gets changed as per the algorithm that is 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.

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 controller to encrypt neighbor discovery packets.

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

Guidelines

- This feature enables you to be compliant with the PCI specifications.
- An RF group can only be formed between controllers that have the same encryption mechanism. That is, an access point associated to a controller that is encrypted can not be neighbors with an access point associated to a controller that is not encrypted. The two controllers and their access points will not recognize each other as neighbors and cannot form an RF group. It is possible to assign two controllers in a static RF group configuration that has mismatched encryption settings. In this case, the two controllers do not function as a single RF group because the access points belonging to the mismatched controllers do not recognize one another as neighbors in the group.
- Ensure that the Cisco Wave 2 APs have an SSID enabled for the APs to send NDP packets. If only the AP radios are enabled but not SSID, then the APs cannot send NDP packets and thus RRM does not work as expected.

Information About 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.

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.

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.

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 the RF Group Mode (GUI)

Step 1 Choose **Wireless** > **802.11a/n/ac** 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:

a. In the Cisco WLC Name text box, enter the Cisco WLC that you want to add as a member to this group.

b. In the **IP Address (IPv4/IPv6)** text box, enter the IPv4/IPv6 address of the RF Group Member.

c. 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-or-ipv6-address*
- **config advanced** {**802.11a** | **802.11b**} *group-member* **remove** *controller-name ipv4-or-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/ac** or **802.11b/g/n** > **RRM** > **TPC** to open the 802.11a/n/ac (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

Off-Channel Scanning Deferral

A lightweight access point, in normal operational conditions, periodically goes off-channel and scans another channel. This is in order to perform RRM operations such as the following:

- Transmitting and receiving Neighbor Discovery Protocol (NDP) packets with other APs.
- Detecting rogue APs and clients.
- Measuring noise and interference.

During the off-channel period, which normally is about 70 milliseconds, the AP is unable to transmit or receive data on its serving channel. Therefore, there is a slight impact on its performance and some client transmissions might be dropped.

While the AP is sending and receiving important data, it is possible to configure off-channel scanning deferral so that the AP does not go off-channel and its normal operation is not impacted. You can configure off-channel scanning deferral on a per-WLAN basis, per WMM UP class basis, with a specified time threshold in milliseconds. If the AP sends or receives, on a particular WLAN, a data frame marked with the given UP class within the specified threshold, the AP defers its next RRM off-channel scan. For example, by default, off-channel scanning deferral is enabled for UP classes 4, 5, and 6, with a time threshold of 100 millseconds. Therefore, when RRM is about to perform an off-channel scan, a data frame marked with UP 4, 5, or 6 is received within the last 100 milliseconds, RRM defers going off-channel. The AP radio does not go off-channel when a voice call sending and receiving audio samples are marked as UP class 6 for every active 20 milliseconds.

Off-channel scanning deferral does come with a tradeoff. Off-channel scanning can impact throughput by 2 percent or more, depending on the configuration, traffic patterns, and so on. Throughput can be slightly improved if you enable off-channel scanning deferral for all traffic classes and increase the time threshold. However, by not going off-channel, RRM can fail to identify AP neighbors and rogues, resulting in negative impact to security, DCA, TPC, and 802.11k messages.

We recommend that you do not change the default off-channel scanning deferral settings.

Configuring Off-Channel Scanning Defer for WLANs

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

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

Step 2 Click the WLAN ID.

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

Step 4 In 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** field.

Valid values are between 0 and 60000 milliseconds; the default value is 100 milliseconds. If you sent the time to 0, the scan deferral does not happen.

The scan defer time is common for all priorities on the same WLAN and the scan is deferred if a packet is transmitted or received in any one of the defer priorities.

Step 6 Save the configuration.

Configuring Off Channel Scanning Deferral 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-value* {**enable** | **disable**} *wlan-id*

Valid priority value is betweeen 0 and 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 *time-in-msecswlan-id*

The time value is in miliseconds (ms) and the valid range is between 0 and 60000 ms (60 seconds); the default value is 100 ms. This setting should match the requirements of the equipment on your WLAN. If you sent the time to 0, the scan deferral does not happen.

The scan defer time is common for all priorities on the same WLAN and the scan is deferred if a packet is transmitted or received in any one of the defer priorities.

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 controller 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/ac or 802.11b/g/n network as follows:

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

Step 2 Choose **Wireless** > **802.11a/n/ac** 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 controller's DCA mode:

- **Automatic**—Causes the controller to periodically evaluate and, if necessary, update the channel assignment for all joined access points. This is the default value.

- **Freeze**—Causes the controller 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 controller 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.

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 controller 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 Check the **Avoid Foreign AP Interference** check box to cause the controller'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 uncheck 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 Check the **Avoid Cisco AP Load** check box to cause the controller's RRM algorithms to consider 802.11 traffic from APs in your wireless network when assigning channels, or uncheck 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 Check the **Avoid Non-802.11a (802.11b) Noise** check box to cause the controller's RRM algorithms to consider noise (non-802.11 traffic) in the channel when assigning channels to lightweight access points, or uncheck 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 Check the **Avoid Persistent Non-WiFi Interference** check box to configure the controller to stop ignoring persistent non-Wi-Fi interference in new channel calculation. The persistent non-Wi-Fi interference is considered during the metric calculation for channels.

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

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

Step 11 For 802.11a/n/ac 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.
- **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 802.11a radio, you cannot pair channels 116, 140, and 165 with any other channels.

- **80 MHz**—The 80-MHz bandwidth for the 802.11ac radios.
- **160 MHz**—The 160-MHz bandwidth for 802.11ac radios.
- **best**—It selects the best bandwidth suitable. This option is enabled for the 5-GHz radios only.

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 controller 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** field shows the channels that are currently selected. To choose a channel, check its check box in the **Select** column. To exclude a channel, uncheck 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, check 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, check its check box in the **Select** column. To exclude a channel, uncheck 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:

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

b. Check the **802.11a** (or **802.11b/g**) **Network Status** check box.

c. 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/ac** 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/ac** or **802.11b/g/n** > **RRM** > **Coverage** to open the 802.11a/ac (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/ac** 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/ac** or **802.11b/g/n** > **RRM** > **General** to open the 802.11a/n/ac (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 200, 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.

Note Neighbor Discovery Protocol (NDP) request is sent only on Dynamic Channel Assignment (DCA) channels.

Step 4 Configure monitor intervals as follows:

a. In the **Channel Scan Interval** 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.

b. In the **Neighbor Packet Frequency** 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.

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** {**20** | **40** | **80** | **80+80** }—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 configure an access point's radio mode using the **config 802.11a chan_width** *Cisco_AP* {**20** | **40** | **80**} 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.

  - **80** sets the channel width for the 802.11ac radios to 80 MHz.
  - **80+80** sets the channel width for the 802.11 radio to 80+80 MHz.

- Configure slot-specific channel width by entering this command:

  config slot *slot-id* **chan_width***ap-name* {**20** | **40** | **80**}

- **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 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 Configure RRM NDP mode by entering 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.

Note See the discovery type by entering the **show advanced 802.11**{**a**|**b**} **monitor** command.

Step 8 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 9 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.