CHAPTER 6

Monitoring Wireless Devices

This chapter describes how to use WCS to monitor your wireless LANs. It contains these sections:

Monitoring Rogue Access Points, Adhocs, and Clients

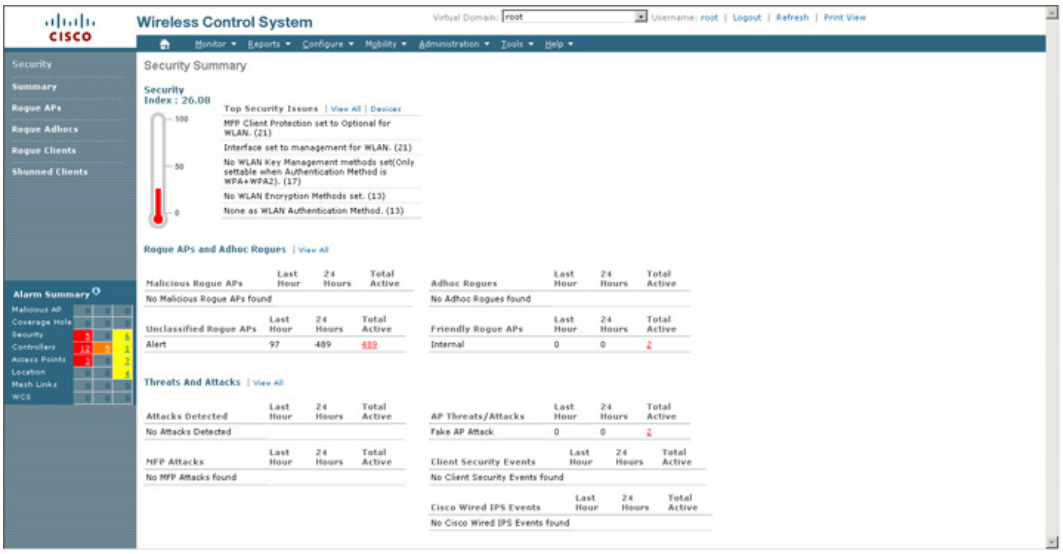
Because unauthorized rogue access points are inexpensive and readily available, employees sometimes plug them into existing LANs and build ad hoc wireless networks without IT department knowledge or consent. These rogue access points can be a serious breach of network security because they can be plugged into a network port behind the corporate firewall. Because employees generally do not enable any security settings on the rogue access point, it is easy for unauthorized users to use the access point to intercept network traffic and hijack client sessions. Even more alarming, wireless users frequently publish unsecure access point locations, increasing the odds of having the enterprise security breached.

Rather than having a person with a scanner manually detect rogue access points, the Cisco Unified Wireless Network Solution automatically collects information on rogue access points detected by its managed access points (by MAC and IP address) and allows the system operator to locate, tag, and contain them. It can also be used to discourage rogue access point clients by sending them deauthenticate and disassociate messages from one to four access points.

Interpreting Security Summary Window

You can see a summary of existing events and the security state of the network by choosing **Monitor > Security**. The Security Summary window appears (see Figure 6-1).

Figure 6-1 Security Summary Window



The Security Summary window provides information in the following sections:

- Security Index
- Top Security Issues
- Malicious Rogue Access Points
- Adhocs Rogues
- Unclassified Rogue Access Points
- Friendly Rogue Access Points
- Attacks Detected
- Access Point Threats or Attacks
- MFP Attacks
- Client Security Events
- Cisco Wired IPS Events

Security Index

The Security Index gives an indication of the security of the WCS managed network, and it is calculated as part of daily background tasks. It is calculated by assigning weight to the various security configurations and displaying it in visual form. The combined weighting can vary from 0 to 100 where 0 signifies the least secured and 100 is the maximum secured. The weighting comes from the lowest scoring controller and the lowest scoring Location Server/Mobility Service Engine related security configurations that are maintained within WCS itself. The Security Index of the WCS managed network is calculated as the lowest scoring controller plus the lowest scoring Location Service/Mobility Service Engine.

The security thermometer color range is represented as follows:

- Above 80 - Green
- Below 80 but greater than 60 - Yellow
- Below 60 - Red

Note Guest WLANs are excluded from the WLANs. A WLAN which has web authentication or web passthrough enabled is identified as a guest WLAN.

The security index of the latest release is the benchmark for the required security configurations. For example, if AES encryption was not present in an earlier version of code, the index is reduced by the number associated with the AES encryption security configuration. Likewise, if new security configurations are introduced, the weighting would be altered.

Note The configurations stored in WCS may not be up-to-date with the ones in the controllers unless the Refresh from Controller command is run from WCS. You can run Security Index calculations from the Configuration Sync task to get the latest configuration data from all the controllers. Refer to the "Configuration Sync" section on page 16-4 for steps on enabling the security index.

Top Security Issues

The View All and Devices links sort relevant columns and show a report of security issues occurring across all controllers. If you click **View All**, the Security Index Detailed Report appears (see Figure 6-2). It displays all security issues found across all controllers, location servers, and mobility service engines. It details problems found in a particular security configuration retrieved from the device. If a particular issue has been acknowledged (just as you would an alarm), it will be ignored the next time the Configuration Sync task runs (provided Security Index Calculation is enabled).

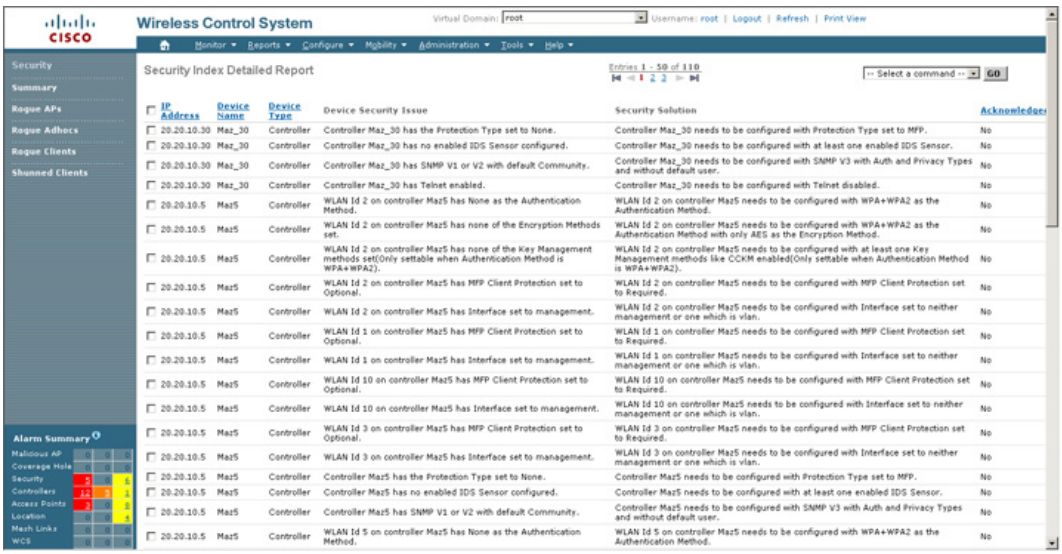
Note In some cases, when an ACK happens and is ignored in the next iteration, the final security index score may change. There could be multiple reasons for this change:

- The acknowledged issue on the controller is not directly affecting the security index score.
- The acknowledged issue on a WLAN is not directly affecting the security index score. Only the lowest scoring WLAN of the lowest scoring controller affects the security index score, so an issue on any other WLAN would not make the score higher.
- Some cases, like SSH and Telnet being enabled on a controller, are both flagged as issues. However, a Telnet issue has a higher precedence than an SSH issue. For instance, if SSH is acknowledged on a controller with the lowest score, no changes would occur for the security index.

The following three different view can be viewed:

- Show Unacknowledged which shows only unacknowledged security issues (the default value). When **View All** is clicked, this view is shown.
- Show Acknowledged shows acknowledged security issues.
- Show All shows all security issues (acknowledged or unacknowledged).

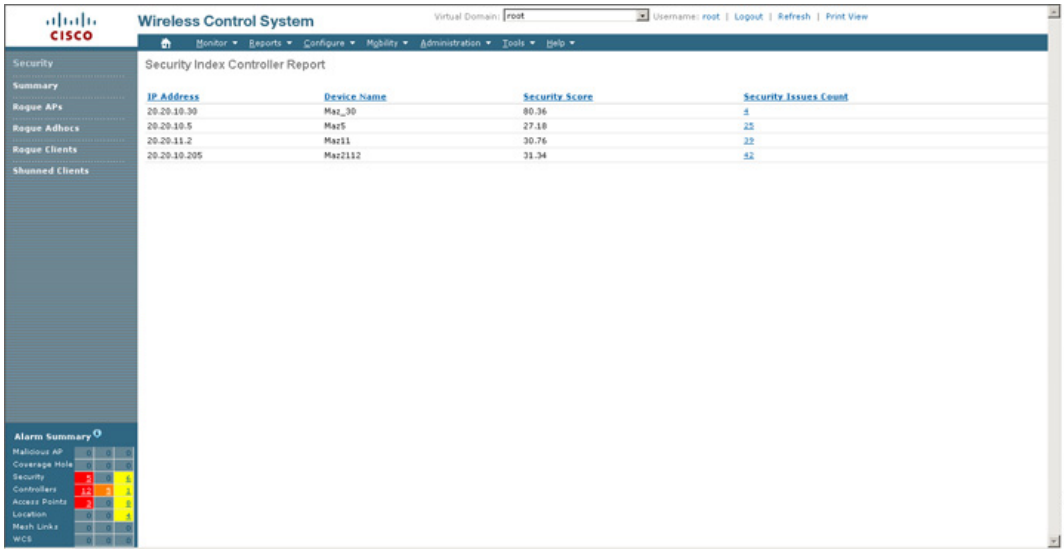
Figure 6-2 Security Index Detailed Report



If you click **Devices** from the Security Summary window (Figure 6-1), the Security Index Controller Report appears (see Figure 6-3). This screen shows the security violation report as a summary for each controller. By row, each controller shows the number of security issues that occurred on that controller and provides a link to all security issues.

Note The security score of the lowest scoring controller is not the same as the security index for WCS. Some score comes from the lowest scoring Location or Mobility Server Engine, and the lowest scoring controller score shown is calibrated to out of 100.

Figure 6-3 Security Index Controller Report



If you click the number in the Security Issues Count column, the Security Index Detailed Report appears (see Figure 6-2).

Table 6-1 lists top security issues, provides a description of why the issue occurs, and defines what action should be taken as a solution. Table 6-2 lists top security issues for location and mobility servers, provides a description of why the issue occurs, and defines what action should be taken as a solution.

Table 6-1 Top Security Issues

Controller Security Issue	Why is this an issue?	What is the solution?
Static WEP configured as the authentication method for a WLAN.	Weak authentication method for a WLAN which can be broken by using tools available online if WLAN packets are sniffed.	Use the most secured authentication method — WPA+WPA2.
CKIP configured as the authentication method for a WLAN.	Weak authentication method for a WLAN.	Use the most secured authentication method — WPA+WPA2.
An authentication method as *None* for a WLAN.	No authentication method is a clear security risk for a WLAN.	Use the most secured authentication method — WPA+WPA2.
CKIP WEP 10/104 bits (with MMH or Key Permutation or both) as one of the encryption methods for a WLAN.	A weak encryption method for a WLAN.	Use the most secured encryption method —AES. AES is only available when WPA+WPA2 is the authentication method.
WEP 40/104/128 bits as one of the encryption methods (802.1X or WEP Authentication Method) for a WLAN.	A weak encryption method for a WLAN.	Use the most secured encryption method —AES. AES is only available when WPA+WPA2 is the authentication method.

Table 6-1 (continued)Top Security Issues

Controller Security Issue	Why is this an issue?	What is the solution?
One of the encryption methods for a WLAN is TKIP.	A weak encryption method for a WLAN.	Use the most secured encryption method —AES. AES is only available when WPA+WPA2 is the authentication method.
None of the encryption methods for a WLAN are set.	A clear security risk exists for a WLAN when no encryption method is set.	Use the most secured encyrption method —AES. AES is only available when WPA+WPA2 is the authentication method.
None of the key management methods are set for a WLAN. You can set these methods only when the authentication method is WPA+WPA2.	A key management method enhances the security of keys. Without one, WLAN is less secure.	At least one key management method (such as CCKM enabled) must be enabled to improve the security of the WLAN. This method can be set only when the authentication method is WPA+WPA2.
MFP Client Protection is set to *optional* for a WLAN.	With the MFP Client Protection set to *optional*, authenticated clients may not be shielded from spoofed frames.	To shield authenticated clients from spoofed frames, set MFP Client Protection to *required* for a WLAN.
MFP Client Protection is set to *disabled* for a WLAN.	With the MFP Client Protection set to *disabled*, authenticated clients may not be shielded from spoofed frames.	To shield authenticated clients from spoofed frames, set MFP Client Protection to *required* for a WLAN.
The interface is mapped to *management* for a WLAN.	As recommended from SAFE, user traffic should be separated from management traffic.	The WLAN needs its interface mapped to a non-managment interface.
Client Exlusion is disabled for a WLAN.	With Client Exlusion policies disabled, an attacker is free to continuously try for access into the WLAN network.	The WLAN needs to have Client Exclusion policy enabled to prevent a single or a set of clients (rogues) from gaining access to the WLAN network.
The Protection Type is set to AP Authentication.	When AP Authentication is set, an access point checks beacon/probe-response frames in neighboring access points to see if they contain an authenticated information element (IE) that matches that of RF groups. Some level of security is introduced, but all management frames are not covered or open to alteration by rogue access points.	The Protection Type set to Management Frame Protection is the most secured option. It includes message integrity check (MIC) into all management frames sent by an access point, and if the management frames are altered, they can be detected by other access points.

Table 6-1 (continued)Top Security Issues

Controller Security Issue	Why is this an issue?	What is the solution?
Protection Type is set to *none*.	No security for 802.11 management messages is passed between the access points and clients.	Protection Type set to Management Frame Protection is the most secured option. It includes message integrity check (MIC) into all management frames sent by an access point, and if the management frames are altered, they can be detected by other access points.
Rogue detection exists only on DCA channels.	Rogue detection done on only a subset of countries or channels is less secure than rogue detection done on all countries or channels.	Rogue detection should be turned on for all countries and channels to improve the chances of discovering rogue access points no matter where they are transmitting.
Detection and reporting of adhoc networks is turned off for rogue policies.	With detection and reporting of adhoc networks turned off, adhoc rogues go undetected.	Adhoc rogues need to be detected; therefore, detection and reporting of adhoc networks needs to be turned on for rogue policies.
The check for all Standard and Custom Signatures is disabled.	If the check for all Standard and Custom Signatures is disabled, various types of attacks from incoming 802.11 packets may go undetected.	The check for all Standard and Custom Signatures needs to be turned on to identify various types of attacks in incoming 802.11 packets.
The Excessive 802.11 Association Failures Client Exclusion Policy is disabled.	Excessive failed association attempts may consume system resources and launch potential denial-of-service attacks to the infrastructure.	Enable Excessive 802.11 Association Failures Client Exclusion Policy to prevent denial-of-service attacks on the infrastructure.
The Excessive 802.11 Authentication Failures Client Exclusion Policy is disabled.	Excessive failed authentication attempts can consume system resources and launch potential denial-of-sevice attacks to the infrastructure.	Enable Excessive 802.11 Authentication Failures Client Exclusion Policy to prevent denial-of-service attacks on the infrastructure.
The Excessive 802.1X Authentication Failures Client Exclusion Policy is disabled.	The excessive 802.1X failed authentication attempts can consume system resources and launch potential denial-of-service attacks to the infrastructure.	Enable the Excessive 802.1X Authentication Failures Client Exclusion Policy to prevent denial-of-service attacks to the infrastructure.
The Excessive 802.11 Web Authentication Failures Client Exclusion Policy is disabled.	If excessive 802.11 web is disabled, web authentication attempts consume system resources and launch potential denial-of-service attacks to the infrastructure.	Enable excessive 802.11 web authentication failures client exclusion policy to prevent denial-of-service attacks to the infrastructure.

Table 6-1 (continued)Top Security Issues

Controller Security Issue	Why is this an issue?	What is the solution?
IP Theft or Reuse Client Exclusion Policy is disabled.	If IP Theft or Reuse Client Exclusion Policy is disabled, an attacker masquerading as another client would not be disallowed.	Enable IP Theft or Reuse Client Exclusion Policy to prevent an attacker from getting into the network as another client.
No enabled IDS sensor is configured.	If no enabled IDS sensor is configured, IP level attacks are not detected.	Configure Enabled IDS Sensors to detect IP level attacks.
SNMP V1 or V2 with a default community is configured.	If SNMP V1 or V2 with default community is configured, the network is open to easy attacks because default communities are well known.	Enable SNMP V3 with Auth and Privacy type and no default user. This is the most secure SNMP connection.
SNMP V1 or V2 with a non-default community is configured.	SNMP V1 or V2 with a non-default community is slightly more secure than a default community but still less secure than SNMP V3.	Enable SNMP V3 with Auth and Privacy type and no default user. This is the most secure SNMP connection.
SNMP V3 with a default user is configured.	Using a default user makes SNMP V3 connections less secure.	Enable SNMP V3 with Auth and Privacy type and no default user. This is the most secure SNMP connection.
SNMP V3 with either Auth or Privacy Type set to *None*.	SNMP V3 with either Auth or Privacy Type set to none reduces the security of an SNMP V3 connection.	Enable SNMP V3 with Auth and Privacy types and no default user. This is the most secure SNMP connection.
HTTP is enabled (Web Mode is enabled but Secure Web Mode is disabled).	HTTP is less secure than HTTPS.	Enable HTTPS.
Telnet is enabled.	If Telnet is enabled, the controller has the risk of attack.	Disable Telnet to reduce the risk of attack.
SSH is enabled and timeout is set to zero.	If SSH is enabled and timeout is zero, the controller runs the risk of attack.	If SSH is enabled, the timeout must be set to zero to reduce the risk of attack.

Table 6-2 Top Security Issues for Location and Mobility Servers

Location Server/Mobility Server Engine Security Issue	Why is this an issue?	What is the solution?
HTTP is enabled.	HTTP is less secure than HTTPS.	Enable HTTPS.
A default password is configured for a location user.	If a default password is configured, the Location Server/Mobility Server Engine is more susceptible to connections from outside the network.	Configure the Location Server/Mobility Server Engine user with a non-default password.

Malicious Rogue Access Points

This section provides information on rogue access points that are classified as *Malicious*. Table 6-3 describes the various parameters. For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Note Malicious access points are detected but untrusted or unknown access points with a malicious intent within the system. They also refer to access points that fit the user-defined malicious rules or have been manually moved from the friendly access point classification.

Table 6-3 Malicious Rogue AP Details

Parameter	Description
Alert	Indicates the number of rogues in an alert state. **Note** An access point is moved to Alert if it is not on the neighbor list or part of the user-configured Friendly AP list.
Contained	Indicates the number of contained rogues.
Threat	Indicates the number of threat rogues.
Contained Pending	Indicates the number of contained rogues pending. **Note** Contained Pending indicates that the containment action is delayed due to unavailable resources.

Adhocs Rogues

This section provides information on rogue adhocs. This section provides information on rogue adhocs. Table 6-4 describes the various parameters. For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Table 6-4 Rogue Adhocs

Parameter	Description
Alert	Indicates the number of rogue adhocs in an alert state. **Note** An access point is moved to Alert if it is not on the neighbor list or part of the user-configured Friendly AP list.
Contained	Indicates the number of contained rogues.
Threat	Indicates the number of threat rogues.
Contained Pending	Indicates the number of contained rogues pending. **Note** Contained pending indicates that the containment action is delayed due to unavailable resources.

Unclassified Rogue Access Points

This section provides information on rogue access points that are not classified. Table 6-5 describes the various parameters. For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Note An unclassified rogue access point refers to a rogue access point that is not classified as either malicious or friendly. These access points can be contained and can be moved manually to the friendly rogue access point list.

Table 6-5 Unclassified Rogue

Parameter	Description
Alert	Number of unclassified rogues in alert state. Rogue access point radios appear as *Alert* when first scanned by the controller or as *Pending* when operating system identification is underway.
Contained	Number of contained unclassified rogues.
Contained Pending	Number of contained unclassified rogues pending.

Friendly Rogue Access Points

This section provides information on rogue access points that are classified as *friendly*. Table 6-6 describes the various parameters. For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Note Friendly rogue access points are known, acknowledged, or trusted access points. They also refer to access points that fit the user-defined friendly rogue access point rules. Friendly rogue access points cannot be contained.

Table 6-6 Friendly Rogue AP Details

Parameter	Description
Alert	Indicates the number of rogues in an alert state. **Note** An access point is moved to Alert if it is not on the neighbor list or part of the user-configured Friendly AP list.
Internal	Indicates the number of internal access points. **Note** Internal indicates that the detected access point is inside the network and has been manually configured as Friendly - Internal.
External	Indicates the number of external access points. **Note** External indicates that the detected access point is outside of the network and has been manually configured as Friendly - External.

Attacks Detected

Attacks reflect network patterns that indicate a possible virus or hacker attack. When an attack occurs, the attack table is updated immediately. The table displays the number of attacks during the last one hour, last 24 hours, and the total active. You can use this information to assess the security state or security threats to the network.

If you click an underlined number in any of the time period categories, a window with further information appears.

Access Point Threats or Attacks

Table 6-7 describes the AP Threats or Attacks parameters. For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Table 6-7 AP Threats/Attacks

Parameter	Description
Fake Attacks	Number of fake attacks
AP Missing	Number of missing access points
AP Impersonation	Number of access point impersonations
AP Invalid SSID	Number of invalid access point SSIDs
AP Invalid Preamble	Number of invalid access point preambles
AP Invalid Encryption	Number of invalid access point encryption
AP Invalid Radio Policy	Number of invalid access point radio policies
Denial of Service (NAV related)	Number of Denial of Service (NAV related) request
AP Detected Duplicate IP	Number of detected duplicate access point IPs

MFP Attacks

A value is provided for Infrastructure and client MFP attacks in the last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

Client Security Events

For each of these parameters, a value is provided for last hour, last 24 hours, and total active. If you click an underlined number in any of the time period categories, a window with further information appears.

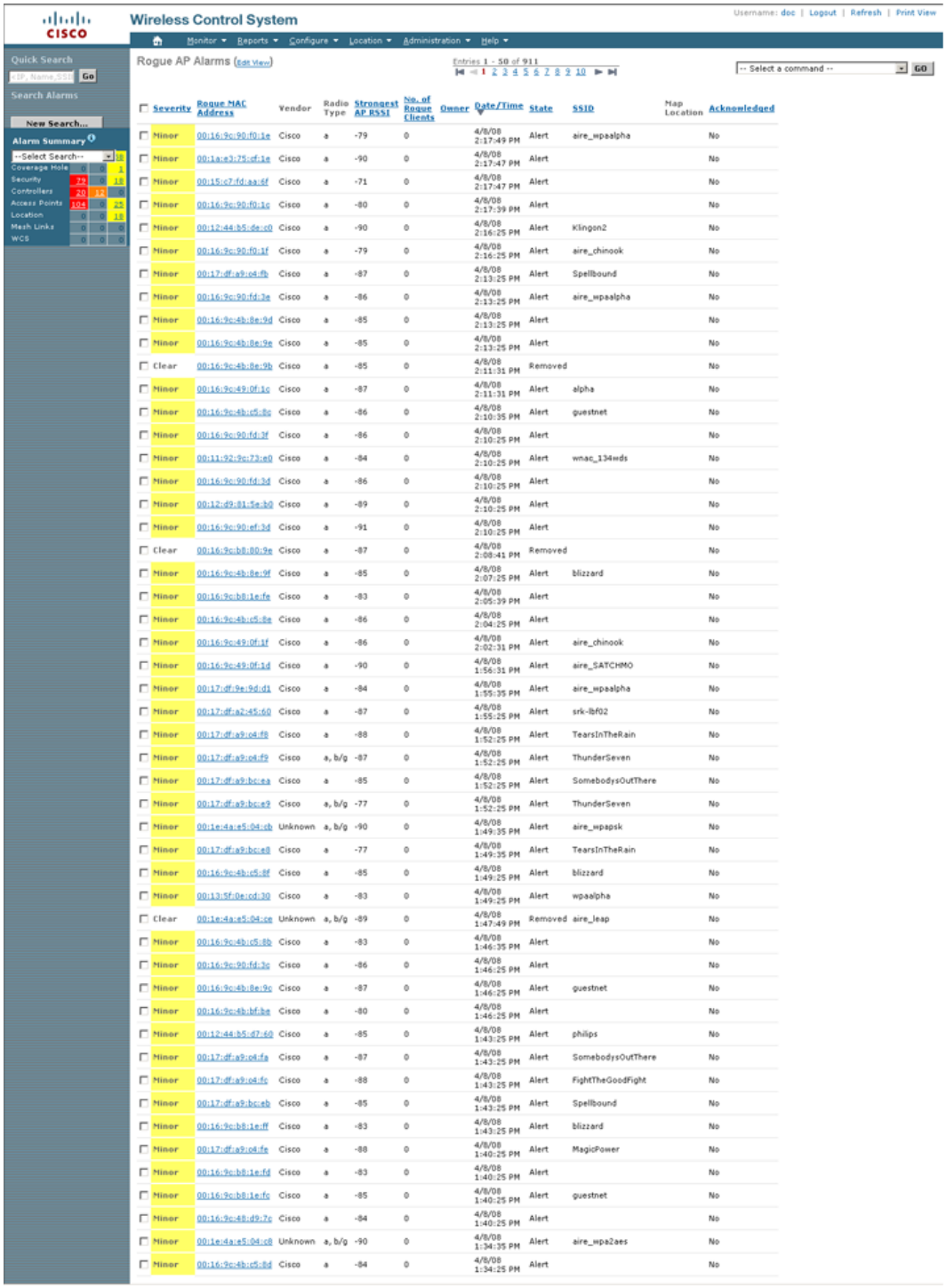
Cisco Wired IPS Events

A value is provided for last hour, last 24 hours, and all. If you click an underlined number in any of the time period categories, a window with further information appears.

Monitoring Rogue Access Point

If you choose **Rogue APs** from the left sidebar menu (of the **Monitor > Security** page), the Rogue AP Alarms window appears (see Figure 6-4). This window allows you to view alarm details and messages regarding any anomalies with the controllers and access points.

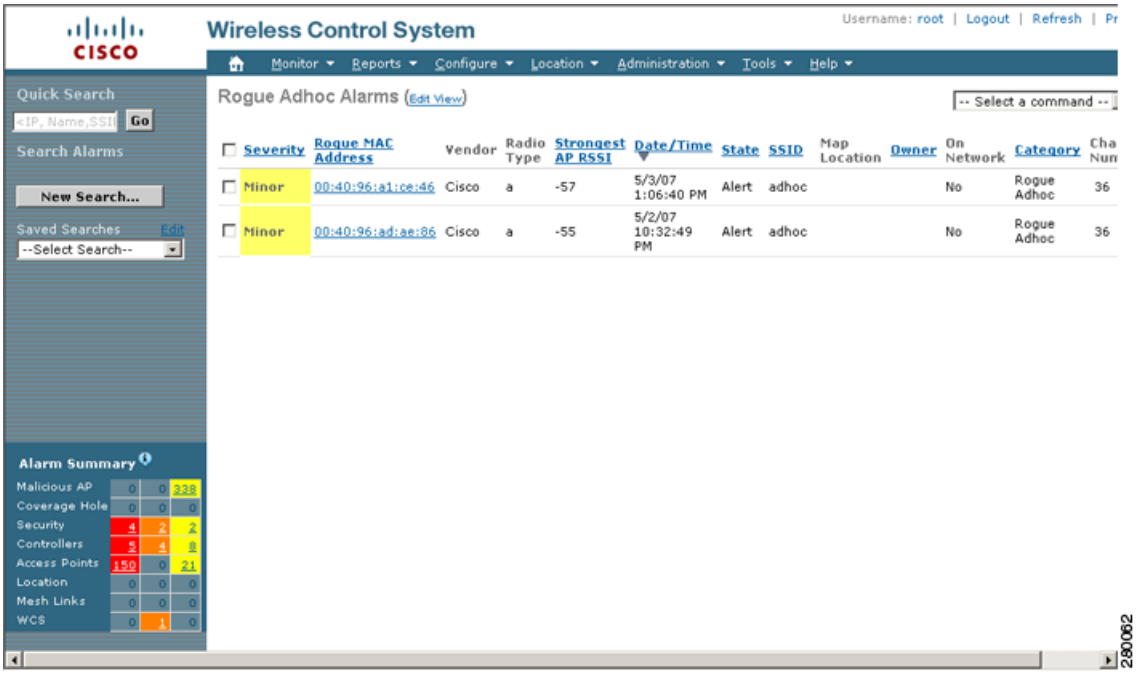
Figure 6-4 Rogue AP Alarms



Monitoring Rogue Adhoc

If you choose **Rogue Adhocs** from the left sidebar menu (of the **Monitor > Security** page), the Rogue Adhoc Alarms window appears (see Figure 6-5). On this window you can view details of rogue adhoc alarms.

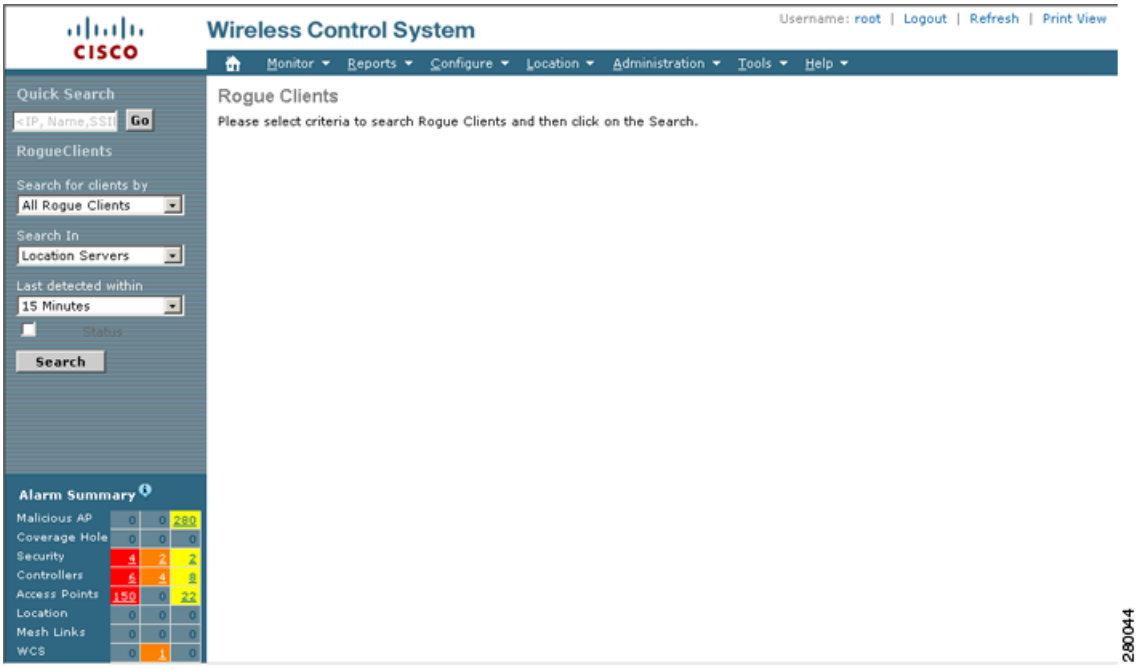
Figure 6-5 Rogue Adhoc Alarms Window



Monitoring Rogue Clients

If you choose **Rogue Clients** from the left sidebar menu (of the **Monitor > Security** page), the Rogue Clients window appears (see Figure 6-6). You can select search criteria in the left sidebar menu and then details about the rogue clients that are found is displayed.

Figure 6-6 Rogue Clients Window



Monitoring Shunned Clients

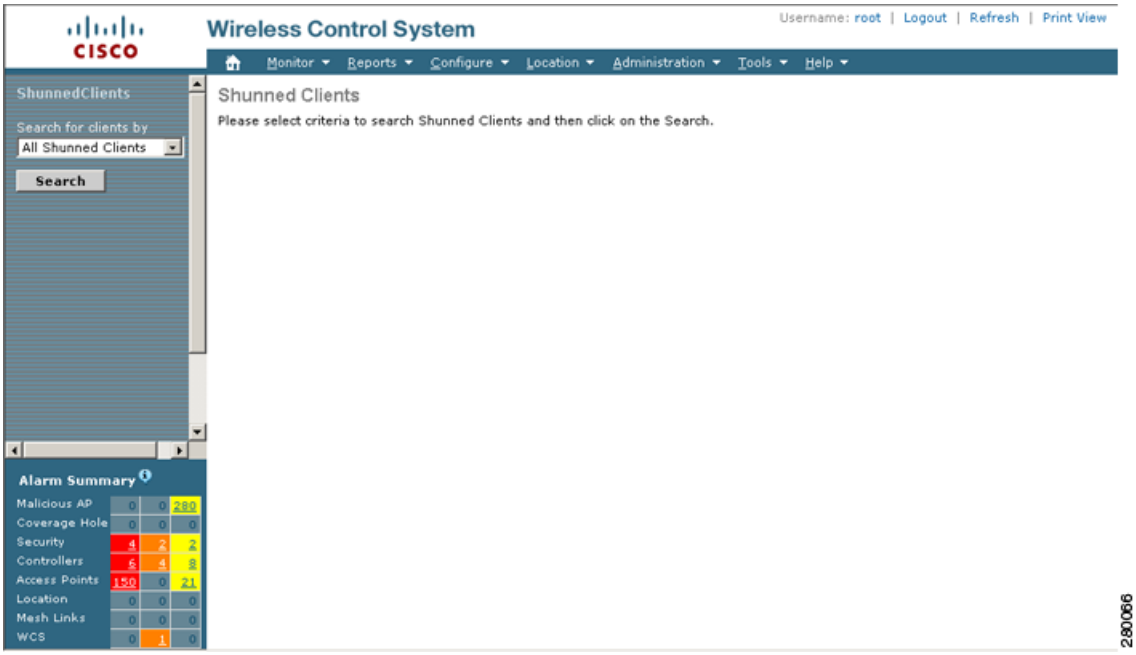
When a Cisco IPS sensor on the wired network detects a suspicious or threatening client, it alerts the controller to shun this client. If the client to be shunned is currently associated to an access point and controller in a mobility group:

1. The shun entry is distributed to all controllers within the same mobility group.
2. The anchor controller adds this client to the dynamic exclusion list.
3. The foreign controller removes the client.

The next time the client tries to connect to a controller, the anchor controller rejects the handcuff and informs the foreign controller that the client is being excluded.

Choose **Monitor > Security** from the left sidebar menu and select **Shunned Clients** to access this window (see Figure 6-7).

Figure 6-7 Shunned Clients Window



The Shunned Client window displays the client IP address, sensor IP address, and the controller for each shunned client.

Rogue Access Point Location, Tagging, and Containment

This built-in detection, tagging, monitoring, and containment capability enables system administrators to take appropriate action:

- Locate rogue access points
- Receive new rogue access point notifications, eliminating hallway scans
- Monitor unknown rogue access points until they are eliminated or acknowledged
- Determine the closest authorized access point, making directed scans faster and more effective
- Contain rogue access points by sending their clients deauthenticate and disassociate messages from one to four access points. This containment can be done for individual rogue access points by MAC address or can be mandated for all rogue access points connected to the enterprise subnet.
- Tag rogue access points:
  - Acknowledge rogue access points when they are outside of the LAN and do not compromise the LAN or wireless LAN security
  - Accept rogue access points when they do not compromise the LAN or wireless LAN security
  - Tag rogue access points as unknown until they are eliminated or acknowledged

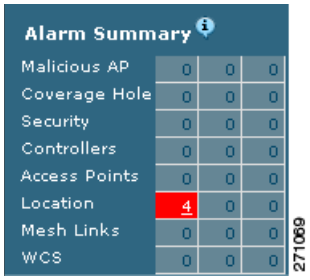
– Tag rogue access points as contained and discourage clients from associating with the rogue access points by having between one and four access points transmit deauthenticate and disassociate messages to all rogue access point clients. This function applies to all active channels on the same rogue access point.

Detecting and Locating Rogue Access Points

When the access points on your wireless LAN are powered up and associated with controllers, WCS immediately starts listening for rogue access points. When a controller detects a rogue access point, it immediately notifies WCS, which creates a rogue access point alarm.

When WCS receives a rogue access point message from a controller, an alarm monitor appears in the lower left corner of all WCS user interface pages. The alarm monitor in Figure 6-8 shows 199 rogue access point alarms.

Figure 6-8 Alarm Monitor for Rogue Access Points



Follow these steps to detect and locate rogue access points.

Step 1 Click the **Rogues** indicator to display the Rogue AP Alarms page. This page lists the severity of the alarms, the rogue access point MAC addresses, the rogue access point types, the date and time when the rogue access points were first detected, and their SSIDs.

Step 2 Click any **Rogue MAC Address** link to display the associated Alarms > Rogue - *AP MAC Address* page. This page shows detailed information about the rogue access point alarm.

Step 3 To modify the alarm, choose one of these commands from the Select a Command drop-down menu and click **GO**.

- **Assign to me**—Assigns the selected alarm to the current user.
- **Unassign**—Unassigns the selected alarm.
- **Delete**—Deletes the selected alarm.
- **Clear**—Clears the selected alarm.
- **Event History—**Enables you to view events for rogue alarms.
- **Detecting APs** (with radio band, location, SSID, channel number, WEP state, short or long preamble, RSSI, and SNR)—Enables you to view the access points that are currently detecting the rogue access point.
- **Rogue Clients**—Enables you to view the clients associated with this rogue access point.
- Set State to ‘Unknown - Alert’—Tags the rogue access point as the lowest threat, continues to monitor the rogue access point, and turns off containment.

Set State to 'Known - Internal'—Tags the rogue access point as internal, adds it to the known rogue access points list, and turns off containment.

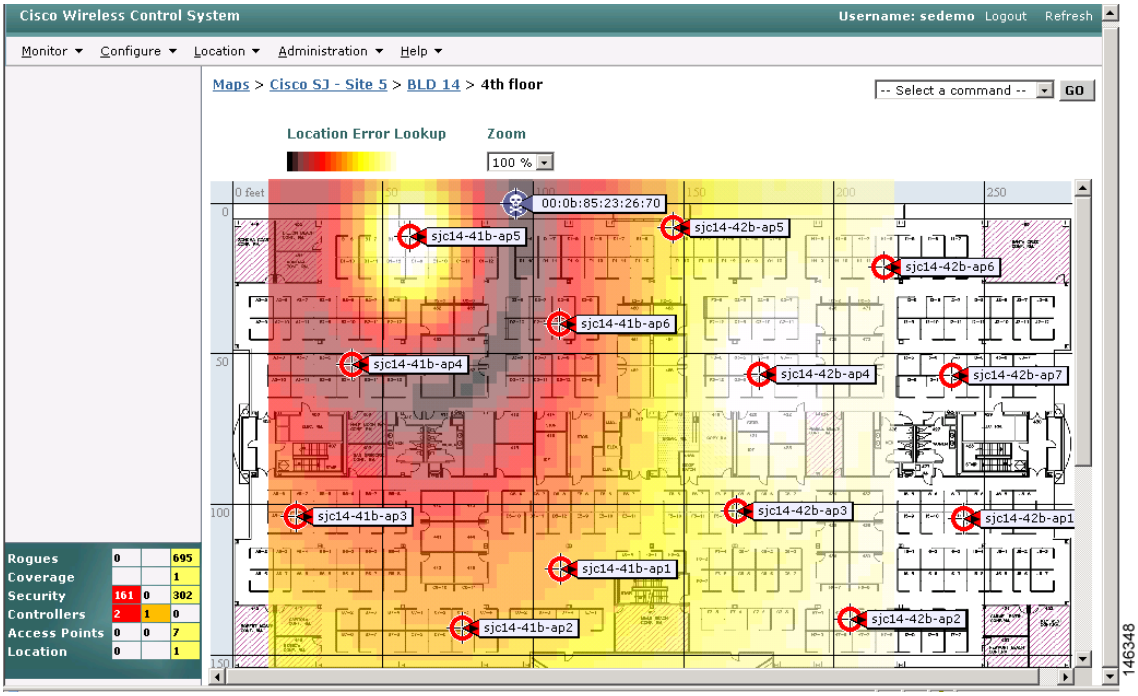
Set State to 'Known - External'—Tags the rogue access point as external, adds it to the known rogue access points list, and turns off containment.

- **1 AP Containment** through **4 AP Containment—**When you select level 1 containment, one access point in the vicinity of the rogue unit sends deauthenticate and disassociate messages to the client devices that are associated to the rogue unit. When you select level 2 containment, two access points in the vicinity of the rogue unit send deauthenticate and disassociate messages to the rogue's clients and so on up to level 4.

Step 4 From the Select a Command drop-down menu, choose **Map (High Resolution)** and click **GO** to display the current calculated rogue access point location on the Maps > *Building Name* > *Floor Name* page.

If you are using WCS Location, WCS compares RSSI signal strength from two or more access points to find the most probable location of the rogue access point and places a small skull-and-crossbones indicator at its most likely location. In the case of an underdeployed network for location with only one access point and an omni antenna, the most likely location is somewhere on a ring around the access point, but the center of likelihood is at the access point. If you are using WCS Base, WCS relies on RSSI signal strength from the rogue access point and places a small skull-and-crossbones indicator next to the access point receiving the strongest RSSI signal from the rogue unit. Figure 6-9 shows a map that indicates that location of a rogue unit.

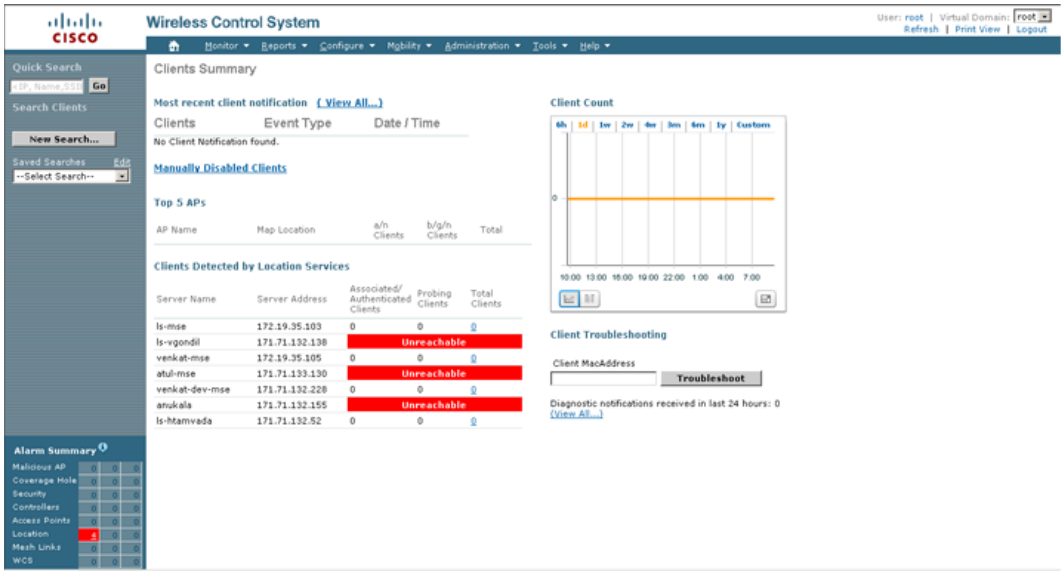
Figure 6-9 Map Indicating Location of Rogue Unit



Monitoring Clients

This section provides access to the controller clients summary details. The information assists in identifying, diagnosing, and resolving client issues. To monitor clients, choose **Monitor > Clients**. The Client Summaries window appears (see Figure 6-10).

Figure 6-10 Clients Summary



The Client Summaries window contains the following portions:

Most Recent Client Notification

- Client—IP address, MAC address, or user-defined name of client.
- Event Type—Reason for client notification. For example, disassociated, WEP decrypt error, or authentication failure.
- Date/Time—Date and time of client notification.

Manually Disabled Clients

Choose **Monitor > Clients** and then click **Manually Disabled Clients** to access this page.

This page enables you to view manually disabled client template information.

- MAC Address—Client MAC address.
- Description—Optional user-defined description.

Top 5 APs

The Top 5 APs section includes the following:

- AP Name—This is the name assigned to the access point. Click an item in the list to see the details of that access point.
- Map Location —The name of the map where the client is located.

- a/n Clients—The number of 802.11a clients currently associated with the controller.
- b/g/n Clients—The number of 802.11b clients and 802.11g clients currently associated with the controller.
- Total Client—Total number of clients currently associated with the controller.

Clients Detected by Location Servers

Displays clients detected by location servers within the last 15 minutes.

- Server Name—User-defined location server name.
- Server Address—IP address of location server.
- Total Clients—Total number of clients currently associated with the location server.

Client Count

A graphic shows the associated clients during a given time frame.

Client Troubleshooting

Client—Enter the IP address, MAC address, or user-defined client name and click **Troubleshoot** to continue to the client details.

Diagnostic Notification Received—Indicates the number of diagnostic notifications received. Click the number to view the list of the diagnostic events.

WLAN Client Troubleshooting

The client reporting protocol is used by the client and the access point to exchange client information. Client reports are collected automatically when the client associates. Follow these steps to run diagnostic tests and reports and to view available logs:

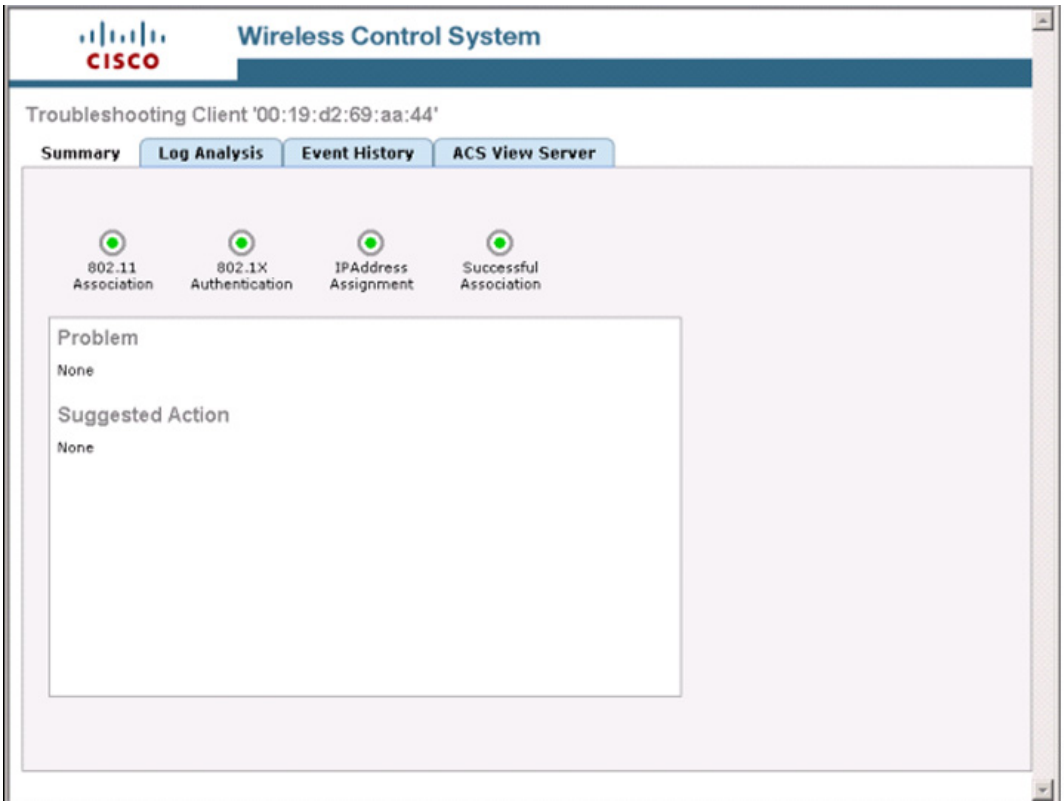
Step 1 Choose **Monitor > Clients**.

Step 2 (optional) In the Quick Search area, type the MAC address of the client in question.

Note To get the current status of the client, you must instead click **New Search** and choose the **Search on Controller Now** option. This option more accurately reflects the 802.11 state of the client because a quick search only periodically updates the database information.

Step 3 To troubleshoot a client, enter the MAC address of the client in the Client field and click **Troubleshoot**. The troubleshooting client options appear (see Figure 6-11).The number of tabs that appear depends on whether the client is a Cisco Compatible Extensions version 5 client or not. The Cisco Compatible Extensions Version 5 clients contain additional tabs like Test Analysis, Messaging, Event Log, and so on. If the MAC address is unknown, enter search criteria of the client (such as user name, floor, and so on) in the Quick Search of the left-hand menu.

Figure 6-11 Troubleshooting Client Tab



The summary page displays a brief description of the problem and recommends a course of action to resolve the issue.

Note Some Cisco Compatible Extension features do not function properly if you use a web browser other than Internet Explorer 6.0 on a Windows workstation.

Step 4 To view log messages logged against the client, click the **Log Analysis** tab (see Figure 6-12).

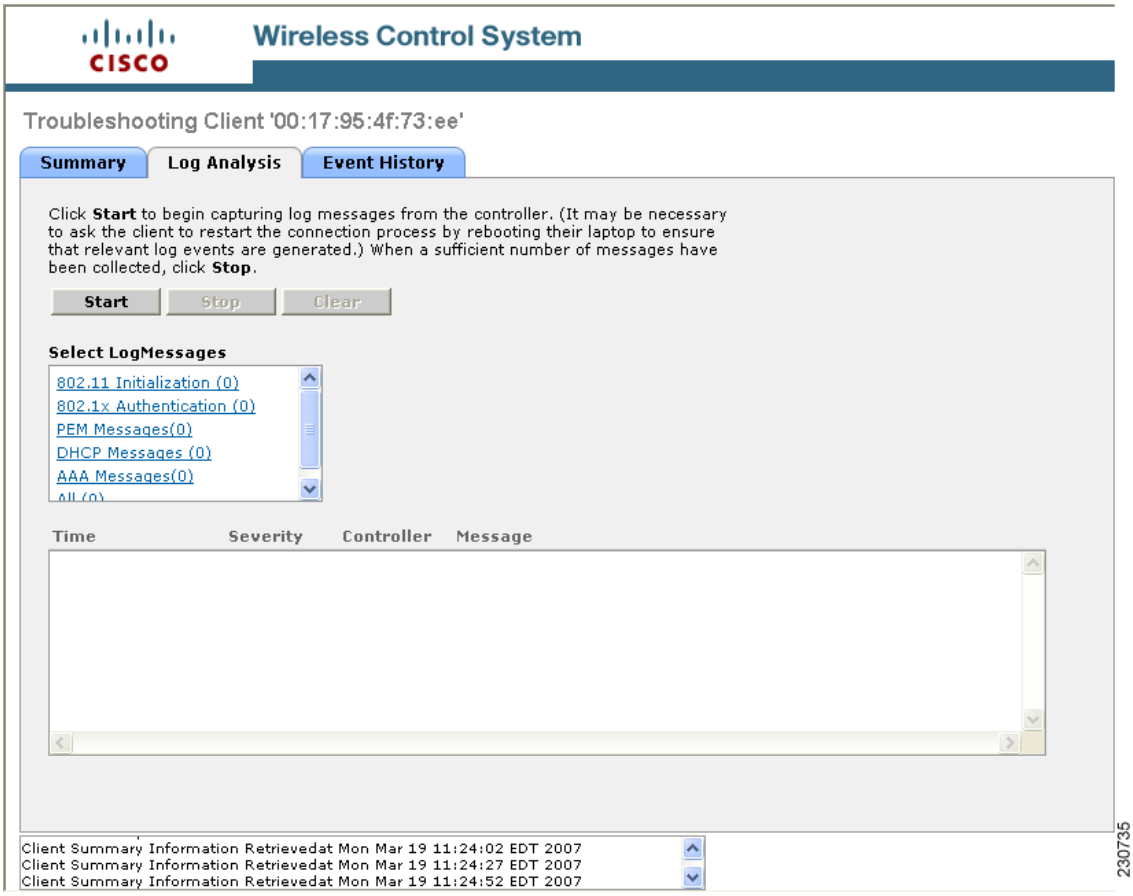
Step 5 To begin capturing log messages about the client from the controller, click **Start**. To stop log message capture, click **Stop**. To clear all log messages, click **Clear**.

Note Log messages are captured for ten minutes and then stopped automatically. A user must click **Start** to continue.

Step 6 To select which log messages to display, click one of the links under Select Log Messages (the number between parentheses indicates the number of messages). The messages appear in the box. It includes the following information:

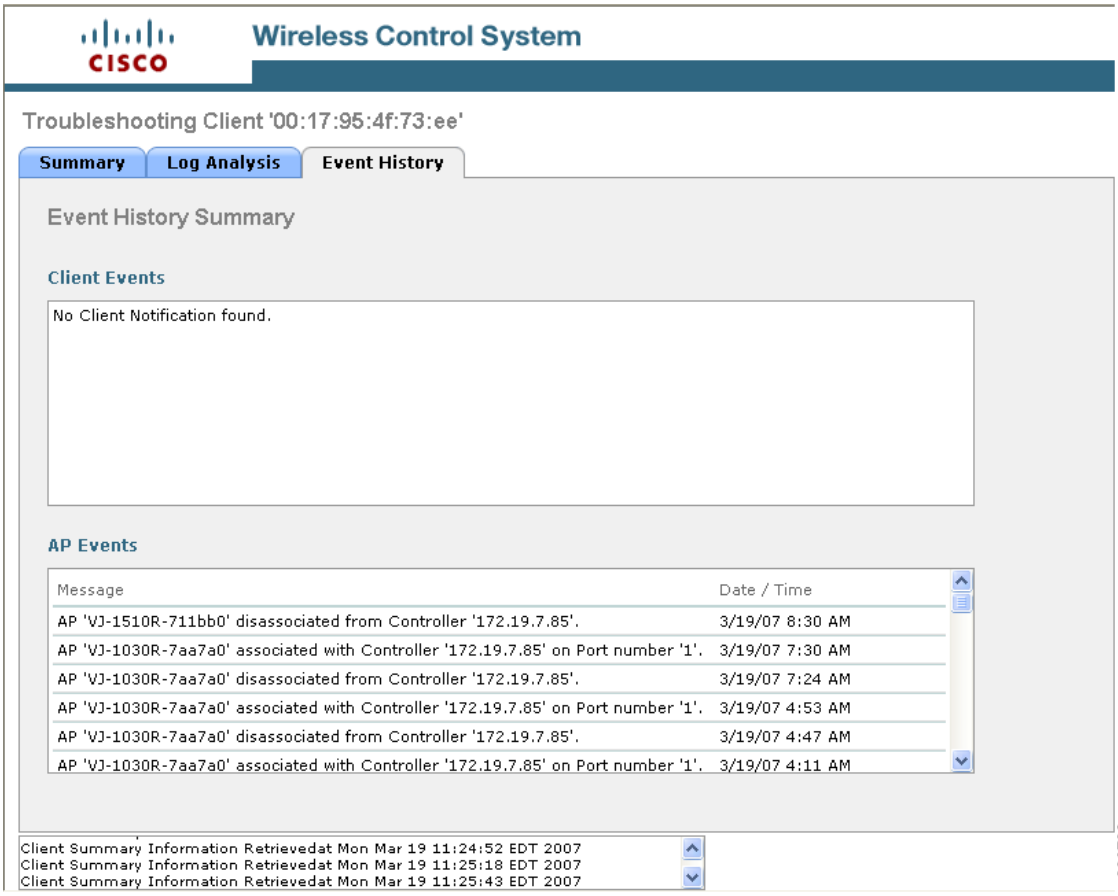
- A status message
- The controller time
- A severity level of info or error (errors are displayed in red)
- The controller to which the client is connected

Figure 6-12 Log Analysis Tab



Step 7 To display a summary of the client's events history, click the **Event History** tab (see Figure 6-13). This page displays client and access point events that occurred within the last 24 hours.

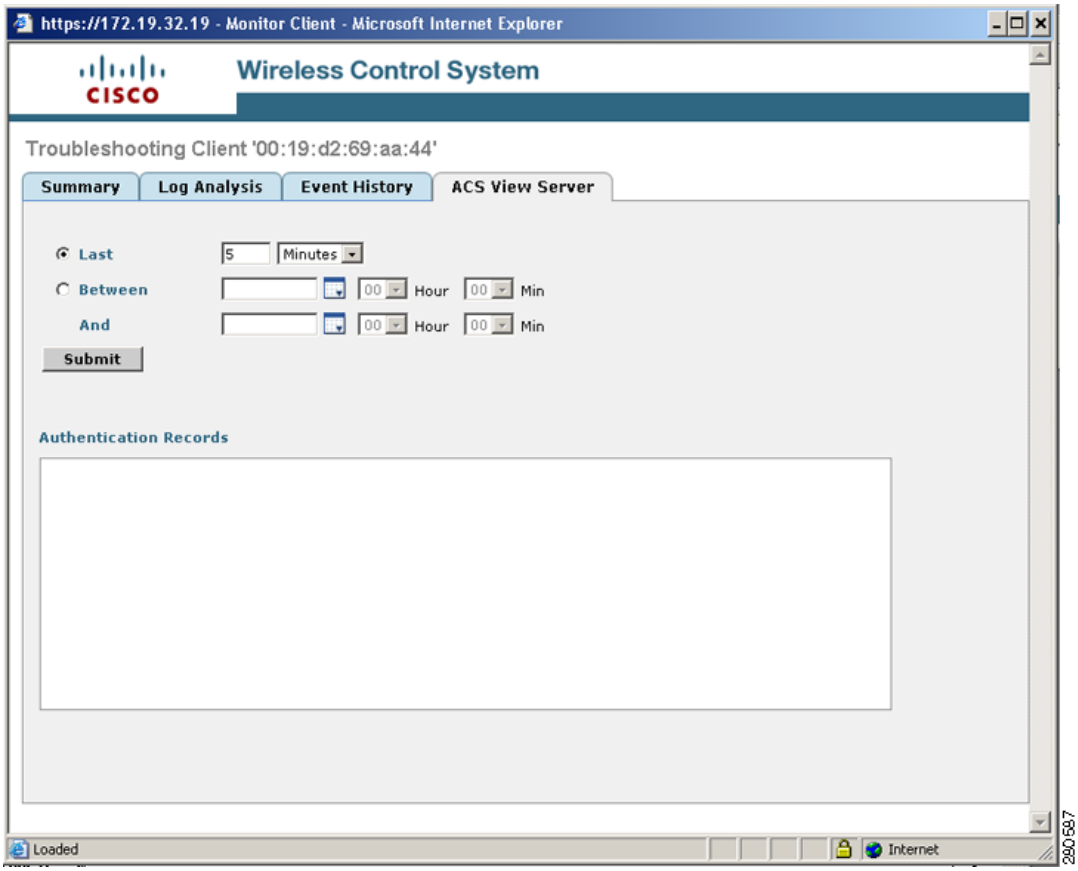
Figure 6-13 Event History Tab



Step 8 If you click the ACS View Server tab, you can inteface with the Cisco Access Control (ACS) System View Server (see Figure 6-14). You must have View Server credentials established before you can access this tab. (The tab will show the server list as empty if no view servers are configured.) Refer to the "Configuring ACS View Server Credentials" section on page 6-34 for steps on establishing credentials.

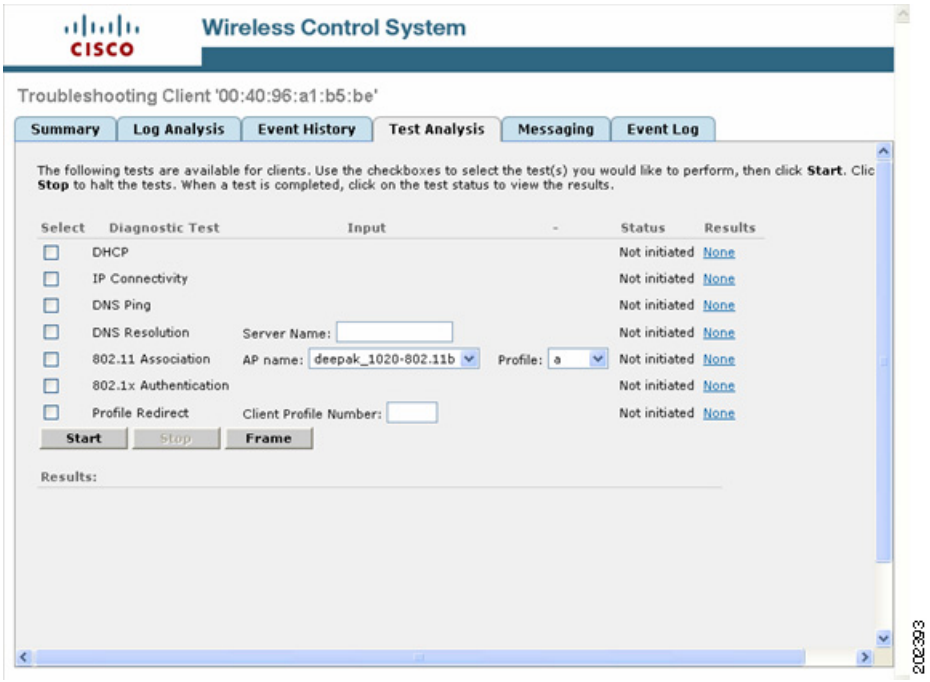
This server provides WCS with aggregated client status information from multiple ACS servers. The client status information allows you to further troubleshoot client issues and determine if they are related to authentication or authorization. Enter the date and time ranges to retrieve the historical authentication and authorization information and click **Submit**. The results of the query are displayed in the Authentication Records portion of the window and is used as a filter for the userid logged into the client.

Figure 6-14 ACS View Server Window



Step 9 (Optional) If Cisco Compatible Extension Version 5 clients are available, a Test Analysis tab as shown in Figure 6-15 appears.

Figure 6-15 Test Analysis Tab



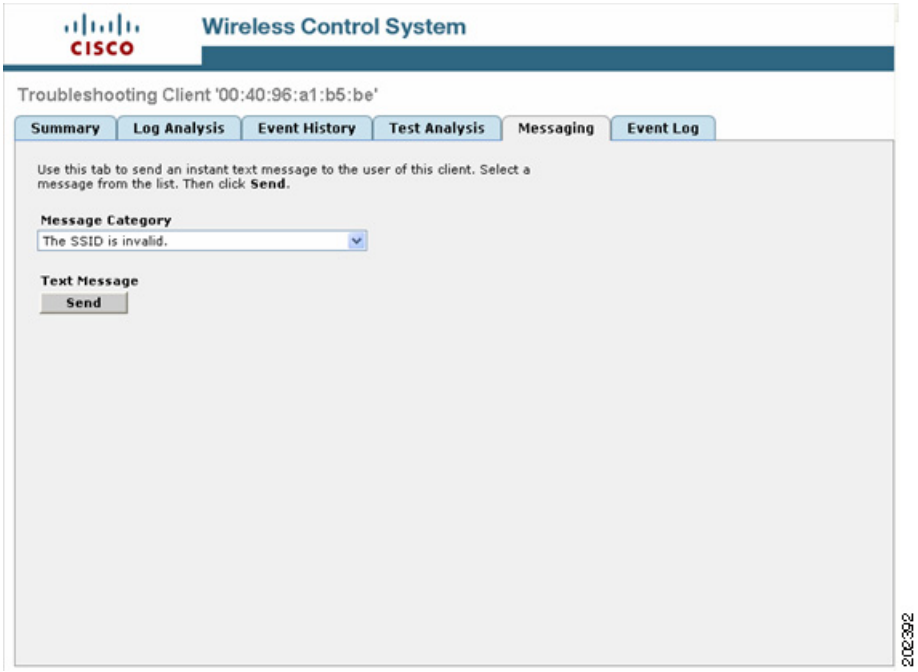
Step 10 The Test Analysis tab allows you to run a variety of diagnostic tests on the client. Click the check box for the applicable diagnostic test, enter any input information (if applicable), and click **Start**. The following diagnostic tests are available:

- DHCP—Executes a complete DHCP Discover/Offer/Request/ACK exchange to determine that the DHCP is operating properly between the controller and the client.
- IP Connectivity—Causes the client to execute a ping test of the default gateway obtained in the DHCP test to determine that IP connectivity exists on the local subnet.
- DNS Ping—Causes the client to execute a ping test of the DNS server obtained in the DHCP test to determine that IP connectivity exists to the DNS server.
- DNS Resolution—Causes the DNS client to attempt to resolve a network name known to be resolvable to determine that name resolution is functioning correctly.
- 802.11 Association—Directs an association to be completed with a specific access point to determine that the client is able to associate properly with a designated WLAN.
- 802.1X Authentication—Directs an association and 802.1X authentication to be completed with a specific access point to determine that the client is able to properly complete an 802.1x authentication.
- Profile Redirect—At any time, the diagnostic system may direct the client to activate one of the client's configured WLAN profiles and to continue operation under that profile.

Note To run the profile diagnostic test, the client must be on the diagnostic channel. This test uses the profile number as an input. To indicate a wildcard redirect, enter 0. With this redirect, the client is asked to disassociate from the diagnostic channel and to associate with any profile. You can also enter a valid profile ID. Because the client is on the diagnostic channel when the test is run, only one profile is returned in the profile list. You should use this profile ID in the profile redirect test (when wildcard redirecting is not desired).

Step 11 (Optional) If Cisco Compatible Extension Version 5 clients are available, a Messaging tab as shown in Figure 6-16 appears. Use this tab to send an instant text message to the user of this client. From the Message Category drop-down menu, choose a message and click **Send**.

Figure 6-16 Messaging Tab



Step 12 Close the Troubleshooting Client window. The **General** tab displays the client details and properties of the access point with which the client is associated. Table 6-8, Table 6-9, and Table 6-10 describe the fields displayed on this General tab.

Table 6-8 General Tab / Client Properties

Parameter	Description
Client User Name	The username the client used for authentication.
Client IP Address	The IP address of the client.
Client MAC Address	The MAC address of the client.
Client Vendor	The client's vendor information.
Controller	The IP address of the controller to which the client is registered. Clicking the controller's IP address displays information about the controller.
Port	The port on the controller to which the client is connected.

Table 6-8 General Tab / Client Properties (continued)

Parameter	Description
802.11 State	802.11 state may be one of the following: • Idle (0)— normal operation: no rejections of client association requests • AAA Pending (1)— completing an AAA transaction • Authenticated (2)— 802.11 authentication completed • Associated (3)— 802.11 association completed • Power Save (4)— client in power save mode • Disassociated (5)— 802.11 disassociation completed • To Be Deleted (6)— to be deleted after disassociation • Probing (7)— client not associated or authorized yet
Interface	The name of the interface to which the client is connected.
VLAN ID	The client has successfully joined an access point for the given SSID. VLAN ID is the reverse lookup of the interface used by the WLAN on the controller side.
802.11 State	The client's state: • Idle— Normal operation; no rejections of client association requests • AAA Pending— Completing an AAA transaction • Authenticated— 802.11 association completed • Associated— 802.11 association completed • Power Save— Client in power save mode • Disassociated— Disassociation completed • To Be Deleted—To be deleted after disassociated • Probing—Client not associated or authorized yet • Blacklisted—Automatically disabled by the system due to perceived security threats
Mobility Role	Local, Anchor, Foreign, Export Anchor, Export Foreign.
Policy Manager State	Internal state of the client's WLAN. Client is working properly when the state is RUN.
Anchor Address	N/A when the client is Local (has not roamed from its original subnet). Anchor IP Address (the IP Address of the original controller) when the client is Foreign (has roamed to another controller on a different subnet). Foreign IP Address (the IP Address of the original controller) when the client is Anchor (has roamed back to another controller on a different subnet).
Mirror Mode	Disable or enable.

Table 6-8 General Tab / Client Properties (continued)

Parameter	Description
Cisco Compatible Extension	Indicates the Cisco Compatible Extension version, if client supports it
E2E	Indicates if E2E is supported.
WGB Status	Indicates the workgroup bridge status as regular client, WGB client, or WGB. If a client is a regular client, the WGB MAC address is not shown. If a client is a workgroup bridge, the state is WGB, and the MAC address is shown. A WGB is a mode that can be configured on an autonomous IOS access point to provide wireless connectivity to a lightweight access point on behalf of clients that are connected by Ethernet to the WGB access point. A WGB connects a wired network over a single wireless segment by learning the MAC addresses of its wired clients on the Ethernet interface and reporting them to the lightweight access point using Internet Access Point Protocol (IAPP) messaging.

Table 6-9 General Tab / RF Properties (read only)

Parameter	Description
AP Name	The name of the access point to which the client is associated. Clicking the link displays information about the access point.
AP Type	The type of access point.
AP Base Radio MAC	The MAC address of the access point's base radio.
Protocol	The protocol used by the radio (802.11a/n or 802.11b/g/n).
AP Mode	The access point mode.
Profile Name	The profile name of the WLAN that the client is associated to or is trying to associate to.
SSID	The SSID assigned to this WLAN. The access points broadcast the SSID on this WLAN. Different WLANs can use the same SSID as long as the Layer 2 security is different.
Security Policy	The WLAN security policy that is used.
Association Id	Client's access point association identification number.

Table 6-9 General Tab / RF Properties (read only) (continued)

Parameter	Description
Reason Code	The client reason code may be one of the following: • Normal (0) — Normal operation. • Unspecified reason (1) — Client associated but no longer authorized. • PreviousAuthNotValid(2) — Client associated but not authorized. • DeauthenticationLeaving (3) — The access point went offline, deauthenticating the client. • DisassociationDueToInactivity (4) — Client session timeout exceeded. • DisassociationAPBusy(5) — The access point is busy, performing load balancing, for example. • Class2FrameFromNonAuthStation (6) —Client attempted to transfer data before it was authenticated. • Class2FrameFromNonAssStation (7) — Client attempted to transfer data before it was associated. • DisassociationStnHasLeft (8) — Controller moved the client to another access point using non-aggressive load balancing. • StaReqAssociationWithoutAuth (9) — Client not authorized yet, still attempting to associate with a Cisco WLAN Solution. • Missing Reason Code (99) — Client momentarily in an unknown state.
802.11 Authentication	Which 802.11 authentication algorithm is in force.

Table 6-10 General Tab / Security

Parameter	Description
Authenticated	Indicates whether the client has been authenticated.
Policy Type	The type of security policy used by the client.
Encryption Cipher	Encryption settings.
EAP Type	Type of Extensible Authentication Protocol (EAP) used.

Step 13 To obtain additional troubleshooting information and perform additional diagnostics tests, choose a command from the drop-down menu and click **GO**.

a. To test the link between the client and the access point to which it is associated, choose **Link Test** from the drop-down menu and click **GO**.

b. To disable XYZ, choose **Disable** from the drop-down menu and click **GO**.

c. To remove XYZ, choose **Remove** from the drop-down menu and click **GO**.

d. To enable the Mirror mode, choose **Enable Mirror Mode** from the drop-down menu and click **GO**.

e. To display a high-resolution map of the client's recent location, choose **Recent Map (High Resolution)** from the drop-down menu and click **GO**.

f. To display a high-resolution map of the client's present location, choose **Present Map (High Resolution)** from the drop-down menu and click GO.

g. To display a graph showing a history of the client-to-access point associations, choose **AP Association History Graph** from the drop-down menu and click **GO**.

h. To display a table showing a history of the client-to-access-point associations, choose **AP Association History Table** from the drop-down menu and click **GO**.

i. To display information about the reasons for client roaming, choose **Roam Reason** from the drop-down menu and click **GO**.

j. To display details of access points that can hear the client, including at which signal strength/SNR, choose **Detecting APs** from the drop-down menu and click **GO**.

k. To display the history of the client location based on RF fingerprinting, choose **Location History** from the drop-down menu and click **GO**.

l. To display client voice matrix, choose **Voice Metrics** from the drop-down menu and click **GO**.

Step 14 To display client statistics, click the **Statistics** tab (see Figure 6-17).

This page displays four graphs:

- Client RSSI History (dBm)— History of RSSI as detected by the access point to which the client is associated
- Client SNR History— History of SNR as detected by the access point to which the client is associated
- Bytes Sent and Received (Kb/s)— The bytes sent and received by the client from the access point to which it is associated
- Packets Sent and Received (per sec.)—The packets sent and received by the client from the access point to which it is associated

Table 6-11 describes the fields displayed on this Statistics tab.

Figure 6-17 Statistics Tab

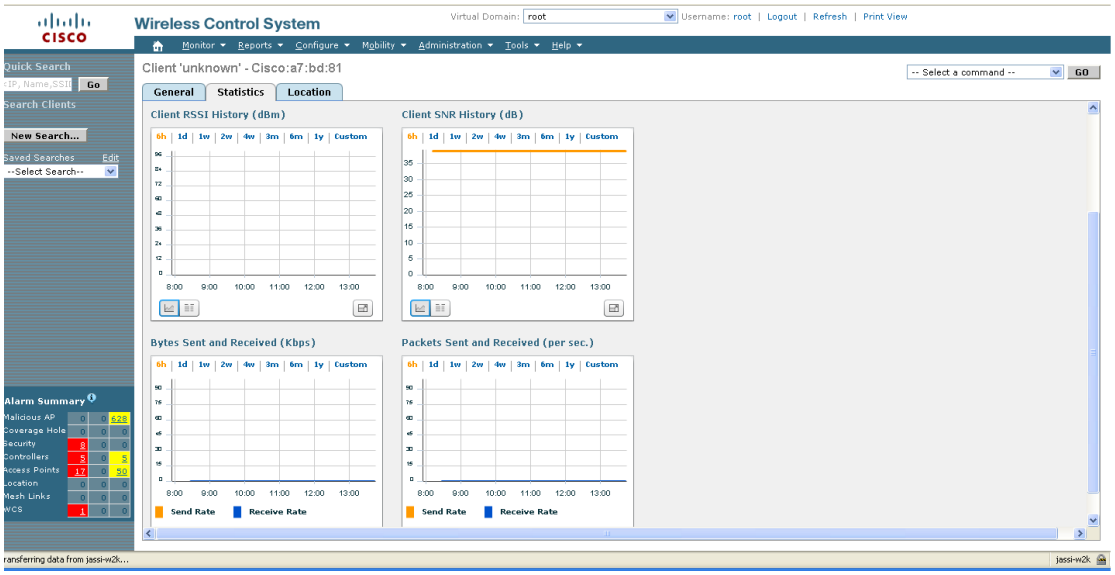


Table 6-11 Statistics Tab / Client Statistics

Parameter	Description
RSSI	Receive signal strength indicator of the client RF session.
SNR	Signal to noise ratio of the client RF session.
Bytes Sent and Received	Total number of bytes sent to the client and received by the controller from the client.
Packets Sent and Received	Total number of packets sent to the client and received by the controller from the client.
Client RSSI History (dBm)	History of RSSI as detected by the access point with which the client is associated.
Client SNR History	History of SNR as detected by the access point with which the client is associated.

Step 15 To display the client's location information, click the **Location** tab (see Figure 6-18). Table 6-12 describes the fields displayed on this Location tab.

Figure 6-18 Location Tab

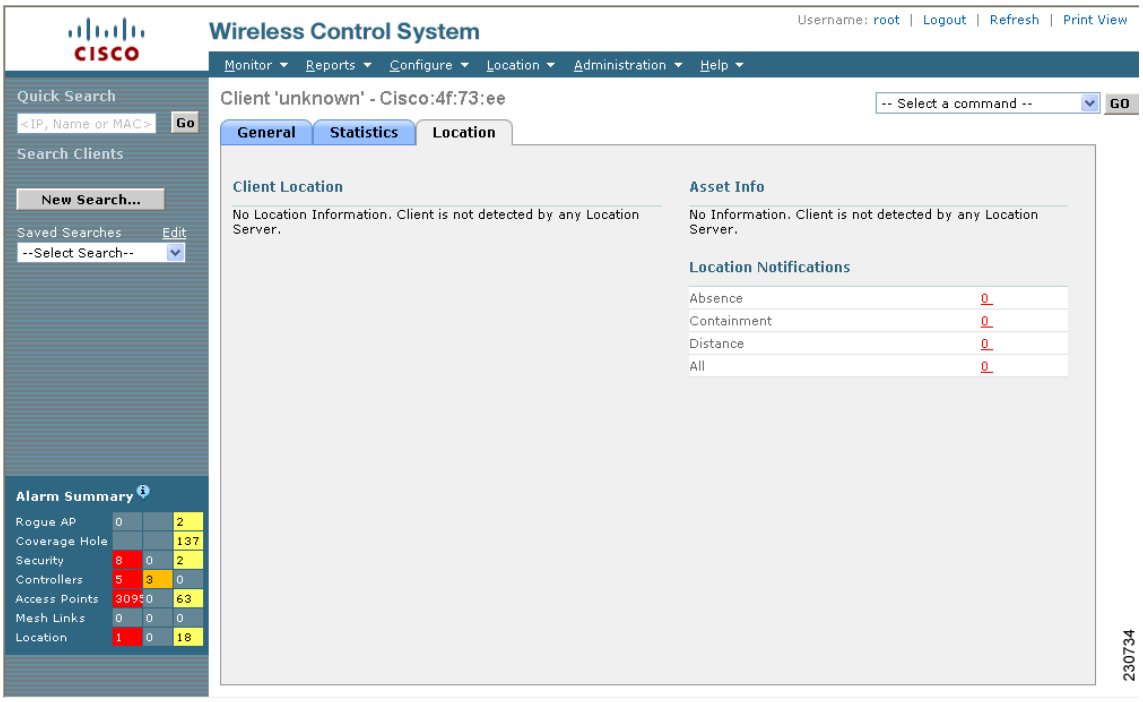


Table 6-12 Location Tab

Parameter	Description
Client Location	Describes the location of the client in the map based on RF fingerprinting.
Asset Information	Describes the asset file destination and name.that
Location Notifications	Displays the number of location notifications logged against the client. Clicking a link displays the notifications.
Absence	The location server generates absence events when the monitored assets go missing. In other words, the location server cannot see the asset in the WLAN for the specified time.
Containment	The location server generates containment events when an asset is moved inside or outside of a designated area. **Tip** You define a containment area (campus, building, or floor) here. You can define a coverage area using the Map Editor.
Distance	The location server generates movement events when an asset is moved beyond a specified distance from a designated marker you define on a map.
All	The total of absence, containment, and distance notifications.

Step 16 Click the **Cisco Compatible Extension (version 5) Info** tab. Reports specific to compatible clients provide client details that enhance client diagnostics and troubleshooting. Table Table 6-13 describes the parameters on the Manufacturer Information portion of the Cisco Compatible Extension (version 5) Info tab.

Note The Cisco Compatible Extensions (version 5) manufacturing information displays for compatible clients only.

- Automated Troubleshooting Report—Displays the automated troubleshooting file.

Note You must click **Export** to save the .zip file. The file contains three logs: automated troubleshoot report, frame log, and watch list log.

Table 6-13 Manufacturer Information

Parameter	Description
Organizationally Unique Identifier	The IEEE assigned organizational unique identifier, for example the first 3 bytes of the MAC address of the wireless network connected device.
ID	The manufacturer identifier of the wireless network adapter.
Model	Model of the wireless network adapter.
Serial Number	Serial number of the wireless network adapter.
Radio	Radio type of the client.
MAC Address	MAC address assigned to the client.
Antenna Type	Type of antenna connected to the wireless network adapter.
Antenna Gain	The peak gain of the dBi of the antenna for directional antennas and the average gain in dBi for omni-directional antennas connected to the wireless network adapter. The gain is in multiples of 0.5 dBm. An integer value 4 means 4 x 0.5 = 2 dBm of gain.
Radio Receiver Sensitivity	
Provides the receiver sensitivity of the each wireless network adapter. It shows the minimum and maximum RSSI for each radio type as well as the data rate.	
CCXV5 Capability Information	
Lists the client status and service capability of the Cisco Compatible Extensions version 5 clients.	
Radio Channels	
Lists all channels used by each radio.	
Transmit Data Rates	
Lists all data rates used by each radio.	

Table 6-14 describes the parameters displayed in the Cisco Compatibility Extensions (version 5) Capability Information portion of the tab.

Note The Cisco Compatible Extensions (version 5) capability information displays for compatible extension clients only.

Table 6-14 Client Statistics

Parameter	Description
Bytes Sent and Received (Kb/s)	Bytes sent and received with the associated access point.
Packets Sent and Received (per second)	Packets sent and received with the associated access point.

Step 17 To display the client's workgroup bridge information, click the **WGB Clients** tab. Table 6-15 describes the fields that display on this WGB tab.

Table 6-15 WGB Clients Tab

Parameter	Description
User	The user name assigned to the work group bridge.
IP Addr	The IP address of the workgroup bridge.
MAC Addr	The MAC address of the workgroup bridge.
802.11 State	Specifies whether the workgroup bridge is associated or not.

Configuring ACS View Server Credentials

In order to facilitate communication between WCS and the ACS View Server and to access the ACS View Server tab, you must add a view server with credentials. Follow these steps to configure the ACS View Server Credentials.

Step 1 Choose **Configure > ACS View Server**.

Step 2 Enter the port number of the ACS View Server you are adding. (Some ACS View Servers do not allow you to change the port on which HTTPS runs.)

Step 3 Enter the password that was established on the ACS View Server. Confirm the password.

Step 4 Specify the number of retries that will be attempted.

Step 5 Click **Submit**.

Enabling Automatic Client Troubleshooting

The Settings > Client page allows you to enable automatic client troubleshooting on a diagnostic channel. This feature is only available for Cisco Compatible Extension clients version 5.

Follow these steps to enable automatic client troubleshooting.

Step 1 Choose **Administration > Settings**.

Step 2 From the left sidebar menu, choose **Client**.

Step 3 Choose the Automatically troubleshoot client on diagnostic channel check box.

Note If the check box is selected, WCS processes the diagnostic association trap. If it is not selected, WCS raises the trap, but automated troubleshooting is not initiated.

Step 4 Click **Save**.

Finding Clients

Follow these steps to use WCS to find clients on your wireless LAN.

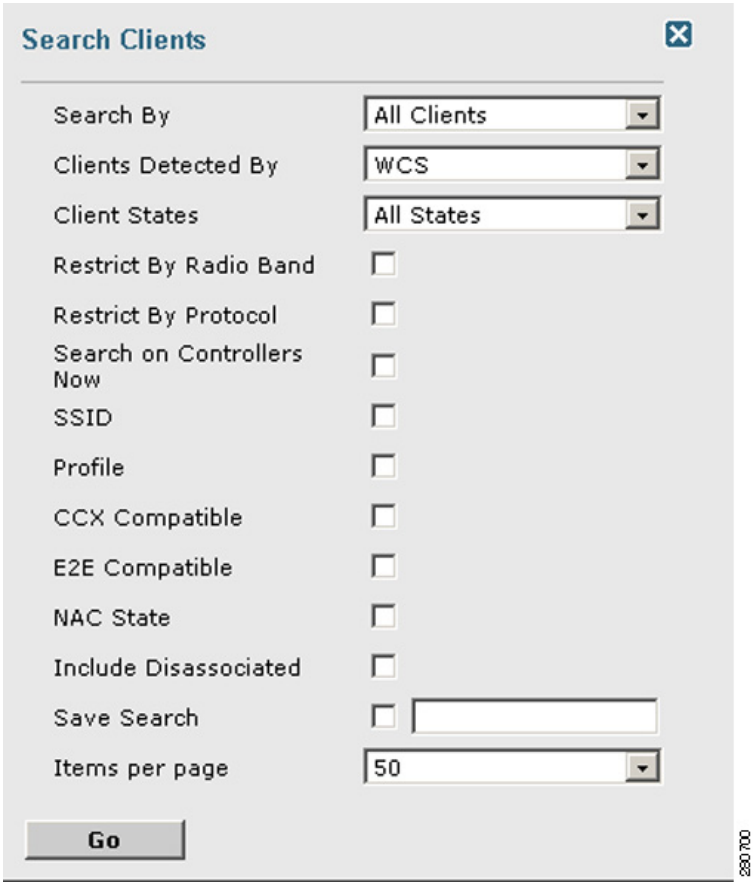
Step 1 Click **Monitor > Clients** to navigate to the Clients Summary page.

Step 2 The sidebar area enables you to select a new configuration panel under the menu area that you have selected. You can make only one choice. The selector area options vary based on the menu that you select.

- **New Search** drop-down menu: Opens the Search Clients window. Use the Search Clients window to configure, run, and save searches.
- **Saved Searches** drop-down menu: Lists the saved custom searches. To open a saved search, choose it from the Saved Searches list.
- **Edit link**: Opens the Edit Saved Searches window. You can delete saved searches in the Edit Saved Searches window.

Step 3 In the sidebar, click **New Search**. The Search Clients window appears (see Figure 6-19).

Figure 6-19 Search Clients



You can configure the following parameters in the Search clients window:

- Search By
- Clients Detected By — Choose WCS for clients stored in WCS that were detected through polling of the controllers from WCS. Choose Location Servers for clients stored on the location server that were detected by the location server through controller polling.
- Client States —Specify if you want to view clients only in a specific state such as idle, authenticated, associated, probing, or excluded.
- Restrict by Radio Band—To see the clients on a particular band, click the check box and choose 2.4GHz (802.11b/g or 802.11n) or 5 GHz (802.11a or 802.11n) from the drop-down menu.
- Restrict by Protocol—To restrict the search by protocol, choose 802.11a/n, 802.11b/n, and 802.11g/n from the drop-down menu.
- Search on Controllers Now—To search controllers rather than just the WCS database, click the check box. This search provides polling results in real time and delayed by 15 minutes, but it may take awhile to perform.
- SSID — To restrict the search by SSID, choose an SSID from the drop-down menu.
- Profile—To restrict the search by the profile that the client is using, click the check box and choose the profile name from the drop-down menu.
- CCX Compatible — To search for Cisco Compatible Extension compatible clients.

- E2E Compatible — To search for E2E compatible clients.
- NAC state—Click the check box and choose the client's network admission control state from the drop-down menu. The choices are invalid (the client is currently probing and not associated), quarantine (the client must go through posture analysis), and access (the client has completed posture analysis and is clean), and not applicable.
- Include Disassociated — To include clients that are no longer on the network but for which WCS has historical records.
- Save Search — To save the search in the Saved Searches drop-down menu.
- Items per page — The number of found items to display on the search results page.

Step 4 Choose **All Clients** in the Search By drop-down menu and click **GO.** The related search results window appears. The search results are listed.

Note You can search for clients under WCS Controllers or Location Servers.

Step 5 Click the username of the client that you want to locate. WCS displays the corresponding Clients *Client Name* page.

Note The Client RSSI History, Client SNR History, Bytes Sent and Received, and Packets Sent and Received reports are displayed. You can specify graph view or table view by clicking the appropriate icon. If it is a report where you can specify time period, enter both the start and end time or a specific time period.

Step 6 To find the client, choose one of these options from the Select a Command drop-down menu and click **GO**:

- **Recent Map (High Resolution)**—Finds the client without disassociating it.
- **Present Map (High Resolution)**—Disassociates the client and then finds it after reassociation. When you choose this method, WCS displays a warning message and asks you to confirm that you want to continue.

If you are using WCS Location, WCS compares the RSSI signal strength from two or more access points to find the most probable location of the client and places a small laptop icon at its most likely location. If you are using WCS Base, WCS relies on the RSSI signal strength from the client and places a small laptop icon next to the access point that receives the strongest RSSI signal from the client. Figure 6-20 shows a heat map that includes a client location.

Figure 6-20 Map with Client Location

Step 7 To view statistics for the selected client, click the **Statistics** tab.

Table 6-16 Client Statistics

Parameter	Description
Bytes received	Total number of bytes received by the controller from the client.
Bytes sent	Total number of bytes sent to the client from the controller.
Packets received	Total number of packets received by the controller from the client.
Packets sent	Total number of packets sent to the client from the controller.
Policy errors	Number of policy errors for the client.
RSSI	Receive signal strength indicator of the client RF session.
SNR	Signal-to-noise ratio of the client RF session.
Client RSSI History (dBm)	History of RSSI as detected by the access point with which the client is associated.
Client SNR History	History of SNR as detected by the access point with which the client is associated.
Bytes Sent and Received (Kb/s)	Bytes sent and received with the associated access point.
Packets Sent and Received (per second)	Packets sent and received with the associated access point.

Step 8 To generate a roam reason report, click **Roam Reason**. This reporting does not require any configuration.

Step 9 To generate a voice TSM report, click **Voice Metrics**.

Step 10 To generate a troubleshooting report, click **Troubleshoot**. You can choose a summary tab, a log analysis tab, or an event history tab.

Step 11 A test analysis generates the following results:

- DHCP—Verifies that DHCP is operating correctly between the controller and the client.
- IP Connectivity—Determines that IP connectivity exists on the local subnet. The IP connectivity test causes the client to execute a ping test to the default gateway.
- DNS Ping—Verifies that IP connectivity exists to the DNS server by having the client perform a ping test to the DNS server.
- DNS Resolution—Verifies that name resolution is functioning correctly. To test, the client tests a network name known to be resolvable, such as www.cisco.com.
- 802.1X Association—Determines that the client is able to associate properly with a designated WLAN and with a specific access point.
- 802.1X Authentication—Determines that the client is able to complete an 802.1X authentication with a designated WLAN and with a specific access point.

Receiving Radio Measurements

On the client window, you can receive radio measurements only if the client is Cisco Compatible Extensions v2 (or higher) and is in the associated state (with a valid IP address). If the client is busy when asked to do the measurement, it determines whether to honor the measurement or not. If it declines to make the measurement, it shows no data from the client.

Step 1 Choose **Monitor > Clients**.

Step 2 Choose a client from the Clients column or enter a client in the Client Troubleshooting section on the bottom right and click **Troubleshoot**.

Step 3 From the Select a command drop-down menu, choose **Radio Measurement**.

Step 4 Click the check box to indicate if you want to specify beacon measurement, frame measurement, channel load, or noise histogram. The different measurements produce differing results:

- Beacon Response
  - Channel—The channel number for this measurement
  - BSSID— 6-byte BSSID of the station that sent the beacon or probe response
  - PHY— Physical Medium Type (FH, DSS, OFDM, high rate DSS or ERP)
  - Received Signal Power— The strength of the beacon or probe response frame in dBm
  - Parent TSF— The lower 4 bytes of the serving access point's TSF value
  - Target TSF— The 8-byte TSF value contained in the beacon or probe response
  - Beacon Interval— The 2-byte beacon interval in the received beacon or probe response
  - Capability information— As present in the beacon or probe response

- Frame Measurement
  - Channel— Channel number for this measurement
  - BSSID— BSSID contained in the MAC header of the data frames received
  - Number of frames— Number of frames received from the transmit address
  - Received Signal Power— The signal strength of 802.11 frames in dBm
- Channel Load
  - Channel—The channel number for this measurement
  - CCA busy fraction— The fractional duration over which CCA indicated the channel was busy during the measurement duration defined as ceiling (255 times the duration the CCA indicated channel was busy divided by measurement duration)
- Noise Histogram
  - Channel— The channel number for this measurement
  - RPI density in each of the eight power ranges

Step 5 Click **Perform Measurement** to initiate the measurement.

The measurements take about 5 msec to perform. A message from WCS indicates the progress. If the client chooses not to perform the measurement, that is also communicated.

Monitoring Mesh Networks Using Maps

You can access and view details for the following elements from a mesh network map in Cisco WCS:

- Mesh Link Statistics
- Mesh Access Points
- Mesh Access Point Neighbors

Details on how this information is accessed and the information displayed for each of these items is detailed in the following sections.

Monitoring Mesh Link Statistics Using Maps

You can view the SNR for a specific mesh network link, view the number of packets transmitted and received on that link, and initiate a link test from the Monitor > Maps display.

To view details on a specific mesh link between two mesh access points or a mesh access point and a root access point, do the following:

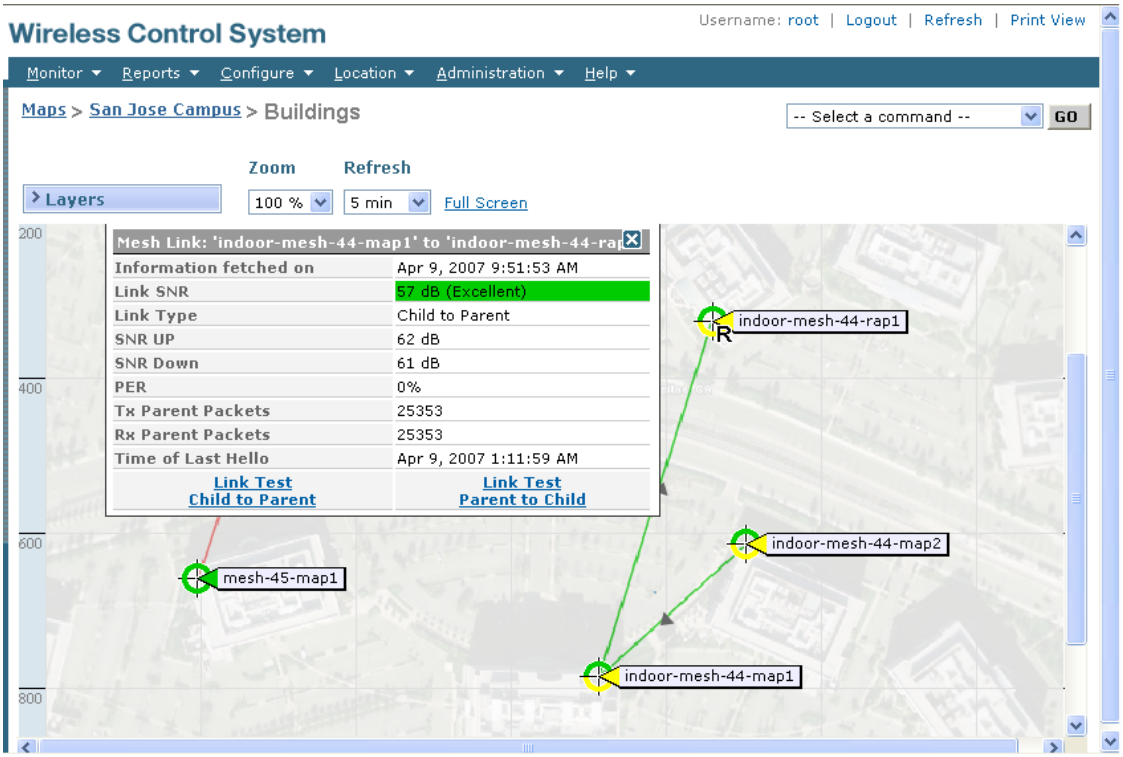
Step 1 In Cisco WCS, choose **Monitor > Maps**.

Step 2 Click the **Map Name** that corresponds to the outdoor area, campus, building, or floor you want to monitor.

Step 3 Move the cursor over the link arrow for the target link (see Figure 6-21). A Mesh Link window appears.

Note The AP Mesh Info check box under the Layers drop-down menu must be checked for links to appear on the map.

Figure 6-21 Mesh Link Details Window

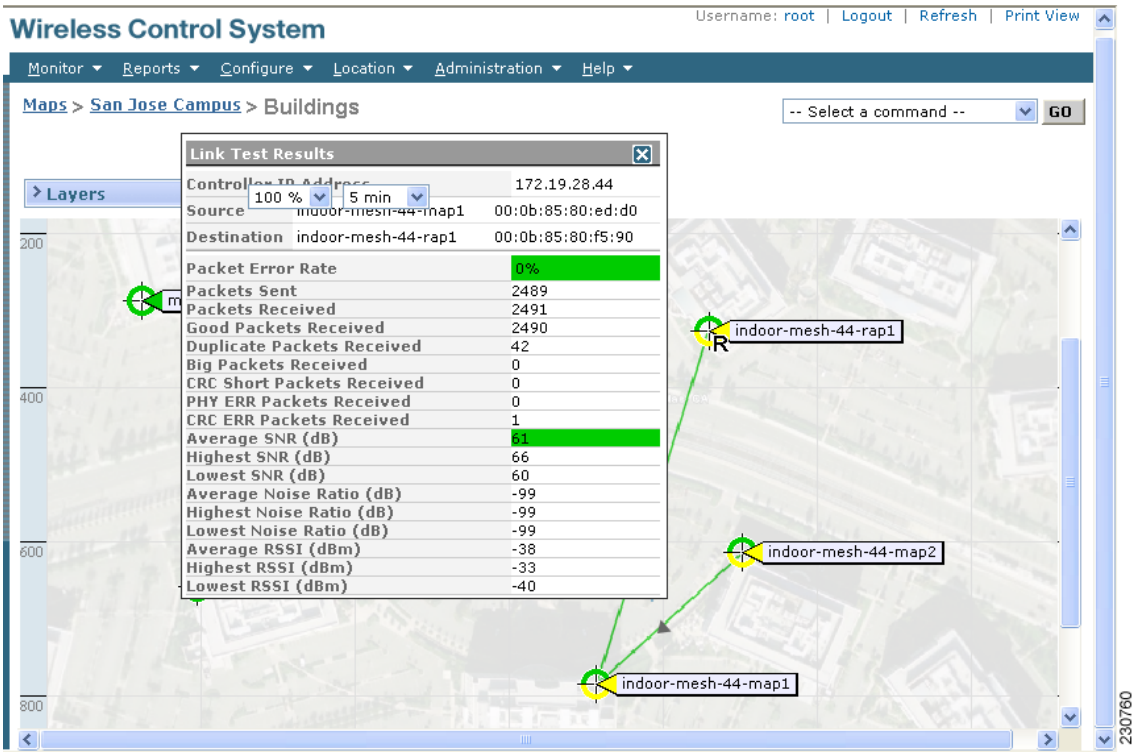


Step 4 Click either **Link Test**, **Child to Parent or Link Test**, or **Parent to Child**. After the link test is complete, a results page appears (see Figure 6-22).

Note A link test runs for 30 seconds.

Note You cannot run link tests for both links (child-to-parent and parent-to-child) at the same time.

Figure 6-22 Link Test Results

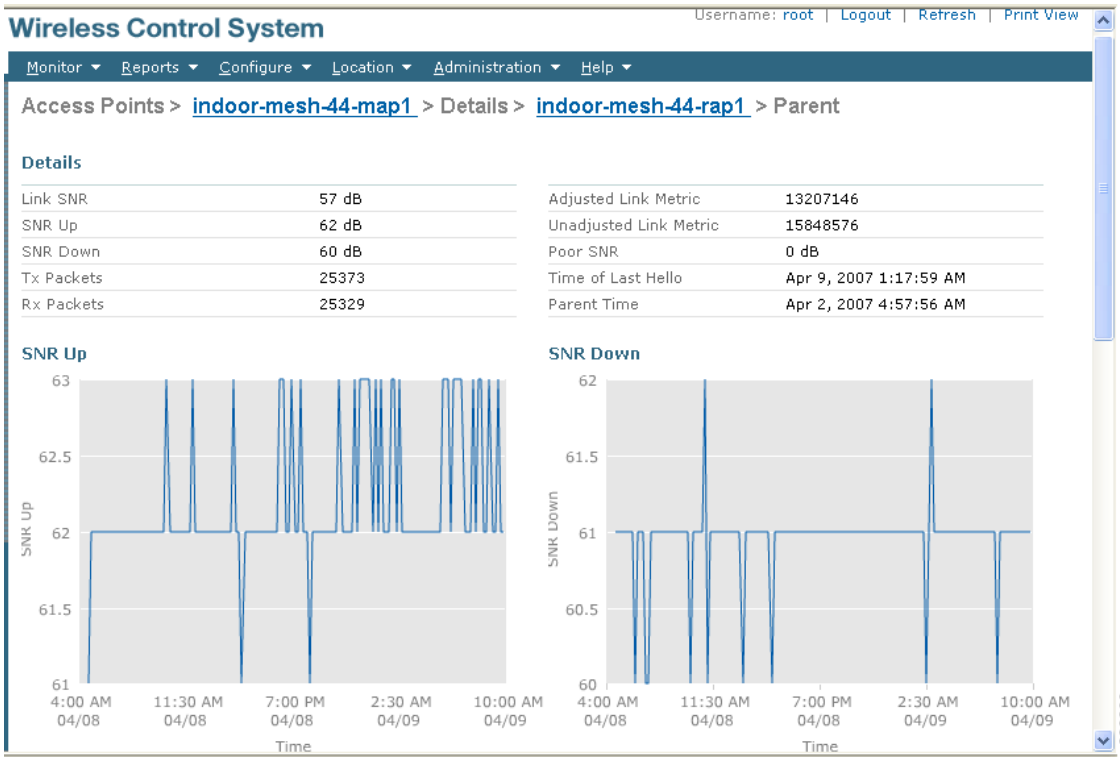


Step 5 To view a graphical representation of SNR statistics over a period of time, click the arrow on the link. A window with multiple SNR graphs appears (see Figure 6-23).

The following graphs are displayed for the link:

- SNR Up—Plots the RSSI values of the neighbor from the perspective of the access point.
- SNR Down—Plots the RSSI values that the neighbor reports to the access point.
- Link SNR—Plots a weighed and filtered measurement based on the SNR Up value.
- The Adjusted Link Metric —Plots the value used to determine the least cost path to the root access point. This value is the ease to get to the rooftop access point and accounts for the number of hops. The lower the ease value, the less likely the path is used.
- The Unadjusted Link Metric —Plots the least cost path to get to the root access point unadjusted by the number of hops. The higher the value for the unadjusted link, the better the path.

Figure 6-23 Mesh SNR Graphs Page (Top)



Monitoring Mesh Access Points Using Maps

You can view the following summary information for a mesh access point from a mesh network map:

- Parent
- Number of children
- Hop count
- Role
- Group name
- Backhaul interface
- Data Rate
- Channel

Note This information is in addition to the information shown for all access points (MAC address, access point model, controller IP address, location, height of access point, access point up time, and LWAPP up time).

Note You can also view detailed configuration and access alarm and event information from the map. For detailed information on the Alarms and Events displayed, refer to the "Alarm and Event Dictionary" section on page 14-15.

To view summary and detailed configuration information for a mesh access point from a mesh network map, do the following:

Step 1 In Cisco WCS, choose **Monitor > Maps**.

Step 2 Click the **Map Name** that corresponds to the outdoor area, campus, building, or floor location of the access point you want to monitor.

Step 3 To view summary configuration information for an access point, move the cursor over the access point that you want to monitor. A window with configuration information for the selected access point appears (see Figure 6-24).

Figure 6-24 Mesh AP Summary Panel

Step 4 To view detailed configuration information for an access point, click the arrow portion of the mesh access point label. The configuration details for the access point appears (see Figure 6-25).

Note For more details on the View Mesh Neighbors link in the access point panel above, see the "Monitoring Mesh Access Point Neighbors Using Maps" section on page 6-45. If the access point has an IP address, a Run Ping Test link is also visible at the bottom of the mesh access point panel.

Figure 6-25 Mesh AP Detail Window

Step 5 At the Access Point configuration window, follow these steps to view configuration details for the mesh access point.

a. Choose the **General** tab to view the overall configuration of the mesh access point such as AP name, MAC address, AP and LWAPP Up time, associated controllers (registered and primary) operational status, and software version.

Note The software version for mesh access points is appended the letter *m* and the word *mesh* in parentheses.

b. Choose the **Interface** tab to view configuration details for the interfaces supported on the mesh access point. Interface options are radio and Ethernet.

c. Choose the **Mesh Links** tab to view parent and neighbors' details (name, MAC address, packet error rate, and link details) for the mesh access point. You can also initiate link tests from this panel.

d. Choose the **Mesh Statistics** tab to view details on the bridging, queue, and security statistics for the mesh access point. For more details on mesh statistics, refer to the "Mesh Statistics for an Access Point" section on page 6-51.

Monitoring Mesh Access Point Neighbors Using Maps

To view details on neighbors of a mesh access point from a mesh network map, do the following:

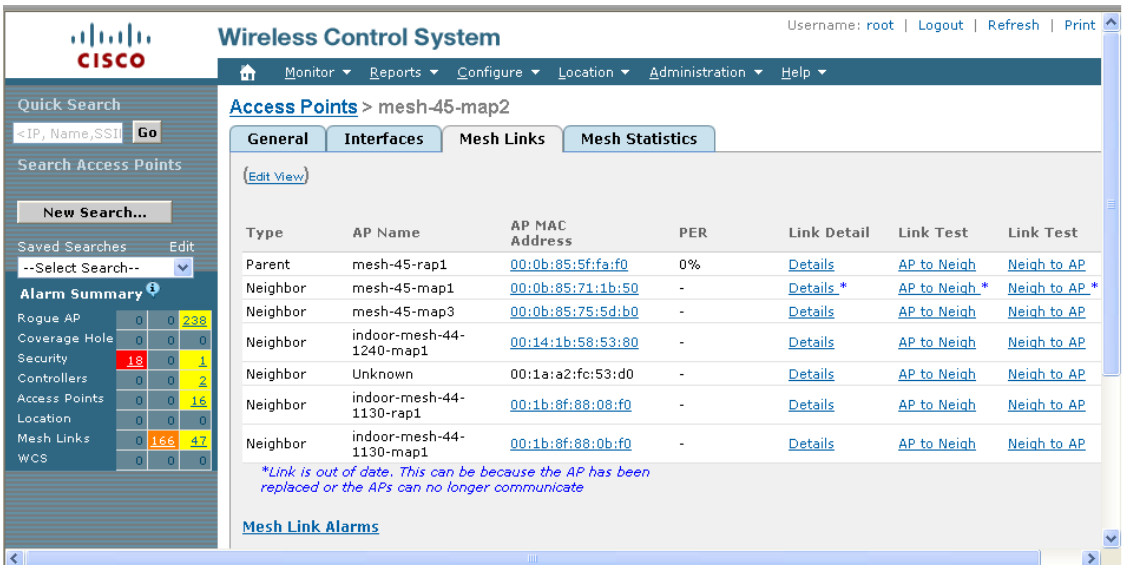
Step 1 In Cisco WCS, choose **Monitor > Maps**.

Step 2 Click the **Map Name** that corresponds to the outdoor area, campus, building, or floor you want to monitor.

Step 3 To view detailed information on mesh links for a mesh access point, click the arrow portion of the access point label. The Access Points screen appears.

Step 4 Click the Mesh Links tab (see Figure 6-26).

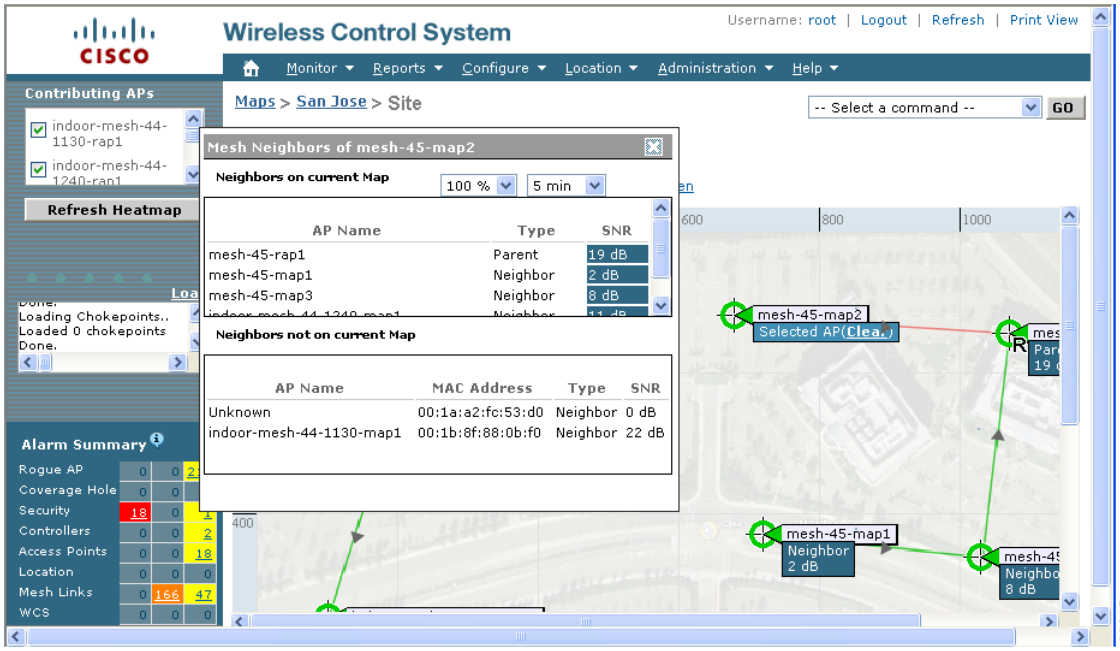
Figure 6-26 Access Points > Mesh Links Panel



Note You can also mesh link details for neighbors of a selected access point by clicking on the View Mesh Neighbors link on the access point configuration summary panel that displays when you mouse over an access point on a map (see Figure 6-25).

Note Signal-to-noise (SNR) only appears on the View Mesh Neighbors panel (see Figure 6-26).

Figure 6-27 View Mesh Neighbors Panel



Note In addition to listing the current and past neighbors in the panel that displays, labels are added to the mesh access points map icons to identify the selected access point, the neighbor access point, and the child access point. Select the **clear** link of the selected access point to remove the relationship labels from the map.

Note The drop-down menus at the top of the mesh neighbors window indicate the resolution of the map (100%) displayed and how often the information displayed is updated (5 mins). You can modify these default values.

Monitoring Mesh Health

Mesh Health monitors the overall health of Cisco Aironet 1500 and 1520 series outdoor access points as well as Cisco Aironet 1130 and 1240 series indoor access points when configured as mesh access points, except as noted. Tracking this environmental information is particularly critical for access points that are deployed outdoors. The following factors are monitored:

- Temperature: Displays the internal temperature of the access point in Fahrenheit and Celsius (Cisco Aironet 1510 and 1520 outdoor access points only).
- Heater status: Displays the heater as on or off (Cisco Aironet 1510 and 1520 outdoor access points only)
- AP Up time: Displays how long the access point has been active to receive and transmit.
- LWAPP Join Taken Time: Displays how long it took to establish the LWAPP connection (excluding Cisco Aironet 1505 access points).

- LWAPP Up Time: Displays how long the LWAPP connection has been active (excluding Cisco Aironet 1505 access points).

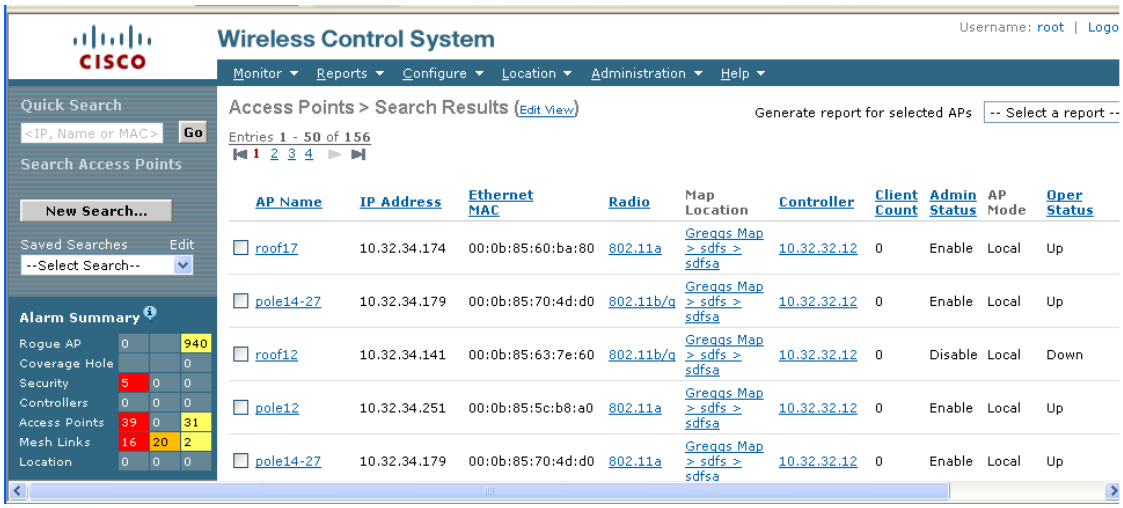
Mesh Health information is displayed in the General Properties panel for mesh access points.

To view the mesh health details for a specific mesh access point, follow these steps.

Step 1 Choose **Monitor > Access Points**. A listing of access points appears (see Figure 6-28).

Note You can also use the New Search button to display the mesh access point summary shown below. With the New Search option, you can further define the criteria of the access points that display. Search criteria include AP Type, AP Mode, Radio Type, and 802.11n Support.

Figure 6-28 Monitor > Access Points



Step 2 Click the AP Name link to display details for that mesh access point. The General Properties panel for that mesh access point appears (see Figure 6-29).

Note You can also access the General properties panel for a mesh access point from a Cisco WCS map window. To display the panel, click the arrow portion of the mesh access point label. A tabbed panel appears and displays the General properties panel for the selected access point.

Figure 6-29 AP Name > General Properties Page

To add, remove, or reorder columns in the table, click the Edit View link. Table 6-17 displays optional access point parameters available from the Edit View window.

Table 6-17 Monitor Access Points Additional Search Results Parameters

Column	Options
AP Type	Indicates the type of access point (unified or autonomous).
Antenna Azim. Angle	Indicates the horizontal angle of the antenna.
Antenna Diversity	Indicates if antenna diversity is enabled or disabled. Antenna diversity refers to the access point sampling the radio signal from two integrated antenna ports in order to choose the preferred antenna.
Antenna Elev. Angle	Indicates the elevation angle of the antenna.
Antenna Gain	The peak gain of the dBi of the antenna for directional antennas and the average gain in dBi for omni-directional antennas connected to the wireless network adapter. The gain is in multiples of 0.5 dBm. An integer value 4 means 4 x 0.5 - 2 dBm of gain.
Antenna Mode	Indicates the antenna mode such as omni, directional, or non-applicable.
Antenna Name	Indicates the antenna name or type.
Antenna Type	Indicates whether the antenna is internal or external.

Table 6-17 Monitor Access Points Additional Search Results Parameters

Column	Options
Audit Status	Indicates one of the following audit statuses: • Mismatch—Config differences were found between WCS and controller during the last audit. • Identical—No config differences were found during the last audit. • Not Available—Audit status is unavailable.
Bridge Group Name	Indicates the name of the bridge group used to group the access points, if applicable.
CDP Neighbors	Indicates all directly connected Cisco devices.
Channel Control	Indicates whether the channel control is automatic or custom.
Channel Number	Indicates the channel on which the Cisco radio is broadcasting.
Controller Port	Indicates the number of controller ports.
Node Hops	Indicates the number of hops between access point.
POE Status	Indicates the Power-over-Ethernet status of the access point. The possible values include: • Low—The access point draws low power from the Ethernet. • Lower than 15.4 volts—The access point draws lower than 15.4 volts from the Ethernet. • Lower than 16.8 volts—The access point draws lower than 16.8 volts from the Ethernet. • Normal—The power is high enough for the operation of the access point. • Not Applicable—The power source is not from the Ethernet.
Primary Controller	Indicates the name of the primary controller for this access point.
Radio MAC	Indicates the radio's MAC address.
Reg. Domain Supported	Indicates whether or not the regulatory domain is supported.
Serial Number	Indicates the access point's serial number.
Slot	Indicates the slot number.
Tx Power Control	Indicates whether the transmission power control is automatic or custom.
Tx Power Level	Indicates the transmission power level.
Up Time	Indicates how long the access point has been up in days, hours, minutes, and seconds.
WLAN Override Names	Indicates the WLAN override profile names.
WLAN Override	Indicates whether WLAN Override is enabled or disabled.

Mesh Statistics for an Access Point

Mesh Statistics are reported when a child mesh access point authenticates or associates with a parent mesh access point.

Security entries are removed and no longer displayed when the child mesh access point disassociates from the controller.

The following mesh security statistics are displayed for mesh access points:

- Bridging
- Queue
- Security

To view the mesh statistics for a specific mesh access point, follow these steps.

Step 1 In Cisco WCS, choose **Monitor > Access Points**. A listing of access points appears (see Figure 6-30).

Note You can also use the New Search button to display the access point summary. With the New Search option, you can further define the criteria of the access points that display. Search criteria include AP Name, IP address, MAC address, Controller IP or Name, Radio type, and Outdoor area.

Step 2 Click the **AP Name** link of the target mesh access point.

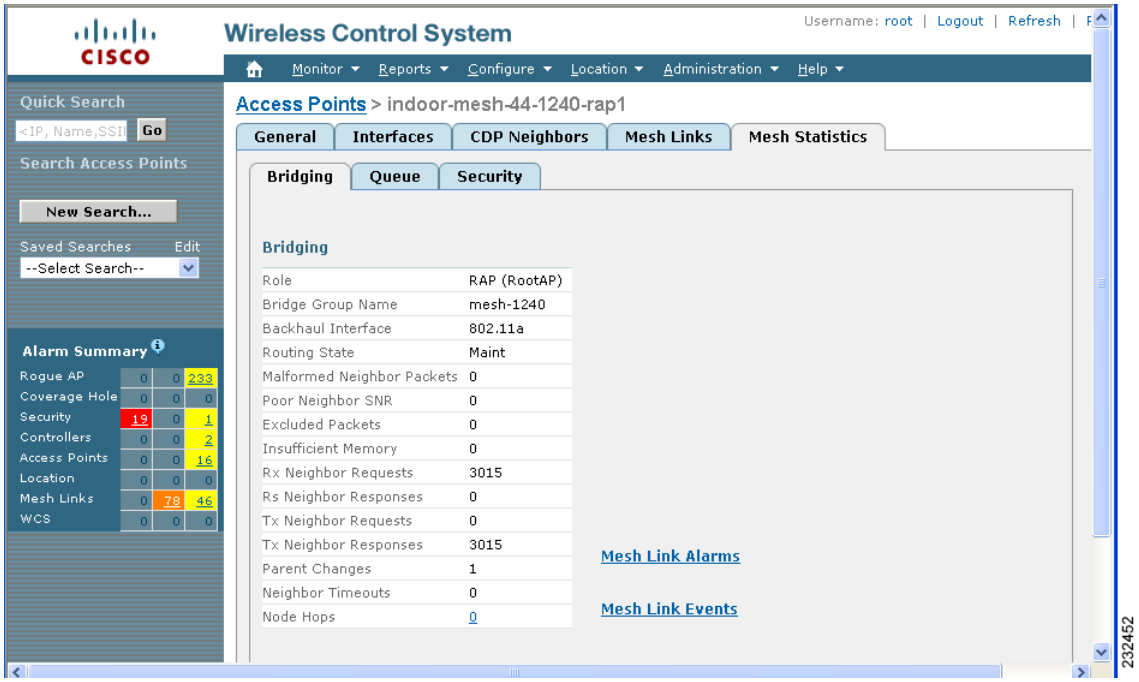
A tabbed panel appears and displays the General Properties page for the selected access point.

Step 3 Click the **Mesh Statistics** tab (see Figure 6-30). A three-tabbed Mesh Statistics panel appears.

Note The Mesh Statistics tab and its subordinate tabs (Bridging, Queue and Security) only appear for mesh access points. The Mesh Link Alarms and Mesh Link Events links are accessible from each of the three tabbed panels.

Note You can also access the Mesh Securities panel for a mesh access point from a Cisco WCS map. To display the panel, click the arrow portion of the mesh access point label.

Figure 6-30 Monitor > Access Points > AP Name > Mesh Statistics



Summaries of the Bridging, Queue and Security Statistics and their definitions are provided in Table 6-18, Table 6-19 and Table 6-20 respectively.

Table 6-18 Bridging Mesh Statistics

Parameter	Description
Role	The role of the mesh access point. Options are mesh access point (MAP) and root access point (RAP).
Bridge Group Name (BGN)	The name of the bridge group to which the MAP or RAP is a member. Assigning membership in a BGN is recommended. If one is not assigned, a MAP is by default assigned to a default BGN.
Backhaul Interface	The radio backhaul for the mesh access point.
Routing State	The state of parent selection. Values that display are seek, scan and maint. Maint displays when parent selection is complete.
Malformed Neighbor Packets	The number of malformed packets received from the neighbor. Examples of malformed packets include malicious floods of traffic such as malformed or short DNS packets and malformed DNS replies.
Poor Neighbor SNR	The number of times the signal-to-noise ratio falls below 12 dB on the backhaul link.

Table 6-18 Bridging Mesh Statistics (continued)

Parameter	Description
Excluded Packets	The number of packets received from excluded neighbor mesh access points.
Insufficient Memory	The number of insufficient memory conditions.
RX Neighbor Requests	The number of broadcast and unicast requests received from the neighbor mesh access points.
RX Neighbor Responses	The number of responses received from the neighbor mesh access points .
TX Neighbor Requests	The number of unicast and broadcast requests sent to the neighbor mesh access points.
TX Neighbor Responses	The number of responses sent to the neighbor mesh access points.
Parent Changes	The number of times a mesh access point (child) moves to another parent.
Neighbor Timeouts	The number of neighbor timeouts.
Node Hops	The number of hops between the MAP and the RAP. Click the value link to display a sub-panel which enables you to configure details of what is reported, how often the node hop value is updated, and view a graphical representation of the report.

Table 6-19 Queue Mesh Statistics

Parameter	Description
Silver Queue	The average and peak number of packets waiting in the silver (best effort) queue during the defined statistics time interval. Packets dropped and queue size is also summarized.
Gold Queue	The average and peak number of packets waiting in the gold (video) queue during the defined statistics time interval. Packets dropped and queue size is also summarized.
Platinum Queue	The average and peak number of packets waiting in the platinum (voice) queue during the defined statistics time interval. Packets dropped and queue size is also summarized.
Bronze Queue	The average and peak number of packets waiting in the bronze (background) queue during the defined statistics time interval. Packets dropped and queue size is also summarized.
Management Queue	The average and peak number of packets waiting in the management queue during the defined statistics time interval. Packets dropped and queue size is also summarized.

Table 6-20 Security Mesh Statistics

Parameter	Description
Association Request Failures	Summarizes the total number of association request failures that occur between the selected mesh access point and its parent.
Association Request Success	Summarizes the total number of successful association requests that occur between the selected mesh access point and its parent.
Association Request Timeouts	Summarizes the total number of association request time outs that occur between the selected mesh access point and its parent.
Authentication Request Failures	Summarizes the total number of failed authentication requests that occur between the selected mesh access point and its parent.
Authentication Request Success	Summarizes the total number of successful authentication requests between the selected mesh access point and its parent mesh node.
Authentication Request Timeouts	Summarizes the total number of authentication request timeouts that occur between the selected mesh access point and its parent.
Invalid Association Request	Summarizes the total number of invalid association requests received by the parent mesh access point from the selected child mesh access point. This state might occur when the selected child is a valid neighbor but is not in a state that allows association.
Invalid Reassociation Request	Summarizes the total number of invalid reassociation requests received by the parent mesh access point from a child. This might happen when a child is a valid neighbor but is not in a proper state for reassociation.
Invalid Reauthentication Request	Summarizes the total number of invalid reauthentication requests received by the parent mesh access point from a child. This may happen when a child is a valid neighbor but is not in a proper state for reauthentication.
Packets Received	Summarizes the total number of packets received during security negotiations by the selected mesh access point.
Packets Transmitted	Summarizes the total number of packets transmitted during security negotiations by the selected mesh access point.
Reassociation Request Failures	Summarizes the total number of failed reassociation requests between the selected mesh access point and its parent.

Table 6-20 Security Mesh Statistics (continued)

Parameter	Description
Reassociation Request Success	Summarizes the total number of successful reassociation requests between the selected mesh access point and its parent.
Reassociation Request Timeouts	Summarizes the total number of reassociation request timeouts between the selected mesh access point and its parent.
Reauthentication Request Failures	Summarizes the total number of failed reauthentication requests between the selected mesh access point and its parent.
Reauthentication Request Success	Summarizes the total number of successful reauthentication requests that occurred between the selected mesh access point and its parent.
Reauthentication Request Timeouts	Summarizes the total number of reauthentication request timeouts that occurred between the selected mesh access point and its parent.
Unknown Association Requests	Summarizes the total number of unknown association requests received by the parent mesh access point from its child. The unknown association requests often occur when a child is an unknown neighbor mesh access point.
Unknown Reassociation Request	Summarizes the total number of unknown reassociation requests received by the parent mesh access point from a child. This might happen when a child mesh access point is an unknown neighbor.
Unknown Reauthentication Request	Summarizes the total number of unknown reauthentication requests received by the parent mesh access point node from its child. This might occur when a child mesh access point is an unknown neighbor.

Viewing the Mesh Network Hierarchy

You can view the parent-child relationship of mesh access points within a mesh network in an easily navigable display. You can also filter which access points display on the Map view, by selecting only access points of interest.

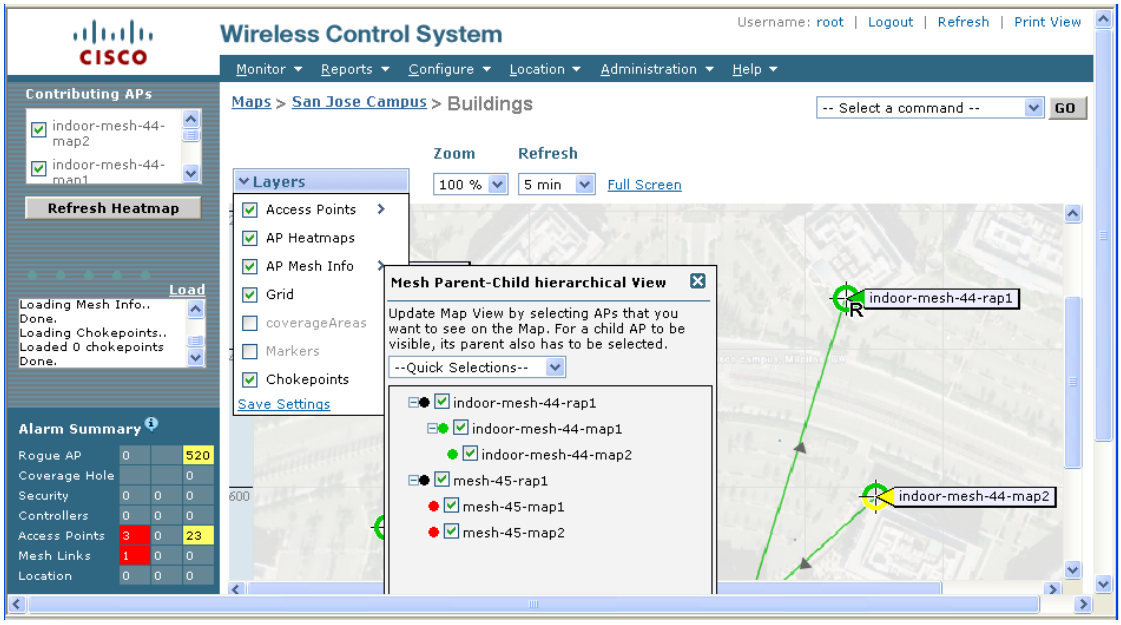
To view the mesh network hierarchy for a selected network, do the following:

Step 1 In Cisco WCS, choose **Monitor > Maps**.

Step 2 Select the map you want to display.

Step 3 Click the **Layers** arrow to expand that menu (see Figure 6-31).

Figure 6-31 Monitor > Maps > Selected Map



Step 4 Check the **AP Mesh Info** check box if it is not already checked.

Note The AP Mesh Info check box is only selectable if mesh access points are present on the map. It must be checked to view the mesh hierarchy.

Step 5 Click the **AP Mesh Info** arrow to display the mesh parent-child hierarchy.

Step 6 Click the **plus (+)** sign next to a mesh access point to display its children.

All subordinate mesh access points are displayed when a negative (-) sign displays next to the parent mesh access point entry. For example, in Figure 6-31, the access point, *indoor-mesh-45-rap2*, has only one child, *indoor-mesh-44-map2*.

Step 7 Move the cursor over the colored dot next to each mesh access point child to view details on the link between it and its parent. Table 6-21 summarizes the parameters that display.

The color of the dot also provides a quick reference point of the SNR strength.

- A green dot represents a high SNR (above 25 dB).
- An amber dot represents an acceptable SNR (20-25 dB).
- A red dot represents a low SNR (below 20 dB).
- A black dot indicates a root access point.

Table 6-21 Bridging Link Information

Parameter	Description
Information fetched on	Date and time that information was compiled.
Link SNR	Link signal-to-noise ratio (SNR).
Link Type	Hierarchical link relationship.
SNR Up	Signal-to-noise radio for the uplink (dB).
SNR Down	Signal-to-noise radio for the downlink (dB).
PER	The packet error rate for the link.
Tx Parent Packets	The TX packets to a node while acting as a parent.
Rx Parent Packets	The RX packets to a node while acting as a parent.
Time of Last Hello	Date and time of last hello.

Using Mesh Filters to Modify Map Display of Maps and Mesh Links

In the mesh hierarchical window, you can also define mesh filters to determine which mesh access points display on the map based on hop values as well as what labels display for mesh links.

Mesh access points are filtered by the number of hops between them and their root access point.

To use mesh filtering, follow these steps:

Step 1 To modify what label and color displays for a mesh link, follow these steps:

a. In the Mesh Parent-Child Hierarchical View, select an option from the Link Label drop-down menu. Options are None, Link SNR, and Packet Error Rate.

b. In the Mesh Parent-Child Hierarchical View, select an option from the Link Color drop-down menu to define which parameter (Link SNR or Packet Error Rate) determines the color of the mesh link on the map.

Note The color of the link provides a quick reference point of the SNR strength or Packet Error Rate.

Table 6-22 Definition for SNR and Packet Error Rate Link Color

Link Color	Link SNR	Packet Error Rate (PER)
Green	Represents a SNR above 25 dB (high value)	Represents a PER of one percent (1%) or lower
Amber	Represents a SNR between 20 and 25 dB (acceptable value)	Represents a PER that is less than ten percent (10%) and greater than one percent (1%)
Red	Represents a SNR below 20 dB (low value)	Represents a PER that is greater than ten percent (10%)

Note The Link label and color settings are reflected on the map immediately (see Figure 6-32). You can display both SNR and PER values simultaneously.

Step 2 To modify which mesh access points display based on the number of hops between them and their parents, do the following:

a. In the Mesh Parent-Child Hierarchical View, click the **Quick Selections** drop-down menu.

b. Select the appropriate option from the menu. A description of the options is provided in Table 6-23.

Table 6-23 Quick Selection Options

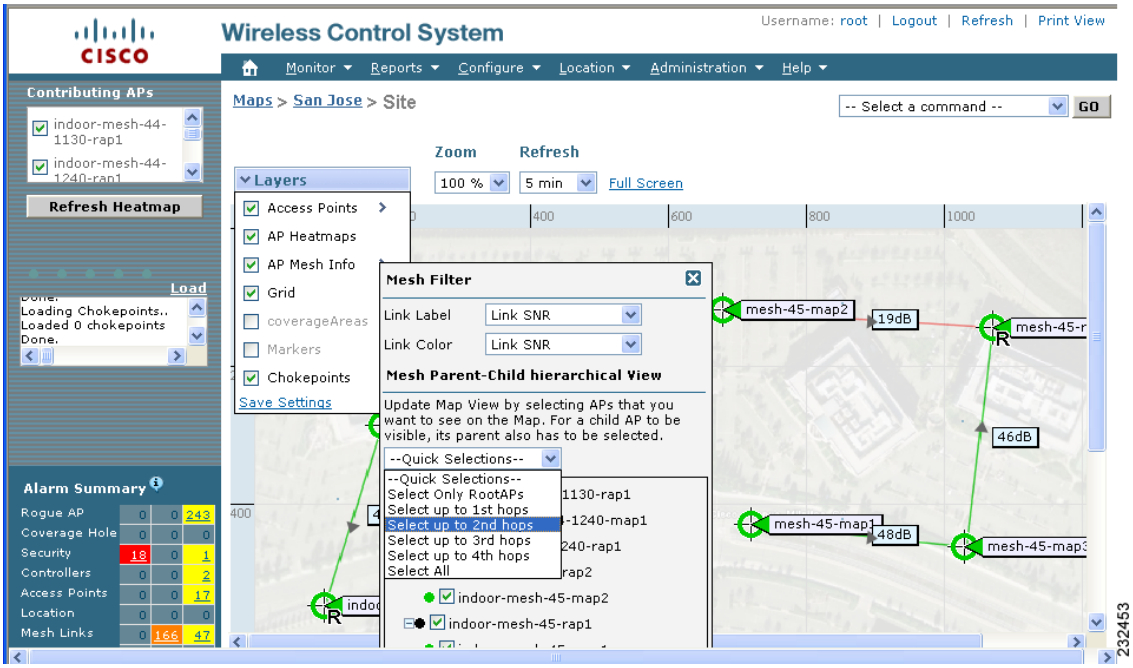
Parameter	Description
Select only Root APs	Choose this setting if you want the map view to display root access points only.
Select up to 1st hops	Choose this setting if you want the map view to display 1st hops only.
Select up to 2nd hops	Choose this setting if you want the map view to display 2nd hops only.
Select up to 3rd hops	Choose this setting if you want the map view to display 3rd hops only.
Select up to 4th hops	Choose this setting if you want the map view to display 4th hops only.
Select All	Select this setting if you want the map view to display all access points.

c. Click **Update Map View** to refresh the screen and redisplay the map view with the selected options.

Note Map view information is retrieved from the WCS database and is updated every 15 minutes.

Note You can also check or uncheck the check boxes of access points in the mesh hierarchical view to modify which mesh access points are displayed. For a child access point to be visible, the parent access point to root access point must be selected.

Figure 6-32 Mesh Filter and Hope Count Configuration Panel



Monitoring Channel Width

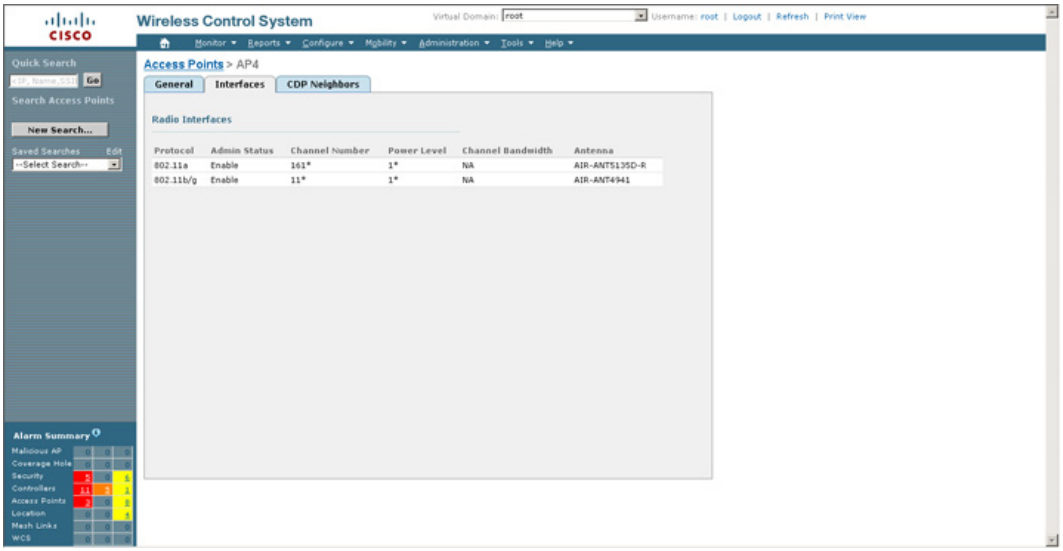
Follow these steps to view the channel width.

Step 1 Choose **Monitor > Access Points**.

Step 2 Click an access point from the AP Name column.

Step 3 Click the **Interfaces** tab. The Interfaces tab as shown in Figure 6-33 appears.

Figure 6-33 Interfaces Tab



Step 4 The Interfaces tab displays the following parameters.

Table 6-24 Interfaces Tab Parameters

Parameter	Description
Protocol	802.11a or 802.11b/g.
Admin Status	Indicates whether the access point is enabled or disabled.
Channel Number	Indicates the channel on which the Cisco Radio is broadcasting.
Power Level	Access Point transmit power level: 1 = Maximum power allowed per Country Code setting, 2 = 50% power, 3 = 25% power, 4 = 6.25 to 12.5% power, and 5 = 0.195 to 6.25% power.
Channel Bandwidth	Indicates the channel width for this radio interface. See "Configuring 40-MHz Channel Bonding" section on page 10-15 for more information on configuring channel bandwidth. **Note** Minimum (default) setting is 20 MHz. Maximum setting is the maximum channel width supported by this radio.
Antenna Name	Identifies the type of antenna.

Viewing Google Earth Maps

Follow these steps to view Google Earth maps. Refer to Chapter 18, "Google Earth Maps," for further information.

Step 1 Log in to WCS.

Step 2 Choose **Monitor > Google Earth Maps**. The Google Earth Maps window displays all folders and the number of access points included within each folder.

Step 3 Click **Launch** for the map you want to view. Google Earth opens in a separate window and displays the location and its access points.

Note To use this feature, you must have Google Earth installed on your computer and configured to auto-launch when data is sent from the server. You can download Google Earth from Google's web site.

To view details for a Google Earth Map folder, follow these steps:

Step 1 From the Google Earth Map window, click the folder name to open the details window for this folder. The Google Earth Details window provide the access point names and MAC or IP addresses.

Note To delete an access point, select the applicable check box and click **Delete**.
To delete the entire folder, select the check box next to **Folder Name** and click **Delete**. Deleting a folder also deletes all subfolders and access points inside the folder.

Step 2 Click **Cancel** to close the details window.

Google Earth Settings

Access point related settings can be defined from the Google Earth Settings window. To configure access point settings for the Google Earth Maps feature, follow these steps:

Step 1 Choose **Monitor > Google Earth Maps**.

Step 2 From the Select a command drop-down menu, choose **Settings**.

Step 3 Click **GO**.

Step 4 Configure the following parameters:

- Refresh Settings—Choose the **Refresh from Network** check box to enable this on-demand refresh. This option is applied only once and then disabled.

Caution Because this refresh occurs directly from the network, the length of time it takes to collect data depends on the number of access points.

- Layers—Layer filters for access points, access point heat maps, and access point mesh information can be selected and saved. Select the check box to activate the applicable layer and click the **>** to open the filter window.

Note These settings apply when Google Earth sends the request for the next refresh.

– Access Points—From the drop-down menu, select to display channels, Tx power level, coverage holes, MAC addresses, names, controller IP, utilization, profiles, or clients.

Note If the access point layer is not checked, no data is returned and an error message is returned to Google Earth as a Placemark without an icon.

– AP Heatmap—From the Protocol drop-down menu, choose **802.11a/n**, **802.11b/g/n**, **802.11a/n & 802.11b/g/n**, or **None**. Choose the cutoff from the RSSI Cutoff drop-down menu (- 60 to - 90 dBm).

Note If both 802.11a/n and 802.11b/g/n protocols are chosen, the heat maps are generated for both and overlaid on top of each other. The order cannot be defined. To prevent this overlay, you must turn off individual overlay in Google Earth or change it in the Google Earth Settings on WCS.

– AP Mesh Info—Choose **Link SNR**, **Packet Error Rate**, or **none** from the Link Label drop-down menu. Choose **Link SNR** or **Packet Error Rate** from the Link Color drop-down menu.

Note When the AP Mesh Info check box is chosen, Mesh Links are also automatically shown.

Step 5 Click **Save** to confirm these changes or **Cancel** to close the window without saving the changes.

Viewing Clients Identified as WGBs

When you click Monitor > WGB, you get a list of all clients identified as a workgroup bridges (see Figure 6-34). WGB clients bridge wireless to wired. Any IOS access point can take on the role of a WGB, acting as a wireless client with a wired client connected to it. The information about this WGB is propogated to the controller and appears as a client in both WCS and WLC.

Figure 6-34 Monitor > WGBs

Clients(detected as WGBs) (Edit View)

This page lists the Clients identified as Work Group Bridge.

User	Vendor	IP Addr	MAC Addr	AP	Controller	Port	Loc Server	802.11 State	Profile Name	SSID	Authenticat
<none>	Cisco	10.32.33.139	00:17:94:5c:05:10	SJC14-42A-AP-C2	10.32.32.9	1	<unknown>	Associated	wgbme	wgbme	Yes
<none>	Cisco	10.32.33.110	00:19:30:f0:39:c6	SJC14-42A-AP-C2	10.32.32.9	1	<unknown>	Associated	wgbme	wgbme	Yes

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Running a Link Test

A link test uses a ping from parent-to-child or child-to-parent to test the link quality. The RF parameters of the ping reply packets received by the access point are polled by the controller to find the link quality. Because radio link quality can differ depending on the direction (client to access point versus access point to client), it is critical to have Cisco Compatible Extensions linktest support so that link quality is tested in both directions. It polls the controller every so many seconds until the row status indicates success or failure. During the link test, the table is populated. If the link test fails, the controller reverts to a ping test.

You can access the link test in one of two ways. The first option is described below.

Step 1 Choose **Monitor > Clients**.

Step 2 From the left sidebar menu, choose **All Clients** in the Search for Clients By drop-down menu.

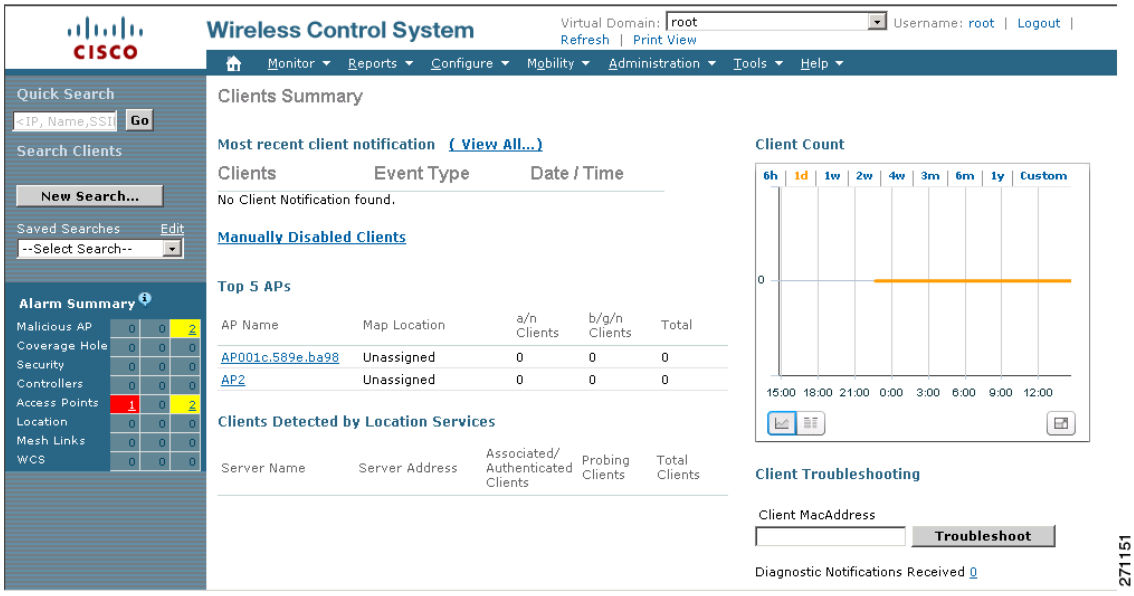
Step 3 In the Client States drop-down menu, choose **All States**. The client list page appears.

Step 4 Click the **Link Test** link in the last column. The link test begins. Figure 6-36 shows a sample link test result. The results show on the same page if the client is associated. Unsuccessful link tests show a failure message.

Another method for accessing the link test is as follows:

Step 1 Choose **Monitor > Clients**. The Clients Summary window appears (see Figure 6-35).

Figure 6-35 Clients Summary



Step 2 Click the URL under the Total Clients column of the Clients Detected by Location Servers portion of the window.

Step 3 Click a link in the User column to advance to the detail page.

Step 4 From the Select a command drop-down menu, choose **Link Test**.

Figure 6-36 shows a sample Cisco Compatible Extensions link test result and Figure 6-37 shows a sample ping test result.

Figure 6-36 Cisco Compatible Extensions Link Test Result

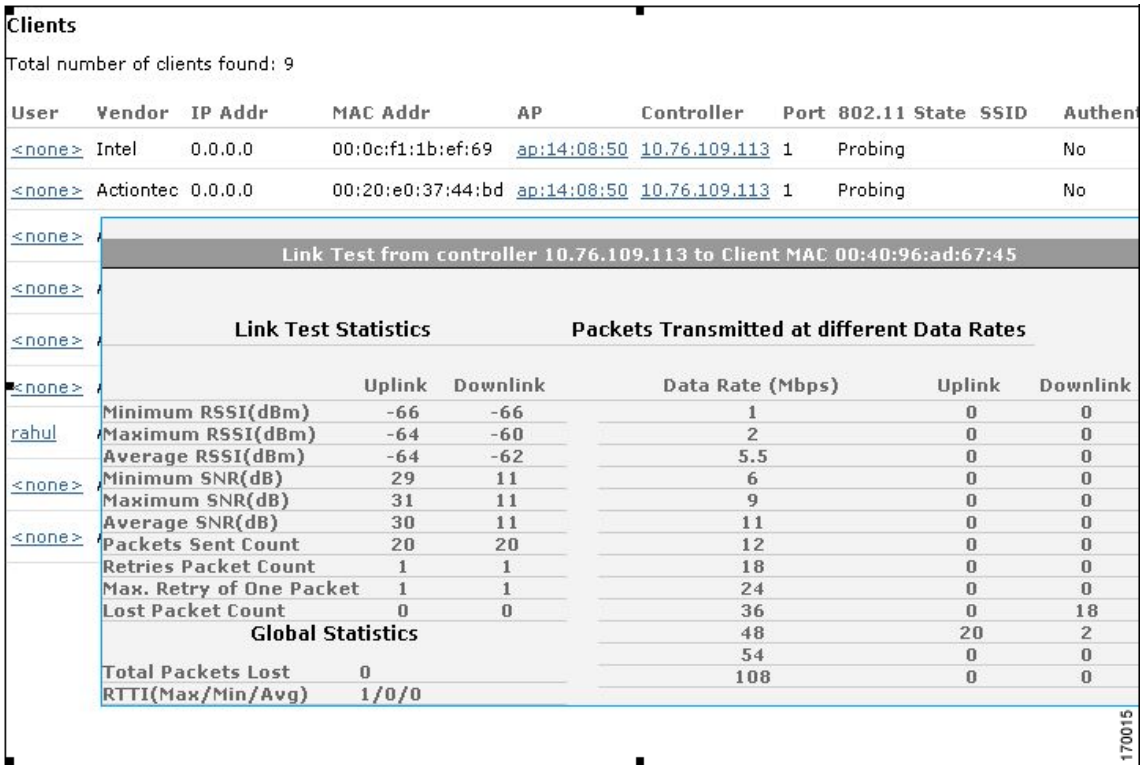
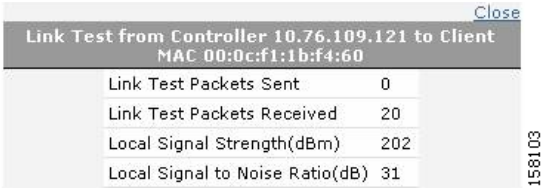


Figure 6-37 Ping Test Result



Retrieving the Unique Device Identifier on Controllers and Access Points

The unique device identifier (UDI) standard uniquely identifies products across all Cisco hardware product families, enabling customers to identify and track Cisco products throughout their business and network operations and to automate their asset management systems. The standard is consistent across all electronic, physical, and standard business communications. The UDI consists of five data elements:

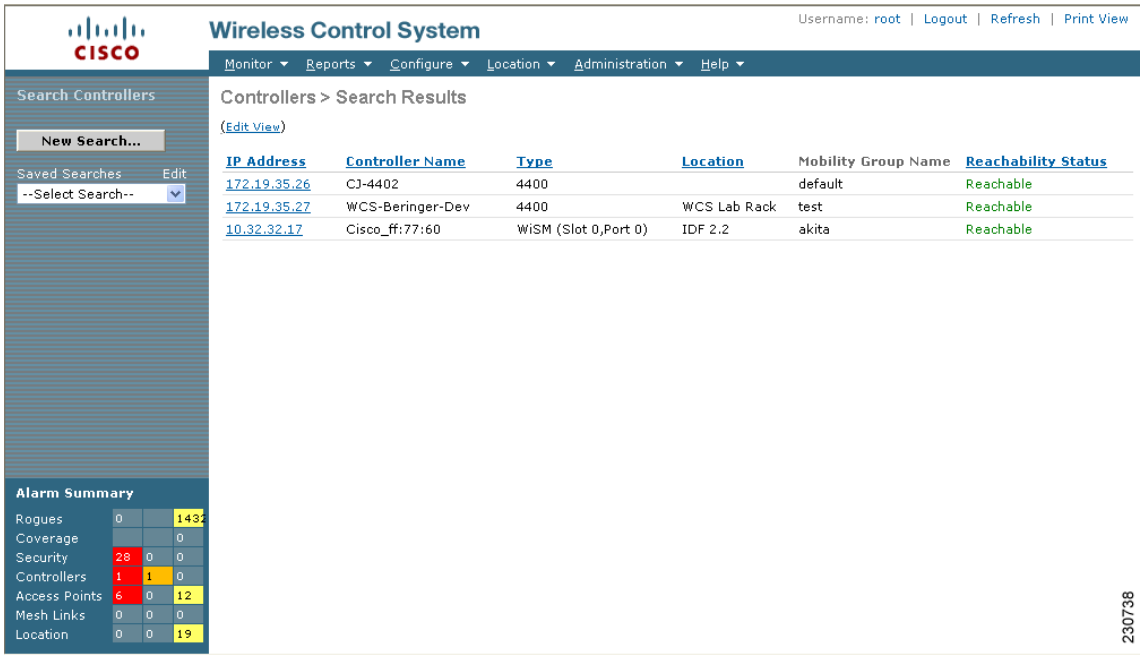
- The orderable product identifier (PID)
- The version of the product identifier (VID)
- The serial number (SN)
- The entity name
- The product description

The UDI is burned into the EEPROM of controllers and lightweight access points at the factory and can be retrieved through the GUI.

Follow these steps to retrieve the UDI on controllers and access points.

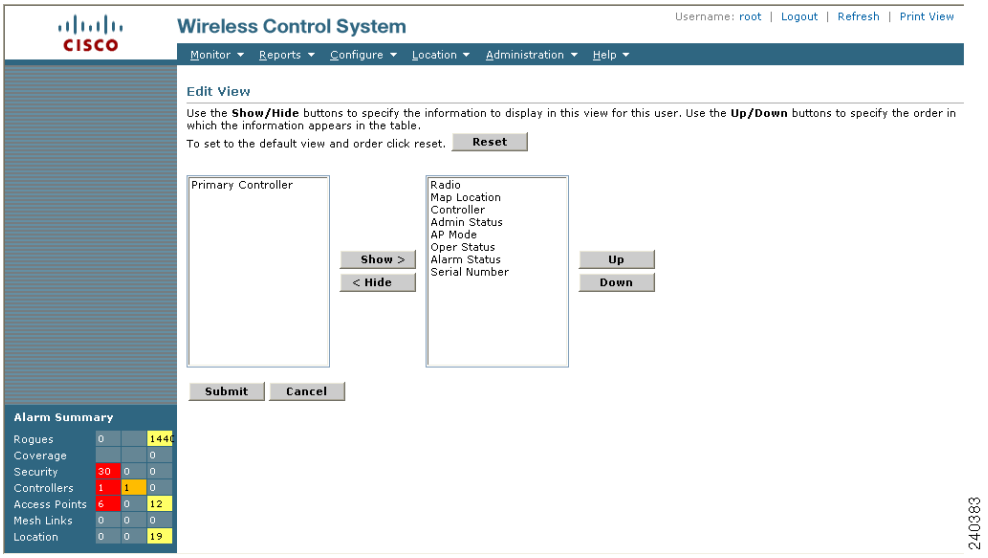
Step 1 Click **Monitor > Controllers**. The Controller > Search Results window displays (see Figure 6-38).

Figure 6-38 Controllers > Search Results



Step 2 (optional) If you want to change how the controller search results are displayed, click **Edit View**. The Edit View window appears (see Figure 6-39). In the left-hand window, highlight the areas you want to view and click **Show** to move them to the right-hand window. You can then highlight the areas in the right-hand menu and click **Up** or **Down** to rearrange the order.

Figure 6-39 Edit View Window



Step 3 Click the IP address of the controller (seen in Figure 6-38) whose UDI information you want to retrieve. Data elements of the controller UDI display. These elements are described in Table 6-25 and Table 6-26:

Table 6-25 Controllers Summary

Parameter	Description
General Portion	
IP Address	Local network IP address of the controller management interface.
Name	User-defined name of the controller.
Type	The type of controller. **Note** For WiSM, the slot and port numbers are also given.
UP Time	Time in days, hours, and minutes since the last reboot.
System Time	Time used by the controller.
Internal Temperature	The current internal temperature of the unit (in Centigrade).
Location	User-defined physical location of the controller.
Contact	The contact person for this controller, their textual identification, and ways to contact them. If no contact information is known, this is an empty string.
Total Client Count	Total number of clients currently associated with the controller.
Current LWAPP Transport Mode	Lightweight Access Point Protocol transport mode. Communications between controllers and access points. Selections are Layer 2 or Layer 3.
Power Supply One	Indicates the presence or absence of a power supply and its operations state.

Table 6-25 Controllers Summary (continued)

Power Supply Two	Indicates the presence or absence of a power supply and its operation state.
Inventory Portion	
Software Version	The operating system release, version.dot.maintenance number of the code currently running on the controller.
Description	Description of the inventory item.
Model No.	Specifies the machine model as defined by the Vital Product Data.
Serial No.	Unique serial number for this controller.
Burned-in MAC Address	The burned-in MAC address for this controller.
Number of APs supported	The maximum number of access points supported by the controller.
GigE Card Present	Displays the presence or absence of the optional 1000BASE-T/1000BASE-SX GigE card.
Crypto Card One	Displays the presence or absence of an enhanced security module which enables IPSec security and provides enhanced processing power. See Table 6-26 for information on the maximum number of crypto cards that can be installed on a controller. **Note** By default, enhanced security module is not installed on a controller.
Crypto Card Two	Displays the presence or absence of a second enhanced security module.
GIGE Port(s) Status	
Port 1	Up or Down
Port 2	Up or Down
Unique Device Identifier (UDI)	
Name	Product type. Chassis for controller and Cisco AP for access points.
Description	Description of controller and may include number of access points.
Product Id	Orderable product identifier.
Version Id	Version of product identifier.
Serial Number	Unique product serial number.

Table 6-26 Maximum Number of Crypto Cards That Can Be Installed on a Cisco Wireless LAN Controller

Type of Controller	Maximum Number of Crypto Cards
Cisco 2000 Series	None

Table 6-26 Maximum Number of Crypto Cards That Can Be Installed on a Cisco Wireless LAN Controller

Type of Controller	Maximum Number of Crypto Cards
Cisco 4100 Series	One
Cisco 4400 Series	Two

Coverage Hole

Coverage holes are areas where clients cannot receive a signal from the wireless network. The Cisco Unified Wireless Network Solution radio resource management (RRM) identifies these coverage hole areas and reports them to the WCS, enabling the IT manager to fill holes based on user demand.

WCS is informed about the reliability-detected coverage holes by the controllers. WCS alerts the user about these coverage holes. For more information on finding coverage holes, refer to the "Finding Coverage Holes" section on page 5-9.

Note Coverage holes are displayed as alarms. Pre-coverage holes are displayed as events.

Monitoring Pre-Coverage Holes

While coverage holes are displayed as alarms, pre-coverage holes are displayed as events.

Follow these steps to view pre-coverage hole events.

Step 1 Choose **Monitor > Events** to display all current events.

Step 2 To view pre-coverage hole events only, choose **Pre-coverage Hole** from the Event Category drop-down menu on the left sidebar and click **Search**.

The Pre-Coverage Hole Events window provides the information described in the following table:

Table 6-27 Pre-Coverage Hole Parameters

Parameter	Description
Severity	Pre-coverage hole events are always considered informational (Info).
Client MAC Address	MAC address of the client affected by the pre-coverage hole.
AP MAC Address	MAC address of the applicable access point.
AP Name	The name of the applicable access point.
Radio Type	The radio type (802.11b/g or 802.11a) of the applicable access point.
Power Level	Access point transmit power level: 1 = Maximum power allowed per country code setting, 2 = 50% power, 3 = 25% power, 4 = 6.25 to 12.5% power, and 5 = 0.195 to 6.25% power.

Table 6-27 Pre-Coverage Hole Parameters (continued)

Parameter	Description
Client Type	Client type can be any of the following: laptop(0) pc(1) pda(2) dot11mobilephone(3) dualmodephone(4) wgb(5) scanner(6) tabletpc(7) printer(8) projector(9) videoconfsystem(10) camera(11) gamingsystem(12) dot11deskphone(13) cashregister(14) radiotag(15) rfidsensor(16) server(17)
Date/Time	The date and time the event occurred. Click the title to toggle between ascending and descending order.

Step 3 Choose a Client MAC Address to view pre-coverage hole details

- General—Provides the following information:
  - Client MAC Address
  - AP MAC Address
  - AP Name
  - Radio Type
  - Power Level
  - Client Type
  - Category
  - Created
  - Generated By
  - Device AP Address
  - Severity

- Neighbor AP's—Indicates the MAC addresses of nearby access points, their RSSI values, and their radio types.
- Message—Describes what device reported the pre-coverage hole and on which controller it was detected.
- Help—Provides additional information, if available, for handling the event.

Viewing DHCP Statistics

WCS provides DHCP server statistics for version 5.0.6.0 controllers or later. These statistics include information on the packets sent and received, DHCP server response information, and last request timestamp.

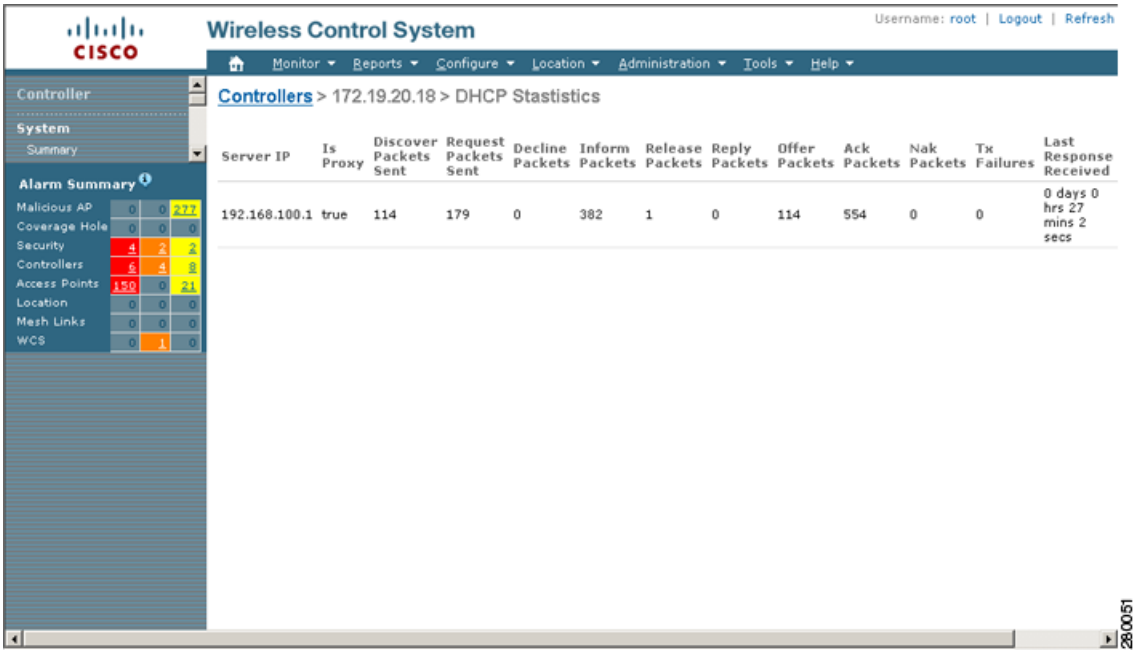
Follow these steps to view DHCP statistics.

Step 1 Choose **Monitor > Controllers**.

Step 2 Click one of the IP addresses in the IP Address column.

Step 3 From the left sidebar menu, choose **System > DHCP Statistics**. The DHCP Statistics window appears (see Figure 6-40).

Figure 6-40 DHCP Statistics Window



The DHCP Statistics screen provides the following information:

Table 6-28 DHCP Statistics

Parameter	Description
Server IP	Identifies the IP address of the server.
Is Proxy	Identifies whether or not this server is proxy.
Discover Packets Sent	Identifies the total number of packets sent with the intent to locate available servers.
Request Packets Sent	Identifies the total number of packets sent from the client requesting parameters from the server or confirming the correctness of an address.
Decline Packets	Identifies the number of packets indicating that the network address is already in use.
Inform Packets	Identifies the number of client requests to the DHCP server for local configuration parameters because the client already has an externally configured network address.
Release Packets	Identifies the number of packets that release the network address and cancel the remaining lease.
Reply Packets	Identifies the number of reply packets.
Offer Packets	Identifies the number of packets that respond to the discover packets with an offer of configuration parameters.
Ack Packets	Identifies the number of packets that acknowledge successful transmission.
Nak Packets	Identifies the number of packets that indicate that the transmission occurred with errors.
Tx Failures	Identifies the number of transfer failures that occurred.
Last Response Received	Provides a timestamp of the last response received.
Last Request Sent	Provides a timestamp of the last request sent.

RRM Dashboard

RRM automatically detects and configures new controllers 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 presences of voice traffic (in the last 100 ms), the access points defer off-channel measurements and do not change channels.

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. In this way, administrators gain the perspective of every access point, thereby increasing network visibility.

Prior to WCS software release 5.1, WCS would receive traps whenever a change in the transmit power of the access point or channel occurred. These trap events or similar events such as RF regrouping were logged into WCS events as informational and were maintained by the event dispatcher. The reason for the transmit power or channel changes (such as signals from neighboring access points, interference, noise, load balancing, and so on) were not evident. You could not view these events and statistics to then perform troubleshooting practices.

WCS software release 5.1 introduces a snapshot of the Radio Resource Management (RRM) statistics. It helps to identify trouble spots and provides possible reasons for channel or power level changes. The dashboard provides network-wide RRM performance statistics and predicts reasons for channel changes based on grouping the events together (access point performance, configuration mismatch between controllers in the same RF group, coverage holes that were detected by access points based on threshold, coverage holes that were detected by controllers, ratios of access points operating at maximum power, and so on).

Note The RRM dashboard information is only available for LWAPP access points.

Channel Change Notifications

Two adjacent access points on the same channel can cause either signal contention or signal collision. In the case of a collision, data is simply not received by the access point. This functionality can become a problem, for example, when someone reading e-mail in a cafe affects the performance of the access point in a neighboring business. Even though these are completely separate networks, someone sending traffic to the cafe on channel 1 can disrupt communication in an enterprise using the same channel. Controllers address this problem by dynamically allocating 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 difference access point far from the cafe, 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, thereby avoiding this problem.

Notifications are sent to the WCS RRM dashboard when a channel change occurs. Channel changes depend on the dynamic channel assignment (DCA) configuration where the mode can be set to auto or on demand. When the mode is *auto*, channel assignment is periodically updated for all LWAPP access points which permit this operation. When the mode is set to *on demand*, channel assignments are updated based upon request. If the DCA is static, no dynamic channel assignments occur, and values are set to their global default.

In WCS software releases prior to 5.1, only radios using 20-MHz channelization are supported by DCA. In WCS software release 5.1, DCA is extended to support 802.11n 40-MHz channels in the 5-GHz band. 40-MHz channelization allows radios to achieve higher instantaneous data rates (potentially 2.25 times higher than 20-MHz channels.) In WCS software release 5.1, you can choose between DCA working at 20 or 40 MHz.

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

When a channel change trap is received and a channel change had occurred earlier, the event is marked as Channel Revised; otherwise, the event is marked as Channel Changed. Each event for channel change can be caused by multiple reasons. The reason code is factored and equated to one irrespective of the number of reasons for the event to occur. For example, suppose a channel change is caused by signal, interference, or noise. When the reason code is received in the notification, the reason code is refactored across the reasons. If three reasons caused the event to occur, the reason code is refactored to 1/3 or 0.33 per reason. If ten channel change events are received with the same reason code, all of the three reasons are equally factored to determine the cause of the channel change.

Transmission Power Change Notifications

The controller dynamically controls access point transmit power based on real0time wireless LAN conditions. Normally, power can be kept low to gain extra capacity and reduce interference. The controller attempts to balance the access points' transmit power according to how the access points are seen by their third strongest neighbor.

The transmit power control algorithm only reduces an access point's power. However, the coverage hole algorithm can increase access point power, thereby filling a coverage hole. For example, if a failed access point is detected, the coverage hole algorithm can automatically increase power on surrounding access points to fill the gap created by the loss in coverage.

Notifications are sent to the WCS RRM dashboard when transmission power changes occur. Each event for transmit power changes is caused by multiple reasons. The reason code is factored and equated to one irrespective of the number of reasons for the event to occur.

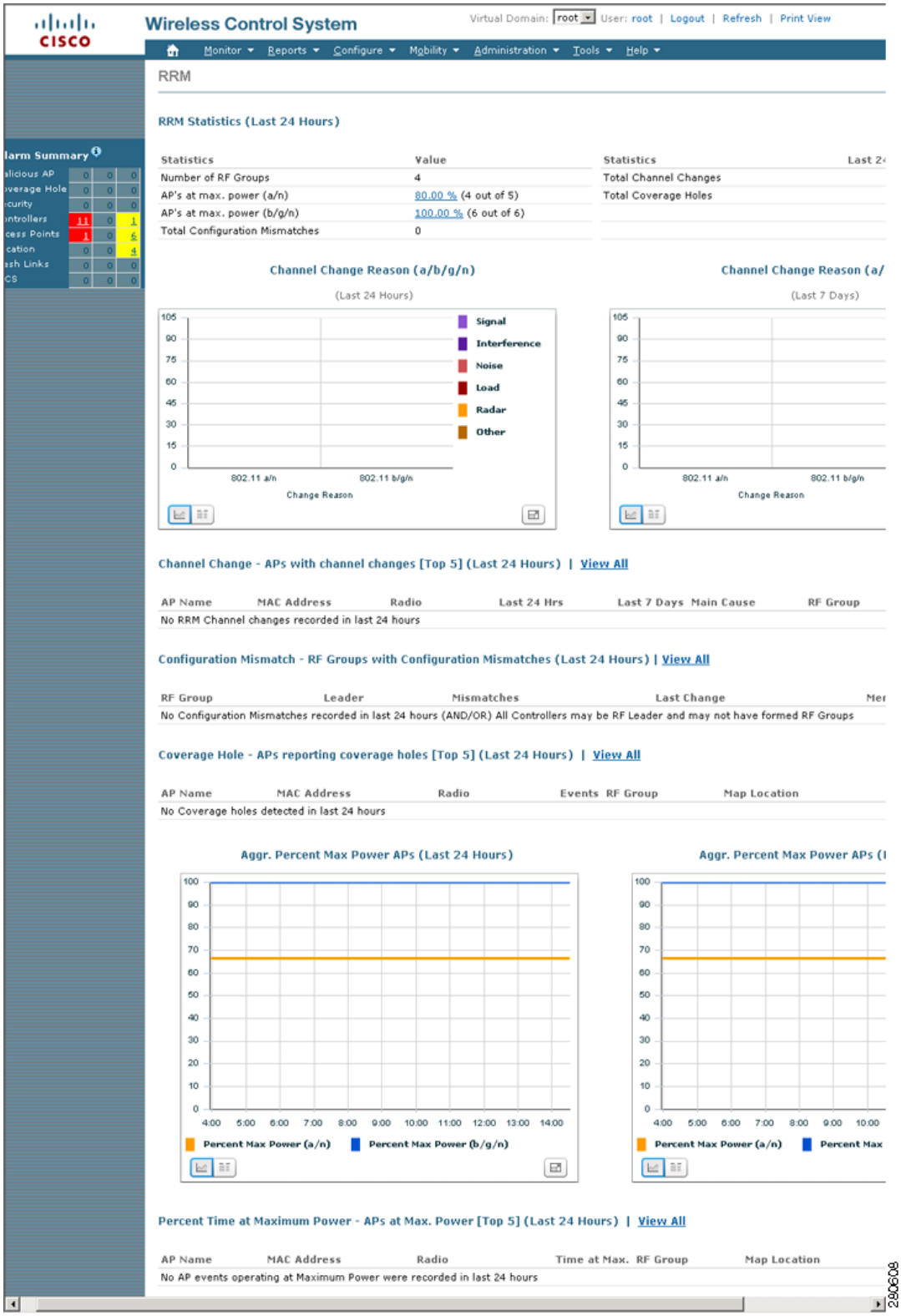
RF Grouping Notifications

When RRM is run on the controller, dynamic grouping is done, and a new group leader is chosen. Dynamic grouping has two modes: on and off. When the grouping is off, no dynamic grouping occurs, and each switch optimizes only its own LWAPP access point parameters. When the grouping is on, switches form groups and elect leaders to perform better dynamic parameter optimization. With grouping on, configured intervals (in seconds) represent the period with which the grouping algorithm is run. (Grouping algorithms also run when the group contents change and automatic grouping is enabled.)

Viewing the RRM Dashboard

The RRM dashboard is accessed by choosing Monitor > RRM (see Figure 6-41).

Figure 6-41 RRM Statistics Dashboard



The dashboard is made up of the following parts:

- The RRM Statistics portion shows network-wide statistics
- The Channel Change Reason portion shows why channels changed for all 802.11a/b/g/n radios.
- The Channel Change shows all events complete with causes.
- The Configuration Mismatch portion shows comparisons between the leaders and members.
- The Coverage Hole portion rates how severe the coverage holes are and gives their location.
- The Percent Time at Maximum Power shows what percent of time the access points were at maximum power and gives the location of those access points.

The following statistics are displayed:

- Total Channel Changes—The sum total of channel changes across 802.11a/b/g/n radios, irrespective of whether the channel was updated or revised. The count is split over a 24-hour and 7-day period. If you click the percentages link or the link under the 24-hour column, a screen with details for that access point only appears.
- Total Configuration Mismatches—The total number of configuration mismatches detected over a 24-hour.
- Total Coverage Hole Events—The total number of coverage hole events over a 24-hour and 7-day period.
- Number of RF Groups—The total number of RF groups currently managed by WCS.
- Configuration Mismatch—The configuration mismatch over a 24-hour period by RF group with details on the group leader.
- Percent of APs at MAX Power—The percentage of access points with 802.11a/n radios as a total percentage across all access points which are at maximum power. The maximum power levels are preset and are derived with reference to the present maximum power of the access point.

Note Maximum power is shown in three areas of the RRM dashboard. This maximum power portion shows the current value and is poll driven.

- Channel Change Causes—A graphical bar chart for 802.11a/n radios. The chart is factored based on the reason for channel change. The chart is divided into two parts, each depicting the percentage of weighted reasons causing the event to occur over a 24-hour and 7-day period. Each event for channel change can be caused by multiple reasons, and the weight is equally divided across these reasons. The net reason code is factored and equated to one irrespective of the number of reasons for the event to occur.
- Channel Change APs—Each event for channel change includes the MAC address of the LWAPP access point. For each reason code, you are given the most channel changes that occurred for the 802.11a/n access point based on the weighted reason for channel events. This count is split over a 24-hour and 7-day period.
- Coverage Hole Events APs—The top five access points filtered by IF Type 11 a/n which triggered a coverage hole event are displayed.
- Aggregated Percent Max Power APs—A graphical progressive chart of the total percentage of 802.11a/n LWAPP access points which are operating at maximum power to accommodate coverage holes and events. The count is split over a 24-hour and 7-day period.

Note This maximum power portion shows the values from the last 24 hours and is poll driven. The power is polled every 15 minutes or as configured for radio performance.

- Percent Time at Maximum Power—A list of the top five 802.11a/n LWAPP access points which have been operating at maximum power.

Note This maximum power portion shows the value from the last 24 hours and is only event driven.