Cisco Wireless LAN Controller Configuration Guide

Software Release 4.0
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Preface

This preface provides an overview of the *Cisco Wireless LAN Controller Configuration Guide*, *Release 4.0*, references related publications, and explains how to obtain other documentation and technical assistance, if necessary. It contains these sections:

Audience

This guide describes Cisco Wireless LAN Controllers and Cisco Lightweight Access Points. This guide is for the networking professional who installs and manages these devices. To use this guide, you should be familiar with the concepts and terminology of wireless LANs.

Purpose

This guide provides the information you need to set up and configure wireless LAN controllers.

Note This version of the *Cisco Wireless LAN Controller Configuration Guide* pertains specifically to controller software release 4.0. If you are using an earlier version of software, you will notice differences in features, functionality, and GUI pages.

Organization

This guide is organized into these chapters:

Chapter 1, "Overview," provides an overview of the network roles and features of wireless LAN controllers.

Chapter 2, "Using the Web-Browser and CLI Interfaces," describes how to use the controller GUI and CLI.

Chapter 3, "Configuring Ports and Interfaces," describes the controller's physical ports and interfaces and provides instructions for configuring them.

Chapter 4, "Configuring Controller SettingsWireless Device Access," describes how to configure settings on the controllers.

Chapter 5, "Configuring Security Solutions," describes application-specific solutions for wireless LANs.

Chapter 6, "Configuring WLANsWireless Device Access," describes how to configure wireless LANs and SSIDs on your system.

Chapter 7, "Controlling Lightweight Access Points," explains how to connect access points to the controller and manage access point settings.

Chapter 8, "Managing Controller Software and Configurations," describes how to upgrade and manage controller software and configurations.

Chapter 9, "Managing User Accounts," explains how to create and manage guest user accounts, describes the web authentication process, and provides instructions for customizing the web authentication login window.

Chapter 10, "Configuring Radio Resource ManagementWireless Device Access," describes radio resource management (RRM) and explains how to configure it on the controllers.

Chapter 11, "Configuring Mobility GroupsWireless Device Access," describes mobility groups and explains how to configure them on the controllers.

Chapter 12, "Configuring Hybrid REAPWireless Device Access," describes hybrid REAP and explains how to configure this feature on controllers and access points.

Appendix A, "Safety Considerations and Translated Safety Warnings," lists safety considerations and translations of the safety warnings that apply to the Cisco Unified Wireless Network Solution products.

Appendix B, "Declarations of Conformity and Regulatory Information," provides declarations of conformity and regulatory information for the products in the Cisco Unified Wireless Network Solution.

Appendix C, "End User License and Warranty," describes the end user license and warranty that apply to the Cisco Unified Wireless Network Solution products.

Appendix D, "System Messages and LED Patterns," lists system messages that can appear on the Cisco Unified Wireless Network Solution interfaces and describes the LED patterns on controllers and lightweight access points.

Appendix E, "Logical Connectivity Diagrams,"provides logical connectivity diagrams and related software commands for controllers that are integrated into other Cisco products.

Conventions

This publication uses these conventions to convey instructions and information:

Command descriptions use these conventions:

- Commands and keywords are in boldface text.
- Arguments for which you supply values are in italic.
- Square brackets ([ ]) mean optional elements.
- Braces ({ }) group required choices, and vertical bars (|) separate the alternative elements.
- Braces and vertical bars within square brackets ([{ | }]) mean a required choice within an optional element.

Interactive examples use these conventions:

- Terminal sessions and system displays are in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters, such as passwords or tabs, are in angle brackets (< >).

Notes, cautions, and timesavers use these conventions and symbols:

Note Means reader take note. Notes contain helpful suggestions or references to materials not contained in this manual.

Caution Means reader be careful. In this situation, you might do something that could result equipment damage or loss of data.

Warning This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. (To see translations of the warnings that appear in this publication, refer to the appendix "Translated Safety Warnings.")

Waarschuwing Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van standaard maatregelen om ongelukken te voorkomen. (Voor vertalingen van de waarschuwingen die in deze publicatie verschijnen, kunt u het aanhangsel "Translated Safety Warnings" (Vertalingen van veiligheidsvoorschriften) raadplegen.)

Varoitus Tämä varoitusmerkki merkitsee vaaraa. Olet tilanteessa, joka voi johtaa ruumiinvammaan. Ennen kuin työskentelet minkään laitteiston parissa, ota selvää sähkökytkentöihin liittyvistä vaaroista ja tavanomaisista onnettomuuksien ehkäisykeinoista. (Tässä julkaisussa esiintyvien varoitusten käännökset löydät liitteestä "Translated Safety Warnings" (käännetyt turvallisuutta koskevat varoitukset).)

Attention Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant entraîner des blessures. Avant d'accéder à cet équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures courantes de prévention des accidents. Pour obtenir les traductions des mises en garde figurant dans cette publication, veuillez consulter l'annexe intitulée « Translated Safety Warnings » (Traduction des avis de sécurité).

Warnung Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an irgendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt. (Übersetzungen der in dieser Veröffentlichung enthaltenen Warnhinweise finden Sie im Anhang mit dem Titel "Translated Safety Warnings" (Übersetzung der Warnhinweise).)

Avvertenza Questo simbolo di avvertenza indica un pericolo. Si è in una situazione che può causare infortuni. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti. La traduzione delle avvertenze riportate in questa pubblicazione si trova nell'appendice, "Translated Safety Warnings" (Traduzione delle avvertenze di sicurezza).

Advarsel Dette varselsymbolet betyr fare. Du befinner deg i en situasjon som kan føre til personskade. Før du utfører arbeid på utstyr, må du være oppmerksom på de faremomentene som elektriske kretser innebærer, samt gjøre deg kjent med vanlig praksis når det gjelder å unngå ulykker. (Hvis du vil se oversettelser av de advarslene som finnes i denne publikasjonen, kan du se i vedlegget "Translated Safety Warnings" [Oversatte sikkerhetsadvarsler].)

Aviso Este símbolo de aviso indica perigo. Encontra-se numa situação que lhe poderá causar danos fisicos. Antes de começar a trabalhar com qualquer equipamento, familiarize-se com os perigos relacionados com circuitos eléctricos, e com quaisquer práticas comuns que possam prevenir possíveis acidentes. (Para ver as traduções dos avisos que constam desta publicação, consulte o apêndice "Translated Safety Warnings" - "Traduções dos Avisos de Segurança").

¡Advertencia! **Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes. (Para ver traducciones de las advertencias que aparecen en esta publicación, consultar el apéndice titulado "Translated Safety Warnings.")**

Varning! **Denna varningssymbol signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanligt förfarande för att förebygga skador. (Se förklaringar av de varningar som förekommer i denna publikation i appendix "Translated Safety Warnings" [Översatta säkerhetsvarningar].)**

Related Publications

These documents provide complete information about the Cisco Unified Wireless Network Solution:

- *Quick Start Guide*: *Cisco 2000 Series Wireless LAN Controllers*
- *Quick Start Guide*: *Cisco 4400 Series Wireless LAN Controllers*
- *Cisco Wireless LAN Controller Command Reference*
- *Cisco Wireless Control System Configuration Guide*
- *Quick Start Guide: Cisco Wireless Control System for Microsoft Windows*
- *Quick Start Guide: Cisco Wireless Control System for Linux*
- Quick start guide and hardware installation guide for your specific lightweight access point

Click this link to browse to the Cisco Support and Documentation page:

http://www.cisco.com/cisco/web/support/index.html

- Cisco 1800 Series Routers Hardware Installation Guide
- Cisco AP HWIC Wireless Configuration Guide
- Cisco Router and Security Device Manager (SDM) Quick Start Guide
- Cisco Aironet 2.4-GHz Articulated Dipole Antenna (AIR-ANT4941)
- Cisco Aironet High Gain Omnidirectional Ceiling Mount Antenna (AIR-ANT1728)
- Mounting Instructions for the Cisco Aironet 6.5 dBi Diversity Patch Wall Mount Antenna
- Cisco Aironet 2 dBi Diversity Omnidirectional Ceiling Mount Antenna (AIR-ANT5959)
- Cisco Multiband 2.4/5GHz Articulated Dipole Antenna (AIR-ANT1841)
- Cisco Multiband 2.4/5G Diversity Omnidirectional Ceiling Mount Antenna (AIR-ANT1828)
- Cisco Multiband 2.4/5G Patch Wall Mount Antenna (AIR-ANT1859)
- Mounting Instructions for the Cisco Diversity Omnidirectional Ceiling Mount Antenna
- Mounting Instructions for the Cisco Patch Wall Mount Antenna

Related documents from the Cisco TAC Web pages include:

- Antenna Cabling

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS Version 2.0.

Overview

This chapter describes the controller components and features. Its contains these sections:

Cisco Unified Wireless Network Solution Overview

The Cisco Unified Wireless Network (Cisco UWN) Solution is designed to provide 802.11 wireless networking solutions for enterprises and service providers. The Cisco UWN Solution simplifies deploying and managing large-scale wireless LANs and enables a unique best-in-class security infrastructure. The operating system manages all data client, communications, and system administration functions, performs radio resource management (RRM) functions, manages system-wide mobility policies using the operating system security solution, and coordinates all security functions using the operating system security framework.

The Cisco UWN Solution consists of Cisco Wireless LAN Controllers and their associated lightweight access points controlled by the operating system, all concurrently managed by any or all of the operating system user interfaces:

- An HTTP and/or HTTPS full-featured Web User Interface hosted by Cisco Wireless LAN Controllers can be used to configure and monitor individual controllers. See Chapter 2.
- A full-featured command-line interface (CLI) can be used to configure and monitor individual Cisco Wireless LAN Controllers. See Chapter 2.
- The Cisco Wireless Control System (WCS), which you use to configure and monitor one or more Cisco Wireless LAN Controllers and associated access points. WCS has tools to facilitate large-system monitoring and control. WCS runs on Windows 2000, Windows 2003, and Red Hat Enterprise Linux ES servers.

  Note WCS software release 4.0 must be used with controllers running controller software release 4.0. Do not attempt to use older versions of WCS software with controllers running controller software release 4.0.

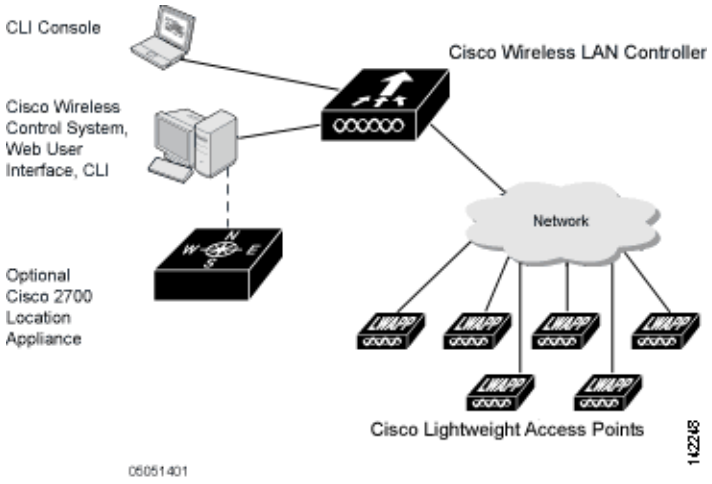
- An industry-standard SNMP V1, V2c, and V3 interface can be used with any SNMP-compliant third-party network management system.

The Cisco UWN Solution supports client data services, client monitoring and control, and all rogue access point detection, monitoring, and containment functions. It uses lightweight access points, Cisco Wireless LAN Controllers, and the optional Cisco WCS to provide wireless services to enterprises and service providers.

Note Unless otherwise noted, all of the Cisco wireless LAN controllers are hereafter referred to as *controllers*, and all of the Cisco lightweight access points are hereafter referred to as *access points.*

Figure 1-1 shows the Cisco Wireless LAN Solution components, which can be simultaneously deployed across multiple floors and buildings.

Figure 1-1 Cisco UWN Solution Components



Single-Controller Deployments

A standalone controller can support lightweight access points across multiple floors and buildings simultaneously, and supports the following features:

- Autodetecting and autoconfiguring lightweight access points as they are added to the network.
- Full control of lightweight access points.
- Full control of up to 16 wireless LAN (SSID) policies for Cisco 1000 series access points.

  Note LWAPP-enabled access points support up to 8 wireless LAN (SSID) policies.

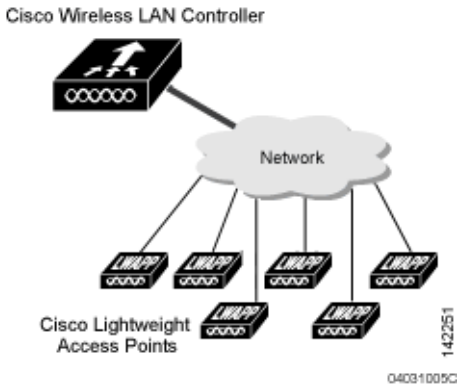
- Lightweight access points connect to controllers through the network. The network equipment may or may not provide Power over Ethernet to the access points.

Note that some controllers use redundant Gigabit Ethernet connections to bypass single network failures.

Note Some controllers can connect through multiple physical ports to multiple subnets in the network. This feature can be helpful when operators want to confine multiple VLANs to separate subnets.

Figure 1-2 shows a typical single-controller deployment.

Figure 1-2 Single-Controller Deployment



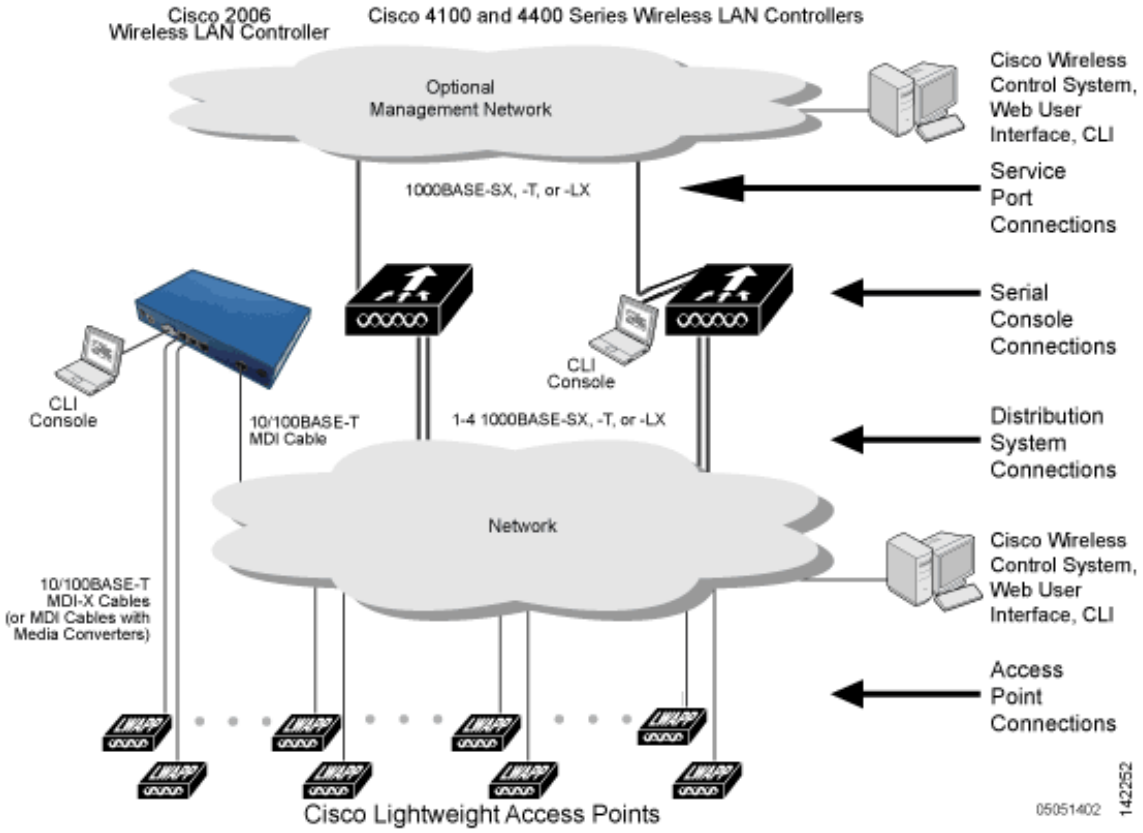
Multiple-Controller Deployments

Each controller can support lightweight access points across multiple floors and buildings simultaneously. However, full functionality of the Cisco Wireless LAN Solution is realized when it includes multiple controllers. A multiple-controller system has the following additional features:

- Autodetecting and autoconfiguring RF parameters as the controllers are added to the network.
- Same-Subnet (Layer 2) Roaming and Inter-Subnet (Layer 3) Roaming.
- Automatic access point failover to any redundant controller with a reduced access point load (refer to the "Cisco Wireless LAN Controller Failover Protection" section on page 1-16).

Figure 1-3 shows a typical multiple-controller deployment. The figure also shows an optional dedicated Management Network and the three physical connection types between the network and the controllers.

Figure 1-3 Typical Multi-Controller Deployment



Operating System Software

The operating system software controls Cisco Wireless LAN Controllers and Cisco 1000 Series Lightweight Access Points. It includes full operating system security and Radio Resource Management (RRM) features.

Operating System Security

Operating system security bundles Layer 1, Layer 2, and Layer 3 security components into a simple, Cisco WLAN Solution-wide policy manager that creates independent security policies for each of up to 16 wireless LANs. (Refer to the "Cisco UWN Solution WLANs" section on page 1-12.)

The 802.11 Static WEP weaknesses can be overcome using robust industry-standard security solutions, such as:

- 802.1X dynamic keys with extensible authentication protocol (EAP).
- Wi-Fi protected access (WPA) dynamic keys. The Cisco WLAN Solution WPA implementation includes:
  - Temporal key integrity protocol (TKIP) + message integrity code checksum (Michael) dynamic keys, or
  - WEP keys, with or without Pre-Shared key Passphrase.
- RSN with or without Pre-Shared key.
- Cranite FIPS140-2 compliant passthrough.
- Fortress FIPS140-2 compliant passthrough.
- Optional MAC Filtering.

The WEP problem can be further solved using industry-standard Layer 3 security solutions, such as:

- Passthrough VPNs
- The Cisco Wireless LAN Solution supports local and RADIUS MAC Address filtering.
- The Cisco Wireless LAN Solution supports local and RADIUS user/password authentication.
- The Cisco Wireless LAN Solution also uses manual and automated Disabling to block access to network services. In manual Disabling, the operator blocks access using client MAC addresses. In automated Disabling, which is always active, the operating system software automatically blocks access to network services for an operator-defined period of time when a client fails to authenticate for a fixed number of consecutive attempts. This can be used to deter brute-force login attacks.

These and other security features use industry-standard authorization and authentication methods to ensure the highest possible security for your business-critical wireless LAN traffic.

Cisco WLAN Solution Wired Security

Many traditional access point vendors concentrate on security for the Wireless interface similar to that described in the "Operating System Security" section on page 1-6. However, for secure Cisco Wireless LAN Controller Service Interfaces, Cisco Wireless LAN Controller to access point, and inter-Cisco Wireless LAN Controller communications during device servicing and client roaming, the operating system includes built-in security.

Each Cisco Wireless LAN Controller and Cisco 1000 series lightweight access point is manufactured with a unique, signed X.509 certificate. These signed certificates are used to verify downloaded code before it is loaded, ensuring that hackers do not download malicious code into any Cisco Wireless LAN Controller or Cisco 1000 series lightweight access point.

Layer 2 and Layer 3 LWAPP Operation

The LWAPP communications between Cisco Wireless LAN Controller and Cisco 1000 series lightweight access points can be conducted at ISO Data Link Layer 2 or Network Layer 3.

Note The IPv4 network layer protocol is supported for transport through an LWAPP controller system. IPv6 (for clients only) and AppleTalk are also supported but only on 4400 series controllers and the Cisco WiSM. Other Layer 3 protocols (such as IPX, DECnet Phase IV, OSI CLNP, and so on) and Layer 2 (bridged) protocols (such as LAT and NetBeui) are not supported.

Operational Requirements

The requirement for Layer 2 LWAPP communications is that the Cisco Wireless LAN Controller and Cisco 1000 series lightweight access points must be connected to each other through Layer 2 devices on the same subnet. This is the default operational mode for the Cisco Wireless LAN Solution. Note that when the Cisco Wireless LAN Controller and Cisco 1000 series lightweight access points are on different subnets, these devices must be operated in Layer 3 mode.

The requirement for Layer 3 LWAPP communications is that the Cisco Wireless LAN Controllers and Cisco 1000 series lightweight access points can be connected through Layer 2 devices on the same subnet, or connected through Layer 3 devices across subnets. Another requirement is that the IP addresses of access points should be either statically assigned or dynamically assigned through an external DHCP server.

Note that all Cisco Wireless LAN Controllers in a mobility group must use the same LWAPP Layer 2 or Layer 3 mode, or you will defeat the Mobility software algorithm.

Configuration Requirements

When you are operating the Cisco Wireless LAN Solution in Layer 2 mode, you must configure a management interface to control your Layer 2 communications.

When you are operating the Cisco Wireless LAN Solution in Layer 3 mode, you must configure an AP-manager interface to control Cisco 1000 series lightweight access points and a management interface as configured for Layer 2 mode.

Cisco Wireless LAN Controllers

When you are adding Cisco 1000 series lightweight access points to a multiple Cisco Wireless LAN Controller deployments network, it is convenient to have all Cisco 1000 series lightweight access points associate with one master controller on the same subnet. That way, the operator does not have to log into multiple controllers to find out which controller newly-added Cisco 1000 series lightweight access points associated with.

One controller in each subnet can be assigned as the master controller while adding lightweight access points. As long as a master controller is active on the same subnet, all new access points without a primary, secondary, and tertiary controller assigned automatically attempt to associate with the master Cisco Wireless LAN Controller. This process is described in the "Cisco Wireless LAN Controller Failover Protection" section on page 1-16.

The operator can monitor the master controller using the WCS Web User Interface and watch as access points associate with the master controller. The operator can then verify access point configuration and assign a primary, secondary, and tertiary controller to the access point, and reboot the access point so it reassociates with its primary, secondary, or tertiary controller.

Note Lightweight access points without a primary, secondary, and tertiary controller assigned always search for a master controller first upon reboot. After adding lightweight access points through the master controller, assign primary, secondary, and tertiary controllers to each access point. Cisco recommends that you disable the master setting on all controllers after initial configuration.

Primary, Secondary, and Tertiary Controllers

In multiple-controller networks, lightweight access points can associate with any controller on the same subnet. To ensure that each access point associates with a particular controller, the operator can assign primary, secondary, and tertiary controllers to the access point.

When a primed access point is added to a network, it looks for its primary, secondary, and tertiary controllers first, then a master controller, then the least-loaded controller with available access point ports. Refer to the "Cisco Wireless LAN Controller Failover Protection" section on page 1-16 for more information.

Client Location

When you use Cisco WCS in your Cisco Wireless LAN Solution, controllers periodically determine client, rogue access point, rogue access point client, radio frequency ID (RFID) tag location and store the locations in the Cisco WCS database. For more information on location solutions, refer to the *Cisco Wireless Control System Configuration Guide* and the *Cisco Location Appliance Configuration Guide* at these URLs:

Cisco Wireless Control System Configuration Guide:

http://www.cisco.com/en/US/products/ps6305/products_installation_and_configuration_guides_list.html

Cisco Location Appliance Configuration Guide:

http://www.cisco.com/en/US/products/ps6386/products_installation_and_configuration_guides_list.html

Controller Platforms

Controllers are enterprise-class high-performance wireless switching platforms that support 802.11a and 802.11b/802.11g protocols. They operate under control of the operating system, which includes the Radio Resource Management (RRM), creating a Cisco UWN Solution that can automatically adjust to real-time changes in the 802.11 RF environment. The controllers are built around high-performance network and security hardware, resulting in highly-reliable 802.11 enterprise networks with unparalleled security.

The following controllers are supported for use with software release 4.0:

- Cisco 2000 series controllers
- Cisco 2100 series controllers (4.0.206.0 and later)
- Cisco 4400 series controllers
- Catalyst 6500 Series Wireless Services Module (WiSM)
- Cisco 28/37/38xx Series Integrated Services Router with Controller Network Module
- Catalyst 3750G Integrated Wireless LAN Controller Switch

The first three controllers are stand-alone platforms. The remaining three controllers are integrated into Cisco switch and router products.

Cisco 2000 and 2100 Series Controllers

The Cisco 2000 and 2100 series (2106) Wireless LAN Controllers work in conjunction with Cisco lightweight access points and the Cisco Wireless Control System (WCS) to provide system-wide wireless LAN functions.

Each 2000 and 2100 series controller controls up to six lightweight access points for multi-controller architectures typical of enterprise branch deployments. It may also be used for single controller deployments for small and medium-sized business environments.

Caution Do not connect a power-over-Ethernet (PoE) cable to the controller's console port. Doing so may damage the controller.

Note Wait at least 20 seconds before reconnecting an access point to the controller. Otherwise, the controller may fail to detect the device.

Features Not Supported

These hardware features are not supported on 2000 and 2100 series controllers:

- Power over Ethernet (PoE) [2000 series controllers only]

  Note Ports 7 and 8 on 2100 series controllers are PoE ports.

- Service port (separate out-of-band management 10/100-Mbps Ethernet interface)

These software features are not supported on 2000 and 2100 series controllers:

- VPN termination (such as IPSec and L2TP)
- Termination of guest controller tunnels (origination of guest controller tunnels is supported)
- External web authentication web server list
- Layer 2 LWAPP
- Spanning tree
- Port mirroring
- Cranite
- Fortress
- AppleTalk
- QoS per-user bandwidth contracts
- IPv6 pass-through
- Link aggregation (LAG)

Cisco 4400 Series Controllers

Figure - The Cisco 4400 Series Wireless LAN Controller is available in two models: 4402 and 4404. The 4402 supports up to 50 lightweight access points while the 4404 supports up to 100, making it ideal for large-sized enterprises and large-density applications. Cisco 4400 Series Wireless LAN Controller

The Cisco 4400 Series Wireless LAN Controller can be factory-ordered with a VPN/Enhanced Security Module (Crypto Card) to support VPN, IPSec and other processor-intensive tasks. The VPN/Enhanced Security Module can also be installed in the field.
The 4400 series controller can be equipped with one or two Cisco 4400 series power supplies. When the controller is equipped with two Cisco 4400 series power supplies, the power supplies are redundant, and either power supply can continue to power the controller if the other power supply fails.

Catalyst 6500 Series Wireless Services Module

The Catalyst 6500 Series Wireless Services Module (WiSM) is an integrated Catalyst 6500 switch and two Cisco 4404 controllers that supports up to 300 lightweight access points. The switch has eight internal gigabit Ethernet ports that connect the switch and the controller. The switch and the internal controller run separate software versions, which must be upgraded separately.

Note The Catalyst 6500 Series Switch chassis can support up to five Cisco WiSMs without any other service module installed. If one or more service modules are installed, the chassis can support up to a maximum of four service modules (WiSMs included).

Refer to the following documents for additional information:

- *Catalyst 6500 Series Switch Installation Guide*
- *Catalyst 6500 Series Switch Wireless Services Module Installation and Configuration Note*
- *Release Notes for Catalyst 6500 Series Switch Wireless LAN Services Module*

You can find these documents at this URL:

http://www.cisco.com/en/US/products/hw/switches/ps708/tsd_products_support_series_home.html

Cisco 28/37/38xx Series Integrated Services Router

The Cisco 28/37/38xx Series Integrated Services Router is an integrated 28/37/38xx router and Cisco 2006 controller network module that supports up to six lightweight access points. The router has one Ethernet port that connects the router and the controller. The router and the internal controller run separate software versions, which must be upgraded separately. Refer to the following documents for additional information:

- *Cisco Wireless LAN Controller Module Feature Guide*
- *Cisco 28/37/38xx Series Hardware Installation Guide*

You can find these documents at this URL:

http://www.cisco.com/en/US/products/hw/wireless/index.html

Catalyst 3750G Integrated Wireless LAN Controller Switch

The Catalyst 3750G Integrated Wireless LAN Controller Switch is an integrated Catalyst 3750 switch and Cisco 4400 series controller that supports up to 25 or 50 lightweight access points. The switch has two internal gigabit Ethernet ports that connect the switch and the controller. The switch and the internal controller run separate software versions, which must be upgraded separately. Refer to the following documents for additional information:

- *Catalyst 3750G Integrated Wireless LAN Controller Switch Getting Started Guide*
- *Catalyst 3750 Switch Hardware Installation Guide*
- *Release Notes for the Catalyst 3750 Integrated Wireless LAN Controller Switch, Cisco IOS Release 12.2(25)FZ*

You can find these documents at this URL:

http://www.cisco.com/en/US/products/hw/switches/ps5023/tsd_products_support_series_home.html

Cisco UWN Solution Wired Connections

The Cisco UWN Solution components communicate with each other using industry-standard Ethernet cables and connectors. The following paragraphs contain details of the wired connections.

- The 2000 series controller connects to the network using from one to four 10/100BASE-T Ethernet cables.
- The 2100 series controller connects to the network using from one to six 10/100BASE-T Ethernet cables.

- The 4402 controller connects to the network using one or two fiber-optic Gigabit Ethernet cables, and the 4404 controller connects to the network using up to four fiber-optic Gigabit Ethernet cables: two redundant Gigabit Ethernet connections to bypass single network failures.
- The controllers in the Wireless Services Module (WiSM), installed in a Cisco Catalyst 6500 Series Switch, connect to the network through switch ports on the switch.
- The Wireless LAN Controller Network Module, installed in a Cisco Integrated Services Router, connects to the network through the ports on the router.
- The controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch connects to the network through the ports on the switch.
- Cisco lightweight access points connects to the network using 10/100BASE-T Ethernet cables. The standard CAT-5 cable can also be used to conduct power for the Cisco 1000 series lightweight access points from a network device equipped with Power over Ethernet (PoE) capability. This power distribution plan can be used to reduce the cost of individual AP power supplies and related cabling.

Cisco UWN Solution WLANs

The Cisco UWN Solution can control up to 16 WLANs for lightweight access points. Each WLAN has a separate WLAN ID (1 through 16), a separate WLAN SSID (WLAN name), and can be assigned unique security policies. Using software release 3.2 and later you can configure both static and dynamic WEP on the same WLAN.

The lightweight access points broadcast all active Cisco UWN Solution WLAN SSIDs and enforce the policies defined for each WLAN.

Note Cisco recommends that you assign one set of VLANs for WLANs and a different set of VLANs for management interfaces to ensure that controllers operate with optimum performance and ease of management.

If management over wireless is enabled across Cisco UWN Solution, the operator can manage the System across the enabled WLAN using CLI and Telnet, http/https, and SNMP.

To configure the WLANs, refer to Chapter 6.

Identity Networking

Controllers can have the following parameters applied to all clients associating with a particular wireless LAN: QoS, global or Interface-specific DHCP server, Layer 2 and Layer 3 Security Policies, and default Interface (which includes physical port, VLAN and ACL assignments).

However, the controllers can also have individual clients (MAC addresses) override the preset wireless LAN parameters by using MAC Filtering or by Allowing AAA Override parameters. This configuration can be used, for example, to have all company clients log into the corporate wireless LAN, and then have clients connect using different QoS, DHCP server, Layer 2 and Layer 3 Security Policies, and Interface (which includes physical port, VLAN and ACL assignments) settings on a per-MAC Address basis.

When Cisco UWN Solution operators configure MAC Filtering for a client, they can assign a different VLAN to the MAC Address, which can be used to have operating system automatically reroute the client to the management interface or any of the operator-defined interfaces, each of which have their own

VLAN, access control list (ACL), DHCP server, and physical port assignments. This MAC Filtering can be used as a coarse version of AAA Override, and normally takes precedence over any AAA (RADIUS or other) Override.

However, when Allow AAA Override is enabled, the RADIUS (or other AAA) server can alternatively be configured to return QoS, DSCP, 802.1p priority tag values and ACL on a per-MAC Address basis. Allow AAA Override gives the AAA Override precedence over the MAC Filtering parameters set in the controller; if there are no AAA Overrides available for a given MAC Address, the operating system uses the MAC Filtering parameters already in the controller. This AAA (RADIUS or other) Override can be used as a finer version of AAA Override, but only takes precedence over MAC Filtering when Allow AAA Override is enabled.

Note that in all cases, the Override parameters (Operator-Defined Interface and QoS, for example) must already be defined in the controller configuration.

In all cases, the operating system will use QoS, DSCP, 802.1p priority tag values and ACL provided by the AAA server or MAC Filtering regardless of the Layer 2 and/or Layer 3 authentication used.

Also note that the operating system only moves clients from the default Cisco UWN Solution WLAN VLAN to a different VLAN when configured for MAC filtering, 802.1X, and/or WPA Layer 2 authentication. To configure WLANs, refer to Chapter 6.

Enhanced Integration with Cisco Secure ACS

The identity-based networking feature uses authentication, authorization, and accounting (AAA) override. When the following vendor-specific attributes are present in the RADIUS access accept message, the values override those present in the wireless LAN profile:

- QoS level
- 802.1p value
- VLAN interface name
- Access control list (ACL) name

In this release, support is being added for the AAA server to return the VLAN number or name using the standard “RADIUS assigned VLAN name/number” feature defined in IETF RFC 2868 (RADIUS Attributes for Tunnel Protocol Support). To assign a wireless client to a particular VLAN, the AAA server sends the following attributes to the controller in the access accept message:

- IETF 64 (Tunnel Type): VLAN
- IETF 65 (Tunnel Medium Type): 802
- IETF 81 (Tunnel Private Group ID): VLAN # or VLAN Name String

This enables Cisco Secure ACS to communicate a VLAN change that may be a result of a posture analysis. Benefits of this new feature include:

- Integration with Cisco Secure ACS reduces installation and setup time
- Cisco Secure ACS operates smoothly across both wired and wireless networks

This feature supports 2000, 2100 and 4400 series controllers and 1000, 1130, 1200 and 1500 series lightweight access points.

File Transfers

The Cisco UWN Solution operator can upload and download operating system code, configuration, and certificate files to and from controller using the GUI, CLI commands, or Cisco WCS.

- To use CLI commands, refer to the "Transferring Files to and from a Controller" section on page 8-2.
- To use Cisco WCS to upgrade software, refer to the *Cisco Wireless Control System Configuration Guide*. Click this URL to browse to this document:

  http://www.cisco.com/en/US/products/ps6305/products_installation_and_configuration_guides_list.html

Power over Ethernet

Lightweight access points can receive power via their Ethernet cables from 802.3af-compatible Power over Ethernet (PoE) devices, which can reduce the cost of discrete power supplies, additional wiring, conduits, outlets, and installer time. PoE also frees installers from having to mount Cisco 1000 series lightweight access points or other powered equipment near AC outlets, providing greater flexibility in positioning Cisco 1000 series lightweight access points for maximum coverage.

When you are using PoE, the installer runs a single CAT-5 cable from each lightweight access point to PoE-equipped network elements, such as a PoE power hub or a Cisco WLAN Solution Single-Line PoE Injector. When the PoE equipment determines that the lightweight access point is PoE-enabled, it sends 48 VDC over the unused pairs in the Ethernet cable to power the lightweight access point.

The PoE cable length is limited by the 100BASE-T or 10BASE-T specification to 100 m or 200 m, respectively.

Lightweight access points can receive power from an 802.3af-compliant device or from the external power supply.

Pico Cell Functionality

A Pico Cell is a small area of wireless provisioning provided by antenna, which allows for a dense high-bandwidth deployment for installations such as stock exchanges. Pico Cell wireless configurations require a specific supplicant to function correctly with Pico Cell environments. Off-the-shelf laptop supplicants are not supported.

Note Do not attempt to configure Pico Cell functionality within your wireless LAN without consulting your sales team. Non-standard installation is not supported.

Note Do not change the configuration database setting unless you are committing to a Pico Cell installation or without the advice of Cisco technical support.

Pico Cell functionality includes optimization of the operating system (operating system) to support this functionality as follows:

- The Cisco WCS Pico Cell Mode parameter reconfigures operating system parameters, allowing operating system to function efficiently in pico cell deployments. Note that when the operator is deploying a pico cell network the operating system must also have more memory allocated (512 to 2048 MB) using the **config database size 2048** CLI command.
- Client mobility between multiple mobility domains when such exist.
- Addition of a WPA2 VFF extension to eliminate the need to re-key after every association. This allows the re-use of existing PTK and GTK.
- With WPA2 PMK caching and VFF, the PMK cache is transferred as part of context transfer prior to the authentication phase. This allows expedited handoffs to work for both intra- and inter-controller roaming events.
- A beacon/probe response that allows lightweight access point to indicate which controller it is attached to so that reauthorization events only occur when needed, minimizing inter-controller handoffs and thus reducing CPU usage.
- Allows changes to lightweight access point sensitivity for pico cells.
- Allows control of lightweight access point fallback behavior to optimize pico cell use.
- Supports heat maps for directional antennas.
- Allows specific control over blacklisting events
- Allows configuring and viewing basic LWAPP configuration using the lightweight access point CLI.

Startup Wizard

When a controller is powered up with a new factory operating system software load or after being reset to factory defaults, the bootup script runs the Startup Wizard, which prompts the installer for initial configuration. The Startup Wizard:

- Ensures that the controller has a System Name, up to 32 characters.
- Adds an Administrative username and password, each up to 24 characters.
- Ensures that the controller can communicate with the GUI, CLI, or Cisco WCS (either directly or indirectly) through the service port by accepting a valid IP configuration protocol (none or DHCP), and if none, IP Address and netmask. If you do not want to use the service port, enter 0.0.0.0 for the IP Address and netmask.
- Ensures that the controller can communicate with the network (802.11 Distribution System) through the management interface by collecting a valid static IP Address, netmask, default router IP address, VLAN identifier, and physical port assignment.
- Prompts for the IP address of the DHCP server used to supply IP addresses to clients, the controller management interface, and optionally to the service port interface.
- Asks for the LWAPP Transport Mode, described in the "Layer 2 and Layer 3 LWAPP Operation" section on page 1-7.
- Collects the Virtual Gateway IP Address; any fictitious, unassigned IP address (such as 1.1.1.1) to be used by Layer 3 Security and Mobility managers.
- Allows you to enter the Mobility Group (RF Group) Name.
- Collects the wireless LAN 1 802.11 SSID, or Network Name.

- Asks you to define whether or not clients can use static IP addresses. Yes = more convenient, but lower security (session can be hijacked), clients can supply their own IP Address, better for devices that cannot use DHCP. No = less convenient, higher security, clients must DHCP for an IP Address, works well for Windows XP devices.
- If you want to configure a RADIUS server from the Startup Wizard, the RADIUS server IP address, communication port, and Secret.
- Collects the Country Code.
- Enables and/or disables the 802.11a, 802.11b and 802.11g lightweight access point networks.
- Enables or disables Radio Resource Management (RRM).

To use the Startup Wizard, refer to the "Using the Configuration Wizard" section on page 4-2.

Cisco Wireless LAN Controller Memory

The controller contains two kinds of memory: volatile RAM, which holds the current, active controller configuration, and NVRAM (non-volatile RAM), which holds the reboot configuration. When you are configuring the operating system in controller, you are modifying volatile RAM; you must save the configuration from the volatile RAM to the NVRAM to ensure that the controller reboots in the current configuration.

Knowing which memory you are modifying is important when you are:

- Using the Configuration Wizard
- Clearing the Controller Configuration
- Saving Configurations
- Resetting the Controller
- Logging Out of the CLI

Cisco Wireless LAN Controller Failover Protection

Each controller has a defined number of communication ports for lightweight access points. This means that when multiple controllers with unused access point ports are deployed on the same network, if one controller fails, the dropped access points automatically poll for unused controller ports and associate with them.

During installation, Cisco recommends that you connect all lightweight access points to a dedicated controller, and configure each lightweight access point for final operation. This step configures each lightweight access point for a primary, secondary, and tertiary controller and allows it to store the configured mobility group information.

During failover recovery, the configured lightweight access points obtain an IP address from the local DHCP server (only in Layer 3 operation), attempt to contact their primary, secondary, and tertiary controllers, and then attempt to contact the IP addresses of the other controllers in the Mobility group. This prevents the access points from spending time sending out blind polling messages, resulting in a faster recovery period.

In multiple-controller deployments, this means that if one controller fails, its dropped access points reboot and do the following under direction of the radio resource management (RRM):

- Obtain an IP address from a local DHCP server (one on the local subnet).

- If the lightweight access point has a primary, secondary, and tertiary controller assigned, it attempts to associate with that controller.
- If the access point has no primary, secondary, or tertiary controllers assigned or if its primary, secondary, or tertiary controllers are unavailable, it attempts to associate with a master controller on the same subnet.
- If the access point finds no master controller on the same subnet, it attempts to contact stored mobility group members by IP address.
- Should none of the mobility group members be available, and if the lightweight access point has no primary, secondary, and tertiary controllers assigned and there is no master controller active, it attempts to associate with the least-loaded controller on the same subnet to respond to its discovery messages with unused ports.

This means that when sufficient controllers are deployed, should one controller fail, active access point client sessions are momentarily dropped while the dropped access point associates with an unused port on another controller, allowing the client device to immediately reassociate and reauthenticate.

Network Connections to Cisco Wireless LAN Controllers

Regardless of operating mode, all controllers use the network as an 802.11 distribution system. Regardless of the Ethernet port type or speed, each controller monitors and communicates with its related controllers across the network. The following sections give details of these network connections:

- Cisco 2000 and 2100 Series Wireless LAN Controllers, page 1-17
- Cisco 4400 Series Wireless LAN Controllers, page 1-18

Note Chapter 3 provides information on configuring the controller's ports and assigning interfaces to them.

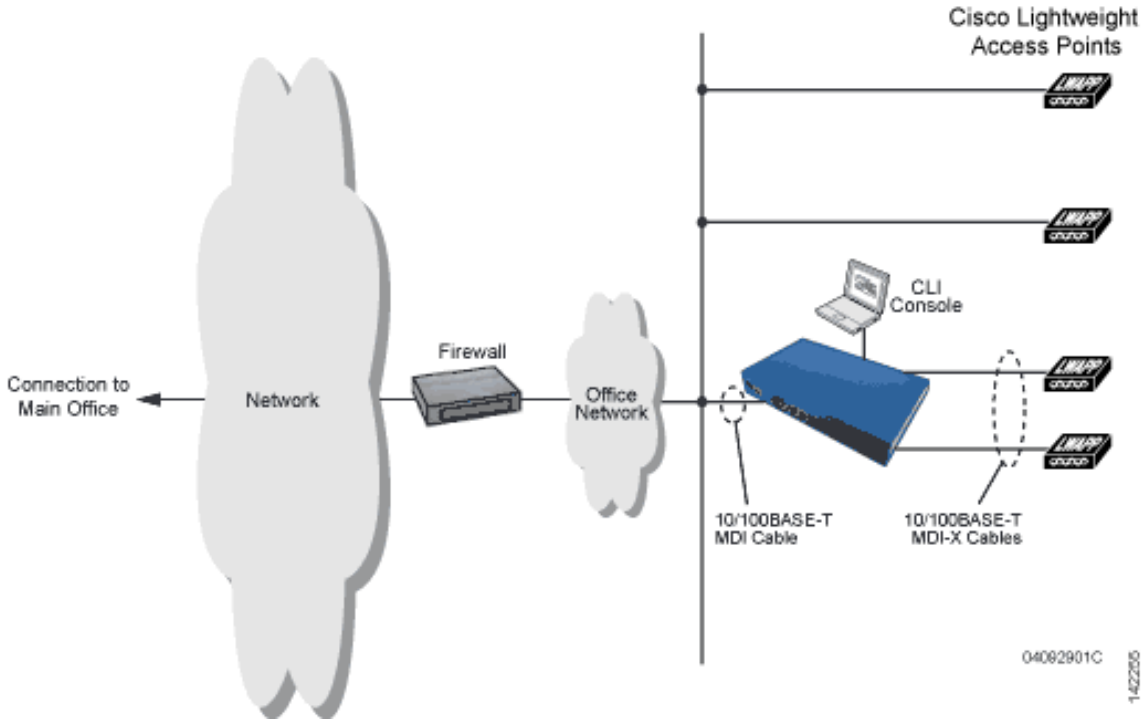
Cisco 2000 and 2100 Series Wireless LAN Controllers

Cisco 2000 and 2100 series controllers can communicate with the network through any one of their physical data ports, as the logical management interface can be assigned to one of the ports. The physical port description follows:

- Up to four 10/100BASE-T cables can plug into the four back-panel data ports on the 2000 series controller chassis.
- Up to six 10/100BASE-T cables can plug into the six back-panel data ports on the 2100 series controller chassis. The 2100 series also has two PoE ports (ports 7 and 8).

Figure 1-4 shows connections to a 2000 series controller.

Figure 1-4 Physical Network Connections to the 2000 Series Controller



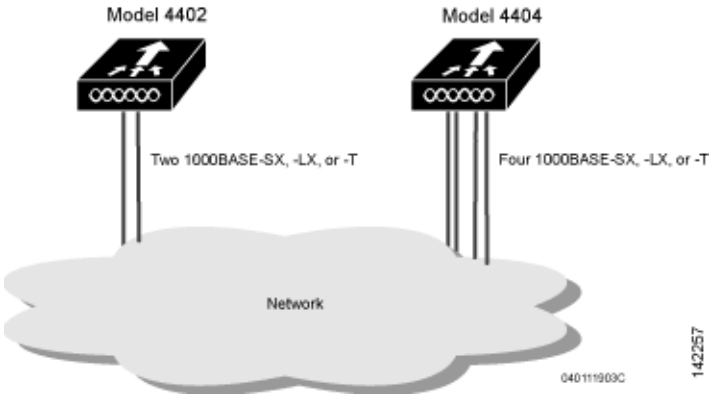
Cisco 4400 Series Wireless LAN Controllers

Cisco 4400 series controllers can communicate with the network through one or two pairs of physical data ports, and the logical management interface can be assigned to the ports. The physical port descriptions follows:

- For the 4402 controller, up to two of the following connections are supported in any combination:
  - 1000BASE-T (Gigabit Ethernet, front panel, RJ-45 physical port, UTP cable).
  - 1000BASE-SX (Gigabit Ethernet, front panel, LC physical port, multi-mode 850nM (SX) fiber-optic links using LC physical connectors).
  - 1000BASE-LX (Gigabit Ethernet, front panel, LC physical port, multi-mode 1300nM (LX/LH) fiber-optic links using LC physical connectors).
- For the 4404 controller, up to four of the following connections are supported in any combination:
  - 1000BASE-T (Gigabit Ethernet, front panel, RJ-45 physical port, UTP cable).
  - 1000BASE-SX (Gigabit Ethernet, front panel, LC physical port, multi-mode 850nM (SX) fiber-optic links using LC physical connectors).
  - 1000BASE-LX (Gigabit Ethernet, front panel, LX physical port, multi-mode 1300nM (LX/LH) fiber-optic links using LC physical connectors).

Figure 1-5 shows connections to the 4400 series controller.

Figure 1-5 Physical Network Connections to 4402 and 4404 Series Controllers



Rogue Access Points

Because they are inexpensive and readily available, employees sometimes plug unauthorized rogue access points 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 and war chalkers frequently publish unsecure access point locations, increasing the odds of having the enterprise security breached.

Rather than using a person with a scanner to manually detect rogue access point, the Cisco UWN Solution automatically collects information on rogue access point detected by its managed access points, by MAC and IP Address, and allows the system operator to locate, tag and monitor them. The operating system can also be used to discourage rogue access point clients by sending them deauthenticate and disassociate messages from one to four lightweight access points. Finally, the operating system can be used to automatically discourage all clients attempting to authenticate with all rogue access point on the enterprise subnet. Because this real-time detection is automated, it saves labor costs used for detecting and monitoring rogue access point while vastly improving LAN security. Note that peer-to-peer, or ad-hoc, clients can also be considered rogue access points.

Rogue Access Point Location, Tagging, and Containment

This built-in detection, tagging, monitoring, and containment capability allows system administrators to take required actions:

- Locate rogue access point as described in the *Cisco Wireless Control System Configuration Guide*.
- Receive new rogue access point notifications, eliminating hallway scans.
- Monitor unknown rogue access point 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 lightweight 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 point when they are outside of the LAN and do not compromise the LAN or wireless LAN security.
  - Accept rogue access point when they do not compromise the LAN or wireless LAN security.
  - Tag rogue access point as unknown until they are eliminated or acknowledged.
  - Tag rogue access point as contained and discourage clients from associating with the rogue access point by having between one and four lightweight access points transmit deauthenticate and disassociate messages to all rogue access point clients. This function contains all active channels on the same rogue access point.

Rogue Detector mode detects whether or not a rogue access point is on a trusted network. It does not provide RF service of any kind, but rather receives periodic rogue access point reports from the controller, and sniffs all ARP packets. If it finds a match between an ARP request and a MAC address it receives from the controller, it generates a rogue access point alert to the controller.

To facilitate automated rogue access point detection in a crowded RF space, lightweight access points can be configured to operate in monitor mode, allowing monitoring without creating unnecessary interference.

Using the Web-Browser and CLI Interfaces

This chapter describes the web-browser and CLI interfaces that you use to configure the controllers. It contains these sections:

Using the Web-Browser Interface

The web-browser interface (hereafter called the GUI) is built into each controller. It allows up to five users to simultaneously browse into the controller http or https (http + SSL) management pages to configure parameters and monitor operational status for the controller and its associated access points.

Note Cisco recommends that you enable the https: and disable the http: interfaces to ensure more robust security for your Cisco UWN Solution.

Guidelines for Using the GUI

Keep these guidelines in mind when using the GUI:

- The GUI must be used on a PC running Windows XP SP1 or higher or Windows 2000 SP4 or higher.
- The GUI is fully compatible with Microsoft Internet Explorer version 6.0 SP1 or higher.

  Note Opera, Mozilla, and Netscape are not supported.

  Note Microsoft Internet Explorer version 6.0 SP1 or higher is required for using Web Authentication.

- You can use either the service port interface or the management interface to open the GUI. Cisco recommends that you use the service-port interface. Refer to Chapter 3, "Using the CLI to Configure the Service-Port Interface" for instructions on configuring the service port interface.
- You might need to disable your browser's pop-up blocker to view the online help.
- Before accessing the controller using the web browser interface verify the following items:
  - The IP address and network mask are configured correctly on the Management interface
  - The native vlan is configured correctly on the switch that connects to the WLC
  - The management interface and the AP management interface VLANs are configured correctly or the VLANS should be left at default settings, which is an untagged VLAN (VLAN 0 on the WLC)
- By default only https access is enabled. To enable http access, enter the following command from the controller CLI interface:

  config network webmode enable

Opening the GUI

To open the GUI, enter the controller IP address in the browser's address line. For an unsecure connection enter **http://***ip-address*. For a secure connection, enter **https://***ip-address*. See the "Configuring the GUI for HTTPS" section on page 2-3 for instructions on setting up HTTPS.

Enabling Web and Secure Web Modes

Use these commands to enable or disable the distribution system port as a web port or as a secure web port:

- **config network webmode** {**enable** | **disable**}
- **config network secureweb** {**enable** | **disable**}

Web and secure web modes are enabled by default.

Configuring the GUI for HTTPS

You can protect communication with the GUI by enabling HTTPS. HTTPS protects HTTP browser sessions by using the Secure Socket Layer (SSL) protocol. When you enable HTTPS, the controller generates its own local Web Administration SSL certificate and automatically applies it to the GUI.

You can also load an externally generated certificate. Follow the instructions in the "Loading an Externally Generated HTTPS Certificate" section on page 2-4 for instructions on loading an externally generated certificate.

Using the CLI, follow these steps to enable HTTPS:

Step 1 Enter **show certificate summary** to verify that the controller has generated a certificate:

```
>show certificate summary
Web Administration Certificate..................... Locally Generated
Web Authentication Certificate..................... Locally Generated
Certificate compatibility mode:.................... off
```

Step 2 (Optional) If you need to generate a new certificate, enter this command:

```
>config certificate generate webadmin
```

After a few seconds the controller verifies that the certificate is generated:

```
Web Administration certificate has been generated
```

Step 3 Enter this command to enable HTTPS:

```
>config network secureweb enable
```

Step 4 Save the SSL certificate, key, and secure web password to NVRAM (non-volatile RAM) so your changes are retained across reboots:

```
>save config
Are you sure you want to save? (y/n) y
Configuration Saved!
```

Step 5 Reboot the controller:

```
>reset system
Are you sure you would like to reset the system? (y/n) y
System will now restart!
```

The controller reboots.

Loading an Externally Generated HTTPS Certificate

You use a TFTP server to load the certificate. Follow these guidelines for using TFTP:

- If you load the certificate through the service port, the TFTP server must be on the same subnet as the controller because the service port is not routable. However, if you load the certificate through the distribution system (DS) network port, the TFTP server can be on any subnet.
- A third-party TFTP server cannot run on the same computer as the Cisco WCS because the WCS built-in TFTP server and the third-party TFTP server require the same communication port.

Note Every HTTPS certificate contains an embedded RSA Key. The length of the RSA key can vary from 512 bits, which is relatively insecure, through thousands of bits, which is very secure. When you obtain a new certificate from a Certificate Authority, make sure the RSA key embedded in the certificate is at least 768 bits long.

Follow these steps to load an externally generated HTTPS certificate:

Step 1 Use a password to encrypt the HTTPS certificate in a .PEM-encoded file. The PEM-encoded file is called a Web Administration Certificate file (*webadmincert_name*.pem).

Step 2 Move the *webadmincert_name*.pem file to the default directory on your TFTP server.

Step 3 In the CLI, enter **transfer download start** and answer **n** to the prompt to view the current download settings:

```
>transfer download start
Mode..................................... TFTP
Data Type................................ Admin Cert
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ <directory path>
TFTP Filename.............................
Are you sure you want to start? (y/n) n
Transfer Canceled
```

Step 4 Use these commands to change the download settings:

```
>transfer download mode tftp
>transfer download datatype webauthcert
>transfer download serverip TFTP server IP address
>transfer download path absolute TFTP server path to the update file
>transfer download filename webadmincert_name.pem
```

Step 5 Enter the password for the .PEM file so the operating system can decrypt the Web Administration SSL key and certificate:

```
>transfer download certpassword private_key_password
>Setting password to private_key_password
```

Step 6 Enter **transfer download start** to view the updated settings, and answer **y** to the prompt to confirm the current download settings and start the certificate and key download:

```
>transfer download start
Mode..................................... TFTP
Data Type................................ Site Cert
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ directory path
TFTP Filename............................ webadmincert_name
Are you sure you want to start? (y/n) y
TFTP Webadmin cert transfer starting.
```

```
Certificate installed.
Please restart the switch (reset system) to use the new certificate.
```

Step 7 Enter this command to enable HTTPS:

```
>config network secureweb enable
```

Step 8 Save the SSL certificate, key, and secure web password to NVRAM (non-volatile RAM) so your changes are retained across reboots:

```
>save config
Are you sure you want to save? (y/n) y
Configuration Saved!
```

Step 9 Reboot the controller:

```
>reset system
Are you sure you would like to reset the system? (y/n) y
System will now restart!
```

The controller reboots.

Disabling the GUI

To prevent all use of the GUI, select the **Disable Web-Based Management** check box on the Services: HTTP-Web Server page and click **Apply**.

To re-enable the GUI, enter this command on the CLI:

```
>ip http server
```

Using Online Help

Click the help icon at the top of any page in the GUI to display online help. You might have to disable the browser pop-up blocker to view online help.

Using the CLI

The Cisco UWN Solution command line interface (CLI) is built into each controller. The CLI allows operators to use a VT-100 emulator to locally or remotely configure, monitor and control individual controllers, and to access extensive debugging capabilities. Because the CLI works with one controller at a time, the command line interface is especially useful when you wish to configure or monitor a single controller.

The controller and its associated lightweight access points can be configured and monitored using the command line interface (CLI), which consists of a simple text-based, tree-structured interface that allows up to five users with Telnet-capable terminal emulators to simultaneously configure and monitor all aspects of the controller and associated lightweight access points.

The CLI allows you to use a VT-100 emulator to locally or remotely configure, monitor, and control a WLAN controller and its associated lightweight access points. The CLI is a simple text-based, tree-structured interface that allows up to five users with Telnet-capable terminal emulators to access the controller.

Note Refer to the C*isco Wireless LAN Controller Command Reference* for information on specific commands.

Logging into the CLI

You access the CLI using either of two methods:

- A direct ASCII serial connection to the controller console port
- A remote console session over Ethernet through the pre-configured Service Port or through Distribution System Ports

Before you log into the CLI, configure your connectivity and environment variables based on the type of connection you use.

Using a Local Serial Connection

You need these items to connect to the serial port:

- A computer that has a DB-9 serial port and is running a terminal emulation program
- A DB-9 male-to-female null-modem serial cable

Follow these steps to log into the CLI through the serial port.

Step 1 Connect your computer to the controller using the DB-9 null-modem serial cable.

Step 2 Open a terminal emulator session using these settings:

- 9600 baud
- 8 data bits
- 1 stop bit
- no parity
- no hardware flow control

Step 3 At the prompt, log into the CLI. The default username is *admin*, and the default password is *admin*.

Note The controller serial port is set for a 9600 baud rate and a short timeout. If you would like to change either of these values, enter **config serial baudrate** *baudrate* and **config serial timeout** *timeout* to make your changes. If you enter **config serial timeout 0**, serial sessions never time out.

Using a Remote Ethernet Connection

You need these items to connect to a controller remotely:

- A computer with access to the controller over the Ethernet network
- The IP address of the controller
- A terminal emulation program or a DOS shell for the Telnet session

Note By default, controllers block Telnet sessions. You must use a local connection to the serial port to enable Telnet sessions.

Follow these steps to log into the CLI through the serial port:

Step 1 Verify that your terminal emulator or DOS shell interface is configured with these parameters:

- Ethernet address
- Port 23

Step 2 Use the controller IP address to Telnet to the CLI.

Step 3 At the prompt, log into the CLI. The default username is *admin* and the default password is *admin*.

Logging Out of the CLI

When you finish using the CLI, navigate to the root level and enter **logout**. The system prompts you to save any changes you made to the volatile RAM.

Navigating the CLI

The is organized around five levels:

Root Level

Level 2

Level 3

Level 4

Level 5

When you log into the CLI, you are at the root level. From the root level, you can enter any full command without first navigating to the correct command level. Table 2-1 lists commands you use to navigate the CLI and to perform common tasks.

Table 2-1 Commands for CLI Navigation and Common Tasks

Command	Action
help	At the root level, view system-wide navigation commands
?	View commands available at the current level
command **?**	View parameters for a specific command
exit	Move down one level
Ctrl-Z	Return from any level to the root level
save config	At the root level, save configuration changes from active working RAM to non-volatile RAM (NVRAM) so they are retained after reboot
reset system	At the root level, reset the controller without logging out

Enabling Wireless Connections to the Web-Browser and CLI Interfaces

You can monitor and configure controllers using a wireless client. This feature is supported for all management tasks except uploads from and downloads to the controller.

Before you can open the GUI or the CLI from a wireless client device you must configure the controller to allow the connection. Follow these steps to enable wireless connections to the GUI or CLI:

Step 1 Log into the CLI.

Step 2 Enter **config network mgmt-via-wireless enable**

Step 3 Use a wireless client to associate to a lightweight access point connected to the controller.

Step 4 On the wireless client, open a Telnet session to the controller, or browse to the controller GUI.

Tip To use the controller GUI to enable wireless connections, browse to the Management Via Wireless page and select the **Enable Controller Management to be accessible from Wireless Clients** check box.

Configuring Ports and Interfaces

This chapter describes the controller's physical ports and interfaces and provides instructions for configuring them. It contains these sections:

Overview of Ports and Interfaces

Three concepts are key to understanding how controllers connect to a wireless network: ports, interfaces, and WLANs.

Ports

A port is a physical entity that is used for connections on the controller platform. Controllers have two types of ports: distribution system ports and a service port. The following figures show the ports available on each controller.

Note The controller in a Cisco Integrated Services Router and the controllers on the Cisco WiSM do not have external physical ports. They connect to the network through ports on the router or switch, respectively.

Figure 3-1 Ports on the Cisco 2000 Series Wireless LAN Controllers

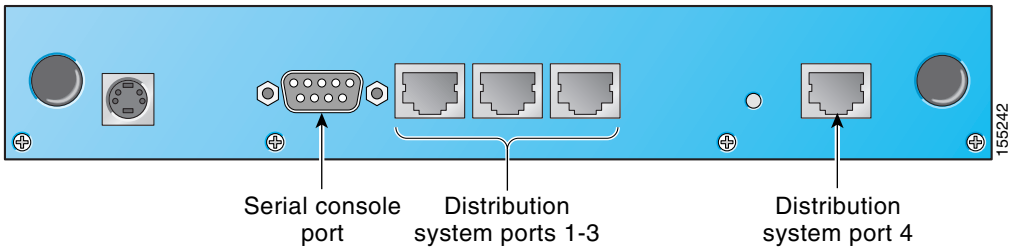
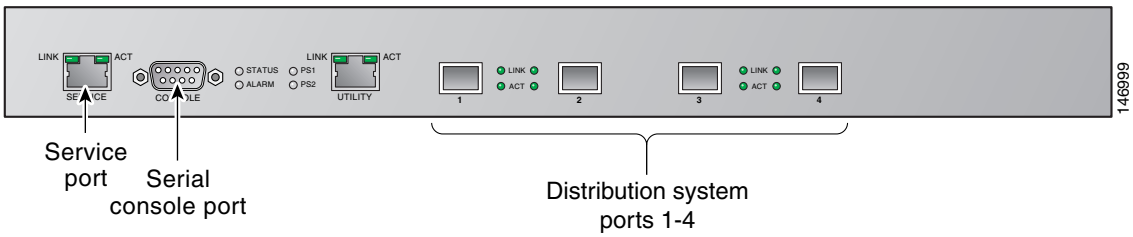


Figure 3-2 Ports on the Cisco 4400 Series Wireless LAN Controllers



Note Figure 3-2 shows a Cisco 4404 controller. The Cisco 4402 controller is similar but has only two distribution system ports. The utility port, which is the unlabeled port in Figure 3-2, is currently not operational.

Figure 3-3 Ports on the Catalyst 3750G Integrated Wireless LAN Controller Switch

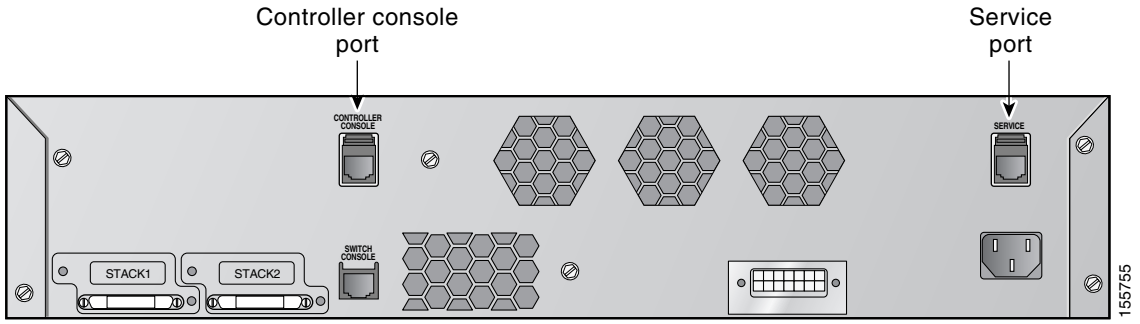


Table 3-1 provides a list of ports per controller.

Table 3-1 Controller Ports

Controller	Service Ports	Distribution System Ethernet Ports	Serial Console Port
2000 series	None	4	1
2100 series	None	6 + 2 PoE ports	1
4402	1	2	1
4404	1	4	1
Cisco WiSM	2 (ports 9 and 10)	8 (ports 1-8)	2
Controller Network Module within the Cisco 28/37/38xx Series Integrated Services Routers	None	1	1
Catalyst 3750G Integrated Wireless LAN Controller Switch	1	2 (ports 27 and 28)	1

Note Appendix E provides logical connectivity diagrams and related software commands for the integrated controllers.

Distribution System Ports

A distribution system port connects the controller to a neighbor switch and serves as the data path between these two devices.

- Cisco 2000 series controllers have four 10/100 copper Ethernet distribution system ports through which the controller can support up to six access points.
- Cisco 2100 series controllers have six 10/100 copper Ethernet distribution system ports through which the controller can support up to six access points. Ports 7 and 8 can function as PoE ports.

- Cisco 4402 controllers have two gigabit Ethernet distribution system ports, each of which is capable of managing up to 48 access points. However, Cisco recommend no more than 25 access points per port due to bandwidth constraints. The 4402-25 and 4402-50 models allow a total of 25 or 50 access points to join the controller.
- Cisco 4404 controllers have four gigabit Ethernet distribution system ports, each of which is capable of managing up to 48 access points. However, Cisco recommend no more than 25 access points per port due to bandwidth constraints. The 4404-25, 4404-50, and 4404-100 models allow a total of 25, 50, or 100 access points, respectively, to join the controller.

Note The gigabit Ethernet ports on the 4402 and 4404 controllers accept these SX/LC/T small form-factor plug-in (SFP) modules:
- 1000BASE-SX SFP modules, which provide a 1000-Mbps wired connection to a network through an 850nM (SX) fiber-optic link using an LC physical connector
- 1000BASE-LX SFP modules, which provide a 1000-Mbps wired connection to a network through a 1300nM (LX/LH) fiber-optic link using an LC physical connector
- 1000BASE-T SFP modules, which provide a 1000-Mbps wired connection to a network through a copper link using an RJ-45 physical connector

- The Cisco Catalyst 6500 Series Switch Wireless Services Module (WiSM) has eight internal gigabit Ethernet distribution system ports (ports 1 through 8) that connect the switch and the integrated controller. These internal ports are located on the switch backplane and are not visible on the front panel. Through these ports, the controller can support up to 300 access points.
- The Controller Network Module within the Cisco 28/37/38xx Series Integrated Services Router has one Fast Ethernet distribution system port that connects the router and the integrated controller. This port is located on the router backplane and is not visible on the front panel. Through this port, the controller can support up to six access points.
- The Catalyst 3750G Integrated Wireless LAN Controller Switch has two internal gigabit Ethernet distribution system ports (ports 27 and 28) that connect the switch and the integrated controller. These internal ports are located on the switch backplane and are not visible on the front panel. Each port is capable of managing up to 48 access points. However, Cisco recommends no more than 25 access points per port due to bandwidth constraints. The -S25 and -S50 models allow a total of 25 or 50 access points to join the controller.

Note Refer to the "Configuring a 4400 Series Controller to Support More Than 48 Access Points" section on page 3-36 if you want to configure your Cisco 4400 series controller to support more than 48 access points.

Each distribution system port is, by default, an 802.1Q VLAN trunk port. The VLAN trunking characteristics of the port are not configurable.

Note Some controllers support link aggregation (LAG), which bundles all of the controller's distribution system ports into a single 802.3ad port channel. Cisco 4400 series controllers support LAG in software release 3.2 and higher, and LAG is enabled automatically on the Cisco WiSM controllers. Refer to the "Enabling Link Aggregation" section on page 3-29 for more information.

The controller's gigabit Ethernet ports can be configured for fiber-optic or wire Ethernet cables and require gigabit Ethernet ports on the switch. They cannot operate with fast ethernet switch ports.

Note GLC-T adapters can purchased for use with wire Ethernet cables. This adapter converts the controller port into a gigabit Ethernet port with an RJ45 connector for wire Ethernet cables. The wire Ethernet cable from the controller must be connected to a gigabit Ethernet port on the switch. Fiber adapters might also be required for the switch if it has fiber ports.

Note For smaller systems needing only 6 access points, the Cisco 2006 or 2106 controllers can be used. A Cisco CAT6k with a service module or a Cisco 2800 router can also support 6 access points.

Service Port

Cisco 4400 series controllers also have a 10/100 copper Ethernet service port. The service port is controlled by the service-port interface and is reserved for out-of-band management of the controller and system recovery and maintenance in the event of a network failure. It is also the only port that is active when the controller is in boot mode. The service port is not capable of carrying 802.1Q tags, so it must be connected to an access port on the neighbor switch. Use of the service port is optional.

Note The Cisco WiSM's 4404 controllers use the service port for internal protocol communication between the controllers and the Supervisor 720.

Note The Cisco 2000 series controller and the controller in the Cisco Integrated Services Router do not have a service port.

Note The service port is not auto-sensing. You must use the correct straight-through or crossover Ethernet cable to communicate with the service port.

Interfaces

An interface is a logical entity on the controller. An interface has multiple parameters associated with it, including an IP address, default-gateway (for the IP subnet), primary physical port, secondary physical port, VLAN identifier, and DHCP server.

These five types of interfaces are available on the controller. Four of these are static and are configured at setup time:

- Management interface (Static and configured at setup time; mandatory)
- AP-manager interface (When using Layer 3 LWAPP, static and configured at setup time; mandatory)
- Virtual interface (Static and configured at setup time; mandatory)
- Service-port interface (Static and configured at setup time; optional)
- Dynamic interface (User-defined)

Each interface is mapped to at least one primary port, and some interfaces (management and dynamic) can be mapped to an optional secondary (or backup) port. If the primary port for an interface fails, the interface automatically moves to the backup port. In addition, multiple interfaces can be mapped to a single controller port.

Note Refer to the "Enabling Link Aggregation" section on page 3-29 if you want to configure the controller to dynamically map the interfaces to a single port channel rather than having to configure primary and secondary ports for each interface.

Management Interface

The management interface is the default interface for in-band management of the controller and connectivity to enterprise services such as AAA servers. The management interface has the only consistently "pingable" in-band interface IP address on the controller. You can access the controller's GUI by entering the controller's management interface IP address in Internet Explorer's Address field.

The management interface is also used for Layer 2 communications between the controller and Cisco 1000 series lightweight access points. It must be assigned to distribution system port 1 but can also be mapped to a backup port and can be assigned to WLANs if desired. It may be on the same VLAN or IP subnet as the AP-manager interface. However, the management interface can also communicate through the other distribution system ports as follows:

- Sends messages through the Layer 2 network to autodiscover and communicate with other controllers through all distribution system ports.
- Listens across the Layer 2 network for Cisco 1000 series lightweight access point LWAPP polling messages to autodiscover, associate to, and communicate with as many Cisco 1000 series lightweight access points as possible.

When LWAPP communications are set to Layer 2 (same subnet) mode, the controller requires one management interface to control all inter-controller and all controller-to-access point communications, regardless of the number of ports. When LWAPP communications are set to Layer 3 (different subnet) mode, the controller requires one management interface to control all inter-controller communications and one AP-manager interface to control all controller-to-access point communications, regardless of the number of ports.

Note If the service port is in use, the management interface must be on a different Supernet from the service-port interface.

AP-Manager Interface

A controller has one or more AP-manager interfaces, which are used for all Layer 3 communications between the controller and lightweight access points after the access points have joined the controller. The AP-manager IP address is used as the tunnel source for LWAPP packets from the controller to the access point and as the destination for LWAPP packets from the access point to the controller.

For Cisco 4404 and WiSM controllers, configure the AP-manager interface on all distribution system ports (1, 2, 3, and 4). For Cisco 4402 controllers, configure the AP-manager interface on distribution system ports 1 and 2. In both cases, the static (or permanent) AP-manager interface is always assigned to distribution system port 1 and given a unique IP address. Configuring the AP-manager interface on the same VLAN or IP subnet as the management interface results in optimum access point association, but it is not a requirement.

Note If LAG is enabled, there can be only one AP-manager interface. But when LAG is disabled, you must assign an AP-manager interface to each port on the controller.

Note If only one distribution system port can be used, you should use distribution system port 1.

The AP-manager interface communicates through any distribution system port by listening across the Layer 3 or Layer 2 network for lightweight access point (LWAPP) join messages to associate and communicate with as many lightweight access points as possible.

Note

- Port redundancy for the AP-manager interface is not supported. You cannot map the AP-manager interface to a backup port. If the AP-manager interface fails, all of the access points connected to the controller through that interface are evenly distributed among the other configured AP-manager interfaces.
- Refer to the "Using Multiple AP-Manager Interfaces" section on page 3-36 for information on creating and using multiple AP-manager interfaces.

Virtual Interface

The virtual interface is used to support mobility management, Dynamic Host Configuration Protocol (DHCP) relay, and embedded Layer 3 security such as guest web authentication. It also maintains the DNS gateway host name used by Layer 3 security and mobility managers to verify the source of certificates when Layer 3 web authorization is enabled.

Specifically, the virtual interface plays these two primary roles:

- Acts as the DHCP server placeholder for wireless clients that obtain their IP address from a DHCP server.
- Serves as the redirect address for the web authentication login window.

Note See Chapter 5 for additional information on web authentication.

The virtual interface IP address is used only in communications between the controller and wireless clients. It never appears as the source or destination address of a packet that goes out a distribution system port and onto the switched network. For the system to operate correctly, the virtual interface IP address must be set (it cannot be 0.0.0.0), and no other device on the network can have the same address as the virtual interface. Therefore, the virtual interface must be configured with an unassigned and unused gateway IP address, such as 1.1.1.1. The virtual interface IP address is not pingable and should not exist in any routing table in your network. In addition, the virtual interface cannot be mapped to a backup port.

Note All controllers within a mobility group must be configured with the same virtual interface IP address. Otherwise, inter-controller roaming may appear to work, but the hand-off does not complete, and the client loses connectivity for a period of time.

Service-Port Interface

The service-port interface controls communications through and is statically mapped by the system to the service port. It must have an IP address on a different Supernet from the management, AP-manager, and any dynamic interfaces, and it cannot be mapped to a backup port. This configuration enables you to manage the controller directly or through a dedicated operating system network, such as 10.1.2.x, which can ensure service access during network downtime.

The service port can obtain an IP address using DHCP, or it can be assigned a static IP address, but a default gateway cannot be assigned to the service-port interface. Static routes can be defined through the controller for remote network access to the service port.

Note Only Cisco 4400 series controllers have a service-port interface.

Note You must configure an IP address on the service-port interface of both Cisco WiSM controllers. Otherwise, the neighbor switch is unable to check the status of each controller.

Dynamic Interface

Dynamic interfaces, also known as VLAN interfaces, are created by users and designed to be analogous to VLANs for wireless LAN clients. A controller can support up to 512 dynamic interfaces (VLANs). Each dynamic interface is individually configured and allows separate communication streams to exist on any or all of a controller's distribution system ports. Each dynamic interface controls VLAN and other communications between controllers and all other network devices, and each acts as a DHCP relay for wireless clients associated to WLANs mapped to the interface. You can assign dynamic interfaces to distribution system ports, WLANs, the Layer 2 management interface, and the Layer 3 AP-manager interface, and you can map the dynamic interface to a backup port.

You can configure zero, one, or multiple dynamic interfaces on a distribution system port. However, all dynamic interfaces must be on a different VLAN or IP subnet from all other interfaces configured on the port. If the port is untagged, all dynamic interfaces must be on a different IP subnet from any other interface configured on the port.

Note Tagged VLANs must be used for dynamic interfaces.

Note Cisco recommends that wired devices (DHCP servers, RADIUS servers, file servers, desktops, etc) be configured on separate VLANs and subnets from wireless devices.

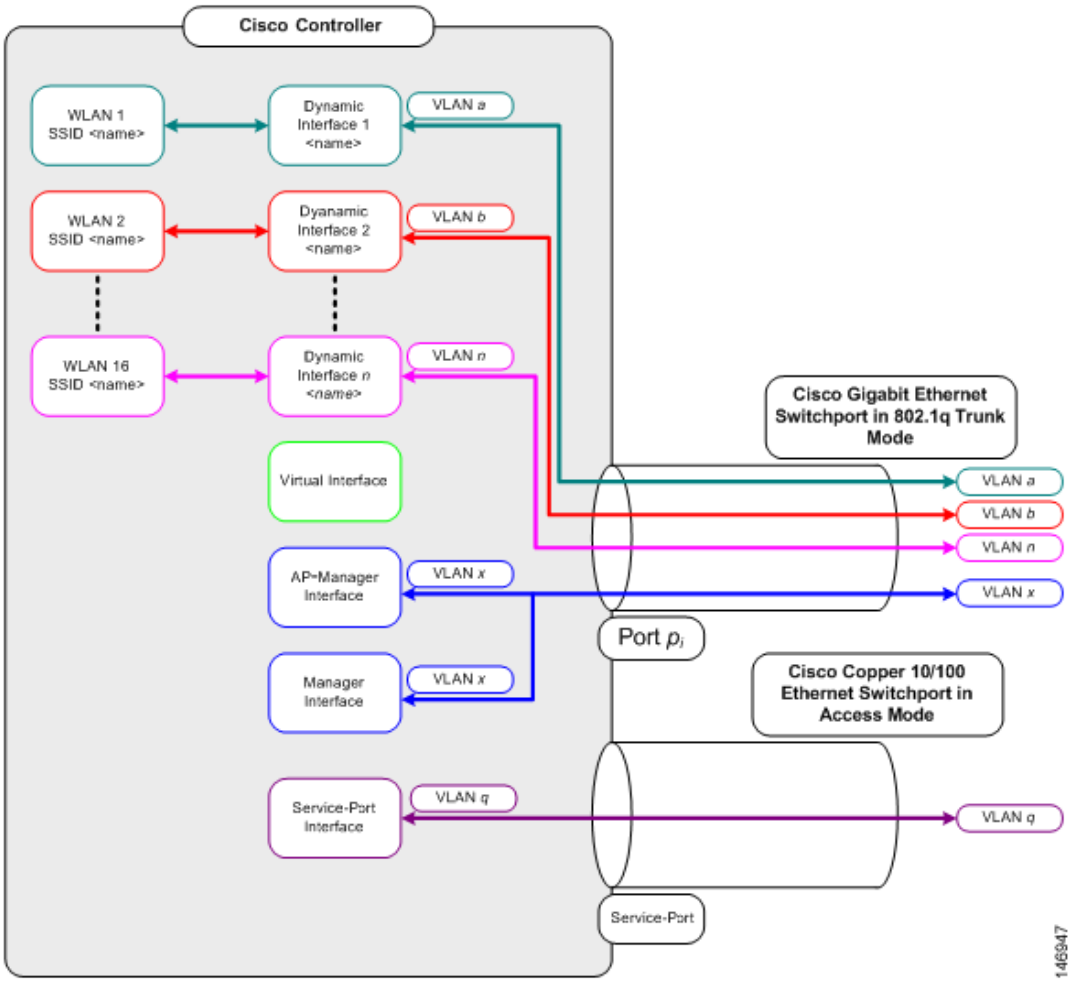
WLANs

A WLAN associates a service set identifier (SSID) to an interface. It is configured with security, quality of service (QoS), radio policies, and other wireless network parameters. Up to 16 access point WLANs can be configured per controller.

Note Chapter 6 provides instructions for configuring WLANs.

Figure 3-4 illustrates the relationship between ports, interfaces, and WLANs.

Figure 3-4 Ports, Interfaces, and WLANs



As shown in Figure 3-4, each controller port connection is an 802.1Q trunk and should be configured as such on the neighbor switch. On Cisco switches, the native VLAN of an 802.1Q trunk is an untagged VLAN. Therefore, if you configure an interface to use the native VLAN on a neighboring Cisco switch, make sure you configure the interface on the controller to be untagged.

Note A zero value for the VLAN identifier (on the Controller > Interfaces page) means that the interface is untagged.

The default (untagged) native VLAN on Cisco switches is VLAN 1. When controller interfaces are configured as tagged (meaning that the VLAN identifier is set to a non-zero value), the VLAN must be allowed on the 802.1Q trunk configuration on the neighbor switch and not be the native untagged VLAN.

Cisco recommends that only tagged VLANs be used on the controller. You should also allow only relevant VLANs on the neighbor switch's 802.1Q trunk connections to controller ports. All other VLANs should be disallowed or pruned in the switch port trunk configuration. This practice is extremely important for optimal performance of the controller.

Note Cisco recommends that you assign one set of VLANs for WLANs and a different set of VLANs for management interfaces to ensure that controllers properly route VLAN traffic.

Follow the instructions on the pages indicated to configure your controller's interfaces and ports:

- Configuring the Management, AP-Manager, Virtual, and Service-Port Interfaces, page 3-10
- Configuring Dynamic Interfaces, page 3-15
- Configuring Ports, page 3-19
- Enabling Link Aggregation, page 3-29
- Configuring a 4400 Series Controller to Support More Than 48 Access Points, page 3-36

Configuring the Management, AP-Manager, Virtual, and Service-Port Interfaces

Typically, you define the management, AP-manager, virtual, and service-port interface parameters using the Startup Wizard. However, you can display and configure interface parameters through either the GUI or CLI after the controller is running.

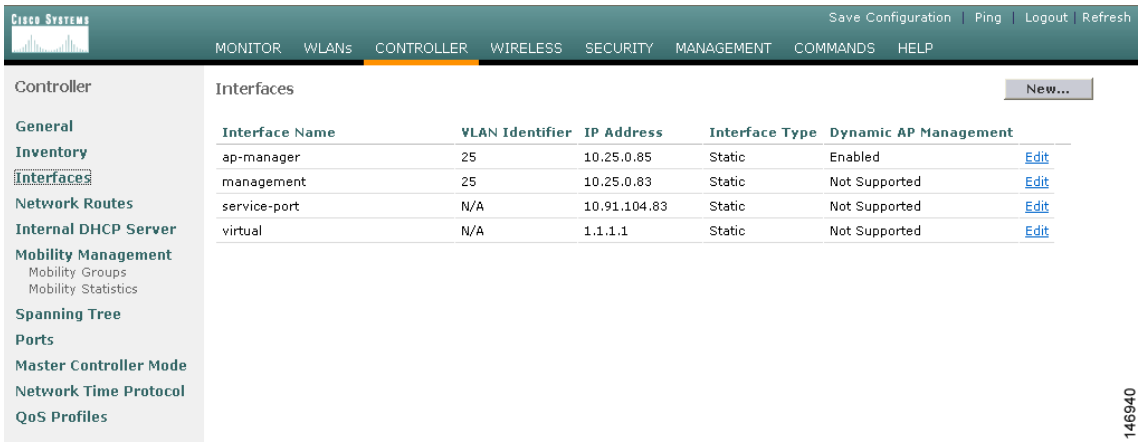
Note When assigning a WLAN to a DHCP server, both should be on the same subnet. Otherwise, you will need to use a router to route traffic between the WLAN and the DHCP server.

Using the GUI to Configure the Management, AP-Manager, Virtual, and Service-Port Interfaces

Follow these steps to display and configure the management, AP-manager, virtual, and service-port interface parameters using the GUI.

Step 1 Click **Controller** > **Interfaces** to access the Interfaces page (see Figure 3-5).

Figure 3-5 Interfaces Page



This page shows the current controller interface settings.

Step 2 If you want to modify the settings of a particular interface, click the interface's **Edit** link. The Interfaces > Edit page for that interface appears.

Step 3 Configure the following parameters for each interface type:

Management Interface

Note The management interface uses the controller's factory-set distribution system MAC address.

- VLAN identifier

  Note Enter **0** for an untagged VLAN or a non-zero value for a tagged VLAN. Cisco recommends that only tagged VLANs be used on the controller.

- Fixed IP address, IP netmask, and default gateway
- Physical port assignment
- Primary and secondary DHCP servers
- Access control list (ACL) setting, if required

  Note To create ACLs, follow the instructions in Chapter 5.

AP-Manager Interface

- VLAN identifier

  Note Enter **0** for an untagged VLAN or a non-zero value for a tagged VLAN. Cisco recommends that only tagged VLANs be used on the controller.

- Fixed IP address, IP netmask, and default gateway

Note The AP-manager interface's IP address must be different from the management interface's IP address and may or may not be on the same subnet as the management interface. However, Cisco recommends that both interfaces be on the same subnet for optimum access point association.

- Physical port assignment
- Primary and secondary DHCP servers
- Access control list (ACL) name, if required

Note To create ACLs, follow the instructions in Chapter 5.

Virtual Interface

- Any fictitious, unassigned, and unused gateway IP address, such as 1.1.1.1
- DNS gateway host name

Note To ensure connectivity and web authentication, the DNS server should always point to the virtual interface. If a DNS host name is configured for the virtual interface, then the same DNS host name must be configured on the DNS server(s) used by the client.

Service-Port Interface

Note The service-port interface uses the controller's factory-set service-port MAC address.

- DHCP protocol (enabled) or
- DHCP protocol (disabled) and IP address and IP netmask

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

Step 5 If you made any changes to the virtual interface, reboot the controller so your changes take effect.

Using the CLI to Configure the Management, AP-Manager, Virtual, and Service-Port Interfaces

This section provides instructions for displaying and configuring the management, AP-manager, virtual, and service-port interfaces using the CLI.

Using the CLI to Configure the Management Interface

Follow these steps to display and configure the management interface parameters using the CLI.

Step 1 Enter **show interface detailed management** to view the current management interface settings.

Note The management interface uses the controller's factory-set distribution system MAC address.

Step 2 Enter **config wlan disable** *wlan-number* to disable each WLAN that uses the management interface for distribution system communication.

Step 3 Enter these commands to define the management interface:

- **config interface address management** *ip-addr ip-netmask gateway*
- **config interface vlan management** {*vlan-id* | **0**}

Note Enter **0** for an untagged VLAN or a non-zero value for a tagged VLAN. Cisco recommends that only tagged VLANs be used on the controller.

- **config interface port management** *physical-ds-port-number*
- **config interface dhcp management** *ip-address-of-primary-dhcp-server* [*ip-address-of-secondary-dhcp-server*]
- **config interface acl management** *access-control-list-name*

Note See Chapter 5 for more information on ACLs.

Step 4 Enter **save config** to save your changes.

Step 5 Enter **show interface detailed management** to verify that your changes have been saved.

Using the CLI to Configure the AP-Manager Interface

Follow these steps to display and configure the AP-manager interface parameters using the CLI.

Step 1 Enter **show interface summary** to view the current interfaces.

Note If the system is operating in Layer 2 mode, the AP-manager interface is not listed.

Step 2 Enter **show interface detailed ap-manager** to view the current AP-manager interface settings.

Step 3 Enter **config wlan disable** *wlan-number* to disable each WLAN that uses the AP-manager interface for distribution system communication.

Step 4 Enter these commands to define the AP-manager interface:

- **config interface address ap-manager** *ip-addr ip-netmask gateway*
- **config interface vlan ap-manager** {*vlan-id* | **0**}

Note Enter **0** for an untagged VLAN or a non-zero value for a tagged VLAN. Cisco recommends that only tagged VLANs be used on the controller.

- **config interface port ap-manager** *physical-ds-port-number*
- **config interface dhcp ap-manager** *ip-address-of-primary-dhcp-server* [*ip-address-of-secondary-dhcp-server*]
- **config interface acl ap-manager** *access-control-list-name*

Note See Chapter 5 for more information on ACLs.

Step 5 Enter **save config** to save your changes.

Step 6 Enter **show interface detailed ap-manager** to verify that your changes have been saved.

Using the CLI to Configure the Virtual Interface

Follow these steps to display and configure the virtual interface parameters using the CLI.

Step 1 Enter **show interface detailed virtual** to view the current virtual interface settings.

Step 2 Enter **config wlan disable** *wlan-number* to disable each WLAN that uses the virtual interface for distribution system communication.

Step 3 Enter these commands to define the virtual interface:

- **config interface address virtual** *ip-address*

Note For *ip-address*, enter any fictitious, unassigned, and unused gateway IP address, such as 1.1.1.1.

- **config interface hostname virtual** *dns-host-name*

Step 4 Enter **reset system**. At the confirmation prompt, enter **Y** to save your configuration changes to NVRAM. The controller reboots.

Step 5 Enter **show interface detailed virtual** to verify that your changes have been saved.

Using the CLI to Configure the Service-Port Interface

Follow these steps to display and configure the service-port interface parameters using the CLI.

Step 1 Enter **show interface detailed service-port** to view the current service-port interface settings.

Note The service-port interface uses the controller's factory-set service-port MAC address.

Step 2 Enter these commands to define the service-port interface:

- To configure the DHCP server: **config interface dhcp service-port** *ip-address-of-primary-dhcp-server* [*ip-address-of-secondary-dhcp-server*]
- To disable the DHCP server: **config interface dhcp service-port none**
- To configure the IP address: **config interface address service-port** *ip-addr ip-netmask gateway*

Step 3 The service port is used for out-of-band management of the controller. If the management workstation is in a remote subnet, you may need to add a route on the controller in order to manage the controller from that remote workstation. To do so, enter this command:

config route *network-ip-addr ip-netmask gateway*

Step 4 Enter **save config** to save your changes.

Step 5 Enter **show interface detailed service-port** to verify that your changes have been saved.

Configuring Dynamic Interfaces

This section provides instructions for configuring dynamic interfaces using either the GUI or CLI.

Using the GUI to Configure Dynamic Interfaces

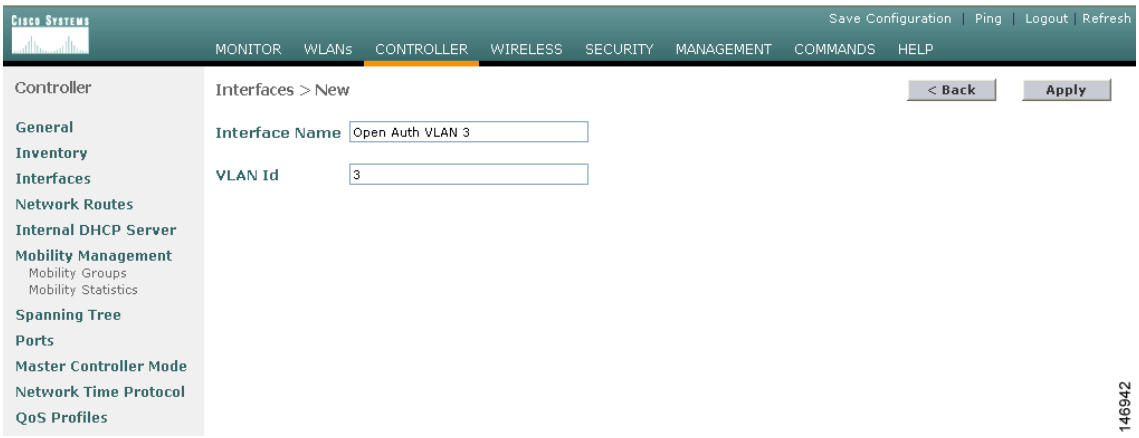
Follow these steps to create new or edit existing dynamic interfaces using the GUI.

Step 1 Click **Controller** > **Interfaces** to access the Interfaces page (see Figure 3-5).

Step 2 Perform one of the following:

- To create a new dynamic interface, click **New**. The Interfaces > New page appears (see Figure 3-6). Go to Step 3.
- To modify the settings of an existing dynamic interface, click the interface's **Edit** link. The Interfaces > Edit page for that interface appears (see Figure 3-7). Go to Step 5.
- To delete an existing dynamic interface, click the interface's **Remove** link.

Figure 3-6 Interfaces > New Page

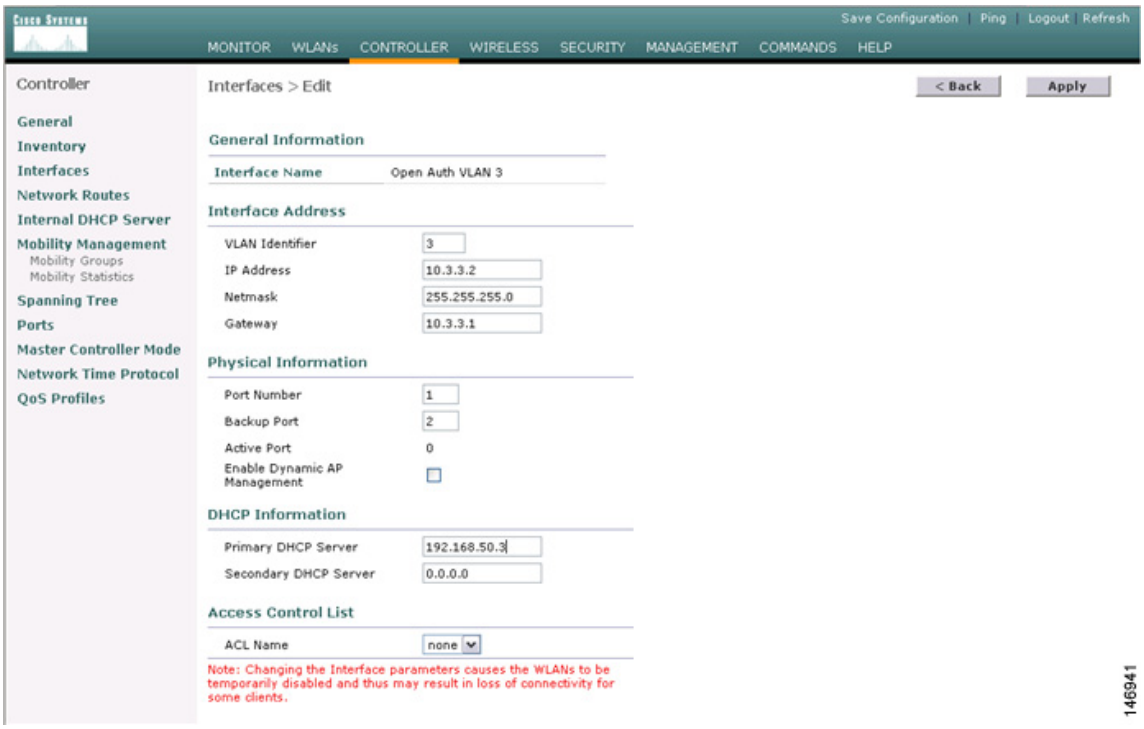


Step 3 Enter an interface name and a VLAN identifier, as shown in Figure 3-6.

Note Enter a non-zero value for the VLAN identifier. Tagged VLANs must be used for dynamic interfaces.

Step 4 Click **Apply** to commit your changes. The Interfaces > Edit page appears (see Figure 3-7).

Figure 3-7 Interfaces > Edit Page



Step 5 Configure the following parameters:

- VLAN identifier
- Fixed IP address, IP netmask, and default gateway
- Physical port assignment
- Quarantine

Note Check the **Quarantine** check box if you want to configure this VLAN as unhealthy. Doing so causes the data traffic of any client that is assigned to this VLAN to pass through the controller, even if the WLAN is configured for local switching. This command is generally used for clients that are associated to a hybrid-REAP access point and the access point's controller is configured for network access control (NAC). See Chapter 12 for more information on hybrid REAP.

- Primary and secondary DHCP servers
- Access control list (ACL) name, if required

Note See Chapter 5 for more information on ACLs.

Note To ensure proper operation, you must set the Port Number and Primary DHCP Server parameters.

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

Step 7 Repeat this procedure for each dynamic interface that you want to create or edit.

Using the CLI to Configure Dynamic Interfaces

Follow these steps to configure dynamic interfaces using the CLI.

Step 1 Enter **show interface summary** to view the current dynamic interfaces.

Step 2 To view the details of a specific dynamic interface, enter **show interface detailed** *operator-defined-interface-name*.

Step 3 Enter **config wlan disable** *wlan-number* to disable each WLAN that uses the dynamic interface for distribution system communication.

Step 4 Enter these commands to configure dynamic interfaces:

- **config interface create** *operator-defined-interface-name* {*vlan-id* | ***x***}

  Note Enter a non-zero value for the VLAN identifier. Tagged VLANs must be used for dynamic interfaces.

- **config interface address** *operator-defined-interface-name ip-addr ip-netmask* [*gateway*]
- **config interface vlan** *operator-defined-interface-name* {*vlan-id* | **0**}
- **config interface port** *operator-defined-interface-name physical-ds-port-number*
- **config interface dhcp** *operator-defined-interface-name ip-address-of-primary-dhcp-server* [*ip-address-of-secondary-dhcp-server*]
- **config interface** *operator-defined-interface-name* **quarantine enable**

  Note Use this command if you want to configure this VLAN as unhealthy. Doing so causes the data traffic of any client that is assigned to this VLAN to pass through the controller, even if the WLAN is configured for local switching. This command is generally used for clients that are associated to a hybrid-REAP access point and the access point's controller is configured for network access control (NAC). See Chapter 12 for more information on hybrid REAP.

- **config interface acl** *operator-defined-interface-name access-control-list-name*

  Note See Chapter 5 for more information on ACLs.

Step 5 Enter **save config** to save your changes.

Step 6 Enter **show interface detailed** *operator-defined-interface-name* and **show interface summary** to verify that your changes have been saved.

Note If desired, you can enter **config interface delete** *operator-defined-interface-name* to delete a dynamic interface.

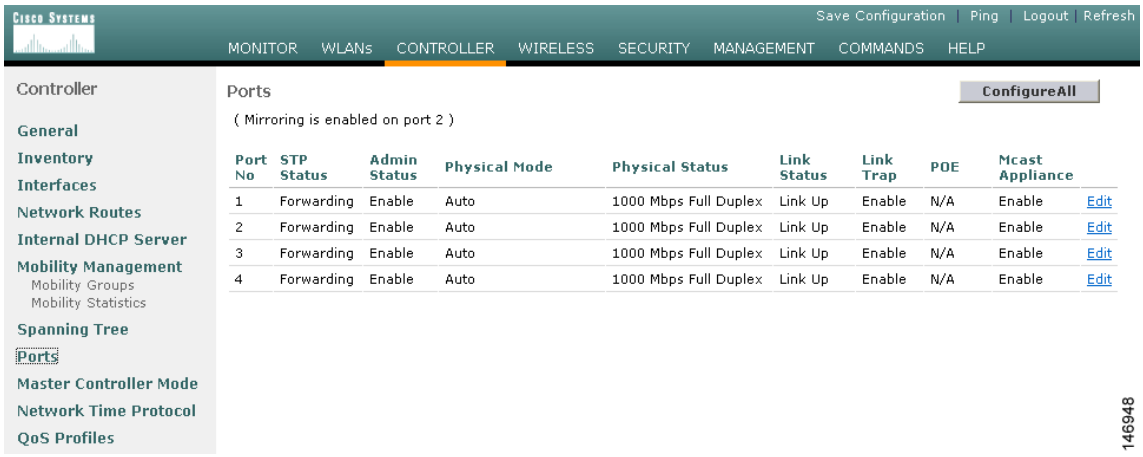
Configuring Ports

The controller's ports are preconfigured with factory default settings designed to make the controllers' ports operational without additional configuration. However, you can view the status of the controller's ports and edit their configuration parameters at any time.

Follow these steps to use the GUI to view the status of the controller's ports and make any configuration changes if necessary.

Step 1 Click **Controller** > **Ports** to access the Ports page (see Figure 3-8).

Figure 3-8 Ports Page



This page shows the current configuration for each of the controller's ports.

Step 2 If you want to change the settings of any port, click the **Edit** link for that specific port. The Port > Configure page appears (see Figure 3-9).

Note If the management and AP-manager interfaces are mapped to the same port and are members of the same VLAN, you must disable the WLAN before making a port-mapping change to either interface. If the management and AP-manager interfaces are assigned to different VLANs, you do not need to disable the WLAN.

Note The number of parameters available on the Port > Configure page depends on your controller type. For instance, 2000 and 2100 series controllers and the controller in a Cisco Integrated Services Router have fewer configurable parameters than a 4400 series controller, which is shown in Figure 3-9.

Figure 3-9 Port > Configure Page

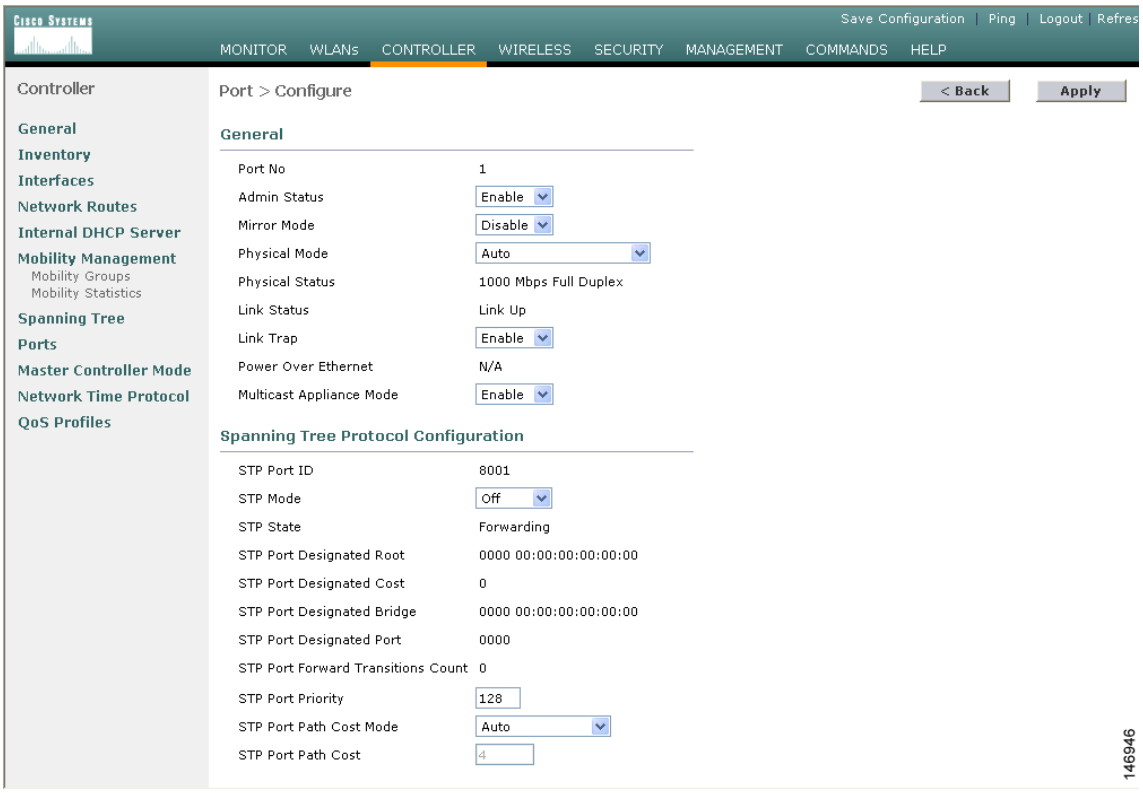


Table 3-2 interprets the current status of the port.

Table 3-2 Port Status

Parameter	Description	
Port Number	The number of the current port.	
Physical Status	The data rate being used by the port. The available data rates vary based on controller type.	
	Controller	**Available Data Rates**
	4400 series	1000 Mbps full duplex
	2000 and 2100 series	10 or 100 Mbps, half or full duplex
	WiSM	1000 Mbps full duplex
	Catalyst 3750G Integrated Wireless LAN Controller Switch	1000 Mbps full duplex
	WLAN controller module	100 Mbps full duplex
Link Status	The port's link status. **Values:** Link Up or Link Down	

Table 3-2 Port Status

Parameter	Description
Power Over Ethernet (PoE)	Determines if the connecting device is equipped to receive power through the Ethernet cable and if so provides -48 VDC. **Values:** Enable or Disable **Note** Some older Cisco access points do not draw PoE even if it is enabled on the controller port. In such cases, contact the Cisco Technical Assistance Center (TAC). **Note** The controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch supports PoE on all ports.

Step 3 Table 3-3 lists and describes the port's configurable parameters. Follow the instructions in the table to make any desired changes.

Table 3-3 Port Parameters

Parameter	Description
Admin Status	Enables or disables the flow of traffic through the port. **Options:** Enable or Disable **Default:** Enable **Note** Administratively disabling the port on a controller does not affect the port's link status. The link can be brought down only by other Cisco devices. On other Cisco products, however, administratively disabling a port brings the link down.
Physical Mode	Determines whether the port's data rate is set automatically or specified by the user. The supported data rates vary based on controller type. **Default:** Auto

Controller	Supported Data Rates
4400 series	Auto or 1000 Mbps full duplex
2000 and 2100 series	Auto or 10 or 100 Mbps, half or full duplex
WiSM	Auto or 1000 Mbps full duplex
Catalyst 3750G Integrated Wireless LAN Controller Switch	Auto or 1000 Mbps full duplex
WLAN controller module	Auto or 100 Mbps full duplex

Link Trap	Causes the port to send a trap when the port's link status changes. **Options:** Enable or Disable **Default:** Enable

Table 3-3 Port Parameters (continued)

Parameter	Description
Multicast Appliance Mode	Enables or disables the multicast appliance service for this port. **Options:** Enable or Disable **Default:** Enable

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

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

Step 6 Click **Back** to return to the Ports page and review your changes.

Step 7 Repeat this procedure for each additional port that you want to configure.

Step 8 Go to the following sections if you want to configure the controller's ports for these advanced features:

- Port mirroring, see below
- Spanning Tree Protocol (STP), page 3-23

Configuring Port Mirroring

Mirror mode enables you to duplicate to another port all of the traffic originating from or terminating at a single client device or access point. It is useful in diagnosing specific network problems. Mirror mode should be enabled only on an unused port as any connections to this port become unresponsive.

Note WiSM controllers do not support mirror mode. Also, a controller's service port cannot be used as a mirrored port.

Note Port mirroring is not supported when link aggregation (LAG) is enabled on the controller.

Note Cisco recommends that you do not mirror traffic from one controller port to another as this setup could cause network problems.

Follow these steps to enable port mirroring.

Step 1 Click **Controller** > **Ports** to access the Ports page (see Figure 3-8).

Step 2 Click **Edit** for the unused port for which you want to enable mirror mode. The Port > Configure page appears (see Figure 3-9).

Step 3 Set the Mirror Mode parameter to **Enable**.

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

Step 5 Perform one of the following:

- Follow these steps if you want to choose a specific client device that will mirror its traffic to the port you selected on the controller:
  a. Click **Wireless > Clients** to access the Clients page.
  b. Click **Detail** for the client on which you want to enable mirror mode. The Clients > Detail page appears.
  c. Under Client Details, set the Mirror Mode parameter to **Enable**.
- Follow these steps if you want to choose an access point that will mirror its traffic to the port you selected on the controller:
  a. Click **Wireless > All APs** to access the All APs page.
  b. Click **Detail** for the access point on which you want to enable mirror mode. The All APs > Details page appears.
  c. Under General, set the Mirror Mode parameter to **Enable**.

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

Configuring Spanning Tree Protocol

Spanning Tree Protocol (STP) is a Layer 2 link management protocol that provides path redundancy while preventing loops in the network. For a Layer 2 Ethernet network to function properly, only one active path can exist between any two network devices. STP allows only one active path at a time between network devices but establishes redundant links as a backup if the initial link should fail.

The spanning-tree algorithm calculates the best loop-free path throughout a Layer 2 network. Infrastructure devices such as controllers and switches send and receive spanning-tree frames, called bridge protocol data units (BPDUs), at regular intervals. The devices do not forward these frames but use them to construct a loop-free path.

Multiple active paths among end stations cause loops in the network. If a loop exists in the network, end stations might receive duplicate messages. Infrastructure devices might also learn end-station MAC addresses on multiple Layer 2 interfaces. These conditions result in an unstable network.

STP defines a tree with a root bridge and a loop-free path from the root to all infrastructure devices in the Layer 2 network.

Note STP discussions use the term *root* to describe two concepts: the controller on the network that serves as a central point in the spanning tree is called the *root bridge*, and the port on each controller that provides the most efficient path to the root bridge is called the *root port*. The root bridge in the spanning tree is called the *spanning-tree root*.

STP forces redundant data paths into a standby (blocked) state. If a network segment in the spanning tree fails and a redundant path exists, the spanning-tree algorithm recalculates the spanning-tree topology and activates the standby path.

When two ports on a controller are part of a loop, the spanning-tree port priority and path cost settings determine which port is put in the forwarding state and which is put in the blocking state. The port priority value represents the location of a port in the network topology and how well it is located to pass traffic. The path cost value represents media speed.

The controller maintains a separate spanning-tree instance for each active VLAN configured on it. A bridge ID, consisting of the bridge priority and the controller's MAC address, is associated with each instance. For each VLAN, the controller with the lowest controller ID becomes the spanning-tree root for that VLAN.

STP is disabled for the controller's distribution system ports by default. The following sections provide instructions for configuring STP for your controller using either the GUI or CLI.

Note STP cannot be configured for the controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch.

Using the GUI to Configure Spanning Tree Protocol

Follow these steps to configure STP using the GUI.

Step 1 Click **Controller** > **Ports** to access the Ports page (see Figure 3-8).

Step 2 Click **Edit** for the specific port for which you want to configure STP. The Port > Configure page appears (see Figure 3-9). This page shows the STP status of the port and enables you to configure STP parameters.

Table 3-4 interprets the current STP status of the port.

Table 3-4 Port Spanning Tree Status

Parameter	Description	
STP Port ID	The number of the port for which STP is enabled or disabled.	
STP State	The port's current STP state. It controls the action that a port takes upon receiving a frame. **Values:** Disabled, Blocking, Listening, Learning, Forwarding, and Broken	
	STP State	**Description**
	Disabled	The port is not participating in spanning tree because the port is shut down, the link is down, or STP is not enabled for this port.
	Blocking	The port does not participate in frame forwarding.
	Listening	The first transitional state after the blocking state when STP determines that the port should participate in frame forwarding.
	Learning	The port prepares to participate in frame forwarding.
	Forwarding	The port forwards frames.
	Broken	The port is malfunctioning.
STP Port Designated Root	The unique identifier of the root bridge in the configuration BPDUs.	
STP Port Designated Cost	The path cost of the designated port.	
STP Port Designated Bridge	The identifier of the bridge that the port considers to be the designated bridge for this port.	

Table 3-4 Port Spanning Tree Status (continued)

Parameter	Description
STP Port Designated Port	The port identifier on the designated bridge for this port.
STP Port Forward Transitions Count	The number of times that the port has transitioned from the learning state to the forwarding state.

Step 3 Table 3-5 lists and describes the port's configurable STP parameters. Follow the instructions in the table to make any desired changes.

Table 3-5 Port Spanning Tree Parameters

Parameter	Description	
STP Mode	The STP administrative mode associated with this port. **Options:** Off, 802.1D, or Fast **Default:** Off	
	STP Mode	**Description**
	Off	Disables STP for this port.
	802.1D	Enables this port to participate in the spanning tree and go through all of the spanning tree states when the link state transitions from down to up.
	Fast	Enables this port to participate in the spanning tree and puts it in the forwarding state when the link state transitions from down to up more quickly than when the STP mode is set to 802.1D. **Note** In this state, the forwarding delay timer is ignored on link up.
STP Port Priority	The location of the port in the network topology and how well the port is located to pass traffic. **Range:** 0 to 255 **Default:** 128	
STP Port Path Cost Mode	Determines whether the STP port path cost is set automatically or specified by the user. If you choose User Configured, you also need to set a value for the STP Port Path Cost parameter. **Range:** Auto or User Configured **Default:** Auto	

Table 3-5 Port Spanning Tree Parameters (continued)

Parameter	Description
STP Port Path Cost	The speed at which traffic is passed through the port. This parameter must be set if the STP Port Path Cost Mode parameter is set to User Configured. **Options:** 0 to 65535 **Default:** 0, which causes the cost to be adjusted for the speed of the port when the link comes up. **Note** Typically, a value of 100 is used for 10-Mbps ports and 19 for 100-Mbps ports.

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

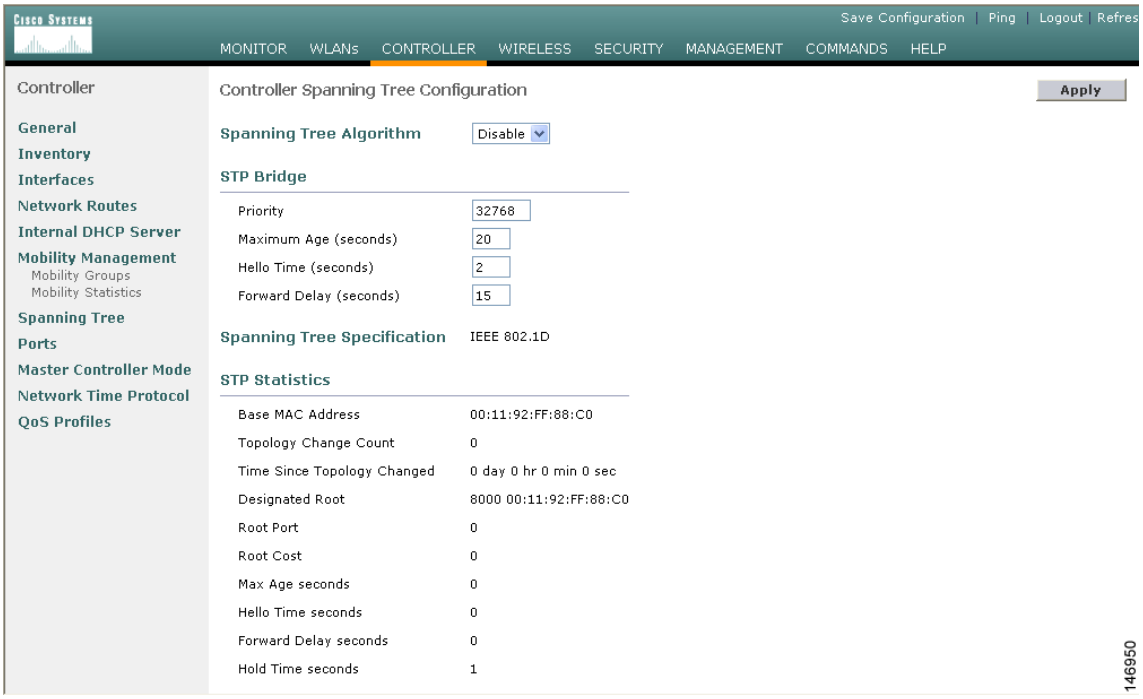
Step 5 Click **Save Configuration** to save your changes.

Step 6 Click **Back** to return to the Ports page.

Step 7 Repeat Step 2 through Step 6 for each port for which you want to enable STP.

Step 8 Click **Controller > Spanning Tree** to access the Controller Spanning Tree Configuration page (see Figure 3-10).

Figure 3-10 Controller Spanning Tree Configuration Page



This page allows you to enable or disable the spanning tree algorithm for the controller, modify its characteristics, and view the STP status.Table 3-6 interprets the current STP status for the controller.

Table 3-6 Controller Spanning Tree Status

Parameter	Description
Spanning Tree Specification	The STP version being used by the controller. Currently, only an IEEE 802.1D implementation is available.
Base MAC Address	The MAC address used by this bridge when it must be referred to in a unique fashion. When it is concatenated with dot1dStpPriority, a unique bridge identifier is formed that is used in STP.
Topology Change Count	The total number of topology changes detected by this bridge since the management entity was last reset or initialized.
Time Since Topology Changed	The time (in days, hours, minutes, and seconds) since a topology change was detected by the bridge.
Designated Root	The bridge identifier of the spanning tree root. This value is used as the Root Identifier parameter in all configuration BPDUs originated by this node.
Root Port	The number of the port that offers the lowest cost path from this bridge to the root bridge.
Root Cost	The cost of the path to the root as seen from this bridge.
Max Age (seconds)	The maximum age of STP information learned from the network on any port before it is discarded.
Hello Time (seconds)	The amount of time between the transmission of configuration BPDUs by this node on any port when it is the root of the spanning tree or trying to become so. This is the actual value that this bridge is currently using.
Forward Delay (seconds)	This value controls how fast a port changes its spanning tree state when moving toward the forwarding state. It determines how long the port stays in each of the listening and learning states that precede the forwarding state. This value is also used, when a topology change has been detected and is underway, to age all dynamic entries in the forwarding database. **Note** This is the actual value that this bridge is currently using, in contrast to *Stp Bridge Forward Delay*, which is the value that this bridge and all others would start using if this bridge were to become the root.
Hold Time (seconds)	The minimum time period to elapse between the transmission of configuration BPDUs through a given LAN port. **Note** At most, one configuration BPDU can be transmitted in any hold time period.

Step 9 Table 3-7 lists and describes the controller's configurable STP parameters. Follow the instructions in the table to make any desired changes.

Table 3-7 Controller Spanning Tree Parameters

Parameter	Description
Spanning Tree Algorithm	Enables or disables STP for the controller. **Options:** Enable or Disable **Default:** Disable
Priority	The location of the controller in the network topology and how well the controller is located to pass traffic. **Range:** 0 to 65535 **Default:** 32768
Maximum Age (seconds)	The length of time that the controller stores protocol information received on a port. **Range:** 6 to 40 seconds **Default:** 20 seconds
Hello Time (seconds)	The length of time that the controller broadcasts hello messages to other controllers. **Options:** 1 to 10 seconds **Default:** 2 seconds
Forward Delay (seconds)	The length of time that each of the listening and learning states lasts before the port begins forwarding. **Options:** 4 to 30 seconds **Default:** 15 seconds

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

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

Using the CLI to Configure Spanning Tree Protocol

Follow these steps to configure STP using the CLI.

Step 1 Enter **show spanningtree port** and **show spanningtree switch** to view the current STP status.

Step 2 If STP is enabled, you must disable it before you can change STP settings. Enter **config spanningtree switch mode disable** to disable STP on all ports.

Step 3 Enter one of these commands to configure the STP port administrative mode:

- **config spanningtree port mode 802.1d** {*port-number* | **all**}
- **config spanningtree port mode fast** {*port-number* | **all**}
- **config spanningtree port mode off** {*port-number* | **all**}

Step 4 Enter one of these commands to configure the STP port path cost on the STP ports:

- **config spanningtree port pathcost** *1-65535* {*port-number* | **all**}—Specifies a path cost from 1 to 65535 to the port.
- **config spanningtree port mode pathcost auto** {*port-number* | **all**}—Enables the STP algorithm to automatically assign the path cost. This is the default setting.

Step 5 Enter **config spanningtree port priority** *0-255 port-number* to configure the port priority on STP ports. The default priority is 128.

Step 6 If necessary, enter **config spanningtree switch bridgepriority** *0-65535* to configure the controller's STP bridge priority. The default bridge priority is 32768.

Step 7 If necessary, enter **config spanningtree switch forwarddelay** *4-30* to configure the controller's STP forward delay in seconds. The default forward delay is 15 seconds.

Step 8 If necessary, enter **config spanningtree switch hellotime** *1-10* to configure the controller's STP hello time in seconds. The default hello time is 2 seconds.

Step 9 If necessary, enter **config spanningtree switch maxage** *6-40* to configure the controller's STP maximum age. The default maximum age is 20 seconds.

Step 10 After you configure STP settings for the ports, enter **config spanningtree switch mode enable** to enable STP for the controller. The controller automatically detects logical network loops, places redundant ports on standby, and builds a network with the most efficient pathways.

Step 11 Enter **save config** to save your settings.

Step 12 Enter **show spanningtree port** and **show spanningtree switch** to verify that your changes have been saved.

Enabling Link Aggregation

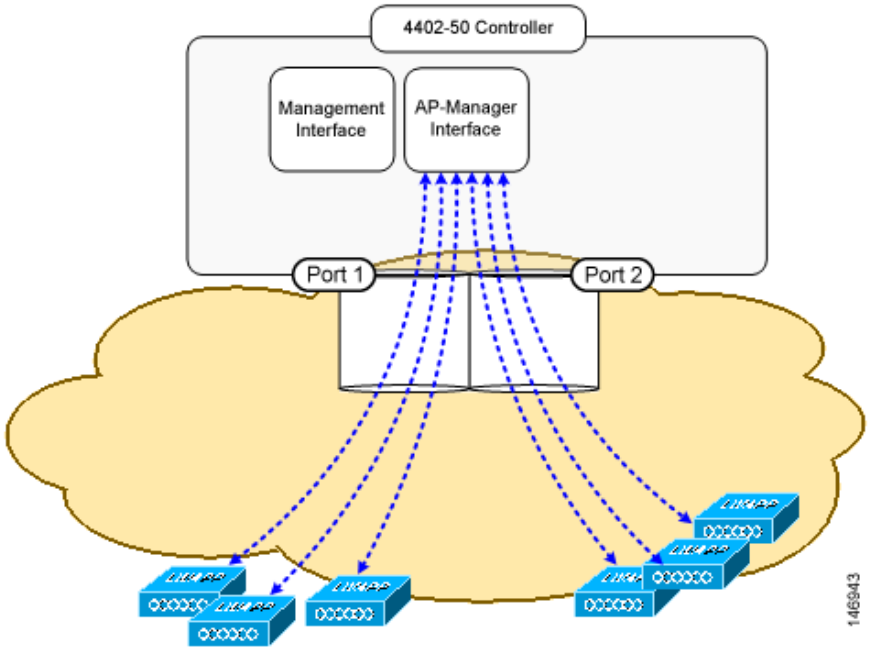
Link aggregation (LAG) is a partial implementation of the 802.3ad port aggregation standard. It bundles all of the controller's distribution system ports into a single 802.3ad port channel, thereby reducing the number of IP addresses needed to configure the ports on your controller. When LAG is enabled, the system dynamically manages port redundancy and load balances access points transparently to the user.

Cisco 4400 series controllers support LAG in software release 3.2 and higher, and LAG is enabled automatically on the controllers within the Cisco WiSM and the Catalyst 3750G Integrated Wireless LAN Controller Switch. Without LAG, each distribution system port on the controller supports up to 48 access points. With LAG enabled, a 4402 controller's logical port supports up to 50 access points, a 4404 controller's logical port supports up to 100 access points, and the logical port on each Cisco WiSM controller supports up to 150 access points.

Note You can bundle all four ports on a 4404 controller (or two on a 4402 controller) into a single link.

Figure 3-11 illustrates LAG.

Figure 3-11 Link Aggregation



LAG simplifies controller configuration because you no longer need to configure primary and secondary ports for each interface. If any of the controller ports fail, traffic is automatically migrated to one of the other ports. As long as at least one controller port is functioning, the system continues to operate, access points remain connected to the network, and wireless clients continue to send and receive data.

When configuring bundled ports on the controller, you may want to consider terminating on two different modules within a modular switch such as the Catalyst 6500; however, we do not recommend connecting LAG ports of a 4400 controller to multiple Catalyst 6500 or 3750G switches.

Terminating on two different modules within a single Catalyst 6500 switch provides redundancy and ensures that connectivity between the switch and the controller is maintained when one module fails. Figure 3-12 illustrates this use of redundant modules. A 4402-50 controller is connected to two different gigabit modules (slots 2 and 3) within the Catalyst 6500. The controller's port 1 is connected to gigabit interface 3/1, and the controller's port 2 is connected to gigabit interface 2/1 on the Catalyst 6500. Both switch ports are assigned to the same channel group.

Note When a 4404 controller or WiSM controller module LAG port is connected to a Catalyst 3750G or 6500 channel group employing load balancing, note the following:

- LAG requires the etherchannel to be configured for the "on" mode on both the controller and the Catalyst switch.
- Once the etherchannel is configured as "on," at both ends of the link, it does not matter if the Catalyst switch is configured with either Link Aggregation Control Protocol (LACP) or Cisco proprietary Port Aggregation Protocol (PAgP) because no channel negotiation is done between the controller and the switch. Additionally, LACP and PAgP are not supported on the controller.
- However, the load-balancing method configured on the Catalyst switch must be a load-balancing method that terminates all IP datagram fragments on a single controller port. Not following this recommendation may result in problems with access point association.
- The recommended load-balancing method for Catalyst switches is *src-dest-ip* (Command line interface command: **port-channel load-balance** *src-dest-ip*).
- The Catalyst 6500 series switches running in PFC3 or PFC3CXL mode implement enhanced EtherChannel load balancing. The enhanced EtherChannel load balancing adds the VLAN number to the hash function, which is incompatible with LAG. From Release 12.2(33)SXH and later releases, Catalyst 6500 IOS software offers the **exclude vlan** keyword to the **port-channel load-balance** command to implement **src-dst-ip** load distribution. See the *Cisco IOS Interface and Hardware Component Command Reference* guide for more information.
- Enter the **show platform hardware pfc mode** command on the Catalyst 6500 switch to confirm the PFC operating mode.

  The following example shows a Catalyst 6500 series switch in PFC3B mode when you enter the global configuration **port-channel load-balance src-dst-ip** command for proper LAG functionality:

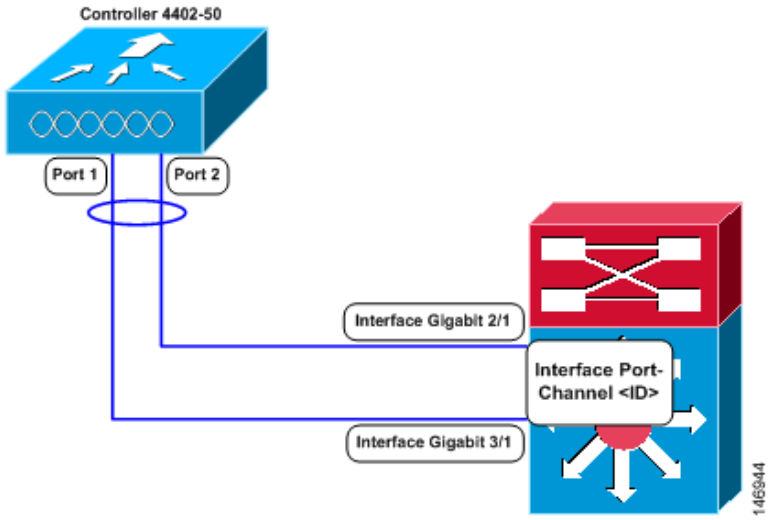
```
# show platform hardware pfc mode PFC operating mode
PFC operating mode : PFC3B
# show EtherChannel load-balance
EtherChannel Load-Balancing Configuration:
src-dst-ip
```

  The following example shows Catalyst 6500 series switch in PFC3C mode when you enter the **exclude vlan** keyword in the **port-channel load- balance src-dst-ip exclude vlan** command.

```
# show platform hardware pfc mode
PFC operating mode : PFC3C
# show EtherChannel load-balance
EtherChannel Load-Balancing Configuration:
src-ip enhanced
# mpls label-ip
```

- If the recommended load-balancing method cannot be configured on the Catalyst switch, then configure the LAG connection as a single member link or disable LAG on the controller.

Figure 3-12 Link Aggregation with Catalyst 6500 Neighbor Switch



Link Aggregation Guidelines

Keep these guidelines in mind when using LAG:

- You cannot configure the controller's ports into separate LAG groups. Only one LAG group is supported per controller. Therefore, you can connect a controller in LAG mode to only one neighbor device.

  Note The two internal gigabit ports on the controller within the Catalyst 3750G Integrated Wireless LAN Controller Switch are always assigned to the same LAG group.

- When LAG is enabled, any change to the LAG configuration requires a controller reboot.
- When you enable LAG, you can configure only one AP-manager interface because only one logical port is needed. LAG removes the requirement for supporting multiple AP-manager interfaces.
- When you enable LAG, all dynamic AP-manager interfaces and untagged interfaces are deleted, and all WLANs are disabled and mapped to the management interface. Also, the management, static AP-manager, and VLAN-tagged dynamic interfaces are moved to the LAG port.
- Multiple untagged interfaces to the same port are not allowed.
- When you enable LAG, you cannot create interfaces with a primary port other than 29.
- When you enable LAG, all ports participate in LAG by default. Therefore, you must configure LAG for all of the connected ports in the neighbor switch.
- When you enable LAG, port mirroring is not supported.
- With LAG, if any single link goes down, traffic migrates to the other links.
- With LAG, only one functional physical port is needed for the controller to pass client traffic.
- When you enable LAG, access points remain connected to the switch and data service for users continues uninterrupted.
- When you enable LAG, you eliminate the need to configure primary and secondary ports for each interface.
- When you disable LAG, the management, static AP-manager, and dynamic interfaces are moved to port 1.
- When you disable LAG, you may configure primary and secondary ports for all interfaces.
- When you disable LAG, you must assign an AP-manager interface to each port on the controller.
- When you enable LAG, the controller sends packets out on the same port on which it received them. If an LWAPP packet from an access point enters the controller on physical port 1, the controller removes the LWAPP wrapper, processes the packet, and forwards it to the network on physical port 1. This may not be the case if you disable LAG.
- Cisco 4400 series controllers support a single static link aggregation bundle.
- LAG is typically configured using the Startup Wizard, but you can enable or disable it at any time through either the GUI or CLI.

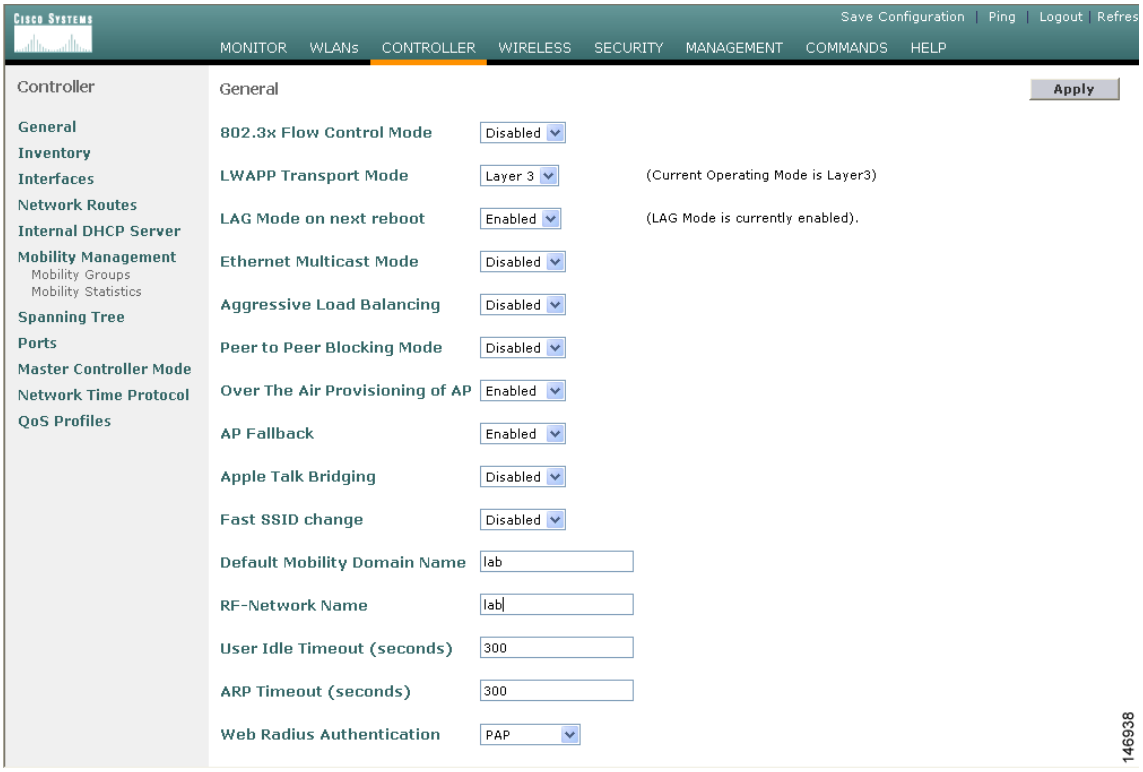
  Note LAG is enabled by default and is the only option on the WiSM controller and the controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch.

Using the GUI to Enable Link Aggregation

Follow these steps to enable LAG on your controller using the GUI.

Step 1 Click **Controller** > **General** to access the General page (see Figure 3-13).

Figure 3-13 General Page



Step 2 Set the LAG Mode on Next Reboot parameter to **Enabled**.

Note Choose **Disabled** if you want to disable LAG. LAG is disabled by default on the Cisco 4400 series controllers but enabled by default on the Cisco WiSM.

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

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

Step 5 Reboot the controller.

Step 6 Assign the WLAN to the appropriate VLAN.

Using the CLI to Enable Link Aggregation

Follow these steps to enable LAG on your controller using the CLI.

Step 1 Enter **config lag enable** to enable LAG.

Note Enter **config lag disable** if you want to disable LAG.

Step 2 Enter **save config** to save your settings.

Step 3 Reboot the controller.

Verifying LAG Settings Using the CLI

To verify the new LAG settings, enter **show lag summary**.

To show the physical port used for a specific MAC address, enter **show lag eth-port-hash** *mac_address*. Use this command for Layer 2 packets (LWAPP Layer 2 mode).

To show the physical port used for a specific IP address, enter **show lag ip-port-hash** *ip_address*. Use this command for Layer 3 packets (LWAPP Layer 3 mode).

Examples:

```
>show lag summary
LAG Enabled

>show lag eth-port-hash 00:0b:85:1b:e2:b0
Destination MAC 00:0b:85:1b:e2:b0 currently maps to port 2

>show lag ip-port-hash 10.9.4.128
Destination IP 10.9.4.128 currently maps to port 2
```

Configuring Neighbor Devices to Support LAG

The controller's neighbor devices must also be properly configured to support LAG.

- Each neighbor port to which the controller is connected should be configured as follows:

```
interface GigabitEthernet <interface id>
    switchport
    channel-group <id> mode on
    no shutdown
```

- The port channel on the neighbor switch should be configured as follows:

```
interface port-channel <id>
    switchport
    switchport trunk encapsulation dot1q
    switchport trunk native vlan <native vlan id>
    switchport trunk allowed vlan <allowed vlans>
    switchport mode trunk
    no shutdown
```

Configuring a 4400 Series Controller to Support More Than 48 Access Points

As noted earlier, 4400 series controllers can support up to 48 access points per port. When the limit is reached and another access point tries to register with the controller, the following error message is generated:

Error: AP cannot join because the maximum number of APs on interface 1 is reached.

However, you can configure your 4400 series controller to support more access points using one of the following methods:

- Link aggregation (for controllers in Layer 3 mode), see page 3-36.
- Multiple AP-manager interfaces (for controllers in Layer 3 mode). A single AP manager interface supports upto 48 access points, but multiple AP manager interfaces allows more than 48 access points to be registered with the controller. See page 3-36.
- Connecting additional ports (for controllers in Layer 2 mode), see page 3-41.

Follow the instructions on the page indicated for the method you want to use.

The following factors should help you decide which method to use if your controller is set for Layer 3 operation:

- With link aggregation, all of the controller ports need to connect to the same neighbor switch. If the neighbor switch goes down, the controller loses connectivity.
- With multiple AP-manager interfaces, you can connect your ports to different neighbor devices. If one of the neighbor switches goes down, the controller still has connectivity. However, using multiple AP-manager interfaces presents certain challenges (as discussed in the "Using Multiple AP-Manager Interfaces" section below) when port redundancy is a concern.

Using Link Aggregation

See the "Enabling Link Aggregation" section on page 3-29 for more information and instructions on enabling link aggregation.

Note Link aggregation is the only method that can be used for the Cisco WiSM and Catalyst 3750G Integrated Wireless LAN Controller Switch controllers.

Using Multiple AP-Manager Interfaces

Note This method can be used only with Cisco 4400 series stand-alone controllers.

When you create two or more AP-manager interfaces, each one is mapped to a different port (see Figure 3-14). The ports should be configured in sequential order such that AP-manager interface 2 is on port 2, AP-manager interface 3 is on port 3, and AP-manager interface 4 is on port 4.

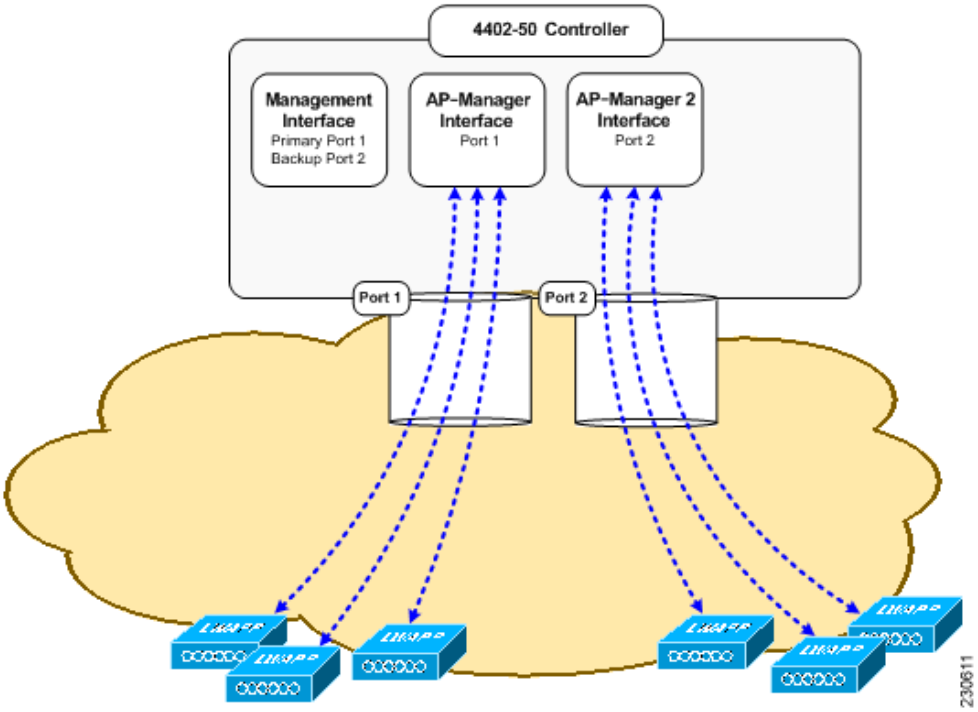
Note AP-manager interfaces need not be on the same VLAN or IP subnet, and they may or may not be on the same VLAN or IP subnet as the management interface. However, Cisco recommends that you configure all AP-manager interfaces on the same VLAN or IP subnet.

Note You must assign an AP-manager interface to each port on the controller.

Before an access point joins a controller, it sends out a discovery request. From the discovery response that it receives, the access point can tell the number of AP-manager interfaces on the controller and the number of access points on each AP-manager interface. The access point generally joins the AP-manager with the least number of access points. In this way, the access point load is dynamically distributed across the multiple AP-manager interfaces.

Note Access points may not be distributed completely evenly across all of the AP-manager interfaces, but a certain level of load balancing occurs.

Figure 3-14 Two AP-Manager Interfaces



Before implementing multiple AP-manager interfaces, you should consider how they would impact your controller's port redundancy.

Examples:

1. The 4402-50 controller supports a maximum of 50 access points and has two ports. To support the maximum number of access points, you would need to create two AP-manager interfaces (see Figure 3-14) because a controller can support only 48 access points on one port.

2. The 4404-100 controller supports up to 100 access points and has four ports. To support the maximum number of access points, you would need to create three (or more) AP-manager interfaces (see Figure 3-15). If the port of one of the AP-manager interfaces fails, the controller clears the access points' state, and the access points must reboot to reestablish communication with the controller using the normal controller join process. The controller no longer includes the failed AP-manager interface in the LWAPP discovery responses. The access points then rejoin the controller and are load-balanced among the available AP-manager interfaces.

Figure 3-15 Three AP-Manager Interfaces

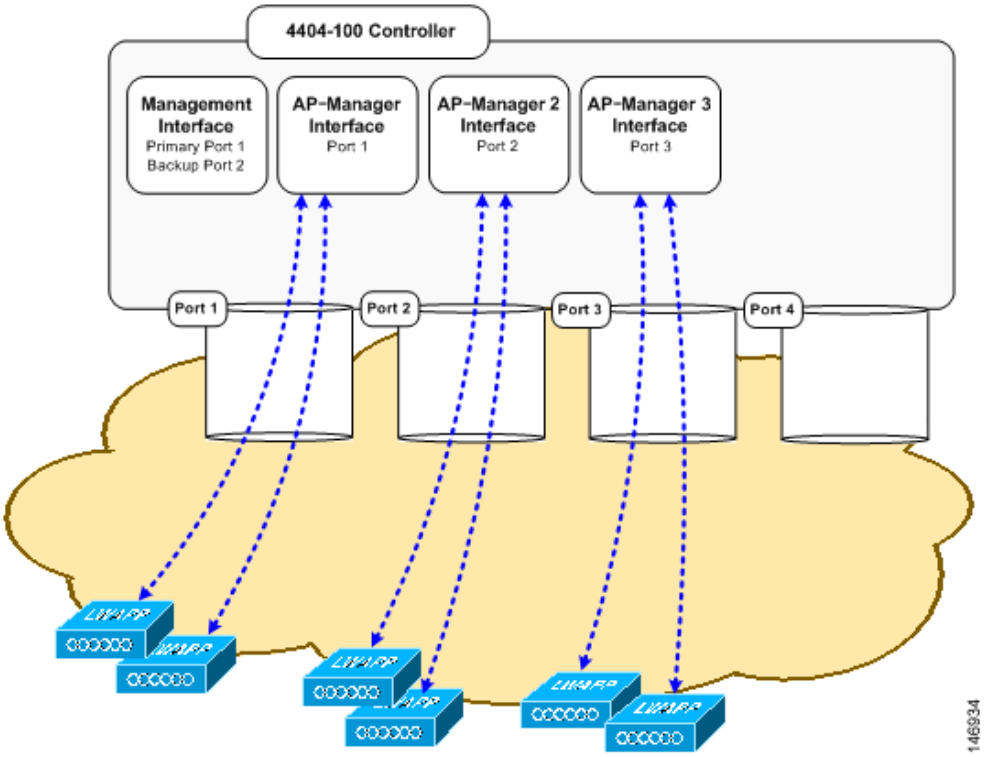
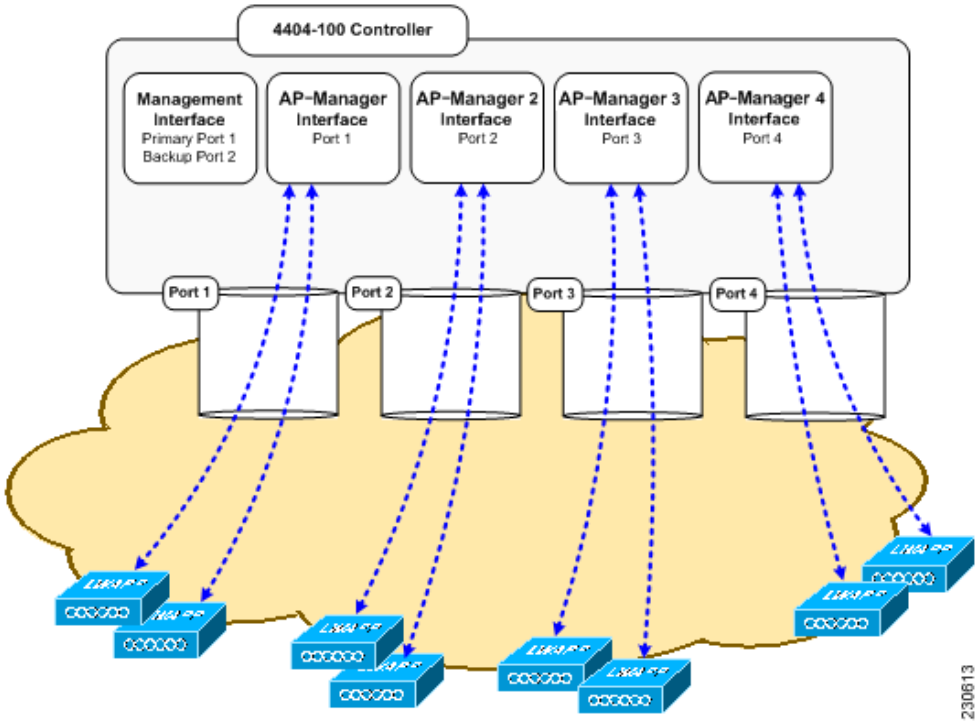


Figure 3-16 illustrates the use of four AP-manager interfaces to support 100 access points.

Figure 3-16 Four AP-Manager Interfaces



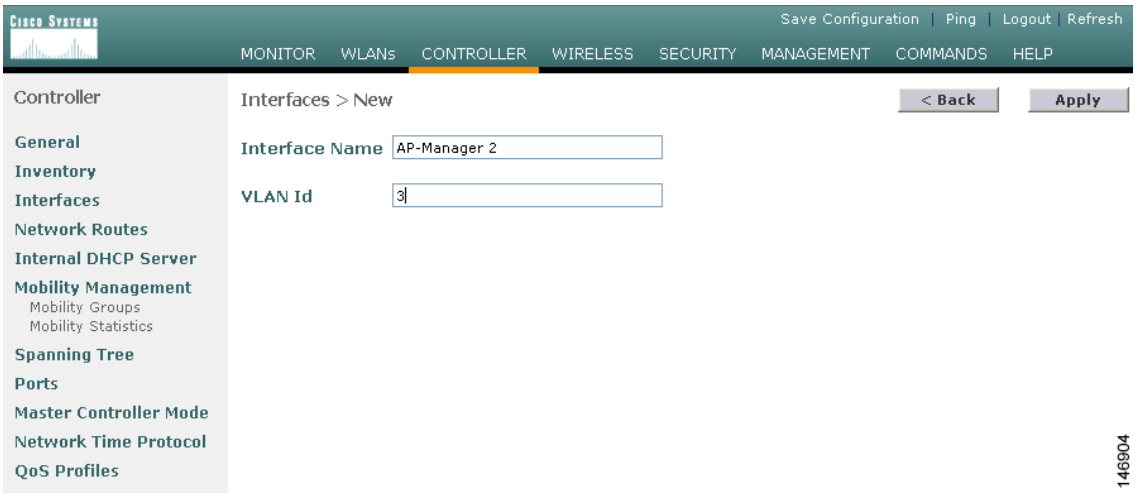
This configuration has the advantage of load-balancing all 100 access points evenly across all four AP-manager interfaces. If one of the AP-manager interfaces fails, all of the access points connected to the controller would be evenly distributed among the three available AP-manager interfaces. For example, if AP-manager interface 2 fails, the remaining AP-manager interfaces (1, 3, and 4) would each manage approximately 33 access points.

Follow these steps to create multiple AP-manager interfaces.

Step 1 Click **Controller** > **Interfaces** to access the Interfaces page.

Step 2 Click **New**. The Interfaces > New page appears (see Figure 3-18).

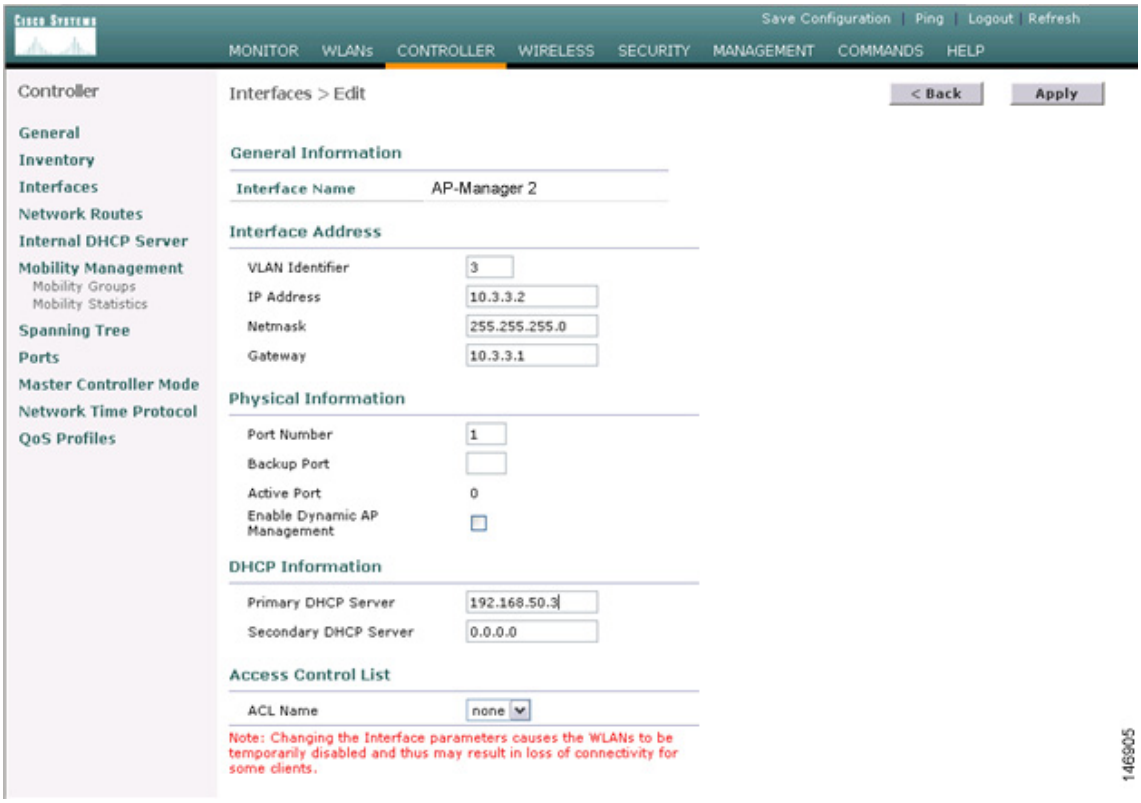
Figure 3-17 Interfaces > New Page



Step 3 Enter an AP-manager interface name and a VLAN identifier, as shown above.

Step 4 Click **Apply** to commit your changes. The Interfaces > Edit page appears (see Figure 3-18).

Figure 3-18 Interfaces > Edit Page



Step 5 Enter the appropriate interface parameters.

Note Do not define a backup port for an AP-Manager Interface. Port redundancy is not supported for AP-manager interfaces. If the AP-manager interface fails, all of the access points connected to the controller through that interface are evenly distributed among the other configured AP-manager interfaces.

Step 6 To make the interface an AP-manager interface, check the **Enable Dynamic AP Management** check box.

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

Step 8 Repeat this procedure for each additional AP-manager interface that you want to create.

Connecting Additional Ports

To support more than 48 access points with a 4400 series controller in Layer 2 mode, you must connect more controller ports to individual broadcast domains that are completely separated. Table 3-8 provides an example in which each controller port is connected to an individual switch.

Table 3-8 Example Port Configuration on a 4404 Controller in Layer 2 Mode

[Distribution Switch 1]=Trunk=[Distribution Switch 2]			
dot1q	access	access	access
VLAN 250	VLAN 992	VLAN 993	VLAN 994
port 1	port 2	port 3	port 4

VLANs 992, 993, and 994 (used here as VLAN examples) are access VLANs, and you can assign them any VLAN IDs that you choose. An IP address is not allocated to these VLANs, and these ports are access ports only. To connect additional access points, assign the access port connecting the access point to VLAN 992, 993, or 994. The access point then joins the controller using that isolated VLAN with Layer 2 LWAPP. All Layer 2 LWAPP traffic received on ports 2, 3, and 4 egresses the management port (configured as port 1) on VLAN 250 with a dot1q tag of 250.

With a Layer 2 LWAPP configuration, you should distribute access points across VLANs 250, 992, 993, and 994 manually. Ideally, you should distribute 25 access points per port to balance a total of 100 access points. If you have less than 100 access points, divide the number of access points by 4 and distribute that number. For example, 48 total access points divided by 4 equals 12 access points per 4404 port. You could connect 48 access points to port 1, 48 to port 2, and only 2 to port 3, but this unbalanced distribution does not provide the best throughput performance for wireless clients and is not recommended.

It does not matter where you connect ports 2, 3, and 4 as long as they can communicate with the access points configured for their isolated VLANs. If VLAN 250 is a widely used infrastructure VLAN within your network and you notice network congestion, redistribute all of the access points connected to VLAN 250 to ports 2, 3, and 4. Port 1 still remains connected to VLAN 250 as the management network interface but transports data only from wireless clients proxied by the controller.

Configuring Controller SettingsWireless Device Access

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

Using the Configuration Wizard

This section describes how to configure basic settings on a controller for the first time or after the configuration has been reset to factory defaults. The contents of this chapter are similar to the instructions in the quick start guide that shipped with your controller.

You use the configuration wizard to configure basic settings. You can run the wizard on the CLI or the GUI. This section explains how to run the wizard on the CLI.

This section contains these sections:

Before You Start

You should collect these basic configuration parameters before configuring the controller:

- System name for the controller
- 802.11 protocols supported: 802.11a and/or 802.11b/g
- Administrator usernames and passwords (optional)
- Distribution system (network) port static IP address, netmask, and optional default gateway IP address
- Service port static IP address and netmask (optional)
- Distribution system physical port (1000BASE-T, 1000BASE-SX, or 10/100BASE-T)

Note Each 1000BASE-SX connector provides a 100/1000-Mbps wired connection to a network through an 850nM (SX) fiber-optic link using an LC physical connector.

- Distribution system port VALN assignment (optional)
- Distribution system port web and secure web mode settings: enabled or disabled
- Distribution system port Spanning Tree Protocol: enabled/disabled, 802.1D/fast/off mode per port, path cost per port, priority per port, bridge priority, forward delay, hello time, maximum age
- WLAN configuration: SSID, VLAN assignments, Layer 2 security settings, Layer 3 security settings, QoS assignments
- Mobility Settings: Mobility Group Name (optional)
- RADIUS Settings
- SNMP Settings
- NTP server settings (the wizard prompts you for NTP server settings only when you run the wizard on a wireless controller network module installed in a Cisco Integrated Services router)
- Other port and parameter settings: service port, Radio Resource Management (RRM), third-party access points, console port, 802.3x flow control, and system logging

Resetting the Device to Default Settings

If you need to start over during the initial setup process, you can reset the controller to factory default settings.

Note After resetting the configuration to defaults, you need a serial connection to the controller to use the configuration wizard.

Resetting to Default Settings Using the CLI

Follow these steps to reset the configuration to factory default settings using the CLI.

Step 1 Enter **reset system**. At the prompt that asks whether you need to save changes to the configuration, enter **Y** or **N**. The unit reboots.

Step 2 When you are prompted for a username, enter **recover-config** to restore the factory default configuration. The controller reboots and displays this message:

```
Welcome to the Cisco WLAN Solution Wizard Configuration Tool
```

Step 3 Use the configuration wizard to enter configuration settings.

Resetting to Default Settings Using the GUI

Follow these steps to return to default settings using the GUI.

Step 1 Open your Internet browser. The GUI is fully compatible with Microsoft Internet Explorer version 6.0 or later on Windows platforms.

Step 2 Enter the controller IP address in the browser address line and press **Enter**. An Enter Network Password windows appears.

Step 3 Enter your username in the User Name field. The default username is *admin*.

Step 4 Enter the wireless device password in the Password field and press **Enter**. The default password is *admin*.

Step 5 Browse to the Commands > Reset to Factory Defaults page.

Step 6 Click **Reset**. At the prompt, confirm the reset.

Step 7 Reboot the unit and do not save changes.

Step 8 Use the configuration wizard to enter configuration settings.

Running the Configuration Wizard on the CLI

When the controller boots at factory defaults, the bootup script runs the configuration wizard, which prompts the installer for initial configuration settings. Follow these steps to enter settings using the wizard on the CLI.

Note To configure the controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch, Cisco recommends that you use the GUI configuration wizard that launches from the 3750 Device Manager. Refer to the *Catalyst 3750G Integrated Wireless LAN Controller Switch Getting Started Guide* for instructions.

Step 1 Connect your computer to the controller using a DB-9 null-modem serial cable.

Step 2 Open a terminal emulator session using these settings:

- 9600 baud
- 8 data bits
- 1 stop bit
- no parity
- no hardware flow control

Step 3 At the prompt, log into the CLI. The default username is *admin* and the default password is *admin*.

Step 4 If necessary, enter **reset system** to reboot the unit and start the wizard.

Step 5 The first wizard prompt is for the system name. Enter up to 32 printable ASCII characters.

Step 6 Enter an administrator username and password, each up to 24 printable ASCII characters.

Step 7 Enter the service-port interface IP configuration protocol: **none** or **DHCP**. If you do not want to use the service port or if you want to assign a static IP Address to the service port, enter **none**.

Step 8 If you entered **none**, enter the service-port interface IP address and netmask on the next two lines. If you do not want to use the service port, enter a fictitious IP address that is not routable anywhere on your network.

Step 9 Enter the management interface IP Address, netmask, default router IP address, and optional VLAN identifier (a valid VLAN identifier, or **0** for untagged).

Step 10 Enter the Network Interface (Distribution System) Physical Port number. For the controller, the possible ports are 1 through 4 for a front panel GigE port.

Step 11 Enter the IP address of the default DHCP Server that will supply IP Addresses to clients, the management interface, and the service port interface if you use one.

Step 12 Enter the LWAPP Transport Mode, **LAYER2** or **LAYER3** (refer to the Layer 2 and Layer 3 LWAPP Operation chapter for an explanation of this setting).

Note The controller in the Catalyst 3750G Integrated Wireless LAN Controller Switch operates only in Layer 3 mode.

Step 13 Enter the Virtual Gateway IP Address. This address can be any fictitious, unassigned IP address (such as 1.1.1.1) to be used by Layer 3 Security and Mobility managers.

Step 14 Enter the Cisco WLAN Solution Mobility Group (RF group) name.

Step 15 Enter the WLAN 1 SSID, or network name. This is the default SSID that lightweight access points use to associate to a controller.

Step 16 Allow or disallow Static IP Addresses for clients. Enter **yes** to allow clients to supply their own IP addresses. Enter **no** to require clients to request an IP Address from a DHCP server.

Step 17 If you need to configure a RADIUS Server, enter **yes**, and enter the RADIUS server IP address, the communication port, and the shared secret. If you do not need to configure a RADIUS server or you want to configure the server later, enter **no**.

Step 18 Enter a country code for the unit. Enter **help** to list the supported countries.

Note When you run the wizard on a wireless controller network module installed in a Cisco Integrated Services Router, the wizard prompts you for NTP server settings. The controller network module does not have a battery and cannot save a time setting. It must receive a time setting from an NTP server when it powers up.

Step 19 Enable and disable support for 802.11b, 802.11a, and 802.11g.

Step 20 Enable or disable radio resource management (RRM) (auto RF).

When you answer the last prompt, the controller saves the configuration, reboots with your changes, and prompts you to log in or to enter **recover-config** to reset to the factory default configuration and return to the wizard.

Managing the System Time and Date

You can configure the controller to obtain the time and date from a Network Time Protocol (NTP) server, or you can configure the time and date manually.

Configuring the Time and Date Manually

On the CLI, enter **show time** to check the system time and date. If necessary, enter **config time** *mm/dd/yy hh:mm:ss* to set the time and date.

To enable Daylight Saving Time, enter **config time timezone enable**.

Configuring an NTP Server

Each NTP server IP address is added to the controller database. Each controller searches for an NTP server and obtains the current time upon reboot and at each user-defined polling interval (daily to weekly).

On the CLI, enter **config time ntp** *server-ip-address* to specify the NTP server for the controller. Enter **config time ntp** *interval* to specify, in seconds, the polling interval.

Note For access points to successfully join a Cisco WLAN controller, Cisco recommends that you configure the controller to obtain the time from an NTP server.

Configuring a Country Code

Controllers are designed for use in many countries with varying regulatory requirements. You can configure a country code for the controller to ensure that it complies with your country's regulations.

Note Controllers and access points may not operate properly if they are not designed for use in your country of operation. For example, an access point with part number AIR-AP1030-A-K9 (which is included in the Americas regulatory domain) cannot be used in Australia. Always be sure to purchase controllers and access points that match your country's regulatory domain.

On the controller GUI, click **Wireless > Country**, enter the desired country code in the Country Code field, and click **Save Configuration**.

On the controller CLI, enter **config country** *code* to configure the country code. Enter **show country** to check the configuration.

Note For an access point to successfully join a controller, the access point's regulatory domain must match the country code of the controller.

Note Controllers running software release 4.0 or earlier do not have the ability to control access points in more than one regulatory domain.

Note The controller must be installed by a network administrator or qualified IT professional, and the proper country code must be selected. Following installation, access to the unit should be password protected by the installer to maintain compliance with regulatory requirements and to ensure proper unit functionality.

Table 4-1 lists commonly used country codes and the 802.11 bands that they allow. For a complete list of country codes supported per product, go to http://www.cisco.com/en/US/prod/collateral/wireless/ps5679/ps5861/product_data_sheet0900aecd80537b6a_ps430_Products_Data_Sheet.html.

Table 4-1 Commonly Used Country Codes

Country Code	Country	802.11 Bands Allowed
US	United States of America	802.11b, 802.11g, and 802.11a low, medium, and high bands
USL	US Low	802.11b, 802.11g, and 802.11a low and medium bands (used for legacy 802.11a interface cards that do not support 802.11a high band)
AU	Australia	802.11b, 802.11g, and 802.11a
AT	Austria	802.11b, 802.11g, and 802.11a
BE	Belgium	802.11b, 802.11g, and 802.11a
CA	Canada	802.11b and 802.11g

Table 4-1 Commonly Used Country Codes (continued)

Country Code	Country	802.11 Bands Allowed
DK	Denmark	802.11b, 802.11g, and 802.11a
FI	Finland	802.11b, 802.11g, and 802.11a
FR	France	802.11b, 802.11g, and 802.11a
DE	Germany	802.11b, 802.11g, and 802.11a
GR	Greece	802.11b and 802.11g
IE	Ireland	802.11b, 802.11g, and 802.11a
IN	India	802.11b and 802.11a
IT	Italy	802.11b, 802.11g, and 802.11a
JP	Japan	802.11b, 802.11g, and 802.11a
KR	Republic of Korea	802.11b, 802.11g, and 802.11a
LU	Luxembourg	802.11b, 802.11g, and 802.11a
NL	Netherlands	802.11b, 802.11g, and 802.11a
PT	Portugal	802.11b, 802.11g, and 802.11a
ES	Spain	802.11b, 802.11g, and 802.11a
SE	Sweden	802.11b, 802.11g, and 802.11a
GB	United Kingdom	802.11b, 802.11g, and 802.11a

Enabling and Disabling 802.11 Bands

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

On the CLI, enter **config 80211b disable network** to disable 802.11b/g operation on the controller. Enter **config 80211b enable network** to re-enable 802.11b/g operation.

Enter **config 80211a disable network** to disable 802.11a operation on the controller. Enter **config 80211a enable network** to re-enable 802.11a operation.

Configuring Administrator Usernames and Passwords

Note The controller does not have a password recovery mechanism. If you use WCS to manage the controller, you should be able to access the controller from WCS and create a new admin user without logging into the controller itself. If you have not saved the configuration on the controller after deleting the user, then rebooting (power cycling) the controller should bring it back up with the deleted user still in the system. If you do not have the default admin account or another user account with which you can log in, your only option is to default the controller to factory settings and reconfigure it from scratch or to reload the previously saved configuration.

You can configure administrator usernames and passwords to prevent unauthorized users from reconfiguring the controller and viewing configuration information.

On the CLI, enter **config mgmtuser add** *username password* **read-write** to create a username-password pair with read-write privileges. Enter **config mgmtuser add** *username password* **read-only** to create a username-password pair with read-only privileges. Usernames and passwords are case-sensitive and can contain up to 24 ASCII characters. Usernames and passwords cannot contain spaces.

To change the password for an existing username, enter
config mgmtuser password *username new_password*

To list configured users, enter **show mgmtuser**.

Configuring RADIUS Settings

If you need to use a RADIUS server for accounting or authentication, follow these steps on the CLI to configure RADIUS settings for the controller:

Step 1 Enter **config radius acct** *ip-address* to configure a RADIUS server for accounting.

Step 2 Enter **config radius acct** *port* to specify the UDP port for accounting.

Step 3 Enter **config radius acct** *secret* to configure the shared secret.

Step 4 Enter **config radius acct** *enable* to enable accounting. Enter **config radius acct** *disable* to disable accounting. Accounting is disabled by default.

Step 5 Enter **config radius auth** *ip-address* to configure a RADIUS server for authentication.

Step 6 Enter **config radius auth** *port* to specify the UDP port for authentication.

Step 7 Enter **config radius auth** *secret* to configure the shared secret.

Step 8 Enter **config radius auth** *enable* to enable authentication. Enter **config radius acct** *disable* to disable authentication. Authentication is disabled by default.

Step 9 Use the **show radius acct statistics**, **show radius auth statistics**, and **show radius summary** commands to verify that the RADIUS settings are correctly configured.

Configuring SNMP

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Changing the Default Values of SNMP Community Strings

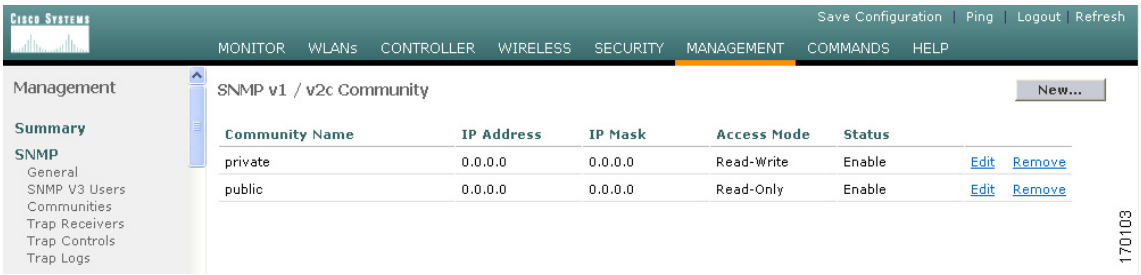
The controller has commonly known default values of "public" and "private" for the read-only and read-write SNMP community strings. Using these standard values presents a security risk. Therefore, Cisco strongly advises that you change these values.

Using the GUI to Change the SNMP Community String Default Values

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

Step 1 Click **Management** and then **Communities** under SNMP. The SNMP v1 / v2c Community page appears (see Figure 4-1).

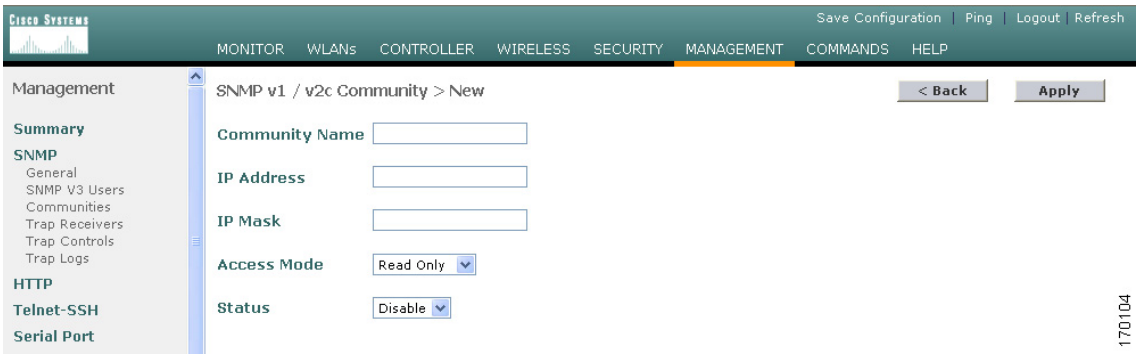
Figure 4-1 SNMP v1 / v2c Community Page



Step 2 If “public” or “private” appears in the Community Name column, click **Remove** to delete this community.

Step 3 Click **New** to create a new community. The SNMP v1 / v2c Community > New page appears (see Figure 4-2).

Figure 4-2 SNMP v1 / v2c Community > New Page



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

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

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

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

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

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

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

Using the CLI to Change the SNMP Community String Default Values

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

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

show snmp community

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

config snmp community delete *name*

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

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

config snmp community create *name*

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

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

config snmp community ipaddr *ip_address ip_mask name*

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

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

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

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

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

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

Changing the Default Values for SNMP v3 Users

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

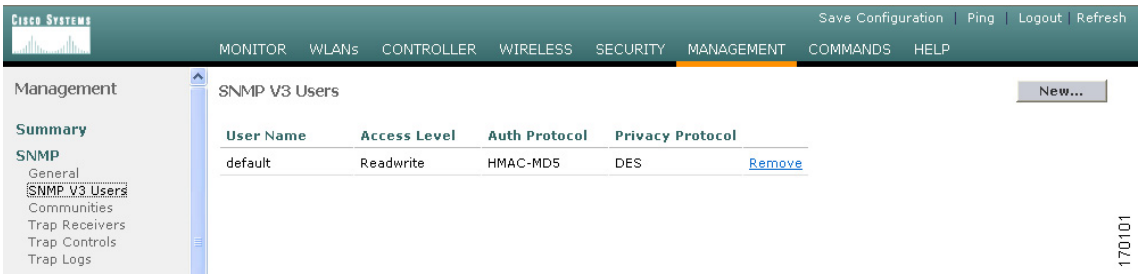
Note SNMP v3 is time sensitive. Make sure that you have configured the correct time and timezone on your controller.

Using the GUI to Change the SNMP v3 User Default Values

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

Step 1 Click **Management** and then **SNMP V3 Users** under SNMP. The SNMP V3 Users page appears (see Figure 4-3).

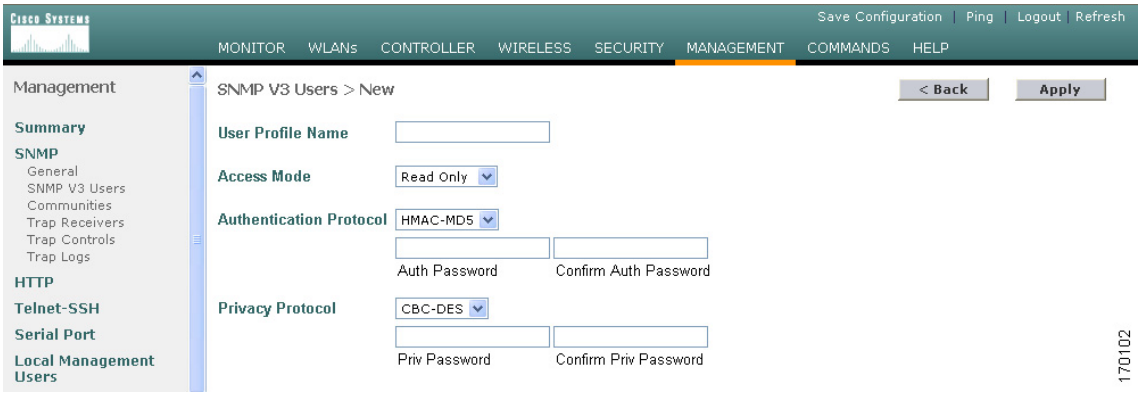
Figure 4-3 SNMP V3 Users Page



Step 2 If "default" appears in the User Name column, click **Remove** to delete this SNMP v3 user.

Step 3 Click **New** to add a new SNMP v3 user. The SNMP V3 Users > New page appears (see Figure 4-4).

Figure 4-4 SNMP V3 Users > New Page



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

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

Step 6 In the next two fields, choose the authentication and privacy protocols to be used, and enter a password for each.

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

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

Using the CLI to Change the SNMP v3 User Default Values

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

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

show snmpv3user

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

config snmp v3user delete *username*

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

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

config snmp v3user create *username* {**ro** | **rw**} {**none** | **hmacmd5** | **hmacsha**} {**none** | **des**} *auth_password privacy_password*

where

- *username* is the SNMP v3 username,
- **ro** is read-only mode and **rw** is read/write mode,
- **none**, **hmacmd5**, and **hmacsha** are the authentication protocol options,
- **none** and **des** are the privacy protocol options,
- *auth_password* is the authentication password, and
- *privacy_password* is the privacy password.

Do not enter "default" for the *username* and *password* parameters.

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

Enabling 802.3x Flow Control

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

Enabling System Logging

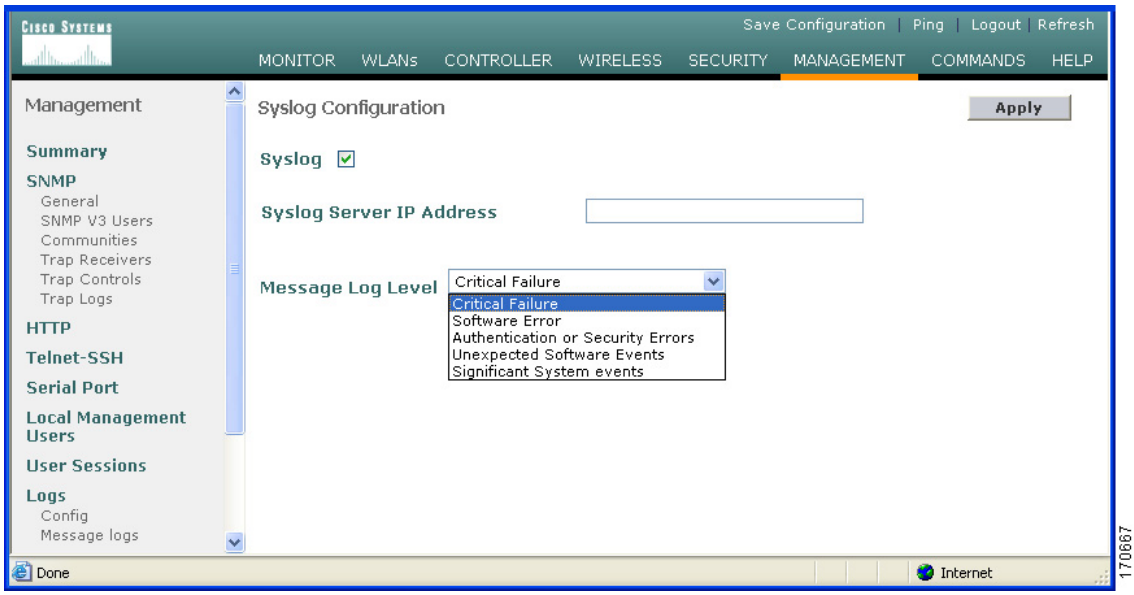
System logging allows controllers to log their system events to an external syslog server. System logging is disabled by default. You can use the GUI or CLI to enable system logging.

Using the GUI to Enable System Logging

Follow these steps to enable system logging through the controller GUI.

Step 1 Click **Management** and then **Config** under Logs. The Syslog Configuration page appears (Figure 4-5).

Figure 4-5 Syslog Configuration Page



Step 2 Check the **Syslog** check box.

Step 3 In the Syslog Server IP Address field, enter the IP address of the server to which to send the system log.

Step 4 Choose a logging level from the Message Log Level drop-down box.

There are five logging levels from which you can choose:

- Critical Failure
- Software Error
- Authentication or Security Errors
- Unexpected Software Events
- Significant System Events

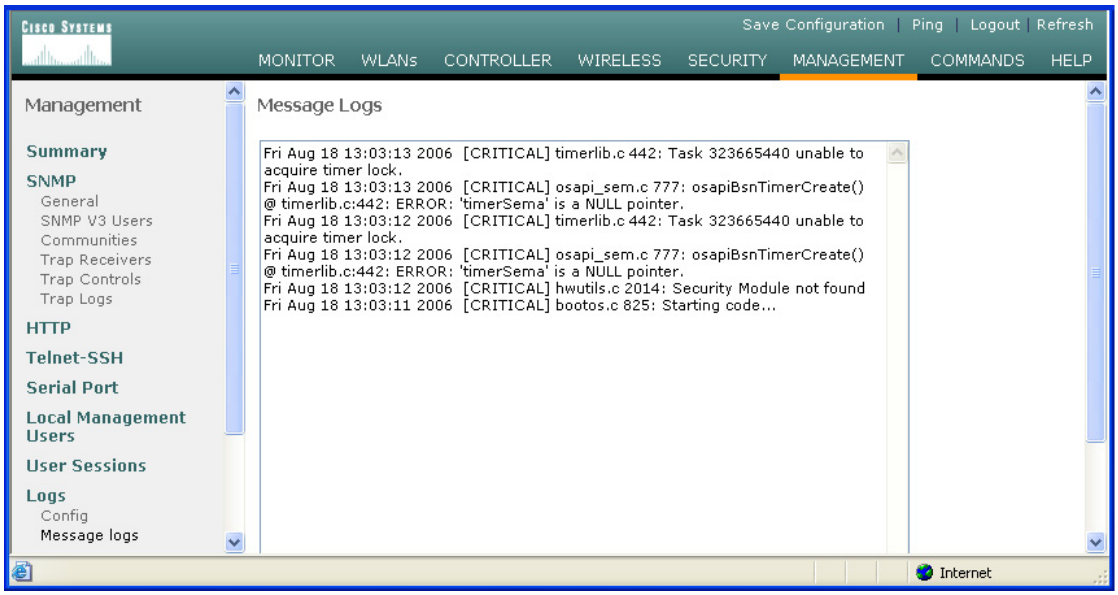
When you choose a logging level, the system logs messages for that level and for the levels above it. For example, if you choose Unexpected Software Events, the system logs unexpected software events, authentication or security errors, software errors, and critical failures.

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

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

Step 7 To view the message logs, click **Management** and then **Message Logs** under Logs (see Figure 4-6).

Figure 4-6 Message Logs Page



Using the CLI to Enable System Logging

Follow these steps to enable system logging through the controller CLI.

Step 1 Enter **config syslog** *ip_address* to enable system logging and set the IP address of the Syslog server.

Step 2 Enter **config msglog level** *msg_level* to set the logging level.

For *msg_level*, you can enter one of the following five values:

- **critical**—Critical hardware or software failure
- **error**—Non-critical software errors
- **security**—Authentication- or security-related errors
- **warning**—Unexpected software events
- **verbose**—Significant system events

Step 3 To view the current syslog status, enter **show syslog**. To view the message logs, enter **show msglog**.

Enabling Dynamic Transmit Power Control

When you enable Dynamic Transmit Power Control (DTPC), access points add channel and transmit power information to beacons. (On access points that run Cisco IOS software, this feature is called world mode.) Client devices using DTPC receive the information and adjust their settings automatically. For example, a client device used primarily in Japan could rely on DTPC to adjust its channel and power settings automatically when it travels to Italy and joins a network there. DTPC is enabled by default.

Enter this command to disable or enable DTPC:

config {802.11a | 802.11bg} dtpc {enable | disable}

Configuring Multicast Mode

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

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

Understanding Multicast Mode

When you enable multicast mode, the controller does not become a member the multicast group. When the controller receives a multicast packet from the wired LAN, the controller encapsulates the packet using LWAPP and forwards the packet to the LWAPP multicast group address. The controller always uses the management interface for sending multicast packets. Access points in the multicast group receive the packet and forward it to all the BSSIDs mapped to the interface on which clients receive multicast traffic. From the access point perspective, the multicast appears to be a broadcast to all SSIDs.

When the source of the multicast is a wireless client, the multicast packet is unicast to the controller. In this case the controller makes two copies of the packet. One copy is the raw Ethernet packet that the controller sends out to the interface for the wireless LAN on which the client is associated, enabling the receivers on the wired LAN to receive the multicast traffic. The second copy of the packet is LWAPP-encapsulated and is sent to the multicast group. In this case the source of the multicast also receives the multicast packet, which helps the wireless client receive the multicast source.

Guidelines for Using Multicast Mode

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

- The Cisco Unified Wireless Network solution uses some IP address ranges for specific purposes, and you should keep these ranges in mind when configuring a multicast group:
  - 224.0.0.0 through 224.0.0.255—Reserved link local addresses
  - 224.0.1.0 through 238.255.255.255—Globally scoped addresses
  - 239.0.0.0 through 239.255.255.255—Limited scope addresses

- When you enable multicast mode on the controller you also must configure an LWAPP multicast group address on the controller. Access points subscribe to the LWAPP multicast group using IGMP.
- Cisco 1100, 1130, 1200, 1230, and 1240 access points use IGMP versions 1, 2, and 3. However, Cisco 1000 series access points use only IGMP v1 to join the multicast group.
- Multicast mode works only in Layer 3 LWAPP mode.
- Access points in monitor mode, sniffer mode, or rogue detector mode do not join the LWAPP multicast group address.
- When using Multiple controllers on the network, make sure that the same multicast address is configured on all the controllers.
- Multicast mode does not work across intersubnet mobility events such as guest tunneling, site-specific VLANs, or interface override using RADIUS. However, multicast mode does work in these subnet mobility events when you disable the Layer 2 IGMP snooping/CGMP features on the wired LAN.
- The controller drops any multicast packets sent to the UDP port numbers 12222, 12223, and 12224. Make sure the multicast applications on your network do not use those port numbers.
- Multicast traffic is transmitted at 6 Mbps in an 802.11a network. Therefore, if several WLANs attempt to transmit at 1.5 Mbps, packet loss occurs, which breaks the multicast session.

Enabling Multicast Mode

Multicasting is disabled by default. Use the commands in Table 4-2 to configure multicast mode on the controller CLI.

Table 4-2 CLI Commands for Configuring Multicast Mode

Command	Multicast Mode
config network multicast global {**enable** | **disable**}	Enable or disable multicasting
config network multicast mode unicast	Configure the controller to use the unicast method to send multicast packets
config network multicast mode multicast *multicast-group-ip-address*	Configure the controller to use the multicast method to send multicast packets to an LWAPP multicast group.

You can also enable multicast mode on the Configure > Switch IP System General page on the WCS interface.

Configuring Client Roaming

The Cisco UWN Solution supports seamless client roaming across lightweight access points managed by the same controller, between controllers in the same mobility group on the same subnet, and across controllers in the same mobility group on different subnets.

Note In controller software release 4.0.206.0 and later, client roaming with multicast is supported.

Intra-Controller Roaming

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

Inter-Controller Roaming

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

Note Cisco 1030 remote edge lightweight access points at a remote location must be on the same subnet to support roaming.

Inter-Subnet Roaming

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

Note Cisco 1030 remote edge lightweight access points at a remote location must be on the same subnet to support roaming.

Voice-over-IP Telephone Roaming

802.11 voice-over-IP (VoIP) telephones actively seek out associations with the strongest RF signal to ensure the best quality of service (QoS) and the maximum throughput. The minimum VoIP telephone requirement of 20-millisecond or shorter latency time for the roaming handover is easily met by the Cisco UWN Solution, which has an average handover latency of 9 or fewer milliseconds. This short latency period is controlled by controllers rather than allowing independent access points to negotiate roaming handovers.

The Cisco UWN Solution supports 802.11 VoIP telephone roaming across lightweight access points managed by controllers on different subnets, as long as the controllers are in the same mobility group. This roaming is transparent to the VoIP telephone because the session is sustained and a tunnel between controllers allows the VoIP telephone to continue using the same DHCP-assigned IP address as long as

the session remains active. The tunnel is torn down, and the VoIP client must reauthenticate when the VoIP telephone sends a DHCP Discover with a 0.0.0.0 VoIP telephone IP address or a 169.254.*.* VoIP telephone auto-IP address or when the operator-set user timeout is exceeded.

CCX Layer 2 Client Roaming

Controller software release 4.0 supports five CCX Layer 2 client roaming enhancements:

- **Access point assisted roaming**—This feature helps clients save scanning time. Whenever a CCXv2 client associates to an access point, it sends an information packet to the new access point listing the characteristics of its previous access point. The access point uses this information to build a list of previous access points, which it sends (via unicast) to clients immediately after association to reduce roaming time. The access point list contains the channels, BSSIDs of neighbor access points that support the client's current SSID(s), and time elapsed since disassociation.
- **Enhanced neighbor list**—This feature focuses on improving a CCXv4 client's roam experience and network edge performance, especially when servicing voice applications. The access point provides its associated client information about its neighbors using a neighbor-list update unicast message.
- **Enhanced neighbor list request (E2E)**—The End-2-End specification is a Cisco and Intel joint program that defines new protocols and interfaces to improve the overall voice and roaming experience. It applies only to Intel clients in a CCX environment. Specifically, it enables Intel clients to request a neighbor list at will. When this occurs, the access point forwards the request to the controller. The controller receives the request and replies with the current CCX roaming sublist of neighbors for the access point to which the client is associated.

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

- **Roam reason report**—This feature enables CCXV4 clients to report the reason why they roamed to a new access point. It also allows network administrators to build and monitor a roam history.

The 4.0 release of controller software supports CCX versions 1 through 4. CCX support is enabled automatically for every WLAN on the controller and cannot be disabled. The controller stores the CCX version of the client in its client database and uses it to generate and respond to CCX frames appropriately. Clients must support CCX v4 (or CCXv2 for access point assisted roaming) in order to utilize these roaming enhancements. See the "Configuring Quality of Service Profiles" section on page 6-19 for more information on CCX.

The roaming enhancements mentioned above are enabled automatically, with the appropriate CCX support. However, you can fine-tune client roaming behavior by configuring several RF parameters through either the GUI or the CLI.

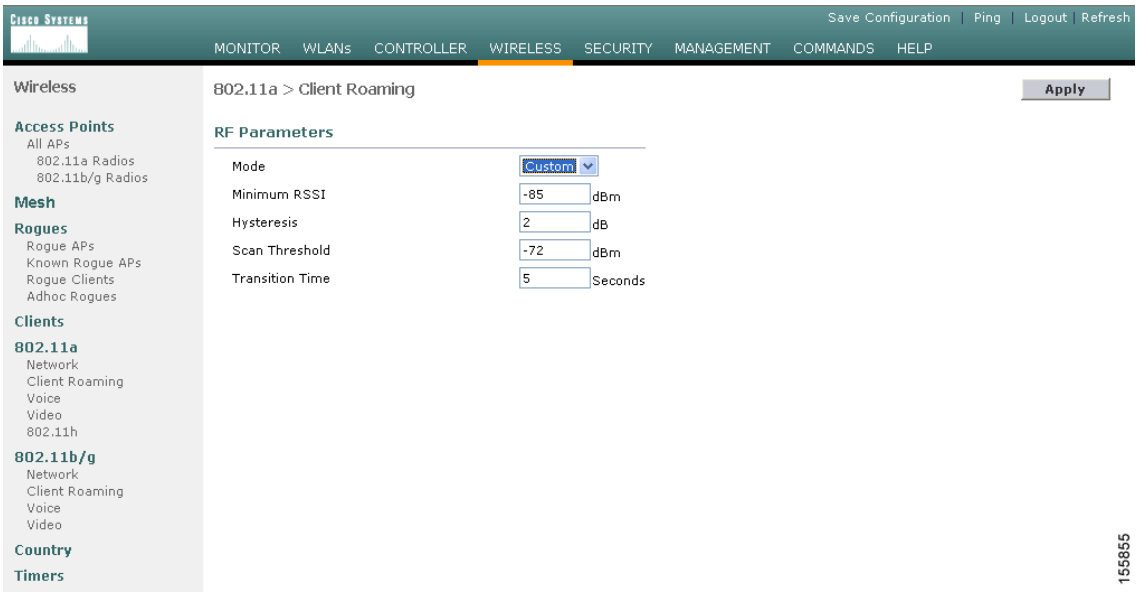
Note AP1030s in REAP mode and hybrid-REAP access points in standalone mode do not support CCX Layer 2 roaming.

Using the GUI to Configure CCX Client Roaming Parameters

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

Step 1 Click **Wireless** and then click **Client Roaming** under either 802.11a or 802.11b/g. The 802.11a (or 802.11b) > Client Roaming page appears (see Figure 4-7).

Figure 4-7 802.11a > Client Roaming Page



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

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

Range: –80 to –90 dBm

Default: –85 dBm

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

Range: 2 to 4 dB

Default: 2 dB

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

Range: –70 to –72 dBm

Default: –72 dBm

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

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

Range: 1 to 10 seconds

Default: 5 seconds

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

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

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

Using the CLI to Configure CCX Client Roaming Parameters

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

config {**802.11a** | **802.11bg**} **l2roam rf-params min-rssi** *rssi_value* **roam-hyst** *hyst_value* **scan-thres** *thres_value* **trans-time** *time_value*

Note See the description, range, and default value of each RF parameter in the "Using the GUI to Configure CCX Client Roaming Parameters" section on page 4-20.

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

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

   show {**802.11a** | **802.11bg**} **l2roam rf-params**

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

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

   This command provides the following information:

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

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

   show client roam-history *client_mac*

   This command provides the following information:

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

To obtain debug information for CCX Layer 2 client roaming, enter this command:

debug l2roam {**detail** | **error** | **packet** | **all**} **enable**

Configuring Voice and Video Parameters

You can configure two parameters on the controller that affect voice and/or video quality:

- Call admission control
- Unscheduled automatic power save delivery

You can also configure the traffic stream metrics parameter to monitor voice and video quality.

Each of these parameters is supported in Cisco Compatible Extensions (CCX) v4. See the "Configuring Cisco Client Extensions" section on page 6-22 for more information on CCX.

Note CCX is not supported on the AP1030.

Call Admission Control

Call admission control (CAC) enables an access point to maintain controlled quality of service (QoS) when the wireless LAN is experiencing congestion. The Wi-Fi Multimedia (WMM) protocol deployed in CCX v3 ensures sufficient QoS as long as the wireless LAN is not congested. However, in order to maintain QoS under differing network loads, CAC in CCX v4 is required.

CAC enables the client to specify how much bandwidth or shared medium time would be required to accept a new call and in turn enables the access point to determine whether it is capable of accommodating this particular call. The access point rejects the call if necessary in order to maintain the maximum allowed number of calls with acceptable quality.

The QoS setting for a WLAN determines the level of CAC support. To use CAC with voice applications, the WLAN must be configured for Platinum QoS. To use CAC with video applications, the WLAN must be configured for Gold QoS. Also, make sure that WMM is enabled for the WLAN. See the "Configuring Quality of Service" section on page 6-17 for QoS and WMM configuration instructions.

Note You must enable admission control (ACM) for CCXv4 clients that have WMM enabled. Otherwise, CAC does not operate properly.

U-APSD

Unscheduled automatic power save delivery (U-APSD) is a QoS facility defined in IEEE 802.11e that extends the battery life of mobile clients. In addition to extending battery life, this feature reduces the latency of traffic flow delivered over the wireless media. Because U-APSD does not require the client to poll each individual packet buffered at the access point, it allows delivery of multiple downlink packets by sending a single uplink trigger packet. U-APSD is enabled automatically when WMM is enabled.

Traffic Stream Metrics

In a voice-over-wireless LAN (VoWLAN) deployment, four variables can affect audio quality: packet latency, packet jitter, packet loss, and roaming time. These variables are referred to as *traffic stream metrics (TSM)*. An administrator can isolate poor voice quality issues by studying these variables.

The metrics consist of a collection of uplink (client side) and downlink (access point side) statistics between an access point and a client device that supports CCX v4. If the client is not CCX v4 compliant, only downlink statistics are captured. The client and access point measure these metrics. The access point also collects the measurements every 5 seconds, prepares 90-second reports, and then sends the reports to the controller. The controller organizes the uplink measurements on a client basis and the downlink measurements on an access point basis and maintains an hour's worth of historical data. To store this data, the controller requires 32 MB of additional memory for uplink metrics and 4.8 MB for downlink metrics.

TSM can be configured through either the GUI or the CLI on a per radio-band basis (for example, all 802.11a radios). The controller saves the configuration in flash memory so that it persists across reboots. After an access point receives the configuration from the controller, it enables TSM on the specified radio band.

Note Access points support TSM in both local and hybrid-REAP modes.

Using the GUI to Configure Voice Parameters

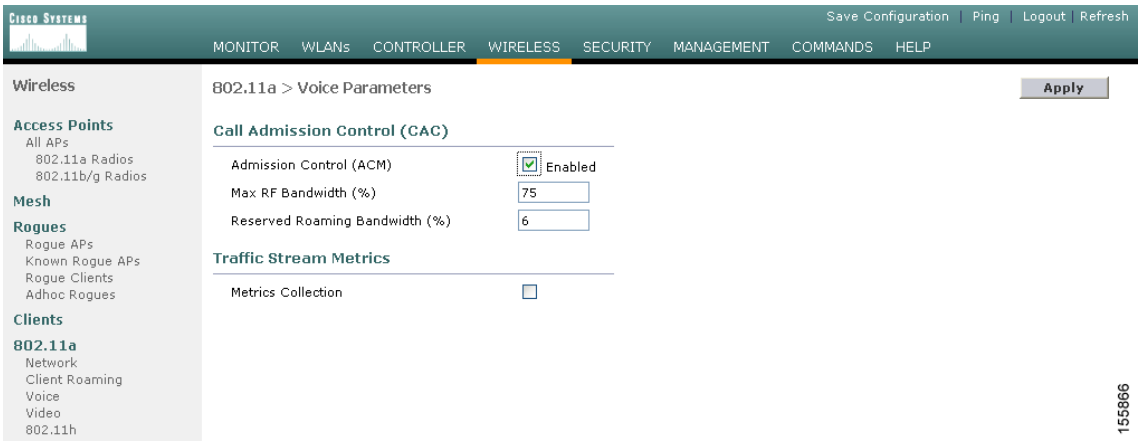
Follow these steps to configure voice parameters using the GUI.

Step 1 Make sure that the WLAN is configured for WMM and the Platinum QoS level.

Step 2 To disable the radio network, click **Wireless** and then **Network** under 802.11a or 802.11b/g, uncheck the 802.11a (or 802.11b/g) Network Status check box, and click **Apply**.

Step 3 Click **Voice** under 802.11a or 802.11b/g. The 802.11a (or 802.11b) > Voice Parameters page appears (see Figure 4-8).

Figure 4-8 802.11a > Voice Parameters Page



Step 4 To enable voice CAC for this radio band, check the **Admission Control (ACM)** check box. The default value is disabled.

Note For WMM clients that do not support traffic specifications (TSPEC), disable ACM to allow for proper QoS mapping.

Step 5 In the Max RF Bandwidth field, enter the percentage of the maximum bandwidth allocated to clients for voice applications on this radio band. Once the client reaches the value specified, the access point rejects new calls on this radio band.

Range: 40 to 85%

Default: 75%

Step 6 In the Reserved Roaming Bandwidth field, enter the percentage of maximum allocated bandwidth reserved for roaming voice clients. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming voice clients.

Range: 0 to 25%

Default: 6%

Step 7 To enable TSM, check the **Metrics Collection** check box.

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

Step 9 To enable the radio network, click **Network** under 802.11a or 802.11b/g, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 10 Click **Save Configuration** to save your changes.

Step 11 Repeat this procedure if you want to configure voice parameters for another radio band (802.11a or 802.11b/g).

Using the GUI to Configure Video Parameters

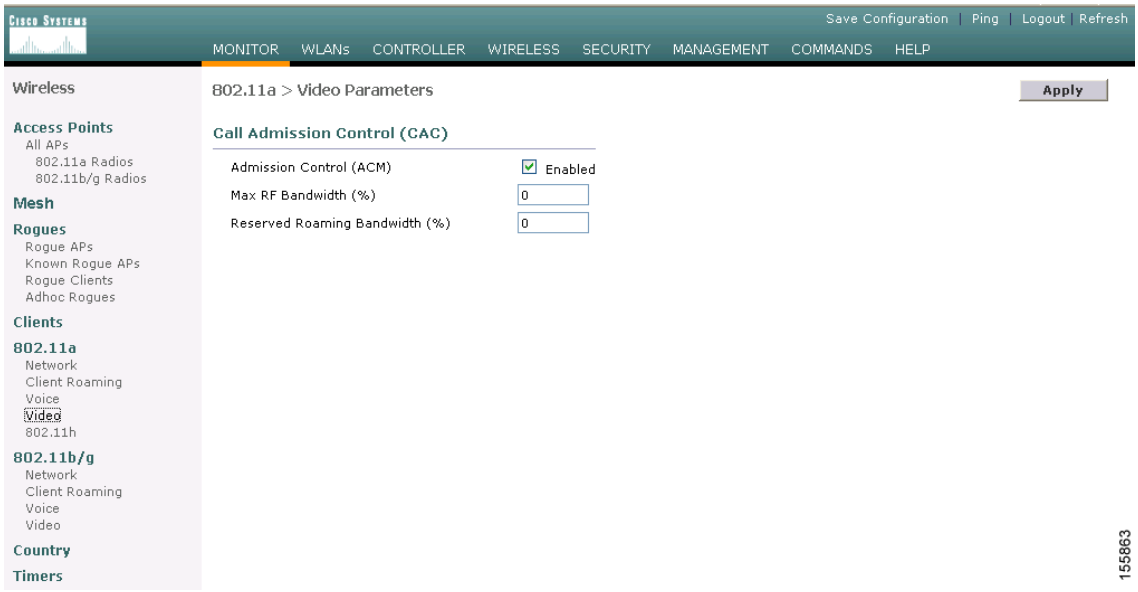
Follow these steps to configure video parameters using the GUI.

Step 1 Make sure that the WLAN is configured for WMM and the Gold QoS level.

Step 2 To disable the radio network, click **Wireless** and then **Network** under 802.11a or 802.11b/g, uncheck the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

Step 3 Click **Video** under 802.11a or 802.11b/g. The 802.11a (or 802.11b) > Video Parameters page appears (see Figure 4-8).

Figure 4-9 802.11a > Video Parameters Page



Step 4 To enable video CAC for this radio band, check the **Admission Control (ACM)** check box. The default value is disabled.

Step 5 In the Max RF Bandwidth field, enter the percentage of the maximum bandwidth allocated to clients for video applications on this radio band. Once the client reaches the value specified, the access point rejects new requests on this radio band.

Range: 0 to 100% (However, the maximum RF bandwidth cannot exceed 100% for voice + video.)

Default: 0%

Note If this parameter is set to zero (0), the controller assumes that the operator does not want to do any bandwidth allocation and, therefore, allows all bandwidth requests.

Step 6 In the Reserved Roaming Bandwidth field, enter the percentage of maximum allocated bandwidth reserved for roaming video clients. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming video clients.

Range: 0 to 25%

Default: 0%

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

Step 8 To enable the radio network, click **Network** under 802.11a or 802.11b/g, check the **802.11a** (or **802.11b/g**) **Network Status** check box, and click **Apply**.

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

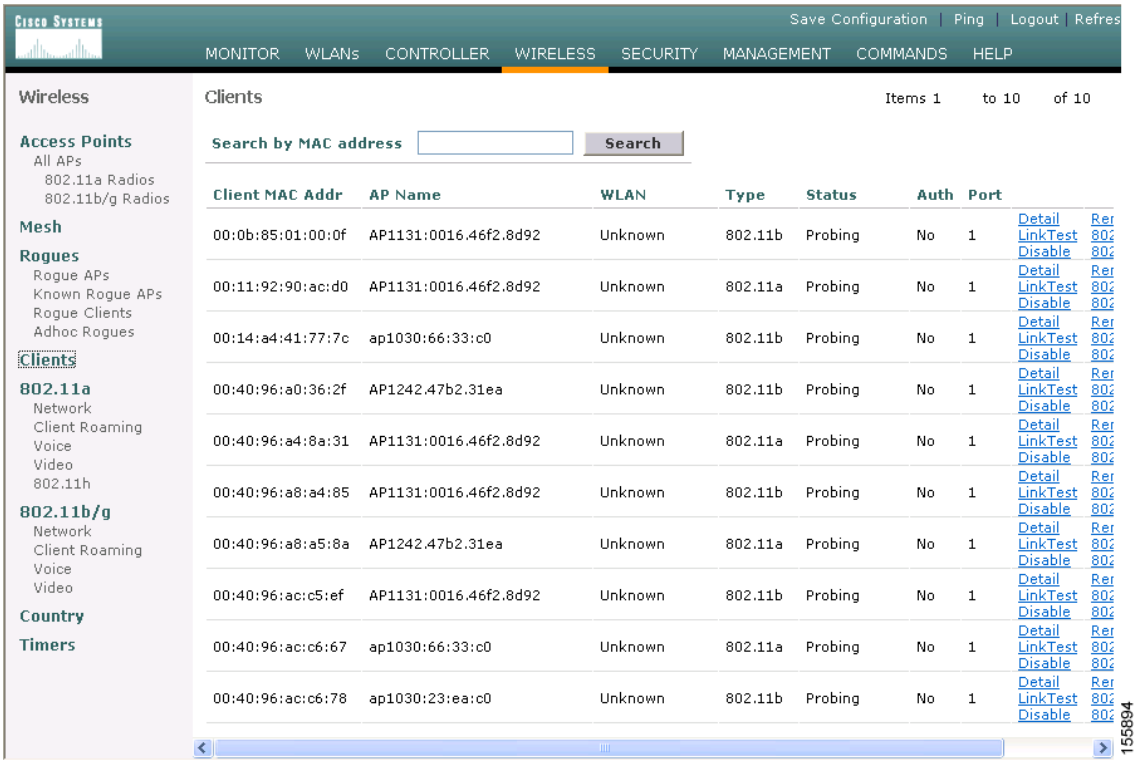
Step 10 Repeat this procedure if you want to configure video parameters for another radio band (802.11a or 802.11b/g).

Using the GUI to View Voice and Video Settings

Follow these steps to view voice and video settings using the GUI.

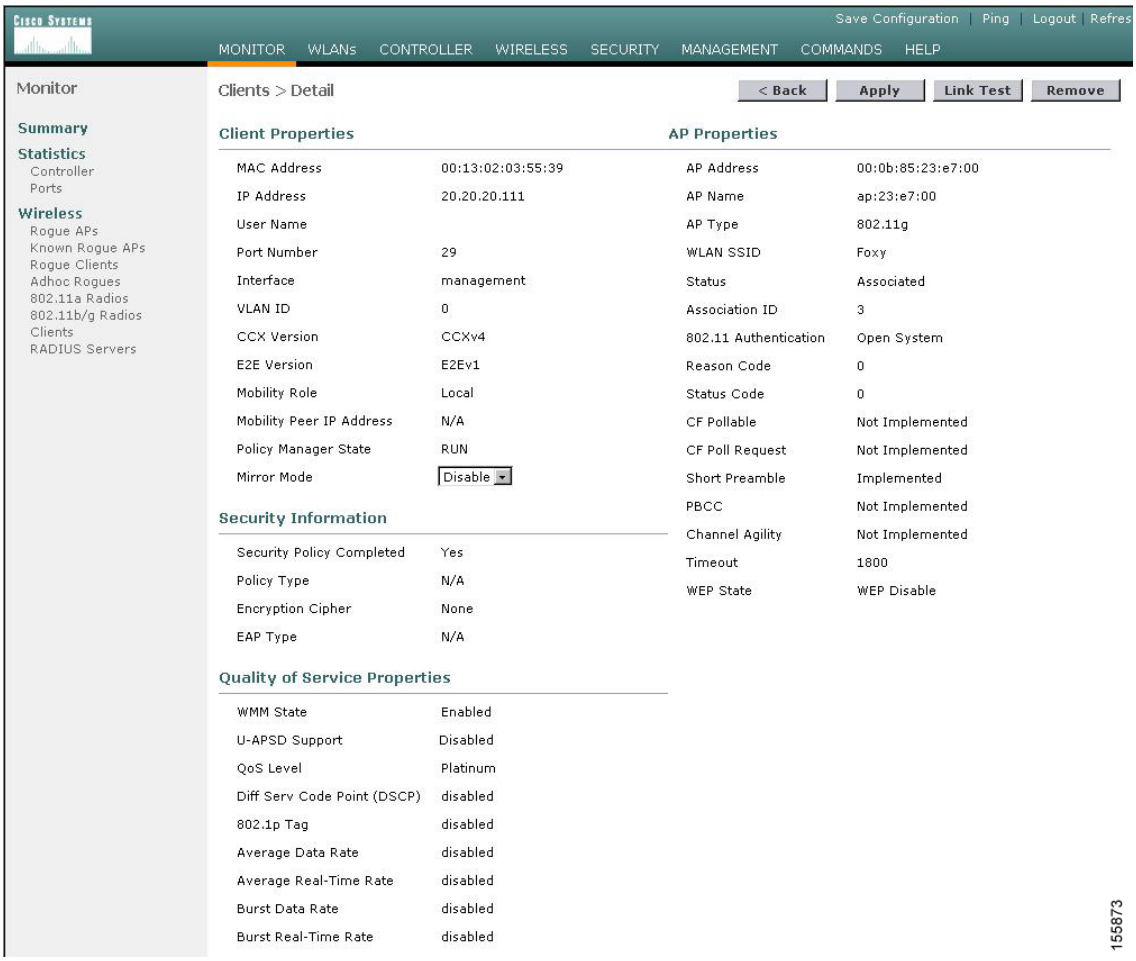
Step 1 Click **Wireless** > **Clients** to access the Clients page (see Figure 4-10).

Figure 4-10 Clients Page



Step 2 Click the **Detail** link for the desired client to access the Clients > Detail page (see Figure 4-11).

Figure 4-11 Clients > Detail Page



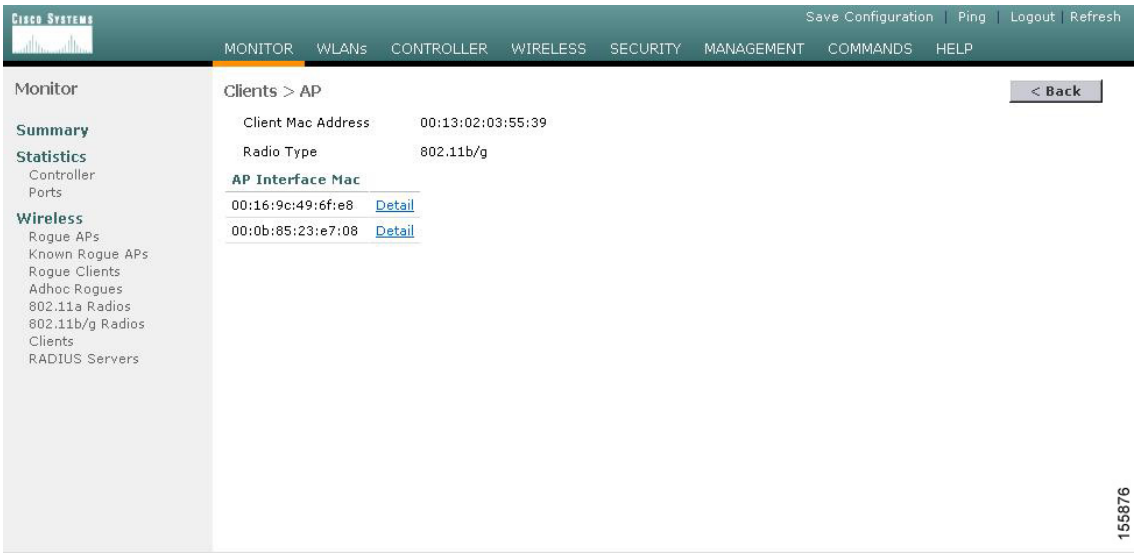
This page shows the U-APSD status for this client under Quality of Service Properties.

Step 3 Click **Back** to return to the Clients page.

Step 4 Follow these steps to see the TSM statistics for a particular client and the access point to which this client is associated:

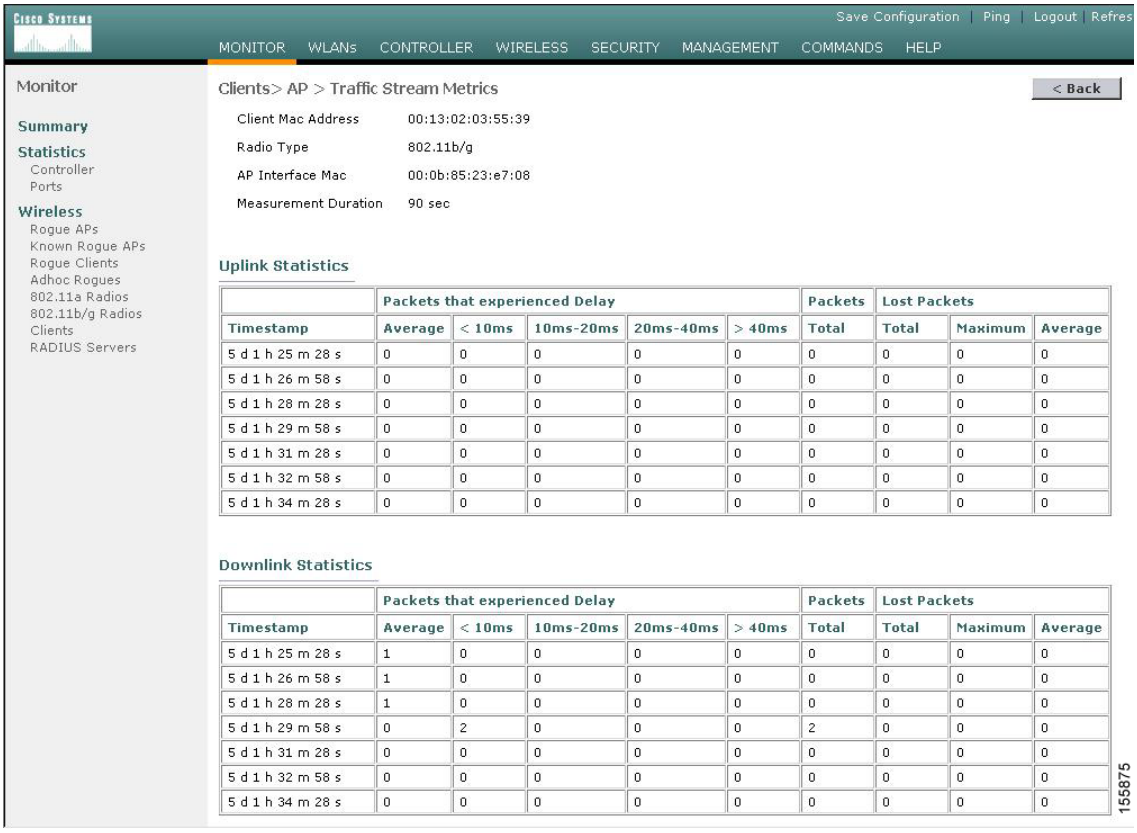
a. Click the **802.11aTSM or 802.11b/gTSM** link for the desired client. The Clients > AP page appears (see Figure 4-12).

Figure 4-12 Clients > AP Page



b. Click the **Detail** link for the desired access point to access the Clients > AP > Traffic Stream Metrics page (see Figure 4-13).

Figure 4-13 Clients > AP > Traffic Stream Metrics Page

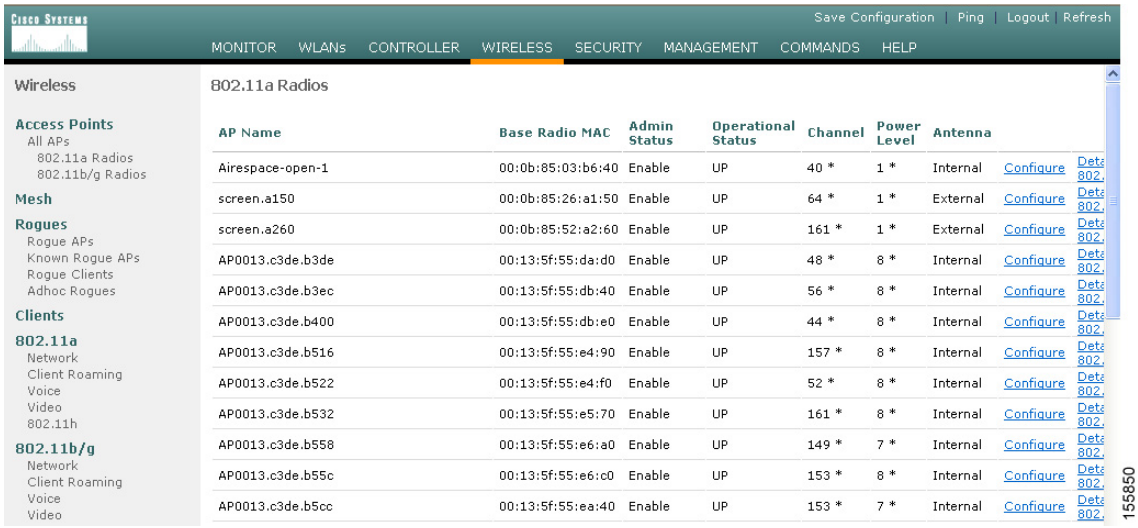


This page shows the TSM statistics for this client and the access point to which it is associated. The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Step 5 Follow these steps to see the TSM statistics for a particular access point and a particular client associated to this access point:

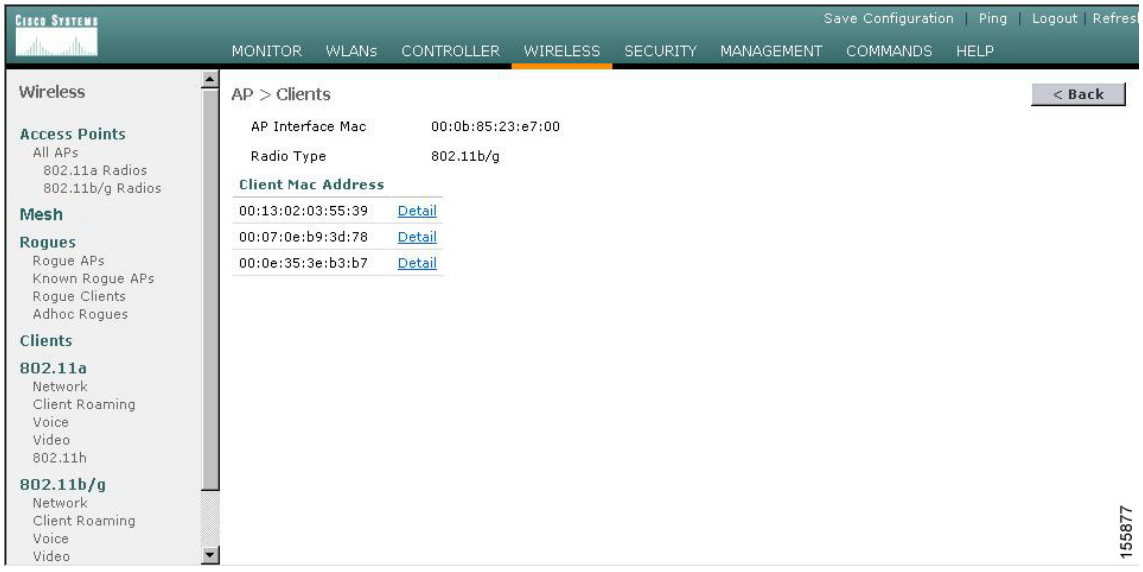
a. Click **Wireless** and then click **802.11a Radios** or **802.11b/g Radios** under Access Points. The 802.11a Radios or 802.11b/g Radios page appears (see Figure 4-14).

Figure 4-14 802.11a Radios Page



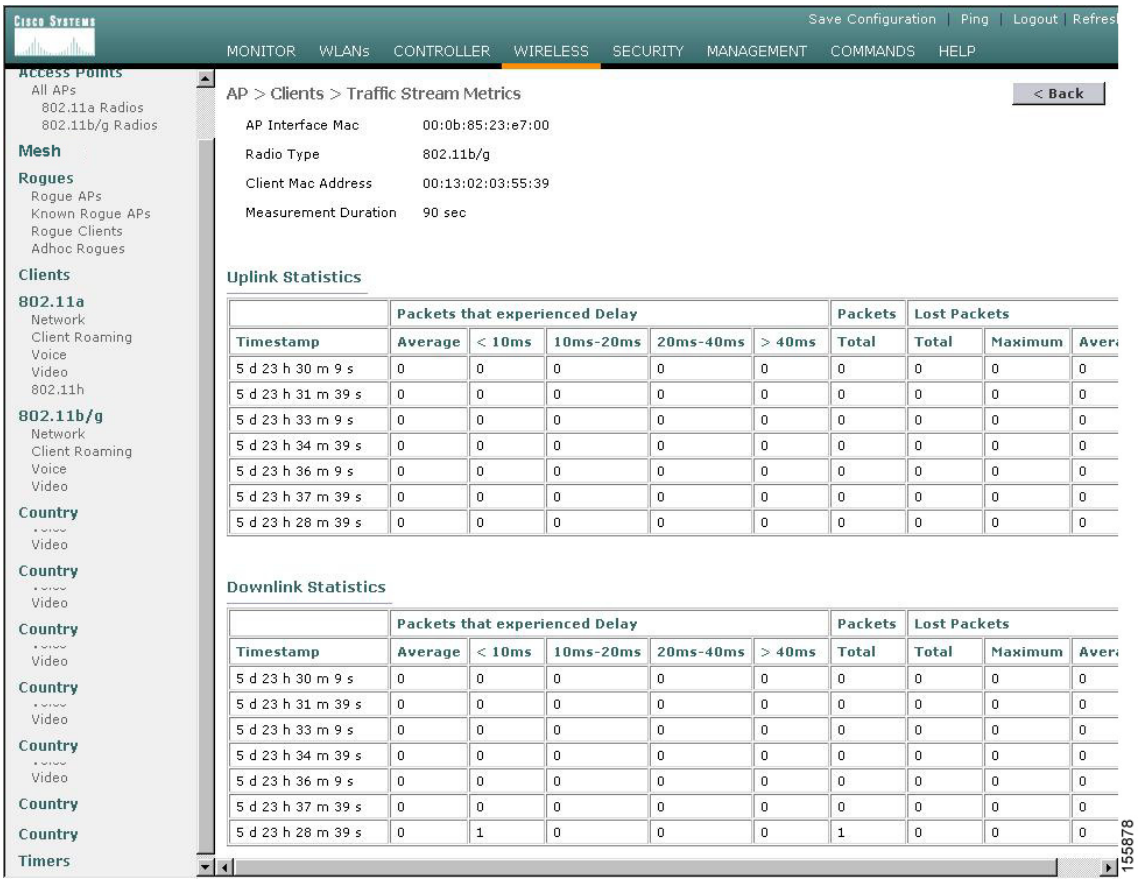
b. Click the **802.11aTSM or 802.11b/gTSM** link for the desired access point. The AP > Clients page appears (see Figure 4-15).

Figure 4-15 AP > Clients Page



c. Click the **Detail** link for the desired client to access the AP > Clients > Traffic Stream Metrics page (see Figure 4-16).

Figure 4-16 AP > Clients > Traffic Stream Metrics Page



This page shows the TSM statistics for this access point and a client associated to it. The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Using the CLI to Configure Voice Parameters

Follow these steps to configure voice parameters using the CLI.

Step 1 Make sure that the WLAN is configured for WMM and the QoS level is set to Platinum. See "Configuring Quality of Service" section on page 6-17 for instructions.

Step 2 To disable the radio network, enter this command:

config {802.11a | 802.11b} disable network

Step 3 To save your settings, enter this command:

save config

Step 4 To enable or disable voice CAC for the 802.11a or 802.11b/g network, enter this command:

config {802.11a | 802.11b} cac voice acm {enable | disable}

Step 5 To set the percentage of maximum bandwidth allocated to clients for voice applications on the 802.11a or 802.11b/g network, enter this command:

config {802.11a | 802.11b} cac voice max-bandwidth *bandwidth*

The *bandwidth* range is 40 to 85%, and the default value is 75%. Once the client reaches the value specified, the access point rejects new calls on this network.

Step 6 To set the percentage of maximum allocated bandwidth reserved for roaming voice clients, enter this command:

config {802.11a | 802.11b} cac voice roam-bandwidth *bandwidth*

The *bandwidth* range is 0 to 25%, and the default value is 6%. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming voice clients.

Step 7 To enable or disable TSM for the 802.11a or 802.11b/g network, enter this command:

config {802.11a | 802.11b} tsm {enable | disable}

Step 8 To enable the radio network, enter this command:

config {802.11a | 802.11b} enable network

Step 9 To save your settings, enter this command:

save config

Using the CLI to Configure Video Parameters

Follow these steps to configure video parameters using the CLI.

Step 1 Make sure that the WLAN is configured for WMM and the QoS level is set to Gold. See "Configuring Quality of Service" section on page 6-17 for instructions.

Step 2 To disable the radio network, enter this command:

config {802.11a | 802.11b} disable network

Step 3 To save your settings, enter this command:

save config

Step 4 To enable or disable video CAC for the 802.11 or 802.11b/g network, enter this command:

config {802.11a | 802.11b} cac video acm {enable | disable}

Step 5 To set the percentage of maximum bandwidth allocated to clients for video applications on the 802.11a or 802.11b/g network, enter this command:

config {802.11a | 802.11b} cac video max-bandwidth *bandwidth*

The *bandwidth* range is 0 to 100%, and the default value is 0%. However, the maximum RF bandwidth cannot exceed 100% for voice + video. Once the client reaches the value specified, the access point rejects new calls on this network.

Note If this parameter is set to zero (0), the controller assumes that the operator does not want to do any bandwidth allocation and, therefore, allows all bandwidth requests.

Step 6 To set the percentage of maximum allocated bandwidth reserved for roaming video clients, enter this command:

config {**802.11a** | **802.11b**} **cac video roam-bandwidth** *bandwidth*

The *bandwidth* range is 0 to 25%, and the default value is 0%. The controller reserves this much bandwidth from the maximum allocated bandwidth for roaming video clients.

Step 7 To enable the radio network, enter this command:

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

Step 8 To save your settings, enter this command:

save config

Using the CLI to View Voice and Video Settings

Use these commands to view voice and video settings using the CLI.

1. To see the CAC configuration for the 802.11a or 802.11b/g network, enter this command:

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

2. To see the CAC statistics for a particular access point, enter this command:

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

   Information similar to the following appears:

```
Call Admission Control (CAC) Stats
  Voice Bandwidth in use(% of config bw)..... 0
  Video Bandwidth in use(% of config bw)..... 0
  Total num of voice calls in progress....... 0
  Num of roaming voice calls in progress..... 0
  Total Num of voice calls since AP joined..... 0
  Total Num of roaming calls since AP joined..... 0
  Num of voice calls rejected since AP joined.... 0
  Num of roam calls rejected since AP joined..... 0
  Num of calls rejected due to insufficient bw.... 0
  Num of calls rejected due to invalid params.... 0
  Num of calls rejected due to PHY rate..... 0
  Num of calls rejected due to QoS policy..... 0
```

3. To see the U-APSD status for a particular client, enter this command:

   show client detail *client_mac*

4. To see the TSM statistics for a particular client and the access point to which this client is associated, enter this command:

   show client tsm {**802.11a** | **802.11b**} *client_mac* [*ap_mac* | **all**]

   The optional **all** command shows all access points to which this client has associated. Information similar to the following appears:

```
AP Interface Mac:                   00:0b:85:01:02:03
Client Interface Mac:               00:01:02:03:04:05
Measurement Duration:               90 seconds

  Timestamp                           1st Jan 2006, 06:35:80
    UpLink Stats
    ================
       Average Delay (5sec intervals).........................35
       Delay less than 10 ms..................................20
       Delay bet 10 - 20 ms...................................20
       Delay bet 20 - 40 ms...................................20
       Delay greater than 40 ms...............................20
      Total packet Count......................................80
      Total packet lost count (5sec)..........................10
      Maximum Lost Packet count(5sec).........................5
      Average Lost Packet count(5secs)........................2
    DownLink Stats
    ================
       Average Delay (5sec intervals).........................35
       Delay less than 10 ms..................................20
       Delay bet 10 - 20 ms...................................20
       Delay bet 20 - 40 ms...................................20
       Delay greater than 40 ms...............................20
      Total packet Count......................................80
      Total packet lost count (5sec)..........................10
      Maximum Lost Packet count(5sec).........................5
      Average Lost Packet count(5secs)........................2
```

Note The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

5. To see the TSM statistics for a particular access point and a particular client associated to this access point, enter this command:

   show ap stats {**802.11a** | **802.11b**} *ap_name* **tsm** [*client_mac* | **all**]

   The optional **all** command shows all clients associated to this access point. Information similar to the following appears:

```
AP Interface Mac:                   00:0b:85:01:02:03
Client Interface Mac:               00:01:02:03:04:05
Measurement Duration:               90 seconds

  Timestamp                           1st Jan 2006, 06:35:80
    UpLink Stats
    ================
       Average Delay (5sec intervals).........................35
       Delay less than 10 ms..................................20
       Delay bet 10 - 20 ms...................................20
       Delay bet 20 - 40 ms...................................20
       Delay greater than 40 ms...............................20
      Total packet Count......................................80
      Total packet lost count (5sec)..........................10
```

```
  Maximum Lost Packet count(5sec).............................5
  Average Lost Packet count(5secs)............................2
DownLink Stats
================
   Average Delay (5sec intervals).............................35
   Delay less than 10 ms......................................20
   Delay bet 10 - 20 ms.......................................20
   Delay bet 20 - 40 ms.......................................20
   Delay greater than 40 ms...................................20
  Total packet Count..........................................80
  Total packet lost count (5sec)..............................10
  Maximum Lost Packet count(5sec).............................5
  Average Lost Packet count(5secs)............................2
```

Note The statistics are shown in 90-second intervals. The timestamp field shows the specific interval when the statistics were collected.

Configuring the Supervisor 720 to Support the WiSM

When you install a WiSM in a Cisco Catalyst 6500 switch, you must configure the Supervisor 720 to support the WiSM. When the supervisor detects the WiSM, the supervisor creates 10 GigabitEthernet interfaces, ranging from Gig*slot*/1 to Gig*slot*/8. For example, if the WiSM is in slot 9, the supervisor creates interfaces Gig9/1 through Gig9/8. The first eight GigabitEthernet interfaces must be organized into two etherchannel bundles of four interfaces each. The remaining two GigabitEthernet interfaces are used as service-port interfaces, one for each controller on the WiSM. You must manually create VLANs to communicate with the ports on the WiSM.

Note The WiSM is also supported on Cisco 7600 Series Routers running only Cisco IOS Release 12.2(18)SXF5.

General WiSM Guidelines

Keep these general guidelines in mind when you add a WiSM to your network:

- The switch ports leading to the controller service port are automatically configured and cannot be manually configured.
- The switch ports leading to the controller data ports should be configured as edge ports to avoid sending unnecessary BPDUs.
- The switch ports leading to the controller data ports should not be configured with any additional settings (such as port channel or SPAN destination) other than settings necessary for carrying data traffic to and from the controllers.
- The WiSM controllers support Layer 3 LWAPP mode, but they do not support Layer 2 LWAPP mode.

Note Refer to Chapter 3 for information on configuring the WiSM's ports and interfaces.

Configuring the Supervisor

Log into the switch CLI and, beginning in Privileged Exec mode, follow these steps to configure the supervisor to support the WiSM:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *vlan*	Create a VLAN to communicate with the data ports on the WiSM and enter interface config mode.
Step 3	**ip address** *ip-address gateway*	Assign an IP address and gateway to the VLAN.
Step 4	**ip helper-address** *ip-address*	Assign a helper address to the VLAN.
Step 5	**end**	Return to global config mode.
Step 6	**wism module** *module_number* **controller** {**1** | **2**} **allowed-vlan** *vlan_number*	Create Gigabit port-channel interfaces automatically for the specified WiSM controller and configure the port-channel interfaces as trunk ports. Also, specify the VLAN you created earlier as the allowed VLAN on the port-channel trunk. VLAN traffic will be carried on the trunk between the WiSM controller and the supervisor.
Step 7	**wism module** *module_number* **controller** {**1** | **2**} **native-vlan** *vlan_number*	For the native VLAN on the ports, specify the VLAN that you created earlier to communicate with the WiSM data ports.
Step 8	**interface** *vlan*	Create a VLAN to communicate with the service ports on the WiSM.
Step 9	**ip address** *ip-address gateway*	Assign an IP address and gateway to the VLAN.
Step 10	**end**	Return to global config mode.
Step 11	**wism service-vlan** *vlan*	Configure the VLAN that you created in steps 8 through 10 to communicate with the WiSM service ports.
Step 12	**end**	Return to global config mode.
Step 13	**show wism status**	Verify that the WiSM is operational.

Using the Wireless LAN Controller Network Module

Keep these guidelines in mind when using a wireless LAN controller network module (CNM) installed in a Cisco Integrated Services Router:

- The controller network module does not support IPSec. To use IPSec with the CNM, configure IPSec on the router in which the CNM is installed. Click this link to browse to IPSec configuration instructions for routers:

  http://www.cisco.com/en/US/tech/tk583/tk372/tech_configuration_guides_list.html

- The controller network module does not have a battery and cannot save a time setting. It must receive a time setting from an NTP server when it powers up. When you install the module the configuration wizard prompts you for NTP server information.

- To access the CNM bootloader, Cisco recommends that you reset the CNM from the router. If you reset the CNM from a CNM user interface the router might reset the CNM while you are using the bootloader.

  When you reset the CNM from a CNM interface you have 17 minutes to use the bootloader before the router automatically resets the CNM. The CNM bootloader does not run the Router Blade Configuration Protocol (RBCP), so the RBCP heartbeat running on the router times out after 17 minutes, triggering a reset of the CNM.

  If you reset the CNM from the router, the router stops the RBCP heartbeat exchange and does not restart it until the CNM boots up. To reset the CNM from the router, enter this command on the router CLI:

  service-module wlan-controller 1/0 reset

Configuring Security Solutions

This chapter describes security solutions for wireless LANs. It contains these sections:

Cisco UWN Solution Security

Cisco UWN Solution security includes the following sections:

Security Overview

The Cisco UWN security solution bundles potentially complicated Layer 1, Layer 2, and Layer 3 802.11 Access Point security components into a simple policy manager that customizes system-wide security policies on a per-WLAN basis. The Cisco UWN security solution provides simple, unified, and systematic security management tools.

One of the biggest hurdles to WLAN deployment in the enterprise is WEP encryption, which is a weak standalone encryption method. A newer problem is the availability of low-cost access points, which can be connected to the enterprise network and used to mount man-in-the-middle and denial-of-service attacks. Also, the complexity of add-on security solutions has prevented many IT managers from embracing the benefits of the latest advances in WLAN security.

Layer 1 Solutions

The Cisco UWN security solution ensures that all clients gain access within an operator-set number of attempts. Should a client fail to gain access within that limit, it is automatically excluded (blocked from access) until the operator-set timer expires. The operating system can also disable SSID broadcasts on a per-WLAN basis.

Layer 2 Solutions

If a higher level of security and encryption is required, the network administrator can also implement industry-standard security solutions, such as: 802.1X dynamic keys with EAP (extensible authentication protocol), or WPA (Wi-Fi protected access) dynamic keys. The Cisco UWN Solution WPA implementation includes AES (advanced encryption standard), TKIP + Michael (temporal key integrity protocol + message integrity code checksum) dynamic keys, or WEP (Wired Equivalent Privacy) static keys. Disabling is also used to automatically block Layer 2 access after an operator-set number of failed authentication attempts.

Regardless of the wireless security solution selected, all Layer 2 wired communications between controllers and lightweight access points are secured by passing data through LWAPP tunnels.

Layer 3 Solutions

The WEP problem can be further solved using industry-standard Layer 3 security solutions such as passthrough VPNs (virtual private networks).

The Cisco UWN Solution supports local and RADIUS MAC (media access control) filtering. This filtering is best suited to smaller client groups with a known list of 802.11 access card MAC addresses.

Finally, the Cisco UWN Solution supports local and RADIUS user/password authentication. This authentication is best suited to small to medium client groups.

Rogue Access Point Solutions

This section describes security solutions for rogue access points.

Rogue Access Point Challenges

Rogue access points can disrupt WLAN operations by hijacking legitimate clients and using plaintext or other denial-of-service or man-in-the-middle attacks. That is, a hacker can use a rogue access point to capture sensitive information, such as passwords and username. The hacker can then transmit a series of clear-to-send (CTS) frames, which mimics an access point informing a particular NIC to transmit and instructing all others to wait, which results in legitimate clients being unable to access the WLAN resources. WLAN service providers thus have a strong interest in banning rogue access points from the air space.

The operating system security solution uses the radio resource management (RRM) function to continuously monitor all nearby access points, automatically discover rogue access points, and locate them as described in the "Tagging and Containing Rogue Access Points" section on page 5-3.

Tagging and Containing Rogue Access Points

When the Cisco UWN Solution is monitored using WCS. WCS generates the flags as rogue access point traps, and displays the known rogue access points by MAC address. The operator can then display a map showing the location of the lightweight access points closest to each rogue access point, allowing Known or Acknowledged rogue access points (no further action), marking them as Alert rogue access points (watch for and notify when active), or marking them as contained rogue access points. Between one and four lightweight access points discourage rogue access point clients by sending the clients deauthenticate and disassociate messages whenever they associate with the rogue access point.

When the Cisco UWN Solution is monitored using a GUI or a CLI, the interface displays the known rogue access points by MAC address. The operator then has the option of marking them as Known or Acknowledged rogue access points (no further action), marking them as Alert rogue access points (watch for and notify when active), or marking them as Contained rogue access points (have between one and four lightweight access points discourage rogue access point clients by sending the clients deauthenticate and disassociate messages whenever they associate with the rogue access point).

Integrated Security Solutions

- Cisco UWN Solution operating system security is built around a robust 802.1X AAA (authorization, authentication and accounting) engine, which allows operators to rapidly configure and enforce a variety of security policies across the Cisco UWN Solution.
- The controllers and lightweight access points are equipped with system-wide authentication and authorization protocols across all ports and interfaces, maximizing system security.
- Operating system security policies are assigned to individual WLANs, and lightweight access points simultaneously broadcast all (up to 16) configured WLANs. This can eliminate the need for additional access points, which can increase interference and degrade system throughput.
- Operating system security uses the RRM function to continually monitor the air space for interference and security breaches, and notify the operator when they are detected.
- Operating system security works with industry-standard authorization, authentication, and accounting (AAA) servers, making system integration simple and easy.

Configuring the System for SpectraLink NetLink Telephones

For best integration with the Cisco UWN Solution, SpectraLink NetLink Telephones require an extra operating system configuration step: enable long preambles. The radio preamble (sometimes called a header) is a section of data at the head of a packet that contains information that wireless devices need when sending and receiving packets. Short preambles improve throughput performance, so they are enabled by default. However, some wireless devices, such as SpectraLink NetLink phones, require long preambles.

Use one of these methods to enable long preambles:

- Using the GUI to Enable Long Preambles, page 5-4
- Using the CLI to Enable Long Preambles, page 5-5

Using the GUI to Enable Long Preambles

Use this procedure to use the GUI to enable long preambles to optimize the operation of SpectraLink NetLink phones on your wireless LAN.

Step 1 Log into the controller GUI.

Step 2 Follow this path to navigate to the 802.11b/g Global Parameters page:

Wireless > Global RF > 802.11b/g Network

If the **Short Preamble Enabled** box is checked, continue with this procedure. However, if the **Short Preamble Enabled** box is unchecked (which means that long preambles are enabled), the controller is already optimized for SpectraLink NetLink phones and you do not need to continue this procedure.

Step 3 Uncheck the **Short Preamble Enabled** check box to enable long preambles.

Step 4 Click **Apply** to update the controller configuration.

Note If you do not already have an active CLI session to the controller, Cisco recommends that you start a CLI session to reboot the controller and watch the reboot process. A CLI session is also useful because the GUI loses its connection when the controller reboots.

Step 5 Reboot the controller using Commands > Reboot > Reboot. Click **OK** in response to this prompt:

```
Configuration will be saved and switch will be rebooted. Click ok to confirm.
```

The controller reboots.

Step 6 Log back into the controller GUI and verify that the controller is properly configured. Follow this path to navigate to the 802.11b/g Global Parameters page:

Wireless > Global RF > 802.11b/g Network

If the **Short Preamble Enabled** box is unchecked, the controller is optimized for SpectraLink NetLink phones.

Using the CLI to Enable Long Preambles

Use this procedure to use the CLI to enable long preambles to optimize the operation of SpectraLink NetLink phones on your wireless LAN.

Step 1 Log into the controller CLI.

Step 2 Enter **show 802.11b** and check the Short preamble mandatory parameter. If the parameter indicates that short preambles are enabled, continue with this procedure. This example shows that short preambles are enabled:

```
Short Preamble mandatory..................... Enabled
```

However, if the parameter shows that short preambles are disabled (which means that long preambles are enabled), the controller is already optimized for SpectraLink NetLink phones and you do not need to continue this procedure. This example shows that short preambles are disabled:

```
Short Preamble mandatory..................... Disabled
```

Step 3 Enter **config 802.11b disable network** to disable the 802.11b/g network. (You cannot enable long preambles on the 802.11a network.)

Step 4 Enter **config 802.11b preamble long** to enable long preambles.

Step 5 Enter **config 802.11b enable network** to re-enable the 802.11b/g network.

Step 6 Enter **reset system** to reboot the controller. Enter **y** when this prompt appears:

```
The system has unsaved changes. Would you like to save them now? (y/n)
```

The controller reboots.

Step 7 To verify that the controller is properly configured, log back into the CLI and enter **show 802.11b** to view these parameters:

```
802.11b Network.............................. Enabled
Short Preamble mandatory..................... Disabled
```

These parameters show that the 802.11b/g network is enabled and that short preambles are disabled.

Using the CLI to Configure Enhanced Distributed Channel Access

Use this CLI command to configure 802.11 enhanced distributed channel access (EDCA) parameters to support SpectraLink phones.

config advanced edca-parameters {**svp-voice** | **wmm-default**}

where

svp-voice enables SpectraLink voice priority (SVP) parameters and

wmm-default enables wireless multimedia (WMM) default parameters

Note To propagate this command to all access points connected to the controller, make sure to disable and then re-enable the 802.11b/g network after entering this command.

Using Management over Wireless

The Cisco UWN Solution Management over Wireless feature allows operators to monitor and configure local controllers using a wireless client. This feature is supported for all management tasks except uploads to and downloads from (transfers to and from) the controller.

Before you can use the Management over Wireless feature, you must properly configure the controller using one of these sections:

- Using the GUI to Enable Management over Wireless, page 5-6
- Using the CLI to Enable Management over Wireless, page 5-7

Using the GUI to Enable Management over Wireless

Step 1 Click Management > Mgmt Via Wireless to access the Management Via Wireless page.

Step 2 Check the **Enable Controller Management to be accessible from Wireless Clients** check box. If the selection box is not checked, continue with Step 3. Otherwise, continue with Step 3.

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

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

Step 5 Use a wireless client web browser to connect to the controller management port or DNS port IP address, and log into the controller GUI to verify that you can manage the WLAN using a wireless client.

Using the CLI to Enable Management over Wireless

Step 1 In the CLI, use the **show network** command to verify whether the Mgmt Via Wireless Interface is Enabled or Disabled. If Mgmt Via Wireless Interface is Disabled, continue with Step 2. Otherwise, continue with Step 3.

Step 2 To Enable Management over Wireless, enter **config network mgmt-via-wireless enable**.

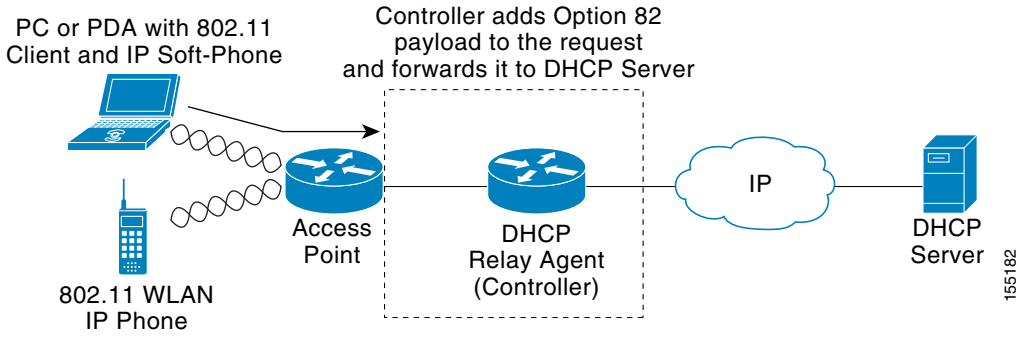
Step 3 Use a wireless client to associate with an access point connected to the controller that you want to manage.

Step 4 Enter **telnet controller-ip-address** and log into the CLI to verify that you can manage the WLAN using a wireless client.

Configuring DHCP Option 82

DHCP option 82 provides additional security when DHCP is used to allocate network addresses. Specifically, it enables the controller to act as a DHCP relay agent to prevent DHCP client requests from untrusted sources. The controller can be configured to add option 82 information to DHCP requests from clients before forwarding the requests to the DHCP server. See Figure 5-1 for an illustration of this process.

Figure 5-1 DHCP Option 82



The access point forwards all DHCP requests from a client to the controller. The controller adds the DHCP option 82 payload and forwards the request to the DHCP server. The payload can contain the MAC address or the MAC address and SSID of the access point, depending on how you configure this option.

Note Any DHCP packets that already include a relay agent option are dropped at the controller.

Note DHCP option 82 is not supported for use with auto-anchor mobility, which is described in Chapter 11.

Use these commands to configure DHCP option 82 on the controller.

1. To configure the format of the DHCP option 82 payload, enter one of these commands:
   - **config dhcp opt-82 remote-id** *ap_mac*

     This command adds the MAC address of the access point to the DHCP option 82 payload.
   - **config dhcp opt-82 remote-id** *ap_mac:ssid*

     This command adds the MAC address and SSID of the access point to the DHCP option 82 payload.
2. To enable or disable DHCP option 82 on the controller, enter this command:

   config interface dhcp ap-manager opt-82 {**enable** | **disable**}
3. To see the status of DHCP option 82 on the controller, enter this command:

   show interface detailed ap-manager

   Information similar to the following appears:

```
Interface Name................................. ap-manager
IP Address..................................... 10.30.16.13
IP Netmask..................................... 255.255.248.0
IP Gateway..................................... 10.30.16.1
VLAN........................................... untagged
Active Physical Port........................... LAG (29)
Primary Physical Port.......................... LAG (29)
Backup Physical Port........................... Unconfigured
Primary DHCP Server............................ 10.1.0.10
Secondary DHCP Server.......................... Unconfigured
DHCP Option 82................................. Enabled
ACL............................................ Unconfigured
AP Manager..................................... Yes
```

Configuring Access Control Lists

An access control list (ACL) is a set of rules used to limit access to a particular interface (for example, if you want to restrict a wireless client from pinging the management interface of the controller). ACLs can be applied to data traffic to and from wireless clients or to all traffic destined for the controller CPU. After they are defined, ACLs can be applied to the management interface, the AP-manager interface, or any of the dynamic interfaces for client data traffic or to the NPU interface for traffic to the controller CPU.

Note If you are using an external web server, you must configure a preauthentication ACL on the WLAN for the external web server.

You can define up to 64 ACLs, each with up to 64 rules (or filters). Each rule has parameters that affect its action. When a packet matches all of the parameters for a rule, the action set for that rule is applied to the packet.

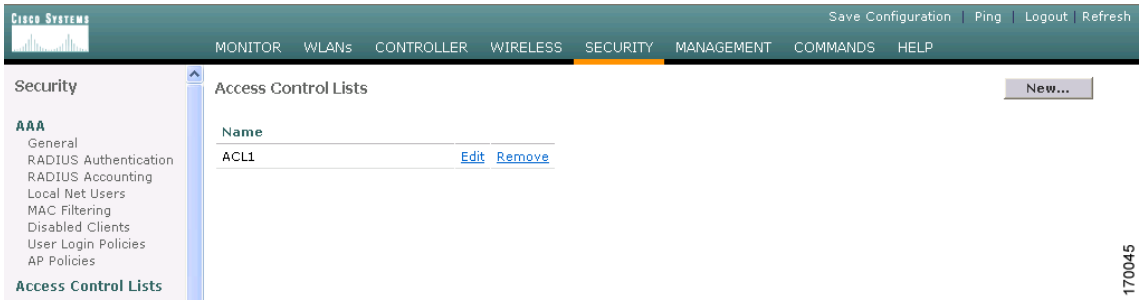
You can configure ACLs through either the GUI or the CLI.

Using the GUI to Configure Access Control Lists

Follow these steps to configure ACLs using the controller GUI.

Step 1 Click **Security** > **Access Control Lists** to access the Access Control Lists page (see Figure 5-2).

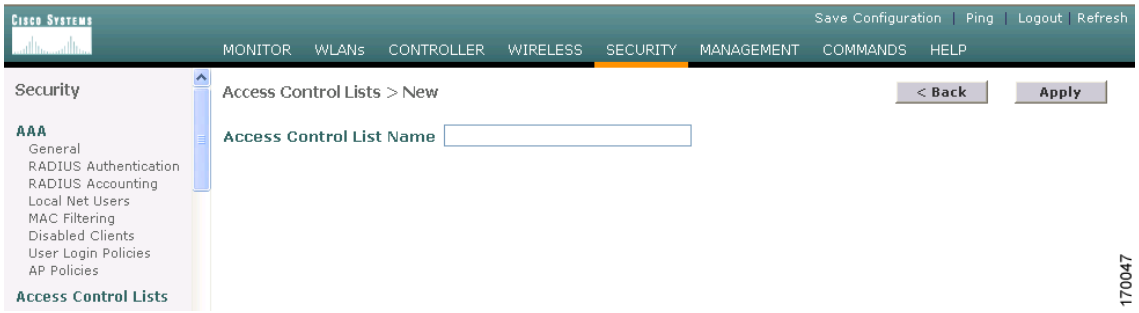
Figure 5-2 Access Control Lists Page



This page lists all of the ACLs that have been configured for this controller. It also enables you to edit or remove any of the ACLs.

Step 2 To add a new ACL, click **New**. The Access Control Lists > New page appears (see Figure 5-3).

Figure 5-3 Access Control Lists > New Page

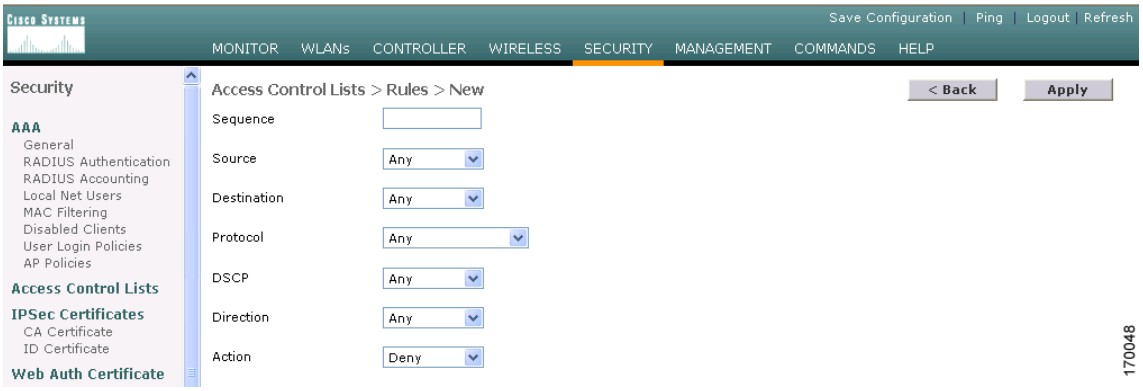


Step 3 In the Access Control List Name field, enter a name for the new ACL. You can enter up to 32 alphanumeric characters.

Step 4 Click **Apply**. When the Access Control Lists page reappears, click the **Edit** link for the new ACL.

Step 5 When the Access Control Lists > Edit page appears, click **Add New Rule**. The Access Control Lists > Rules > New page appears (see Figure 5-4).

Figure 5-4 Access Control Lists > Rules > New Page



Step 6 Follow these steps to configure a rule for this ACL:

a. The controller supports up to 64 rules for each ACL. These rules are listed in order from 1 to 64. In the Sequence field, enter a value (between 1 and 64) to determine the order of this rule in relation to any other rules defined for this ACL.

Note If rules 1 through 4 are already defined and you add rule 29, it is added as rule 5. If you add or change a sequence number for a rule, the sequence numbers for other rules adjust to maintain a contiguous sequence. For instance, if you change a rule's sequence number from 7 to 5, the rules with sequence numbers 5 and 6 are automatically reassigned as 6 and 7, respectively.

b. From the Source drop-down box, choose one of these options to specify the source of the packets to which this ACL applies:

- **Any**—Any source (This is the default value.)
- **IP Address**—A specific source. If you choose this option, enter the IP address and netmask of the source in the edit boxes.

c. From the Destination drop-down box, choose one of these options to specify the destination of the packets to which this ACL applies:

- **Any**—Any destination (This is the default value.)
- **IP Address**—A specific destination. If you choose this option, enter the IP address and netmask of the destination in the edit boxes.

d. From the Protocol drop-down box, choose the protocol to be used for this ACL. These are the protocol options:

- **Any**—All protocol (This is the default value.)
- **TCP**—Transmission Control Protocol
- **UDP**—User Datagram Protocol
- **ICMP**—Internet Control Message Protocol
- **ESP**—IP Encapsulating Security Payload

- **AH**—Authentication Header
- **GRE**—Generic Routing Encapsulation
- **IP**—Internet Protocol
- **Eth Over IP**—Ethernet-over-Internet Protocol
- **OSPF**—Open Shortest Path First
- **Other**—Any other Internet Assigned Numbers Authority (IANA) protocol (http://www.iana.org)

e. If you chose TCP or UDP in the previous step, two additional parameters appear: Source Port and Destination Port. These parameters enable you to choose a specific source port and destination protocol or port ranges. The port options are used by applications that send and receive data to and from the networking stack. Some ports are designated for certain applications such as telnet, ssh, http, ICMP, and so on.

f. From the DSCP drop-down box, choose one of these options to specify the differentiated services code point (DSCP) value of this ACL. DSCP is a packet header code that can be used to define the quality of service across the Internet.

- **Any**—Any DSCP (This is the default value.)
- **Specific**—A specific DSCP from 0 to 63, which you enter in the DSCP edit box

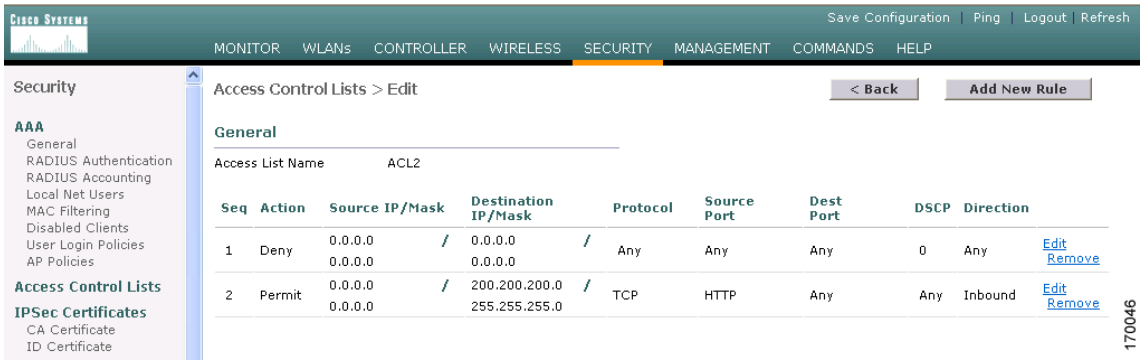
g. From the Direction drop-down box, choose one of these options to specify the direction of the traffic to which this ACL applies:

- **Any**—Any direction (This is the default value.)
- **Inbound**—From the client
- **Outbound**—To the client

h. From the Action drop-down box, choose **Deny** to cause this ACL to block packets or **Permit** to cause this ACL to allow packets. The default value is Deny.

i. Click **Apply** to commit your changes. The Access Control Lists > Edit page reappears, showing the rules for this ACL. See Figure 5-5.

Figure 5-5 Access Control Lists > Edit Page



This page also enables you to edit or remove any of the rules.

j. Repeat this procedure to add any additional rules for this ACL.

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

Step 8 Repeat this procedure to add any additional ACLs.

Step 9 To apply an ACL to a management, AP-manager, or dynamic interface, choose the desired ACL from the ACL Name drop-down box on the interface's Edit page and click **Apply**. See Chapter 3 for more information on configuring controller interfaces.

Note You cannot apply an ACL to the NPU-CPU interface through the GUI. You can configure this setting only through the CLI.

Step 10 To apply a preauthentication ACL to a WLAN for an external web server, choose the desired ACL from the Preauthentication ACL drop-down box under Security Policies > Web Policy on the WLAN's Edit page. See Chapter 6 for more information on configuring WLANs.

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

Using the CLI to Configure Access Control Lists

Follow these steps to configure ACLs using the controller CLI.

Step 1 To see all of the ACLs that are configured on the controller, enter this command:

show acl summary

Step 2 To see detailed information for a particular ACL, enter this command:

show acl detailed *acl_name*

Step 3 To add a new ACL, enter this command:

config acl create *acl_name*

You can enter up to 32 alphanumeric characters for the *acl_name* parameter.

Step 4 To add a rule for an ACL, enter this command:

config acl rule {

action *acl_name rule_index* {**permit** | **deny**} |

add *acl_name rule_index* |

change index *acl_name old_index new_index* |

destination address *acl_name rule_index ip_address netmask* |

destination port range *acl_name rule_index start_port end_port* |

direction *acl_name rule_index* {**in** | **out** | **any**} |

dscp *acl_name rule_index dscp* |

protocol *acl_name rule_index protocol* |

source address *acl_name rule_index ip_address netmask* |

source port range *acl_name rule_index start_port end_port* |

swap index *acl_name index_1 index_2*}

Refer to Step 6 in the previous section for explanations of the rule parameters.

Step 5 To apply an ACL to the data path, enter this command:

config acl apply *acl_name*

Step 6 To create a new ACL that restricts the type of traffic (wired, wireless, or both) reaching the controller CPU, enter this command:

config acl cpu *acl_name* {**wired** | **wireless** | **both**}

Step 7 To see the ACL that is configured on the controller CPU, enter this command:

show acl cpu

Step 8 To apply an ACL to a management, AP-manager, or dynamic interface, enter this command:

config interface acl {**management** | **ap-manager** | *dynamic_interface_name*} *acl_name*

See Chapter 3 for more information on configuring controller interfaces.

Step 9 To apply a preauthentication ACL to a WLAN for an external web server, enter this command:

config wlan security web-auth acl *wlan_id acl_name*

See Chapter 6 for more information on configuring WLANs.

Step 10 To save your settings, enter this command:

save config

Note To delete an ACL, enter **config acl delete** *acl_name*. To delete an ACL rule, enter **config acl rule delete** *acl_name rule_index*.

Configuring Management Frame Protection

Management frame protection (MFP) provides for the authentication of 802.11 management frames by the wireless network infrastructure. Management frames can be protected in order to detect adversaries that are invoking denial-of-service attacks, flooding the network with associations and probes, interjecting as rogue access points, and affecting network performance by attacking the QoS and radio measurement frames. MFP also provides a quick and effective means to detect and report phishing incidents.

MFP performs three main functions:

- **Management frame protection**—When management frame protection is enabled, the access point protects the management frames it transmits by adding a message integrity check information element (MIC IE) to each frame. Any attempt to copy, alter, or replay the frame invalidates the MIC, causing any receiving access point configured to detect MFP frames to report the discrepancy.
- **Management frame validation**—When management frame validation is enabled, the access point validates every management frame that it receives from other access points in the network. It ensures that the MIC IE is present (when the originator is configured to transmit MFP frames) and matches the content of the management frame. If it receives any frame that does not contain a valid MIC IE from a BSSID belonging to an access point that is configured to transmit MFP frames, it reports the discrepancy to the network management system. In order for the timestamps to operate properly, all controllers must be Network Transfer Protocol (NTP) synchronized.

- **Event reporting**—The access point notifies the controller when it detects an anomaly, and the controller aggregates the received anomaly events and can report the results through SNMP traps to alert the network manager.

You can globally configure MFP on a controller. When you do so, management frame protection and validation are enabled by default for each joined access point, and access point authentication is automatically disabled. Once MFP is globally enabled on a controller, you can disable and re-enable it for individual WLANs and access points.

Note Access points support MFP in local and monitor modes and in REAP and H-REAP modes when the access point is connected to a controller.

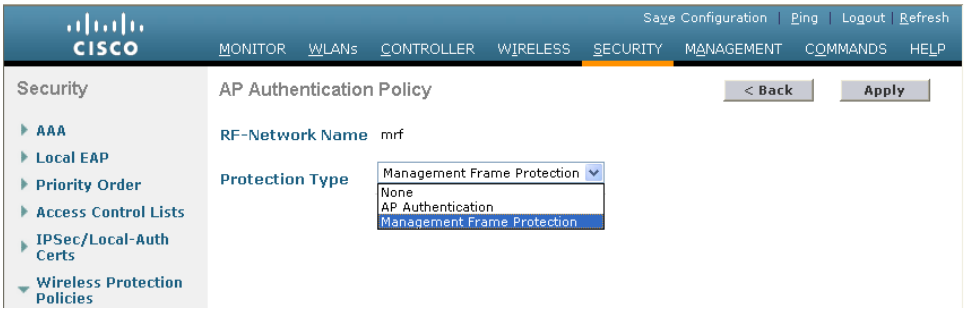
You can configure MFP through either the GUI or the CLI.

Using the GUI to Configure MFP

Follow these steps to configure MFP using the controller GUI.

Step 1 Click **Security** and then **AP Authentication/MFP** under Wireless Protection Policies. The AP Authentication Policy page appears (see Figure 5-6).

Figure 5-6 AP Authentication Policy Page



Step 2 To enable MFP globally for the controller, choose **Management Frame Protection** from the Protection Type drop-down box.

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

Step 4 Follow these steps if you want to disable or re-enable MFP protection for a particular WLAN after MFP has been enabled globally for the controller:

a. Click **WLANs**.

b. Click the **Edit** link of the desired WLAN. The WLANs > Edit page appears.

c. Uncheck the **MFP Signature Generation** check box to disable MFP for this WLAN or check this check box to enable MFP for this WLAN.

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

Step 5 Follow these steps if you want to disable or re-enable MFP validation for a particular access point after MFP has been enabled globally for the controller:

a. Click **Wireless** to access the All APs page.

b. Click the **Detail** link of the desired access point. The All APs > Details page appears.

c. Uncheck the **MFP Frame Validation** check box to disable MFP for this access point or check this check box to enable MFP for this access point.

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

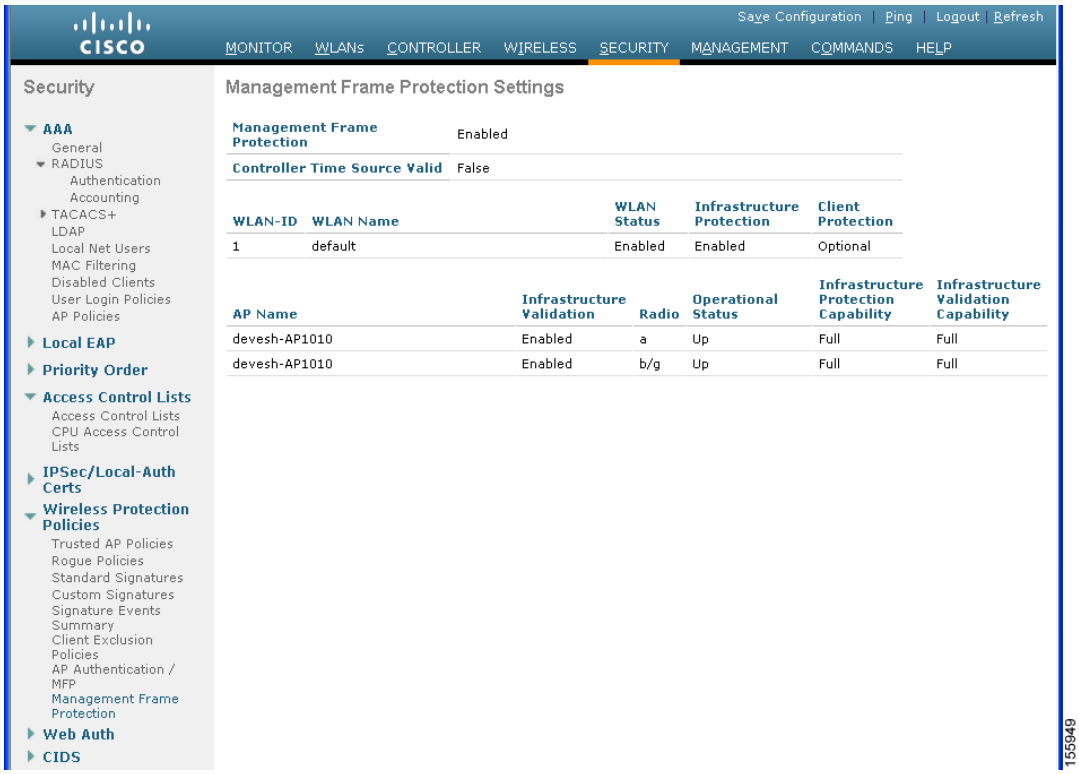
Step 6 Click **Save Configuration** to save your settings.

Using the GUI to View MFP Settings

Follow these steps to view MFP settings using the controller GUI.

Step 1 To see the controller's current global MFP settings, click **Security** and then **Management Frame Protection** under Wireless Protection Policies. The Management Frame Protection Settings page appears (see Figure 5-7).

Figure 5-7 Management Frame Protection Settings Page

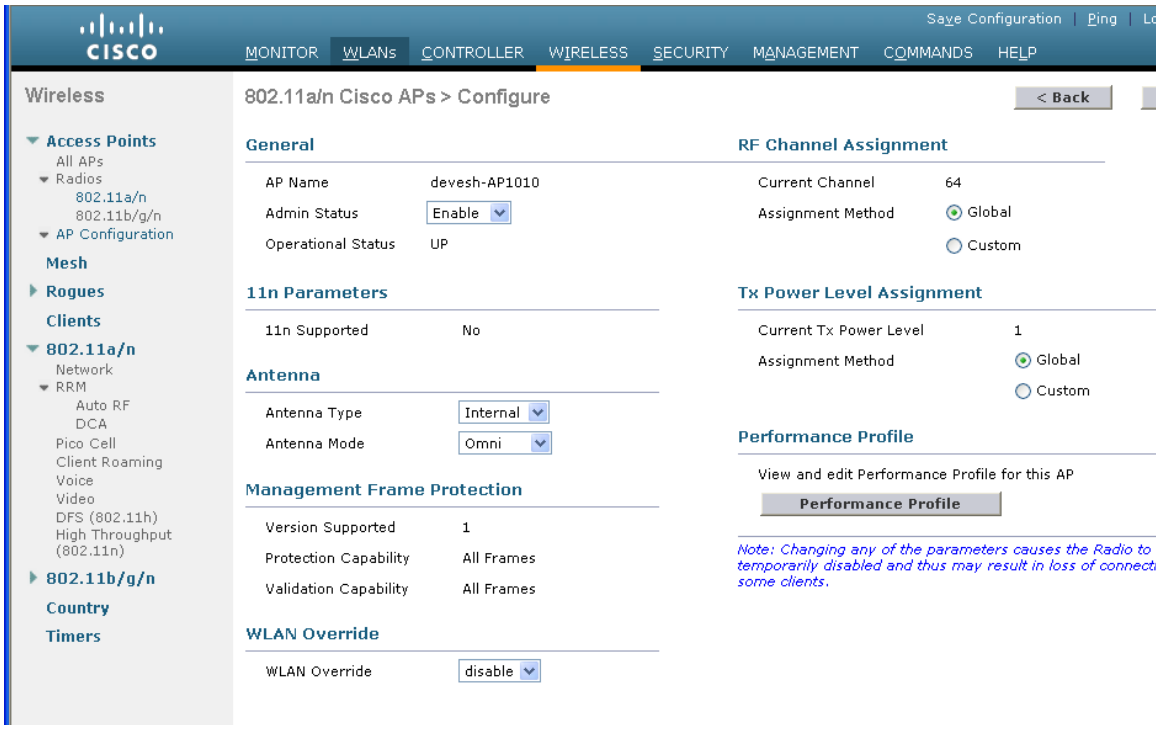


On this page, you can see the following MFP settings:

- The Management Frame Protection field shows if MFP is enabled globally for the controller.
- The Controller Time Source Valid field indicates whether the controller time is set locally (by manually entering the time) or through an external source (such as NTP server). If the time is set by an external source, the value of this field is "True." If the time is set locally, the value is "False." The time source is used for validating management frames between access points of different controllers that also have mobility configured.
- The MFP Protection field shows if MFP is enabled for individual WLANs.
- The MFP Validation field shows if MFP is enabled for individual access points.

Step 2 To see the current MFP state for a particular access point, click **Wireless**, **802.11a Radios** or **802.11b/g Radios** under Access Points, and the **Configure** link of the desired access point. The 802.11a (or 802.11b/g) Cisco APs > Configure page appears (see Figure 5-8).

Figure 5-8 802.11a Cisco APs > Configure Page



Under Management Frame Protection, this page shows the level of MFP protection and validation.

Using the CLI to Configure MFP

Use these commands to configure MFP using the controller CLI.

1. To enable or disable MFP globally for the controller, enter this command:

   config wps mfp {**enable** | **disable**}

2. If MFP is enabled globally for the controller and you want to disable or re-enable it for a particular WLAN, enter this command:

   config wlan mfp protection {**enable** | **disable**} *wlan_id*

3. If MFP is enabled globally for the controller and you want to disable or re-enable it for a particular access point, enter this command:

   config ap mfp validation {**enable** | **disable**} *Cisco_AP*

Using the CLI to View MFP Settings

Use these commands to view MFP settings using the controller CLI.

1. To see a summary of the controller's current wireless protection policies (including MFP), enter this command:

   show wps summary

   Information similar to the following appears:

```
Client Exclusion Policy
  Excessive 802.11-association failures..... Enabled
  Excessive 802.11-authentication failures..... Enabled
  Excessive 802.1x-authentication..... Enabled
  Network access control failure..... Enabled
  IP-theft..... Enabled
  Excessive Web authentication failure..... Enabled

Trusted AP Policy
  Management Frame Protection..... Enabled
  Mis-configured AP Action..... Alarm Only
    Enforced encryption policy..... none
    Enforced preamble policy..... none
    Enforced radio type policy..... none
    Validate SSID..... Disabled
  Alert if Trusted AP is missing..... Disabled
  Trusted AP timeout..... 120

Untrusted AP Policy
  Rogue Location Discovery Protocol..... Disabled
    RLDP Action..... Alarm Only
    Automatically contain rogues advertising .... Alarm Only
    Detect Ad-Hoc Networks..... Alarm Only
  Rogue Clients
    Validate rogue clients against AAA..... Disabled
    Detect trusted clients on rogue APs..... Alarm Only
  Rogue AP timeout..... 1200

Signature Policy
  Signature Processing..... Enabled
```

2. To see the controller's current global MFP settings, enter this command:

   show wps mfp summary

   Information similar to the following appears:

```
Management Frame Protection state..... enabled
Controller Time Source Valid..... true
WLAN ID  WLAN Name               Status     MFP Protection
-------  ----------------------  ---------  --------------
1        tester-2006             Enabled    Enabled
                      MFP                      Operational         MFP Capability
AP Name               Validation  Slot  Radio  State           Protection  Validation
--------------------  ----------  ----  -----  --------------  ----------  ----------
tester-1000           Enabled     0     a      Up              Full        Full
                                  1     b/g    Up              Full        Full
tester-1000b          Enabled     0     a      Up              Full        Full
                                  1     b/g    Up              Full        Full
```

3. To see the current MFP state for a particular WLAN, enter this command:

   show wlan *wlan_id*

   Information similar to the following appears:

```
WLAN Identifier.................................. 1
Network Name (SSID).............................. tester-2006
Status........................................... Enabled
MAC Filtering.................................... Disabled
Broadcast SSID................................... Disabled
AAA Policy Override.............................. Disabled
Network Access Control........................... Disabled
Number of Active Clients......................... 0
Exclusionlist.................................... Disabled
Session Timeout.................................. 1800 seconds
Interface........................................ management
DHCP Server...................................... Default
Quality of Service............................... Silver (best effort)
WMM.............................................. Disabled
CCX - AironetIe Support.......................... Disabled
Dot11-Phone Mode (7920).......................... Disabled
Wired Protocol................................... None
IPv6 Support..................................... Disabled
Radio Policy..................................... All
Security
   802.11 Authentication:........................ Open System
   Static WEP Keys............................... Disabled
   802.1X........................................ Enabled
   Encryption:................................... 104-bit WEP
   Wi-Fi Protected Access (WPA1)................. Disabled
   Wi-Fi Protected Access v2 (WPA2).............. Disabled
   IP Security Passthru.......................... Disabled
   Web Based Authentication...................... Disabled
   Web-Passthrough............................... Disabled
   Auto Anchor................................... Disabled
   Management Frame Protection .................. Enabled
```

4. To see the current MFP state for a particular access point, enter this command:

   show ap config general *AP_name*

   Information similar to the following appears:

```
Cisco AP Identifier.............................. 0
Cisco AP Name.................................... ap:52:c5:c0
AP Regulatory Domain............................. 80211bg: -N 80211a: -N
Switch Port Number .............................. 1
MAC Address...................................... 00:0b:85:52:c5:c0
IP Address Configuration......................... Static IP assigned
IP Address....................................... 10.67.73.33
IP NetMask....................................... 255.255.255.192
Cisco AP Location................................ default_location
Cisco AP Group Name.............................. default-group
Primary Cisco Switch............................. tester-2006
Secondary Cisco Switch........................... 
Tertiary Cisco Switch............................ 
Administrative State ............................ ADMIN_ENABLED
Operation State ................................. REGISTERED
Mirroring Mode .................................. Disabled
AP Mode ......................................... Local
Remote AP Debug ................................. Disabled
S/W  Version .................................... 4.0.2.0
Boot  Version ................................... 2.1.78.0
Mini IOS Version ................................      --
```

```
Stats Reporting Period ......................... 180
LED State...................................... Enabled
ILP Pre Standard Switch........................ Disabled
ILP Power Injector............................. Disabled
Number Of Slots................................ 2
AP Model....................................... AP1020
AP Serial Number............................... WCN09260057
AP Certificate Type............................ Manufacture Installed
Management Frame Protection Validation ......... Enabled
```

5. To see MFP statistics for the controller, enter this command:

   show wps mfp statistics

   Information similar to the following appears:

```
BSSID              Radio  Validator AP Name Invalid MIC   Invalid Seq   No MIC   MIC
---------------- -------  ----------------- ------------  ------------  ------- ------
00:12:44:b0:6a:80  a      tester-1000b               28  0              0     0
00:0b:85:56:c2:c0  b/g    tester-1000b                0  0              3     0
00:14:1b:5b:fc:80  a      tester-1000b              774  0              0     0
```

6. Use these commands to obtain MFP debug information:

   debug wps mfp *?*

   where *?* is one of the following:

   lwapp—Shows debug information for MFP messages.

   detail—Shows detailed debug information for MFP messages.

   report—Shows debug information for MFP reporting.

   mm—Shows debug information for MFP mobility (inter-controller) messages.

Configuring Identity Networking

These sections explain the identity networking feature, how it is configured, and the expected behavior for various security policies:

Identity Networking Overview

In most wireless LAN systems, each WLAN has a static policy that applies to all clients associated with an SSID. Although powerful, this method has limitations since it requires clients to associate with different SSIDs to inherit different QoS and security policies.

However, the Cisco Wireless LAN Solution supports identity networking, which allows the network to advertise a single SSID but allows specific users to inherit different QoS or security policies based on their user profiles. The specific policies that you can control using identity networking include:

- Quality of Service. When present in a RADIUS Access Accept, the QoS-Level value overrides the QoS value specified in the WLAN profile.
- ACL. When the ACL attribute is present in the RADIUS Access Accept, the system applies the ACL-Name to the client station after it authenticates. This overrides any ACLs that are assigned to the interface.
- VLAN. When a VLAN Interface-Name or VLAN-Tag is present in a RADIUS Access Accept, the system places the client on a specific interface.

  Note The VLAN feature only supports MAC filtering, 802.1X, and WPA. The VLAN feature does not support Web Authentication or IPSec.

- Tunnel Attributes.

  Note When any of the other RADIUS attributes (QoS-Level, ACL-Name, Interface-Name, or VLAN-Tag), which are described later in this section, are returned, the Tunnel Attributes must also be returned.

The operating system's local MAC Filter database has been extended to include the interface name, allowing local MAC filters to specify to which interface the client should be assigned. A separate RADIUS server can also be used, but the RADIUS server must be defined using the Security menus.

RADIUS Attributes Used in Identity Networking

This section explains the RADIUS attributes used in identity networking.

QoS-Level

This attribute indicates the Quality of Service level to be applied to the mobile client's traffic within the switching fabric, as well as over the air. This example shows a summary of the QoS-Level Attribute format. The fields are transmitted from left to right.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |  Length       |            Vendor-Id
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     Vendor-Id (cont.)          | Vendor type   | Vendor length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           QoS Level                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- Type – 26 for Vendor-Specific
- Length – 10
- Vendor-Id – 14179
- Vendor type – 2
- Vendor length – 4
- Value – Three octets:
  - 0 – Bronze (Background)
  - 1 – Silver (Best Effort)
  - 2 – Gold (Video)
  - 3 – Platinum (Voice)

ACL-Name

This attribute indicates the ACL name to be applied to the client. A summary of the ACL-Name Attribute format is shown below. The fields are transmitted from left to right.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |  Length       |            Vendor-Id
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     Vendor-Id (cont.)          | Vendor type   | Vendor length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        ACL Name...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

- Type – 26 for Vendor-Specific
- Length – >7
- Vendor-Id – 14179

- Vendor type – 6
- Vendor length – >0
- Value – A string that includes the name of the ACL to use for the client

Interface-Name

This attribute indicates the VLAN Interface a client is to be associated to. A summary of the Interface-Name Attribute format is shown below. The fields are transmitted from left to right.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |  Length       |            Vendor-Id
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     Vendor-Id (cont.)          |  Vendor type  | Vendor length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Interface Name...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
```

- Type – 26 for Vendor-Specific
- Length – >7
- Vendor-Id – 14179
- Vendor type – 5
- Vendor length – >0
- Value – A string that includes the name of the interface the client is to be assigned to.

Note This Attribute only works when MAC filtering is enabled or if 802.1X or WPA is used as the security policy.

VLAN-Tag

This attribute indicates the group ID for a particular tunneled session, and is also known as the Tunnel-Private-Group-ID attribute.

This attribute might be included in the Access-Request packet if the tunnel initiator can predetermine the group resulting from a particular connection and should be included in the Access-Accept packet if this tunnel session is to be treated as belonging to a particular private group. Private groups may be used to associate a tunneled session with a particular group of users. For example, it may be used to facilitate routing of unregistered IP addresses through a particular interface. It should be included in Accounting-Request packets which contain Acct-Status-Type attributes with values of either Start or Stop and which pertain to a tunneled session.

A summary of the Tunnel-Private-Group-ID Attribute format is shown below. The fields are transmitted from left to right.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type     |    Length     |     Tag       |   String...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- Type – 81 for Tunnel-Private-Group-ID.
- Length – >= 3

- Tag – The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same tunnel. If the value of the Tag field is greater than 0x00 and less than or equal to 0x1F, it should be interpreted as indicating which tunnel (of several alternatives) this attribute pertains. If the Tag field is greater than 0x1F, it should be interpreted as the first byte of the following String field.
- String – This field must be present. The group is represented by the String field. There is no restriction on the format of group IDs.

Tunnel Attributes

Note When any of the other RADIUS attributes (QoS-Level, ACL-Name, Interface-Name, or VLAN-Tag) are returned, the Tunnel Attributes must also be returned.

Reference RFC2868 defines RADIUS tunnel attributes used for authentication and authorization, and RFC2867 defines tunnel attributes used for accounting. Where the IEEE 802.1X Authenticator supports tunneling, a compulsory tunnel may be set up for the Supplicant as a result of the authentication.

In particular, it may be desirable to allow a port to be placed into a particular Virtual LAN (VLAN), defined in IEEE8021Q, based on the result of the authentication. This can be used, for example, to allow a wireless host to remain on the same VLAN as it moves within a campus network.

The RADIUS server typically indicates the desired VLAN by including tunnel attributes within the Access-Accept. However, the IEEE 802.1X Authenticator may also provide a hint as to the VLAN to be assigned to the Supplicant by including Tunnel attributes within the Access- Request.

For use in VLAN assignment, the following tunnel attributes are used:

- Tunnel-Type=VLAN (13)
- Tunnel-Medium-Type=802
- Tunnel-Private-Group-ID=VLANID

Note that the VLANID is 12-bits, taking a value between 1 and 4094, inclusive. Since the Tunnel-Private-Group-ID is of type String as defined in RFC2868, for use with IEEE 802.1X, the VLANID integer value is encoded as a string.

When Tunnel attributes are sent, it is necessary to fill in the Tag field. As noted in RFC2868, section 3.1:

- The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same tunnel. Valid values for this field are 0x01 through 0x1F, inclusive. If the Tag field is unused, it must be zero (0x00).
- For use with Tunnel-Client-Endpoint, Tunnel-Server-Endpoint, Tunnel-Private-Group-ID, Tunnel-Assignment-ID, Tunnel-Client-Auth-ID or Tunnel-Server-Auth-ID attributes (but not Tunnel-Type, Tunnel-Medium-Type, Tunnel-Password, or Tunnel-Preference), a tag field of greater than 0x1F is interpreted as the first octet of the following field.
- Unless alternative tunnel types are provided, (e.g. for IEEE 802.1X Authenticators that may support tunneling but not VLANs), it is only necessary for tunnel attributes to specify a single tunnel. As a result, where it is only desired to specify the VLANID, the tag field should be set to zero (0x00) in all tunnel attributes. Where alternative tunnel types are to be provided, tag values between 0x01 and 0x1F should be chosen.

Configuring AAA Override

The Allow AAA Override option of a WLAN allows you to configure the WLAN for identity networking. This option allows you to apply VLAN tagging, QoS, and ACLs to individual clients based on the returned RADIUS attributes from the AAA server.

Most of the configuration for allowing AAA override is done at the RADIUS server where you should configure the Access Control Server (ACS) with the override properties you would like it to return to the controller (for example, Interface-Name, QoS-Level, and VLAN-Tag).

On the controller, all you have to do is enable the Allow AAA Override configuration parameter using the GUI or CLI. Enabling this flag allows the controller to accept the attributes returned by the RADIUS server. The controller then applies these attributes to its clients.

Note Multicast traffic is not supported when the AAA override for a client assigns a VLAN other than one mapped to the WLAN.

Using the GUI to Configure AAA Override

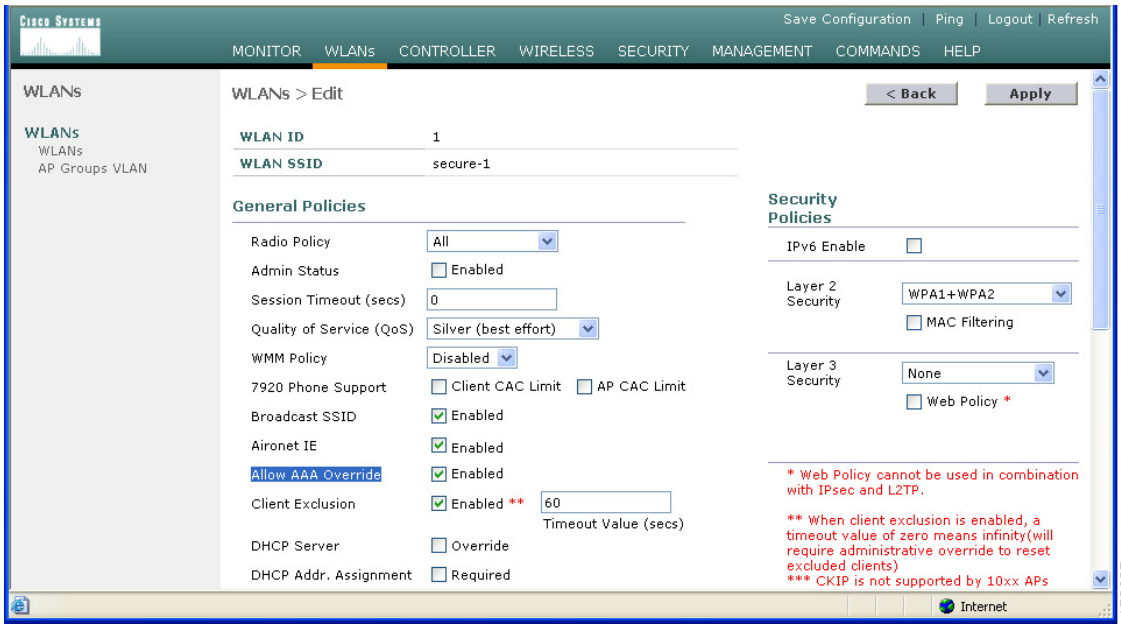
Follow these steps to configure AAA override using the controller GUI.

Step 1 Click **WLAN**s.

Step 2 Click the **Edit** link for the WLAN you want to configure.

Step 3 Check the **Allow AAA Override** check box (see Figure 5-9).

Figure 5-9 WLANs > Edit Page



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

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

Using the CLI to Configure AAA Override

To enable AAA override using the controller CLI, enter this command:

config wlan aaa-override enable *wlan-id*

For *wlan-id*, enter an ID from 1 to 16.

Configuring IDS

The Cisco intrusion detection system/intrusion prevention system (CIDS/IPS) instructs controllers to block certain clients from accessing the wireless network when attacks involving these clients are detected at Layer 3 through Layer 7. This system offers significant network protection by helping to detect, classify, and stop threats including worms, spyware/adware, network viruses, and application abuse. Two methods are available to detect IDS attacks:

- IDS sensors, see below
- IDS signatures, see page 5-30

Configuring IDS Sensors

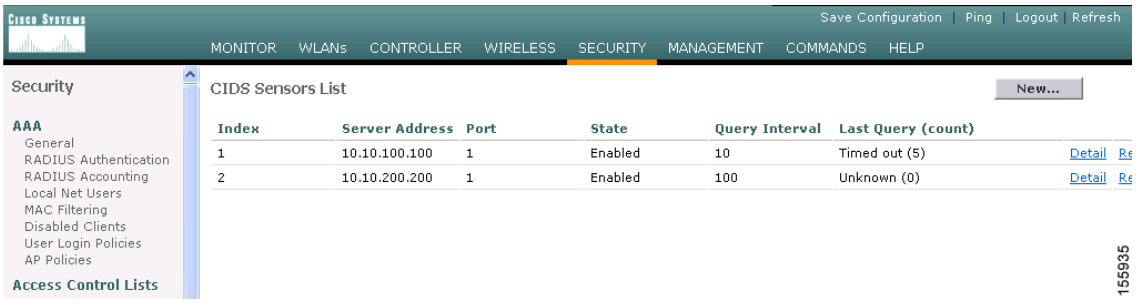
You can configure IDS sensors to detect various types of IP-level attacks in your network. When the sensors identify an attack, they can alert the controller to shun the offending client. When you add a new IDS sensor, you register the controller with that IDS sensor so that the controller can query the sensor to get the list of shunned clients. You can configure IDS sensor registration through either the GUI or the CLI.

Using the GUI to Configure IDS Sensors

Follow these steps to configure IDS sensors using the controller GUI.

Step 1 Click **Security** and then **Sensors** under CIDS. The CIDS Sensors List page appears (see Figure 5-10).

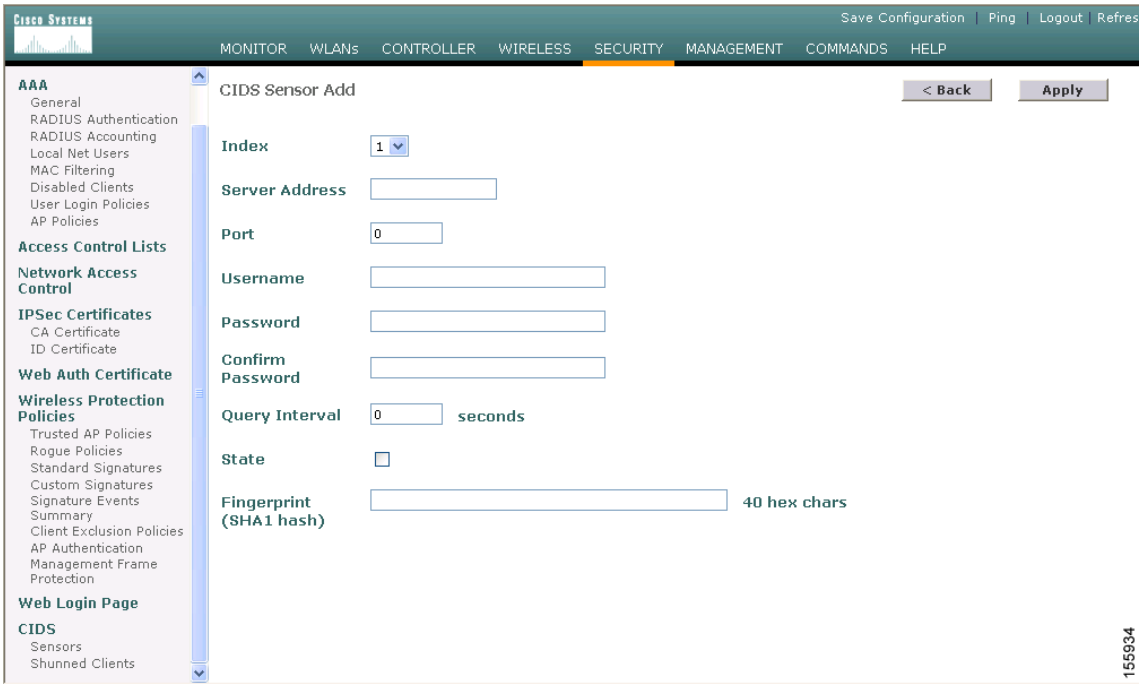
Figure 5-10 CIDS Sensors List Page



This page lists all of the IDS sensors that have been configured for this controller. It also enables you to edit or remove any of the sensors.

Step 2 To add an IDS sensor to the list, click **New**. The CIDS Sensor Add page appears (see Figure 5-11).

Figure 5-11 CIDS Sensor Add Page



Step 3 The controller supports up to five IPS sensors. From the Index drop-down box, choose a number (between 1 and 5) to determine the sequence in which the controller consults the IPS sensors. For example, if you choose 1, the controller consults this IPS sensor first.

Step 4 In the Server Address field, enter the IP address of your IDS server.

Step 5 The Port field contains the number of the HTTPS port through which the controller is to communicate with the IDS sensor. Cisco recommends that you set this parameter to 443 because the sensor uses this value to communicate by default.

Default: 0

Range: 1 to 65535

Step 6 In the Username field, enter the name that the controller uses to authenticate to the IDS sensor.

Note This username must be configured on the IDS sensor and have at least a read-only privilege.

Step 7 In the Password and Confirm Password fields, enter the password that the controller uses to authenticate to the IDS sensor.

Step 8 In the Query Interval field, enter the time (in seconds) for how often the controller should query the IDS server for IDS events.

Default: 0 seconds

Range: 10 to 3600 seconds

Step 9 Check the **State** check box to register the controller with this IDS sensor or uncheck this check box to disable registration.

Step 10 Enter a 40-hexadecimal-character security key in the Fingerprint field. This key is used to verify the validity of the sensor and is used to prevent security attacks.

Note Do not include the colons that appear between every two bytes within the key. For example, enter AABBCCDD instead of AA:BB:CC:DD.

Step 11 Click **Apply**. Your new IDS sensor appears in the list of sensors on the CIDS Sensors List page.

Step 12 Click **Save Configuration** to save your changes.

Using the CLI to Configure IDS Sensors

Follow these steps to configure IDS sensors using the controller CLI.

Step 1 To add an IDS sensor, enter this command:

config wps cids-sensor add *index ids_ip_address username password*

The *index* parameter determines the sequence in which the controller consults the IPS sensors. The controller supports up to five IPS sensors. Enter a number (between 1 and 5) to determine the priority of this sensor. For example, if you enter 1, the controller consults this IPS sensor first.

Note The username must be configured on the IDS sensor and have at least a read-only privilege.

Step 2 (Optional) To specify the number of the HTTPS port through which the controller is to communicate with the IDS sensor, enter this command:

config wps cids-sensor port *index port_number*

For the *port-number* parameter, you can enter a value between 1 and 65535. The default value is 443. This step is optional because Cisco recommends that you use the default value of 443. The sensor uses this value to communicate by default.

Step 3 To specify how often the controller should query the IDS server for IDS events, enter this command:

config wps cids-sensor interval *index interval*

For the *interval* parameter, you can enter a value between 10 and 3600 seconds. The default value is 60 seconds.

Step 4 To enter a 40-hexadecimal-character security key used to verify the validity of the sensor, enter this command:

config wps cids-sensor fingerprint *index* **sha1** *fingerprint*

You can get the value of the fingerprint by entering **show tls fingerprint** on the sensor's console.

Note Make sure to include the colons that appear between every two bytes within the key (for example, AA:BB:CC:DD).

Step 5 To enable or disable this controller's registration with an IDS sensor, enter this command:

config wps cids-sensor {**enable** | **disable**} *index*

Step 6 To save your settings, enter this command:

save config

Step 7 To view the IDS sensor configuration, enter one of these commands:

- **show wps cids-sensor summary**
- **show wps cids-sensor detail** *index*

The second command provides more information than the first.

Step 8 To obtain debug information regarding IDS sensor configuration, enter this command:

debug wps cids enable

Note If you ever want to delete or change the configuration of a sensor, you must first disable it by entering **config wps cids-sensor disable** *index*. To then delete the sensor, enter **config wps cids-sensor delete** *index*.

Viewing Shunned Clients

When an IDS sensor detects a suspicious client, it alerts the controller to shun this client. The shun entry is distributed to all controllers within the same mobility group. If the client to be shunned is currently joined to a controller in this mobility group, the anchor controller adds this client to the dynamic exclusion list, and the foreign controller removes the client. The next time the client tries to connect to a controller, the anchor controller rejects the handoff and informs the foreign controller that the client is being excluded. See Chapter 11 for more information on mobility groups.

You can view the list of clients that the IDS sensors have identified to be shunned through either the GUI or the CLI.

Using the GUI to View Shunned Clients

Follow these steps to view the list of clients that the IDS sensors have identified to be shunned using the controller GUI.

Step 1 Click **Security** and then **Shunned Clients** under CIDS. The CIDS Shun List page appears (see Figure 5-12).

Figure 5-12 CIDS Shun List Page

This page shows the IP address and MAC address of each shunned client, the length of time that the client's data packets should be blocked by the controller as requested by the IDS sensor, and the IP address of the IDS sensor that discovered the client.

Step 2 Click **Re-sync** to purge and reset the list as desired.

Using the CLI to View Shunned Clients

Follow these steps to view the list of clients that the IDS sensors have identified to be shunned using the controller CLI.

Step 1 To view the list of clients to be shunned, enter this command:

show wps shun-list

Step 2 To force the controller to sync up with other controllers in the mobility group for the shun list, enter this command:

config wps shun-list re-sync

Configuring IDS Signatures

You can configure IDS signatures, or bit-pattern matching rules used to identify various types of attacks in incoming 802.11 packets, on the controller. When the signatures are enabled, the access points joined to the controller perform signature analysis on the received 802.11 data or management frames and report any discrepancies to the controller.

A standard signature file exists on the controller by default. You can upload this signature file from the controller, or you can create a custom signature file and download it to the controller or modify the standard signature file to create a custom signature. You can configure signatures through either the GUI or the CLI.

Using the GUI to Configure IDS Signatures

You must follow these instructions to configure signatures using the controller GUI:

- Uploading or downloading IDS signatures, page 5-31
- Enabling or disabling IDS signatures, page 5-32
- Viewing IDS signature events, page 5-35

Using the GUI to Upload or Download IDS Signatures

Follow these steps to upload or download IDS signatures using the controller GUI.

Step 1 If desired, create your own custom signature file.

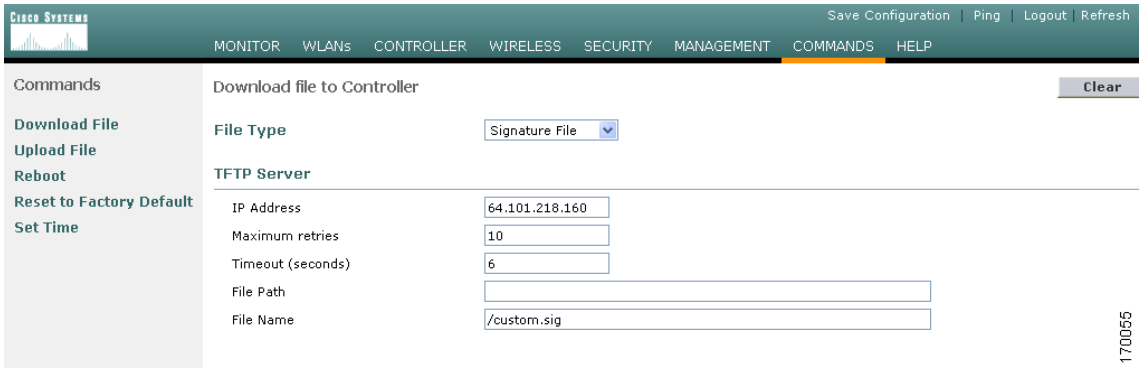
Step 2 Make sure that you have a Trivial File Transfer Protocol (TFTP) server available. Keep these guidelines in mind when setting up a TFTP server:

- If you are downloading through the service port, the TFTP server must be on the same subnet as the service port because the service port is not routable.
- If you are downloading through the distribution system network port, the TFTP server can be on the same or a different subnet because the distribution system port is routable.
- A third-party TFTP server cannot run on the same computer as the Cisco WCS because the WCS built-in TFTP server and the third-party TFTP server require the same communication port.

Step 3 If you are downloading a custom signature file (*.sig), copy it to the default directory on your TFTP server.

Step 4 Click **Commands** to access the Download File to Controller page (see Figure 5-13).

Figure 5-13 Download File to Controller Page



Step 5 Perform one of the following:

- If you want to download a custom signature file to the controller, choose **Signature File** from the File Type drop-down box on the Download File to Controller page.
- If you want to upload a standard signature file from the controller, click **Upload File** and then choose **Signature File** from the File Type drop-down box on the Upload File from Controller page.

Step 6 In the IP Address field, enter the IP address of the TFTP server.

Step 7 If you are downloading the signature file, enter the maximum number of times the controller should attempt to download the signature file in the Maximum Retries field.

Range: 1 to 254

Default: 10

Step 8 If you are downloading the signature file, enter the amount of time in seconds before the controller times out while attempting to download the signature file in the Timeout field.

Range: 1 to 254 seconds

Default: 6 seconds

Step 9 In the File Path field, enter the path of the signature file to be downloaded or uploaded. The default value is "/."

Step 10 In the File Name field, enter the name of the signature file to be downloaded or uploaded.

Note When uploading signatures, the controller uses the filename you specify as a base name and then adds "_std.sig" and "_custom.sig" to it in order to upload *both* standard and custom signature files to the TFTP server. For example, if you upload a signature file called "ids1," the controller automatically generates and uploads both ids1_std.sig and ids1_custom.sig to the TFTP server. If desired, you can then modify ids1_custom.sig on the TFTP server (making sure to set "Revision = custom") and download it by itself.

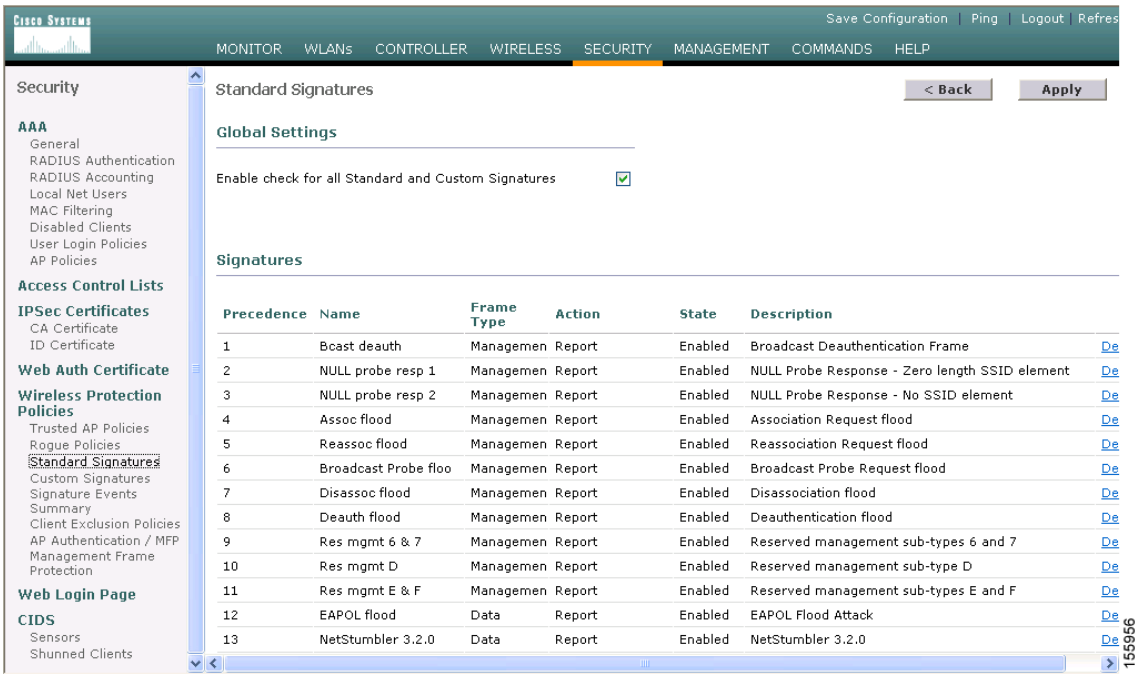
Step 11 Click **Download** to download the signature file to the controller or **Upload** to upload the signature file from the controller.

Using the GUI to Enable or Disable IDS Signatures

Follow these steps to enable or disable IDS signatures using the controller GUI.

Step 1 Click **Security** and then **Standard Signatures** or **Custom Signatures** under Wireless Protection Policies. The Standard Signatures page (see Figure 5-14) or the Custom Signatures page appears.

Figure 5-14 Standard Signatures Page



The Standard Signatures page shows the list of Cisco-supplied signatures that are currently on the controller. The Custom Signatures page shows the list of customer-supplied signatures that are currently on the controller. This page shows the following information for each signature:

- The order, or precedence, in which the controller performs the signature checks.
- The name of the signature, which specifies the type of attack that the signature is trying to detect.
- The frame type on which the signature is looking for a security attack. The possible frame types are data and management.
- The action that the controller is directed to take when the signature detects an attack. The possible action are None and Report.
- The state of the signature, which indicates whether the signature is enabled to detect security attacks.
- A description of the type of attack that the signature is trying to detect.

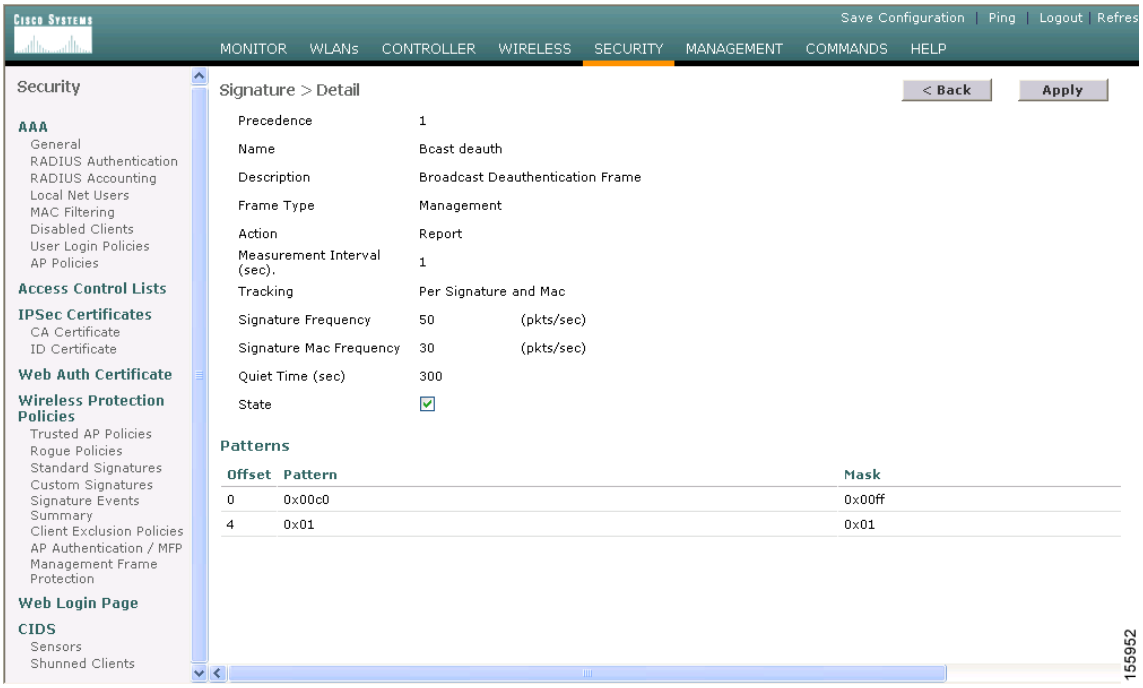
Step 2 Perform one of the following:

- If you want to allow all signatures (both standard and custom) whose individual states are set to Enabled to remain enabled, check the **Enable Check for All Standard and Custom Signatures** check box at the top of either the Standard Signatures page or the Custom Signatures page. The default value is enabled (or checked). When the signatures are enabled, the access points joined to the controller perform signature analysis on the received 802.11 data or management frames and report any discrepancies to the controller.
- If you want to disable all signatures (both standard and custom) on the controller, uncheck the **Enable Check for All Standard and Custom Signatures** check box. If you uncheck this check box, all signatures are disabled, even the ones whose individual states are set to Enabled.

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

Step 4 To enable or disable an individual signature, click the **Detail** link for the desired signature. The Signature > Detail page appears (see Figure 5-15).

Figure 5-15 Signature > Detail Page



This page shows much of the same information as the Standard Signatures and Custom Signatures pages but provides these additional details:

- The measurement interval, or the number of seconds that must elapse before the controller resets the signature threshold counters
- The tracking method used by the access points to perform signature analysis and report the results to the controller. The possible values are:
  - Per Signature—Signature analysis and pattern matching are tracked and reported on a per-signature and per-channel basis.
  - Per MAC—Signature analysis and pattern matching are tracked and reported separately for individual client MAC addresses on a per-channel basis.
  - Per Signature and MAC—Signature analysis and pattern matching are tracked and reported on a per-signature and per-channel basis as well as on a per-MAC-address and per-channel basis.
- The signature frequency, or the number of matching packets per second that must be identified at the individual access point level before an attack is detected
- The signature MAC frequency, or the number of matching packets per second that must be identified per client per access point before an attack is detected
- The quiet time, or the length of time (in seconds) after which no attacks have been detected at the individual access point level and the alarm can stop
- The pattern that is being used to detect a security attack

Step 5 Check the **State** check box to enable this signature to detect security attacks or uncheck it to disable this signature. The default value is enabled (or checked).

Step 6 Click **Apply** to commit your changes. The Standard Signatures or Custom Signatures page reflects the signature's updated state.

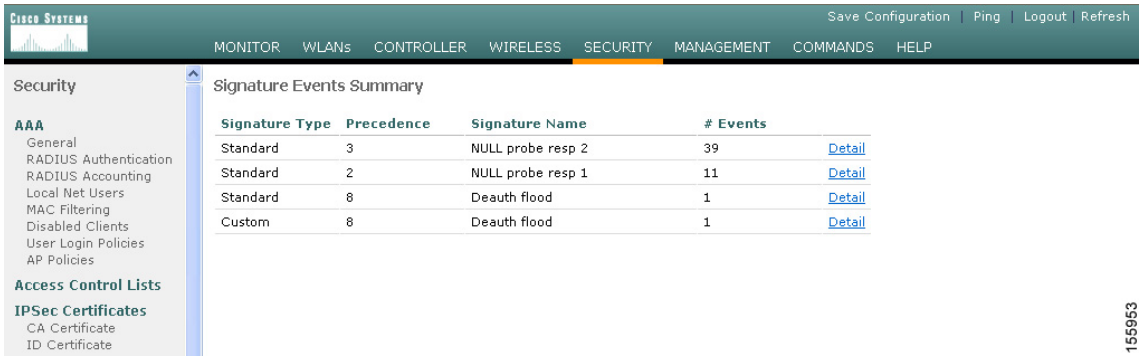
Step 7 Click **Save Configuration** to save your changes.

Using the GUI to View IDS Signature Events

Follow these steps to view signature events using the controller GUI.

Step 1 Click **Security** and then **Signature Events Summary** under Wireless Protection Policies. The Signature Events Summary page appears (see Figure 5-16).

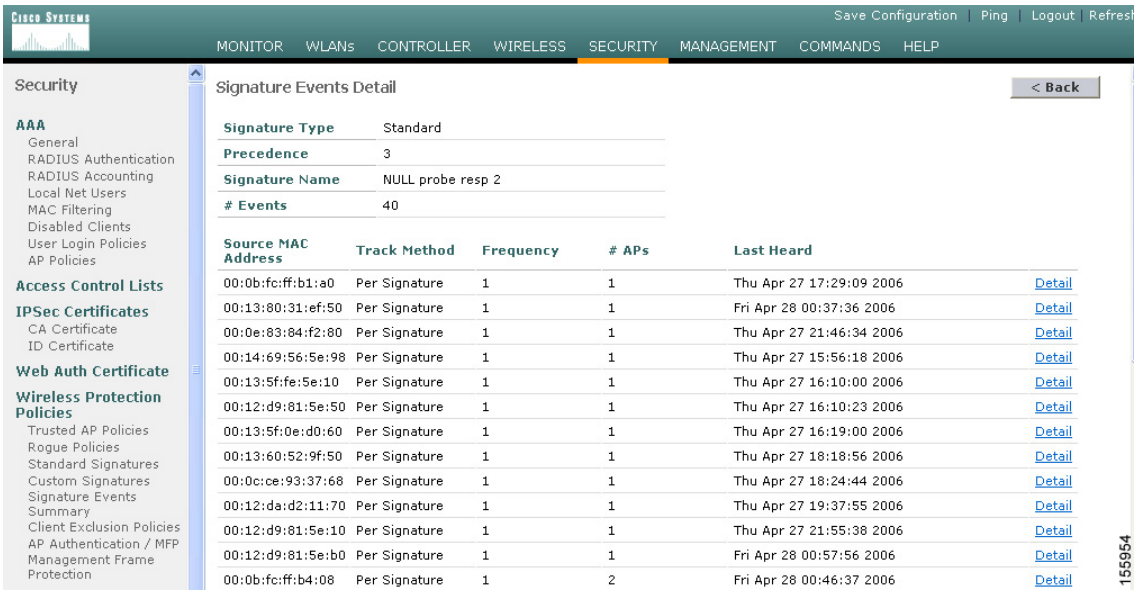
Figure 5-16 Signature Events Summary Page



This page shows the number of attacks detected by the enabled signatures.

Step 2 To see more information on the attacks detected by a particular signature, click the **Detail** link for that signature. The Signature Events Detail page appears (see Figure 5-17).

Figure 5-17 Signature Events Detail Page

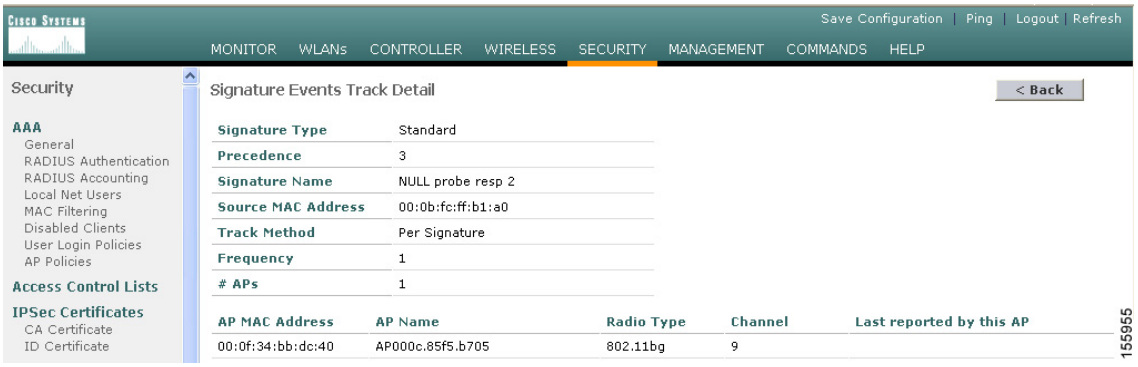


This page shows the following information:

- The MAC addresses of the clients identified as attackers
- The method used by the access point to track the attacks
- The number of matching packets per second that were identified before an attack was detected
- The number of access points on the channel on which the attack was detected
- The day and time when the access point detected the attack

Step 3 To see more information for a particular attack, click the **Detail** link for that attack. The Signature Events Track Detail page appears (see Figure 5-18).

Figure 5-18 Signature Events Track Detail Page



This page shows the following information:

- The MAC address of the access point that detected the attack
- The name of the access point that detected the attack
- The type of radio (802.11a or 802.11b/g) used by the access point to detect the attack

- The radio channel on which the attack was detected
- The day and time when the access point reported the attack

Using the CLI to Configure IDS Signatures

Follow these steps to configure IDS signatures using the controller CLI.

Step 1 If desired, create your own custom signature file.

Step 2 Make sure that you have a TFTP server available. See the guidelines for setting up a TFTP server in Step 2 of the "Using the GUI to Upload or Download IDS Signatures" section on page 5-31.

Step 3 Copy the custom signature file (*.sig) to the default directory on your TFTP server.

Step 4 To specify the download or upload mode, enter **transfer** {**download** | **upload**} **mode tftp**.

Step 5 To specify the type of file to be downloaded or uploaded, enter **transfer** {**download** | **upload**} **datatype signature**.

Step 6 To specify the IP address of the TFTP server, enter **transfer** {**download** | **upload**} **serverip** *tftp-server-ip-address*.

Note Some TFTP servers require only a forward slash (/) as the TFTP server IP address, and the TFTP server automatically determines the path to the correct directory.

Step 7 To specify the download or upload path, enter **transfer** {**download** | **upload**} **path** *absolute-tftp-server-path-to-file*.

Step 8 To specify the file to be downloaded or uploaded, enter **transfer** {**download** | **upload**} **filename** *filename.sig*.

Note When uploading signatures, the controller uses the filename you specify as a base name and then adds "_std.sig" and "_custom.sig" to it in order to upload *both* standard and custom signature files to the TFTP server. For example, if you upload a signature file called "ids1," the controller automatically generates and uploads both ids1_std.sig and ids1_custom.sig to the TFTP server. If desired, you can then modify ids1_custom.sig on the TFTP server (making sure to set "Revision = custom") and download it by itself.

Step 9 Enter **transfer** {**download** | **upload**} **start** and answer **y** to the prompt to confirm the current settings and start the download or upload.

Step 10 To enable or disable individual signatures, enter this command:

config wps signature {**standard** | **custom**} **state** *precedence#* {**enable** | **disable**}

Step 11 To save your changes, enter this command:

save config

Using the CLI to View IDS Signature Events

Use these commands to view signature events using the controller CLI.

1. To see all of the standard and custom signatures installed on the controller, enter this command:

   show wps signature summary

2. To see the number of attacks detected by the enabled signatures, enter this command:

   show wps signature events summary

   Information similar to the following appears:

```
Precedence Signature Name     Type     No. Events
---------- ------------------ -----    -----------
1          Bcast deauth       Standard    2
2          NULL probe resp 1  Standard    1
```

3. To see more information on the attacks detected by a particular standard or custom signature, enter this command:

   show wps signature events {**standard** | **custom**} *precedence#* **summary**

   Information similar to the following appears:

```
Precedence..................................... 1
Signature Name................................. Bcast deauth
Type........................................... Standard
Number of active events..................... 2

Source MAC Addr   Track Method  Frequency No. APs Last Heard
----------------- ------------  --------- -------- ------------------------
00:01:02:03:04:01 Per Signature   4          3    Tue Dec 6 00:17:44 2005
00:01:02:03:04:01 Per Mac         6          2    Tue Dec 6 00:30:04 2005
```

4. To see information on attacks that are tracked by access points on a per-signature and per-channel basis, enter this command:

   show wps signature events {**standard** | **custom**} *precedence#* **detailed per-signature** *source_mac*

5. To see information on attacks that are tracked by access points on an individual-client basis (by MAC address), enter this command:

   show wps signature events {**standard** | **custom**} *precedence#* **detailed per-mac** *source_mac*

   Information similar to the following appears:

```
Source MAC..................................... 00:01:02:03:04:01
Precedence..................................... 1
Signature Name................................. Bcast deauth
Type........................................... Standard
Track.......................................... Per Mac
Frequency...................................... 6
Reported By
    AP 1
        MAC Address............................ 00:0b:85:01:4d:80
        Name................................... Test_AP_1
        Radio Type............................. 802.11bg
        Channel................................ 4
        Last reported by this AP............... Tue Dec 6 00:17:49 2005
```

```
AP 2
    MAC Address..............................  00:0b:85:26:91:52
    Name.....................................  Test_AP_2
    Radio Type...............................  802.11bg
    Channel..................................  6
     Last reported by this AP.................  Tue Dec 6 00:30:04 2005
```

Configuring AES Key Wrap

You can use the GUI or CLI to configure a controller to use AES key wrap, which makes the shared secret between the controller and the RADIUS server more secure. AES key wrap is designed for Federal Information Processing Standards (FIPS) customers and requires a key-wrap compliant RADIUS authentication server.

Using the GUI to Configure AES Key Wrap

To configure a controller to use AES key wrap using the GUI, follow these steps.

Step 1 Click **Security > AAA > RADIUS Authentication** to access the RADIUS Authentication Servers page.

Step 2 To enable AES key wrap, check the **Use AES Key Wrap** check box.

Step 3 Click **Apply**.

Step 4 Click **Save Configuration**.

Step 5 Click **New** to configure a new RADIUS authentication server or click the **Edit** link of one of the servers listed on the page to configure AES key wrap.

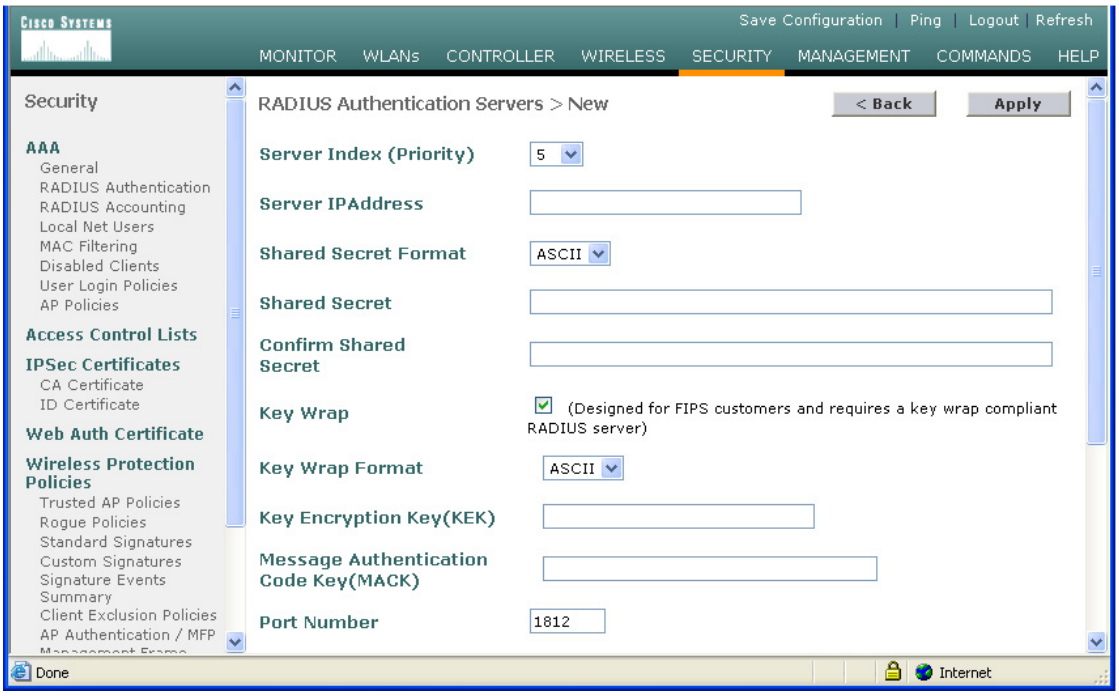
Step 6 Check the **Key Wrap** check box (see Figure 5-19).

Step 7 Choose **ASCII** or **Hex** from the Key Wrap Format drop-down box to specify the format of the AES key wrap keys: Key Encryption Key (KEK) and Message Authentication Code Key (MACK).

Step 8 Enter the 16-byte KEK in the Key Encryption Key (KEK) field.

Step 9 Enter the 20-byte KEK in the Message Authentication Code Key (MACK) field.

Figure 5-19 RADIUS Authentication Servers > New Page



Step 10 Click **Apply**.

Step 11 Click **Save Configuration**.

Using the CLI to Configure AES Key Wrap

To configure a controller to use AES key wrap using the CLI, follow these steps.

Step 1 To enable the use of AES key wrap attributes, enter this command:

config radius auth keywrap enable

Step 2 To configure AES key wrap attributes, enter this command:

config radius auth keywrap add {ascii | hex} *index*

The *index* attribute specifies the index of the RADIUS authentication server on which to configure AES key wrap.

Configuring Maximum Local Database Entries

You can use the GUI or CLI to specify the maximum local database entries used for storing users' authentication information. The information in the database is used in conjunction with the web authentication feature of the controller.

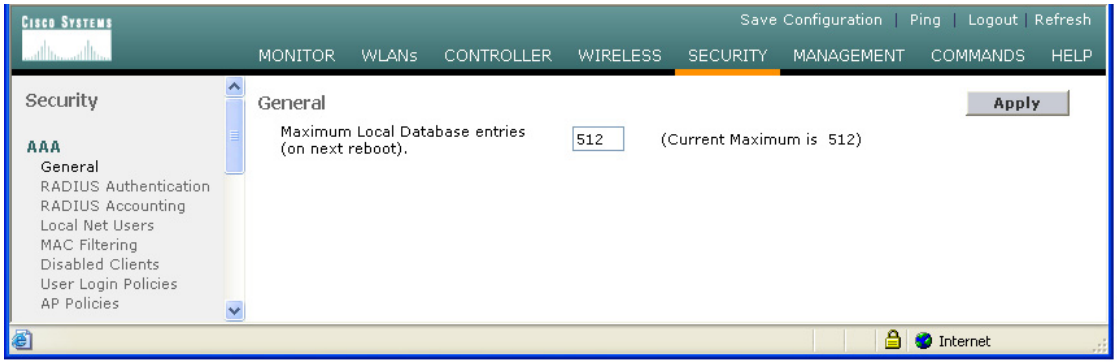
Using the GUI to Specify the Maximum Number of Local Database Entries

To configure a controller to use the maximum local database entries using the GUI, follow these steps.

Step 1 Click **Security > AAA > General** to open the General page (see Figure 5-20).

Step 2 Type the desired maximum value in the Maximum Local Database entries field. The range of possible values is 512 to 2048 (which also includes any configured MAC filter entries). The default value is 2048.

Figure 5-20 Security > AAA > General Page



Step 3 Click **Apply**.

Step 4 Click **Save Configuration**.

Using the CLI to Specify the Maximum Number of Local Database Entries

To configure the maximum number of local database entries using the CLI, enter this command:

config database size *max_entries*

Configuring WLANsWireless Device Access

This chapter describes how to configure up to 16 WLANs for your Cisco UWN Solution. It contains these sections:

WLAN Overview

The Cisco UWN Solution can control up to 16 WLANs for lightweight access points. Each WLAN has a separate WLAN ID (1 through 16), a separate WLAN SSID (WLAN name), and can be assigned unique security policies.

Lightweight access points broadcast all active Cisco UWN Solution WLAN SSIDs and enforce the policies that you define for each WLAN.

Note Cisco recommends that you assign one set of VLANs for WLANs and a different set of VLANs for management interfaces to ensure that controllers properly route VLAN traffic.

Configuring WLANs

These sections describe how to configure WLANs:

Displaying, Creating, Disabling, and Deleting WLANs

On the controller CLI, enter these commands to display, create, disable, and delete WLANs:

- Enter **show wlan summary** to display existing WLANs and whether they are enabled or disabled. Note that each WLAN is assigned a WLAN ID from 1 to 16.
- Enter **config wlan create** *wlan-id wlan-name* to create a new WLAN. For *wlan-id*, enter an ID from 1 to 16. For *wlan-name*, enter an SSID of up to 31 alphanumeric characters.

Note For release 4.0.206.0 and greater , the command format is expanded to allow support for multiple WLANs with the same SSID. To distinguish between the two WLANs, a unique profile name is added. The definition of the profile name is added to the command as follows: **config wlan create** *wlan_id profile_name ssid.* If you do not specify an *ssid* the *profile_name* parameter is used for both the profile name and the SSID. Refer to the "Configuring Multiple WLANs with the Same SSID" section on page 6-30 for more details.

Note When WLAN 1 is created in the configuration wizard, it is created in enabled mode; disable it until you have finished configuring it. When you create a new WLAN using the **config wlan create** command, it is created in disabled mode; leave it disabled until you have finished configuring it.

- Enter **config wlan disable** *wlan-id* to disable a WLAN, before making any modifications.

Note If the management and AP-manager interfaces are mapped to the same port and are members of the same VLAN, you must disable the WLAN before making a port-mapping change to either interface. If the management and AP-manager interfaces are assigned to different VLANs, you do not need to disable the WLAN.

- Enter **config wlan enable** *wlan-id* to enable a WLAN.
- Enter **config wlan delete** *wlan-id* to delete a WLAN.

Activating WLANs

After you have completely configured your WLAN settings, enter **config wlan enable** *wlan-id* to activate the WLAN.

Configuring DHCP

WLANs can be configured to use the same or different DHCP servers or no DHCP server. Two types of DHCP servers are available: internal and external.

Note When using the Layer 3 LWAPP mode, you should configure the management and AP-manager interfaces to be on the same subnet so that access points can join the controller.

Internal DHCP Server

The controllers contain an internal DHCP server. This server is typically used in branch offices that do not already have a DHCP server. The wireless network generally contains 10 access points or fewer, with the access points on the same IP subnet as the controller. The internal server provides DHCP addresses to wireless clients, direct-connect access points, appliance-mode access points on the management interface, and DHCP requests that are relayed from access points. Only lightweight access points are supported.

DHCP option 43 is not supported on the internal server. Therefore, the access point must use an alternative method to locate the management interface IP address of the controller, such as local subnet broadcast, DNS, priming, or over-the-air discovery.

Note Refer to Chapter 7 or the *Controller Deployment Guide* at this URL for more information on how access points find controllers:
http://www.cisco.com/en/US/products/ps6366/prod_technical_reference_list.html

External DHCP Servers

The operating system is designed to appear as a DHCP Relay to the network and as a DHCP server to clients with industry-standard external DHCP servers that support DHCP Relay. This means that each controller appears as a DHCP Relay agent to the DHCP server. This also means that the controller appears as a DHCP server at the virtual IP Address to wireless clients.

Because the controller captures the client IP address obtained from a DHCP server, it maintains the same IP address for that client during intra-controller, inter-controller, and inter-subnet client roaming.

Per-WLAN Assignment

WLANs that support management over wireless must allow management (device-servicing) clients to obtain an IP address from a DHCP server. See the "Using Management over Wireless" section on page 5-6 for instructions on configuring management over wireless.

Per-Interface Assignment

You can assign DHCP servers for individual interfaces. The Layer 2 management interface, Layer 3 AP-manager interface, and dynamic interfaces can be configured for a primary and secondary DHCP server, and the service-port interface can be configured to enable or disable DHCP servers.

Note Refer to Chapter 3 for information on configuring the controller's interfaces.

Security Considerations

For enhanced security, Cisco recommends that operators require all clients to obtain their IP addresses from a DHCP server. To enforce this requirement, all WLANs can be configured with a DHCP Required setting and a valid DHCP server IP address, which disallows client static IP addresses. If DHCP Required is selected, clients must obtain an IP address via DHCP. Any client with a static IP address is not be allowed on the network. The controller monitors DHCP traffic because it acts as a DHCP proxy for the clients.

If slightly less security is tolerable, operators can create WLANs with DHCP Required disabled and a valid DHCP server IP address. Clients then have the option of using a static IP address or obtaining an IP address from the designated DHCP server.

Operators are also allowed to create separate WLANs with DHCP Required disabled and a DHCP server IP address of 0.0.0.0. These WLANs drop all DHCP requests and force clients to use a static IP address. Note that these WLANs do not support management over wireless connections.

This section provides both GUI and CLI instructions for configuring your WLAN to use a DHCP server.

Using the GUI to Configure DHCP

Follow these steps to use the GUI to configure DHCP.

Step 1 In the web user interface, navigate to the **WLANs** page.

Step 2 Locate the WLAN which you wish to configure for a DHCP server, and click the associated **Edit** link to display the **WLANs > Edit** page.

Step 3 Under **General Policies**, check the **DHCP Relay/DHCP Server IP Addr** check box to verify whether you have a valid DHCP server assigned to the WLAN. If you have no DHCP server assigned to the WLAN, continue with Step 4. Otherwise, continue with Step 9.

Step 4 Under **General Policies**, uncheck the **Admin Status** check box.

Step 5 Click **Apply** to disable the WLAN.

Step 6 In the **DHCP Relay/DHCP Server IP Addr** edit box, enter a valid DHCP server IP address for this WLAN.

Step 7 Under **General Policies**, check the **Admin Status** check box.

Step 8 Click **Apply** to assign the DHCP server to the WLAN and to enable the WLAN. You are returned to the **WLANs** page.

Step 9 In the upper-right corner of the **WLANs** page, click **Ping** and enter the DHCP server IP address to verify that the WLAN can communicate with the DHCP server.

Using the CLI to Configure DHCP

Follow these steps to use the CLI to configure DHCP.

Step 1 In the CLI, enter **show wlan** to verify whether you have a valid DHCP server assigned to the WLAN. If you have no DHCP server assigned to the WLAN, continue with Step 2. Otherwise, continue with Step 4.

Step 2 If necessary, use these commands:

- **config wlan disable** *wlan-id*
- **config wlan dhcp_server** *wlan-id dhcp-server-ip-address*
- **config wlan enable** *wlan-id*

In these commands, *wlan-id* = 1 through 16, and *dhcp-server-ip-address* = DHCP server IP address.

Step 3 Enter **show wlan** to verify that you have a DHCP server assigned to the WLAN.

Step 4 Enter **ping** *dhcp-ip-address* to verify that the WLAN can communicate with the DHCP server.

Configuring MAC Filtering for WLANs

When you use MAC filtering for client or administrator authorization, you need to enable it at the WLAN level first. If you plan to use local MAC address filtering for any WLAN, use the commands in this section to configure MAC filtering for a WLAN.

Enabling MAC Filtering

Use these commands to enable MAC filtering on a WLAN:

- Enter **config wlan mac-filtering enable** *wlan-id* to enable MAC filtering.
- Enter **show wlan** to verify that you have MAC filtering enabled for the WLAN.

When you enable MAC filtering, only the MAC addresses that you add to the WLAN are allowed to join the WLAN. MAC addresses that have not been added are not allowed to join the WLAN.

Creating a Local MAC Filter

Controllers have built-in MAC filtering capability, similar to that provided by a RADIUS authorization server.

Use these commands to add MAC addresses to a WLAN MAC filter:

- Enter **show macfilter** to view MAC addresses assigned to WLANs.
- Enter **config macfilter add** *mac-addr wlan-id* to assign a MAC address to a WLAN MAC filter.
- Enter **show macfilter** to verify that MAC addresses are assigned to the WLAN.

Configuring a Timeout for Disabled Clients

You can configure a timeout for disabled clients. Clients who fail to authenticate three times when attempting to associate are automatically disabled from further association attempts. After the timeout period expires, the client is allowed to retry authentication until it associates or fails authentication and is excluded again. Use these commands to configure a timeout for disabled clients:

- Enter **config wlan blacklist** *wlan-id timeout* to configure the timeout for disabled clients. Enter a timeout from **1** to **65535** seconds, or enter **0** to permanently disable the client.
- Use the **show wlan** command to verify the current timeout.

Assigning WLANs to VLANs

Use these commands to assign a WLAN to a VLAN:

- Enter this command to assign a WLAN to a VLAN:

  config wlan vlan *wlan-id* {**default** | **untagged** | *vlan-id controller-vlan-ip-address vlan-netmask vlan-gateway*}

  - Use the **default** option to assign the WLAN to the VLAN configured on the network port.
  - Use the **untagged** option to assign the WLAN to VLAN 0.
  - Use the *vlan-id, controller-vlan-ip-address, vlan-netmask,* and *vlan-gateway* options to assign the WLAN to a specific VLAN and to specify the controller VLAN IP address, the local IP netmask for the VLAN, and the local IP gateway for the VLAN.

- Enter **show wlan** to verify VLAN assignment status.

Note Cisco recommends that you assign one set of VLANs for WLANs and a different set of VLANs for management interfaces to ensure that controllers properly route VLAN traffic.

- To remove a VLAN assignment from a WLAN, use this command:

  config wlan vlan *wlan-id* **untagged**

Configuring Layer 2 Security

This section explains how to assign Layer 2 security settings to WLANs.

Note Clients using the Microsoft Wireless Configuration Manager and 802.1X must use WLANs configured for 40- or 104-bit key length. Configuring for 128-bit key length results in clients that can associate but cannot authenticate.

Static WEP Keys

Controllers can control static WEP keys across access points. Use these commands to configure static WEP for WLANs:

- Enter this command to disable 802.1X encryption:

  config wlan security 802.1X disable *wlan-id*

- Enter this command to configure 40/64, 104/128, or 128/152-bit WEP keys:

  config wlan security static-wep-key encryption *wlan-id* {**40** | **104** | **128**} {**hex** | **ascii**} *key key-index*

  - Use the **40**, **104**, or **128** options to specify 40/64-bit, 104/128-bit, or 128/152-bit encryption. The default setting is 104/128.
  - Use the **hex** or **ascii** option to specify the character format for the WEP key.
  - Enter 10 hexadecimal digits (any combination of 0-9, a-f, or A-F) or five printable ASCII characters for 40-bit/64-bit WEP keys; enter 26 hexadecimal or 13 ASCII characters for 104-bit/128-bit keys; enter 32 hexadecimal or 16 ASCII characters for 128-bit/152-bit keys.
  - Enter a key index (sometimes called a key slot) of **1** through **4**.

Dynamic 802.1X Keys and Authorization

Controllers can control 802.1X dynamic WEP keys using Extensible Authentication Protocol (EAP) across access points and support 802.1X dynamic key settings for WLANs.

Note To use LEAP with lightweight access points and wireless clients, make sure to choose **Cisco-Aironet** as the RADIUS server type when configuring the CiscoSecure Access Control Server (ACS).

- Enter **show wlan** *wlan-id* to check the security settings of each WLAN. The default security setting for new WLANs is 802.1X with dynamic keys enabled. To maintain robust Layer 2 security, leave 802.1X configured on your WLANs.

- To disable or enable the 802.1X authentication, use this command:

  config wlan security 802.1X {**enable** | **disable**} *wlan-id*

  After you enable 802.1X authentication, the controller sends EAP authentication packets between the wireless client and the authentication server. This command allows all EAP-type packets to be sent to and from the controller.

- If you want to change the 802.1X encryption level for a WLAN, use this command:

  config wlan security 802.1X encryption *wlan-id* [**40** | **104** | **128**]

  - Use the 40 option to specify 40/64-bit encryption.
  - Use the 104 option to specify 104/128-bit encryption. (This is the default encryption setting.)
  - Use the 128 option to specify 128/152-bit encryption.

- If you want to configure Cisco Aironet 802.11a/b/g Wireless LAN Client Adapters (CB21AG and PI21AG) running PEAP-GTC to authenticate to a controller through a one-time password to a token server, use these commands:
  - **config advanced eap identity-request-timeout**—Configures the EAP identity request timeout value in seconds. The default setting is 1 second.
  - **config advanced eap identity-request-retries**—Configures the EAP identity request maximum retries value. The default setting is 20.
  - **config advanced eap request-timeout**—Configures the EAP request timeout value in seconds. The default setting is 1 second.
  - **config advanced eap request-retries**—Configures the EAP request maximum retries value. The default setting is 2.
  - **show advanced eap**—Shows the values that are currently configured for the **config advanced eap** commands. Information similar to the following appears:

```
EAP-Identity-Request Timeout (seconds)..... 1
EAP-Identity-Request Max Retries.............. 20
EAP-Request Timeout (seconds)................. 1
EAP-Request Max Retries....................... 2
```

Configuring a WLAN for Both Static and Dynamic WEP

You can configure up to four WLANs to support static WEP keys, and you can also configure dynamic WEP on any of these static-WEP WLANs. Follow these guidelines when configuring a WLAN for both static and dynamic WEP:

- The static WEP key and the dynamic WEP key must be the same length.
- When you configure both static and dynamic WEP as the Layer-2 security policy, no other security policies can be specified. That is, you cannot configure web authentication. However, when you configure either the dynamic WEP or the static WEP as the Layer 2 security policy, you can configure web authentication.

WPA1 and WPA2

Wi-Fi Protected Access (WPA or WPA1) and WPA2 are standards-based security solutions from the Wi-Fi Alliance that provide data protection and access control for wireless LAN systems. WPA1 is compatible with the IEEE 802.11i standard but was implemented prior to the standard's ratification; WPA2 is the Wi-Fi Alliance's implementation of the ratified IEEE 802.11i standard.

By default, WPA1 uses Temporal Key Integrity Protocol (TKIP) and message integrity check (MIC) for data protection while WPA2 uses the stronger Advanced Encryption Standard encryption algorithm using Counter Mode with Cipher Block Chaining Message Authentication Code Protocol (AES-CCMP). Both WPA1 and WPA2 use 802.1X for authenticated key management by default. However, these options are also available: PSK, CCKM, and 802.1X+CCKM.

- **802.1X**—The standard for wireless LAN security, as defined by IEEE, is called *802.1X for 802.11*, or simply *802.1X*. An access point that supports 802.1X acts as the interface between a wireless client and an authentication server, such as a RADIUS server, to which the access point communicates over the wired network. If 802.1X is selected, only 802.1X clients are supported.
- **PSK**—When you choose PSK (also known as *WPA pre-shared key* or *WPA passphrase*), you need to configure a pre-shared key (or a passphrase). This key is used as the pairwise master key (PMK) between the clients and the authentication server.
- **CCKM**—Cisco Centralized Key Management (CCKM) uses a fast rekeying technique that enables clients to roam from one access point to another without going through the controller, typically in under 150 milliseconds (ms). CCKM reduces the time required by the client to mutually authenticate with the new access point and derive a new session key during reassociation. CCKM fast secure roaming ensures that there is no perceptible delay in time-sensitive applications such as wireless Voice over IP (VoIP), enterprise resource planning (ERP), or Citrix-based solutions. CCKM is a CCXv4-compliant feature. If CCKM is selected, only CCKM clients are supported.

  Note The 4.0 release of controller software supports CCX versions 1 through 4. CCX support is enabled automatically for every WLAN on the controller and cannot be disabled. The controller stores the CCX version of the client in its client database and uses it to limit client functionality. Clients must support CCX v4 in order to use CCKM. See the "Configuring Quality of Service Profiles" section on page 6-19 for more information on CCX.

- **802.1X+CCKM**—During normal operation, 802.1X-enabled clients mutually authenticate with a new access point by performing a complete 802.1X authentication, including communication with the main RADIUS server. However, when you configure your WLAN for 802.1X and CCKM fast secure roaming, CCKM-enabled clients securely roam from one access point to another without the need to reauthenticate to the RADIUS server. 802.1X+CCKM is considered optional CCKM because both CCKM and non-CCKM clients are supported when this option is selected.

On a single WLAN, you can allow WPA1, WPA2, and 802.1X/PSK/CCKM/802.1X+CCKM clients to join. All of the access points on such a WLAN advertise WPA1, WPA2, and 802.1X/PSK/CCKM/ 802.1X+CCKM information elements in their beacons and probe responses. When you enable WPA1 and/or WPA2, you can also enable one or two *ciphers*, or cryptographic algorithms, designed to protect data traffic. Specifically, you can enable AES and/or TKIP data encryption for WPA1 and/or WPA2. TKIP is the default value for WPA1, and AES is the default value for WPA2.

You can configure WPA1+WPA2 through either the GUI or the CLI.

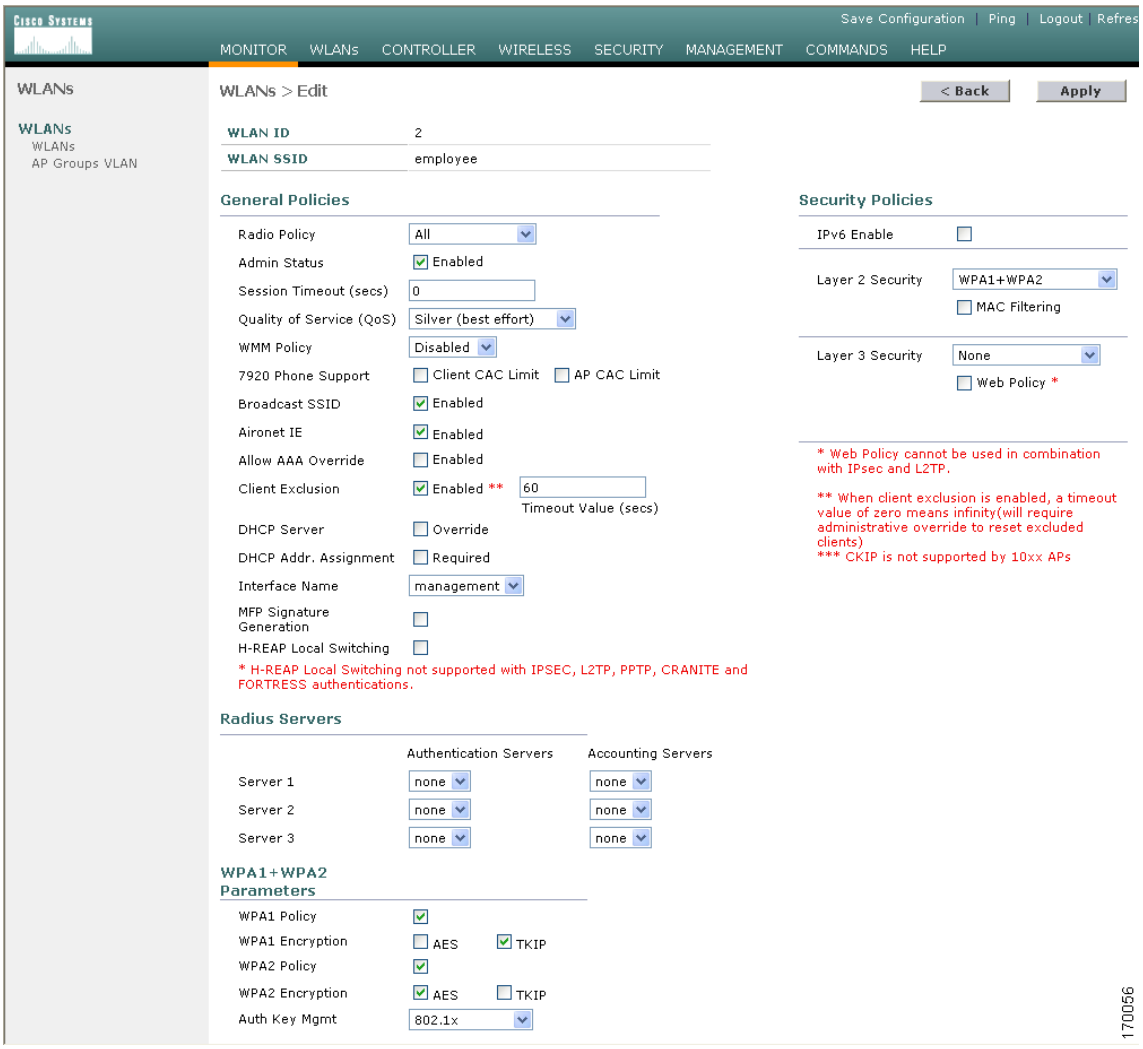
Using the GUI to Configure WPA1+WPA2

Follow these steps to configure a WLAN for WPA1+WPA2 using the controller GUI.

Step 1 Click **WLANs** to access the WLANs page.

Step 2 Click the **Edit** link for the desired WLAN to access the WLANs > Edit page (see Figure 6-1).

Figure 6-1 WLANs > Edit Page



Step 3 Under Security Policies, choose **WPA1+WPA2** from the Layer 2 Security drop-down box.

Step 4 Under WPA1+WPA2 Parameters, check the **WPA1 Policy** check box to enable WPA1, check the **WPA2 Policy** check box to enable WPA2, or check both check boxes to enable both WPA1 and WPA2.

Note The default value is disabled for both WPA1 and WPA2. If you leave both WPA1 and WPA2 disabled, the access points advertise in their beacons and probe responses information elements only for the authentication key management method you choose in Step 6.

Step 5 Check the **AES** check box to enable AES data encryption or the **TKIP** check box to enable TKIP data encryption for WPA1, WPA2, or both. The default values are TKIP for WPA1 and AES for WPA2.

Step 6 Choose one of the following key management methods from the Auth Key Mgmt drop-down box: **802.1X**, **CCKM**, **PSK**, or **802.1X+CCKM**.

Step 7 If you chose PSK in Step 6, choose **ascii** or **hex** from the PSK Format drop-down box and then enter a pre-shared key in the blank field. WPA pre-shared keys must contain 8 to 63 ASCII text characters or 64 hexadecimal characters.

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

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

Using the CLI to Configure WPA1+WPA2

Follow these steps to configure a WLAN for WPA1+WPA2 using the controller CLI.

Step 1 Enter this command to disable the WLAN:

config wlan disable *wlan_id*

Step 2 Enter this command to enable or disable WPA for the WLAN:

config wlan security wpa {**enable** | **disable**} *wlan_id*

Step 3 Enter this command to enable or disable WPA1 for the WLAN:

config wlan security wpa wpa1 {**enable** | **disable**} *wlan_id*

Step 4 Enter this command to enable or disable WPA2 for the WLAN:

config wlan security wpa wpa2 {**enable** | **disable**} *wlan_id*

Step 5 Enter these commands to enable or disable AES or TKIP data encryption for WPA1 or WPA2:

- **config wlan security wpa wpa1 ciphers** {**aes** | **tkip**} {**enable** | **disable**} *wlan_id*
- **config wlan security wpa wpa2 ciphers** {**aes** | **tkip**} {**enable** | **disable**} *wlan_id*

The default values are TKIP for WPA1 and AES for WPA2.

Step 6 Enter this command to enable or disable 802.1X, PSK, or CCKM authenticated key management:

config wlan security wpa akm {**802.1X** | **psk** | **cckm**} {**enable** | **disable**} *wlan_id*

The default value is 802.1X.

Step 7 If you enabled PSK in Step 6, enter this command to specify a pre-shared key:

config wlan security wpa akm psk set-key {**ascii** | **hex**} *psk-key wlan_id*

WPA pre-shared keys must contain 8 to 63 ASCII text characters or 64 hexadecimal characters.

Step 8 Enter this command to enable the WLAN:

config wlan enable *wlan_id*

Step 9 Enter this command to save your settings:

save config

CKIP

Cisco Key Integrity Protocol (CKIP) is a Cisco-proprietary security protocol for encrypting 802.11 media. CKIP improves 802.11 security in infrastructure mode using key permutation, message integrity check (MIC), and message sequence number. Software release 4.0 supports CKIP with static key. For this feature to operate correctly, you must enable Aironet information elements (IEs) for the WLAN.

A lightweight access point advertises support for CKIP in beacon and probe response packets by adding an Aironet IE and setting one or both of the CKIP negotiation bits [key permutation and multi-modular hash message integrity check (MMH MIC)]. Key permutation is a data encryption technique that uses the basic encryption key and the current initialization vector (IV) to create a new key. MMH MIC prevents bit-flip attacks on encrypted packets by using a hash function to compute message integrity code.

The CKIP settings specified in a WLAN are mandatory for any client attempting to associate. If the WLAN is configured for both CKIP key permutation and MMH MIC, the client must support both. If the WLAN is configured for only one of these features, the client must support only this CKIP feature.

CKIP requires that 5-byte and 13-byte encryption keys be expanded to 16-byte keys. The algorithm to perform key expansion happens at the access point. The key is appended to itself repeatedly until the length reaches 16 bytes. All lightweight access points except the AP1000 support CKIP.

You can configure CKIP through either the GUI or the CLI.

Using the GUI to Configure CKIP

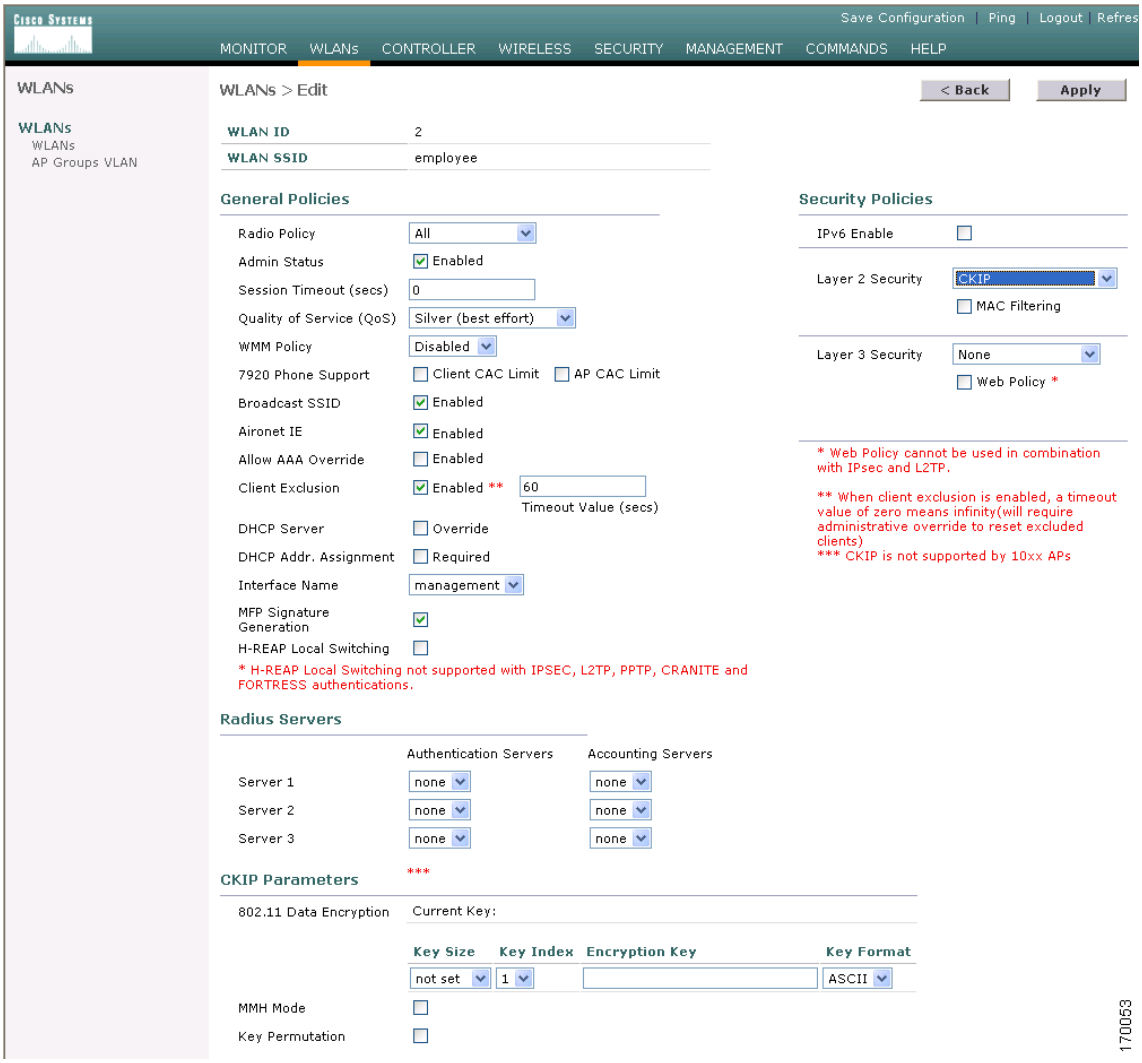
Follow these steps to configure a WLAN for CKIP using the controller GUI.

Step 1 To enable Aironet IEs for this WLAN, check the **Aironet IE** check box under Cisco Client Extension (CCX).

Step 2 Click **WLANs** to access the WLANs page.

Step 3 Click the **Edit** link for the desired WLAN to access the WLANs > Edit page (see Figure 6-1).

Figure 6-2 WLANs > Edit Page



Step 4 Uncheck the **Admin Status** check box, if checked, to disable this WLAN and click **Apply**.

Step 5 Under Security Policies, choose **CKIP** from the Layer 2 Security drop-down box.

Step 6 Under CKIP Parameters, choose the length of the CKIP encryption key from the Key Size drop-down box.

Range: Not Set, 40 bits, or 104 bits

Default: Not Set

Step 7 Choose the number to be assigned to this key from the Key Index drop-down box. You can configure up to four keys.

Step 8 Choose **ASCII** or **HEX** from the Key Format drop-down box and then enter an encryption key in the Encryption Key field. 40-bit keys must contain 5 ASCII text characters or 10 hexadecimal characters. 104-bit keys must contain 13 ASCII text characters or 26 hexadecimal characters.

Step 9 Check the **MMH Mode** check box to enable MMH MIC data protection for this WLAN. The default value is disabled (or unchecked).

Step 10 Check the **Key Permutation** check box to enable this form of CKIP data protection. The default value is disabled (or unchecked).

Step 11 Check the **Admin Status** check box to enable this WLAN.

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

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

Using the CLI to Configure CKIP

Follow these steps to configure a WLAN for CKIP using the controller CLI.

Step 1 Enter this command to disable the WLAN:

config wlan disable *wlan_id*

Step 2 Enter this command to enable Aironet IEs for this WLAN:

config wlan ccx aironet-ie enable *wlan_id*

Step 3 Enter this command to enable or disable CKIP for the WLAN:

config wlan security ckip {**enable** | **disable**} *wlan_id*

Step 4 Enter this command to specify a CKIP encryption key for the WLAN:

config wlan security ckip akm psk set-key *wlan_id* {**40** | **104**} {**hex** | **ascii**} *key key_index*

Step 5 Enter this command to enable or disable CKIP MMH MIC for the WLAN:

config wlan security ckip mmh-mic {**enable** | **disable**} *wlan_id*

Step 6 Enter this command to enable or disable CKIP key permutation for the WLAN:

config wlan security ckip kp {**enable** | **disable**} *wlan_id*

Step 7 Enter this command to enable the WLAN:

config wlan enable *wlan_id*

Step 8 Enter this command to save your settings:

save config

Configuring Layer 3 Security

This section explains how to configure Layer 3 security settings for a wireless LAN on the controller.

Note VPN termination (IPSec) and Layer 2 Tunnel Protocol (L2TP) are not supported on controllers with software release 4.0x or greater.

VPN Passthrough

Using the GUI to Configure VPN Passthrough

Follow these steps to configure a WLAN for VPN Passthrough using the controller GUI.

Step 1 Select WLANs from the navigation bar at top of window.

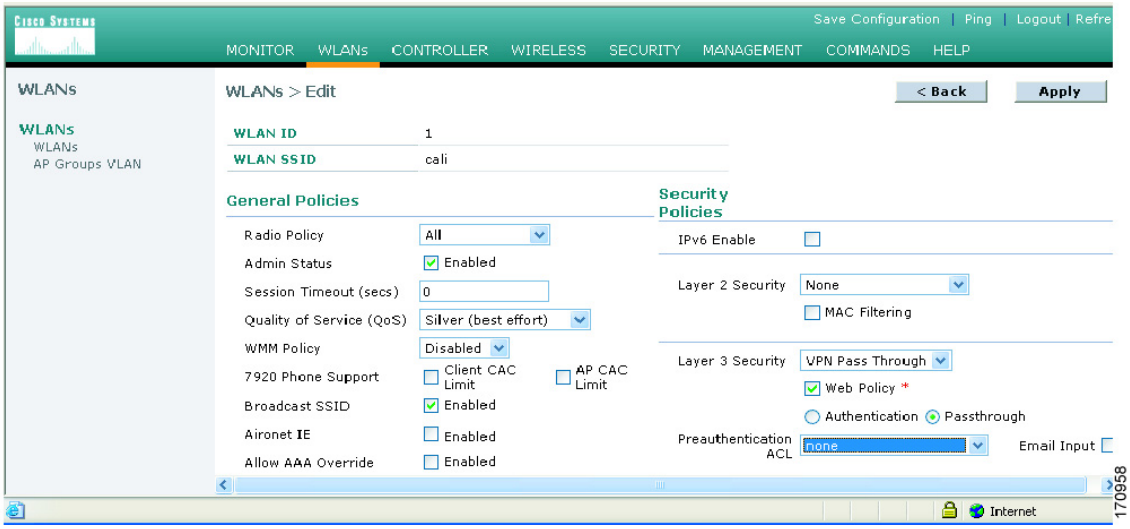
Step 2 At the WLANs window, select the **Edit** link next to the WLAN for which you want to configure VPN passthrough.

The WLANs > Edit page appears.

Step 3 Select **VPN Passthrough** from the Layer 3 Security drop-down menu (right-hand).

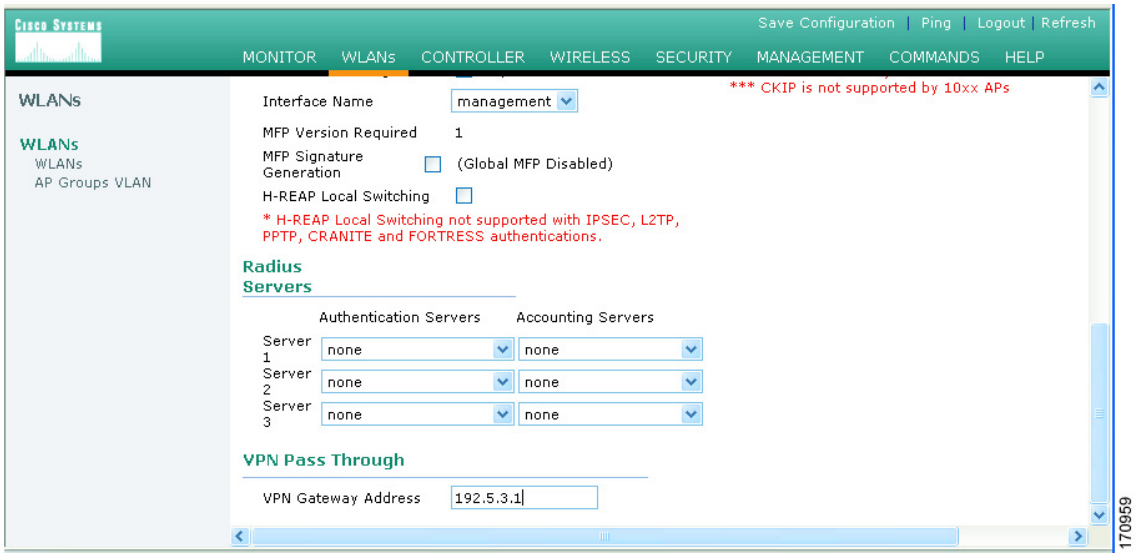
Step 4 Check the **Web Policy** box and the **Passthrough** option that appears (Figure 6-3).

Figure 6-3 WLANs > Edit Page (top)



Step 5 Scroll to the bottom of the WLAN > Edit window to enter the **VPN Gateway Address** (Figure 6-4). This IP address is that of the gateway router that is terminating the VPN tunnels initiated by the client and passed through the controller.

Figure 6-4 WLANs > Edit Page (bottom)



Step 6 Click **Save Configuration**.

Using the CLI to Configure VPN Passthrough

Enter this command to enable VPN Passthrough for a WLAN using the controller CLI.

- **config wlan security passthru** {**enable** | **disable**} *wlan-id gateway*
  - For *gateway*, enter the IP address of the router that is terminating the VPN tunnel.
  - Enter **show wlan** to verify that the passthrough is enabled.

Web-Based Authentication

Web authentication is simple to set up and use and can be used with SSL to improve the overall security of the WLAN. The use of Web authentication requires Microsoft Internet Explorer with Active Scripts enabled. Enter these commands to enable web authentication for a WLAN:

- **config wlan security web** {**enable** | **disable**} *wlan-id*
- Enter **show wlan** to verify that web authentication is enabled.

Local Netuser

Controllers have built-in network client authentication capability, similar to that provided by a RADIUS authentication server. Enter these commands to create a list of usernames and passwords allowed access to the WLAN:

- Enter **show netuser** to display client names assigned to WLANs.
- Enter **config netuser add** *username password wlan-id* to add a user to a WLAN.

Note Local netuser names must be unique because they are stored in the same database.

- Enter **config netuser wlan-id** *username wlan-id* to add a user to a WLAN without specifying a password for the user.
- Enter **config netuser password** *username password* to create or change a password for a particular user.
- Enter **config netuser delete** *username* to delete a user from the WLAN.

Configuring 802.3 Bridging

Controller software release 4.0 supports 802.3 frames and the applications that use them, such as those typically used for cash registers and cash register servers. To make these applications work with the controller, the 802.3 frames must be bridged on the controller.

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

```
+------------------+--------------------+----------------+------------------------+
| Destination      | Source             | Total packet | Payload .....
| MAC address      | MAC address        | length       |
+------------------+--------------------+----------------+------------------------
```

Use these commands to configure 802.3 bridging using the controller CLI.

1. To enable or disable 802.3 bridging globally on all WLANs, enter this command:

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

   The default value is disabled.

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

   show network

Configuring Quality of Service

Cisco UWN Solution WLANs support four levels of QoS: Platinum/Voice, Gold/Video, Silver/Best Effort (default), and Bronze/Background. You can configure the voice traffic WLAN to use Platinum QoS, assign the low-bandwidth WLAN to use Bronze QoS, and assign all other traffic between the remaining QoS levels. Enter these commands to assign a QoS level to a WLAN:

- **config wlan qos** *wlan-id* {**bronze** | **silver** | **gold** | **platinum**}
- Enter **show wlan** to verify that you have QoS properly set for each WLAN.

The WLAN QoS level (platinum, gold, silver, or bronze) defines a specific 802.11e user priority (UP) for over-the-air traffic. This UP is used to derive the over-the-wire priorities for non-WMM traffic, and it also acts as the ceiling when managing WMM traffic with various levels of priorities. The access point uses this QoS-profile-specific UP in accordance with the values in Table 6-1 to derive the IP DSCP value that is visible on the wired LAN.

Table 6-1 Access Point QoS Translation Values

AVVID 802.1p UP-Based Traffic Type	AVVID IP DSCP	AVVID 802.1p UP	IEEE 802.11e UP
Network control	–	7	–
Inter-network control (LWAPP control, 802.11 management)	48	6	7
Voice	46 (EF)	5	6
Video	34 (AF41)	4	5
Voice control	26 (AF31)	3	4
Background (Gold)	18 (AF21)	2	2
Background (Gold)	20 (AF22)	2	2
Background (Gold)	22 (AF23)	2	2
Background (Silver)	10 (AF11)	1	1
Background (Silver)	12 (AF12)	1	1
Background (Silver)	14 (AF13)	1	1
Best Effort	0 (BE)	0	0, 3
Background	2	0	1
Background	4	0	1
Background	6	0	1

Configuring QoS Enhanced BSS (QBSS)

You can enable QBSS in these two modes:

- Wireless Multimedia (WMM) mode, which supports devices that meet the 802.11E QBSS standard
- 7920 support mode, which supports Cisco 7920 IP telephones on your 802.11b/g network

QBSS is disabled by default.

Enabling WMM Mode

Enter this command to enable WMM mode:

config wlan wmm {**disabled** | **allowed** | **required**} *wlan-id*

- The **allowed** option allows client devices to use WMM on the WLAN.
- The **required** option requires client devices to use WMM; devices that do not support WMM cannot join the WLAN.

Note Do not enable WMM mode if Cisco 7920 phones are used on your network.

Note When the controller is in Layer 2 mode and WMM is enabled, you must put the access points on a trunk port in order to allow them to join the controller.

Enabling 7920 Support Mode

The 7920 support mode contains two options:

- Support for 7920 phones that require call admission control (CAC) to be configured on and advertised by the client device (these are typically older 7920 phones)
- Support for 7920 phones that require CAC to be configured on and advertised by the access point (these are typically newer 7920 phones)

Note When access point-controlled CAC is enabled, the access point sends out a Cisco proprietary CAC Information Element (IE) and does not send out the standard QBSS IE.

Enter this command to enable 7920 support mode for phones that require client-controlled CAC:

config wlan 7920-support client-cac-limit {**enabled** | **disabled**} *wlan-id*

Note You cannot enable both WMM mode and client-controlled CAC mode on the same WLAN.

Enter this command to enable 7920 support mode for phones that require access point-controlled CAC:

config wlan 7920-support ap-cac-limit {**enabled** | **disabled**} *wlan-id*

QBSS Information Elements Sometimes Degrade 7920 Phone Performance

If your WLAN contains both 1000 series access points and Cisco 7920 wireless phones, do not enable the WMM or AP-CAC-LIMIT QBSS information elements. Do not enter either of these commands:

config wlan 7920-support ap-cac-limit enable *wlan-id*

config wlan wmm [**allow** | **require**] *wlan-id*

The information sent by 1000 series access points in the WMM and AP-CAC-LIMIT QBSS information elements is inaccurate and could result in degradation of voice quality 7920 wireless phones. This issue does not affect the CLIENT-CAC-LIMIT QBSS IE, which you enable using this command:

config wlan 7920-support client-cac-limit enable *wlan-id*

The CLIENT-CAC-LIMIT QBSS IE is the only QBSS IE that should be used in networks containing both 1000 series access points and 7920 wireless phones.

Configuring Quality of Service Profiles

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

Using the GUI to Configure QoS Profiles

To configure the Platinum, Gold, Silver, and Bronze QoS profiles using the GUI, follow these steps.

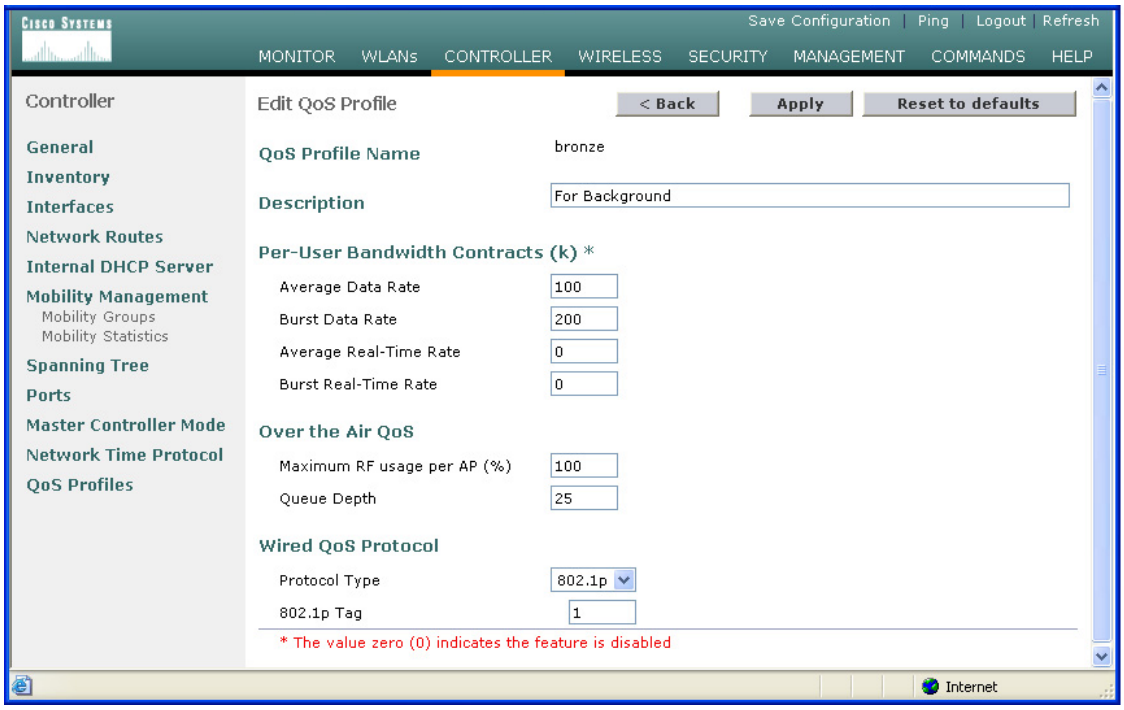
Step 1 Disable the 802.11a and 802.11b/g networks so that you can configure the QoS profiles.

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

Step 2 Click **Controller > QoS > Profiles** to access the QoS Profiles page.

Step 3 Click **Edit** for the specific profile you want to configure (see Figure 6-5).

Figure 6-5 Controller > Edit QoS Profiles Page



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

Step 5 To define the average data rate for TCP traffic on a per user basis, enter the rate in Kbps in the Average Data Rate field. A value of 0 disables this option.

Step 6 To define the peak data rate for TCP traffic on a per user basis, enter the rate in Kbps in the Burst Data Rate field. A value of 0 disables this option.

Step 7 To define the average real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Average Real-Time Rate field. A value of 0 disables this option.

Step 8 To define the peak real-time rate for UDP traffic on a per user basis, enter the rate in Kbps in the Burst Real-Time Rate field. A value of 0 disables this option.

Step 9 In the Maximum RF usage per AP (%) field, enter the maximum percentage of air bandwidth given to a user class.

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

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

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

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

Step 12 Click **Apply**.

Step 13 Click **Save Configuration**.

Step 14 Reenable the 802.11a and 802.11b/g networks.

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

Using the CLI to Configure QoS Profiles

To configure the Platinum, Gold, Silver, and Bronze QoS profiles using the CLI, follow these steps.

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

config 802.11a disable network

config 802.11b disable network

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Step 10 Reenable the 802.11a and 802.11b/g networks so that you can configure the QoS profiles. Enter these commands:

config 802.11a enable network

config 802.11b enable network

Configuring Cisco Client Extensions

Cisco Client Extensions (CCX) software is licensed to manufacturers and vendors of third-party client devices. The CCX code resident on these clients enables them to communicate wirelessly with Cisco access points and to support Cisco features that other client devices do not, including those related to increased security, enhanced performance, fast roaming, and superior power management.

The 4.0 release of controller software supports CCX versions 1 through 4, which enables controllers and their access points to communicate wirelessly with third-party client devices that support CCX. CCX support is enabled automatically for every WLAN on the controller and cannot be disabled. However, you can configure a specific CCX feature per WLAN. This feature is Aironet information elements (IEs).

If Aironet IE support is enabled, the access point sends an Aironet IE 0x85 (which contains the access point name, load, number of associated clients, and so on) in the beacon and probe responses of this WLAN, and the controller sends Aironet IEs 0x85 and 0x95 (which contains the management IP address of the controller and the IP address of the access point) in the reassociation response if it receives Aironet IE 0x85 in the reassociation request.

Follow the instructions in this section to configure a WLAN for the CCX Aironet IE feature and to see the CCX version supported by specific client devices using either the GUI or the CLI.

Note CCX is not supported on the AP1030.

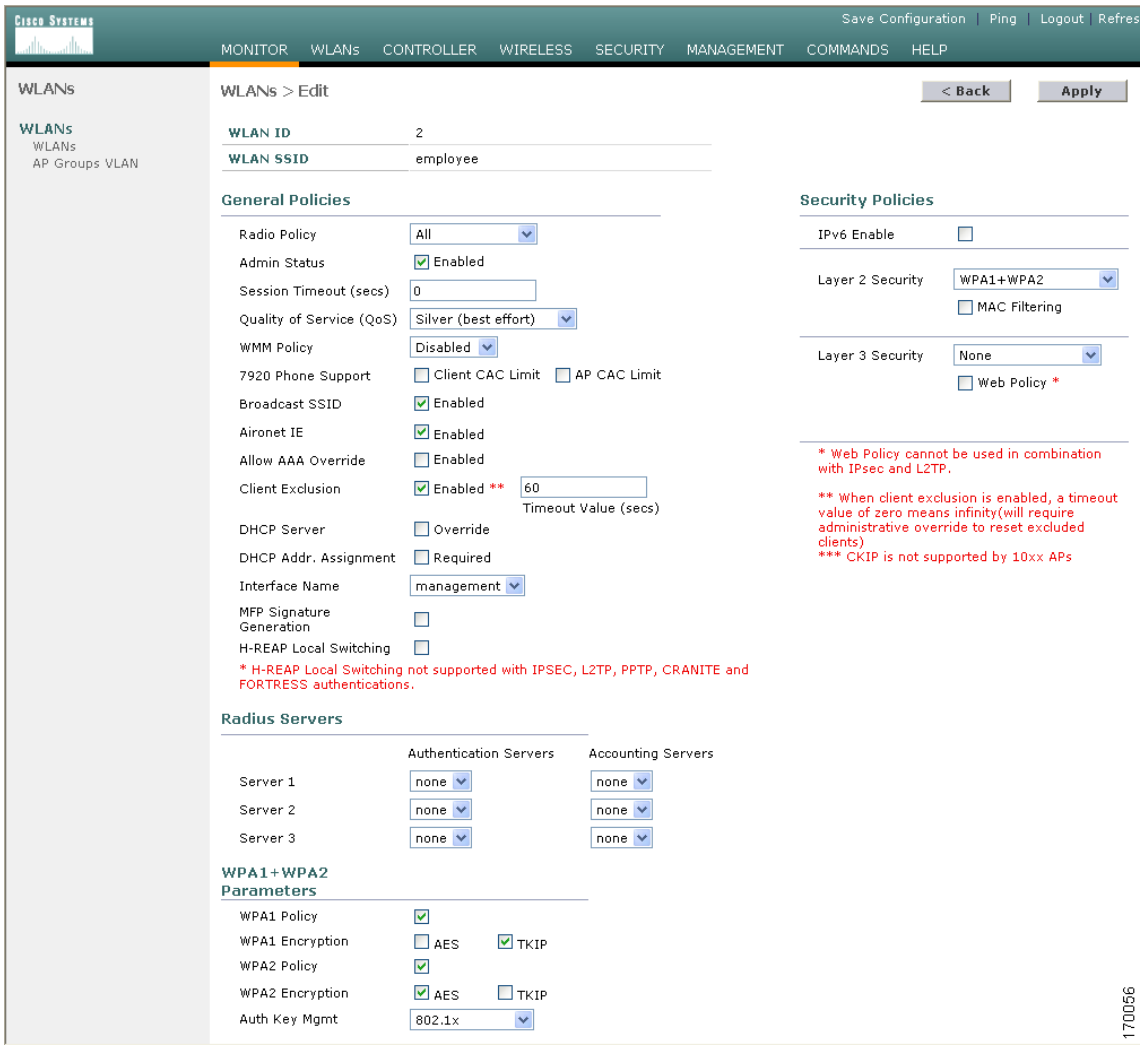
Using the GUI to Configure CCX Aironet IEs

Follow these steps to configure a WLAN for CCX Aironet IEs using the GUI.

Step 1 Click **WLANs** to access the WLANs page.

Step 2 Click the **Edit** link of the desired WLAN to access the WLANs > Edit page (see Figure 6-6).

Figure 6-6 WLANs > Edit Page



Step 3 Check the **Aironet IE** check box if you want to enable support for Aironet IEs for this WLAN. Otherwise, uncheck this check box. The default value is enabled (or checked).

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

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

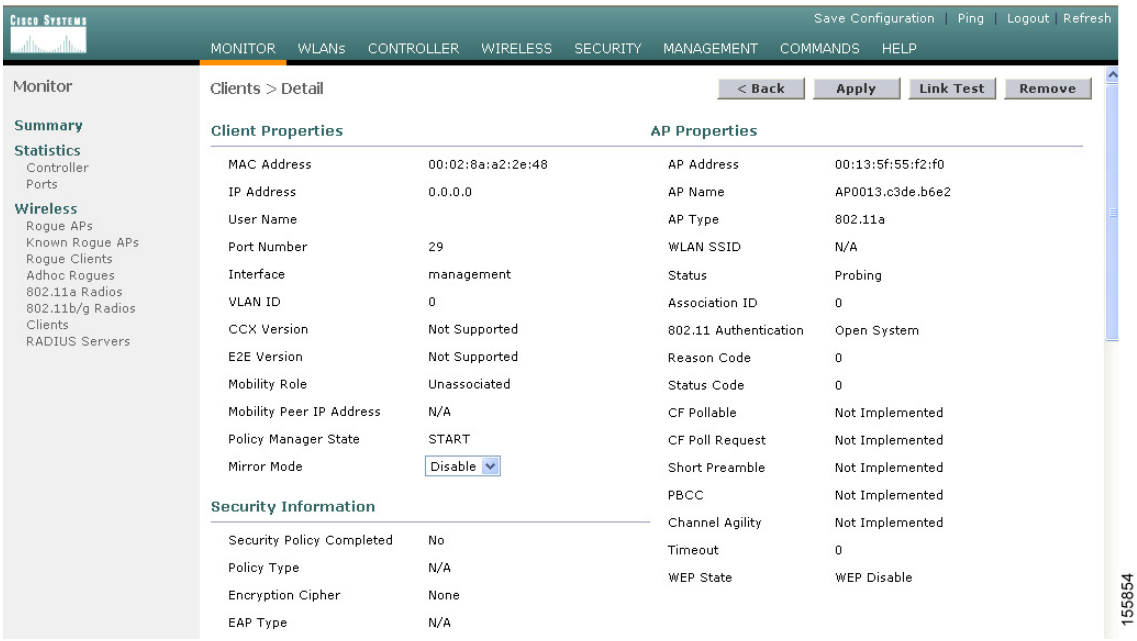
Using the GUI to View a Client's CCX Version

A client device sends its CCX version in association request packets to the access point. The controller then stores the client's CCX version in its database and uses it to limit the features for this client. For example, if a client supports CCX version 2, the controller does not allow the client to use CCX version 4 features. Follow these steps to see the CCX version supported by a particular client device using the GUI.

Step 1 Click **Wireless** > **Clients** to access the Clients page.

Step 2 Click the **Detail** link for the desired client device to access the Clients > Detail page (see Figure 6-7).

Figure 6-7 Clients > Detail Page



The CCX Version field shows the CCX version supported by this client device. *Not Supported* appears if the client does not support CCX.

Step 3 Click **Back** to return to the previous screen.

Step 4 Repeat this procedure to view the CCX version supported by any other client devices.

Using the CLI to Configure CCX Aironet IEs

To enable or disable support for Aironet IEs for a particular WLAN, enter this command:

config wlan ccx aironet-ie {**enable** | **disable**} *wlan_id*

The default value is enabled.

Using the CLI to View a Client's CCX Version

To see the CCX version supported by a particular client device, enter this command:

show client detail *mac-addr*

Enabling WLAN Override

By default, access points transmit all defined WLANs on the controller. However, you can use the WLAN Override option to select which WLANs are transmitted and which ones are not on a per access point basis. For example, you can use WLAN override to control where in the network the guest WLAN is transmitted or you can use it to disable a specific WLAN in a certain area of the network.

Using the GUI to Enable WLAN Override

Follow these steps to enable the WLAN Override option.

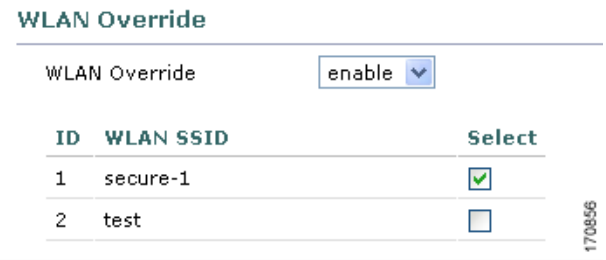
Step 1 Click **Wireless** to access the Wireless page.

Step 2 Click **802.11a Radios** or **802.11b/g Radios** under Access Points to list the corresponding access points.

Step 3 Click the **Configure** link for the desired access point.

Step 4 Choose **Enable** from the WLAN Override drop-down box to enable this option and display a list of the available WLANs (see Figure 6-8).

Figure 6-8 802.11a Cisco APs > Configure Page



Step 5 Check the check boxes for the WLANs you want this access point to broadcast.

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

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

Using the CLI to Enable WLAN Override

To enable the WLAN Override option using the controller CLI, enter this command:

config ap wlan enable {**802.11a** | **802.11b**} *cisco_ap*

To define which WLANs you wish to transmit, enter this command:

config ap wlan add {**802.11a** | **802.11b**} *wlan-id cisco_ap*

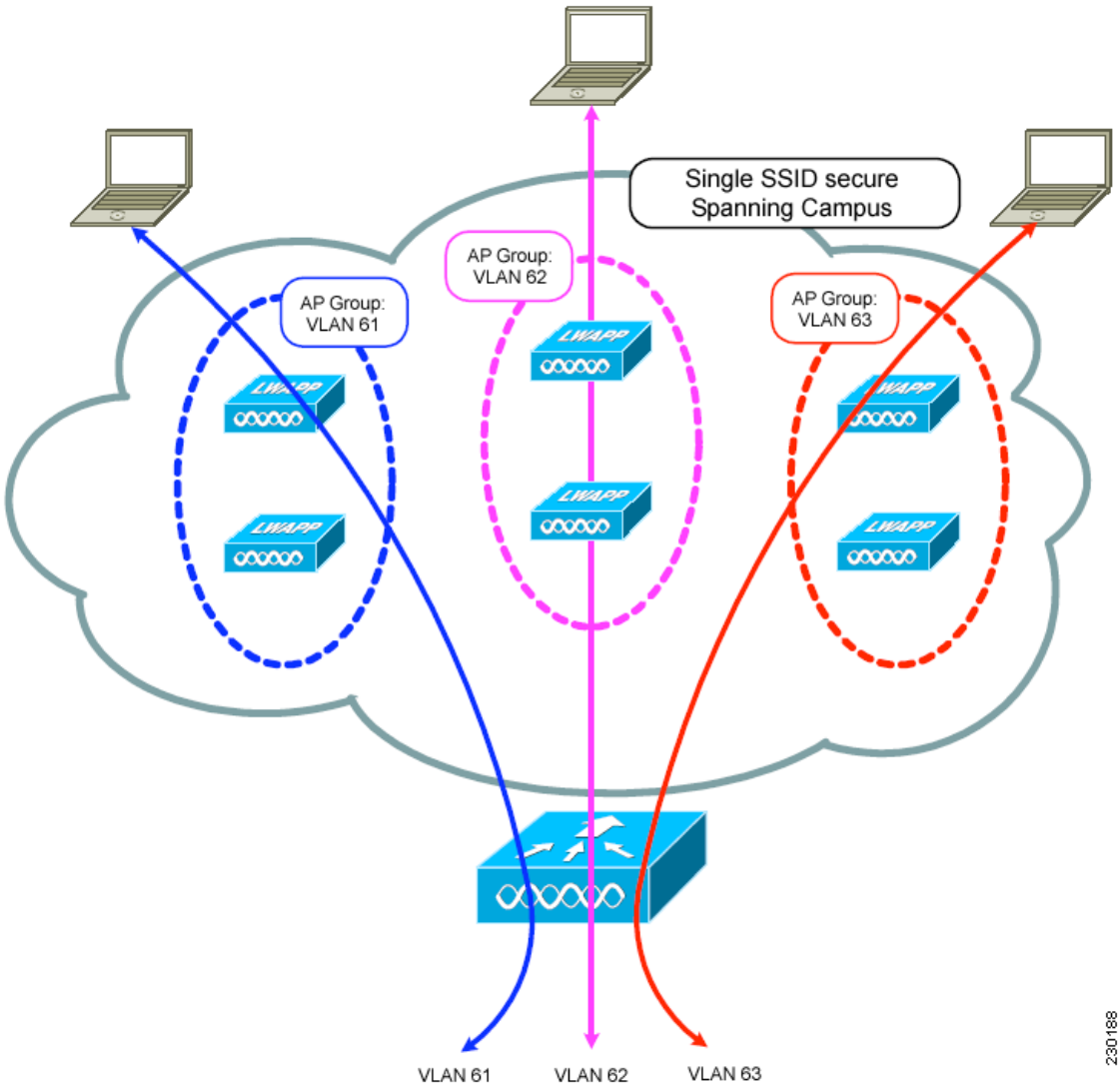
Configuring Access Point Groups

In a typical deployment, all users on a WLAN are mapped to a single interface on the controller. Therefore, all users associated with that WLAN are on the same subnet or VLAN. However, you can override this default WLAN setting to distribute the load among several interfaces or to group users based on specific criteria such as individual departments (for example, marketing) by creating *access point groups* (formerly known as site-specific VLANs). Additionally, these access point groups can be configured in separate VLANs to simplify network administration as illustrated in the example in Figure 6-9.

Note The required access control list (ACL) must be defined on the router that serves the VLAN or subnet.

Note Multicast traffic is not supported when access point group VLANs are configured.

Figure 6-9 Access Point Groups



In Figure 6-9, there are three configured dynamic interfaces that are mapped to three different VLANs identified as VLAN 61, VLAN 62, and VLAN 63. Three access point groups are defined and each is a member of a different VLAN but all are members of the same SSID. A client within the wireless SSID is assigned an IP address from the VLAN subnet on which its access point is a member. For example, any user that associates with an access point that is a member of the access point group: VLAN 61 is assigned an IP address from that subnet.

In the example in Figure 6-9, the controller internally treats roaming between access points as a Layer 3 roaming event. In this way, WLAN clients maintain their original IP addresses.

To configure access point groups, follow these top-level steps.

1. Configure the appropriate dynamic interfaces and map them to the desired VLANs.

   For example, to implement the network in Figure 6-9, create dynamic interfaces for VLANs 61, 62, and 63 on the controller. Refer to Chapter 3, "Configuring Ports and Interfaces" for more information about how to configure dynamic interfaces.

2. Create the access point groups. Refer to the "Creating Access Point Groups" section on page 6-27.

3. Assign access points to the appropriate access point group. Refer to the "Assigning Access Points to Access Point Groups" section on page 6-29.

Creating Access Point Groups

Once all access points have joined the controller, you can create access point groups and assign each group to one or more WLANs. You also need to define WLAN-to-interface mapping.

Using the GUI to Create Access Point Groups

To create an access point group using the GUI, follow these steps.

Step 1 Click **WLANs**.

Step 2 Click **AP Groups VLAN**.

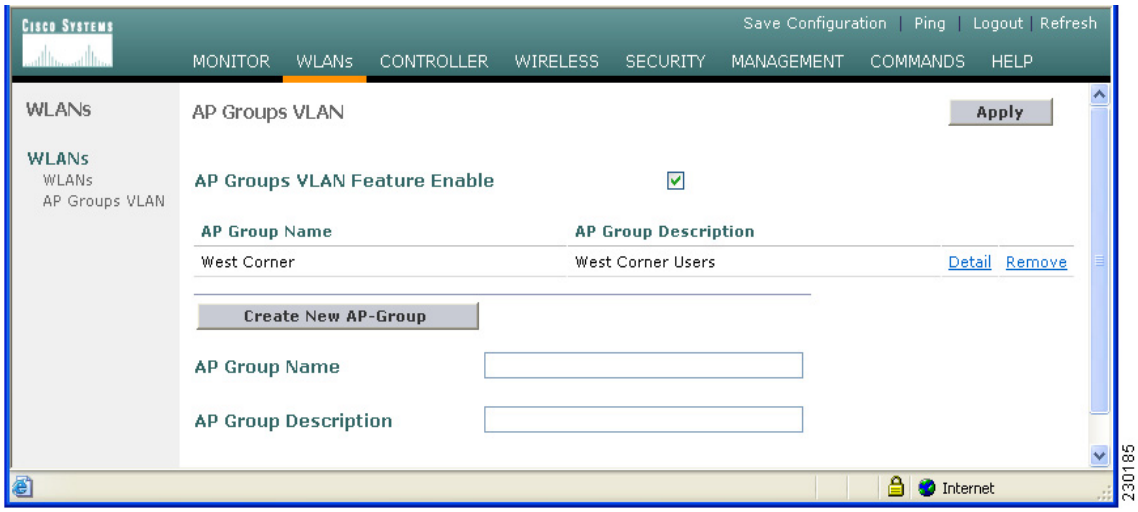
Step 3 Check the **AP Groups VLAN Feature Enable** check box.

Step 4 Enter the group's name in the **AP Group Name** field.

Step 5 Enter the group's description in the **AP Group Description** field.

Step 6 Click **Create New AP Group** to create the group. The newly created access point group appears on the AP Groups VLAN page (see Figure 6-10).

Figure 6-10 AP Groups VLAN Page



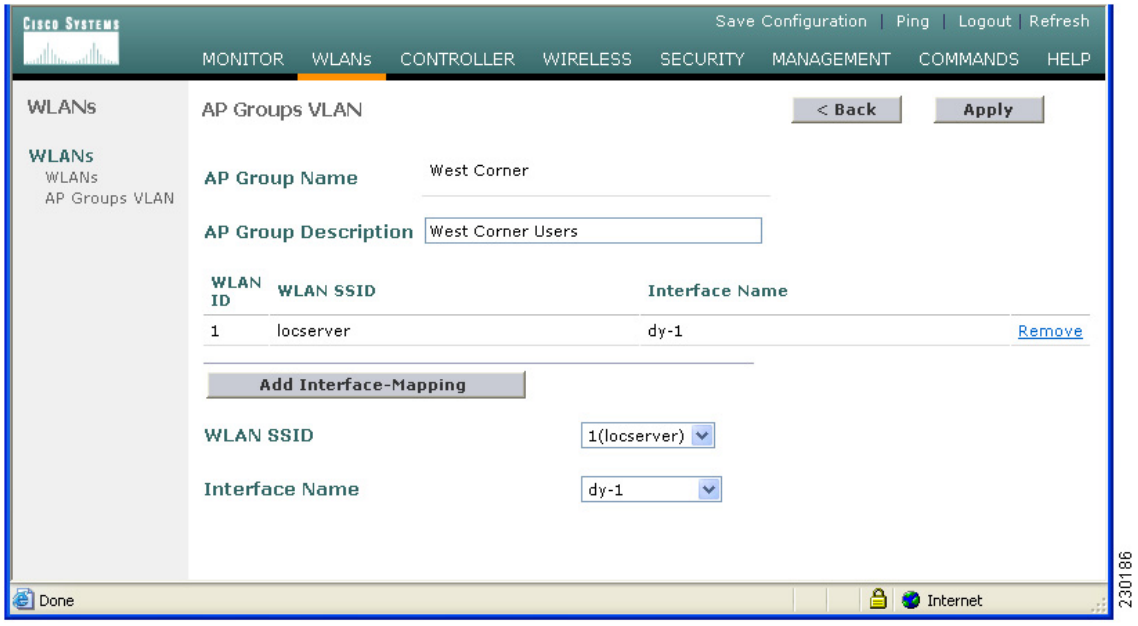
Step 7 To edit this new group, click **Detail**. The window seen in Figure 6-11 appears.

Step 8 To map the access point group to a WLAN, choose its ID from the WLAN SSID drop-down box.

Step 9 To map the access point group to an interface, choose its name from the Interface Name drop-down box.

Step 10 Click **Add Interface-Mapping** to add WLAN-to-interface mappings to the group.

Figure 6-11 AP Groups VLAN Page



Step 11 When you are done adding your interface mappings, click **Apply**.

Step 12 Repeat Steps 4 through 11 to add more access point groups.

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

Using the CLI to Create Access Point Groups

To create an access point group, enter this command:

config ap group-name *group_name*

Assigning Access Points to Access Point Groups

After you have created your access point groups, use the GUI or CLI to assign access points to these groups.

Using the GUI to Assign Access Points to Access Point Groups

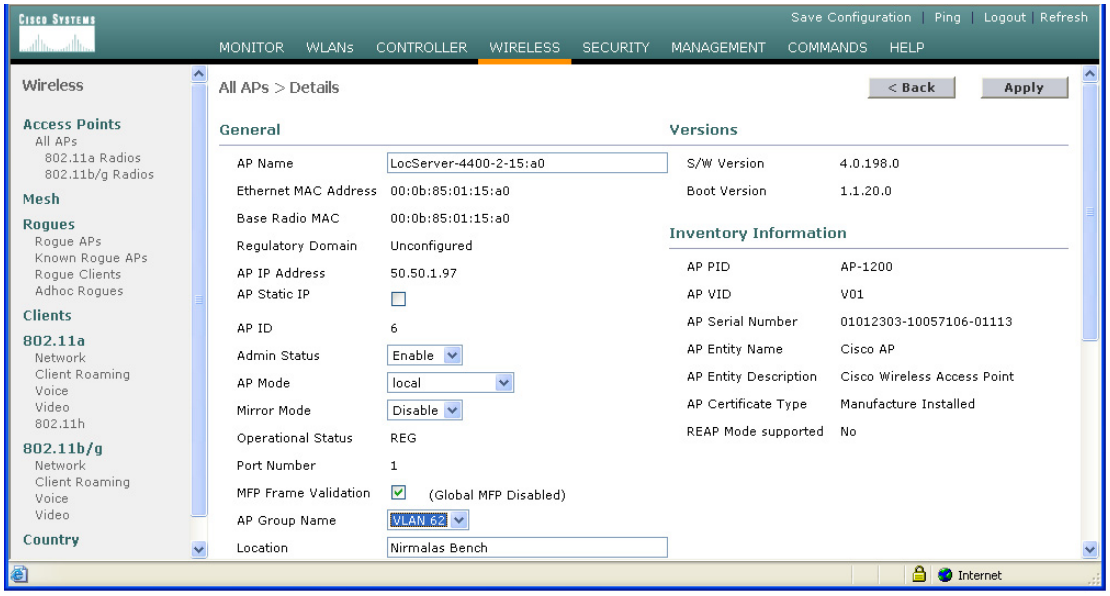
To assign an access point to an access point group, follow these steps:

Step 1 Click **Wireless > Access Points > All APs**.

Step 2 Click the **Detail** link for the access point.

Step 3 Select the access point group from the AP Group Name drop-down box (see Figure 6-12).

Figure 6-12 All APs > Details Page



Step 4 Click **Apply**.

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

Using the CLI to Assign Access Points to Access Point Groups

To assign an access point to an access point group, enter this command:

config ap group-name *group_name ap_name*

Configuring Multiple WLANs with the Same SSID

In release 4.0.206.0 and greater, you can configure multiple WLANs with the same SSID. This feature enables you to assign different Layer 2 security policies within the same wireless LAN. To distinguish among WLANs with the same SSID, you must create a unique profile name for each WLAN.

These restrictions apply when configuring multiple WLANs with the same SSID:

- WLANs with the same SSID must have unique Layer 2 security policies so that clients can make a WLAN selection based on information advertised in beacon and probe response. These are the available Layer 2 security policies:
  - None (open WLAN)
  - Static WEP or 802.1X

    Note Because static WEP and 802.1X are both advertised by the same bit in beacon and probe responses, they cannot be differentiated by clients. Therefore, they cannot both be used by multiple WLANs with the same SSID.

  - CKIP
  - WPA/WPA2

    Note Although WPA and WPA2 cannot both be used by multiple WLANs with the same SSID, two WLANs with the same SSID could be configured with WPA/TKIP with PSK and WPA/TKIP with 802.1X, respectively, or with WPA/TKIP with 802.1X or WPA/AES with 802.1X, respectively.

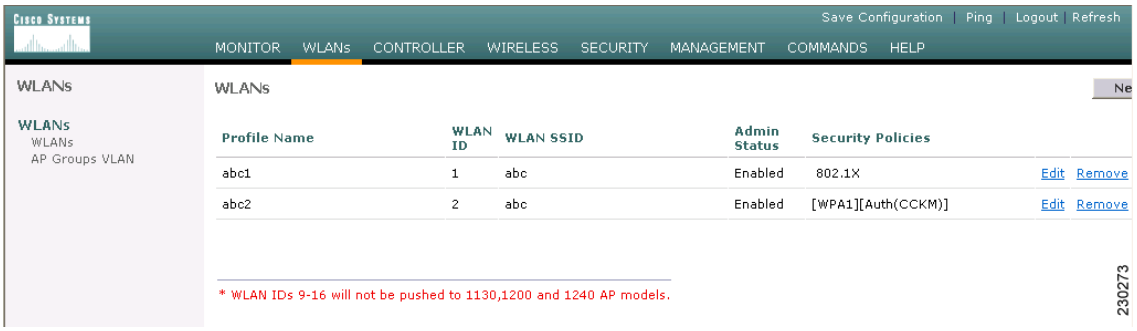
- Hybrid-REAP access points do not support multiple SSIDs.

Additions to the Controller GUI

The new Profile Name parameter appears on three controller GUI pages:

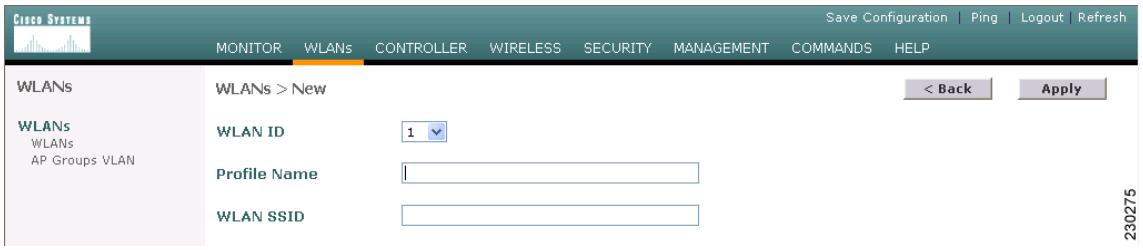
1. The **WLANs** page, which lists all WLANs configured on the controller. Figure 6-13 shows two SSIDs named “abc” but with different profile names (abc1 and abc2). Notice that their security policies are also different.

Figure 6-13 WLANs Page



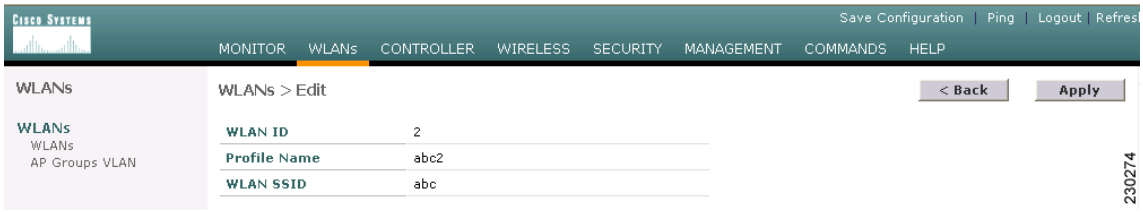
2. The WLANs > New page, which appears when you click **New** on the WLANs page to create a WLAN. Figure 6-14 shows the fields in which to enter the profile name and SSID for the WLAN.

Figure 6-14 WLANs > New Page



3. The WLANs > Edit page, which appears when you click **Apply** on the WLANs > New page or when you edit an existing WLAN. Figure 6-15 shows the ID, profile name, and SSID of the WLAN.

Figure 6-15 WLANs > Edit Page



Addition to the Controller CLI

In release 4.0.206.0, the command for creating a WLAN has expanded to allow the addition of the profile name in the command.

Note The **config wlan enable** *wlan_id* and **config wlan delete** *wlan_id* commands do not require the profile name to be specified. Their format has not changed.

The new command for creating a WLAN is as follows.

config wlan create *wlan_id profile_name ssid*

Note If you do not specify an *ssid*, the *profile_name* parameter is used for both the profile name and the SSID.

Note For releases earlier than 4.0.206.0, the CLI command for creating a WLAN remains as **config wlan create** *wlan_id ssid.*

Configuring Conditional Web Redirect with 802.1X Authentication

In release 4.0.206.0 and later, a user can be conditionally redirected to a particular web page after 802.1X authentication has completed successfully. Such conditions might include the user's password reaching expiration or the user needing to pay his or her bill for continued usage. You can specify the redirect page and the conditions under which the redirect occurs on your RADIUS server.

If the RADIUS server returns the Cisco AV-pair "url-redirect," then the user is redirected to the specified URL upon opening a browser. If the server also returns the Cisco AV-pair "url-redirect-acl," the specified access control list (ACL) is installed as a preauthentication ACL for this client. The client is not considered fully authorized at this point and is only allowed to pass traffic allowed by the preauthentication ACL.

After the client completes a particular operation at the specified URL (for example, changing a password or paying a bill), it must reauthenticate. When the RADIUS server does not return a "url-redirect," the client is considered fully authorized and allowed to pass traffic.

The conditional web redirect feature is available only for WLANs that are configured for 802.1X or WPA1+WPA2 Layer 2 Security.

Once the RADIUS server is configured, you can then configure the conditional web redirect on the controller using either the controller GUI or CLI.

Configuring the RADIUS Server

Follow these steps to configure your RADIUS server.

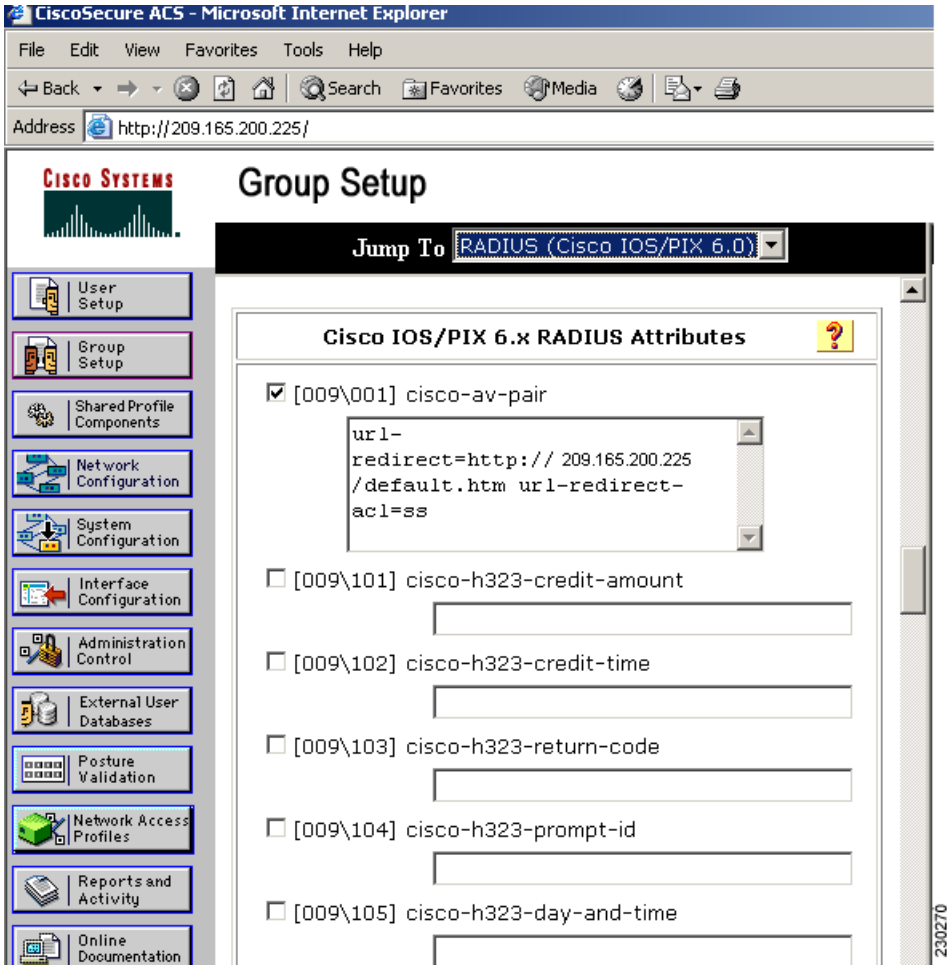
Note These instructions are specific to the CiscoSecure ACS; however, they should be similar to those for other RADIUS servers.

Step 1 From the CiscoSecure ACS main menu, click **Group Setup**.

Step 2 Click **Edit Settings**.

Step 3 From the Jump To drop-down menu, choose **RADIUS (Cisco IOS/PIX 6.0)**. The window seen in Figure 6-16 appears.

Figure 6-16 ACS Server Configuration



Step 4 Check the **[009\001] cisco-av-pair** check box.

Step 5 Enter the following Cisco AV-pairs in the [009\001] cisco-av-pair edit box to specify the URL to which the user is redirected and the conditions under which the redirect takes place, respectively:

url-redirect=http://*url*

url-redirect-acl=*acl_name*

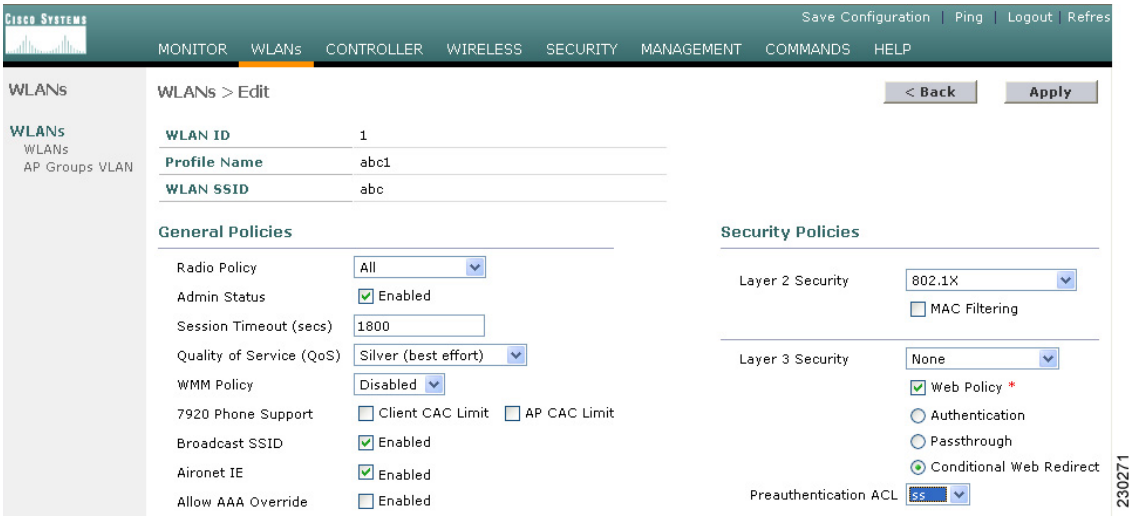
Using the GUI to Configure Conditional Web Redirect

Follow these steps to configure conditional web redirect using the controller GUI.

Step 1 Click **WLANs** to access the WLANs page.

Step 2 Click the **Edit** link for the desired WLAN. The WLANs > Edit page appears (see Figure 6-17).

Figure 6-17 WLANs > Edit Page



Step 3 Make sure that **802.1X** or **WPA1+WPA2** is selected for Layer 2 Security.

Step 4 Check the **Web Policy** check box under Layer 3 Security.

Step 5 Choose **Conditional Web Redirect** to enable this feature. The default value is disabled (unchecked box).

Step 6 If the user is to be redirected to a site external to the controller, choose the ACL that was configured on your RADIUS server from the Preauthentication ACL drop-down list.

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

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

Using the CLI to Configure Conditional Web Redirect

Follow these steps to configure conditional web redirect using the controller CLI.

Step 1 To enable or disable conditional web redirect, enter this command:

config wlan security cond-web-redir {**enable** | **disable**} *wlan_id*

Step 2 To save your settings, enter this command:

save config

Disabling Accounting Servers per WLAN

In release 4.0.206.0 and later, a new check box in the RADIUS Servers section of the WLANs > Edit page allows you to disable all accounting servers on a WLAN.

Disabling accounting servers disables all accounting operations and prevents the controller from falling back to the default RADIUS server for the WLAN.

Follow these steps to disable all accounting servers for a RADIUS authentication server.

Step 1 Click **WLANs**.

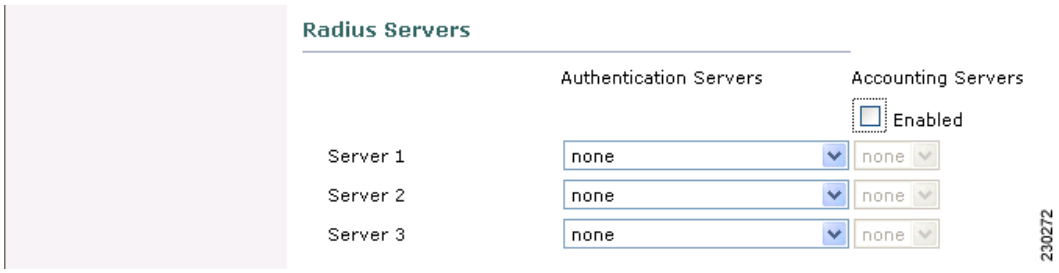
Step 2 Select the edit link next to WLAN to be modified.

The WLANs > Edit page appears.

Step 3 Scroll down to the RADIUS servers section of the page (see Figure 6-18).

Step 4 Uncheck the **Enabled** box for the Accounting Servers.

Figure 6-18 WLANs > Edit Page



Controlling Lightweight Access Points

This chapter describes the Cisco lightweight access points and explains how to connect them to the controller and manage access point settings. It contains these sections:

The Controller Discovery Process

Cisco's lightweight access points use the Lightweight Access Point Protocol (LWAPP) to communicate between the controller and other lightweight access points on the network. In an LWAPP environment, a lightweight access point discovers a controller by using LWAPP discovery mechanisms and then sends it an LWAPP join request. The controller sends the access point an LWAPP join response allowing the access point to join the controller. When the access point joins the controller, the controller manages its configuration, firmware, control transactions, and data transactions.

Note You must install software release 4.0.155.0 or greater on the controller before connecting 1100 and 1300 series access points to the controller. The 1120 and 1310 access points were not supported prior to software release 4.0.155.0.

Note The Cisco controllers cannot edit or query any access point information using the CLI if the name of the access point contains a space.

Lightweight access points must be discovered by a controller before they can become an active part of the network. The lightweight access points support these controller discovery processes:

- **Layer 3 LWAPP discovery**—Can occur on different subnets from the access point and uses IP addresses and UDP packets rather the MAC addresses used by Layer 2 discovery.
- **Layer 2 LWAPP discovery**—Occurs on the same subnet as the access point and uses encapsulated Ethernet frames containing MAC addresses for communications between the access point and the controller. Layer 2 LWAPP discovery is not suited for Layer 3 environments.
- **Over-the-air provisioning (OTAP)**—This feature is supported by Cisco 4400 series controllers. If this feature is enabled on the controller, all associated access points transmit wireless LWAPP neighbor messages, and new access points receive the controller IP address from these messages. This feature should be disabled when all access points are installed.
- **Locally stored controller IP address discovery**—If the access point was previously associated to a controller, the IP addresses of the primary, secondary, and tertiary controllers are stored in the access point's non-volatile memory. This process of storing controller IP addresses on access points for later deployment is called *priming the access point*.
- **DHCP server discovery**—This feature uses DHCP option 43 to provide controller IP addresses to the access points. Cisco switches support a DHCP server option that is typically used for this capability. For more information about DHCP option 43, see the "Using DHCP Option 43" section on page 7-22.
- **DNS discovery**—The access point can discover controllers through your domain name server (DNS). For the access point to do so, you must configure your DNS to return controller IP addresses in response to CISCO-LWAPP-CONTROLLER.*localdomain*, where *localdomain* is the access point domain name. When an access point receives an IP address and DNS information from a DHCP server, it contacts the DNS to resolve CISCO-LWAPP-CONTROLLER@*localdomain*. When the DNS sends a list of controller IP addresses, the access point sends discovery requests to the controllers.

Verifying that Access Points Join the Controller

When replacing a controller, you need to make sure that access points join the new controller.

Verifying that Access Points Join the Controller Using the GUI

Follow these steps to ensure that access points join the new controller.

Step 1 Follow these steps to configure the new controller as a master controller.

a. Using the GUI, click **Controller > Master Controller Mode**.

b. Check the **Master Controller Mode** check box.

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

d. Click **Save Configuration** to save your changes.

Step 2 (Optional) Flush the ARP and MAC address tables within the network infrastructure. Ask your network administrator for more information about this step.

Step 3 Restart the access points.

Step 4 Once all the access points have joined the new controller, configure the controller not to be a master controller by unchecking the **Master Controller Mode** check box in the GUI.

Verifying that Access Points Join the Controller Using the CLI

Follow these steps to ensure that access points join the new controller.

Step 1 Enter this command to configure the new controller as a master controller:

config network master-base enable

Step 2 (Optional) Flush the ARP and MAC address tables within the network infrastructure. Ask your network administrator for more information about this step.

Step 3 Restart the access points.

Step 4 Once all the access points have joined the new controller, configure the controller not to be a master controller by entering this command in the CLI:

config network master-base disable

Cisco 1000 Series Lightweight Access Points

The Cisco 1000 series lightweight access point is a part of the innovative Cisco Unified Wireless Network (UWN) Solution. When associated with controllers as described below, the Cisco 1000 series lightweight access point provides advanced 802.11a and/or 802.11b/g Access Point functions in a single aesthetically pleasing plenum-rated enclosure. Figure 7-1 shows the two types of Cisco 1000 Series IEEE 802.11a/b/g lightweight access point: without and with connectors for external antennas.

Figure 7-1 1000 Series Lightweight Access Points

The Cisco WLAN Solution also offers 802.11a/b/g Cisco 1030 Remote Edge Lightweight Access Points, which are Cisco 1000 series lightweight access points designed for remote deployment, Radio Resource Management (RRM) control via a WAN link, and which include connectors for external antennas.

The Cisco 1000 series lightweight access point is manufactured in a neutral color so it blends into most environments (but can be painted), contains pairs of high-gain internal antennas for unidirectional (180-degree) or omnidirectional (360-degree) coverage, and is plenum-rated for installations in hanging ceiling spaces.

In the Cisco Wireless LAN Solution, most of the processing responsibility is removed from traditional SOHO (small office, home office) access points and resides in the Cisco Wireless LAN Controller.

Cisco 1030 Remote Edge Lightweight Access Points

The only exception to the general rule of lightweight access points being continuously controlled by Cisco Wireless LAN Controllers is the Cisco 1030 IEEE 802.11a/b/g remote edge lightweight access point (Cisco 1030 remote edge lightweight access point). The Cisco 1030 remote edge lightweight access point is intended to be located at a remote site, initially configured by a Cisco Wireless LAN Controller, and normally controlled by a Cisco Wireless LAN Controller.

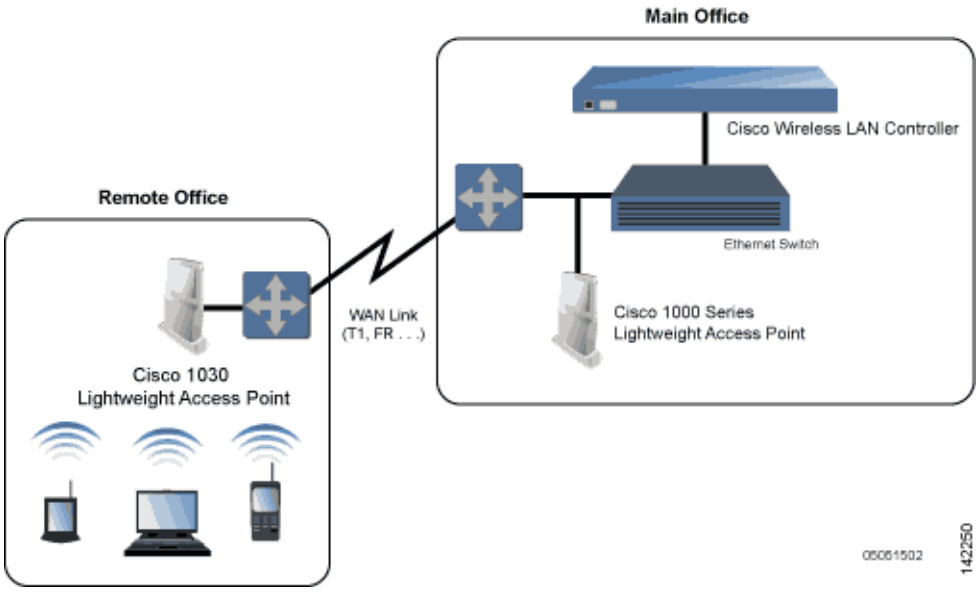
However, because the Cisco 1030 remote edge lightweight access point bridges the client data (compared with other Cisco 1000 series lightweight access points, which pass all client data through their respective Cisco Wireless LAN Controller), if the WAN link breaks between the Cisco 1030 remote edge lightweight access point and its Cisco Wireless LAN Controller, the Cisco 1030 remote edge lightweight access point continues transmitting wireless LAN 1 client data through other Cisco 1030 remote edge lightweight access points on its local subnet. However, it cannot take advantage of features accessed from the Cisco Wireless LAN Controller, such as establishing new VLANs, until communication is reestablished.

The Cisco 1030 remote edge lightweight access point includes the traditional SOHO (small office, home office) AP processing power, and thus can continue operating if the WAN link to its associated Cisco Wireless LAN Controller fails. Because it is configured by its associated Cisco Wireless LAN Controller, it has the same wireless LAN configuration as the rest of the Cisco Wireless LAN Solution. As long as it remains connected to its Cisco Wireless LAN Controller, it varies its transmit power and channel selection under control of the RRM, and performs the same rogue access point location as any other Cisco 1000 series lightweight access point.

Note that the Cisco 1030 remote edge lightweight access point can support multiple wireless LANs while it is connected to its Cisco Wireless LAN Controller. However, when it loses connection to its Cisco Wireless LAN Controller, it supports only one wireless LAN on its local subnet.

Figure 7-2 shows a typical Cisco 1030 remote edge lightweight access point configuration:

Figure 7-2 Typical 1030 Lightweight Access Point Configuration



Note that the Cisco 1030 remote edge lightweight access point must have a DHCP server available on its local subnet, so it can obtain an IP address upon reboot. Also note that the Cisco 1030 remote edge lightweight access points at each remote location must be on the same subnet to allow client roaming.

Cisco 1000 Series Lightweight Access Point Models

The Cisco 1000 series lightweight access point includes one 802.11a and one 802.11b/g radio. The Cisco 1000 series lightweight access point is available in the following configurations:

- **AP1010**—A 1000 series access point with four high-gain internal antennas and no external antenna adapters.
- **AP1020**—A 1000 series access point with four high-gain internal antennas and one 5-GHz external antenna adapter and two 2.4-GHz external antenna adapters.
- **AP1030**—A 1030 remote edge access point with four high-gain internal antennas and one 5-GHz external antenna adapter and two 2.4-GHz external antenna adapters.

The 1000 series access point is shipped with a color-coordinated ceiling mount base and hanging-ceiling rail clips. You can also order projection- and flush-mount sheet metal wall mounting bracket kits. The base, clips, and optional brackets allow quick mounting to ceiling or wall. The access point can be powered by power over Ethernet or by an external power supply.

Cisco 1000 Series Lightweight Access Point External and Internal Antennas

The Cisco 1000 series lightweight access point enclosure contains one 802.11a or one 802.11b/g radio and four (two 802.11a and two 802.11b/g) high-gain antennas, which can be independently enabled or disabled to produce a 180-degree sectorized or 360-degree omnidirectional coverage area.

Note Cisco 1000 series lightweight access points must use the factory-supplied internal or external antennas to avoid violating FCC requirements and voiding the user's authority to operate the equipment.

Note that the wireless LAN operator can disable either one of each pair of the Cisco 1000 series lightweight access point internal antennas to produce a 180-degree sectorized coverage area. This feature can be useful, for instance, for outside-wall mounting locations where coverage is only desired inside the building, and in a back-to-back arrangement that can allow twice as many clients in a given area.

External Antenna Connectors

The AP1020 and AP1030 have male reverse-polarity TNC jacks for installations requiring factory-supplied external directional or high-gain antennas. The external antenna option can create more flexibility in Cisco 1000 series lightweight access point antenna placement.

Note The AP1010 is designed to be used exclusively with the internal high-gain antenna. It has no jacks for external antennas.

Note that the 802.11b/g 2.4 GHz Left external antenna connector is associated with the internal Side A antenna, and that the 2.4 GHz Right external antenna connector is associated with the internal Side B antenna. When you have 802.11b/g diversity enabled, the Left external or Side A internal antennas are diverse from the Right external or Side B internal antennas.

Also note that the 802.11a 5 GHz Left external antenna connector is separate from the internal antennas, and adds diversity to the 802.11a transmit and receive path. Note that no external 802.11a antennas are certified in FCC-regulated areas, but external 802.11a antennas may be certified for use in other countries.

Antenna Sectorization

Note that the Cisco WLAN Solution supports Antenna Sectorization, which can be used to increase the number of clients and/or client throughput a given air space. Installers can mount two Cisco 1000 series lightweight access points back-to-back, and the Network operator can disable the second antenna in both access points to create a 360-degree coverage area with two sectors.

Installers can also mount Cisco 1000 series lightweight access points on the periphery of a building and disable the Side B internal antennas. This configuration can be used to supply service to the building interior without extending coverage to the parking lot, at the cost of eliminating the internal antenna diversity function.

Cisco 1000 Series Lightweight Access Point LEDs

Each Cisco 1000 series lightweight access point is equipped with four LEDs across the top of the case. They can be viewed from nearly any angle. The LEDs indicate power and fault status, 2.4 GHz (802.11b/g) Cisco Radio activity, and 5 GHz (802.11a) Cisco Radio activity.

This LED display allows the wireless LAN manager to quickly monitor the Cisco 1000 series lightweight access point status. For more detailed troubleshooting instructions, refer to the hardware installation guide for the access point.

Cisco 1000 Series Lightweight Access Point Connectors

The AP1020 and AP1030 Cisco 1000 series lightweight access points have the following external connectors:

- One RJ-45 Ethernet jack, used for connecting the Cisco 1000 series lightweight access point to the network.
- One 48 VDC power input jack, used to plug in an optional factory-supplied external power adapter.
- Three male reverse-polarity TNC antenna jacks, used to plug optional external antennas into the Cisco 1000 series lightweight access point: two for an 802.11b/g radio, and one for an 802.11a radio.

Note The AP1010 Cisco 1000 Series lightweight access points are designed to be used exclusively with the internal high-gain antennas, and have no jacks for external antennas.

The Cisco 1000 series lightweight access point communicates with a Cisco Wireless LAN Controller using standard CAT-5 (Category 5) or higher 10/100 Mbps twisted pair cable with RJ-45 connectors. Plug the CAT-5 cable into the RJ-45 jack on the side of the Cisco 1000 series lightweight access point.

Note that the Cisco 1000 series lightweight access point can receive power over the CAT-5 cable from network equipment. Refer to Power over Ethernet for more information about this option.

The Cisco 1000 series lightweight access point can be powered from an optional factory-supplied external AC-to-48 VDC power adapter. If you are powering the Cisco 1000 series lightweight access point using an external adapter, plug the adapter into the 48 VDC power jack on the side of the Cisco 1000 series lightweight access point.

The Cisco 1000 series lightweight access point includes two 802.11a and two 802.11b/g high-gain internal antennas, which provide omnidirectional coverage. However, some Cisco 1000 series lightweight access points can also use optional factory-supplied external high-gain and/or directional antennas. When you are using external antennas, plug them into the male reverse-polarity TNC jacks on the side of the AP1020 and AP1030 Cisco 1000 series lightweight access points.

Note Cisco 1000 Series lightweight access points must use the factory-supplied internal or external antennas to avoid violating FCC requirements and voiding the user's authority to operate the equipment.

Cisco 1000 Series Lightweight Access Point Power Requirements

Each Cisco 1000 series lightweight access point requires a 48 VDC nominal (between 38 and 57 VDC) power source capable of providing 7 W. If you use +48 VDC, the connector is center positive. Because the power supply on the access point is isolated, a negative 48-volt supply could be used. In this case, the ground side of the supply would go to the center pole "tip," and the negative 48-volt side would go to the outside "ring" portion.

Cisco 1000 series lightweight access points can receive power from the external power supply (which draws power from a 110-220 VAC electrical outlet) plugged into the side of the access point case, or from Power over Ethernet.

Cisco 1000 Series Lightweight Access Point External Power Supply

The Cisco 1000 series lightweight access point can receive power from an external 110-220 VAC-to-48 VDC power supply or from Power over Ethernet equipment.

The external power supply plugs into a secure 110 through 220 VAC electrical outlet. The converter produces the required 48 VDC output for the Cisco 1000 series lightweight access point. The converter output feeds into the side of the Cisco 1000 series lightweight access point through a 48 VDC jack.

Note that the AIR-PWR-1000 external power supply can be ordered with country-specific electrical outlet power cords. Contact Cisco when ordering to receive the correct power cord.

Cisco 1000 Series Lightweight Access Point Mounting Options

Refer to the *Internal-Antenna AP1010 Cisco 1000 Series IEEE 802.11a/b/g Lightweight Access Point Quick Start Guide* or the *External-Antenna AP1020 and AP1030 Cisco 1000 Series IEEE 802.11a/b/g Lightweight Access Point Quick Start Guide* for the Cisco 1000 series lightweight access point mounting options.

Cisco 1000 Series Lightweight Access Point Physical Security

The side of the Cisco 1000 series lightweight access point housing includes a slot for a Kensington MicroSaver Security Cable. Refer to the Kensington website for more information about their security products, or to the *Internal-Antenna AP1010 Cisco 1000 Series IEEE 802.11a/b/g Lightweight Access Point Quick Start Guide* or *External-Antenna AP1020 and AP1030 Cisco 1000 Series IEEE 802.11a/b/g Lightweight Access Point Quick Start Guide* for installation instructions.

Cisco 1000 Series Lightweight Access Point Monitor Mode

The Cisco 1000 series lightweight access points and Cisco Wireless LAN Controllers can perform rogue access point detection and containment while providing regular service. The rogue access point detection is performed across all 801.11 channels, regardless of the Country Code selected.

However, if the administrator would prefer to dedicate specific Cisco 1000 series lightweight access points to rogue access point detection and containment, the Monitor mode should be enabled for individual Cisco 1000 series lightweight access points.

The Monitor function is set for all 802.11 Cisco Radios on a per-access point basis using any of the Cisco Wireless LAN Controller user interfaces.

Cisco Aironet 1510 Series Lightweight Outdoor Mesh Access Points

The Cisco Aironet 1510 Series Lightweight Outdoor Mesh Access Point (hereafter called *AP1510*) is a wireless device designed for wireless client access and point-to-point bridging, point-to-multipoint bridging, and point-to-multipoint mesh wireless connectivity. The outdoor access point is a standalone unit that can be mounted on a wall or overhang, on a rooftop pole, or on a street light pole.

It is a self-contained outdoor unit that can be configured with a wired backhaul connection to an Ethernet segment for a rooftop deployment or with a wireless backhaul for a pole-top deployment. The AP1510 can be installed anywhere power is available, without the need for a network connection. Using the Cisco Adaptive Wireless Path Protocol (AWPP), the AP1510 is able to dynamically optimize the best route to the connected network within the mesh.

The AP1510 operates with controllers to provide centralized and scalable management, high security, and mobility. Designed to support zero-configuration deployments, the AP1510 easily and securely joins the mesh network and is available to manage and monitor the network through the controller GUI or CLI.

The AP1510 is equipped with two simultaneously operating radios: a 2.4-GHz radio used for client access and a 5-GHz radio used for data backhaul to other AP1510s. A wide variety of antennas are available that provide flexibility when deploying the AP1510 over various terrains. Wireless LAN client traffic passes through the access point's backhaul radio or is relayed through other AP1510s until it reaches the controller Ethernet connection.

Note For more information on the AP1510, refer to the quick start guide and hardware installation guide for this access point. You can find these documents at this URL: http://www.cisco.com/en/US/products/ps6548/tsd_products_support_series_home.html

Wireless Mesh

In a wireless mesh deployment (see Figure 7-3), multiple AP1510s are deployed as part of the same network. One or more AP1510s have a wired connection to the controller and are designated as *root access points (RAPs)*. Other AP1510s that relay their wireless connections to connect to the controller are called *mesh access points (MAPs)*. The MAPs use the AWPP protocol to determine the best path through the other AP1510s to the controller. The possible paths between the MAPs and RAPs form the wireless mesh that is used to carry traffic from wireless LAN clients connected to MAPs and to carry traffic from devices connected to MAP Ethernet ports.

The mesh network can carry two types of traffic simultaneously: wireless LAN client traffic and MAP bridge traffic. Wireless LAN client traffic terminates on the controller, and MAP bridge traffic terminates on the Ethernet ports of the AP1510s. You need to keep in mind three important concepts when considering the configuration of a mesh network:

- **Sector**—A collection of mesh access points connected together by the AWPP and through a single RAP to the controller.
- **Network**—A collection of sectors that cover a proximate geographic area.
- **Controller subnet service set**—A collection of controllers on a subnet servicing one or more sectors.

Membership in the mesh network is controlled in a variety of ways:

- Each AP1510 MAC address must be entered into the MAC filter list database to ensure that the access points are authorized to use the controller. Each controller to which the access point may connect must have its MAC address entered into the database.

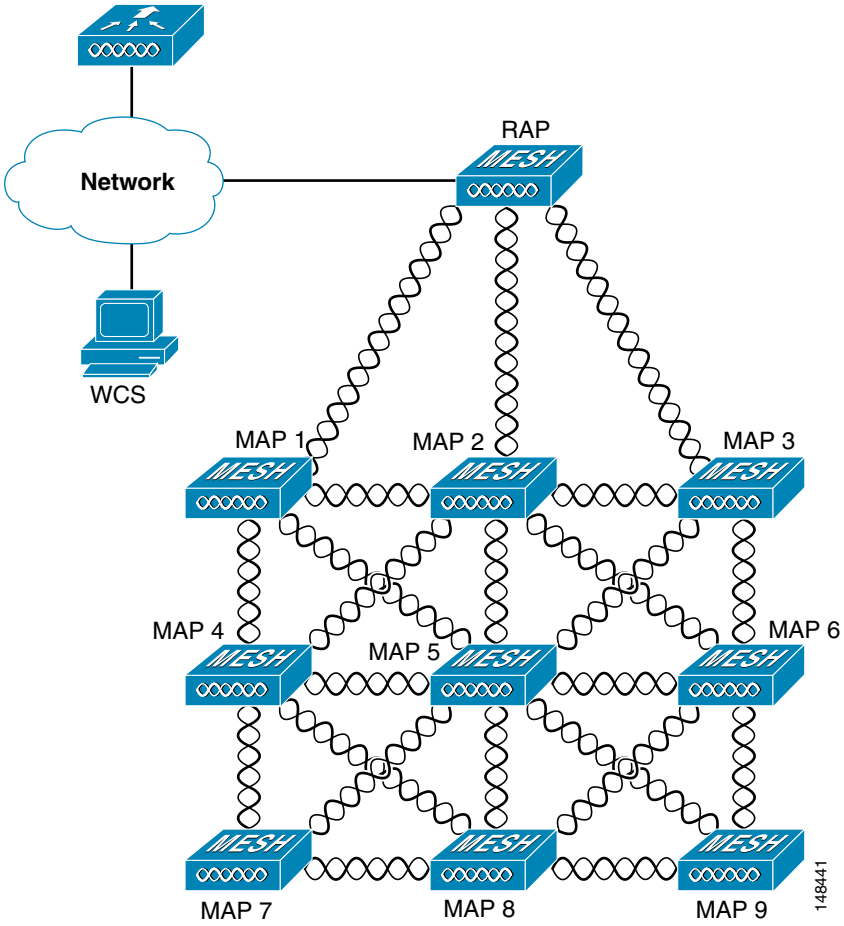
  The MAC filter list works in conjunction with the certificate that is stored in the access point's nonvolatile memory to provide strong security for access points connecting to the network. As such, the MAC filter list is required for mesh access points to be able to connect to the controller.

  Note The MAC filter lists of all controllers on a controller subnet service set must be identical and include all the RAPs and MAPs that may connect on that subnet. Failure to have uniform MAC filter lists on the service set may prevent access points from being able to communicate.

- AP1510s are configured with a shared secret for secure access point-to-access point communication over the backhaul. In order to communicate, all radios in the network must have the same shared secret.
- A bridge group name can be used to logically group access points into sectors. Each sector has a unique bridge group name. Cisco recommends that you use bridge group names whenever multiple sectors are proximate.

  An access point that is unable to connect to a sector with its bridge group name temporarily connects to the sector with the best RF characteristics so that its bridge group name can be configured. The access point connects for short periods of time only (roughly 30 minutes) and then disconnects to seek the sector with the correct bridge group name. When an access point connects to the network using a mismatched bridge group name, the parent access point does not allow it to accept children access points or clients.

Figure 7-3 Wireless Mesh Deployment



Configuring and Deploying the AP1510

Note For information on planning and initially configuring your Cisco mesh network, refer to the *Cisco Mesh Networking Solution Deployment Guide*. You can find this document at this URL: http://www.cisco.com/en/US/products/ps6548/prod_technical_reference_list.html

Before deploying the AP1510, you must perform three procedures on the controller to ensure proper operation:

- Add the MAC address of the access point to the controller filter list, page 7-12
- Configure mesh parameters, page 7-14
- Configure bridging parameters, page 7-16

Adding the MAC Address of the Access Point to the Controller Filter List

You must add the MAC address of the access point to the controller filter list in order for the access point to be able to associate to the controller. This process ensures that the access point is included in the database of access points authorized to use the controller. You can add the access point using either the GUI or the CLI.

Note You can also download the list of access point MAC addresses and push them to the controller using the Cisco Wireless Control System (WCS). Refer to the *Cisco Wireless Control System Configuration Guide* for instructions.

Using the GUI to Add the MAC Address of the Access Point to the Controller Filter List

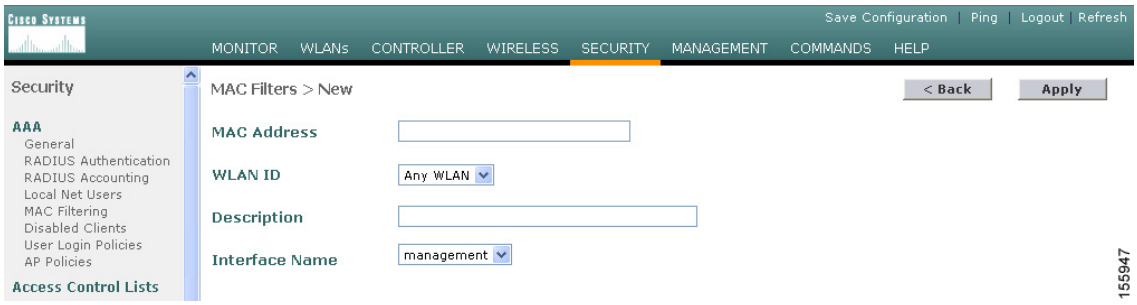
Follow these steps to add a MAC filter entry for the access point on the controller using the controller GUI.

Step 1 Click **Security** and then **MAC Filtering** under AAA. The MAC Filtering page appears (see Figure 7-4).

Figure 7-4 MAC Filtering Page

Step 2 Click **New**. The MAC Filters > New page appears (see Figure 7-5).

Figure 7-5 MAC Filters > New Page



Step 3 In the MAC Address field, enter the MAC address of the access point.

Step 4 From the WLAN ID drop-down box, choose "Any WLAN."

Step 5 In the Description field, enter a description of the access point. The text that you enter identifies the access point on the controller. You may want to include an abbreviated name and the last few digits of the MAC address, such as ap1510:62:39:10.

Step 6 From the Interface Name drop-down box, choose the controller interface to which the access point is to connect.

Step 7 Click **Apply** to commit your changes. The access point now appears in the list of MAC filters on the MAC Filtering page.

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

Step 9 Repeat this procedure to add the MAC addresses of additional access points to the list.

Using the CLI to Add the MAC Address of the Access Point to the Controller Filter List

Follow these steps to add a MAC filter entry for the access point on the controller using the controller CLI.

Step 1 To add the MAC address of the access point to the controller filter list, enter this command:

config macfilter add *ap_mac wlan_id interface* [*description*]

A value of zero (0) for the *wlan_id* parameter specifies any WLAN, and a value of zero (0) for the *interface* parameter specifies none. You can enter up to 32 characters for the optional *description* parameter.

Step 2 To save your changes, enter this command:

save config

Configuring Mesh Parameters

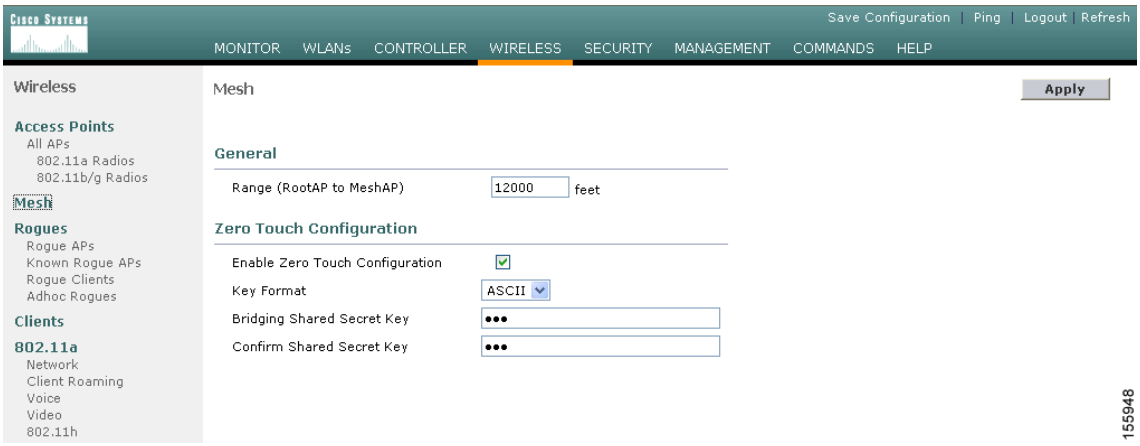
This section provides instructions for configuring the access point to establish a connection with the controller. You can configure the necessary mesh parameters using either the GUI or the CLI.

Using the GUI to Configure Mesh Parameters

Follow these steps to configure mesh parameters using the controller GUI.

Step 1 Click **Wireless** and **Mesh** to access the Mesh page (see Figure 7-6).

Figure 7-6 Mesh Page



Step 2 In the Range field, enter the maximum range (in feet) of all access points in the network. This global parameter applies to all access points joined to the controller, all connected access points in the network, and all new access points upon connecting.

Range: 150 to 132,000 feet

Default: 12,000 feet

Note Cisco recommends that you set all controllers in the mesh network to the same value.

Step 3 Check the **Enable Zero Touch Configuration** check box to enable the access points to get the shared secret key from the controller. If you uncheck the check box, the controller does not provide the shared secret key, and the access points use a default pre-shared key for secure communication. The default value is enabled (or checked).

Step 4 If you enabled zero-touch configuration, the controller automatically fills in the key format (ASCII or hexadecimal) and the shared secret key. This key enables the access points to establish a connection with the controller. It also enables the access points to communicate with other access points in the same bridge group upon installation. If desired, you can change the shared secret key. When you do so, the access points lose connectivity until they are able to negotiate the new shared secret key from the controller.

Note If you change the shared secret key while the access point is not associated to the controller, an "Invalid bridge key hash" error message appears. To clear this error, set the shared secret back to the default value "youshouldsetme." To change the shared secret, you must first enable zero-touch configuration.

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

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

Using the CLI to Configure Mesh Parameters

Follow these steps to configure mesh parameters using the controller CLI.

Step 1 To enter the maximum range (in feet) of all access points in the network, enter this command:

config mesh range *feet*

You can enter a value between 150 and 132,000 feet for the *feet* parameter. The default value is 12,000 feet. This command applies to all access points joined to the controller, all connected access points in the network, and all new access points upon connecting. To see the current range, enter **show mesh range**.

Step 2 To enable zero-touch configuration, enter this command:

config network zero-config

This command enables the access points to get the shared secret key from the controller. If you do not enable zero-touch configuration, the controller does not provide the shared secret key, and the access points use a default pre-shared key for secure communication.

Step 3 If you enabled zero-touch configuration, the controller automatically provides the shared secret key that enables the access points to establish a connection with the controller. It also enables the access points to communicate with other access points in the same bridge group upon installation. If desired, you can change the shared secret key by entering this command:

config network bridging-shared-secret *shared_secret*

After you enter this command, the access points lose connectivity until they are able to negotiate the new shared secret key from the controller.

Step 4 To save your changes, enter this command:

save config

Step 5 Use these commands to obtain information on your mesh access points:

- **show mesh summary** *Cisco_AP*— Displays the mesh configuration for the specified access point.
- **show mesh stats** *Cisco_AP*—Displays the mesh statistics for the specified access point.
- **show mesh neigh** *Cisco_AP*—Displays the mesh neighbors for the specified access point.
- **show mesh path** *Cisco_AP*—Displays the mesh path for the specified access point.

Configuring the Mesh Security Timer

Beginning with controller software release 4.0.206.0, you can configure a security timer for the mesh access point (MAP) with regard to the bridge shared secret. Once the timer is configured, the MAP will only attempt to join a network with the same bridge shared secret for a specified period of time (for example, 10 hours). To eliminate access point stranding, the MAP starts to use PMK after the timer expires. The timer gives the MAP enough buffered time (up to 24 hours) to rejoin the correct network in case of any scheduled or unscheduled network downtime.

Follow these steps to configure the mesh security timer using the controller CLI.

Step 1 To see your current network settings, enter this command:

show network

Step 2 Make sure that Allow Old Bridging APs to Authenticate is disabled.

Step 3 Make sure that the default bridge shared secret is not set to "youshouldsetme."

Step 4 To configure the mesh security timer, enter this command:

config mesh security-timer *timer*

where *timer* is a value between 0 and 24 hours.

After you enter this command, all of the MAPs reboot with the security timer set.

Step 5 To see the length of time set for the mesh security timer, enter this command:

show mesh security-timer

Information similar to the following appears:

```
Bridge Security Timer:    10 hour(s)
```

Note If you change the bridge shared secret, the MAPs do not re-join the network until the security timer expires. Setting the security timer to zero (0) allows the bridge shared secret to be changed without delay. However, changing the security timer on an operational system may cause the MAPs to reboot.

Configuring Bridging Parameters

This section provides instructions for configuring the access point's role in the mesh network and related bridging parameters. You can configure these parameters using either the GUI or the CLI.

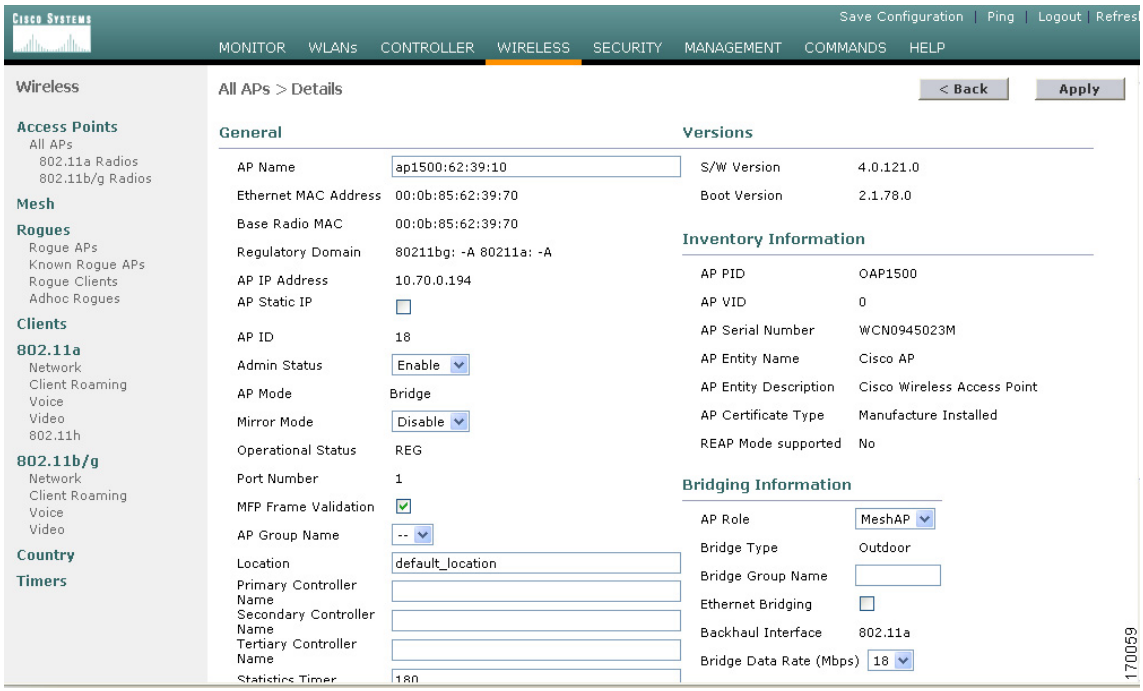
Using the GUI to Configure Bridging Parameters

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

Step 1 Click **Wireless** and then **All APs** under Access Points. The All APs page appears.

Step 2 Click the **Detail** link for your AP1510 to access the All APs > Details page (see Figure 7-7).

Figure 7-7 All APs > Details Page



On this page, the AP Mode under General is automatically set to Bridge for access points that have bridge functionality, such as the AP1510. This page also shows the following information under Bridging Information:

- The bridge type, which specifies whether the access point is designed for indoor or outdoor use. This field is set to Outdoor for the AP1510.
- The backhaul interface, or the radio band that this access point uses to transfer data to other AP1510s. The only possible value is 802.11a.

Step 3 Under Bridging Information, choose one of the following options to specify the role of this access point in the mesh network:

- **MeshAP**—Choose this option if the AP1510 has a wireless connection to the controller. This is the default setting in software release 4.0.
- **RootAP**—Choose this option if the AP1510 has a wired connection to the controller.

Note If you upgrade to software release 4.0 from a previous release, your root access points default to the MeshAP role. You must reconfigure them for the RootAP role.

Note You must set the root access point to RootAP. Otherwise, a mesh network is not created.

Step 4 To assign this AP1510 to a bridge group, enter a name for the group in the Bridge Group Name field.

Step 5 Check the **Ethernet Bridging** check box if you want to enable Ethernet bridging on the access point. Otherwise, uncheck this check box. The default setting is disabled (or unchecked).

Note You must enable bridging on all access points for which you want to allow bridging, including the RAP. Therefore, if you want to allow an Ethernet on a MAP to bridge to the RAP's Ethernet, you must enable bridging on the RAP as well as the MAP.

Step 6 From the Bridge Data Rate drop-down box, choose a value (in Mbps) for the rate at which data is shared between access points on the backhaul interface. The default value is 18 Mbps for the 802.11a backhaul interface.

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

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

Using the CLI to Configure Bridging Parameters

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

Step 1 To specify that your AP1510 has bridge functionality, enter this command:

config ap mode bridge *Cisco_AP*

Step 2 To specify the role of this access point in the mesh network, enter this command:

config ap role {**rootAP** | **meshAP**} *Cisco_AP*

Use the **meshAP** parameter if the AP1510 has a wireless connection to the controller (this is the default setting in software release 4.0), or use the **rootAP** parameter if the AP1510 has a wired connection to the controller.

Note If you upgrade to software release 4.0 from a previous release, your root access points default to the meshAP role. You must reconfigure them for the rootAP role.

Step 3 To assign this AP1510 to a bridge group, enter this command:

config ap bridgegroupname set *groupname Cisco_AP*

Step 4 To specify the rate (in Kbps) at which data is shared between access points on the backhaul interface, enter this command:

config ap bhrate *rate Cisco_AP*

The default value is 18 Kbps for the 802.11a backhaul interface.

Step 5 To save your settings, enter this command:

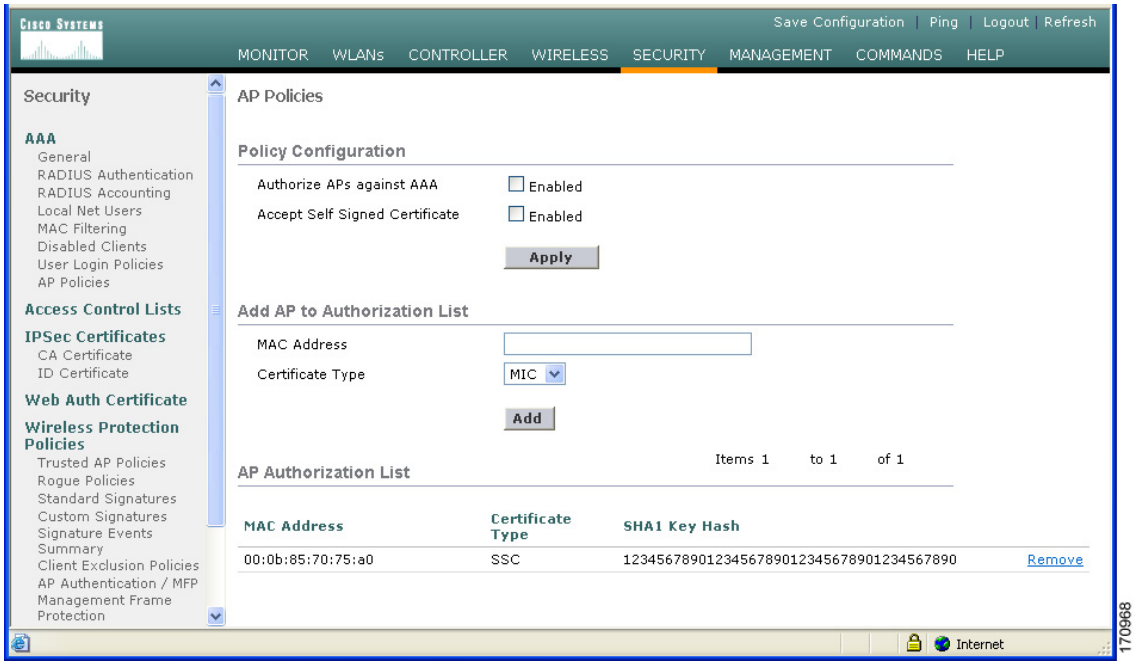
save config

Autonomous Access Points Converted to Lightweight Mode

You can use an upgrade conversion tool to convert autonomous Cisco Aironet 1100, 1130AG, 1200, 1240AG, and 1300 Series Access Points to lightweight mode. When you upgrade one of these access points to lightweight mode, the access point communicates with a controller and receives a configuration and software image from the controller.

Note The conversion tool adds the self-signed certificate (SSC) key-hash to only one of the controllers on the Cisco WiSM. After the conversion has been completed, add the SSC key-hash to the second controller on the Cisco WiSM by copying the SSC key-hash from the first controller to the second controller. To copy the SSC key-hash, open the AP Policies page of the controller GUI (Security > AAA > AP Policies) and copy the SSC key-hash from the SHA1 Key Hash column under AP Authorization List (see Figure 7-8). Then, using the second controller's GUI, open the same page and paste the key-hash into the SHA1 Key Hash field under Add AP to Authorization List. If you have more than one Cisco WiSM, use WCS to push the SSC key-hash to all the other controllers.

Figure 7-8 Security > AAA > AP Policies Page



Refer to the *Upgrading Autonomous Cisco Aironet Access Points to Lightweight Mode* document for instructions on upgrading an autonomous access point to lightweight mode. You can find this document at this URL:

http://cisco-images.cisco.com/en/US/docs/wireless/access_point/conversion/lwapp/upgrade/guide/lwapnote.html

Guidelines for Using Access Points Converted to Lightweight Mode

Keep these guidelines in mind when you use autonomous access points that have been converted to lightweight mode:

- Converted access points support 2006, and 4400, and WiSM controllers only. When you convert an autonomous access point to lightweight mode, the access point can communicate with Cisco 2006 series controllers, and 4400 series controllers, or the controllers on a WiSM only.
- Access points converted to lightweight mode do not support Wireless Domain Services (WDS). Converted access points communicate only with Cisco wireless LAN controllers and cannot communicate with WDS devices. However, the controller provides functionality equivalent to WDS when the access point associates to it.
- Access points converted to LWAPP mode support 8 BSSIDs per radio and a total of 8 wireless LANs per access point. (Cisco 1000 series access points support 16 BSSIDs per radio and 16 wireless LANs per access point.) When a converted access point associates to a controller, only wireless LANs with IDs 1 through 8 are pushed to the access point.
- Access points converted to lightweight mode do not support Layer 2 LWAPP. Access Points converted to lightweight mode must get an IP address and discover the controller using DHCP, DNS, or IP subnet broadcast.
- After you convert an access point to lightweight mode, the console port provides read-only access to the unit.
- The 1130AG and 1240AG access points support hybrid-REAP mode. See Chapter 12 for details.

Reverting from Lightweight Mode to Autonomous Mode

After you use the upgrade tool to convert an autonomous access point to lightweight mode, you can convert the access point from a lightweight unit back to an autonomous unit by loading a Cisco IOS release that supports autonomous mode (Cisco IOS release 12.3(7)JA or earlier). If the access point is associated to a controller, you can use the controller to load the Cisco IOS release. If the access point is not associated to a controller, you can load the Cisco IOS release using TFTP. In either method, the access point must be able to access a TFTP server that contains the Cisco IOS release to be loaded.

Using a Controller to Return to a Previous Release

Follow these steps to revert from lightweight mode to autonomous mode using a wireless LAN controller:

Step 1 Log into the CLI on the controller to which the access point is associated.

Step 2 Enter this command:

config ap tftp-downgrade *tftp-server-ip-address filename access-point-name*

Step 3 Wait until the access point reboots and reconfigure the access point using the CLI or GUI.

Using the MODE Button and a TFTP Server to Return to a Previous Release

Follow these steps to revert from lightweight mode to autonomous mode by using the access point MODE (reset) button to load a Cisco IOS release from a TFTP server:

Step 1 The PC on which your TFTP server software runs must be configured with a static IP address in the range of 10.0.0.2 to 10.0.0.30.

Step 2 Make sure that the PC contains the access point image file (such as *c1200-k9w7-tar.123-7.JA.tar* for a 1200 series access point) in the TFTP server folder and that the TFTP server is activated.

Step 3 Rename the access point image file in the TFTP server folder to **c1200-k9w7-tar.default** for a 1200 series access point.

Step 4 Connect the PC to the access point using a Category 5 (CAT5) Ethernet cable.

Step 5 Disconnect power from the access point.

Step 6 Press and hold the **MODE** button while you reconnect power to the access point.

Note The MODE button on the access point must be enabled. Follow the steps in the "Disabling the Reset Button on Access Points Converted to Lightweight Mode" section on page 7-24 to check the status of the access point MODE button.

Step 7 Hold the **MODE** button until the status LED turns red (approximately 20 to 30 seconds), and release the MODE button.

Step 8 Wait until the access point reboots as indicated by all LEDs turning green followed by the Status LED blinking green.

Step 9 After the access point reboots, reconfigure the access point using the GUI or the CLI.

Access Point Authorization

Depending on whether access points have manufacturing-installed certificates (MICs), the controller may either use self-signed certificates (SSCs) to authenticate access points or send the authorization information to a RADIUS server.

Controllers Accept SSCs from Access Points Converted to Lightweight Mode

The lightweight access point protocol (LWAPP) secures the control communication between the access point and controller by means of a secure key distribution requiring X.509 certificates on both the access point and controller. LWAPP relies on a priori provisioning of the X.509 certificates. Cisco Aironet access points shipped before July 18, 2005 do not have a MIC, so these access points create an SSC when upgraded to operate in lightweight mode. Controllers are programmed to accept local SSCs for authentication of specific access points and do not forward those authentication requests to a RADIUS server. This behavior is acceptable and secure.

Using DHCP Option 43

Cisco 1000 series access points use a string format for DHCP option 43, whereas Cisco Aironet access points use the type-length-value (TLV) format for DHCP option 43. DHCP servers must be programmed to return the option based on the access point's DHCP Vendor Class Identifier (VCI) string (DHCP Option 60). Table 7-1 lists the VCI strings for Cisco access points capable of operating in lightweight mode.

Table 7-1 VCI Strings For Lightweight Access Points

Access Point	VCI String
Cisco 1000 Series	Airespace 1200
Cisco Aironet 1130 Series	Cisco AP c1130
Cisco Aironet 1200 Series	Cisco AP c1200
Cisco Aironet 1240 Series	Cisco AP c1240

This is the format of the TLV block:

- Type: 0xf1 (decimal 241)
- Length: Number of controller IP addresses * 4
- Value: List of the IP addresses of controller management interfaces

Refer to the product documentation for your DHCP server for instructions on configuring DHCP option 43. The *Upgrading Autonomous Cisco Aironet Access Points to Lightweight Mode* document contains example steps for configuring option 43 on a DHCP server.

Using a Controller to Send Debug Commands to Access Points Converted to Lightweight Mode

Enter this command to enable the controller to send debug commands to an access point converted to lightweight mode:

config ap remote-debug [**enable** | **disable** | **exc-command**] *Cisco_AP*

When this feature is enabled, the controller sends debug commands to the converted access point as character strings. You can send any debug command supported by Cisco Aironet access points that run Cisco IOS software in lightweight mode.

Converted Access Points Send Crash Information to Controller

When a converted access point unexpectedly reboots, the access point stores a crash file on its local flash memory at the time of crash. After the unit reboots, it sends the reason for the reboot to the controller. If the unit rebooted because of a crash, the controller pulls up the crash file using existing LWAPP messages and stores it in the controller flash memory. The crash info copy is removed from the access point flash memory when the controller pulls it from the access point.

Converted Access Points Send Radio Core Dumps to Controller

When a radio module in a converted access point generates a core dump, the access point stores the core dump file of the radio on its local flash memory at the time of the radio crash. It sends a notification message to the controller indicating which radio generated a core dump file. The controller sends a trap alerting the network administrator, and the administrator can retrieve the radio core file from the access point.

On the controller CLI, enter this command to pull the core file from the access point:

config ap get-radio-core-dump *slot ap-name*

For *slot*, enter the radio interface number on the access point.

The retrieved core file is stored in the controller flash and can subsequently be uploaded through TFTP to an external server for analysis. The core file is removed from the access point flash memory when the controller pulls it from the access point.

Enabling Memory Core Dumps from Converted Access Points

By default, access points converted to lightweight mode do not send memory core dumps to the controller. To enable this feature, enter this command:

config ap core-dump enable *tftp-server-ip-address filename* {**compress** | **uncompress**} {*ap-name* | **all**}

- For *tftp-server-ip-address*, enter the IP address of the TFTP server to which the access point sends core files. The access point must be able to reach the TFTP server.
- For *filename*, enter a filename that the access points uses to label the core file.
- Enter **compress** to configure the access point to send compressed core files. Enter **uncompress** to configure the access point to send uncompressed core files.
- For *ap-name*, enter the name of a specific access point, or enter **all** to enable memory core dumps from all access points converted to lightweight mode.

Display of MAC Addresses for Converted Access Points

There are some differences in the way that controllers display the MAC addresses of converted access points on information pages in the controller GUI:

- On the AP Summary page, the controller lists the Ethernet MAC addresses of converted access points.
- On the AP Detail page, the controller lists the BSS MAC addresses and Ethernet MAC addresses of converted access points.
- On the Radio Summary page, the controller lists converted access points by radio MAC address.

Disabling the Reset Button on Access Points Converted to Lightweight Mode

You can disable the reset button on access points converted to lightweight mode. The reset button is labeled MODE on the outside of the access point.

Use this command to disable or enable the reset button on one or all converted access points associated to a controller:

config ap reset-button {**enable** | **disable**} {*ap-name* | **all**}

The reset button on converted access points is enabled by default.

Configuring a Static IP Address on an Access Point Converted to Lightweight Mode

After an access point converted to lightweight mode associates to a controller, enter this command to configure a static IP address on the access point:

config ap static-ip enable *ap-name ip-address mask gateway*

Note If you configure an access point to use a static IP address that is not on the same subnet on which the access point's previous DHCP address was, the access point falls back to a DHCP address after the access point reboots. If the access point falls back to a DHCP address, the **show ap config general** *ap-name* CLI command correctly shows that the access point is using a fallback IP address. However, the GUI shows both the static IP address and the DHCP address, but it does not identify the DHCP address as a fallback address.

Dynamic Frequency Selection

The Cisco UWN Solution complies with regulations that require radio devices to use Dynamic Frequency Selection (DFS) to detect radar signals and avoid interfering with them.

When a lightweight access point with a 5-GHz radio operates on one of the 15 channels listed in Table 7-2, the controller to which the access point is associated automatically uses DFS to set the operating frequency.

When you manually select a channel for DFS-enabled 5-GHz radios, the controller checks for radar activity on the channel for 60 seconds. If there is no radar activity, the access point operates on the channel you selected. If there is radar activity on the channel you selected the controller automatically selects a different channel, and after 30 minutes, the access point re-tries the channel you selected.

Note The Rogue Location Detection Protocol (RLDP) is not supported on the channels listed in Table 7-2.

Note The maximum legal transmit power is greater for some 5-GHz channels than for others. When it randomly selects a 5-GHz channel on which power is restricted, the controller automatically reduces transmit power to comply with power limits for that channel.

Table 7-2 5-GHz Channels on Which DFS is Automatically Enabled

52 (5260 MHz)	104 (5520 MHz)	124 (5620 MHz)
56 (5280 MHz)	108 (5540 MHz)	128 (5640 MHz)
60 (5300 MHz)	112 (5560 MHz)	132 (5660 MHz)
64 (5320 MHz)	116 (5580 MHz)	136 (5680 MHz)
100 (5500 MHz)	120 (5600 MHz)	140 (5700 MHz)

Using DFS, the controller monitors operating frequencies for radar signals. If it detects radar signals on a channel, the controller takes these steps:

- It changes the access point channel to a channel that has not shown radar activity. The controller selects the channel at random.
- If the channel selected is one of the channels in Table 7-2, it scans the new channel for radar signals for 60 seconds. If there are no radar signals on the new channel, the controller accepts client associations.
- It records the channel that showed radar activity as a radar channel and prevents activity on that channel for 30 minutes.
- It generates a trap to alert the network manager.

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

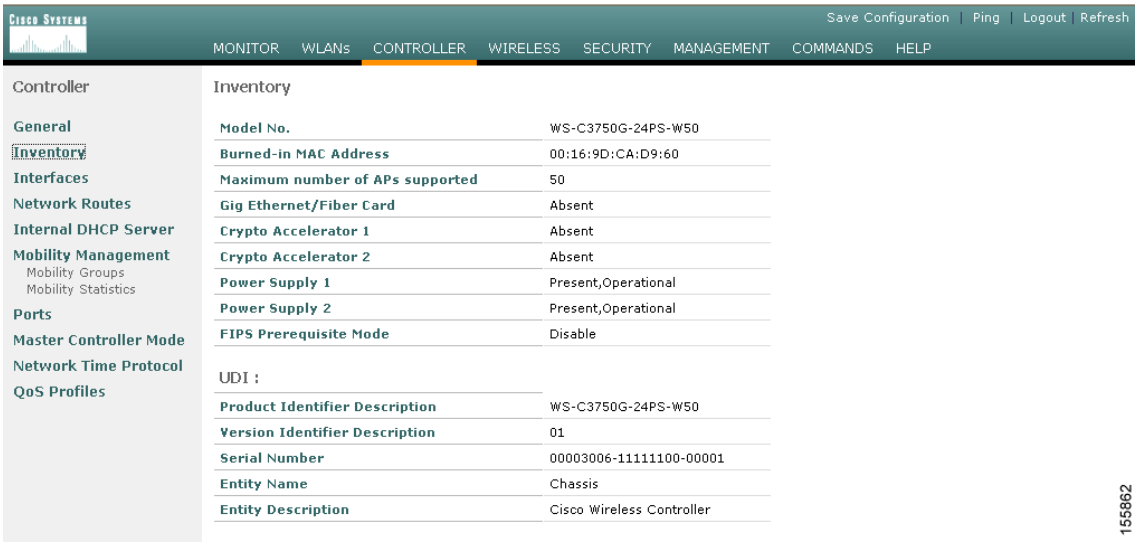
The UDI is burned into the EEPROM of controllers and lightweight access points at the factory. It can be retrieved through either the GUI or the CLI.

Using the GUI to Retrieve the Unique Device Identifier on Controllers and Access Points

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

Step 1 Click **Controller** > **Inventory** to access the Inventory page (see Figure 7-9).

Figure 7-9 Inventory Page

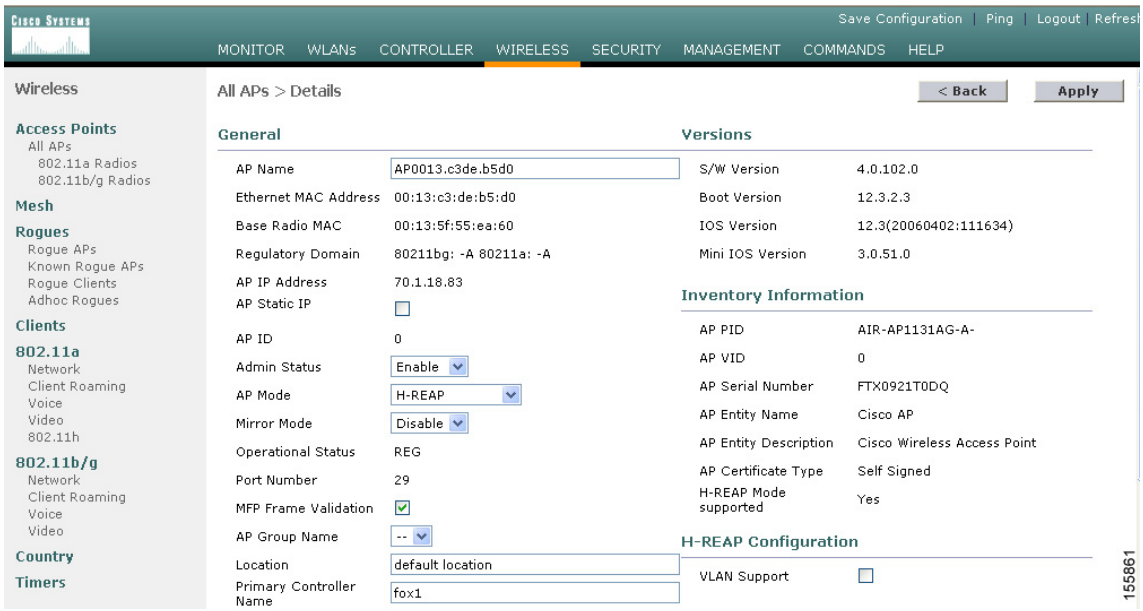


This page shows the five data elements of the controller UDI.

Step 2 Click **Wireless** to access the All APs page.

Step 3 Click the **Detail** link for the desired access point. The All APs > Details page appears (see Figure 7-10).

Figure 7-10 All APs > Details Page



This page shows the five data elements of the access point UDI under Inventory Information.

Using the CLI to Retrieve the Unique Device Identifier on Controllers and Access Points

Enter these commands to retrieve the UDI on controllers and access points using the CLI:

- **show inventory**—Shows the UDI string of the controller. Information similar to the following appears:

```
NAME: "Chassis"    , DESCR: "Cisco Wireless Controller"
PID: WS-C3750G-24PS-W24,  VID: V01,  SN: FLS0952H00F
```

- **show inventory ap** *ap_id*—Shows the UDI string of the access point specified.

Performing a Link Test

A link test is used to determine the quality of the radio link between two devices. Two types of link-test packets are transmitted during a link test: request and response. Any radio receiving a link-test request packet fills in the appropriate fields and echoes the packet back to the sender with the response type set.

The radio link quality in the client-to-access point direction can differ from that in the access point-to-client direction due to the asymmetrical distribution of transmit power and receive sensitivity on both sides. Two types of link tests can be performed: a ping test and a CCX link test.

With the *ping link test*, the controller can test link quality only in the client-to-access point direction. The RF parameters of the ping reply packets received by the access point are polled by the controller to determine the client-to-access point link quality.

With the *CCX link test*, the controller can also test the link quality in the access point-to-client direction. The controller issues link-test requests to the client, and the client records the RF parameters [received signal strength indicator (RSSI), signal-to-noise ratio (SNR), etc.] of the received request packet in the response packet. Both the link-test requestor and responder roles are implemented on the access point and controller. Therefore, not only can the access point or controller initiate a link test to a CCX v4 client, but a CCX v4 client can initiate a link test to the access point or controller.

The controller shows these link-quality metrics for CCX link tests in both directions (out: access point to client; in: client to access point):

- Signal strength in the form of RSSI (minimum, maximum, and average)
- Signal quality in the form of SNR (minimum, maximum, and average)
- Total number of packets that are retried
- Maximum retry count for a single packet
- Number of lost packets
- Data rate of a successfully transmitted packet

The controller shows this metric regardless of direction:

- Link test request/reply round-trip time (minimum, maximum, and average)

The 4.0 release of controller software supports CCX versions 1 through 4. CCX support is enabled automatically for every WLAN on the controller and cannot be disabled. The controller stores the CCX version of the client in its client database and uses it to limit the features for this client. If a client does not support CCX v4, the controller performs a ping link test on the client. If a client supports CCX v4, the controller performs a CCX link test on the client. If a client times out during a CCX link test, the controller switches to the ping link test automatically. See the "Configuring Quality of Service Profiles" section on page 6-19 for more information on CCX.

Note CCX is not supported on the AP1030.

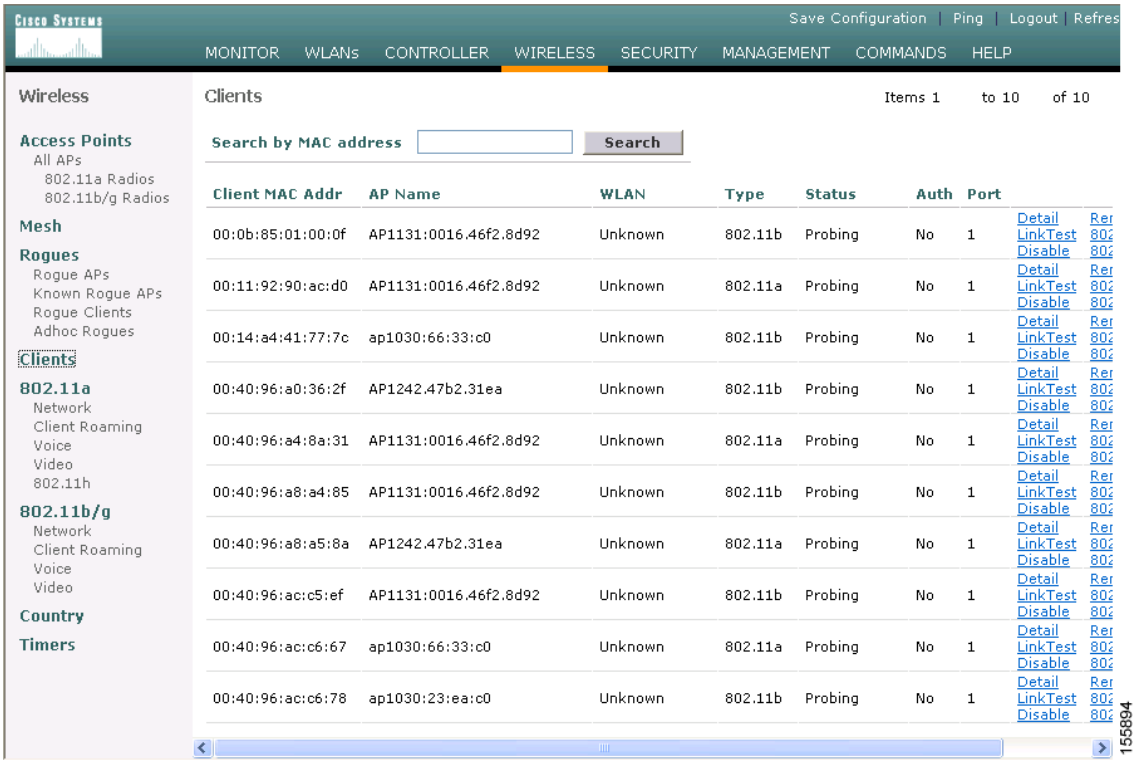
Follow the instructions in this section to perform a link test using either the GUI or the CLI.

Using the GUI to Perform a Link Test

Follow these steps to run a link test using the GUI.

Step 1 Click **Wireless** > **Clients** to access the Clients page (see Figure 7-11).

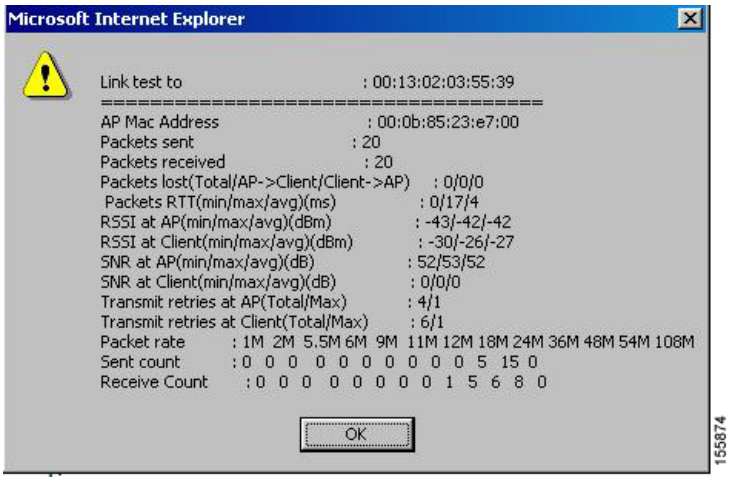
Figure 7-11 Clients Page



Step 2 Click the **LinkTest** link for the desired client. A link test page appears (see Figure 7-12).

Note You can also access this screen by clicking the **Detail** link for the desired client and then clicking the **Link Test** button on the top of the Clients > Detail page.

Figure 7-12 Link Test Page



This page shows the results of the CCX link test.

Note If the client and/or controller does not support CCX v4, the controller performs a ping link test on the client instead, and a much more limited link test page appears.

Step 3 Click **OK** to exit the link test page.

Using the CLI to Perform a Link Test

Use these commands to run a link test using the CLI.

1. To run a link test, enter this command:

   linktest *ap_mac*

   When CCX v4 is enabled on both the controller and the client being tested, information similar to the following appears:

```
CCX Link Test to 00:0d:88:c5:8a:d1.
     Link Test Packets Sent..................................... 20
     Link Test Packets Received................................. 10
     Link Test Packets Lost (Total/AP to Client/Client to AP).... 10/5/5
     Link Test Packets round trip time (min/max/average)........ 5ms/20ms/15ms
     RSSI at AP (min/max/average)............................... -60dBm/-50dBm/-55dBm
     RSSI at Client (min/max/average)........................... -50dBm/-40dBm/-45dBm
     SNR at AP (min/max/average)................................ 40dB/30dB/35dB
     SNR at Client (min/max/average)............................ 40dB/30dB/35dB
     Transmit Retries at AP (Total/Maximum)..................... 5/3
     Transmit Retries at Client (Total/Maximum)................. 4/2
     Transmit rate:  1M   2M   5.5M   6M   9M  11M 12M 18M   24M   36M  48M  54M  108M
     Packet Count:   0     0     0    0    0    0   0   0     0     2    0   18     0
     Transmit rate:  1M   2M   5.5M   6M   9M  11M 12M 18M   24M   36M  48M  54M  108M
     Packet Count:   0     0     0    0    0    0   0   0     0     2    0    8     0
```

When CCX v4 is not enabled on either the controller or the client being tested, fewer details appear:

```
Ping Link Test to 00:0d:88:c5:8a:d1.
        Link Test Packets Sent..... 20
        Link Test Packets Received..... 20
        Local Signal Strength..... -49dBm
        Local Signal to Noise Ratio..... 39dB
```

2. To adjust the link-test parameters that are applicable to both the CCX link test and the ping test, enter these commands from config mode:

   config > **linktest frame-size** *size_of_link-test_frames*

   config > **linktest num-of-frame** *number_of_link-test_request_frames_per_test*

Configuring Cisco Discovery Protocol

Cisco Discovery Protocol (CDP) is a device discovery protocol that runs on all Cisco-manufactured equipment. A device enabled with CDP sends out periodic interface updates to a multicast address in order to make itself known to neighboring devices.

The default value for the frequency of periodic transmissions is 60 seconds, and the default advertised time-to-live value is 180 seconds. The second and latest version of the protocol, CDPv2, introduces new time-length-values (TLVs) and provides a reporting mechanism that allows for more rapid error tracking, thereby reducing down time.

CDPv1 and CDPv2 are supported on the following devices:

- 2000, 2100 and 4400 series controllers

  Note CDP is not supported on the controllers that are integrated into Cisco switches and routers, including those in the Catalyst 3750G Integrated Wireless LAN Controller Switch, the Cisco WiSM and the Cisco 28/37/38xx Series Integrated Services Router.

- LWAPP-enabled access points
- 1000 series access points that run VxWorks
- An access point connected directly to a 2000 or 2100 series controller

This support enables network management applications to discover Cisco devices.

These TLVs are supported by both the controller and the access point:

- **Device-ID TLV: 0x0001**—The host name of the controller or the access point.
- **Address TLV: 0x0002**—The IP address of the controller or the access point.
- **Port-ID: 0x0003**—The name of the interface on which CDP packets are sent out.
- **Capabilities TLV: 0x0004**—The capabilities of the device. The controller sends out this TLV with a value of Host: 0x10, and the access point sends out this TLV with a value of Transparent Bridge: 0x02.

- **Version TLV: 0x0005**—The software version of the controller or the access point.
- **Platform TLV: 0x0006**—The hardware platform of the controller or the access point.

This TLV is supported only by the access point:

- **Full/Half Duplex TLV: 0x000b**—The full- or half-duplex mode of the Ethernet link on which the CDP packet is sent out. This TLV is not supported on access points that are connected directly to a 2000 or 2100 series controller.
- **Power Consumption TLV: 0x0010**—The maximum amount of power consumed by the access point. This TLV is not supported on access points that are connected directly to a 2000 or 2100 series controller.

Use these commands to configure CDP.

1. To enable or disable CDP on the controller, enter this command:

   config cdp {**enable** | **disable**}

   CDP is enabled by default.

2. To specify the refresh time interval, enter this command:

   config cdp timer *seconds*

   The range is 5 to 900 seconds, and the default value is 60 seconds.

3. To specify the holdtime that would be advertised as the time-to-live value in generated CDP packets, enter this command:

   config cdp holdtime *seconds*

   The range is 10 to 255 seconds, and the default value is 180 seconds.

4. To specify the highest CDP version supported on the controller, enter this command:

   config cdp advertise {**v1** | **v2**}

   The default value is CDPv1.

5. To enable or disable CDP on all access points that are joined to this controller, enter this command:

   config ap cdp {**enable** | **disable**} ***all***

   The **config ap cdp disable all** command disables CDP on all access points that are joined to the controller and all access points that join in the future. CDP remains disabled on both current and future access points even after the controller or access point reboots. To disable this behavior, enter **config ap cdp enable all**.

   Note After you enable CDP on all access points joined to the controller, you can disable and then re-enable CDP on individual access points using the commands in #6 below. After you disable CDP on all access points joined to the controller, you cannot enable and then disable CDP on individual access points.

6. To enable or disable CDP on a specific access point, enter this command:

   config ap cdp {**enable** | **disable**} *Cisco_AP*

7. To save your settings, enter this command:

   save config

Use these commands to obtain information about CDP neighbors on the controller.

1. To see the status of CDP and to view CDP protocol information, enter this command:

   show cdp

2. To see a list of all CDP neighbors on all interfaces, enter this command:

   show cdp neighbors [**detail**]

   The optional **detail** command provides detailed information for the controller's CDP neighbors.

   Note This command shows only the CDP neighbors of the controller. It does not show the CDP neighbors of the controller's associated access points.

3. To see all CDP entries in the database, enter this command:

   show cdp entry all

4. To see various traffic-related parameters on a given port (for example, packets sent and received, CRC errors, and so on), enter this command:

   show cdp traffic

5. To see the CDP status for a specific access point, enter this command:

   show ap cdp *Cisco_AP*

6. To see the CDP status for all access points that are connected to this controller, enter this command:

   show ap cdp all

Use these commands to obtain CDP debug information for the controller.

1. To obtain debug information related to CDP packets, enter this command:

   debug cdp packets

2. To obtain debug information related to CDP events, enter this command:

   debug cdp events

Configuring Power over Ethernet

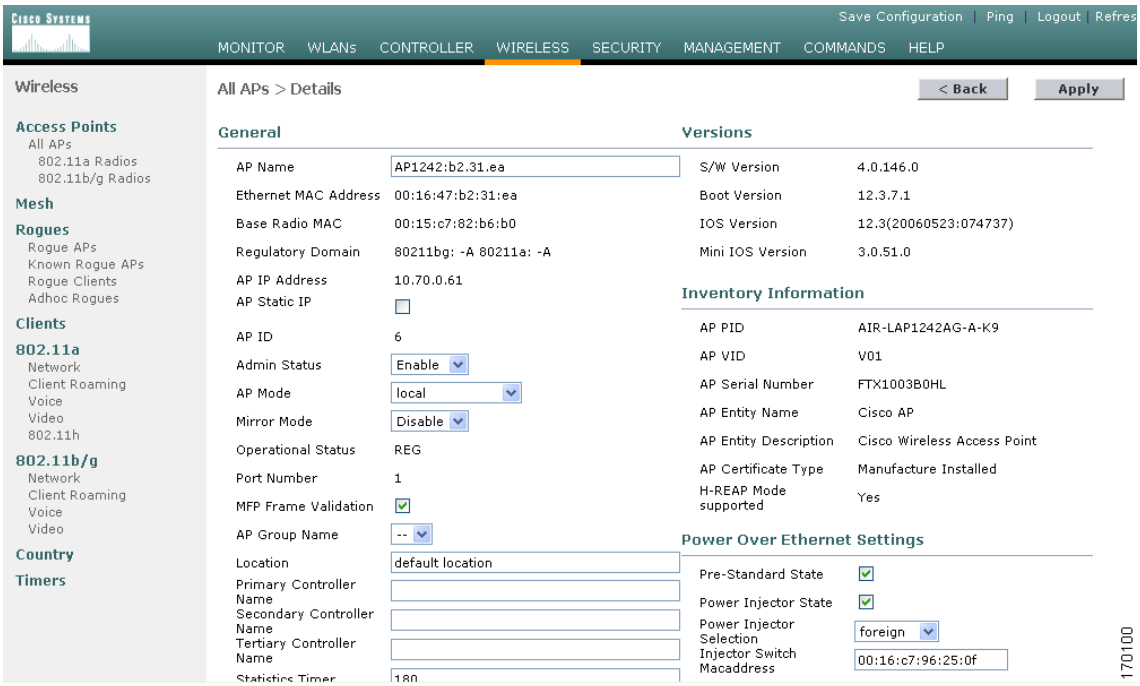
When an LWAPP-enabled access point (such as an AP1131 or AP1242) is powered by a power injector that is connected to a Cisco pre-Intelligent Power Management (pre-IPM) switch, you need to configure power over Ethernet (PoE), also known as *inline power*. You can configure PoE through either the GUI or the CLI.

Using the GUI to Configure Power over Ethernet

Follow these steps to configure PoE using the controller GUI.

Step 1 Click **Wireless** and then the **Detail** link of the desired access point. The All APs > Details page appears (see Figure 7-13).

Figure 7-13 All APs > Details Page



Step 2 Perform one of the following:

- Check the **Pre-Standard State** check box if the access point is being powered by a high-power Cisco switch. These switches provide more than the traditional 6 Watts of power but do not support the intelligent power management (IPM) feature. These switches include:
  - WS-C3550, WS-C3560, WS-C3750,
  - C1880,
  - 2600, 2610, 2611, 2621, 2650, 2651,
  - 2610XM, 2611XM, 2621XM, 2650XM, 2651XM, 2691,
  - 2811, 2821, 2851,
  - 3620, 3631-telco, 3640, 3660,
  - 3725, 3745,
  - 3825, and 3845.
- Uncheck the **Pre-Standard State** check box if power is being provided by a power injector or by a switch not on the above list.

Step 3 Check the **Power Injector State** check box if the attached switch does not support IPM and a power injector is being used. If the attached switch supports IPM, you do not need to check this check box.

Step 4 If you checked the Power Injector State check box in the previous step, the **Power Injector Selection** parameter appears. This parameter enables you to protect your switch port from an accidental overload if the power injector is inadvertently bypassed. Choose one of these options from the drop-down box to specify the desired level of protection:

- **Installed**—This option examines and remembers the MAC address of the currently connected switch port and assumes that a power injector is connected. Choose this option if your network contains older Cisco 6-Watt switches and you want to avoid possible overloads by forcing a double-check of any relocated access points.

  Note Each time an access point is relocated, the MAC address of the new switch port will fail to match the remembered MAC address, and the access point will remain in low-power mode. You must then physically verify the existence of a power injector and reselect this option to cause the new MAC address to be remembered.

- **Override**—This option allows the access point to operate in high-power mode without first verifying a matching MAC address. It is acceptable to use this option if your network does not contain any older Cisco 6-Watt switches that could be overloaded if connected directly to a 12-Watt access point. The advantage of this option is that if you relocate the access point, it continues to operate in high-power mode without any further configuration. The disadvantage of this option is that if the access point is connected directly to a 6-Watt switch, an overload will occur.
- **Foreign**—This option causes the Injector Switch MAC Address parameter to appear. The Injector Switch MAC Address parameter allows the remembered MAC address to be modified by hand. Choose this option if you know the MAC address of the connected switch port and do not wish to automatically detect it using the Installed option.

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

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

Using the CLI to Configure Power over Ethernet

Use these commands to configure PoE using the controller CLI.

1. **config ap power injector enable ap installed**

   This command is recommended if your network contains any older Cisco 6-Watt switches that could be accidentally overloaded if connected directly to a 12-Watt access point. The access point remembers that a power injector is connected to this particular switch port. If you relocate the access point, you must reissue this command after the presence of a new power injector is verified.

   Note Make sure CDP is enabled before issuing this command. Otherwise, this command will fail. See the previous section for information on enabling CDP.

2. **config ap power injector enable ap override**

   This command removes the safety checks and allows the access point to be connected to any switch port. It is acceptable to use this command if your network does not contain any older Cisco 6-Watt switches that could be overloaded if connected directly to a 12-Watt access point. The access point assumes that a power injector is always connected. If you relocate the access point, it continues to assume that a power injector is present.

Configuring Flashing LEDs

Controller software release 4.0 enables you to flash the LEDs on an access point in order to locate it. All IOS lightweight access points support this feature.

Use these commands to configure LED flashing from the Privileged Exec mode of the controller.

Note The output of these commands is sent only to the controller console, regardless of whether the commands were issued on the console or in a TELNET/SSH CLI session.

1. To enable the controller to send commands to the access point from its CLI, enter this command:

   config ap remote-debug enable *Cisco_AP*

2. To cause a specific access point to flash its LEDs for a specified number of seconds, enter this command:

   config ap remote-debug exc-command "led flash *seconds***"** *Cisco_AP*

   You can enter a value between 1 and 3600 seconds for the *seconds* parameter.

3. To disable LED flashing for a specific access point, enter this command:

   config ap remote-debug exc-command "led flash disable" *Cisco_AP*

   This command disables LED flashing immediately. For example, if you run the previous command (with the *seconds* parameter set to 60 seconds) and then disable LED flashing after only 20 seconds, the access point's LEDs stop flashing immediately.

Authorizing Access Points Using MICs

You can configure controllers to use RADIUS servers to authorize access points using MICs. The controller uses an access point's MAC address as both the username and password when sending the information to a RADIUS server. For example, if the MAC address of the access point is 000b85229a70, both the username and password used by the controller to authorize the access point are 000b85229a70.

Note The lack of a *strong password* by the use of the access point's MAC address should not be an issue because the controller uses MIC to authenticate the access point prior to authorizing the access point through the RADIUS server. Using MIC provides strong authentication.

Note If you use the MAC address as the username and password for access point authentication on a RADIUS AAA server, do not use the same AAA server for client authentication.

Managing Controller Software and Configurations

This chapter describes how to manage configurations and software versions on the controllers. It contains these sections:

Transferring Files to and from a Controller

Controllers have built-in utilities for uploading and downloading software, certificates, and configuration files.

Use these **transfer** commands:

- **transfer download datatype**
- **transfer download filename**
- **transfer download mode**
- **transfer download path**
- **transfer download serverip**
- **transfer download start**
- **transfer upload datatype**
- **transfer upload filename**
- **transfer upload mode**
- **transfer upload path**
- **transfer upload serverip**
- **transfer upload start**

Upgrading Controller Software

When a controller is upgraded, the code on its associated access points is also automatically upgraded. When an access point is loading code, each of its lights blinks in succession.

Note In release 4.0.206.0, up to10 access points can be concurrently upgraded from the controller.

Caution Do not power down the controller or any access point during this process; otherwise, you might corrupt the software image! Upgrading a controller with a large number of access points can take as long as 30 minutes, depending on the size of your network. However, with the increased number of concurrent access point upgrades supported in software release 4.0.206.0, the upgrade time should be significantly reduced. The access points must remain powered, and the controller must not be reset during this time.

Cisco recommends the following sequence when performing an upgrade:

1. Upload your controller configuration files to a server to back them up.
2. Turn off the controller 802.11a and 802.11b/g networks.
3. Upgrade your controller to the latest software release, following the steps in the"Updating Controller Software" section on page 8-3.
4. Re-enable your 802.11a and 802.11b/g networks.

Note Controllers can be upgraded from one release to another. However, should you require a downgrade from one release to another, you may be unable to use the higher release configuration. The workaround is to reload the previous controller configuration files saved on the backup server or to reconfigure the controller.

Updating Controller Software

Follow these steps to upgrade the controller software using the CLI.

Note You can also update the controller software using the GUI or through a wireless connection. However, in these cases, you will lose your connection to the controller sometime during the update process. For this reason, Cisco recommends that you use a direct CLI console port connection to update controller software.

Step 1 Make sure you have a TFTP server available for the Operating System software download. Keep these guidelines in mind when setting up a TFTP server:

- If you are downloading through the service port, the TFTP server must be on the same subnet as the service port because the service port is not routable.
- If you are downloading through the distribution system network port, the TFTP server can be on the same or a different subnet because the distribution system port is routable.
- A third-party TFTP server cannot run on the same computer as the Cisco WCS because the WCS built-in TFTP server and the third-party TFTP server require the same communication port.

Step 2 Download the desired Operating System software update file from the Cisco website to the default directory on your TFTP server.

Step 3 Log into the controller CLI.

Step 4 Enter **ping** *server-ip-address* to verify that the controller can contact the TFTP server.

Step 5 Enter **transfer download start** and answer **n** to the prompt to view the current download settings. This example shows the command output:

```
>transfer download start
Mode..................................... TFTP
Data Type................................ Code
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ <directory path>
TFTP Filename............................ AS_2000_3_0_x_x.aes --OR--
                                          AS_4100_3_0_x_x.aes --OR--
                                          AS_4400_3_0_x_x.aes

Are you sure you want to start? (y/n) n
Transfer Canceled
>
```

Step 6 Enter these commands to change the download settings:

transfer download mode tftp

transfer download datatype code

transfer download serverip *tftp-server-ip-address*

transfer download filename *filename*

transfer download path *tftp-server-path-to-file*

Note Pathnames on a TFTP server are relative to the server's default or root directory. For example, in the case of Solarwinds TFTP server, the path is "/".

Step 7 Enter **transfer download start** to view the updated settings, and answer **y** to the prompt to confirm the current download settings and start the Operating System code download. This example shows the download command output:

```
transfer download start
Mode..................................... TFTP
Data Type................................ Code
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ <directory path>
TFTP Filename............................ AS_2000_3_0_x_x.aes --OR--
                                          AS_4100_3_0_x_x.aes --OR--
                                          AS_4400_3_0_x_x.aes

Are you sure you want to start? (y/n) y
TFTP Code transfer starting.
TFTP receive complete... extracting components.
Writing new bootloader to flash.
Making backup copy of RTOS.
Writing new RTOS to flash.
Making backup copy of Code.
Writing new Code to flash.
TFTP File transfer operation completed successfully.
  Please restart the switch (reset system) for update to complete.
```

Step 8 The controller now has the code update in active volatile RAM, but you must enter **reset system** to save the code update to non-volatile NVRAM and reboot the Cisco Wireless LAN Controller:

```
reset system
The system has unsaved changes.
Would you like to save them now? (y/n) y
```

The controller completes the bootup process.

Saving Configurations

Controllers contain two kinds of memory: volatile RAM and NVRAM. At any time, you can save the configuration changes from active volatile RAM to non-volatile RAM (NVRAM) using one of these commands:

- Use the **save config** command. This command saves the configuration from volatile RAM to NVRAM without resetting the controller.
- Use the **reset system** command. The CLI prompts you to confirm that you want to save configuration changes before the controller reboots.
- Use the **logout** command. The CLI prompts you to confirm that you want to save configuration changes before you log out.

Clearing the Controller Configuration

Follow these steps to clear the active configuration in NVRAM.

Step 1 Enter **clear config** and enter **y** at the confirmation prompt to confirm the action.

Step 2 Enter **reset system**. At the confirmation prompt, enter **n** to reboot without saving configuration changes. When the controller reboots, the configuration wizard starts automatically.

Step 3 Follow the instructions in the "Using the Configuration Wizard" section on page 4-2 to complete the initial configuration.

Erasing the Controller Configuration

Follow these steps to reset the controller configuration to default settings:

Step 1 Enter **reset system**. At the confirmation prompt, enter **y** to save configuration changes to NVRAM. The controller reboots.

Step 2 When you are prompted for a username, enter **recover-config** to restore the factory default configuration. The controller reboots and the configuration wizard starts automatically.

Step 3 Follow the instructions in the "Using the Configuration Wizard" section on page 4-2 to complete the initial configuration.

Resetting the Controller

You can reset the controller and view the reboot process on the CLI console using one of the following two methods:

- Turn the controller off and then turn it back on.
- On the CLI, enter **reset system**. At the confirmation prompt, enter **y** to save configuration changes to NVRAM. The controller reboots.

When the controller reboots, the CLI console displays the following reboot information:

- Initializing the system.
- Verifying the hardware configuration.
- Loading microcode into memory.
- Verifying the Operating System software load.
- Initializing with its stored configurations.
- Displaying the login prompt.

Managing User Accounts

This chapter explains how to create and manage guest user accounts, describes the web authentication process, and provides instructions for customizing the web authentication login window. It contains these sections:

Creating Guest User Accounts

The controller can provide guest user access on WLANs. The first step in creating guest user accounts is to create a lobby administrator account, also known as a lobby ambassador account. Once this account has been created, a lobby ambassador can create and manage guest user accounts on the controller. The lobby ambassador has limited configuration privileges and access only to the web pages used to manage the guest accounts.

The lobby ambassador can specify the amount of time that the guest user accounts remain active. After the specified time elapses, the guest user accounts expire automatically.

The local user database is limited to a maximum of 2048 entries and is set to a default value of 512 entries (on the Security > General page). This database is shared by local management users (including lobby ambassadors), net users (including guest users), MAC filter entries, and disabled clients. Together these cannot exceed the configured database size.

Creating a Lobby Ambassador Account

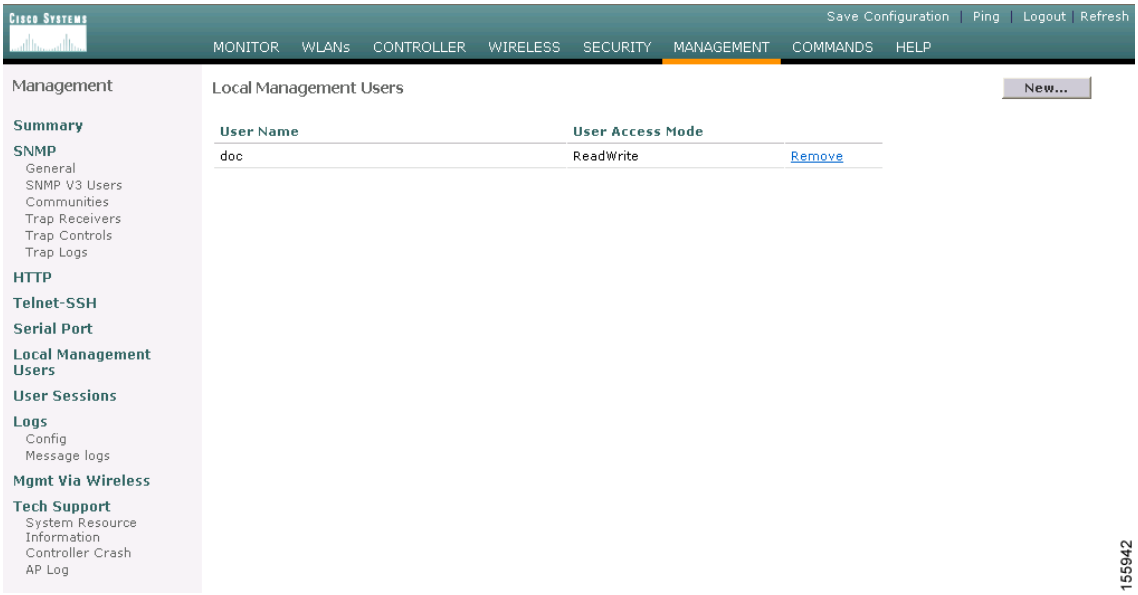
You can create a lobby ambassador account on the controller through either the GUI or the CLI.

Using the GUI to Create a Lobby Ambassador Account

Follow these steps to create a lobby ambassador account using the controller GUI.

Step 1 Click **Management > Local Management Users** to access the Local Management Users page (see Figure 9-1).

Figure 9-1 Local Management Users Page

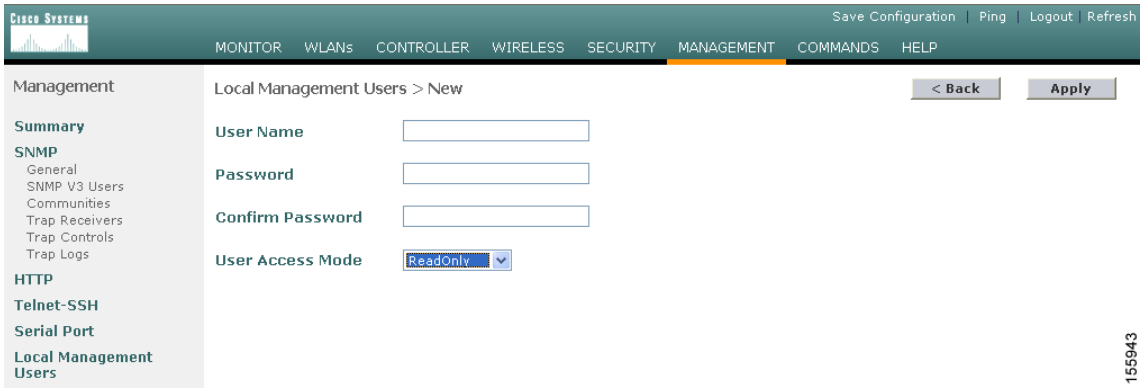


This page lists the names and access privileges of the local management users.

Note You can click **Remove** to delete any of the user accounts from the controller. However, deleting the default administrative user prohibits both GUI and CLI access to the controller. Therefore, you must create a user with administrative privileges (ReadWrite) before you remove the default user.

Step 2 To create a lobby ambassador account, click **New** under Management. The Local Management Users > New page appears (see Figure 9-2).

Figure 9-2 Management > Local Management Users > New Page



Step 3 In the User Name field, enter a username for the lobby ambassador account.

Note Management usernames must be unique because they are stored in a single database.

Step 4 In the Password and Confirm Password fields, enter a password for the lobby ambassador account.

Note Passwords are case sensitive.

Step 5 Choose **LobbyAdmin** from the User Access Mode drop-down box. This option enables the lobby ambassador to create guest user accounts.

Note The **ReadOnly** option creates an account with read-only privileges, and the **ReadWrite** option creates an administrative account with both read and write privileges.

Step 6 Click **Apply** to commit your changes. The new lobby ambassador account appears in the list of local management users.

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

Using the CLI to Create a Lobby Ambassador Account

Enter this command to create a lobby ambassador account using the controller CLI:

config mgmtuser add *lobbyadmin_username lobbyadmin_pwd* **lobby-admin**

Note Replacing **lobby-admin** with **read-only** creates an account with read-only privileges. Replacing **lobby-admin** with **read-write** creates an administrative account with both read and write privileges.

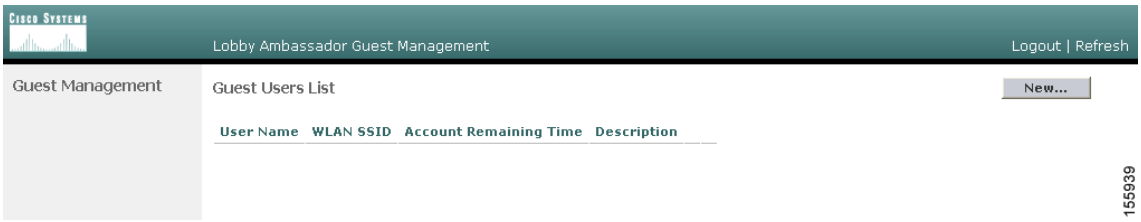
Creating Guest User Accounts as a Lobby Ambassador

A lobby ambassador would follow these steps to create guest user accounts.

Note A lobby ambassador cannot access the controller CLI interface and therefore can create guest user accounts only from the controller GUI.

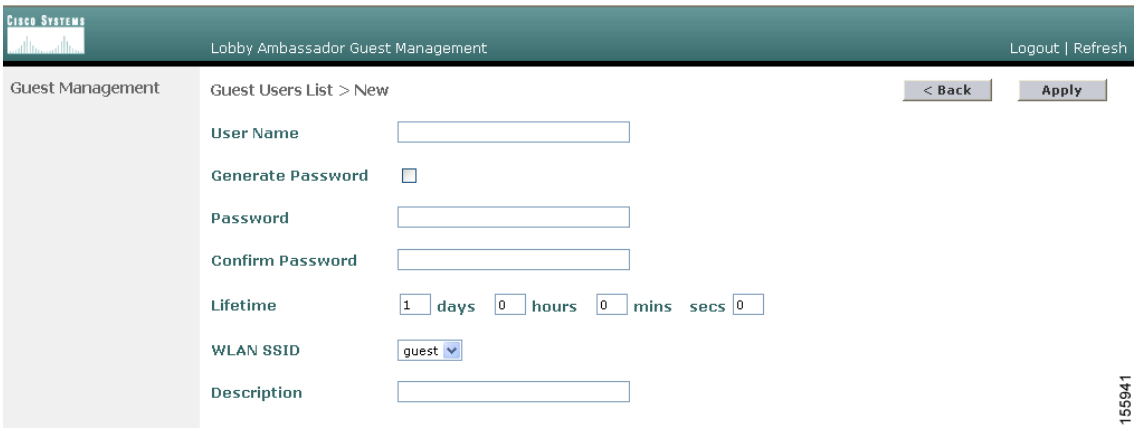
Step 1 Log into the controller as the lobby ambassador, using the username and password specified in the "Creating a Lobby Ambassador Account" section above. The Lobby Ambassador Guest Management > Guest Users List page appears (see Figure 9-3).

Figure 9-3 Lobby Ambassador Guest Management > Guest Users List Page



Step 2 Click **New** to create a guest user account. The Lobby Ambassador Guest Management > Guest Users List > New page appears (see Figure 9-4).

Figure 9-4 Lobby Ambassador Guest Management > Guest Users List > New Page



Step 3 In the User Name field, enter a name for the guest user. You can enter up to 24 characters.

Step 4 Perform one of the following:

- If you want to generate an automatic password for this guest user, check the **Generate Password** check box. The generated password is entered automatically in the Password and Confirm Password fields.
- If you want to create a password for this guest user, leave the **Generate Password** check box unchecked and enter a password in both the Password and Confirm Password fields.

Note Passwords can contain up to 24 characters and are case sensitive.

Step 5 From the Lifetime drop-down boxes, choose the amount of time (in days, hours, minutes, and seconds) that this guest user account is to remain active. A value of zero (0) for all four fields creates a permanent account.

Default: 1 day

Range: 5 minutes to 30 days

Note The smaller of this value or the session timeout for the guest WLAN, which is the WLAN on which the guest account is created, takes precedence. For example, if a WLAN session timeout is due to expire in 30 minutes but the guest account lifetime has 10 minutes remaining, the account is deleted in 10 minutes upon guest account expiry. Similarly, if the WLAN session timeout expires before the guest account lifetime, the client experiences a recurring session timeout that requires reauthentication.

Note You can change a guest user account with a non-zero lifetime to another lifetime value at any time while the account is active. However, to make a guest user account permanent or to change a permanent account to a guest account, you must delete the account and create it again.

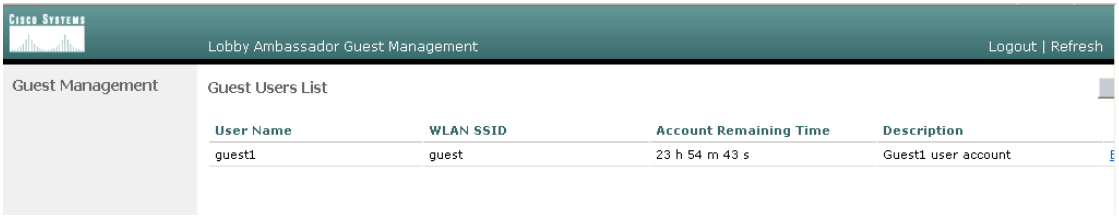
Step 6 From the WLAN SSID drop-down box, choose the SSID that will be used by the guest user. The only WLANs that are listed are those for which Layer 3 web authentication has been configured (under WLAN Security Policies).

Note Cisco recommends that the system administrator create a specific guest WLAN to prevent any potential conflicts. If a guest account expires and it has a name conflict with an account on the RADIUS server and both are on the same WLAN, the users associated with both accounts are disassociated before the guest account is deleted.

Step 7 In the Description field, enter a description of the guest user account. You can enter up to 32 characters.

Step 8 Click **Apply** to commit your changes. The new guest user account appears in the list of guest users on the Guest Users List page (see Figure 9-5).

Figure 9-5 Lobby Ambassador Guest Management > Guest Users List Page



From this page, you can see all of the guest user accounts, their WLAN SSID, and their lifetime. You can also edit or remove a guest user account. When you remove a guest user account, all of the clients that are using the guest WLAN and are logged in using that account's username are deleted.

Step 9 Repeat this procedure to create any additional guest user accounts.

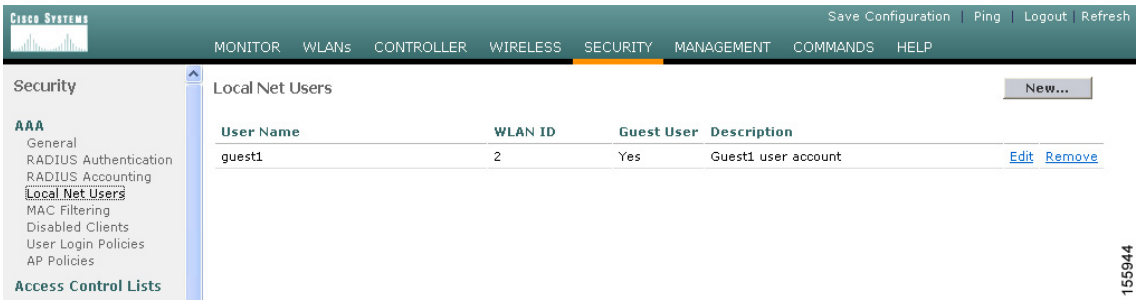
Viewing Guest User Accounts

After a lobby ambassador has created guest user accounts, the system administrator can view them from the controller GUI or CLI.

Using the GUI to View Guest Accounts

To view guest user accounts using the controller GUI, click **Security** and then **Local Net Users** under AAA. The Local Net Users page appears (see Figure 9-6).

Figure 9-6 Local Net Users Page



From this page, the system administrator can see all of the local net user accounts (including guest user accounts) and can edit or remove them as desired. When you remove a guest user account, all of the clients that are using the guest WLAN and are logged in using that account's username are deleted.

Using the CLI to View Guest Accounts

To view all of the local net user accounts (including guest user accounts) using the controller CLI, enter this command:

show netuser summary

Web Authentication Process

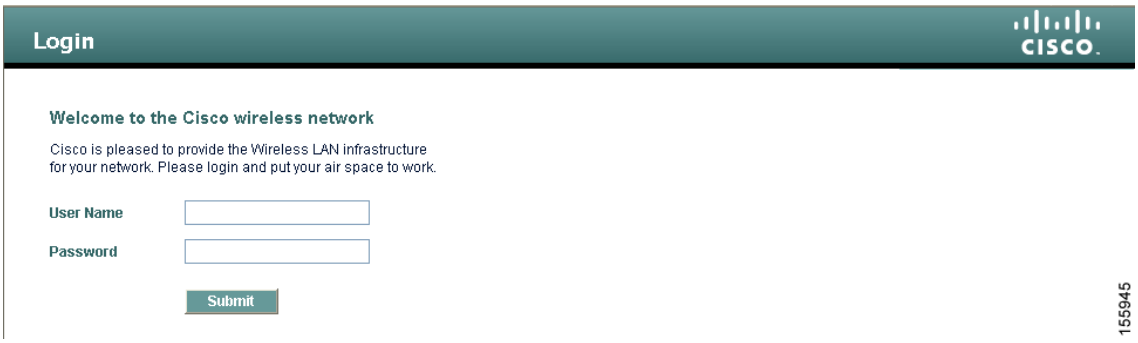
Web authentication is a Layer 3 security feature that causes the controller to not allow IP traffic (except DHCP-related packets) from a particular client until that client has correctly supplied a valid username and password. When you use web authentication to authenticate clients, you must define a username and password for each client. Then when the clients attempt to join the wireless LAN, their users must enter the username and password when prompted by a login window.

When web authentication is enabled (under WLAN Security Policies), users might receive a web-browser security alert the first time that they attempt to access a URL. Figure 9-7 shows a typical security alert.

Figure 9-7 Typical Web-Browser Security Alert

After the user clicks **Yes** to proceed (or if the client's browser does not display a security alert), the web authentication system redirects the client to a login window. Figure 9-8 shows the default web authentication login window.

Figure 9-8 Default Web Authentication Login Window



The default login window contains a Cisco logo and Cisco-specific text. You can choose to have the web authentication system display one of the following:

- The default login window
- A modified version of the default login window
- A customized login window that you configure on an external web server
- A customized login window that you download to the controller

The "Choosing the Web Authentication Login Window" section on page 9-9 provides instructions for choosing how the web authentication login window appears.

When the user enters a valid username and password on the web authentication login window and clicks **Submit**, the web authentication system displays a successful login window and redirects the authenticated client to the requested URL. Figure 9-9 shows a typical successful login window.

Figure 9-9 Successful Login Window

The default successful login window contains a pointer to a virtual gateway address URL: https://1.1.1.1/logout.html. The IP address that you set for the controller virtual interface serves as the redirect address for the login window (see Chapter 3 for more information on the virtual interface).

Choosing the Web Authentication Login Window

This section provides instructions for specifying the content and appearance of the web authentication login window. Follow the instructions in one of these sections to choose the web authentication login window using the controller GUI or CLI:

- Choosing the Default Web Authentication Login Window, page 9-9
- Using a Customized Web Authentication Login Window from an External Web Server, page 9-13
- Downloading a Customized Web Authentication Login Window, page 9-14

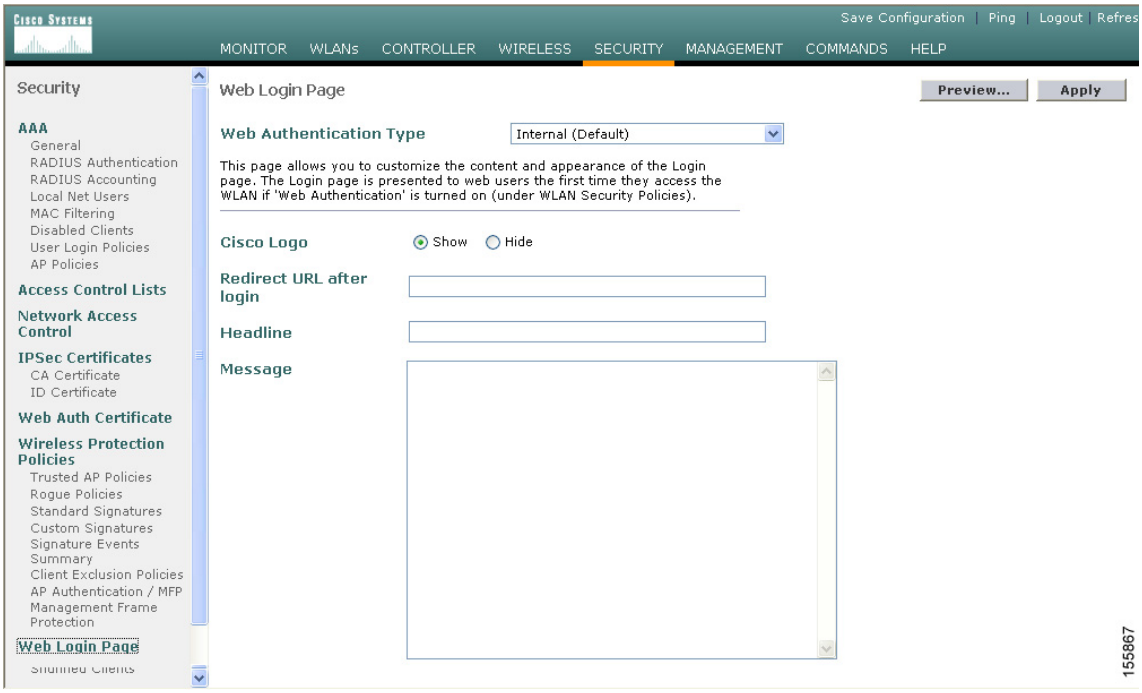
Choosing the Default Web Authentication Login Window

If you want to use the default web authentication login window as is (see Figure 9-8) or with a few modifications, follow the instructions in the GUI or CLI procedure below.

Using the GUI to Choose the Default Web Authentication Login Window

Step 1 Click **Security > Web Login Page** to access the Web Login page (see Figure 9-10).

Figure 9-10 Web Login Page



Step 2 From the Web Authentication Type drop-down box, choose **Internal (Default)**.

Step 3 If you want to use the default web authentication login window as is, go to Step 8. If you want to modify the default login window, go to Step 4.

Step 4 If you want to hide the Cisco logo that appears in the top right corner of the default window, choose the Cisco Logo **Hide** option. Otherwise, click the **Show** option.

Step 5 If you want the user to be directed to a particular URL (such as the URL for your company) after login, enter the desired URL (such as www.AcompanyBC.com) in the Redirect URL After Login field. You can enter up to 254 characters.

Step 6 If you want to create your own headline on the login window, enter the desired text in the Headline field. You can enter up to 127 characters. The default headline is "Welcome to the Cisco wireless network."

Step 7 If you want to create your own message on the login window, enter the desired text in the Message field. You can enter up to 2047 characters. The default message is "Cisco is pleased to provide the Wireless LAN infrastructure for your network. Please login and put your air space to work."

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

Step 9 Click **Preview** to view the web authentication login window.

Step 10 If you are satisfied with the content and appearance of the login window, click **Save Configuration** to save your changes. Otherwise, repeat any of the previous steps as necessary to achieve your desired results.

Using the CLI to Choose the Default Web Authentication Login Window

Step 1 To specify the default web authentication type, enter this command:

config custom-web webauth_type internal

Step 2 If you want to use the default web authentication login window as is, go to Step 7. If you want to modify the default login window, go to Step 3.

Step 3 To show or hide the Cisco logo that appears in the top right corner of the default login window, enter this command:

config custom-web weblogo {**enable** | **disable**}

Step 4 If you want the user to be directed to a particular URL (such as the URL for your company) after login, enter this command:

config custom-web redirecturl *url*

You can enter up to 130 characters for the URL. To change the redirect back to the default setting, enter **clear redirecturl**.

Step 5 If you want to create your own headline on the login window, enter this command:

config custom-web webtitle *title*

You can enter up to 130 characters. The default headline is "Welcome to the Cisco wireless network." To reset the headline to the default setting, enter **clear webtitle**.

Step 6 If you want to create your own message on the login window, enter this command:

config custom-web webmessage *message*

You can enter up to 130 characters. The default message is "Cisco is pleased to provide the Wireless LAN infrastructure for your network. Please login and put your air space to work." To reset the message to the default setting, enter **clear webmessage**.

Step 7 Enter **save config t**o save your settings.

Step 8 If you want to import your own logo into the web authentication login window, follow these steps:

a. Make sure that you have a Trivial File Transfer Protocol (TFTP) server available for the file download. Keep these guidelines in mind when setting up a TFTP server:
   - If you are downloading through the service port, the TFTP server must be on the same subnet as the service port because the service port is not routable.
   - If you are downloading through the distribution system network port, the TFTP server can be on the same or a different subnet because the distribution system port is routable.
   - A third-party TFTP server cannot run on the same computer as the Cisco WCS because the WCS built-in TFTP server and the third-party TFTP server require the same communication port.

b. Enter **ping ip-address** to ensure that the controller can contact the TFTP server.

c. Copy the logo file (in .jpg, .gif, or .png format) to the default directory on your TFTP server. The maximum file size is 30 kilobits. For an optimal fit, the logo should be approximately 180 pixels wide and 360 pixels high.

d. To specify the download mode, enter **transfer download mode tftp**.

e. To specify the type of file to be downloaded, enter **transfer download datatype image**.

f. To specify the IP address of the TFTP server, enter **transfer download serverip** *tftp-server-ip-address*.

Note Some TFTP servers require only a forward slash (/) as the TFTP server IP address, and the TFTP server automatically determines the path to the correct directory.

g. To specify the download path, enter **transfer download path** *absolute-tftp-server-path-to-file*.

h. To specify the file to be downloaded, enter **transfer download filename** {*filename.jpg* | *filename.gif* | *filename.png*}.

i. Enter **transfer download start** to view your updated settings and answer **y** to the prompt to confirm the current download settings and start the download. Information similar to the following appears:

```
Mode..................................... TFTP
Data Type................................ Login Image
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ <directory path>
TFTP Filename.............................. <filename.jpg|.gif|.png>
This may take some time.
Are you sure you want to start? (y/n) y
TFTP Image transfer starting.
Image installed.
```

j. Enter **save config** to save your settings.

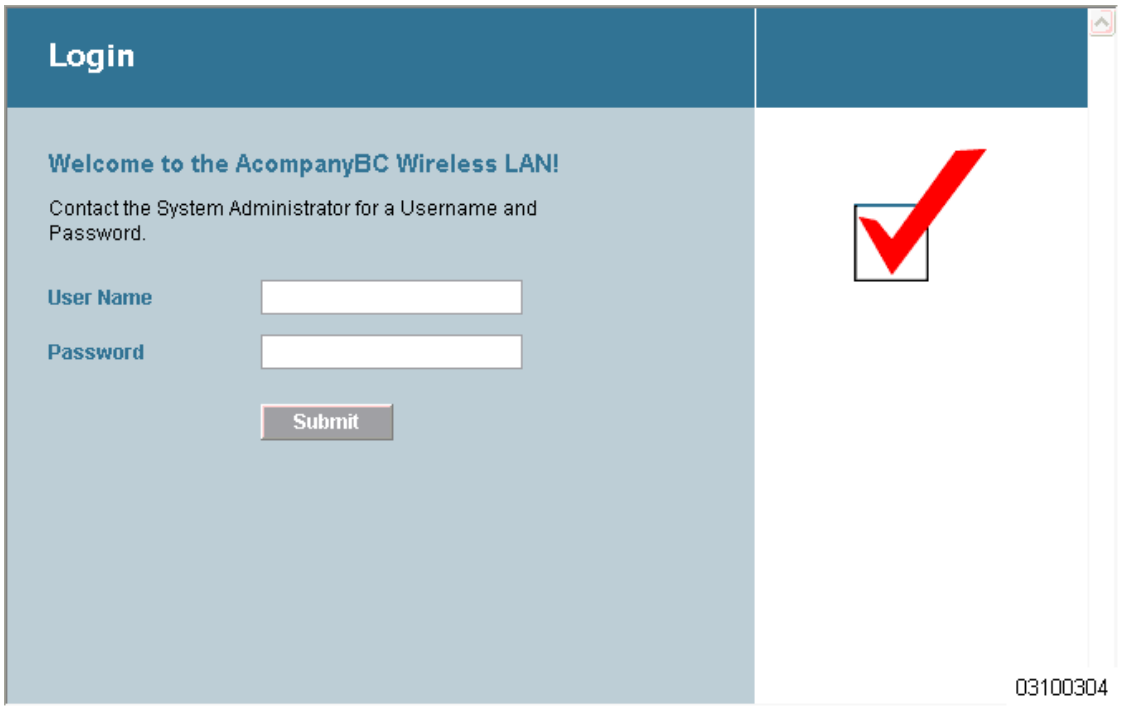
Note If you ever want to remove this logo from the web authentication login window, enter **clear webimage**.

Step 9 Follow the instructions in the "Using the CLI to Verify the Web Authentication Login Window Settings" section on page 9-17 to verify your settings.

Modified Default Web Authentication Login Window Example

Figure 9-11 shows an example of a modified default web authentication login window.

Figure 9-11 Modified Default Web Authentication Login Window Example



These are the CLI commands used to create this login window:

config custom-web weblogo disable

config custom-web webtitle Welcome to the AcompanyBC Wireless LAN!

config custom-web webmessage Contact the System Administrator for a Username and Password.

transfer download start

```
Mode..................................... TFTP
Data Type................................ Login Image
TFTP Server IP........................... xxx.xxx.xxx.xxx
TFTP Path................................ /
TFTP Filename............................ Logo.gif
This may take some time.
Are you sure you want to start? (y/n) y
TFTP Image transfer starting.
Image installed.
```

config custom-web redirecturl http://www.AcompanyBC.com

show custom-web

```
Cisco Logo.............. Disabled
CustomLogo.............. 00_logo.gif
Custom Title............ Welcome to the AcompanyBC Wireless LAN!
Custom Message ......... Contact the System Administrator for a Username and Password.
```

```
Custom Redirect URL......... http://www.AcompanyBC.com
Web Authentication Mode..... Disabled
Web Authentication URL........ Disabled
```

Using a Customized Web Authentication Login Window from an External Web Server

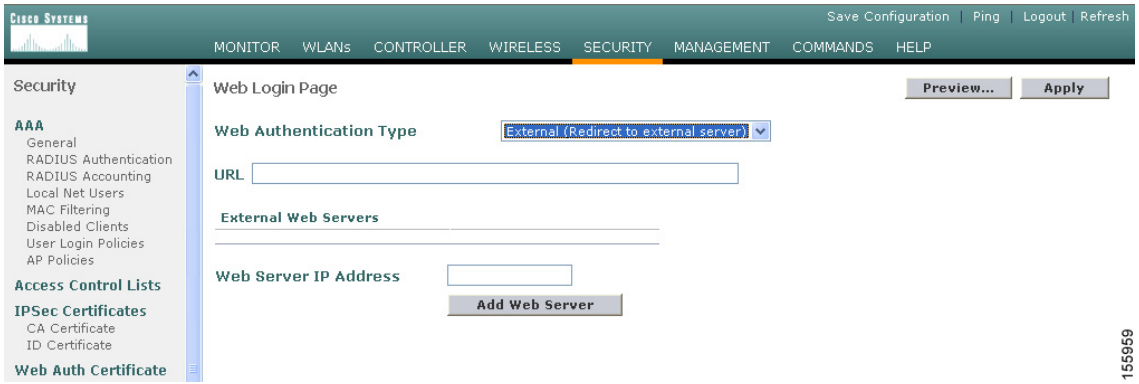
If you want to use a customized web authentication login window that you configured on an external web server, follow the instructions in the GUI or CLI procedure below. When you enable this feature, the user is directed to your customized login window on the external web server.

Note You must configure a preauthentication access control list (ACL) on the WLAN for the external web server and then choose this ACL as the WLAN preauthentication ACL under Security Policies > Web Policy on the WLANs > Edit page. See Chapter 5, "Configuring Access Control Lists" for more information on ACLs.

Using the GUI to Choose a Customized Web Authentication Login Window from an External Web Server

Step 1 Click **Security > Web Login Page** to access the Web Login page (see Figure 9-12).

Figure 9-12 Web Login Page



Step 2 From the Web Authentication Type drop-down box, choose **External (Redirect to external server)**.

Step 3 In the URL field, enter the URL of the customized web authentication login window on your web server. You can enter up to 252 characters.

Step 4 In the Web Server IP Address field, enter the IP address of your web server. Your web server should be on a different network from the controller service port network.

Step 5 Click **Add Web Server**. This server now appears in the list of external web servers.

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

Step 7 If you are satisfied with the content and appearance of the login window, click **Save Configuration** to save your changes.

Using the CLI to Choose a Customized Web Authentication Login Window from an External Web Server

Step 1 To specify the web authentication type, enter this command:

config custom-web webauth_type external.

Step 2 To specify the URL of the customized web authentication login window on your web server, enter this command:

config custom-web ext-webauth-url *url*

You can enter up to 252 characters for the URL.

Step 3 To specify the IP address of your web server, enter this command:

config custom-web ext-webserver {**add** | **delete**} *server_IP_address*

Step 4 Enter **save config** to save your settings.

Step 5 Follow the instructions in the "Using the CLI to Verify the Web Authentication Login Window Settings" section on page 9-17 to verify your settings.

Downloading a Customized Web Authentication Login Window

You can compress the page and image files used for displaying a web authentication login window into a tar file for download to a controller. These files are known as the *webauth bundle*. The maximum allowed size of the files in their uncompressed state is 1 MB. When the .tar file is downloaded from a local TFTP server, it enters the controller's file system as an untarred file.

Follow these guidelines when preparing the customized login window:

- Name the login page "login.html." The controller prepares the web authentication URL based on this name. If the does not find this file after the webauth bundle has been untarred, the bundle is discarded, and an error message appears.
- Include input fields for both a username and password.
- Retain the redirect URL as a hidden input item after extracting from the original URL.
- Extract and set the action URL in the page from the original URL.
- Include scripts to decode the return status code.
- Make sure that all paths used in the main page (to refer to images, for example) are of relative type.

You can download a sample login page from Cisco WCS and use it as a starting point for your customized login page. Refer to the "Downloading a Customized Web Auth Page" section in the Using Templates chapter of the *Cisco Wireless Control System Configuration Guide, Release 4.0* for instructions.

If you want to download a customized web authentication login window to the controller, follow the instructions in the GUI or CLI procedure below.

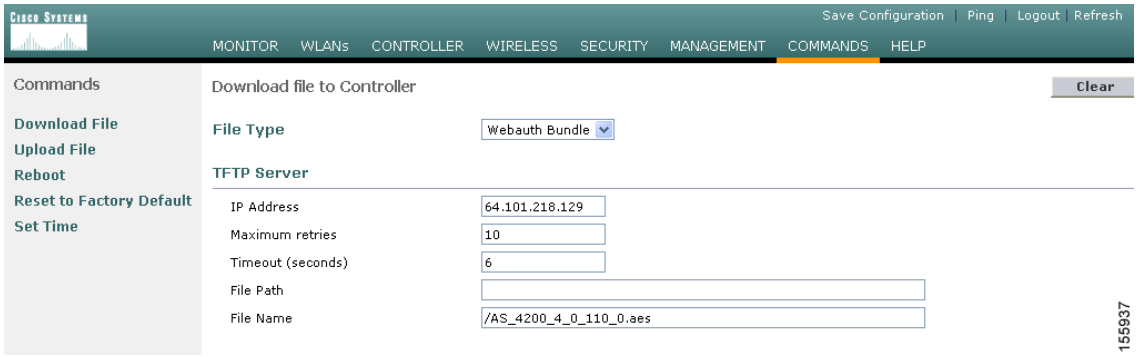
Using the GUI to Download a Customized Web Authentication Login Window

Step 1 Make sure that you have a TFTP server available for the file download. See the guidelines for setting up a TFTP server in Step 8 of the "Using the CLI to Choose the Default Web Authentication Login Window" section on page 9-10.

Step 2 Copy the .tar file containing your login page to the default directory on your TFTP server.

Step 3 Click **Commands** > **Download File** to access the Download File to Controller page (see Figure 9-13).

Figure 9-13 Download File to Controller Page



Step 4 From the File Type drop-down box, choose **Webauth Bundle**.

Step 5 In the IP Address field, enter the IP address of the TFTP server.

Step 6 In the Maximum Retries field, enter the maximum number of times the controller should attempt to download the .tar file.

Range: 1 to 254

Default: 10

Step 7 In the Timeout field, enter the amount of time in seconds before the controller times out while attempting to download the *.tar file.

Range: 1 to 254 seconds

Default: 6 seconds

Step 8 In the File Path field, enter the path of the .tar file to be downloaded. The default value is "/."

Step 9 In the File Name field, enter the name of the .tar file to be downloaded.

Step 10 Click **Download** to download the .tar file to the controller.

Step 11 Click **Security** > **Web Login Page** to access the Web Login page.

Step 12 From the Web Authentication Type drop-down box, choose **Customized (Downloaded)**.

Step 13 Click **Apply** to commit your changes.

Step 14 Click **Preview** to view your customized web authentication login window.

Step 15 If you are satisfied with the content and appearance of the login window, click **Save Configuration** to save your changes.

Using the CLI to Download a Customized Web Authentication Login Window

Step 1 Make sure that you have a TFTP server available for the file download. See the guidelines for setting up a TFTP server in Step 8 of the "Using the CLI to Choose the Default Web Authentication Login Window" section on page 9-10.

Step 2 Copy the .tar file containing your login page to the default directory on your TFTP server.

Step 3 To specify the download mode, enter **transfer download mode tftp**.

Step 4 To specify the type of file to be downloaded, enter **transfer download datatype webauthbundle**.

Step 5 To specify the IP address of the TFTP server, enter **transfer download serverip** *tftp-server-ip-address*.

Note Some TFTP servers require only a forward slash (/) as the TFTP server IP address, and the TFTP server automatically determines the path to the correct directory.

Step 6 To specify the download path, enter **transfer download path** *absolute-tftp-server-path-to-file*.

Step 7 To specify the file to be downloaded, enter **transfer download filename** *filename.tar*.

Step 8 Enter **transfer download start** to view your updated settings and answer **y** to the prompt to confirm the current download settings and start the download.

Step 9 To specify the web authentication type, enter **config custom-web webauth_type customized**.

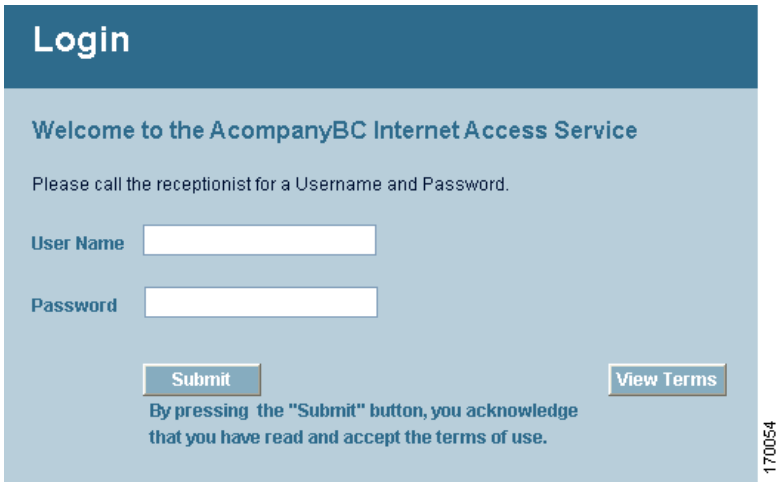
Step 10 Enter **save config** to save your settings.

Step 11 Follow the instructions in the "Using the CLI to Verify the Web Authentication Login Window Settings" section on page 9-17 to verify your settings.

Customized Web Authentication Login Window Example

Figure 9-14 shows an example of a customized web authentication login window.

Figure 9-14 Customized Web Authentication Login Window Example



Using the CLI to Verify the Web Authentication Login Window Settings

Enter **show custom-web** to verify your changes to the web authentication login window. This example shows the information that appears when the configuration settings are set to default values:

```
Cisco Logo..................................... Enabled
CustomLogo..................................... Disabled
Custom Title................................... Disabled
Custom Message................................. Disabled
Custom Redirect URL............................ Disabled
Web Authentication Mode........................ Disabled
Web Authentication URL......................... Disabled
```

This example shows the information that appears when the configuration settings have been modified:

```
Cisco Logo..................................... Disabled
CustomLogo..................................... 00_logo.gif
Custom Title................................... Welcome to the AcompanyBC Wireless LAN!
Custom Message................................. Contact the System Administrator for a
                                                Username and Password.
Custom Redirect URL............................ http://www.AcompanyBC.com
Web Authentication Mode........................ Internal
Web Authentication URL........................... Disabled
```

CHAPTER 10

Configuring Radio Resource ManagementWireless Device Access

This chapter describes radio resource management (RRM) and explains how to configure it on the controllers. It contains these sections:

Overview of Radio Resource Management

The radio resource management (RRM) software embedded in the controller acts as a built-in RF engineer to consistently provide real-time RF management of your wireless network. RRM enables controllers to continually monitor their associated lightweight access points for the following information:

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

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

- Radio resource monitoring
- Dynamic channel assignment
- Dynamic transmit power control
- Coverage hole detection and correction
- Client and network load balancing

Radio Resource Monitoring

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 point goes “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 If packets have been in the voice queue in the last 100 ms, the access point does not go off-channel.

By default, 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.

Dynamic Channel Assignment

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 café affects the performance of the access point in a neighboring business. Even though these are completely separate networks, someone sending traffic to the café on channel 1 can disrupt communication in an enterprise using the same channel. Controllers 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 different access point far from the café, which is more effective than not using channel 1 altogether.

The controller's dynamic channel assignment 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.

The controller examines a variety of real-time RF characteristics to efficiently handle channel assignments. These include:

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

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

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

Dynamic Transmit Power Control

The controller dynamically controls access point transmit power based on real-time wireless LAN conditions. Normally, power can be kept low to gain extra capacity and reduce interference. The controller attempts to balance access points such that they see their fourth strongest neighbor at an optimal –65 dbm or better.

The transmit power control algorithm only reduces an access point's power. However, the coverage hole algorithm, explained below, 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.

Note See Step 5 on page 10-25 for an explanation of the transmit power levels.

Coverage Hole Detection and Correction

RRM's coverage hole detection feature can alert you to the need for an additional (or relocated) lightweight access point. If clients on a lightweight access point are detected at signal-to-noise ratio (SNR) levels that are lower than the thresholds specified in the Auto RF configuration, the access point sends a "coverage hole" alert to the controller. The alert indicates the existence of an area where clients are continually experiencing poor signal coverage, without having a viable access point to which to roam. The administrator can look up the historical record of access points to see if these alerts are chronic, indicating the existence of a persistent coverage hole as opposed to an isolated problem.

Client and Network Load Balancing

RRM load-balances new clients across grouped lightweight access points reporting to each controller. This function is particularly important when many clients converge in one spot (such as a conference room or auditorium) because RRM can automatically force some subscribers to associate with nearby access points, allowing higher throughput for all clients. The controller provides a centralized view of client loads on all access points. This information can be used to influence where new clients attach to the network or to direct existing clients to new access points to improve wireless LAN performance. The result is an even distribution of capacity across an entire wireless network.

Note Client load balancing works only for a single controller. It is not operate in a multi-controller environment.

RRM Benefits

RRM produces a network with optimal capacity, performance, and reliability while enabling you to avoid the cost of laborious historical data interpretation and individual lightweight access point reconfiguration. It also frees you from having to continually monitor the network for noise and interference problems, which can be transient and difficult to troubleshoot. Finally, RRM ensures that clients enjoy a seamless, trouble-free connection throughout the Cisco unified wireless network.

RRM uses separate monitoring and control for each deployed network: 802.11a and 802.11b/g. That is, the RRM algorithms run separately for each radio type (802.11a and 802.11b/g). RRM uses both measurements and algorithms. RRM measurements can be adjusted using the monitor intervals specified in Table 10-1, but they cannot be disabled. RRM algorithms, on the other hand, are enabled automatically but can be disabled by statically configuring channel and power assignment. The RRM algorithms run at a specified updated interval, which is 600 seconds by default.

Note RRM measurements are postponed on a per access point basis where traffic remains in the platinum QoS queue, if there was voice traffic in the last 100 ms.

Overview of RF Groups

An RF group, also known as an RF domain, is a cluster of controllers that coordinates its dynamic RRM calculations on a per 802.11-network basis. An RF group exists for each 802.11 network type. Clustering controllers into RF groups enables the RRM algorithms to scale beyond a single controller.

Lightweight access points periodically send out neighbor messages over the air. The RRM algorithms use a shared secret that is configured on the controller and sent to each access point. Access points sharing the same secret are able to validate messages from each other. When access points on different controllers hear validated neighbor messages at a signal strength of –80 dBm or stronger, the controllers dynamically form an RF group.

Note RF groups and mobility groups are similar in that they both define clusters of controllers, but they are different in terms of their use. These two concepts are often confused because the mobility group name and RF group name are configured to be the same in the Startup Wizard. Most of the time, all of the controllers in an RF group are also in the same mobility group and vice versa. However, an RF group facilitates scalable, system-wide dynamic RF management while a mobility group facilitates scalable, system-wide mobility and controller redundancy. Refer to Chapter 11 for more information on mobility groups.

RF Group Leader

The members of an RF group elect an RF group leader to maintain a “master” power and channel scheme for the group. The RF group leader is dynamically chosen and cannot be selected by the user. In addition, the RF group leader can change at any time, depending on the RRM algorithm calculations.

The RF group leader analyzes real-time radio data collected by the system and calculates the master power and channel plan. The RRM algorithms try to optimize around a signal strength of –65 dBm between all access points and to avoid 802.11 co-channel interference and contention as well as non-802.11 interference. The RRM algorithms employ dampening calculations to minimize system-wide dynamic changes. The end result is dynamically calculated optimal power and channel planning that is responsive to an always changing RF environment.

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

Note Several monitoring intervals are also available. See Table 10-1 for details.

RF Group Name

A controller is configured with an RF group name, which is sent to all access points joined to the controller and used by the access points as the shared secret for generating the hashed MIC in the neighbor messages. To create an RF group, you simply configure all of the controllers to be included in the group with the same RF group name. You can include up to 20 controllers and 1000 access points in an RF group.

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

Configuring an RF Group

This section provides instructions for configuring RF groups through either the GUI or the CLI.

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

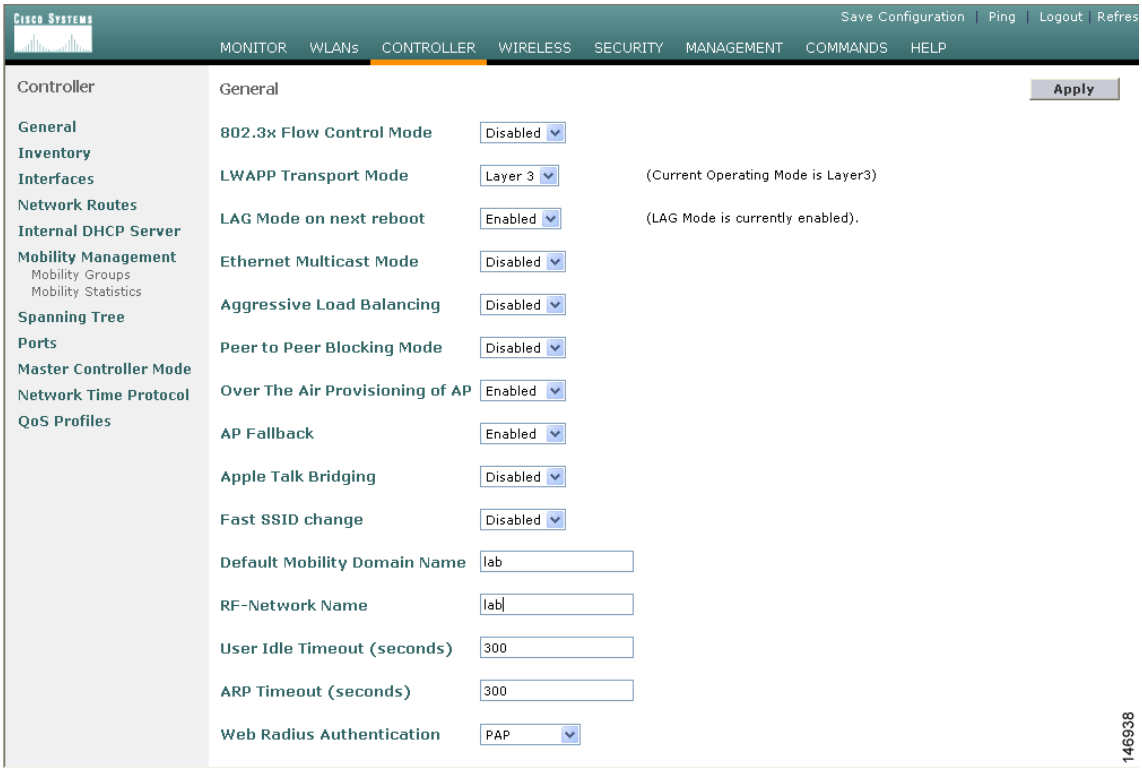
Note You can also configure RF groups using the Cisco Wireless Control System (WCS). Refer to the *Cisco Wireless Control System Configuration Guide* for instructions.

Using the GUI to Configure an RF Group

Follow these steps to create an RF group using the GUI.

Step 1 Click **Controller** > **General** to access the General page (see Figure 10-1).

Figure 10-1 General Page



Step 2 Enter a name for the RF group in the RF-Network Name field. The name can contain up to 19 ASCII characters.

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

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

Step 5 Repeat this procedure for each controller that you want to include in the RF group.

Using the CLI to Configure RF Groups

Follow these steps to configure an RF group using the CLI.

Step 1 Enter **config network rf-network-name** *name* to create an RF group.

Note Enter up to 19 ASCII characters for the group name.

Step 2 Enter **show network** to view the RF group.

Step 3 Enter **save config** to save your settings.

Step 4 Repeat this procedure for each controller that you want to include in the RF group.

Viewing RF Group Status

This section provides instructions for viewing the status of the RF group through either the GUI or the CLI.

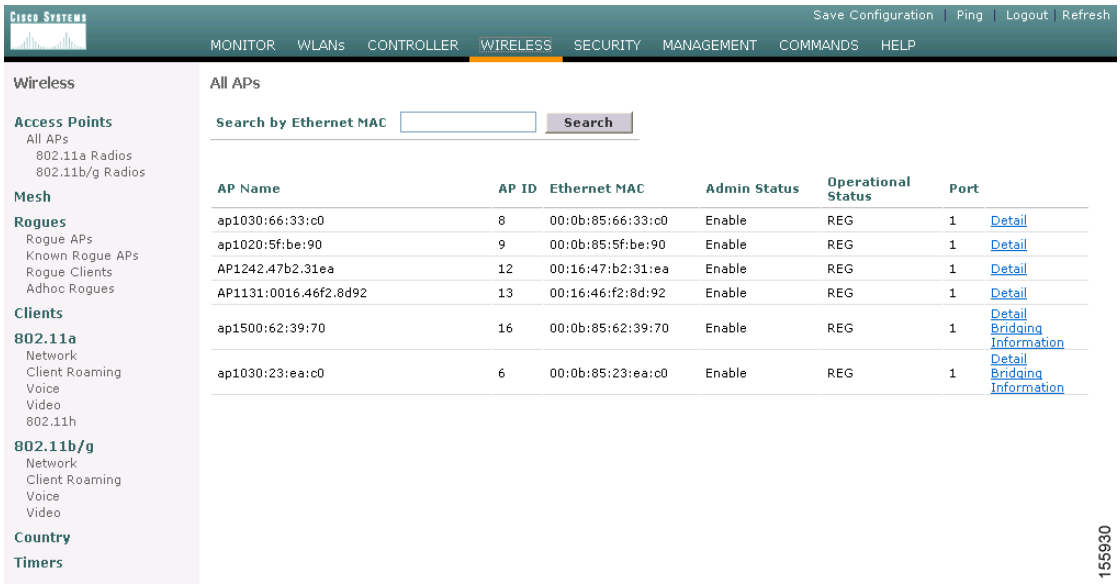
Note You can also view the status of RF groups using the Cisco Wireless Control System (WCS). Refer to the *Cisco Wireless Control System Configuration Guide* for instructions.

Using the GUI to View RF Group Status

Follow these steps to view the status of the RF group using the GUI.

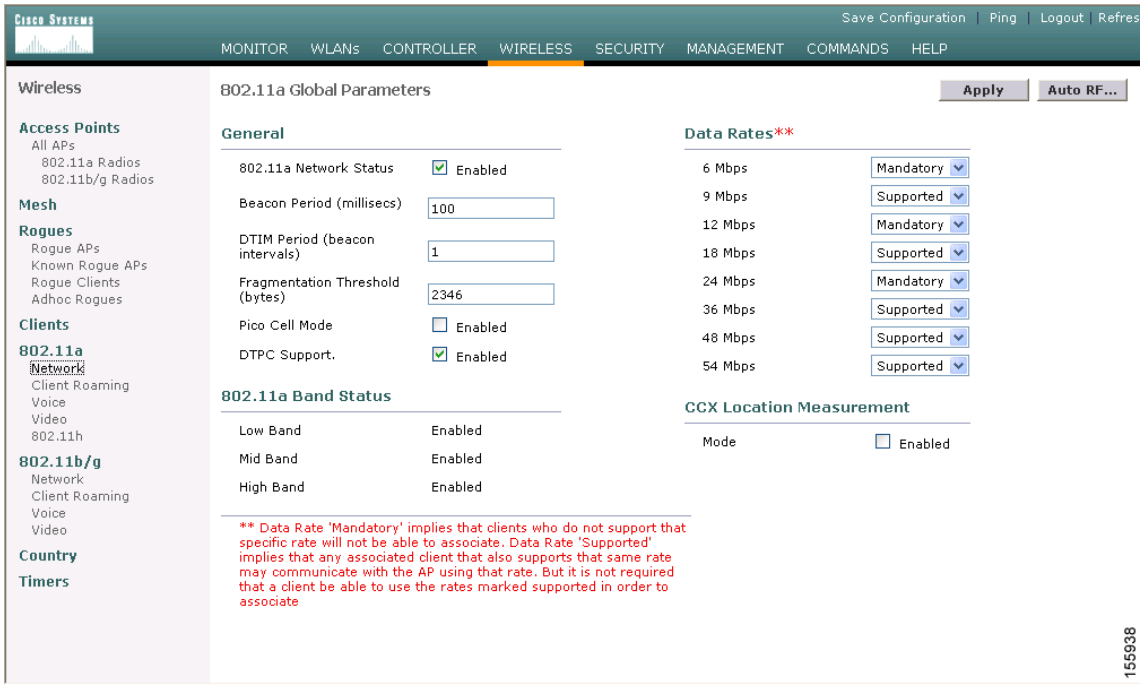
Step 1 Click **Wireless** to access the All APs page (see Figure 10-2).

Figure 10-2 All APs Page



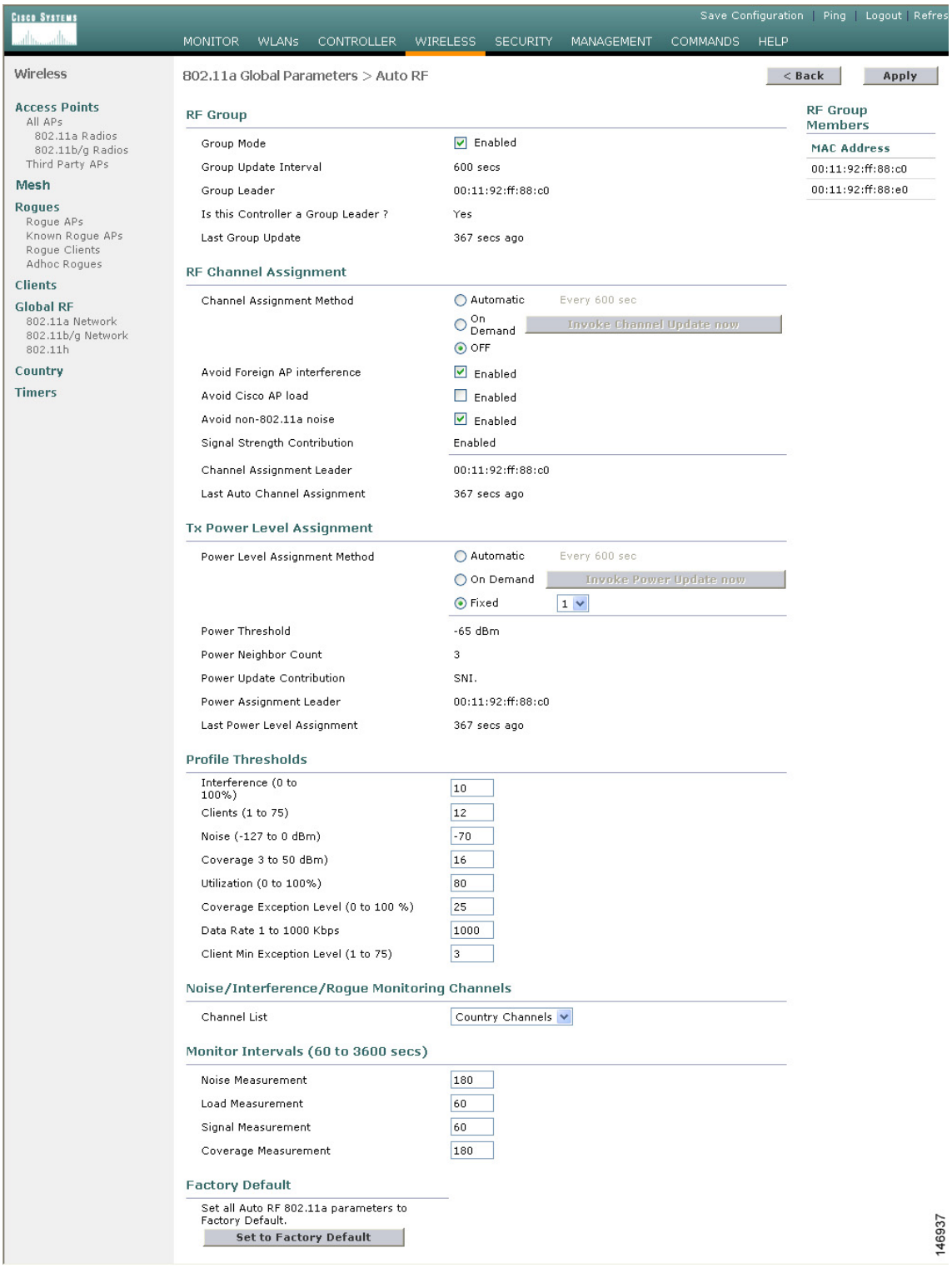
Step 2 Under 802.11a or 802.11b/g, click **Network** to access the 802.11a (or 802.11b/g) Global Parameters page (see Figure 10-3).

Figure 10-3 802.11a Global Parameters Page



Step 3 Click **Auto RF** to access the 802.11a (or 802.11b/g) Global Parameters > Auto RF page (see Figure 10-4).

Figure 10-4 802.11a Global Parameters > Auto RF Page



The top of this page shows the details of the RF group, specifically how often the group information is updated (600 seconds by default), the MAC address of the RF group leader, whether this particular controller is the group leader, the last time the group information was updated, and the MAC addresses of all group members.

Note Automatic RF grouping, which is set through the **Group Mode** check box, is enabled by default. See Table 10-1 for more information on this parameter.

Step 4 If desired, repeat this procedure for the network type you did not select (802.11a or 802.11b/g).

Using the CLI to View RF Group Status

Follow these steps to view the status of the RF group using the CLI.

Step 1 Enter **show advanced 802.11a group** to see which controller is the RF group leader for the 802.11a RF network. Information similar to the following appears:

```
Radio RF Grouping
      802.11a Group Mode.............................. AUTO
      802.11a Group Update Interval................... 600 seconds
      802.11a Group Leader............................ 00:16:9d:ca:d9:60
      802.11a Group Member............................ 00:16:9d:ca:d9:60
      802.11a Last Run............................... 594 seconds ago
```

This text shows the details of the RF group, specifically whether automatic RF grouping is enabled for this controller, how often the group information is updated (600 seconds by default), the MAC address of the RF group leader, the MAC address of this particular controller, and the last time the group information was updated.

Note If the MAC addresses of the group leader and the group member are identical, this controller is currently the group leader.

Step 2 Enter **show advanced 802.11b group** to see which controller is the RF group leader for the 802.11b/g RF network.

Enabling Rogue Access Point Detection

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

Using the GUI to Enable Rogue Access Point Detection

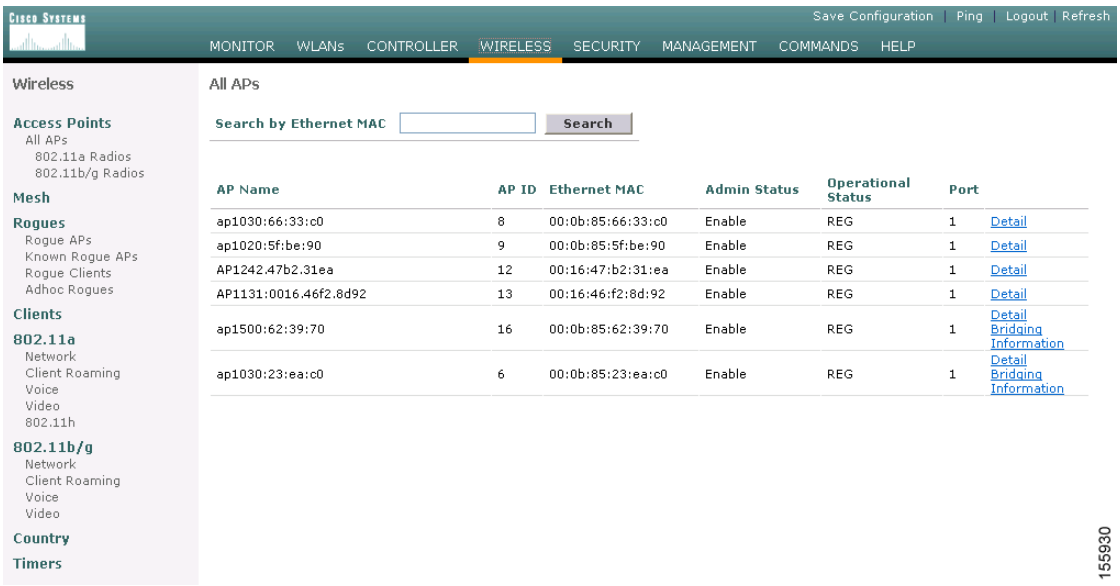
Follow these steps to enable rogue access point detection using the GUI.

Step 1 Make sure that each controller in the RF group has been configured with the same RF group name.

Note The name is used to verify the authentication IE in all beacon frames. If the controllers have different names, false alarms will occur.

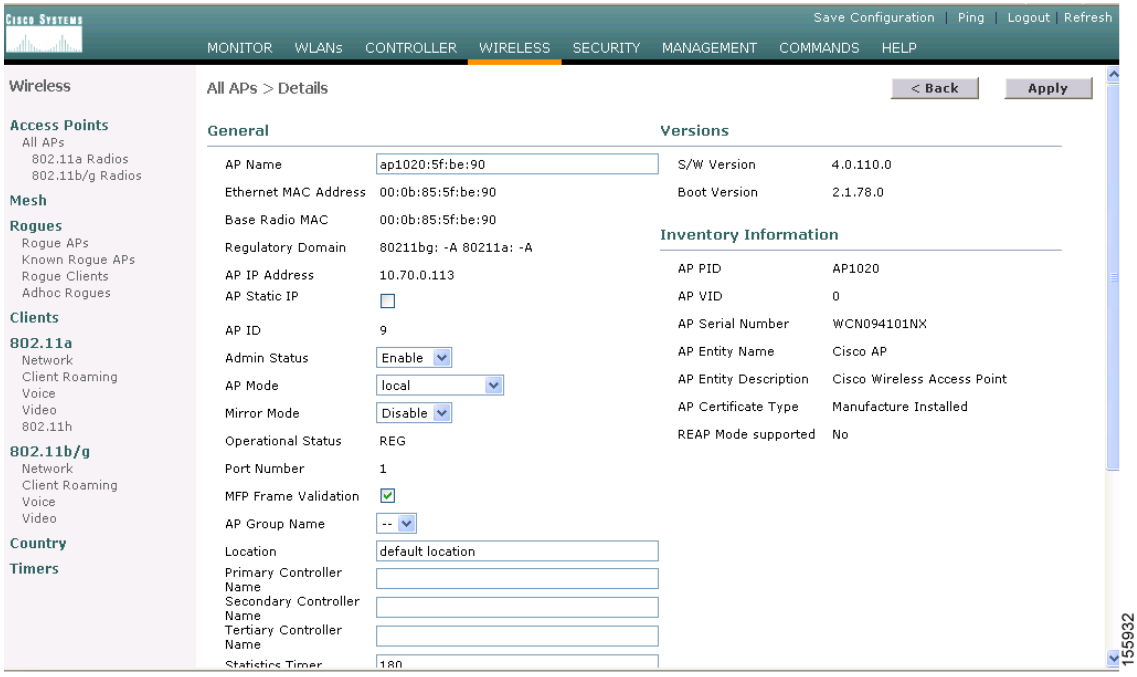
Step 2 Click **Wireless** to access the All APs page (see Figure 10-5).

Figure 10-5 All APs Page



Step 3 Click the **Detail** link for an access point to access the All APs > Details page (see Figure 10-6).

Figure 10-6 All APs > Details Page



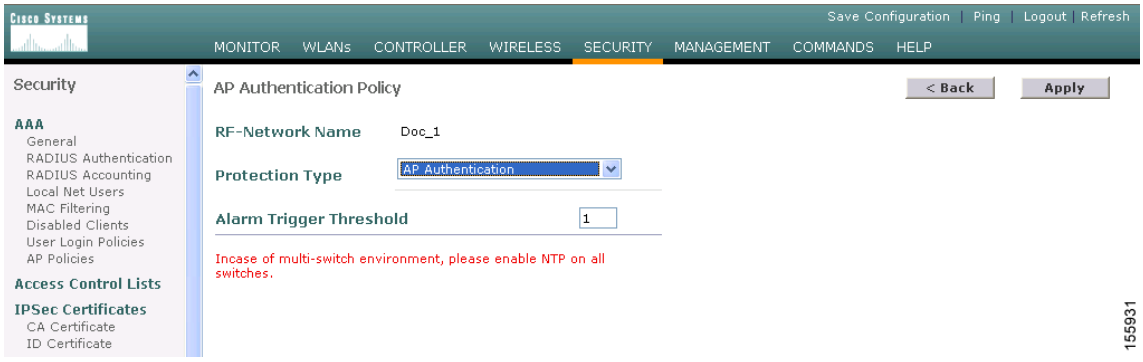
Step 4 Choose either **local** or **monitor** from the AP Mode drop-down box and click **Apply** to commit your changes.

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

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

Step 7 Click **Security > AP Authentication/MFP** (under Wireless Protection Policies) to access the AP Authentication Policy page (see Figure 10-7).

Figure 10-7 AP Authentication Policy Page



The name of the RF group to which this controller belongs appears at the top of the page.

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

Step 9 Enter a number in the Alarm Trigger Threshold edit box to specify when a rogue access point alarm is generated. An alarm occurs when the threshold value (which specifies the number of access point frames with an invalid authentication IE) is met or exceeded within the detection period.

Note The valid threshold range is from1 to 255, and the default threshold value is 1. To avoid false alarms, you may want to set the threshold to a higher value.

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

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

Step 12 Repeat this procedure on every controller in the RF group.

Note If rogue access point detection is not enabled on every controller in the RF group, the access points on the controllers with this feature disabled are reported as rogues.

Using the CLI to Enable Rogue Access Point Detection

Follow these steps to enable rogue access point detection using the CLI.

Step 1 Make sure that each controller in the RF group has been configured with the same RF group name.

Note The name is used to verify the authentication IE in all beacon frames. If the controllers have different names, false alarms will occur.

Step 2 Enter **config ap mode local** *Cisco_AP* or **config ap mode monitor** *Cisco_AP* to configure this particular access point for local (normal) mode or monitor (listen-only) mode.

Step 3 Enter **save config** to save your settings.

Step 4 Repeat Step 2 and Step 3 for every access point connected to the controller.

Step 5 Enter **config wps ap-authentication** to enable rogue access point detection.

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

Note The valid threshold range is from1 to 255, and the default threshold value is 1. To avoid false alarms, you may want to set the threshold to a higher value.

Step 7 Enter **save config** to save your settings.

Step 8 Repeat Step 5 through Step 7 on every controller in the RF group.

Note If rogue access point detection is not enabled on every controller in the RF group, the access points on the controllers with this feature disabled are reported as rogues.

Configuring Dynamic RRM

The controller is preconfigured with factory default RRM settings designed to optimize radio performance. However, you can modify the controller's dynamic RRM configuration parameters at any time through either the GUI or the CLI.

Note You can configure these parameters on an individual controller that is not part of an RF group or on RF group members.

Note The RRM parameters should be set to the same values on every controller in an RF group. The RF group leader can change at any time. If the RRM parameters are not identical for all RF group members, varying results can occur when the group leader changes.

Using the GUI to Configure Dynamic RRM

Follow these steps to configure dynamic RRM parameters using the GUI.

Step 1 Access the 802.11a (or 802.11b/g) Global Parameters > Auto RF page (see Figure 10-4).

Note Click **Set to Factory Default** at the bottom of the page if you want to return all of the controller's RRM parameters to their factory default values.

Step 2 Table 10-1 lists and describes the configurable RRM parameters. Follow the instructions in the table to make any desired changes.

Table 10-1 RRM Parameters

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td colspan="3">RF Group</td></tr>
<tr><td>Group Mode</td><td colspan="2">Determines whether the controller participates in an RF group.
Options: Enabled or Disabled
Default: Enabled</td></tr>
<tr><td></td><td>Group Mode</td><td>Description</td></tr>
<tr><td></td><td>Enabled</td><td>The controller automatically forms an RF group with other controllers. The group dynamically elects a leader to optimize RRM parameter settings for the group.</td></tr>
<tr><td></td><td>Disabled</td><td>The controller does not participate in automatic RF grouping. Rather, it optimizes its own access point parameters.</td></tr>
<tr><td></td><td colspan="2">Note Cisco recommends that controllers participate in automatic RF grouping. However, you can disable this feature if necessary by unchecking the check box. Note also, however, that you override dynamic RRM settings without disabling automatic RF group participation. See the “Overriding Dynamic RRM” section on page 10-23 for instructions.</td></tr>
</table>

Table 10-1 RRM Parameters (continued)

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td colspan="2">RF Channel Assignment</td></tr>
<tr><td>Channel Assignment Method</td><td>The controller's dynamic channel assignment mode.
Options: Automatic, On Demand, or Off
Default: Automatic

<table>
<tr><th>Channel Assignment Method</th><th>Description</th></tr>
<tr><td>Automatic</td><td>Causes the controller to periodically evaluate and, if necessary, update the channel assignment for all joined access points.</td></tr>
<tr><td>On Demand</td><td>Causes the controller to periodically evaluate the channel assignment for all joined access points. However, the controller reassigns channels, if necessary, only when you click Invoke Channel Update Now.
Note The controller does not evaluate and update the channel immediately after you click Invoke Channel Update Now. It waits for the next interval (default is 600 seconds).</td></tr>
<tr><td>Off</td><td>Prevents the controller from evaluating and, if necessary, updating the channel assignment for joined access points.</td></tr>
</table>
Note For optimal performance, Cisco recommends that you use the Automatic setting. Refer to the "Disabling Dynamic Channel and Power Assignment Globally for a Controller" section on page 10-27 for instructions if you ever need to disable the controller's dynamic settings.</td></tr>
<tr><td>Avoid Foreign AP Interference</td><td>Causes the controller's RRM algorithms to consider 802.11 traffic from foreign access points (those not included in your wireless network) when assigning channels to lightweight access points. For example, RRM may adjust the channel assignment to have access points avoid channels close to foreign access points.
Options: Enabled or Disabled
Default: Enabled</td></tr>
</table>

Table 10-1 RRM Parameters (continued)

Parameter	Description
Avoid Cisco AP Load	Causes the controller's RRM algorithms to consider 802.11 traffic from Cisco lightweight access points in your wireless network when assigning channels. For example, RRM can assign better reuse patterns to access points that carry a heavier traffic load. **Options:** Enabled or Disabled **Default:** Disabled
Avoid Non-802.11a (802.11b) Noise	Causes the controller's RRM algorithms to consider noise (non-802.11 traffic) in the channel when assigning channels to lightweight access points. For example, RRM may have access points avoid channels with significant interference from non-access point sources, such as microwave ovens. **Options:** Enabled or Disabled **Default:** Enabled

The following non-configurable RF channel parameter settings are also shown:

- **Signal Strength Contribution**—This parameter is always enabled. RRM constantly monitors the relative location of all access points within the RF group to ensure near-optimal channel reuse.
- **Channel Assignment Leader**—The MAC address of the RF group leader, which is responsible for channel assignment.
- **Last Auto Channel Assignment**—The last time RRM evaluated the current channel assignments.

Table 10-1 RRM Parameters (continued)

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td colspan="2">Tx Power Level Assignment</td></tr>
<tr><td>Power Level Assignment Method</td><td>The controller's dynamic power assignment mode.
Options: Automatic, On Demand, or Fixed
Default: Automatic

<table>
<tr><th>Power Level Assignment Method</th><th>Description</th></tr>
<tr><td>Automatic</td><td>Causes the controller to periodically evaluate and, if necessary, update the transmit power for all joined access points.</td></tr>
<tr><td>On Demand</td><td>Causes the controller to periodically evaluate the transmit power for all joined access points. However, the controller updates the power, if necessary, only when you click Invoke Power Update Now.
Note The controller does not evaluate and update the transmit power immediately after you click Invoke Power Update Now. It waits for the next interval (default is 600 seconds).</td></tr>
<tr><td>Fixed</td><td>Prevents the controller from evaluating and, if necessary, updating the transmit power for joined access points. The power level is set to the fixed value chosen from the drop-down box.
Note The transmit power level is assigned an integer value instead of a value in mW or dBm. The integer corresponds to a power level that varies depending on the regulatory domain in which the access points are deployed. See Step 5 on page 10-25 for information on available transmit power levels.</td></tr>
</table>
Note For optimal performance, Cisco recommends that you use the Automatic setting. Refer to the "Disabling Dynamic Channel and Power Assignment Globally for a Controller" section on page 10-27 for instructions if you ever need to disable the controller's dynamic settings.</td></tr>
</table>

Table 10-1 RRM Parameters (continued)

Parameter	Description
The following non-configurable transmit power level parameter settings are also shown: • **Power Threshold** and **Power Neighbor Count—**These parameters are used to fine tune the power control. The objective is to limit power so that at most the *neighbor count* access points receive the signal of each access point above a *power threshold*. • **Power Update Contribution**—The factors used for changing power assignment levels: load (L), signal (S), noise (N), or interference (I). • **Power Assignment Leader**—The MAC address of the RF group leader, which is responsible for power level assignment. • **Last Power Level Assignment**—The last time RRM evaluated the current transmit power level assignments.	
Profile Thresholds—Lightweight access points send an SNMP trap (or an alert) to the controller when the values set for these threshold parameters are exceeded. The controller's RRM software uses this information to evaluate the integrity of the entire network and makes adjustments accordingly.	
Interference (0 to 100%)	The percentage of interference (802.11 traffic from sources outside of your wireless network) on a single access point. **Default:** 10%
Clients (1 to 75)	The number of clients on a single access point. **Default:** 12
Noise (–127 to 0 dBm)	The level of noise (non-802.11 traffic) on a single access point. **Default:** –70 dBm
Coverage (3 to 50 dB)	The signal-to-noise ratio (SNR) per access point. This value is also used for reporting detected coverage holes. **Default:** 12 dB (802.11b/g) or 16 dB (802.11a)
Utilization (0 to 100%)	The percentage of RF bandwidth being used by a single access point. **Default:** 80%
Coverage Exception Level (0 to 100%)	The percentage of clients on an access point that are experiencing a low signal level but cannot roam to another access point. This value is based on the Coverage threshold and the Client Min Exception Level threshold. **Default:** 25%
Data Rate (1 to 1000 Kbps)	The rate at which a single access point transmits or receives data packets. **Default:** 1000 Kbps

Table 10-1 RRM Parameters (continued)

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Client Min Exception Level (1 to 75)</td><td>The minimum number of clients on an access point with a signal-to-noise ratio (SNR) below the Coverage threshold. This threshold works in conjunction with the Coverage and Coverage Exception Level thresholds. A coverage exception is alerted if the Coverage Exception Level percentage of clients (25%) and the Client Min Exception Level number of clients (3) fall below the Coverage threshold (12 dB). In this example, a coverage alarm would be generated if at least 25% and a minimum of 3 clients have an SNR value below 12 dB (802.11b/g) or 16 dB (802.11a).

Default: 3</td></tr>
<tr><td colspan="2">Noise/Interference/Rogue Monitoring Channels</td></tr>
<tr><td>Channel List</td><td>The set of channels that the access point uses for RRM scanning.

Options: All Channels, Country Channels, or DCA Channels

Default: Country Channels

<table>
<tr><th>Channel List</th><th>Description</th></tr>
<tr><td>All Channels</td><td>RRM channel scanning occurs on all channels supported by the selected radio, which includes channels not allowed in the country of operation.</td></tr>
<tr><td>Country Channels</td><td>RRM channel scanning occurs only on the data channels in the country of operation.</td></tr>
<tr><td>DCA Channels</td><td>RRM channel scanning occurs only on the channel set used by the dynamic channel allocation (DCA) algorithm, which typically includes all the non-overlapping channels allowed in the country of operation.

Note You can specify the channel set to be used for DCA from the controller CLI. See the “Using the CLI to Configure Dynamic RRM” section on page 10-22 for instructions.</td></tr>
</table></td></tr>
<tr><td colspan="2">Monitor Intervals</td></tr>
<tr><td>Noise Measurement</td><td>How frequently the access point measures noise and interference.

Range: 60 to 3600 seconds

Default: 180 seconds</td></tr>
<tr><td>Load Measurement</td><td>How frequently the access point measures 802.11 traffic.

Range: 60 to 3600 seconds

Default: 60 seconds</td></tr>
</table>

Table 10-1 RRM Parameters (continued)

Parameter	Description
Signal Measurement	How frequently the access point measures signal strength and how frequently neighbor packets (messages) are sent, which eventually builds the neighbor list. **Range:** 60 to 3600 seconds **Default:** 60 seconds
Coverage Measurement	How frequently the access point measures the coverage area and passes this information to the controller. **Range:** 60 to 3600 seconds **Default:** 180 seconds

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

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

Step 5 Repeat this procedure to set the same parameter values for every controller in the RF group.

Using the CLI to Configure Dynamic RRM

Follow these steps to configure dynamic RRM using the CLI.

Step 1 Enter this command to disable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} disable

Step 2 Perform one of the following:

- To have RRM automatically configure all 802.11a or 802.11b/g channels based on availability and interference, enter this command:

  config {802.11a | 802.11b} channel global auto

- To have RRM automatically reconfigure all 802.11a or 802.11b/g channels one time based on availability and interference, enter this command:

  config {802.11a | 802.11b} channel global once

- To specify the channel set used for dynamic channel allocation, enter this command:

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

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

Step 3 Perform one of the following:

- To have RRM automatically set the transmit power for all 802.11a or 802.11b/g radios at periodic intervals, enter this command:

  config {802.11a | 802.11b} txPower global auto

- To have RRM automatically reset the transmit power for all 802.11a or 802.11b/g radios one time, enter this command:

  config {802.11a | 802.11b} txPower global once

Step 4 Enter this command to enable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} enable

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

Step 5 Enter this command to save your settings:

save config

Overriding Dynamic RRM

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

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

You can disable dynamic channel and power assignment globally for a controller, or you can leave dynamic channel and power assignment enabled and statically configure specific access point radios with a channel and power setting. Follow the instructions in one of the following sections:

- Statically Assigning Channel and Transmit Power Settings to Access Point Radios, page 10-24
- Disabling Dynamic Channel and Power Assignment Globally for a Controller, page 10-27

Note While you can specify a global default transmit power parameter for each network type that applies to all the access point radios on a controller, you must set the channel for each access point radio when you disable dynamic channel assignment. You may also want to set the transmit power for each access point instead of leaving the global transmit power in effect.

Note You can also override dynamic RRM using the Cisco Wireless Control System (WCS). Refer to the *Cisco Wireless Control System Configuration Guide* for instructions.

Statically Assigning Channel and Transmit Power Settings to Access Point Radios

This section provides instructions for statically assigning channel and power settings using the GUI or CLI.

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

Note Cisco recommends that you do not assign all access points that are within close proximity to each other to the maximum power level.

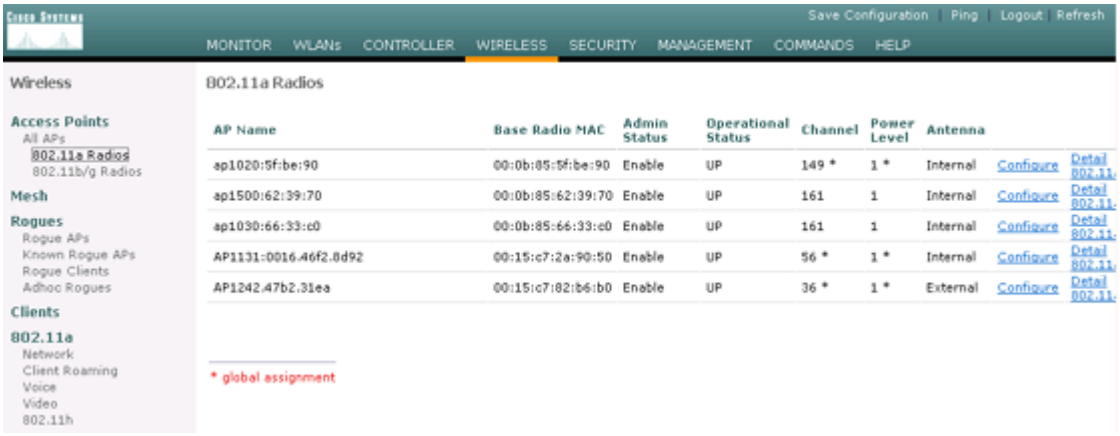
Using the GUI to Statically Assign Channel and Transmit Power Settings

Follow these steps to statically assign channel and/or power settings on a per access point radio basis using the GUI.

Step 1 Click **Wireless** to access the All APs page (see Figure 10-2).

Step 2 Under Access Points, click either **802.11a Radios** or **802.11b/g Radios** to access the 802.11a (or 802.11b/g) Radios page (see Figure 10-8).

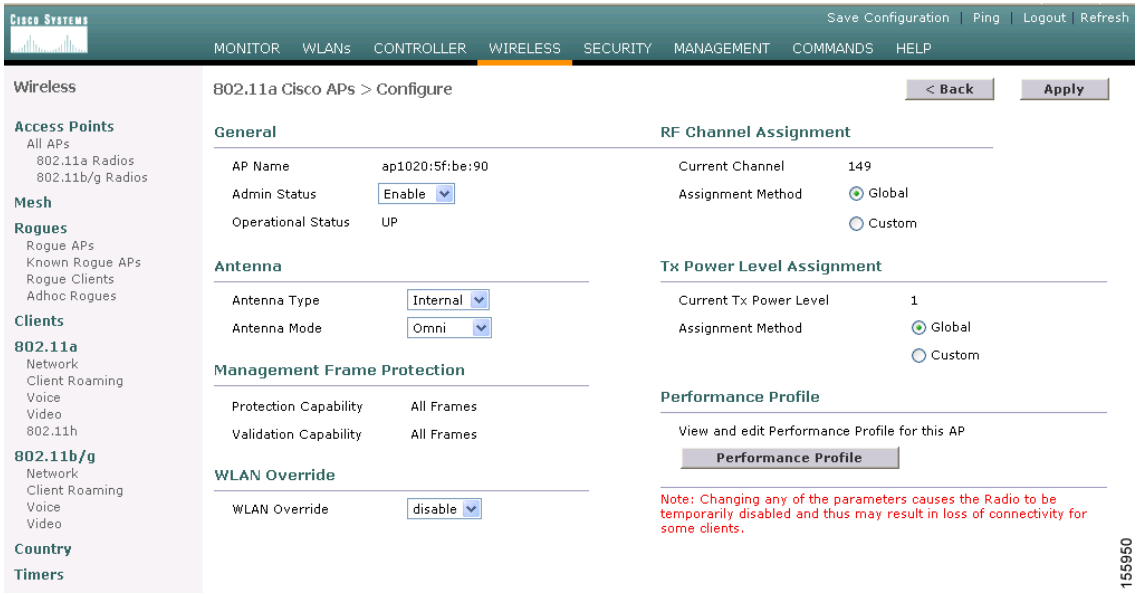
Figure 10-8 802.11a Radios Page



This page shows all the 802.11a or 802.11b/g access point radios that are joined to the controller and their current settings.

Step 3 Click **Configure** for the access point for which you want to modify the radio configuration. The 802.11a (or 802.11b/g) Cisco APs > Configure page appears (see Figure 10-9).

Figure 10-9 802.11a Cisco APs > Configure Page



Step 4 To assign an RF channel to the access point radio, choose **Custom** for the Assignment Method under RF Channel Assignment and choose a channel from the drop-down box.

Step 5 To assign a transmit power level to the access point radio, choose **Custom** for the Assignment Method under Tx Power Level Assignment and choose a transmit power level from the drop-down box.

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

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

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

Step 7 Click **Save Configuration** to save the changes to the access point radio.

Step 8 Repeat this procedure for each access point radio for which you want to assign a static channel and power level.

Using the CLI to Statically Assign Channel and Transmit Power Settings

Follow these steps to statically assign channel and/or power settings on a per access point radio basis using the CLI.

Step 1 Enter this command to disable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} disable

Step 2 To specify the channel that a particular access point is to use, enter this command:

config {802.11a | 802.11b} channel *Cisco_AP channel*

Example: To configure 802.11a channel 36 as the default channel on AP1, enter this command: **config 802.11a channel AP1 36**.

Step 3 To specify the transmit power level that a particular access point is to use, enter this command:

config {802.11a | 802.11b} txPower *Cisco_AP power_level*

Example: To set the transmit power for 802.11a AP1 to power level 2, enter this command: **config 802.11a txPower AP1 2**.

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

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

Step 4 Enter this command to save your settings:

save config

Step 5 Repeat Step 2 through Step 4 for each access point radio for which you want to assign a static channel and power level.

Step 6 Enter this command to enable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} enable

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

Step 7 Enter this command to save your settings:

save config

Disabling Dynamic Channel and Power Assignment Globally for a Controller

You can use the GUI or CLI to disable dynamic channel and power assignment.

Using the GUI to Disable Dynamic Channel and Power Assignment

Follow these steps to configure disable dynamic channel and power assignment using the GUI.

Step 1 Click **Wireless** to access the All APs page (see Figure 10-2).

Step 2 Under 802.11a or 802.11b/g, click **Network** to access the 802.11a (or 802.11b/g) Global Parameters page (see Figure 10-3).

Step 3 Click **Auto RF** to access the 802.11a (or 802.11b/g) Global Parameters > Auto RF page (see Figure 10-4).

Step 4 To disable dynamic channel assignment, choose **Off** under RF Channel Assignment.

Step 5 To disable dynamic power assignment, choose **Fixed** under Tx Power Level Assignment and choose a default transmit power level from the drop-down box.

Note See Step 5 on page 10-25 for information on transmit power levels.

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

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

Step 8 If you are overriding the default channel and power settings on a per radio basis, assign static channel and power settings to each of the access point radios that are joined to the controller.

Step 9 If desired, repeat this procedure for the network type you did not select (802.11a or 802.11b/g).

Using the CLI to Disable Dynamic Channel and Power Assignment

Follow these steps to disable RRM for all 802.11a or 802.11b/g radios.

Step 1 Enter this command to disable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} disable

Step 2 Enter this command to disable RRM for all 802.11a or 802.11b/g radios and set all channels to the default value:

config {802.11a | 802.11b} channel global off

Step 3 Enter this command to enable the 802.11a or 802.11b/g network:

config {802.11a | 802.11b} enable

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

Step 4 Enter this command to save your settings:

save config

Viewing Additional RRM Settings Using the CLI

Use these commands to view additional 802.11a and 802.11b/g RRM settings:

- **show advanced 802.11a** *?*
- **show advanced 802.11b** *?*

  where *?* is one of the following:

  ccx—Shows the Cisco Compatible Extensions (CCX) RRM configuration.

  channel—Shows the channel assignment configuration and statistics.

  logging—Shows the RF event and performance logging.

  monitor—Shows the Cisco radio monitoring.

  profile—Shows the access point performance profiles.

  receiver—Shows the 802.11a or 802.11b/g receiver configuration and statistics.

  summary—Shows the configuration and statistics of the 802.11a or 802.11b/g access points

  txpower—Shows the transmit power assignment configuration and statistics.

Note To troubleshoot RRM-related issues, refer to the *Cisco Wireless LAN Controller Command Reference, Release 3.2* for RRM (airewave-director) debug commands.

Configuring CCX Radio Management Features

In controller software release 4.0, you can configure two parameters that affect client location calculations:

- Broadcast location measurement requests
- Location calibration

These parameters are supported in Cisco Client Extensions (CCX) v2 and higher and are designed to enhance location accuracy and timeliness for participating CCX clients. See the "Configuring Quality of Service Profiles" section on page 6-19 for more information on CCX.

For the location features to operate properly, the access points must be configured for normal, monitor, or hybrid-REAP mode. However, for hybrid-REAP mode, the access point must be connected to the controller.

Note CCX is not supported on the AP1030.

Broadcast Location Measurement Requests

When this feature is enabled, lightweight access points issue broadcast radio measurement request messages to clients running CCXv2 or higher. The access points transmit these messages for every SSID over each enabled radio interface at a configured interval. In the process of performing 802.11 location measurements, CCX clients send 802.11 broadcast probe requests on all the channels specified in the measurement request. The Cisco Location Appliance uses the uplink measurements based on these requests received at the access points to quickly and accurately calculate the client location.

You do not need to specify on which channels the clients are to measure. The controller, access point, and client automatically determine which channels to use.

Note Non-CCX and CCXv1 clients simply ignore the CCX measurement requests and therefore do not participate in this location measurement activity.

Location Calibration

For CCX clients that need to be tracked more closely (for example, when a client calibration is performed), the controller can be configured to command the access point to send unicast measurement requests to these clients at a configured interval and whenever a CCX client roams to a new access point. These unicast requests can be sent out more often to these specific CCX clients than the broadcast measurement requests, which are sent to all clients.

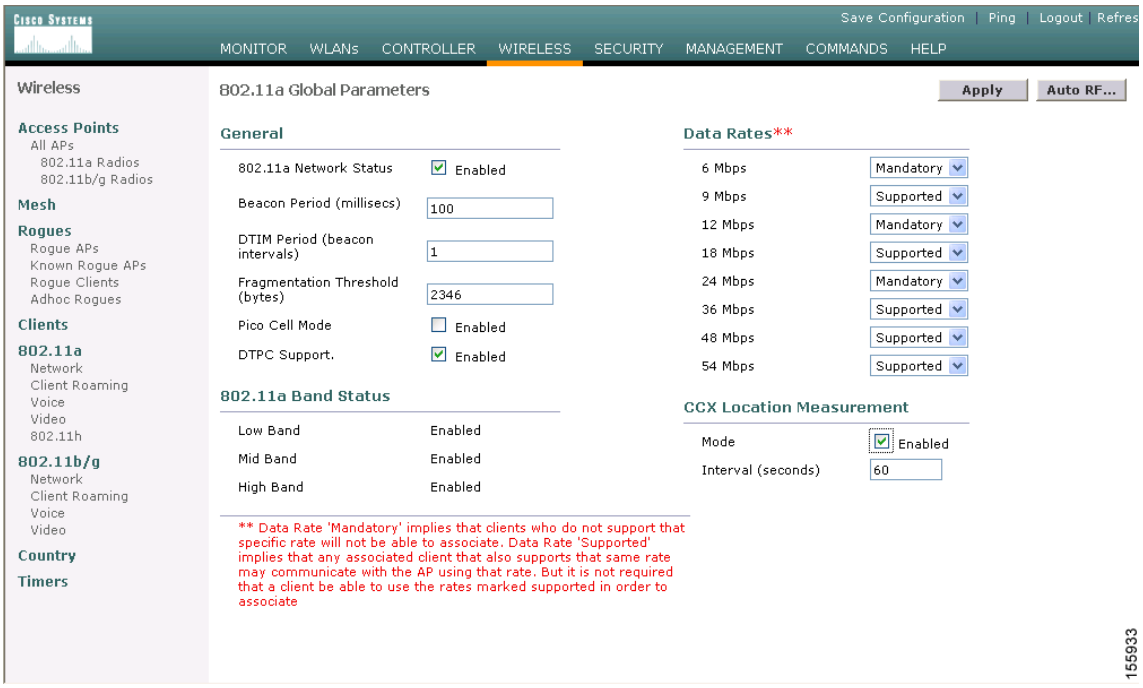
When location calibration is configured for non-CCX and CCXv1 clients, the clients are forced to disassociate at a specified interval to generate location measurements.

Using the GUI to Configure CCX Radio Management

Follow these steps to configure CCX radio management using the controller GUI.

Step 1 Click **Wireless** and then click **Network** under either 802.11a or 802.11b/g. The 802.11a (or 802.11b/g) Global Parameters page appears (see Figure 10-10).

Figure 10-10 802.11a Global Parameters Page



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

Step 3 If you checked the Mode check box in the previous step, enter a value in the Interval field to specify how often the access points are to issue the broadcast radio measurement requests.

Range: 60 to 32400 seconds

Default: 60 seconds

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

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

Step 6 Follow the instructions in Step 2 of the "Using the CLI to Configure CCX Radio Management" section below to enable access point customization.

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

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

Using the CLI to Configure CCX Radio Management

Follow these steps to enable CCX radio management using the controller CLI.

Step 1 Enter this command to globally enable CCX radio management:

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

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

Step 2 Enter these two commands to enable access point customization:

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

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

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

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

Step 3 Enter this command to enable or disable location calibration for a particular client:

config client location-calibration {**enable** | **disable**} *client _mac interval_seconds*

Note You can configure up to five clients per controller for location calibration.

Step 4 Enter this command to save your settings:

save config

Using the CLI to Obtain CCX Radio Management Information

Use these commands to obtain information about CCX radio management on the controller.

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

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

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

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

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

   show client location-calibration summary

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

   show client detail *client_mac*

Use these commands to obtain radio management debug information for the controller.

1. To debug CCX broadcast measurement request activity, enter this command:

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

2. To debug client location calibration activity, enter this command:

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

3. To debug the output for forwarded probes and their included RSSI for both antennas, enter this command:

   debug dot11 load-balancing

CHAPTER 11

Configuring Mobility GroupsWireless Device Access

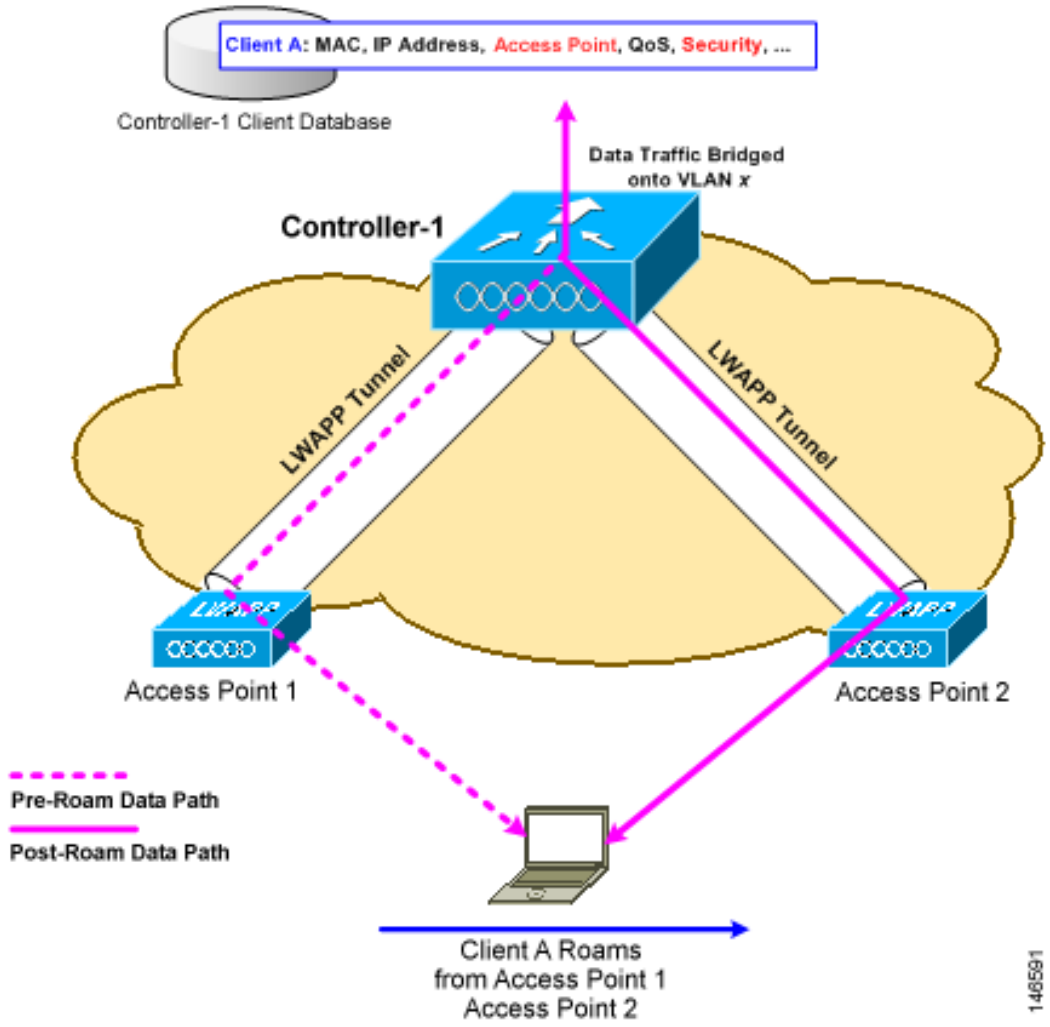
This chapter describes mobility groups and explains how to configure them on the controllers. It contains these sections:

Overview of Mobility

Mobility, or roaming, is a wireless LAN client's ability to maintain its association seamlessly from one access point to another securely and with as little latency as possible. This section explains how mobility works when controllers are included in a wireless network.

When a wireless client associates and authenticates to an access point, the access point's controller places an entry for that client in its client database. This entry includes the client's MAC and IP addresses, security context and associations, quality of service (QoS) contexts, the WLAN, and the associated access point. The controller uses this information to forward frames and manage traffic to and from the wireless client. Figure 11-1 illustrates a wireless client roaming from one access point to another when both access points are joined to the same controller.

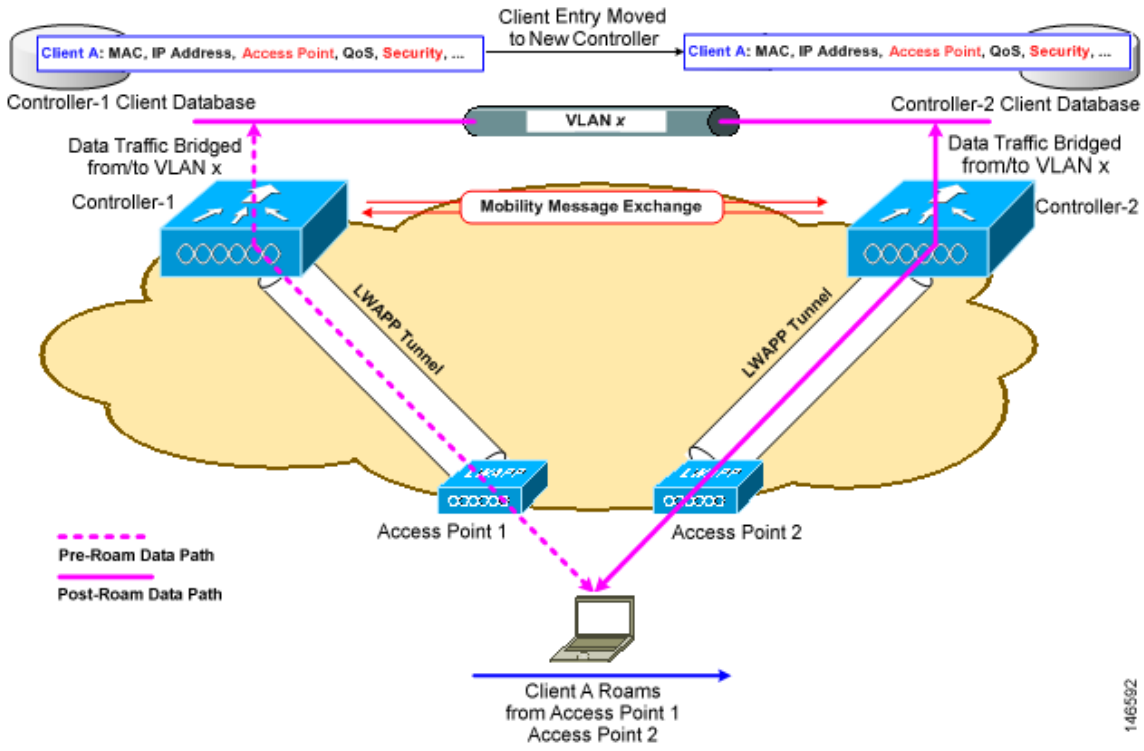
Figure 11-1 Intra-Controller Roaming



When the wireless client moves its association from one access point to another, the controller simply updates the client database with the newly associated access point. If necessary, new security context and associations are established as well.

The process becomes more complicated, however, when a client roams from an access point joined to one controller to an access point joined to a different controller. It also varies based on whether the controllers are operating on the same subnet. Figure 11-2 illustrates inter-controller roaming, which occurs when the controllers' wireless LAN interfaces are on the same IP subnet.

Figure 11-2 Inter-Controller Roaming

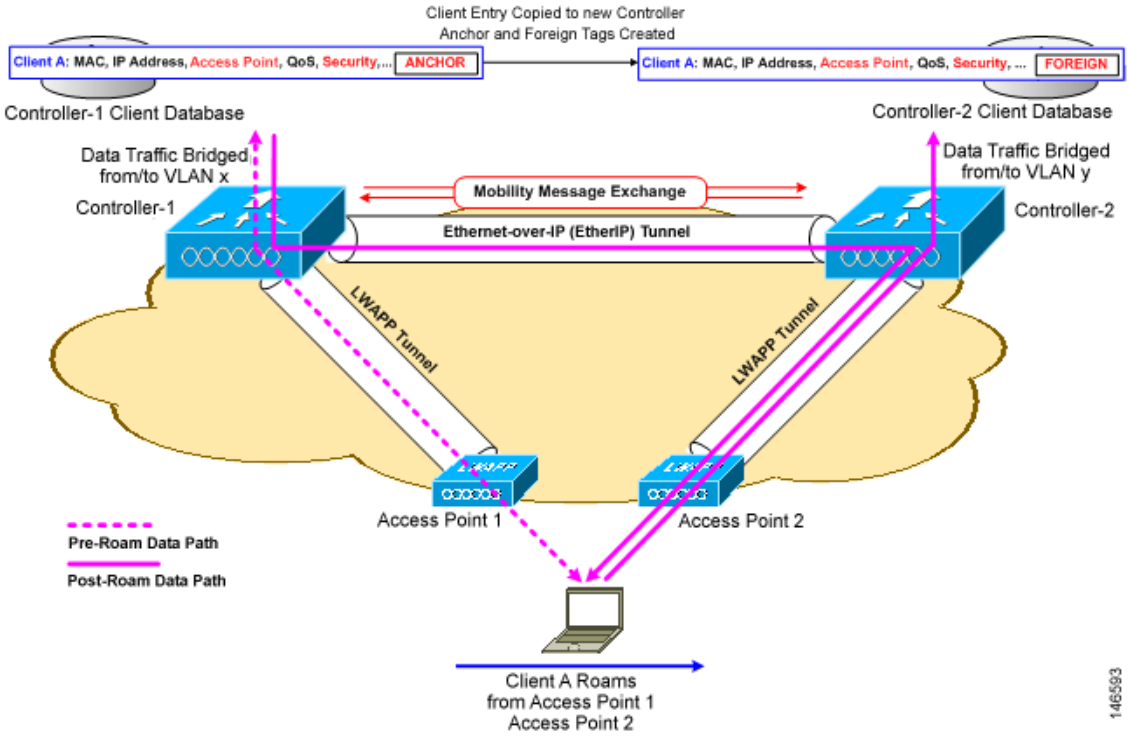


When the client associates to an access point joined to a new controller, the new controller exchanges mobility messages with the original controller, and the client database entry is moved to the new controller. New security context and associations are established if necessary, and the client database entry is updated for the new access point. This process remains transparent to the user.

Note All clients configured with 802.1x/Wi-Fi Protected Access (WPA) security complete a full authentication in order to comply with the IEEE standard.

Figure 11-3 illustrates inter-subnet roaming, which occurs when the controllers' wireless LAN interfaces are on different IP subnets.

Figure 11-3 Inter-Subnet Roaming



Inter-subnet roaming is similar to inter-controller roaming in that the controllers exchange mobility messages on the client roam. However, instead of moving the client database entry to the new controller, the original controller marks the client with an "Anchor" entry in its own client database. The database entry is copied to the new controller client database and marked with a "Foreign" entry in the new controller. The roam remains transparent to the wireless client, and the client maintains its original IP address.

After an inter-subnet roam, data to and from the wireless client flows in an asymmetric traffic path. Traffic from the client to the network is forwarded directly into the network by the foreign controller. Traffic to the client arrives at the anchor controller, which forwards the traffic to the foreign controller in an EtherIP tunnel. The foreign controller then forwards the data to the client. If a wireless client roams to a new foreign controller, the client database entry is moved from the original foreign controller to the new foreign controller, but the original anchor controller is always maintained. If the client moves back to the original controller, it becomes local again.

In inter-subnet roaming, WLANs on both anchor and foreign controllers need to have the same network access privileges and no source-based routing or source-based firewalls in place. Otherwise, the clients may have network connectivity issues after the handoff.

Note Currently, multicast traffic cannot be passed during inter-subnet roaming. With this in mind, you would not want to design an inter-subnet network for SpectraLink phones that need to send multicast traffic while using push to talk.

Note Both inter-controller roaming and inter-subnet roaming require the controllers to be in the same mobility group. See the next two sections for a description of mobility groups and instructions for configuring them.

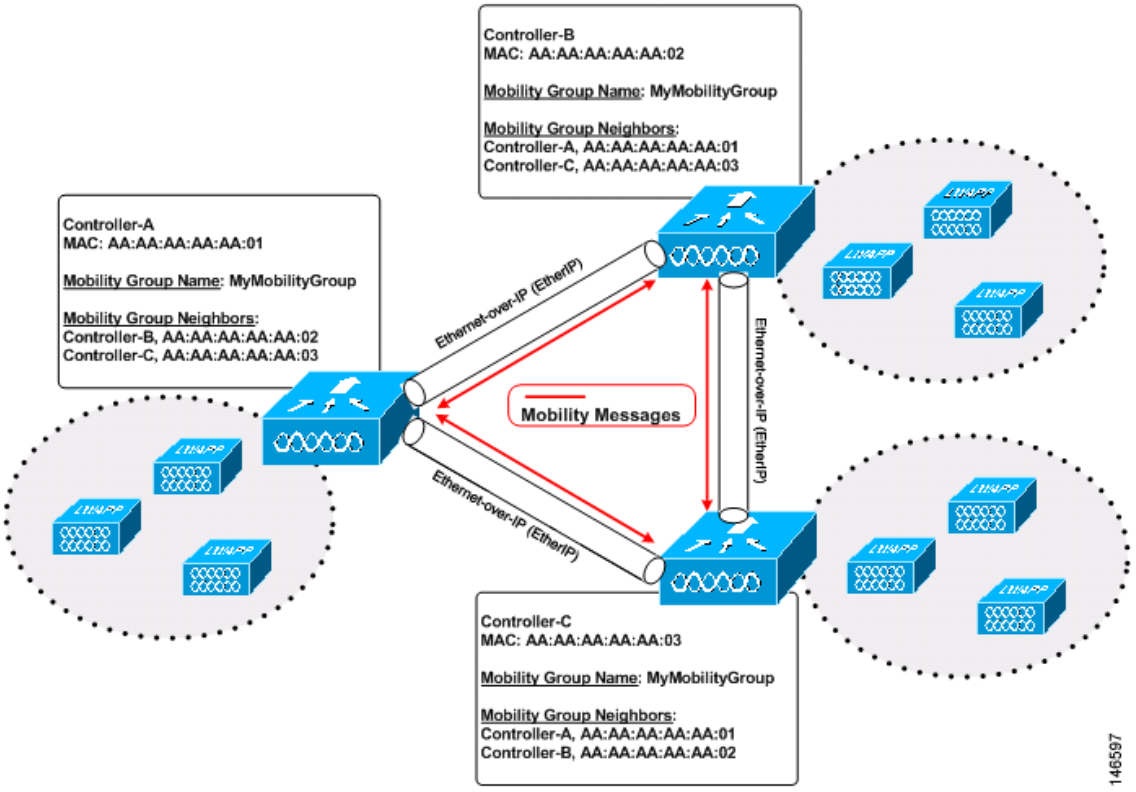
Overview of Mobility Groups

A set of controllers can be configured as a mobility group to allow seamless client roaming within a group of controllers. By creating a mobility group, you can enable multiple controllers in a network to dynamically share information and forward data traffic when inter-controller or inter-subnet roaming occurs. Controllers can share the context and state of client devices and controller loading information. With this information, the network can support inter-controller wireless LAN roaming and controller redundancy.

Note Clients do not roam across mobility groups.

Figure 11-4 shows an example of a mobility group.

Figure 11-4 A Single Mobility Group



As shown above, each controller is configured with a list of the other members of the mobility group. Whenever a new client joins a controller, the controller sends out a unicast message to all of the controllers in the mobility group. The controller to which the client was previously connected passes on the status of the client. All mobility exchange traffic between controllers is carried over an LWAPP tunnel. IPSec encryption can also be configured for the inter-controller mobility messages.

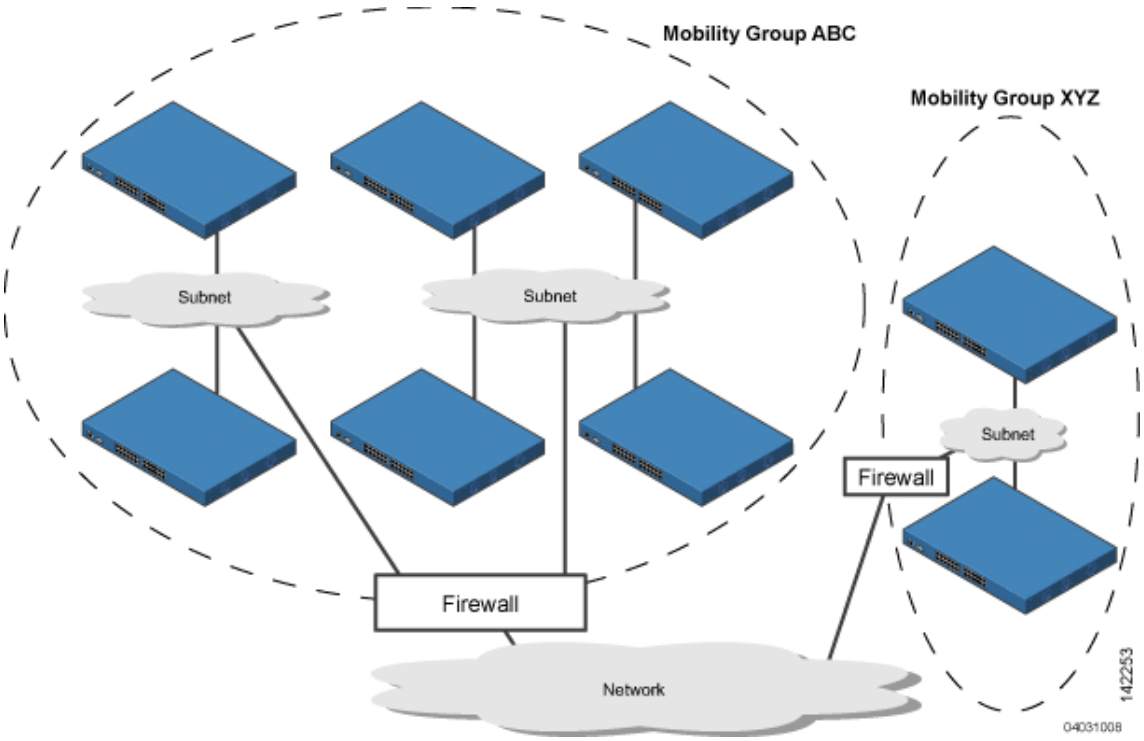
A mobility group can include up to 24 controllers of any type. The number of access points supported in a mobility group is bound by the number of controllers and controller types in the group.

Examples:

1. A 4404-100 controller supports up to 100 access points. Therefore, a mobility group consisting of 24 4404-100 controllers supports up to 2400 access points (24 * 100 = 2400 access points).
2. A 4402-25 controller supports up to 25 access points, and a 4402-50 controller supports up to 50 access points. Therefore, a mobility group consisting of 12 4402-25 controllers and 12 4402-50 controllers supports up to 900 access points (12 * 25 + 12 * 50 = 300 + 600 = 900 access points).

Mobility groups enable you to limit roaming between different floors, buildings, or campuses in the same enterprise by assigning different mobility group names to different controllers within the same wireless network. Figure 11-5 shows the results of creating distinct mobility group names for two groups of controllers.

Figure 11-5 Two Mobility Groups



The controllers in the ABC mobility group recognize and communicate with each other through their access points and through their shared subnets. The controllers in the ABC mobility group do not recognize or communicate with the XYZ controllers, which are in a different mobility group. Likewise, the controllers in the XYZ mobility group do not recognize or communicate with the controllers in the ABC mobility group. This feature ensures mobility group isolation across the network.

Note Clients may roam between access points in different mobility groups, provided they can hear them. However, their session information is not carried between controllers in different mobility groups.

Determining When to Include Controllers in a Mobility Group

If it is possible for a wireless client in your network to roam from an access point joined to one controller to an access point joined to another controller, both controllers should be in the same mobility group.

Configuring Mobility Groups

This section provides instructions for configuring controller mobility groups through either the GUI or the CLI.

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

Prerequisites

Before you add controllers to a mobility group, you must verify that the following requirements have been met for all controllers that are to be included in the group:

- All controllers must be configured for the same LWAPP transport mode (Layer 2 or Layer 3).

  Note You can verify and, if necessary, change the LWAPP transport mode on the Controller > General page.

- IP connectivity must exist between the management interfaces of all controllers.

  Note You can verify IP connectivity by pinging the controllers.

- All controllers must be configured with the same mobility group name.

  Note The mobility group name is generally set at deployment time through the Startup Wizard. However, you can change it if necessary through the Default Mobility Domain Name field on the Controller > General page. The mobility group name is case sensitive.

  Note For the Cisco WiSM, both controllers should be configured with the same mobility group name for seamless routing among 300 access points.

- All controllers must be configured with the same virtual interface IP address.

Note If necessary, you can change the virtual interface IP address by editing the virtual interface name on the Controller > Interfaces page. See Chapter 3 for more information on the controller's virtual interface.

Note If all the controllers within a mobility group are not using the same virtual interface, inter-controller roaming may appear to work, but the hand-off does not complete, and the client loses connectivity for a period of time.

- You must have gathered the MAC address and IP address of every controller that is to be included in the mobility group. This information is necessary because you will be configuring all controllers with the MAC address and IP address of all the other mobility group members.

Note You can find the MAC and IP addresses of the other controllers to be included in the mobility group on the Controller > Mobility Groups page of each controller's GUI.

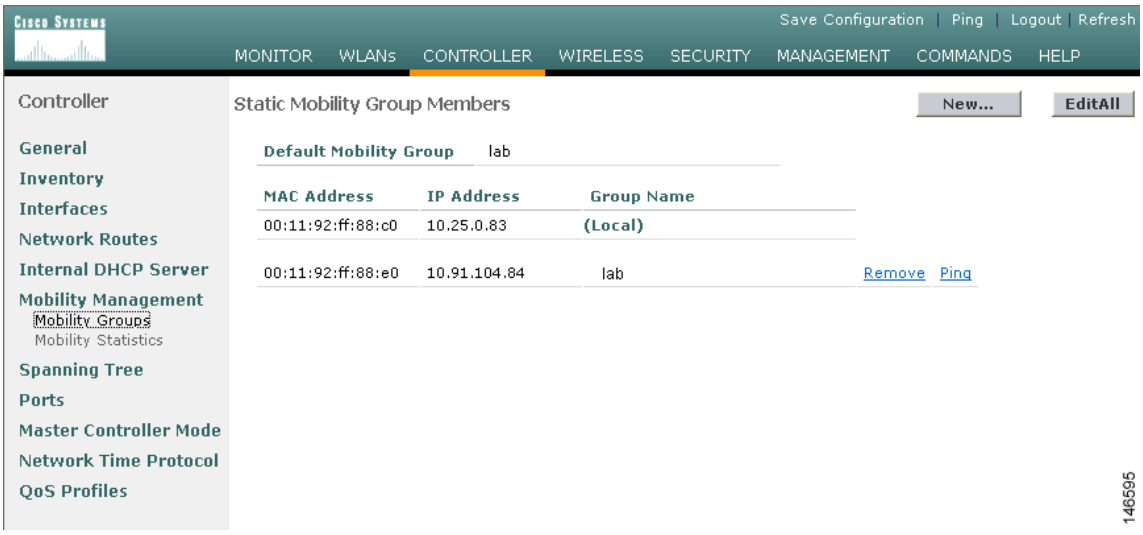
Using the GUI to Configure Mobility Groups

Follow these steps to configure mobility groups using the GUI.

Note See the "Using the CLI to Configure Mobility Groups" section on page 11-11 if you would prefer to configure mobility groups using the CLI.

Step 1 Click **Controller** > **Mobility Groups** to access the Static Mobility Group Members page (see Figure 11-6).

Figure 11-6 Static Mobility Group Members Page



This page shows the mobility group name in the Default Mobility Group field and lists the MAC address and IP address of each controller that is currently a member of the mobility group. The first entry is the local controller, which cannot be deleted.

Note Click **Remove** if you want to delete any of the remote controllers from the mobility group.

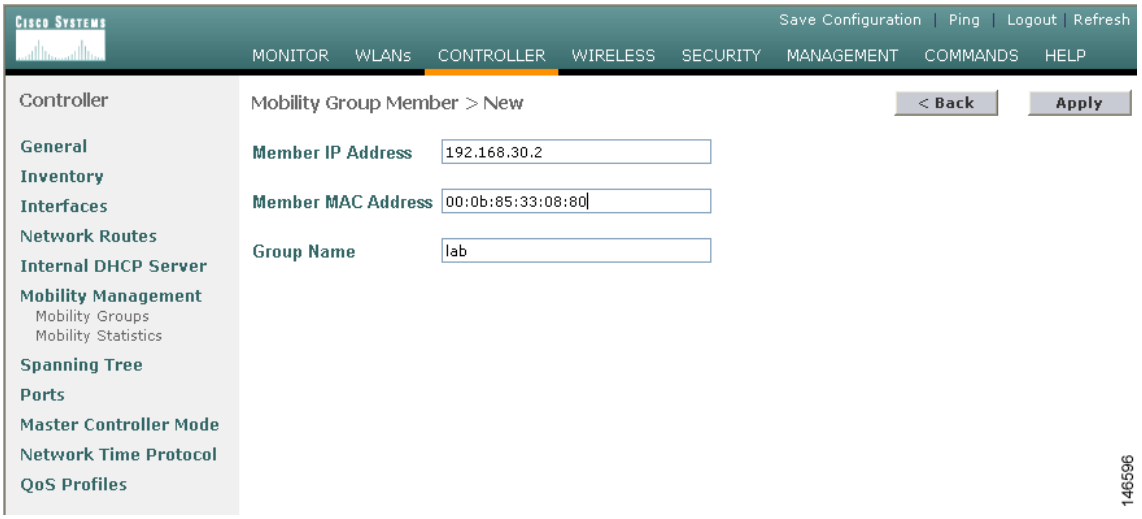
Step 2 Perform one of the following to add controllers to a mobility group:

- If you are adding only one controller or want to individually add multiple controllers, click **New** and go to Step 3.
- If you are adding multiple controllers and want to add them in bulk, click **EditAll** and go to Step 4.

Note The EditAll option enables you to enter the MAC and IP addresses of all the current mobility group members and then copy and paste all the entries from one controller to the other controllers in the mobility group.

Step 3 The Mobility Group Member > New page appears (see Figure 11-7).

Figure 11-7 Mobility Group Member > New Page



Follow these steps to add a controller to the mobility group:

a. In the Member IP Address field, enter the management interface IP address of the controller to be added.

b. In the Member MAC Address field, enter the MAC address of the controller to be added.

c. In the Group Name field, enter the name of the mobility group.

Note The mobility group name is case sensitive.

d. Click **Apply** to commit your changes. The new controller is added to the list of mobility group members on the Static Mobility Group Members page.

e. Click **Save Configuration** to save your changes.

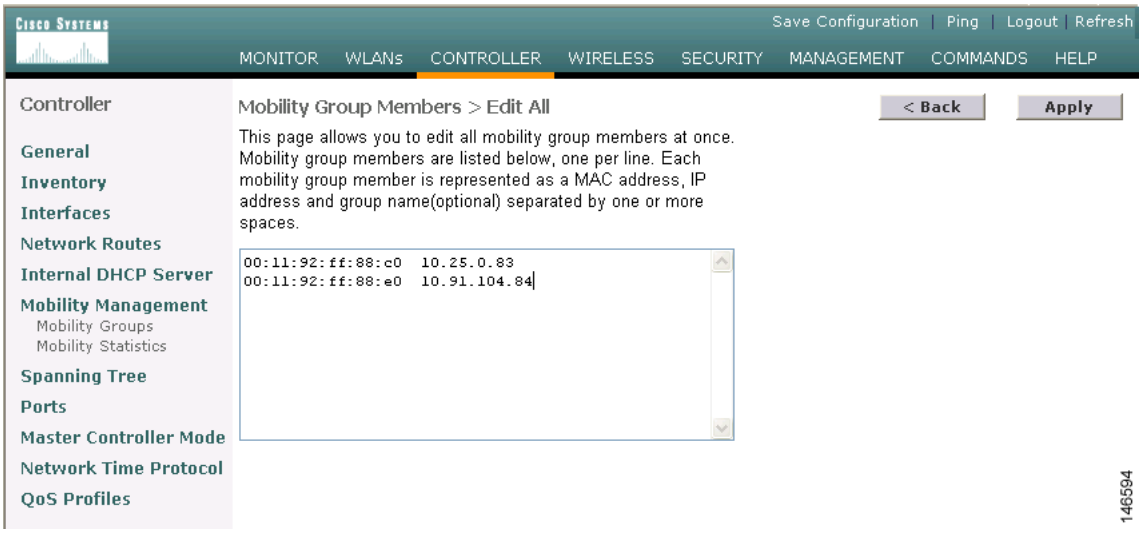
f. Repeat Step a through Step d to add all of the controllers in the mobility group.

g. Repeat this procedure on every controller to be included in the mobility group. All controllers in the mobility group must be configured with the MAC address and IP address of all other mobility group members.

Step 4 The Mobility Group Members > Edit All page (see Figure 11-8) lists the MAC address, IP address, and mobility group name (optional) of all the controllers currently in the mobility group. The controllers are listed one per line with the local controller at the top of the list.

Note If desired, you can edit or delete any of the controllers in the list.

Figure 11-8 Mobility Group Members > Edit All Page



Follow these steps to add more controllers to the mobility group:

a. Click inside the edit box to start a new line.

b. Enter the MAC address, the management interface IP address, and the name of the mobility group for the controller to be added.

Note These values should be entered on one line and separated by one or two spaces.

Note The mobility group name is case sensitive.

c. Repeat Step a and Step b for each additional controller that you want to add to the mobility group.

d. Highlight and copy the complete list of entries in the edit box.

e. Click **Apply** to commit your changes. The new controllers are added to the list of mobility group members on the Static Mobility Group Members page.

f. Click **Save Configuration** to save your changes.

g. Paste the list into the edit box on the Mobility Group Members > Edit All page of all the other controllers in the mobility group and click **Apply** and **Save Configuration**.

Using the CLI to Configure Mobility Groups

Follow these steps to configure mobility groups using the CLI.

Step 1 Enter **show mobility summary** to check the current mobility settings.

Step 2 Enter **config mobility group name** *group_name* to create a mobility group.

Note Enter up to 31 case-sensitive ASCII characters for the group name. Spaces are not allowed in mobility group names.

Step 3 Enter **config mobility group member add** *mac-address ip-addr* to add a group member.

Note Enter **config mobility group member delete** *mac-address ip-addr* if you want to delete a group member.

Step 4 Enter **show mobility summary** to verify the mobility configuration.

Step 5 Enter **save config** to save your settings.

Step 6 Repeat this procedure on every controller to be included in the mobility group. All controllers in the mobility group must be configured with the MAC address and IP address of all other mobility group members.

Configuring Auto-Anchor Mobility

You can use auto-anchor mobility (or guest WLAN mobility) to improve load balancing and security for roaming clients on your wireless LANs. Under normal roaming conditions, client devices join a wireless LAN and are anchored to the first controller that they contact. If a client roams to a different subnet, the controller to which the client roamed sets up a foreign session for the client with the anchor controller. However, using the auto-anchor mobility feature, you can specify a controller or set of controllers as the anchor points for clients on a wireless LAN.

In auto-anchor mobility mode, a subset of a mobility group is specified as the anchor controllers for a WLAN. You can use this feature to restrict a WLAN to a single subnet, regardless of a client's entry point into the network. Clients can then access a guest WLAN throughout an enterprise but still be restricted to a specific subnet. Auto-anchor mobility can also provide geographic load balancing because the WLANs can represent a particular section of a building (such as a lobby, a restaurant, and so on), effectively creating a set of home controllers for a WLAN. Instead of being anchored to the first controller that they happen to contact, mobile clients can be anchored to controllers that control access points in a particular vicinity.

When a client first associates to a controller of a mobility group that has been preconfigured as a mobility anchor for a WLAN, the client associates to the controller locally, and a local session is created for the client. Clients can be anchored only to preconfigured anchor controllers of the WLAN. For a given WLAN, you should configure the same set of anchor controllers on all controllers in the mobility group.

When a client first associates to a controller of a mobility group that has not been configured as a mobility anchor for a WLAN, the client associates to the controller locally, a local session is created for the client, and the controller is announced to the other controllers in the same mobility group. If the announcement is not answered, the controller contacts one of the anchor controllers configured for the WLAN and creates a foreign session for the client on the local switch. Packets from the client are encapsulated through a mobility tunnel using EtherIP and sent to the anchor controller, where they are decapsulated and delivered to the wired network. Packets to the client are received by the anchor controller and forwarded to the foreign controller through a mobility tunnel using EtherIP. The foreign controller decapsulates the packets and forwards them to the client.

Note A 2000 series controller cannot be designated as an anchor for a WLAN. However, a WLAN created on a 2000 series controller can have a 4400 series controller as its anchor.

Note The IPSec and L2TP Layer 3 security policies are unavailable for WLANs configured with a mobility anchor.

Guidelines for Using Auto-Anchor Mobility

Keep these guidelines in mind when you configure auto-anchor mobility:

- Controllers must be added to the mobility group member list before you can designate them as mobility anchors for a WLAN.
- You can configure multiple controllers as mobility anchors for a WLAN.
- You must disable the WLAN before configuring mobility anchors for it.
- Auto-anchor mobility supports web authorization but does not support other Layer 3 security types.
- The WLANs on both the foreign controller and the anchor controller must be configured with mobility anchors. On the anchor controller, configure the anchor controller itself as a mobility anchor. On the foreign controller, configure the anchor as a mobility anchor.
- Auto-anchor mobility is not supported for use with DHCP option 82.

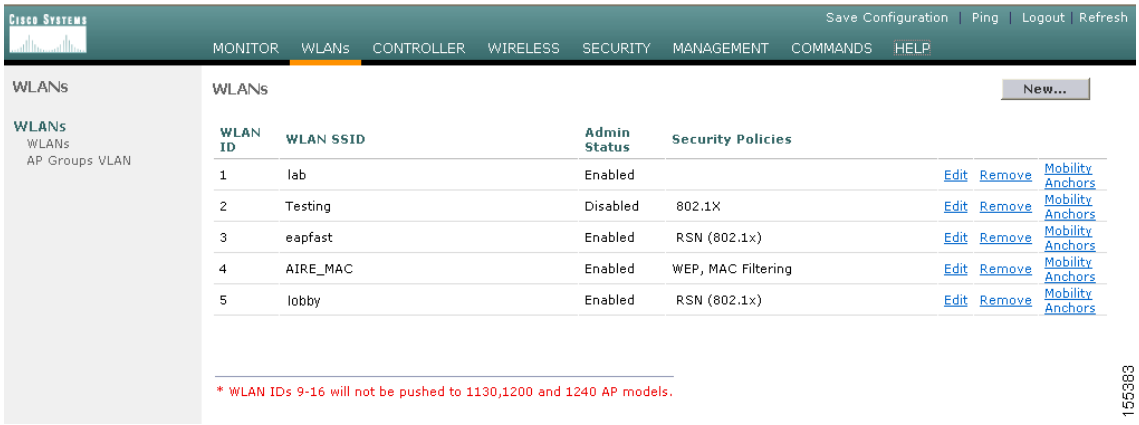
Using the GUI to Configure Auto-Anchor Mobility

Follow these steps to create a new mobility anchor for a WLAN using the GUI.

Note See the "Using the CLI to Configure Auto-Anchor Mobility" section on page 11-14 if you would prefer to configure auto-anchor mobility using the CLI.

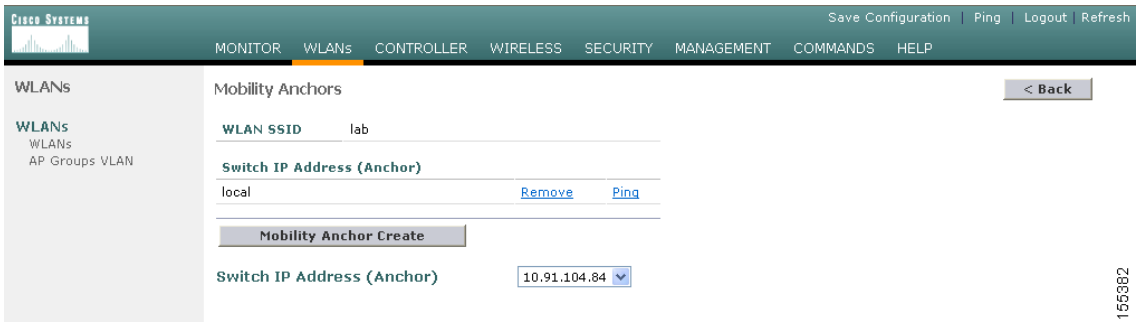
Step 1 Click **Controller > WLANs** to access the WLANs page (see Figure 11-9).

Figure 11-9 WLANs Page



Step 2 On the WLANs page, click the **Mobility Anchors** link for the desired WLAN. The Mobility Anchors page for that WLAN appears (see Figure 11-10).

Figure 11-10 Mobility Anchors Page



Step 3 Select the IP address of the controller to be designated a mobility anchor in the Switch IP Address (Anchor) drop-down box.

Step 4 Click **Mobility Anchor Create**. The selected controller becomes an anchor for this WLAN.

Note To delete a mobility anchor for a WLAN, click **Remove** to the right of the controller's IP address.

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

Step 6 Repeat Step 3 and Step 5 to set any other controllers as mobility anchors for this WLAN.

Step 7 Configure the same set of anchor controllers on every controller in the mobility group.

Using the CLI to Configure Auto-Anchor Mobility

Use these commands to configure auto-anchor mobility using the CLI.

1. Enter **config wlan disable** *wlan-id* to disable the WLAN for which you are configuring anchor controllers.
2. To create a new mobility anchor for the WLAN, enter one of these commands:
   - **config mobility group anchor add** *wlan-id anchor-controller-ip-address*
   - **config wlan mobility anchor add** *wlan-id anchor-controller-ip-address*

   Note The *wlan-id* must exist and be disabled, and the *anchor-controller-ip-address* must be a member of the default mobility group.

   Note Auto-anchor mobility is enabled for the WLAN when you configure the first anchor controller.

3. To delete a mobility anchor for the WLAN, enter one of these commands:
   - **config mobility group anchor delete** *wlan-id anchor-controller-ip-address*
   - **config wlan mobility anchor delete** *wlan-id anchor-controller-ip-address*

   Note The *wlan-id* must exist and be disabled.

   Note Deleting the last anchor disables the auto-anchor mobility feature and resumes normal mobility for new associations.

4. To see the list of controllers configured as mobility anchors for a specific WLAN, enter one of these commands:
   - **show mobility anchor** [*wlan-id*]
   - **show wlan mobility anchor** [*wlan-id*]

   Note The *wlan-id* is optional and constrains the list to the anchors in a particular WLAN. To see all of the mobility anchors on your system, enter **show mobility anchor**.

5. To save your settings, enter this command:

   save config

Running Mobility Ping Tests

Controllers belonging to the same mobility group communicate with each other by controlling information over a well-known UDP port and exchanging data traffic through an Ethernet-over-IP (EoIP) tunnel. Because UDP and EoIP are not reliable transport mechanisms, there is no guarantee that a mobility control packet or data packet will be delivered to a mobility peer. Mobility packets may be lost in transit due to a firewall filtering the UDP port or EoIP packets or due to routing issues.

Controller software release 4.0 enables you to test the mobility communication environment by performing mobility ping tests. These tests may be used to validate connectivity between members of a mobility group (including guest controllers). Two ping tests are available:

- **Mobility ping over UDP**—This test runs over mobility UDP port 16666. It tests whether the mobility control packet can be reached over the management interface.
- **Mobility ping over EoIP**—This test runs over EoIP. It tests the mobility data traffic over the management interface.

Only one mobility ping test per controller can be run at a given time.

Note These ping tests are not Internet Control Message Protocol (ICMP) based. The term “ping” is used to indicate an echo request and an echo reply message.

Use these commands to run mobility ping tests using the controller CLI.

1. To test the mobility UDP control packet communication between two controllers, enter this command:

   mping *mobility_peer_IP_address*

   The *mobility_peer_IP_address* parameter must be the IP address of a controller that belongs to a mobility group.

2. To test the mobility EoIP data packet communication between two controllers, enter this command:

   eping *mobility_peer_IP_address*

   The *mobility_peer_IP_address* parameter must be the IP address of a controller that belongs to a mobility group.

3. To troubleshoot your controller for mobility ping, enter these commands:

   config msglog level verbose

   show msglog

   To troubleshoot your controller for mobility ping over UDP, enter this command to display the mobility control packet:

   debug mobility handoff enable

   Note Cisco recommends using an ethereal trace capture when troubleshooting.

CHAPTER 12

Configuring Hybrid REAPWireless Device Access

This chapter describes hybrid REAP and explains how to configure this feature on controllers and access points. It contains these sections:

Overview of Hybrid REAP

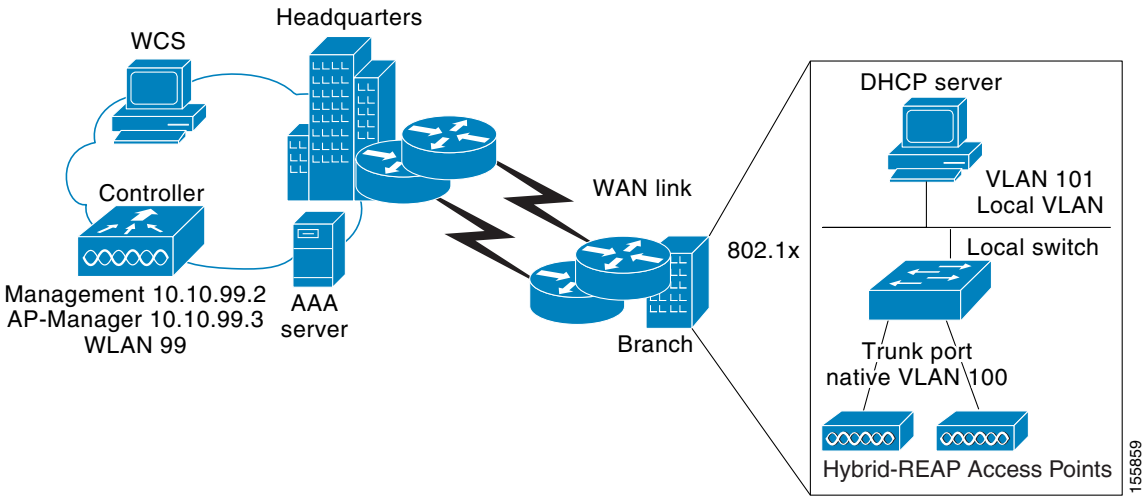
Hybrid REAP is a solution for branch office and remote office deployments. It enables customers to configure and control two or three access points in a branch or remote office from the corporate office through a wide area network (WAN) link without deploying a controller in each office.

Note In release 4.0.206.0 and greater, Hybrid REAP can be used with up to eight access points.

The hybrid-REAP access points can switch client data traffic locally and perform client authentication locally when their connection to the controller is lost. When they are connected to the controller, they can also send traffic back to the controller.

Hybrid REAP is supported only on the 1130AG and 1240AG access points and on the 2000 and 4400 series controllers, the Catalyst 3750G Integrated Wireless LAN Controller Switch, the Cisco WiSM, and the Controller Network Module for Integrated Services Routers. Figure 12-1 illustrates a typical hybrid-REAP deployment.

Figure 12-1 Hybrid REAP Deployment



Hybrid-REAP Authentication Process

When a hybrid-REAP access point boots up, it looks for a controller. If it finds one, it joins the controller, downloads the latest software image and configuration from the controller, and initializes the radio. It saves the downloaded configuration in non-volatile memory for use in standalone mode.

A hybrid-REAP access point can learn the controller IP address in one of these ways:

- If the access point has been assigned an IP address from a DHCP server, it can discover a controller through the regular LWAPP discovery process [Layer 3 broadcast, over-the-air provisioning (OTAP), DNS, or DHCP option 43].

  Note OTAP does not work on the first boot out of the box.

- If the access point has been assigned a static IP address, it can discover a controller through any of the LWAPP discovery process methods except DHCP option 43. If the access point cannot discover a controller through Layer 3 broadcast or OTAP, Cisco recommends DNS resolution. With DNS, any access point with a static IP address that knows of a DNS server can find at least one controller.
- If you want the access point to discover a controller from a remote network where LWAPP discovery mechanisms are not available, you can use priming. This method enables you to specify (through the access point CLI) the controller to which the access point is to connect.

Note Refer to Chapter 7 or the *Deploying Cisco 440X Series Wireless LAN Controllers* at this URL for more information on how access points find controllers:
http://www.cisco.com/en/US/products/ps6366/tsd_products_support_series_home.html

When a hybrid-REAP access point can reach the controller (referred to as *connected mode*), the controller assists in client authentication. When a hybrid-REAP access point cannot access the controller, the access point enters standalone mode and authenticates clients by itself.

Note The LEDs on the access point change as the device enters different hybrid-REAP modes. Refer to the hardware installation guide for your access point for information on LED patterns.

When a client associates to a hybrid-REAP access point, the access point sends all authentication messages to the controller and either switches the client data packets locally (locally switched) or sends them to the controller (centrally switched), depending on the WLAN configuration. With respect to client authentication (open, shared, EAP, web authentication, and NAC) and data packets, the WLAN can be in any one of the following states depending on the configuration and state of controller connectivity:

- **central authentication, central switching**—In this state, the controller handles client authentication, and all client data is tunneled back to the controller. This state is valid only in connected mode.
- **central authentication, local switching**—In this state, the controller handles client authentication, and the hybrid-REAP access point switches data packets locally. After the client authenticates successfully, the controller sends a configuration command with a new payload to instruct the hybrid-REAP access point to start switching data packets locally. This message is sent per client. This state is applicable only in connected mode.
- **local authentication, local switching**—In this state, the hybrid-REAP access point handles client authentication and switches client data packets locally. This state is valid only in standalone mode.
- **authentication down, switching down**—In this state, the WLAN disassociates existing clients and stops sending beacon and probe responses. This state is valid only in standalone mode.
- **authentication down, local switching**—In this state, the WLAN rejects any new clients trying to authenticate, but it continues sending beacon and probe responses to keep existing clients alive. This state is valid only in standalone mode.

When a hybrid-REAP access point enters standalone mode, WLANs that are configured for open, shared, WPA-PSK, or WPA2-PSK authentication enter the “local authentication, local switching” state and continue new client authentications. Other WLANs enter either the “authentication down, switching down” state (if the WLAN was configured for central switching) or the “authentication down, local switching” state (if the WLAN was configured for local switching).

When a hybrid-REAP access point enters standalone mode, it disassociates all clients that are on centrally switched WLANs. For 802.1X or web-authentication WLANs, existing clients are not disassociated, but the hybrid-REAP access point stops sending beacons when the number of associated clients reaches zero (0). It also sends disassociation messages to new clients associating to 802.1X or web-authentication WLANs. Controller-dependent activities such as 802.1X authentication, NAC, and web authentication (guest access) are disabled, and the access point does not send any intrusion detection system (IDS) reports to the controller. Furthermore, most radio resource management (RRM) features (such as neighbor discovery; noise, interference, load, and coverage measurements; use of the neighbor list; and rogue containment and detection) are disabled. However, a hybrid-REAP access point supports dynamic frequency selection in standalone mode.

Note If your controller is configured for network access control (NAC), clients can associate only when the access point is in connected mode. When NAC is enabled, you need to create an unhealthy (or quarantined) VLAN so that the data traffic of any client that is assigned to this VLAN passes through the controller, even if the WLAN is configured for local switching. Once a client is assigned to a quarantined VLAN, all of its data packets are centrally switched. See the "Configuring Dynamic Interfaces" section on page 3-15 for information on creating quarantined VLANs.

The hybrid-REAP access point maintains client connectivity even after entering standalone mode. However, once the access point re-establishes a connection with the controller, it disassociates all clients, applies new configuration information from the controller, and reallows client connectivity.

Hybrid REAP Guidelines

Keep these guidelines in mind when using hybrid REAP:

- A hybrid-REAP access point can be deployed with either a static IP address or a DHCP address. In the case of DHCP, a DHCP server must be available locally and must be able to provide the IP address for the access point at bootup.
- Hybrid REAP supports up to four fragmented packets or a minimum 500-byte maximum transmission unit (MTU) WAN link.
- Roundtrip latency must not exceed 100 milliseconds (ms) between the access point and the controller, and LWAPP control packets must be prioritized over all other traffic.
- The controller can send multicast packets in the form of unicast or multicast packets to the access point. In hybrid-REAP mode, the access point can receive multicast packets only in unicast form.
- Hybrid REAP supports CCKM full authentication but not CCKM fast roaming.
- Hybrid REAP supports a 1-1 network address translation (NAT) configuration. It also supports port address translation (PAT) for all features except true multicast. Multicast is supported across NAT boundaries when configured using the Unicast option.
- VPN, PPTP, Fortress authentication, and Cranite authentication are supported for locally switched traffic, provided that these security types are accessible locally at the access point.

Configuring Hybrid REAP

To configure hybrid REAP, you must follow the instructions in these sections in the order provided:

Configuring the Switch at the Remote Site

Follow these steps to prepare the switch at the remote site.

Step 1 Attach the access point that will be enabled for hybrid REAP to a trunk or access port on the switch.

Note The sample configuration below shows the hybrid-REAP access point connected to a trunk port on the switch.

Step 2 Refer to the sample configuration below to configure the switch to support the hybrid-REAP access point.

In this sample configuration, the hybrid-REAP access point is connected to trunk interface FastEthernet 1/0/2 with native VLAN 100. The access point needs IP connectivity on the native VLAN. The remote site has local servers/resources on VLAN 101. A DHCP pool in created in the local switch for both VLANs in the switch. The first DHCP pool (NATIVE) will be used by the hybrid-REAP access point, and the second DHCP pool (LOCAL-SWITCH) will be used by the clients when they associate to a WLAN that is locally switched. The bolded text in the sample configuration illustrates these settings.

Note The addresses in this sample configuration are for illustration purposes only. The addresses that you use must fit into your upstream network.

Sample local switch configuration:

```
ip dhcp pool NATIVE
   network 10.10.100.0 255.255.255.0
   default-router 10.10.100.1
!
ip dhcp pool LOCAL-SWITCH
   network 10.10.101.0 255.255.255.0
   default-router 10.10.101.1
!
interface FastEthernet1/0/1
 description Uplink port
 no switchport
 ip address 10.10.98.2 255.255.255.0
 spanning-tree portfast
!
interface FastEthernet1/0/2
 description the Access Point port
 switchport trunk encapsulation dot1q
 switchport trunk native vlan 100
 switchport trunk allowed vlan 100,101
```

```
 switchport mode trunk
 spanning-tree portfast
!
interface Vlan100
 ip address 10.10.100.1 255.255.255.0
 ip helper-address 10.10.100.1
!
interface Vlan101
 ip address 10.10.101.1 255.255.255.0
 ip helper-address 10.10.101.1
end
```

Configuring the Controller for Hybrid REAP

This section provides instructions for configuring the controller for hybrid REAP using either the GUI or the CLI.

Using the GUI to Configure the Controller for Hybrid REAP

The controller configuration for hybrid REAP consists of creating centrally switched and locally switched WLANs. Follow the steps in this section to use the GUI to configure the controller for these WLANs. This procedure uses these three WLANs as examples:

WLAN	Security	Switching	Interface Mapping (VLAN)
employee	WPA1+WPA2	Central	management (centrally switched VLAN)
employee-local	WPA1+WPA2 (PSK)	Local	101 (locally switched VLAN)
guest-central	Web authentication	Central	management (centrally switched VLAN)

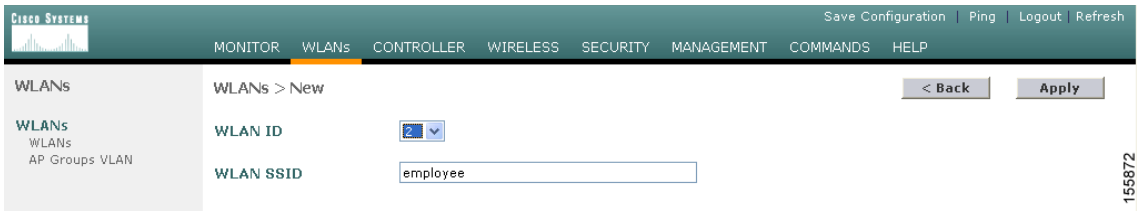
Note See the "Using the CLI to Configure the Controller for Hybrid REAP" section on page 12-12 if you would prefer to configure the controller for hybrid REAP using the CLI.

Step 1 Follow these steps to create a centrally switched WLAN. In our example, this is the first WLAN (employee).

a. Click **WLANs** to access the WLANs page.

b. Click **Next** to access the WLANs > New page (see Figure 12-2).

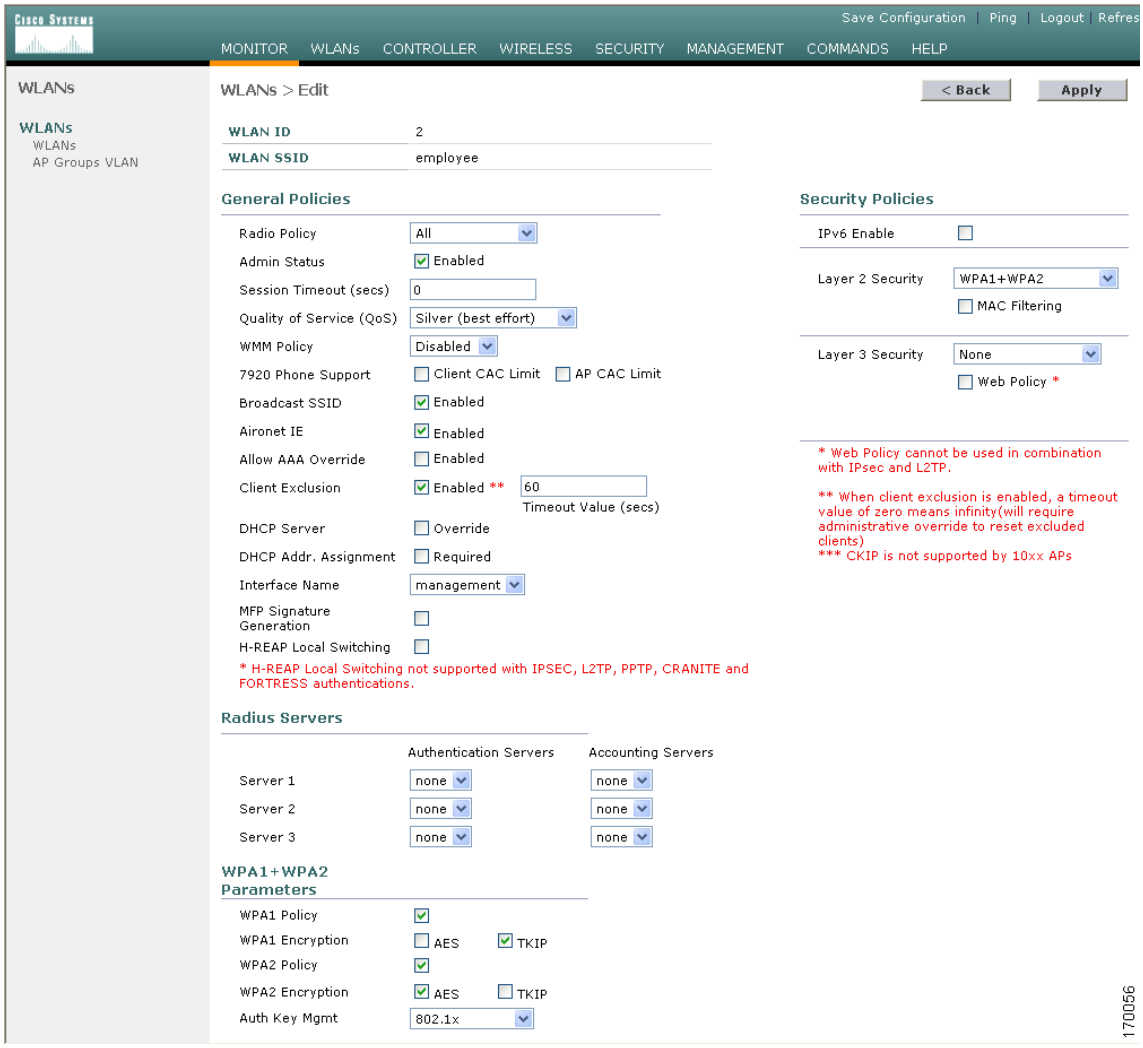
Figure 12-2 WLANs > New Page



c. Enter a name for the WLAN in the WLAN SSID field.

d. Click **Apply** to commit your changes. The WLANs > Edit page appears (see Figure 12-3).

Figure 12-3 WLANs > Edit Page (Centrally Switched WLAN)



e. Modify the configuration parameters for this WLAN using the settings in Figure 12-3 as a reference. In our employee WLAN example, you would need to choose **WPA1+WPA2** from the Layer 2 Security drop-down box and then set the WPA1+WPA2 parameters at the bottom of the page.

Note Be sure to enable this WLAN by checking the **Admin Status** check box under General Policies.

Note If NAC is enabled and you created a quarantined VLAN and want to use it for this WLAN, make sure to select it from the Interface Name drop-down box under General Policies. Also, check the **Allow AAA Override** check box to ensure that the controller checks for a quarantine VLAN assignment.

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

g. Click **Save Configuration** to save your changes.

Step 2 Follow these steps to create a locally switched WLAN. In our example, this is the second WLAN (employee-local).

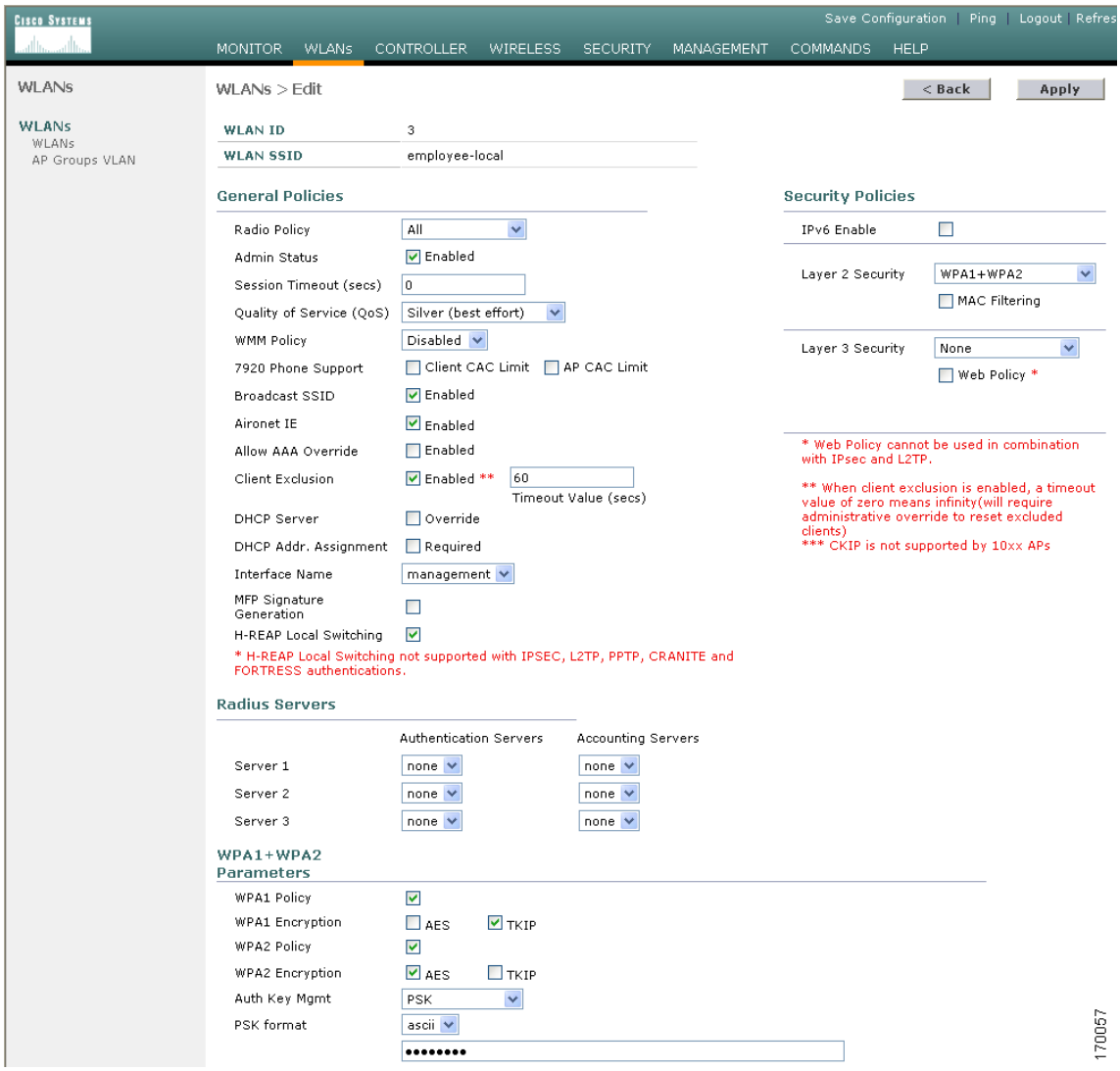
a. Follow the substeps in Step 1 to create a new WLAN. In our example, this WLAN is named "employee-local."

b. When the WLANs > Edit page appears, modify the configuration parameters for this WLAN using the settings in Figure 12-4 as a reference. In our employee WLAN example, you would need to choose **WPA1+WPA2** from the Layer 2 Security drop-down box and then set the WPA1+WPA2 parameters at the bottom of the page. Make sure to choose PSK authentication key management and enter a pre-shared key.

Note Be sure to enable this WLAN by checking the **Admin Status** check box under General Policies. Also, be sure to enable local switching by checking the **H-REAP Local Switching** check box. When you enable local switching, any hybrid-REAP access point that advertises this WLAN is able to locally switch data packets (instead of tunneling them to the controller).

Note For hybrid-REAP access points, the interface mapping at the controller for WLANs configured for H-REAP Local Switching is inherited at the access point as the default VLAN tagging. This can be easily changed per SSID, per hybrid-REAP access point. Non-hybrid-REAP access points tunnel all traffic back to the controller, and VLAN tagging is dictated by each WLAN's interface mapping.

Figure 12-4 WLANs > Edit Page (Locally Switched WLAN)



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

d. Click **Save Configuration** to save your changes.

Step 3 Follow these steps if you also want to create a centrally switched WLAN that is used for guest access. In our example, this is the third WLAN (guest-central). You might want to tunnel guest traffic to the controller so you can exercise your corporate data policies for unprotected guest traffic from a central site.

Note Chapter 9 provides additional information on creating guest user accounts.

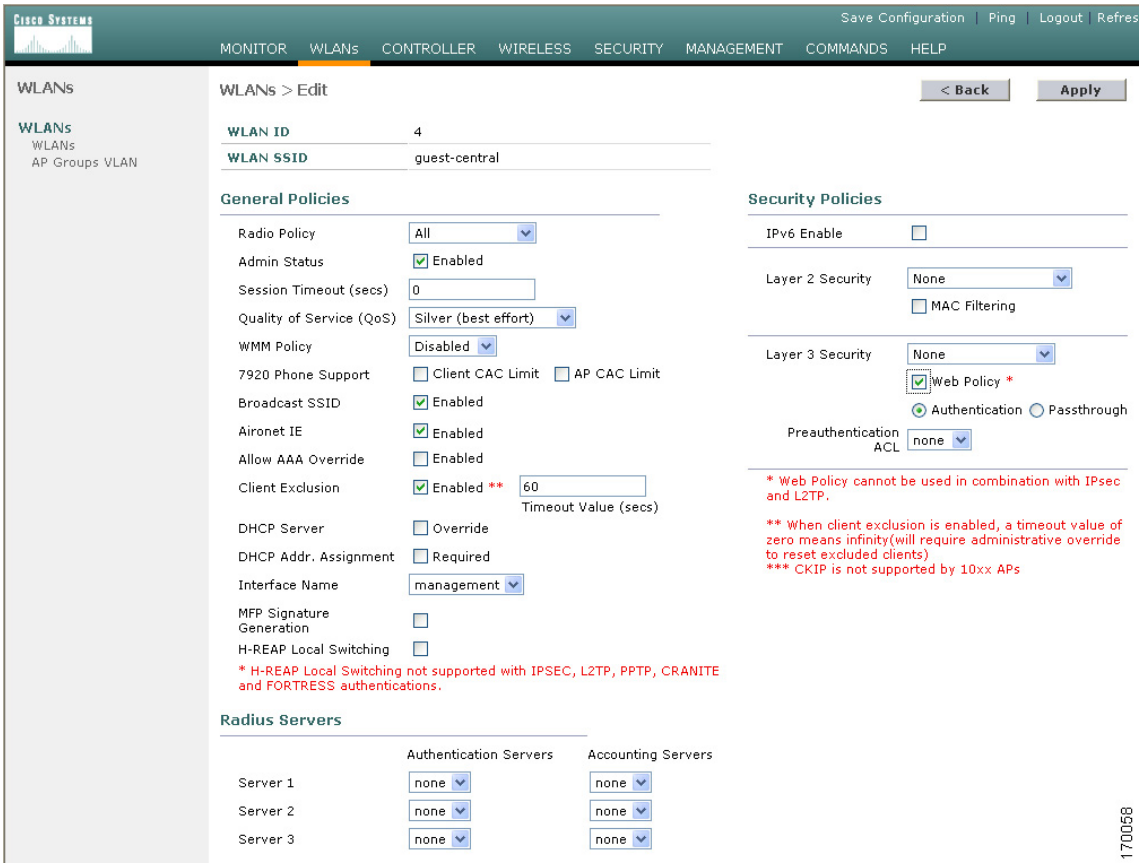
a. Follow the substeps in Step 1 to create a new WLAN. In our example, this WLAN is named "guest-central."

b. When the WLANs > Edit page appears, modify the configuration parameters for this WLAN using the settings in Figure 12-5 as a reference. In our employee WLAN example, you would need to choose **None** from both the Layer 2 Security and Layer 3 Security drop-down boxes, check the **Web Policy** check box, and make sure **Authentication** is selected.

Note If you are using an external web server, you must configure a preauthentication access control list (ACL) on the WLAN for the server and then choose this ACL as the WLAN preauthentication ACL under Security Policies > Web Policy. See Chapter 5 for more information on ACLs.

Note Make sure to enable this WLAN by checking the **Admin Status** check box under General Policies.

Figure 12-5 WLANs > Edit Page (Centrally Switched Guest Access WLAN)



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

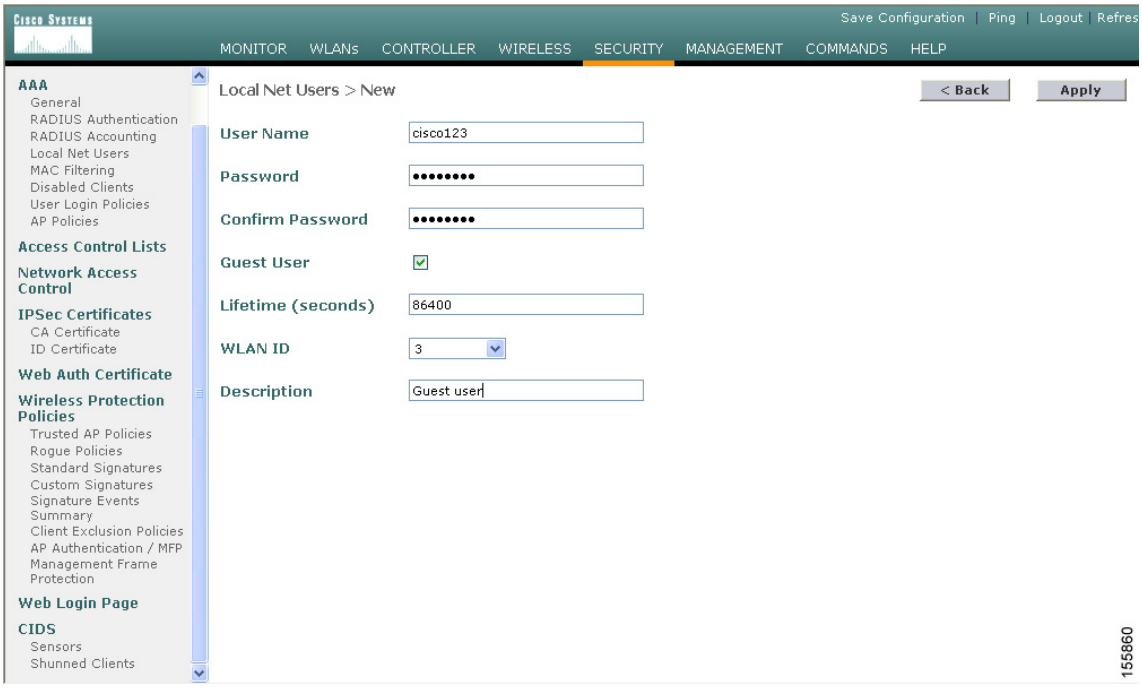
d. Click **Save Configuration** to save your changes.

e. If you want to customize the content and appearance of the login page that guest users will see the first time they access this WLAN, follow the instructions in Chapter 5.

f. To add a local user to this WLAN, click **Security** and then click **Local Net Users** under AAA.

g. When the Local Net Users page appears, click **New**. The Local Net Users > New page appears (see Figure 12-6).

Figure 12-6 Local Net Users > New Page



h. In the User Name and Password fields, enter a username and password for the local user.

i. In the Confirm Password field, re-enter the password.

j. Check the **Guest User** check box to enable this local user account.

k. In the Lifetime field, enter the amount of time (in seconds) for this user account to remain active.

l. In the WLAN ID field, enter the number of the WLAN that will be accessed by the local user.

m. In the Description field, enter a descriptive title for the local user (such as “Guest user”).

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

o. Click **Save Configuration** to save your changes.

Step 4 Go to the “Configuring an Access Point for Hybrid REAP” section on page 12-12 to configure two or three access points for hybrid REAP.

Using the CLI to Configure the Controller for Hybrid REAP

Use these commands to configure the controller for hybrid REAP:

- **config wlan h-reap local-switch** *wlan-id* **enable**—Configures the WLAN for local switching.
- **config wlan h-reap local-switch** *wlan-id* **disable**—Configures the WLAN for central switching. This is the default value.

Note Go to the "Configuring an Access Point for Hybrid REAP" section on page 12-12 to configure two or three access points for hybrid REAP.

Use these commands to obtain hybrid-REAP information:

- **show ap config general** *Cisco_AP*—Shows VLAN configurations.
- **show wlan wlan_id**—Shows whether the WLAN is locally or centrally switched.
- **show client detail** *client_mac*—Shows whether the client is locally or centrally switched.

Use these commands to obtain debug information:

- **debug lwapp events enable**—Provides debug information on LWAPP events.
- **debug lwapp error enable**—Provides debug information on LWAPP errors.
- **debug pem state enable**—Provides debug information on the policy manager State Machine.
- **debug pem events enable**—Provides debug information on policy manager events.
- **debug dhcp packet enable**—Provides debug information on DHCP packets.
- **debug dhcp message enable**—Provides debug information on DHCP error messages.

Configuring an Access Point for Hybrid REAP

This section provides instructions for configuring an access point for hybrid REAP using either the controller GUI or CLI.

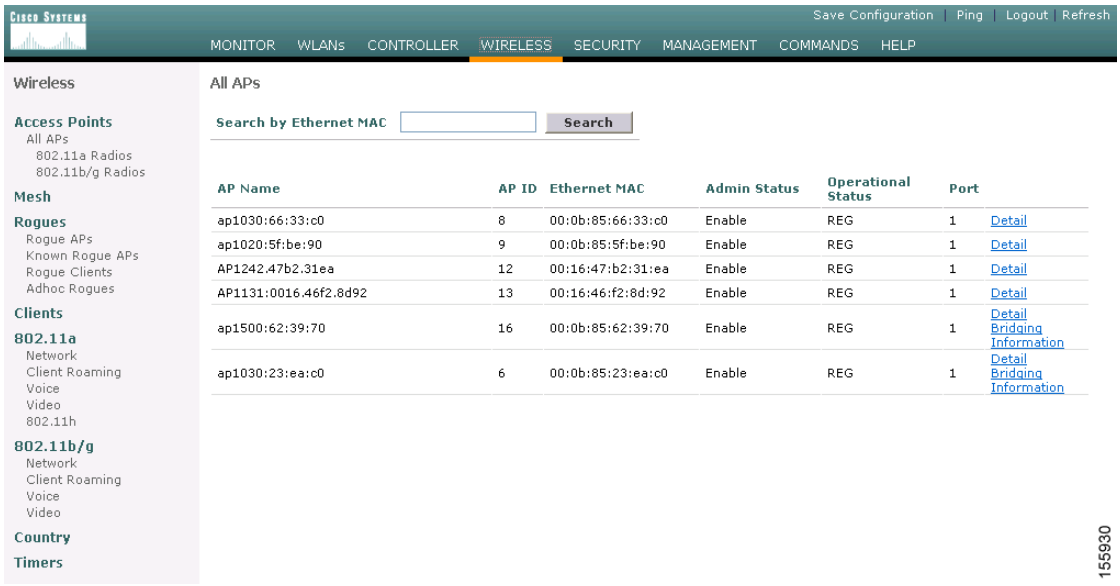
Using the GUI to Configure an Access Point for Hybrid REAP

Follow these steps to configure an access point for hybrid REAP using the controller GUI.

Step 1 Make sure that the access point has been physically added to your network.

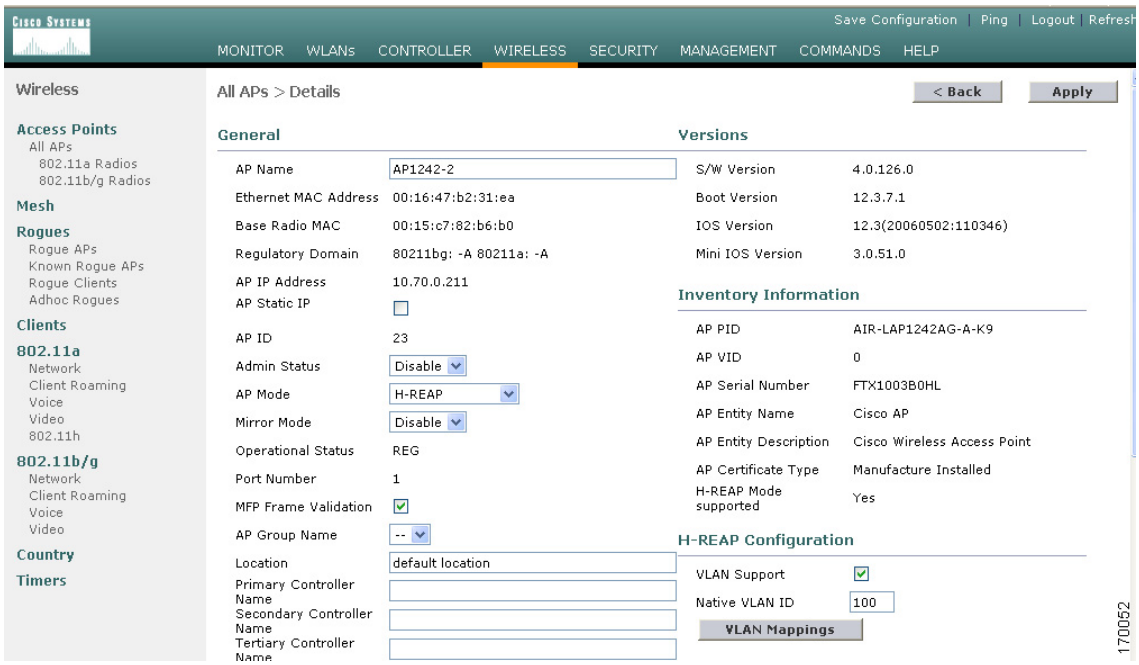
Step 2 Click **Wireless** to access the All APs page (see Figure 12-7).

Figure 12-7 All APs Page



Step 3 Click the **Details** link of the desired access point. The All APs > Details page appears (see Figure 12-8).

Figure 12-8 All APs > Details Page



The last parameter under Inventory Information indicates whether this access point can be configured for hybrid REAP. Only the 1130AG and 1240AG access points support hybrid REAP.

Step 4 Choose **H-REAP** from the AP Mode drop-down box to enable hybrid REAP for this access point.

Step 5 Click **Apply** to commit your changes and to cause the access point to reboot.

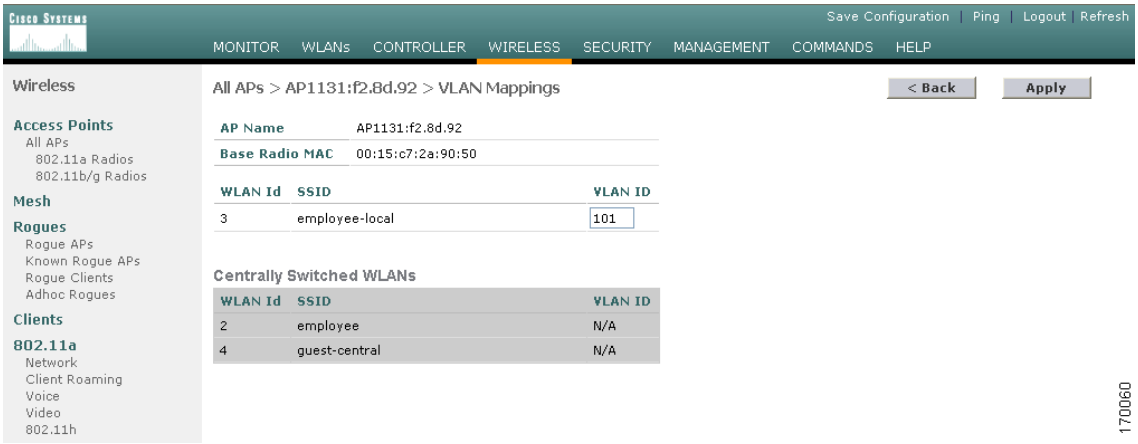
Step 6 Under H-REAP Configuration, check the **VLAN Support** check box and enter the number of the native VLAN on the remote network (such as 100) in the **Native VLAN ID** field.

Note By default, a VLAN is not enabled on the hybrid-REAP access point. Once hybrid REAP is enabled, the access point inherits the VLAN ID associated to the WLAN. This configuration is saved in the access point and received after the successful join response. By default, the native VLAN is 1. One native VLAN must be configured per hybrid-REAP access point in a VLAN-enabled domain. Otherwise, the access point cannot send and receive packets to and from the controller.

Step 7 Click **Apply** to commit your changes. The access point temporarily loses its connection to the controller while its Ethernet port is reset.

Step 8 Click **VLAN Mappings** to access the VLAN Mappings page (see Figure 12-9).

Figure 12-9 VLAN Mappings Page



Step 9 Enter the number of the VLAN from which the clients will get an IP address when doing local switching (VLAN 101, in this example) in the VLAN ID field.

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

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

Step 12 Repeat this procedure for any additional access points that need to be configured for hybrid REAP at the remote site.

Using the CLI to Configure an Access Point for Hybrid REAP

Use these commands on the controller to configure an access point for hybrid REAP:

- **config ap mode h-reap** *Cisco_AP***—**Enables hybrid REAP for this access point.
- **config ap h-reap vlan wlan** *wlan_id vlan-id Cisco_AP***—**Enables you to assign a VLAN ID to this hybrid-REAP access point. By default, the access point inherits the VLAN ID associated to the WLAN.
- **config ap h-reap vlan** {**enable** | **disable**} *Cisco_AP*—Enables or disables VLAN tagging for this hybrid-REAP access point. By default, VLAN tagging is not enabled. Once VLAN tagging is enabled on the hybrid-REAP access point, WLANs enabled for local switching inherit the VLAN assigned at the controller.
- **config ap h-reap vlan native** *vlan-id Cisco_AP*—Enables you to configure a native VLAN for this hybrid-REAP access point. By default, no VLAN is set as the native VLAN. One native VLAN must be configured per hybrid-REAP access point (when VLAN tagging is enabled). Make sure the switchport to which the access point is connected has a corresponding native VLAN configured as well. If the hybrid-REAP access point's native VLAN setting and the upstream switchport native VLAN do not match, the access point cannot transmit packets to and from the controller.

Use these commands on the hybrid-REAP access point to obtain status information:

- **show lwapp reap status**—Shows the status of the hybrid-REAP access point (connected or standalone).
- **show lwapp reap association**—Shows the list of clients associated to this access point and their SSIDs.

Use these commands on the hybrid-REAP access point to obtain debug information:

- **debug lwapp reap**—Shows general hybrid-REAP activities.
- **debug lwapp reap mgmt**—Shows client authentication and association messages.
- **debug lwapp reap load**—Shows payload activities, which is useful when the hybrid-REAP access point boots up in standalone mode.
- **debug dot11 mgmt interface**—Shows 802.11 management interface events.
- **debug dot11 mgmt msg**—Shows 802.11 management messages.
- **debug dot11 mgmt ssid**—Shows SSID management events.
- **debug dot11 mgmt state-machine**—Shows the 802.11 state machine.
- **debug dot11 mgmt station**—Shows client events.

Connecting Client Devices to the WLANs

Follow the instructions for your client device to create profiles to connect to the WLANs you created in the "Configuring the Controller for Hybrid REAP" section on page 12-6.

In our example, you would create three profiles on the client:

1. To connect to the "employee" WLAN, you would create a client profile that uses WPA/WPA2 with PEAP-MSCHAPV2 authentication. Once the client becomes authenticated, it should get an IP address from the management VLAN of the controller.
2. To connect to the "local-employee" WLAN, you would create a client profile that uses WPA/WPA2-PSK authentication. Once the client becomes authenticated, it should get an IP address from VLAN 101 on the local switch.
3. To connect to the "guest-central" WLAN, you would create a client profile that uses open authentication. Once the client becomes authenticated, it should get an IP address from VLAN 101 on the network local to the access point. Once the client connects, the local user can type any http address in the web browser. The user is automatically directed to the controller to complete the web-authentication process. When the web login page appears, the user enters his or her username and password.

To see if a client's data traffic is being locally or centrally switched, click **Monitor > Clients** on the controller GUI, click the **Detail** link for the desired client, and look at the Data Switching parameter under AP Properties.

Safety Considerations and Translated Safety Warnings

This appendix lists safety considerations and translations of the safety warnings that apply to the Cisco UWN Solution products. The following safety considerations and safety warnings appear in this appendix:

Safety Considerations

Keep these guidelines in mind when installing Cisco UWN Solution products:

- The Cisco 1000 Series lightweight access points with or without external antenna ports are only intended for installation in Environment A as defined in IEEE 802.3af. All interconnected equipment must be contained within the same building including the interconnected equipment's associated LAN connections.
- For AP1020 and AP1030 Cisco 1000 Series lightweight access points provided with optional external antenna ports, make sure that all external antennas and their associated wiring are located entirely indoors. Cisco 1000 Series lightweight access points and their optional external antennas are not suitable for outdoor use.
- Make sure that plenum-mounted Cisco 1000 Series lightweight access points are powered using Power over Ethernet (PoE) to comply with safety regulations.
- For all controllers, verify that the ambient temperature remains between 0 and 40° C (32 and 104° F), taking into account the elevated temperatures that occur when they are installed in a rack.
- When multiple controllers are mounted in an equipment rack, be sure that the power source is sufficiently rated to safely run all of the equipment in the rack.
- Verify the integrity of the ground before installing controllers in an equipment rack.
- Lightweight access points are suitable for use in environmental air space in accordance with Section 300.22.C of the National Electrical Code, and Sections 2-128, 12-010(3) and 12-100 of the Canadian Electrical Code, Part 1, C22.1.

Warning Definition

Warning **IMPORTANT SAFETY INSTRUCTIONS**

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Waarschuwing **BELANGRIJKE VEILIGHEIDSINSTRUCTIES**

Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van de standaard praktijken om ongelukken te voorkomen. Gebruik het nummer van de verklaring onderaan de waarschuwing als u een vertaling van de waarschuwing die bij het apparaat wordt geleverd, wilt raadplegen.

BEWAAR DEZE INSTRUCTIES

Varoitus **TÄRKEITÄ TURVALLISUUSOHJEITA**

Tämä varoitusmerkki merkitsee vaaraa. Tilanne voi aiheuttaa ruumiillisia vammoja. Ennen kuin käsittelet laitteistoa, huomioi sähköpiirien käsittelemiseen liittyvät riskit ja tutustu onnettomuuksien yleisiin ehkäisytapoihin. Turvallisuusvaroitusten käännökset löytyvät laitteen mukana toimitettujen käännettyjen turvallisuusvaroitusten joukosta varoitusten lopussa näkyvien lausuntonumeroiden avulla.

SÄILYTÄ NÄMÄ OHJEET

Attention **IMPORTANTES INFORMATIONS DE SÉCURITÉ**

Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant entraîner des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers liés aux circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions des avertissements figurant dans les consignes de sécurité traduites qui accompagnent cet appareil, référez-vous au numéro de l'instruction situé à la fin de chaque avertissement.

CONSERVEZ CES INFORMATIONS

Warnung **WICHTIGE SICHERHEITSHINWEISE**

Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu Verletzungen führen kann. Machen Sie sich vor der Arbeit mit Geräten mit den Gefahren elektrischer Schaltungen und den üblichen Verfahren zur Vorbeugung vor Unfällen vertraut. Suchen Sie mit der am Ende jeder Warnung angegebenen Anweisungsnummer nach der jeweiligen Übersetzung in den übersetzten Sicherheitshinweisen, die zusammen mit diesem Gerät ausgeliefert wurden.

BEWAHREN SIE DIESE HINWEISE GUT AUF.

Avvertenza **IMPORTANTI ISTRUZIONI SULLA SICUREZZA**

Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di intervenire su qualsiasi apparecchiatura, occorre essere al corrente dei pericoli relativi ai circuiti elettrici e conoscere le procedure standard per la prevenzione di incidenti. Utilizzare il numero di istruzione presente alla fine di ciascuna avvertenza per individuare le traduzioni delle avvertenze riportate in questo documento.

CONSERVARE QUESTE ISTRUZIONI

Advarsel **VIKTIGE SIKKERHETSINSTRUKSJONER**

Dette advarselssymbolet betyr fare. Du er i en situasjon som kan føre til skade på person. Før du begynner å arbeide med noe av utstyret, må du være oppmerksom på farene forbundet med elektriske kretser, og kjenne til standardprosedyrer for å forhindre ulykker. Bruk nummeret i slutten av hver advarsel for å finne oversettelsen i de oversatte sikkerhetsadvarslene som fulgte med denne enheten.

TA VARE PÅ DISSE INSTRUKSJONENE

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você está em uma situação que poderá ser causadora de lesões corporais. Antes de iniciar a utilização de qualquer equipamento, tenha conhecimento dos perigos envolvidos no manuseio de circuitos elétricos e familiarize-se com as práticas habituais de prevenção de acidentes. Utilize o número da instrução fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham este dispositivo.

GUARDE ESTAS INSTRUÇÕES

¡Advertencia! **INSTRUCCIONES IMPORTANTES DE SEGURIDAD**

Este símbolo de aviso indica peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considere los riesgos de la corriente eléctrica y familiarícese con los procedimientos estándar de prevención de accidentes. Al final de cada advertencia encontrará el número que le ayudará a encontrar el texto traducido en el apartado de traducciones que acompaña a este dispositivo.

GUARDE ESTAS INSTRUCCIONES

Varning! **VIKTIGA SÄKERHETSANVISNINGAR**

Denna varningssignal signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanliga förfaranden för att förebygga olyckor. Använd det nummer som finns i slutet av varje varning för att hitta dess översättning i de översatta säkerhetsvarningar som medföljer denna anordning.

SPARA DESSA ANVISNINGAR

FONTOS BIZTONSÁGI ELOÍRÁSOK

Ez a figyelmezeto jel veszélyre utal. Sérülésveszélyt rejto helyzetben van. Mielott bármely berendezésen munkát végezte, legyen figyelemmel az elektromos áramkörök okozta kockázatokra, és ismerkedjen meg a szokásos balesetvédelmi eljárásokkal. A kiadványban szereplo figyelmeztetések fordítása a készülékhez mellékelt biztonsági figyelmeztetések között található; a fordítás az egyes figyelmeztetések végén látható szám alapján keresheto meg.

ORIZZE MEG EZEKET AZ UTASÍTÁSOKAT!

Предупреждение ВАЖНЫЕ ИНСТРУКЦИИ ПО СОБЛЮДЕНИЮ ТЕХНИКИ БЕЗОПАСНОСТИ

Этот символ предупреждения обозначает опасность. То есть имеет место ситуация, в которой следует опасаться телесных повреждений. Перед эксплуатацией оборудования выясните, каким опасностям может подвергаться пользователь при использовании электрических цепей, и ознакомьтесь с правилами техники безопасности для предотвращения возможных несчастных случаев. Воспользуйтесь номером заявления, приведенным в конце каждого предупреждения, чтобы найти его переведенный вариант в переводе предупреждений по безопасности, прилагаемом к данному устройству.

СОХРАНИТЕ ЭТИ ИНСТРУКЦИИ

警告 重要的安全性说明

此警告符号代表危险。您正处于可能受到严重伤害的工作环境中。在您使用设备开始工作之前，必须充分意识到触电的危险，并熟练掌握防止事故发生的标准工作程序。请根据每项警告结尾提供的声明号码来找到此设备的安全性警告说明的翻译文本。

请保存这些安全性说明

警告 安全上の重要な注意事項

「危険」の意味です。人身事故を予防するための注意事項が記述されています。装置の取り扱い作業を行うときは、電気回路の危険性に注意し、一般的な事故防止策に留意してください。警告の各国語版は、各注意事項の番号を基に、装置に付属の「Translated Safety Warnings」を参照してください。

これらの注意事項を保管しておいてください。

Class 1 Laser Product Warning

Note The 1000BASE-SX and 1000BASE-LX SFP modules contain Class 1 Lasers (Laser Klasse 1) according to EN 60825-1+A1+A2.

Warning **Class 1 laser product.** Statement 1008

Waarschuwing **Klasse-1 laser produkt.**

Varoitus **Luokan 1 lasertuote.**

Attention **Produit laser de classe 1.**

Warnung **Laserprodukt der Klasse 1.**

Avvertenza **Prodotto laser di Classe 1.**

Advarsel **Laserprodukt av klasse 1.**

Aviso **Produto laser de classe 1.**

¡Advertencia! **Producto láser Clase I.**

Varning! **Laserprodukt av klass 1.**

Class 1 besorolású lézeres termék.

Предупреждение Лазерное устройство класса 1.

警告 这是 1 类激光产品。

警告 クラス1レーザー製品です。

주의 클래스 1 레이저 제품.

Aviso **Produto a laser de classe 1.**

Advarsel **Klasse 1 laserprodukt.**

تحذير **Class 1 Laser ١ منتج**

Upozorenje **Laserski proizvod klase 1**

Upozornění **Laserový výrobek třídy 1.**

Προειδοποίηση Προϊόν λέιζερ κατηγορίας 1.

אזהרה .Class 1 מוצר לייזר

Opomena Ласерски производ од класа 1.

Ostrzeżenie **Produkt laserowy klasy 1.**

Upozornenie **Laserový výrobok triedy 1.**

Class 1 besorolású lézeres termék.

Предупреждение Лазерное устройство класса 1.

警告 这是 1 类激光产品。

警告 クラス1レーザー製品です。

주의 클래스 1 레이저 제품.

تحذير Class 1 Laser منتج ١

Upozorenje Laserski proizvod klase 1

Upozornění Laserový výrobek třídy 1.

Προειδοποίηση Προϊόν λέιζερ κατηγορίας 1.

אזהרה .Class 1 מוצר לייזר

Opomena Ласерски производ од класа 1.

Ostrzeżenie Produkt laserowy klasy 1.

Upozornenie Laserový výrobok triedy 1.

Ground Conductor Warning

Warning **This equipment must be grounded. Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.** Statement 1024

Waarschuwing **Deze apparatuur dient geaard te zijn. De aardingsleiding mag nooit buiten werking worden gesteld en de apparatuur mag nooit bediend worden zonder dat er een op de juiste wijze geïnstalleerde aardingsleiding aanwezig is. Neem contact op met de bevoegde instantie voor elektrische inspecties of met een elektricien als u er niet zeker van bent dat er voor passende aarding gezorgd is.**

Varoitus **Laitteiden on oltava maadoitettuja. Älä koskaan ohita maajohdinta tai käytä laitteita ilman oikein asennettua maajohdinta. Ota yhteys sähkötarkastusviranomaiseen tai sähköasentajaan, jos olet epävarma maadoituksen sopivuudesta.**

Attention **Cet équipement doit être mis à la masse. Ne jamais rendre inopérant le conducteur de masse ni utiliser l'équipement sans un conducteur de masse adéquatement installé. En cas de doute sur la mise à la masse appropriée disponible, s'adresser à l'organisme responsable de la sécurité électrique ou à un électricien.**

Warnung **Dieses Gerät muss geerdet sein. Auf keinen Fall den Erdungsleiter unwirksam machen oder das Gerät ohne einen sachgerecht installierten Erdungsleiter verwenden. Wenn Sie sich nicht sicher sind, ob eine sachgerechte Erdung vorhanden ist, wenden Sie sich an die zuständige Inspektionsbehörde oder einen Elektriker.**

Avvertenza **Questa apparecchiatura deve essere dotata di messa a terra. Non escludere mai il conduttore di protezione né usare l'apparecchiatura in assenza di un conduttore di protezione installato in modo corretto. Se non si è certi della disponibilità di un adeguato collegamento di messa a terra, richiedere un controllo elettrico presso le autorità competenti o rivolgersi a un elettricista.**

Advarsel **Dette utstyret må jordes. Omgå aldri jordingslederen og bruk aldri utstyret uten riktig montert jordingsleder. Ta kontakt med fagfolk innen elektrisk inspeksjon eller med en elektriker hvis du er usikker på om det finnes velegnet jordning.**

Aviso **Este equipamento deve ser aterrado. Nunca anule o fio terra nem opere o equipamento sem um aterramento adequadamente instalado. Em caso de dúvida com relação ao sistema de aterramento disponível, entre em contato com os serviços locais de inspeção elétrica ou um eletricista qualificado.**

¡Advertencia! **Este equipo debe estar conectado a tierra. No inhabilite el conductor de tierra ni haga funcionar el equipo si no hay un conductor de tierra instalado correctamente. Póngase en contacto con la autoridad correspondiente de inspección eléctrica o con un electricista si no está seguro de que haya una conexión a tierra adecuada.**

Varning! **Denna utrustning måste jordas. Koppla aldrig från jordledningen och använd aldrig utrustningen utan en på lämpligt sätt installerad jordledning. Om det föreligger osäkerhet huruvida lämplig jordning finns skall elektrisk besiktningsauktoritet eller elektriker kontaktas.**

A berendezés csak megfelelő védőföldeléssel működtethető. Ne iktassa ki a földelés csatlakozóját, és ne üzemeltesse a berendezést szabályosan felszerelt földelő vezeték nélkül! Ha nem biztos benne, hogy megfelelő földelés áll rendelkezésbe, forduljon a helyi elektromos hatóságokhoz vagy egy villanyszerelőhöz.

Предупреждение Данное устройство должно быть заземлено. Никогда не отключайте провод заземления и не пользуйтесь оборудованием при отсутствии правильно подключенного провода заземления. За сведениями об имеющихся возможностях заземления обратитесь к соответствующим контролирующим организациям по энергоснабжению или к инженеру-электрику.

警告 此设备必须接地。切勿使接地导体失效，或者在没有正确安装接地导体的情况下操作该设备。如果您不能肯定接地导体是否正常发挥作用，请咨询有关电路检测方面的权威人士或电工。

警告 この装置はアース接続する必要があります。アース導体を破損しないよう注意し、アース導体を正しく取り付けないまま装置を稼働させないでください。アース接続が適正であるかどうか分からない場合には、電気検査機関または電気技術者に相談してください。

A berendezés csak megfelelő védőföldeléssel működtethető. Ne iktassa ki a földelés csatlakozóját, és ne üzemeltesse a berendezést szabályosan felszerelt földelő vezeték nélkül! Ha nem biztos benne, hogy megfelelő földelés áll rendelkezésbe, forduljon a helyi elektromos hatóságokhoz vagy egy villanyszerelőhöz.

Предупреждение Данное устройство должно быть заземлено. Никогда не отключайте провод заземления и не пользуйтесь оборудованием при отсутствии правильно подключенного провода заземления. За сведениями об имеющихся возможностях заземления обратитесь к соответствующим контролирующим организациям по энергоснабжению или к инженеру-электрику.

警告 此设备必须接地。切勿使接地导体失效，或者在没有正确安装接地导体的情况下操作该设备。如果您不能肯定接地导体是否正常发挥作用，请咨询有关电路检测方面的权威人士或电工。

警告 この装置はアース接続する必要があります。アース導体を破損しないよう注意し、アース導体を正しく取り付けないまま装置を稼働させないでください。アース接続が適正であるかどうか分からない場合には、電気検査機関または電気技術者に相談してください。

Chassis Warning for Rack-Mounting and Servicing

Warning **To prevent bodily injury when mounting or servicing this unit in a rack, you must take special precautions to ensure that the system remains stable. The following guidelines are provided to ensure your safety:**

- **This unit should be mounted at the bottom of the rack if it is the only unit in the rack.**
- **When mounting this unit in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.**
- **If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the unit in the rack.** Statement 1006

Waarschuwing **Om lichamelijk letsel te voorkomen wanneer u dit toestel in een rek monteert of het daar een servicebeurt geeft, moet u speciale voorzorgsmaatregelen nemen om ervoor te zorgen dat het toestel stabiel blijft. De onderstaande richtlijnen worden verstrekt om uw veiligheid te verzekeren:**

- **Dit toestel dient onderaan in het rek gemonteerd te worden als het toestel het enige in het rek is.**
- **Wanneer u dit toestel in een gedeeltelijk gevuld rek monteert, dient u het rek van onderen naar boven te laden met het zwaarste onderdeel onderaan in het rek.**
- **Als het rek voorzien is van stabiliseringshulpmiddelen, dient u de stabilisatoren te monteren voordat u het toestel in het rek monteert of het daar een servicebeurt geeft.**

Varoitus **Kun laite asetetaan telineeseen tai huolletaan sen ollessa telineessä, on noudatettava erityisiä varotoimia järjestelmän vakavuuden säilyttämiseksi, jotta vältytään loukkaantumiselta. Noudata seuraavia turvallisuusohjeita:**

- **Jos telineessä ei ole muita laitteita, aseta laite telineen alaosaan.**
- **Jos laite asetetaan osaksi täytettyyn telineeseen, aloita kuormittaminen sen alaosasta kaikkein raskaimmalla esineellä ja siirry sitten sen yläosaan.**
- **Jos telinettä varten on vakaimet, asenna ne ennen laitteen asettamista telineeseen tai sen huoltamista siinä.**

Attention **Pour éviter toute blessure corporelle pendant les opérations de montage ou de réparation de cette unité en casier, il convient de prendre des précautions spéciales afin de maintenir la stabilité du système. Les directives ci-dessous sont destinées à assurer la protection du personnelþ:**

- **Si cette unité constitue la seule unité montée en casier, elle doit être placée dans le bas.**
- **Si cette unité est montée dans un casier partiellement rempli, charger le casier de bas en haut en plaçant l'élément le plus lourd dans le bas.**
- **Si le casier est équipé de dispositifs stabilisateurs, installer les stabilisateurs avant de monter ou de réparer l'unité en casier.**

Warnung **Zur Vermeidung von Körperverletzung beim Anbringen oder Warten dieser Einheit in einem Gestell müssen Sie besondere Vorkehrungen treffen, um sicherzustellen, daß das System stabil bleibt. Die folgenden Richtlinien sollen zur Gewährleistung Ihrer Sicherheit dienen:**

- **Wenn diese Einheit die einzige im Gestell ist, sollte sie unten im Gestell angebracht werden.**
- **Bei Anbringung dieser Einheit in einem zum Teil gefüllten Gestell ist das Gestell von unten nach oben zu laden, wobei das schwerste Bauteil unten im Gestell anzubringen ist.**
- **Wird das Gestell mit Stabilisierungszubehör geliefert, sind zuerst die Stabilisatoren zu installieren, bevor Sie die Einheit im Gestell anbringen oder sie warten.**

Avvertenza **Per evitare infortuni fisici durante il montaggio o la manutenzione di questa unità in un supporto, occorre osservare speciali precauzioni per garantire che il sistema rimanga stabile. Le seguenti direttive vengono fornite per garantire la sicurezza personale:**

- **Questa unità deve venire montata sul fondo del supporto, se si tratta dell'unica unità da montare nel supporto.**
- **Quando questa unità viene montata in un supporto parzialmente pieno, caricare il supporto dal basso all'alto, con il componente più pesante sistemato sul fondo del supporto.**
- **Se il supporto è dotato di dispositivi stabilizzanti, installare tali dispositivi prima di montare o di procedere alla manutenzione dell'unità nel supporto.**

Advarsel **Unngå fysiske skader under montering eller reparasjonsarbeid på denne enheten når den befinner seg i et kabinett. Vær nøye med at systemet er stabilt. Følgende retningslinjer er gitt for å verne om sikkerheten:**

- **Denne enheten bør monteres nederst i kabinettet hvis dette er den eneste enheten i kabinettet.**
- **Ved montering av denne enheten i et kabinett som er delvis fylt, skal kabinettet lastes fra bunnen og opp med den tyngste komponenten nederst i kabinettet.**
- **Hvis kabinettet er utstyrt med stabiliseringsutstyr, skal stabilisatorene installeres før montering eller utføring av reparasjonsarbeid på enheten i kabinettet.**

Aviso **Para se prevenir contra danos corporais ao montar ou reparar esta unidade numa estante, deverá tomar precauções especiais para se certificar de que o sistema possui um suporte estável. As seguintes directrizes ajudá-lo-ão a efectuar o seu trabalho com segurança:**

- **Esta unidade deverá ser montada na parte inferior da estante, caso seja esta a única unidade a ser montada.**
- **Ao montar esta unidade numa estante parcialmente ocupada, coloque os itens mais pesados na parte inferior da estante, arrumando-os de baixo para cima.**
- **Se a estante possuir um dispositivo de estabilização, instale-o antes de montar ou reparar a unidade.**

¡Advertencia! **Para evitar lesiones durante el montaje de este equipo sobre un bastidor, o posteriormente durante su mantenimiento, se debe poner mucho cuidado en que el sistema quede bien estable. Para garantizar su seguridad, proceda según las siguientes instrucciones:**

- **Colocar el equipo en la parte inferior del bastidor, cuando sea la única unidad en el mismo.**
- **Cuando este equipo se vaya a instalar en un bastidor parcialmente ocupado, comenzar la instalación desde la parte inferior hacia la superior colocando el equipo más pesado en la parte inferior.**
- **Si el bastidor dispone de dispositivos estabilizadores, instalar éstos antes de montar o proceder al mantenimiento del equipo instalado en el bastidor.**

Varning! **För att undvika kroppsskada när du installerar eller utför underhållsarbete på denna enhet på en ställning måste du vidta särskilda försiktighetsåtgärder för att försäkra dig om att systemet står stadigt. Följande riktlinjer ges för att trygga din säkerhet:**

- **Om denna enhet är den enda enheten på ställningen skall den installeras längst ned på ställningen.**
- **Om denna enhet installeras på en delvis fylld ställning skall ställningen fyllas nedifrån och upp, med de tyngsta enheterna längst ned på ställningen.**
- **Om ställningen är försedd med stabiliseringsdon skall dessa monteras fast innan enheten installeras eller underhålls på ställningen.**

A készülék rackbe történő beszerelése és karbantartása során bekövetkező sérülések elkerülése végett speciális óvintézkedésekkel meg kell őrizni a rendszer stabilitását. A személyes biztonsága érdekében tartsa be a következő szabályokat:

- **Ha a rackben csak ez az egy készülék található, a rack aljába kell beszerelni.**
- **Ha nincs teljesen tele az a rack, amelybe beszerelik a készüléket, alulról fölfelé haladva töltse fel a racket úgy, hogy a legnehezebb készülék kerüljön a rack aljába.**
- **Ha stabilizáló eszközök is tartoznak a rackhez, szerelje fel a stabilizátorokat, mielőtt beszerelné az egységet a rackbe, vagy karbantartást végezne rajta.**

Предупреждение Во избежание травм при монтаже и обслуживании устройства в стойке следует принять особые меры предосторожности, чтобы убедиться в устойчивости оборудования.
Для обеспечения безопасности работ необходимо соблюдать следующие правила.

- Если в стойке находится одно устройство, оно должно быть установлено в нижней части.
- При монтаже устройств в частично заполненную стойку устанавливайте оборудование снизу вверх, размещая наиболее тяжелые устройства в нижней части.
- Если стойка снабжена приспособлениями для стабилизации, их необходимо установить до начала монтажа или обслуживания оборудования.

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- 如果在部分装满的机架中安装此部件，请按从下往上的顺序安装各个部件，并且最重的组件应安装在机架的底部。
- 如果机架配有固定装置，请先装好固定装置，然后再在机架中安装或维修部件。

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Aviso **Para evitar lesões corporais ao montar ou dar manutenção a esta unidade em um rack, é necessário tomar todas as precauções para garantir a estabilidade do sistema. As seguintes orientações são fornecidas para garantir a sua segurança:**

- **Se esta for a única unidade, ela deverá ser montada na parte inferior do rack.**
- **Ao montar esta unidade em um rack parcialmente preenchido, carregue-o de baixo para cima com o componente mais pesado em sua parte inferior.**
- **Se o rack contiver dispositivos estabilizadores, instale-os antes de montar ou dar manutenção à unidade existente.**

Advarsel **For at forhindre legemesbeskadigelse ved montering eller service af denne enhed i et rack, skal du sikre at systemet står stabilt. Følgende retningslinjer er også for din sikkerheds skyld:**

- **Enheden skal monteres i bunden af dit rack, hvis det er den eneste enhed i racket.**
- **Ved montering af denne enhed i et delvist fyldt rack, skal enhederne installeres fra bunden og opad med den tungeste enhed nederst.**
- **Hvis racket leveres med stabiliseringsenheder, skal disse installeres for enheden monteres eller serviceres i racket.**

تحذير

لتجنب حدوث أي إصابات عند تركيب هذه الوحدة، يجب اتباع بعض الاحتياطات لضمان عمل النظام بشكل سليم.
يتم ذكر الإرشادات التالية لضمان الأمان.
يجب تركيب هذه الوحدة في الجزء السفلي من الدولاب المتضمن قضبان إذا كانت هذه الوحدة هي الوحدة الوحيدة في الدولاب الذي يحتوي على قضبان.
عند تركيب هذه الوحدة في دولاب شبه ممتلئ، قم برفع الدولاب من الجزء السفلي لأعلى بحيث يكون الجزء الأثقل وزناً أسفل الدولاب.
إذا كان الدولاب المتضمن قضباناً يحتوي على أجهزة حفظ التوازن، قم بتثبيت هذه الأجهزة قبل تركيب الوحدة في الدولاب.

Upozorenje **Kako ne bi došlo do tjelesnih ozljeda kod postavljanja ili servisiranja uređaja na polici, potrebno je poduzeti mjere predostrožnosti kako bi sustav uvijek bio stabilan. Sigurnost se može osigurati poštivanjem sljedećih smjernica:**
- **Ovaj uređaj treba ugraditi na dno police, ukoliko je to jedini uređaj na polici.**
- **Kod ugradnje uređaja u policu na kojoj se već nalaze drugi uređaji, policu treba opremati počevši od dna, te tako da se na dno stave najteži dijelovi.**
- **Ukoliko su na polici ugrađeni stabilizatori, njih montirajte prije ugradnje ili servisiranja uređaja na polici.**

Upozornění **Abyste předešli poranění osob při montáži nebo opravě zařízení v montážním rámu, musíte dodržovat zvláštní preventivní opatření pro zajištění udržení stability systému. Pro zajištění bezpečnosti obsluhy jsou určeny následující zásady:**
- **Pokud je toto zařízení jedinou jednotkou v montážním rámu, musí být namontováno na nejnižší místo rámu.**
- **Pokud je toto zařízení montováno do částečně obsazeného montážního rámu, obsazujte montážní rám ve směru zdola nahoru tak, aby byla nejtěžší součást nejníže.**
- **Pokud je montážní rám vybaven stabilizačními zařízeními, nainstalujte stabilizátory ještě před montáží nebo opravou zařízení v montážním rámu.**

Προειδοποίηση Για να αποφύγετε τον τραυματισμό κατά την τοποθέτηση ή τη συντήρηση αυτής της συσκευής σε αρθρωτό σύστημα, πρέπει να λάβετε ειδικές προφυλάξεις για να διασφαλίσετε τη σταθερότητα του συστήματος. Οι παρακάτω οδηγίες παρέχονται για να εξασφαλίσουν την ασφάλειά σας:
- Αυτή η συσκευή πρέπει να τοποθετείται στο κάτω μέρος του αρθρωτού συστήματος αν είναι η μοναδική συσκευή σε αυτό.
- Όταν τοποθετείτε αυτήν τη συσκευή σε εν μέρει γεμάτο αρθρωτό σύστημα, τοποθετήστε συσκευές στο αρθρωτό σύστημα από κάτω προς τα επάνω, με τη βαρύτερη συσκευή στο κάτω μέρος του συστήματος.
- Εάν το αρθρωτό σύστημα διαθέτει διατάξεις σταθεροποίησης, τοποθετήστε τους σταθεροποιητές πριν τοποθετήσετε ή συντηρήσετε τη συσκευή στο αρθρωτό σύστημα.

אזהרה כדי למנוע פציעה בעת הרכבת יחידה זו במעמד או טיפול בה, עליך לנקוט אמצעי זהירות מיוחדים כדי להבטיח את יציבות המערכת. הקווים המנחים הבאים ניתנים על מנת להבטיח את ביטחונך:
- אם יחידה זו היא יחידה בודדת במעמד, יש להרכיב את היחידה בחלקו התחתון של המעמד.
- בעת הרכבת יחידה זו במעמד המלא בחלקו, טען את המעמד החל בחלק התחתון וכלפי מעלה כאשר הרכיב הכבד ביותר נמצא בחלקו התחתון של המעמד.
- אם המעמד מסופק עם התקני ייצוב, התקן את המייצבים לפני הרכבה היחידה במעמד או טיפול בה.

Opomena За да се не повредите кога го монтирате или го сервисирате уредот на полица, мора да бидете особено претпазливи за да ја обезбедите стабилноста на системот. Следите напатствија се дадени за да ја осигураат Вашата безбедност:
- Уредот треба да се монтира најдолу на полицата ако е единствен уред на полицата.
- Кога го монтирате уредот на делумно пополнета полица, полнете ја полицата од дното кон врвот со најтешката компонента на дното на полицата.
- Ако полицата има стабилизаторски делови, наместете ги стабилизаторите пред да го монтирате или сервисирате уредот на полицата.

Ostrzeżenie **Aby zapobiec urazom podczas montażu lub serwisowania tego urządzenia w stojaku, należy zastosować szczególne środki ostrożności w celu zapewnienia stabilności układu. Poniżej przedstawiono wskazówki, których przestrzeganie zapewni bezpieczeństwo:**

- **Jeśli urządzenie to jest jedynym urządzeniem w stojaku, powinno być zamontowane na dole.**
- **W przypadku montażu urządzenia w częściowo zapełnionym stojaku należy instalować kolejne urządzenia od najniższego do najwyższego, przy czym element najcięższy powinien być zamontowany najniżej w stojaku.**
- **Jeśli stojak jest wyposażony w elementy stabilizujące, należy zamontować stabilizatory przed przystąpieniem do montażu lub serwisowania urządzeń w stojaku.**

Upozornenie **Aby ste predišli poraneniu osôb pri montáži alebo oprave zariadenia v montážnom ráme, musíte dodržiavať zvláštne preventívne opatrenia na zaistenie udržania stability systému. Na zaistenie bezpečnosti obsluhy sú určené nasledujúce zásady:**

- **Pokiaľ je toto zariadenie jedinou jednotkou v montážnom ráme, musí byť namontované na najnižšie miesto v ráme.**
- **Pokiaľ je toto zariadenie montované do čiastočne obsadeného montážneho rámu, obsadzujte montážny rám v smere zdola nahor tak, aby bola najťažšia súčasť najnižšie.**
- **Pokiaľ je montážny rám vybavený stabilizačnými zariadeniami, nainštalujte stabilizátory ešte pred montážou alebo opravou zariadenia v montážnom ráme.**

A készülék rackbe történő beszerelése és karbantartása során bekövetkező sérülések elkerülése végett speciális óvintézkedésekkel meg kell őrizni a rendszer stabilitását. A személyes biztonsága érdekében tartsa be a következő szabályokat:

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يجب تركيب هذه الوحدة في الجزء السفلي من الدولاب المتضمن قضبان إذا كانت هذه الوحدة هي الوحدة الوحيدة في الدولاب الذي يحتوي على قضبان.

عند تركيب هذه الوحدة في دولاب شبه ممتلئ، قم برفع الدولاب من الجزء السفلي لأعلى بحيث يكون الجزء الأثقل وزناً أسفل الدولاب.

إذا كان الدولاب المتضمن قضباناً يحتوي على أجهزة حفظ التوازن، قم بتثبيت هذه الأجهزة قبل تركيب الوحدة في الدولاب.

Upozorenje Kako ne bi došlo do tjelesnih ozljeda kod postavljanja ili servisiranja uređaja na polici, potrebno je poduzeti mjere predostrožnosti kako bi sustav uvijek bio stabilan. Sigurnost se može osigurati poštivanjem sljedećih smjernica:

- **Ovaj uređaj treba ugraditi na dno police, ukoliko je to jedini uređaj na polici.**
- **Kod ugradnje uređaja u policu na kojoj se već nalaze drugi uređaji, policu treba opremati počevši od dna, te tako da se na dno stave najteži dijelovi.**
- **Ukoliko su na polici ugrađeni stabilizatori, njih montirajte prije ugradnje ili servisiranja uređaja na polici.**

Upozornění Abyste předešli poranění osob při montáži nebo opravě zařízení v montážním rámu, musíte dodržovat zvláštní preventivní opatření pro zajištění udržení stability systému. Pro zajištění bezpečnosti obsluhy jsou určeny následující zásady:

- **Pokud je toto zařízení jedinou jednotkou v montážním rámu, musí být namontováno na nejnižší místo rámu.**
- **Pokud je toto zařízení montováno do částečně obsazeného montážního rámu, obsazujte montážní rám ve směru zdola nahoru tak, aby byla nejtěžší součást nejníže.**
- **Pokud je montážní rám vybaven stabilizačními zařízeními, nainstalujte stabilizátory ještě před montáží nebo opravou zařízení v montážním rámu.**

Προειδοποίηση

Για να αποφύγετε τον τραυματισμό κατά την τοποθέτηση ή τη συντήρηση αυτής της συσκευής σε αρθρωτό σύστημα, πρέπει να λάβετε ειδικές προφυλάξεις για να διασφαλίσετε τη σταθερότητα του συστήματος. Οι παρακάτω οδηγίες παρέχονται για να εξασφαλίσουν την ασφάλειά σας:

- Αυτή η συσκευή πρέπει να τοποθετείται στο κάτω μέρος του αρθρωτού συστήματος αν είναι η μοναδική συσκευή σε αυτό.
- Όταν τοποθετείτε αυτήν τη συσκευή σε εν μέρει γεμάτο αρθρωτό σύστημα, τοποθετήστε συσκευές στο αρθρωτό σύστημα από κάτω προς τα επάνω, με τη βαρύτερη συσκευή στο κάτω μέρος του συστήματος.
- Εάν το αρθρωτό σύστημα διαθέτει διατάξεις σταθεροποίησης, τοποθετήστε τους σταθεροποιητές πριν τοποθετήσετε ή συντηρήσετε τη συσκευή στο αρθρωτό σύστημα.

אזהרה

כדי למנוע פציעה בעת הרכבת יחידה זו במעמד או טיפול בה, עליך לנקוט אמצעי זהירות מיוחדים כדי להבטיח את יציבות המערכת. הקווים המנחים הבאים ניתנים על מנת להבטיח את ביטחונך:

- אם יחידה זו היא יחידה בודדת במעמד, יש להרכיב את היחידה בחלקו התחתון של המעמד.
- בעת הרכבת יחידה זו במעמד המלא בחלקו, טען את המעמד החל בחלק התחתון וכלפי מעלה כאשר הרכיב הכבד ביותר נמצא בחלקו התחתון של המעמד.
- אם המעמד מסופק עם התקני ייצוב, התקן את המייצבים לפני הרכבה היחידה במעמד או טיפול בה.

Opomena

За да се не повредите кога го монтирате или го сервисирате уредот на полица, мора да бидете особено претпазливи за да ја обезбедите стабилноста на системот. Следите напатствија се дадени за да ја осигураат Вашата безбедност:

- Уредот треба да се монтира најдолу на полицата ако е единствен уред на полицата.
- Кога го монтирате уредот на делумно пополнета полица, полнете ја полицата од дното кон врвот со најтешката компонента на дното на полицата.
- Ако полицата има стабилизаторски делови, наместете ги стабилизаторите пред да го монтирате или сервисирате уредот на полицата.

Ostrzeżenie **Aby zapobiec urazom podczas montażu lub serwisowania tego urządzenia w stojaku, należy zastosować szczególne środki ostrożności w celu zapewnienia stabilności układu. Poniżej przedstawiono wskazówki, których przestrzeganie zapewni bezpieczeństwo:**

- **Jeśli urządzenie to jest jedynym urządzeniem w stojaku, powinno być zamontowane na dole.**
- **W przypadku montażu urządzenia w częściowo zapełnionym stojaku należy instalować kolejne urządzenia od najniższego do najwyższego, przy czym element najcięższy powinien być zamontowany najniżej w stojaku.**
- **Jeśli stojak jest wyposażony w elementy stabilizujące, należy zamontować stabilizatory przed przystąpieniem do montażu lub serwisowania urządzeń w stojaku.**

Upozornenie **Aby ste predišli poraneniu osôb pri montáži alebo oprave zariadenia v montážnom ráme, musíte dodržiavať zvláštne preventívne opatrenia na zaistenie udržania stability systému. Na zaistenie bezpečnosti obsluhy sú určené nasledujúce zásady:**

- **Pokiaľ je toto zariadenie jedinou jednotkou v montážnom ráme, musí byť namontované na najnižšie miesto v ráme.**
- **Pokiaľ je toto zariadenie montované do čiastočne obsadeného montážneho rámu, obsadzujte montážny rám v smere zdola nahor tak, aby bola najťažšia súčasť najnižšie.**
- **Pokiaľ je montážny rám vybavený stabilizačnými zariadeniami, nainštalujte stabilizátory ešte pred montážou alebo opravou zariadenia v montážnom ráme.**

Battery Handling Warning for 4400 Series Controllers

Warning **There is the danger of explosion if the Cisco 4400 Series Wireless LAN Controller battery is replaced incorrectly. Replace the battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.** Statement 1015

Waarschuwing **Er is ontploffingsgevaar als de batterij verkeerd vervangen wordt. Vervang de batterij slechts met hetzelfde of een equivalent type dat door de fabrikant aanbevolen is. Gebruikte batterijen dienen overeenkomstig fabrieksvoorschriften weggeworpen te worden.**

Varoitus **Räjähdyksen vaara, jos akku on vaihdettu väärään akkuun. Käytä vaihtamiseen ainoastaan samantai vastaavantyyppistä akkua, joka on valmistajan suosittelema. Hävitä käytetyt akut valmistajan ohjeiden mukaan.**

Attention **Danger d'explosion si la pile n'est pas remplacée correctement. Ne la remplacer que par une pile de type semblable ou équivalent, recommandée par le fabricant. Jeter les piles usagées conformément aux instructions du fabricant.**

Warnung **Bei Einsetzen einer falschen Batterie besteht Explosionsgefahr. Ersetzen Sie die Batterie nur durch den gleichen oder vom Hersteller empfohlenen Batterietyp. Entsorgen Sie die benutzten Batterien nach den Anweisungen des Herstellers.**

Avvertenza **Pericolo di esplosione se la batteria non è installata correttamente. Sostituire solo con una di tipo uguale o equivalente, consigliata dal produttore. Eliminare le batterie usate secondo le istruzioni del produttore.**

Advarsel **Det kan være fare for eksplosjon hvis batteriet skiftes på feil måte. Skift kun med samme eller tilsvarende type som er anbefalt av produsenten. Kasser brukte batterier i henhold til produsentens instruksjoner.**

Aviso **Existe perigo de explosão se a bateria for substituída incorrectamente. Substitua a bateria por uma bateria igual ou de um tipo equivalente recomendado pelo fabricante. Destrua as baterias usadas conforme as instruções do fabricante.**

¡Advertencia! **Existe peligro de explosión si la batería se reemplaza de manera incorrecta. Reemplazar la batería exclusivamente con el mismo tipo o el equivalente recomendado por el fabricante. Desechar las baterías gastadas según las instrucciones del fabricante.**

Varning! **Explosionsfara vid felaktigt batteribyte. Ersätt endast batteriet med samma batterityp som rekommenderas av tillverkaren eller motsvarande. Följ tillverkarens anvisningar vid kassering av använda batterier.**

Robbanásveszélyt idézhet elő, ha helytelenül cserélik ki az akkumulátort. Csak a gyártó által javasolttal megegyező vagy azzal egyenértékű típusúra cserélje ki az akkumulátort! A használt akkumulátorok kidobásakor tartsa be a gyártó előírásait!

Предупреждение При неправильной замене батареи возможен взрыв. Для замены следует использовать батарею того же или аналогичного типа, рекомендованного изготовителем. Утилизацию батареи необходимо производить в соответствии с указаниями изготовителя.

警告 电池更换不当会有爆炸危险。请只用同类电池或制造商推荐的功能相当的电池更换原有电池。请按制造商的说明处理废旧电池。

警告 不適切なバッテリに交換すると、爆発の危険性があります。製造元が推奨するものと同じまたは同等のバッテリだけを使用してください。使用済みのバッテリは、製造元が指示する方法に従って処分してください。

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Equipment Installation Warning

Warning **Only trained and qualified personnel should be allowed to install, replace, or service this equipment.** Statement 1030

Waarschuwing **Deze apparatuur mag alleen worden geïnstalleerd, vervangen of hersteld door bevoegd geschoold personeel.**

Varoitus **Tämän laitteen saa asentaa, vaihtaa tai huoltaa ainoastaan koulutettu ja laitteen tunteva henkilökunta.**

Attention **Il est vivement recommandé de confier l'installation, le remplacement et la maintenance de ces équipements à des personnels qualifiés et expérimentés.**

Warnung **Das Installieren, Ersetzen oder Bedienen dieser Ausrüstung sollte nur geschultem, qualifiziertem Personal gestattet werden.**

Avvertenza **Questo apparato può essere installato, sostituito o mantenuto unicamente da un personale competente.**

Advarsel **Bare opplært og kvalifisert personell skal foreta installasjoner, utskiftninger eller service på dette utstyret.**

Aviso **Apenas pessoal treinado e qualificado deve ser autorizado a instalar, substituir ou fazer a revisão deste equipamento.**

¡Advertencia! **Solamente el personal calificado debe instalar, reemplazar o utilizar este equipo.**

Varning! **Endast utbildad och kvalificerad personal bör få tillåtelse att installera, byta ut eller reparera denna utrustning.**

A berendezést csak szakképzett személyek helyezhetik üzembe, cserélhetik és tarthatják karban.

Предупреждение Установку, замену и обслуживание этого оборудования может осуществлять только специально обученный квалифицированный персонал.

警告 只有经过培训且具有资格的人员才能进行此设备的安装、更换和维修。

警告 この装置の設置、交換、保守は、訓練を受けた相応の資格のある人が行ってください。

주의 교육을 받고 자격을 갖춘 사람만 이 장비를 설치, 교체, 또는 서비스를 수행해야 합니다.

Aviso **Somente uma equipe treinada e qualificada tem permissão para instalar, substituir ou dar manutenção a este equipamento.**

Advarsel **Kun uddannede personer må installere, udskifte komponenter i eller servicere dette udstyr.**

تحذير **يسمح للفنيين المتخصصين فقط بتركيب المعدة أو استبدالها أو إجراء الصيانة عليها.**

Upozorenje **Uređaj smije ugrađivati, mijenjati i servisirati samo za to obučeno i osposobljeno servisno osoblje.**

Upozornění **Instalaci, výměnu nebo opravu tohoto zařízení smějí provádět pouze proškolené a kvalifikované osoby.**

Προειδοποίηση Η τοποθέτηση, η αντικατάσταση και η συντήρηση του εξοπλισμού επιτρέπεται να γίνονται μόνο από καταρτισμένο προσωπικό με τα κατάλληλα προσόντα.

אזהרה רק עובדים מיומנים ומוסמכים רשאים להתקין, להחליף, או לטפל בציד זה.

Opomena Местењето, заменувањето и сервисирањето на оваа опрема треба да му биде дозволено само на обучен и квалификуван персонал.

Ostrzeżenie **Do instalacji, wymiany i serwisowania tych urządzeń mogą być dopuszczone wyłącznie osoby wykwalifikowane i przeszkolone.**

Upozornenie **Inštaláciu, výmenu alebo opravu tohto zariadenia smú vykonávať iba vyškolené a kvalifikované osoby.**

A berendezést csak szakképzett személyek helyezhetik üzembe, cserélhetik és tarthatják karban.

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Upozornenie **Inštaláciu, výmenu alebo opravu tohto zariadenia smú vykonávať iba vyškolené a kvalifikované osoby.**

More Than One Power Supply Warning for 4400 Series Controllers

Warning **The Cisco 4400 Series Wireless LAN Controller might have more than one power supply connection. All connections must be removed to de-energize the unit.** Statement 1028

Waarschuwing **Deze eenheid kan meer dan één stroomtoevoeraansluiting bevatten. Alle aansluitingen dienen ontkoppeld te worden om de eenheid te ontkrachten.**

Varoitus **Tässä laitteessa voi olla useampia kuin yksi virtakytkentä. Kaikki liitännät on irrotettava, jotta jännite poistetaan laitteesta.**

Attention **Cette unité peut avoir plus d'une connexion d'alimentation. Pour supprimer toute tension et tout courant électrique de l'unité, toutes les connexions d'alimentation doivent être débranchées.**

Warnung **Dieses Gerät kann mehr als eine Stromzufuhr haben. Um sicherzustellen, dass der Einheit kein Strom zugeführt wird, müssen alle Verbindungen entfernt werden.**

Avvertenza **Questa unità può avere più di una connessione all'alimentazione elettrica. Tutte le connessioni devono essere staccate per togliere la corrente dall'unità.**

Advarsel **Denne enheten kan ha mer enn én strømtilførselskobling. Alle koblinger må fjernes fra enheten for å utkoble all strøm.**

Aviso **Esta unidade poderá ter mais de uma conexão de fonte de energia. Todas as conexões devem ser removidas para desligar a unidade.**

¡Advertencia! **Puede que esta unidad tenga más de una conexión para fuentes de alimentación. Para cortar por completo el suministro de energía, deben desconectarse todas las conexiones.**

Varning! **Denna enhet har eventuellt mer än en strömförsörjningsanslutning. Alla anslutningar måste tas bort för att göra enheten strömlös.**

Előfordulhat, hogy a készülék többszörösen van csatlakoztatva az áramforráshoz. A készülék áramtalanításához mindegyik csatlakozást meg kell szüntetni.

Предупреждение В данном устройстве может использоваться несколько подключений к электросети. Чтобы обесточить устройство, необходимо отключить все эти подключения.

警告 此部件连接的电源可能不止一个。必须将所有电源断开才能停止给该部件供电。

警告 この装置には、複数の電源が接続されている場合があります。装置の電源を完全にオフにするには、すべての電源を切断する必要があります。

주의 본 장치에는 2개 이상의 전원 공급 연결 단자가 있을 수 있습니다. 이 장치의 전원을 차단하려면 모든 연결 단자를 제거해야 합니다.

Aviso **Esta unidade pode ter mais de uma conexão de fonte de alimentação. Todas as conexões devem ser removidas para interromper a alimentação da unidade.**

Advarsel **Denne enhed har muligvis mere end en strømforsyningstilslutning. Alle tilslutninger skal fjernes for at aflade strømmen fra enheden.**

تحذير **قد تتضمن هذه الوحدة أكثر من اتصال بمورد الطاقة. يجب فصل كافة التوصيلات حتى يمكن إفراغ طاقة الوحدة.**

Upozorenje

Upozornění **Toto zařízení může být připojeno k více než jednomu zdroji napájení. Aby se zařízení zcela odpojilo od proudu, musí být odpojeno od všech zdrojů napájení.**

Προειδοποίηση Αυτή η συσκευή ίσως να έχει περισσότερες συνδέσεις τροφοδοσίας.
Για να απενεργοποιηθεί η συσκευή, πρέπει να αφαιρεθούν όλες οι συνδέσεις.

אזהרה ייתכן שביחידה זו קיים יותר מחיבור אחד לספק כוח. יש להסיר את כל החיבורים כדי להפסיק את אספקת המתח ליחידה.

Opomena Уредот може да има повеќе од еден приклучок за напојување. Сите приклучоци мора да се извадат за да се прекине доводот на енергија во уредот.

Ostrzeżenie **To urządzenie może mieć podłączone więcej niż jedno źródło zasilania. Aby całkowicie odciąć dopływ energii do urządzenia, należy odłączyć wszystkie źródła zasilania.**

Upozornenie **Toto zariadenie môže byť pripojené k viac ako jednému zdroju napájania. Aby sa zariadenie odpojilo od prúdu, musí byť odpojené od všetkých zdrojov.**

Előfordulhat, hogy a készülék többszörösen van csatlakoztatva az áramforráshoz. A készülék áramtalanításához mindegyik csatlakozást meg kell szüntetni.

Предупреждение В данном устройстве может использоваться несколько подключений к электросети. Чтобы обесточить устройство, необходимо отключить все эти подключения.

警告 此部件连接的电源可能不止一个。必须将所有电源断开才能停止给该部件供电。

警告 この装置には、複数の電源が接続されている場合があります。装置の電源を完全にオフにするには、すべての電源を切断する必要があります。

주의 본 장치에는 2개 이상의 전원 공급 연결 단자가 있을 수 있습니다. 이 장치의 전원을 차단하려면 모든 연결 단자를 제거해야 합니다.

تحذير **قد تتضمن هذه الوحدة أكثر من اتصال بمورد الطاقة. يجب فصل كافة التوصيلات حتى يمكن إفراغ طاقة الوحدة.**

Upozorenje **Uređaj može imati više priključaka za izvore napajanja. Za potpuno isključivanje napajanja potrebno je iskopčati sve priključke.**

Upozornění **Toto zařízení může být připojeno k více než jednomu zdroji napájení. Aby se zařízení zcela odpojilo od proudu, musí být odpojeno od všech zdrojů napájení.**

Προειδοποίηση Αυτή η συσκευή ίσως να έχει περισσότερες συνδέσεις τροφοδοσίας. Για να απενεργοποιηθεί η συσκευή, πρέπει να αφαιρεθούν όλες οι συνδέσεις.

אזהרה יתכן שביחידה זו קיים יותר מחיבור אחד לספק כוח. יש להסיר את כל החיבורים כדי להפסיק את אספקת המתח ליחידה.

Opomena Уредот може да има повеќе од еден приклучок за напојување. Сите приклучоци мора да се извадат за да се прекине доводот на енергија во уредот.

Ostrzeżenie **To urządzenie może mieć podłączone więcej niż jedno źródło zasilania. Aby całkowicie odciąć dopływ energii do urządzenia, należy odłączyć wszystkie źródła zasilania.**

Upozornenie **Toto zariadenie môže byť pripojené k viac ako jednému zdroju napájania. Aby sa zariadenie odpojilo od prúdu, musí byť odpojené od všetkých zdrojov.**

Declarations of Conformity and Regulatory Information

This appendix provides declarations of conformity and regulatory information for the products in the Cisco UWN Solution.

This appendix contains these sections:

Regulatory Information for 1000 Series Access Points

This section contains regulatory information for 1000 series access points. The information is in these sections:

Manufacturers Federal Communication Commission Declaration of Conformity Statement

Model:

AIR-AP1010-A-K9, AIR-AP1020-A-K9, AIR-AP1030-A-K9

FCC Certification number:

LDK102057

Manufacturer:

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA

This device complies with Part 15 rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits of a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and radiates radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference. However, there is no guarantee that interference will not

occur. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician.

Caution The Part 15 radio device operates on a non-interference basis with other devices operating at this frequency when using the integrated antennas. Any changes or modification to the product not expressly approved by Cisco could void the user's authority to operate this device.

Caution Within the 5.15 to 5.25 GHz band (5 GHz radio channels 34 to 48) the U-NII devices are restricted to indoor operations to reduce any potential for harmful interference to co-channel Mobile Satellite System (MSS) operations.

Department of Communications—Canada

Model:

AIR-AP1010-A-K9, AIR-AP1020-A-K9, AIR-AP1030-A-K9

Certification number:

2461B-102057

Canadian Compliance Statement

This Class B Digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numerique de la classe B respecte les exigences du Reglement sur le material broilleur du Canada.

This device complies with Class B Limits of Industry Canada. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Cisco Aironet 2.4-GHz Access Points are certified to the requirements of RSS-210 for 2.4-GHz spread spectrum devices, and Cisco Aironet 54-Mbps, 5-GHz Access Points are certified to the requirements of RSS-210 for 5-GHz spread spectrum devices.The use of this device in a system operating either partially or completely outdoors may require the user to obtain a license for the system according to the Canadian regulations. For further information, contact your local Industry Canada office.

European Community, Switzerland, Norway, Iceland, and Liechtenstein

Model:

AIR-AP1010-E-K9, AIR-AP1020-E-K9, AIR-AP1030-E-K9

Declaration of Conformity with Regard to the R&TTE Directive 1999/5/EC

English:	This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Deutsch:	Dieses Gerät entspricht den grundlegenden Anforderungen und den weiteren entsprecheneden Vorgaben der Richtlinie 1999/5/EU.
Dansk:	Dette udstyr er i overensstemmelse med de væsentlige krav og andre relevante bestemmelser i Directiv 1999/5/EF.
Español:	Este equipo cumple con los requisitos esenciales asi como con otras disposiciones de la Directive 1999/5/EC.
Έλληνας:	Αυτός ο εξοπλισμός συμμορφώνεται με τις ουσιώδεις απαιτήσεις και τις λοιπές διατάξεις της Οδηγίας 1999/5/ΕΚ.
Français:	Cet appareil est conforme aux exigencies essentialles et aux autres dispositions pertinantes de la Directive 1999/5/EC.
Íslenska:	Þessi búnaður samrýmist lögboðnum kröfum og öðrum ákvæðum tilskipunar 1999/5/ESB.
Italiano:	Questo apparato é conforme ai requisiti essenziali ed agli altri principi sanciti dalla Direttiva 1999/5/EC.
Nederlands:	Deze apparatuur voldoet aan de belangrijkste eisen en andere voorzieningen van richtlijn 1999/5/EC.
Norsk:	Dette utstyret er i samsvar med de grunnleggende krav og andre relevante bestemmelser i EU-directiv 1999/5/EC.
Português:	Este equipamento satisfaz os requisitos essenciais e outras provisões da Directiva 1999/5/EC.
Suomalainen:	Tämä laite täyttää direktiivin 1999/5/EY oleelliset vaatimukset ja on siinä asetettujen muidenkin ehtojen mukainen.
Svenska:	Denna utrustning är i överensstämmelse med de väsentliga kraven och andra relevanta bestämmelser i Direktiv 1999/5/EC.

For 2.4 GHz radios, the following standards were applied:

- Radio: EN 300.328-1, EN 300.328-2
- EMC: EN 301.489-1, EN 301.489-17
- Safety: EN 60950

Note This equipment is intended to be used in all EU and EFTA countries. Outdoor use may be restricted to certain frequencies and/or may require a license for operation. For more details, contact Cisco Corporate Compliance.

For 54 Mbps, 5 GHz access points, the following standards were applied:

- Radio: EN 301.893
- EMC: EN 301.489-1, EN 301.489-17
- Safety: EN 60950

The following CE mark is affixed to the access point with a 2.4 GHz radio and a 54 Mbps, 5 GHz radio:

CE !

Declaration of Conformity for RF Exposure

The radio has been found to be compliant to the requirements set forth in CFR 47 Sections 2.1091, and 15.247 (b) (4) addressing RF Exposure from radio frequency devices as defined in Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields. The equipment should be installed more than 20 cm (7.9 in.) from your body or nearby persons.

The access point must be installed to maintain a minimum 20 cm (7.9 in.) co-located separation distance from other FCC approved indoor/outdoor antennas used with the access point. Any antennas or transmitters not approved by the FCC cannot be co-located with the access point. The access point's co-located 2.4 GHz and 5 GHz integrated antennas support a minimum separation distance of 8 cm (3.2 in.) and are compliant with the applicable FCC RF exposure limit when transmitting simultaneously.

Note Dual antennas used for diversity operation are not considered co-located.

Guidelines for Operating Cisco Aironet Access Points in Japan

This section provides guidelines for avoiding interference when operating Cisco Aironet access points in Japan. These guidelines are provided in both Japanese and English.

Model:

AIR-AP1010-J-K9, AIR-AP1020-J-K9, AIR-AP1030-J-K9

Japanese Translation

English Translation

This equipment operates in the same frequency bandwidth as industrial, scientific, and medical devices such as microwave ovens and mobile object identification (RF-ID) systems (licensed premises radio stations and unlicensed specified low-power radio stations) used in factory production lines.

1. Before using this equipment, make sure that no premises radio stations or specified low-power radio stations of RF-ID are used in the vicinity.
2. If this equipment causes RF interference to a premises radio station of RF-ID, promptly change the frequency or stop using the device; contact the number below and ask for recommendations on avoiding radio interference, such as setting partitions.
3. If this equipment causes RF interference to a specified low-power radio station of RF-ID, contact the number below.

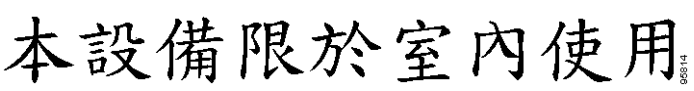
   Contact Number: 03-5549-6500

Administrative Rules for Cisco Aironet Access Points in Taiwan

This section provides administrative rules for operating Cisco Aironet access points in Taiwan. The rules are provided in both Chinese and English.

Access Points with IEEE 802.11a Radios

Chinese Translation

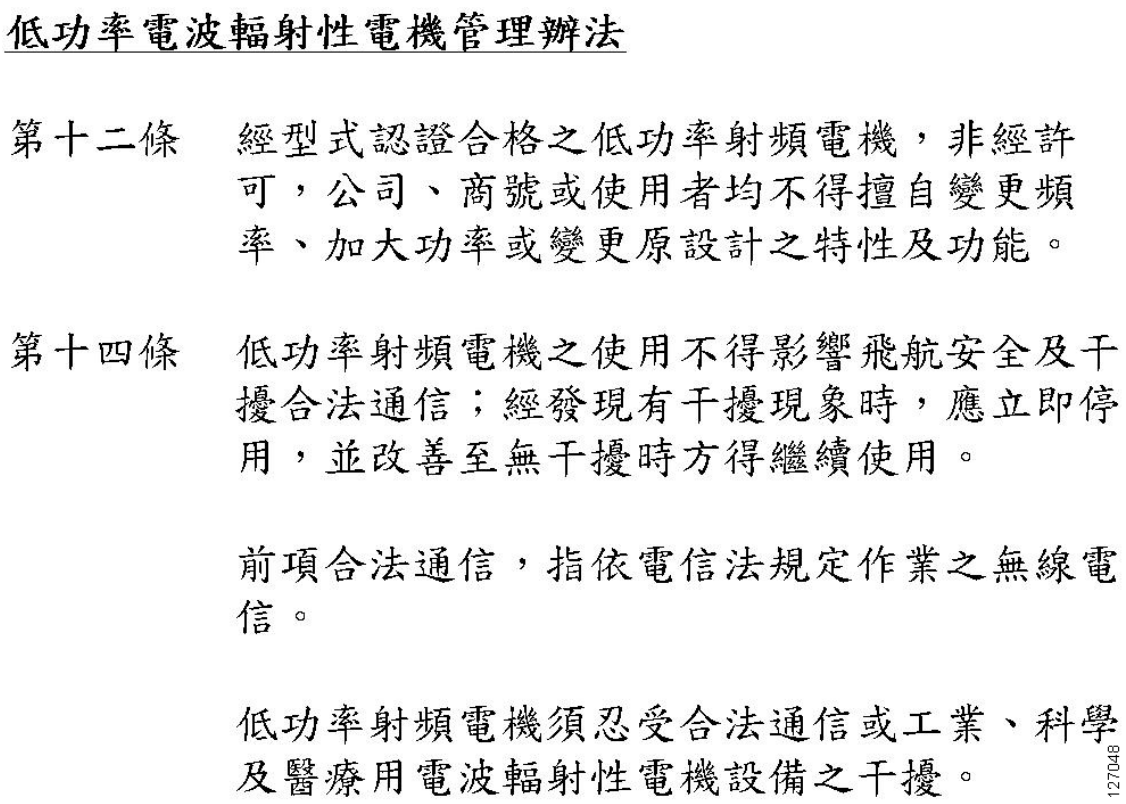


English Translation

This equipment is limited for indoor use.

All Access Points

Chinese Translation



English Translation

Administrative Rules for Low-power Radio-Frequency Devices

Article 12

For those low-power radio-frequency devices that have already received a type-approval, companies, business units or users should not change its frequencies, increase its power or change its original features and functions.

Article 14

The operation of the low-power radio-frequency devices is subject to the conditions that no harmful interference is caused to aviation safety and authorized radio station; and if interference is caused, the user must stop operating the device immediately and can't re-operate it until the harmful interference is clear.

The authorized radio station means a radio-communication service operating in accordance with the Communication Act.

The operation of the low-power radio-frequency devices is subject to the interference caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator.

Declaration of Conformity Statements

All the Declaration of Conformity statements related to this product can be found at the following URL:

http://tools.cisco.com/cse/prdapp/jsp/disclosure.jsp

FCC Statement for Cisco 2000 Series Wireless LAN Controllers

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help. [cfr reference 15.105]

FCC Statement for Cisco 4400 Series Wireless LAN Controllers

The Cisco 4400 Series Wireless LAN Controller equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

End User License and Warranty

This appendix describes the end user license and warranty that apply to the Cisco UWN Solution products:

- Cisco 1000 Series Lightweight Access Points
- Cisco 2000 Series Wireless LAN Controllers
- Cisco 4400 Series Wireless LAN Controllers
- Cisco Wireless Services Modules

This appendix contains these sections:

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replacement parts used in Hardware replacement may be new or equivalent to new. Cisco's obligations hereunder are conditioned upon the return of affected Hardware in accordance with Cisco's or its service center's then-current Return Material Authorization (RMA) procedures.

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System Messages and LED Patterns

This appendix lists system messages that can appear on the Cisco UWN Solution interfaces and describes the LED patterns on controllers and lightweight access points. It contains these sections:

System Messages

Table D-1 lists system messages and descriptions.

Table D-1 System Messages and Descriptions

Error Message	Description
apf_utils.c 680: Received a CIF field without the protected bit set from mobile xx:xx:xx:xx:xx:xx	A client is sending an association request on a security-enabled WLAN with the protected bit set to 0 (in the Capability field of the association request). As designed, the controller rejects the association request, and the client sees an association failure.
dtl_arp.c 480: Got an idle-timeout message from an unknown client xx:xx:xx:xx:xx:xx	The controller's network processing unit (NPU) sends a timeout message to the central processing unit (CPU) indicating that a particular client has timed out or aged out. This normally occurs when the CPU has removed a wireless client from its internal database but has not notified the NPU. Because the client remains in the NPU database, it ages out on the network processor and notifies the CPU. The CPU finds the client that is not present in its database and then sends this message.
STATION_DISASSOCIATE	Client may have intentionally terminated usage or may have experienced a service disruption.
STATION_DEAUTHENTICATE	Client may have intentionally terminated usage or it could indicate an authentication issue.
STATION_AUTHENTICATION_FAIL	Check disable, key mismatch or other configuration issues.
STATION_ASSOCIATE_FAIL	Check load on the Cisco Radio or signal quality issues.
LRAD_ASSOCIATED	The associated Cisco 1000 Series lightweight access point is now managed by this Cisco Wireless LAN Controller.
LRAD_DISASSOCIATED	Cisco 1000 Series lightweight access point may have associated with a different Cisco Wireless LAN Controller or may have become completely unreachable.
LRAD_UP	Cisco 1000 Series lightweight access point is operational, no action required.
LRAD_DOWN	Cisco 1000 Series lightweight access point may have a problem or is administratively disabled.
LRADIF_UP	Cisco Radio is UP.
LRADIF_DOWN	Cisco Radio may have a problem or is administratively disabled.
LRADIF_LOAD_PROFILE_FAILED	Client density may have exceeded system capacity.

Table D-1 System Messages and Descriptions (continued)

Error Message	Description
LRADIF_NOISE_PROFILE_FAILED	The non-802.11 noise has exceed configured threshold.
LRADIF_INTERFERENCE_PROFILE_FAILED	802.11 interference has exceeded threshold on channel -- check channel assignments.
LRADIF_COVERAGE_PROFILE_FAILED	Possible coverage hole detected - check Cisco 1000 Series lightweight access point history to see if common problem - add Cisco 1000 Series lightweight access points if necessary.
LRADIF_LOAD_PROFILE_PASSED	Load is now within threshold limits.
LRADIF_NOISE_PROFILE_PASSED	Detected noise is now less than threshold.
LRADIF_INTERFERENCE_PROFILE_PASSED	Detected interference is now less than threshold.
LRADIF_COVERAGE_PROFILE_PASSED	Number of clients receiving poor signal are within threshold.
LRADIF_CURRENT_TXPOWER_CHANGED	Informational message.
LRADIF_CURRENT_CHANNEL_CHANGED	Informational message.
LRADIF_RTS_THRESHOLD_CHANGED	Informational message.
LRADIF_ED_THRESHOLD_CHANGED	Informational message.
LRADIF_FRAGMENTATION_THRESHOLD_CHANGED	Informational message.
RRM_DOT11_A_GROUPING_DONE	Informational message.
RRM_DOT11_B_GROUPING_DONE	Informational message.
ROGUE_AP_DETECTED	May be a security issue.Use maps and trends to investigate.
ROGUE_AP_REMOVED	Detected rogue access point has timed out. The unit might have shut down or moved out of the coverage area.
AP_MAX_ROGUE_COUNT_EXCEEDED	The current number of active rogue access points has exceeded system threshold.
LINK_UP	Positive confirmation message.
LINK_DOWN	Port may have a problem or is administratively disabled.
LINK_FAILURE	Port may have a problem or is administratively disabled.
AUTHENTICATION_FAILURE	Attempted security breech. Investigate.
STP_NEWROOT	Informational message.
STP_TOPOLOGY_CHANGE	Informational message.
IPSEC_ESP_AUTH_FAILURE	Check WLAN IPSec configuration.
IPSEC_ESP_REPLAY_FAILURE	Check for attempt to spoof IP Address.
IPSEC_ESP_POLICY_FAILURE	Check for IPSec configuration mismatch between WLAN and client.

Table D-1 System Messages and Descriptions (continued)

Error Message	Description
IPSEC_ESP_INVALID_SPI	Informational message.
IPSEC_OTHER_POLICY_FAILURE	Check for IPSec configuration mismatch between WLAN and client.
IPSEC_IKE_NEG_FAILURE	Check for IPSec IKE configuration mismatch between WLAN and client.
IPSEC_SUITE_NEG_FAILURE	Check for IPSec IKE configuration mismatch between WLAN and client.
IPSEC_INVALID_COOKIE	Informational message.
RADIOS_EXCEEDED	Maximum number of supported Cisco Radios exceeded. Check for controller failure in the same Layer 2 network or add another controller.
SENSED_TEMPERATURE_HIGH	Check fan, air conditioning and/or other cooling arrangements.
SENSED_TEMPERATURE_LOW	Check room temperature and/or other reasons for low temperature.
TEMPERATURE_SENSOR_FAILURE	Replace temperature sensor ASAP.
TEMPERATURE_SENSOR_CLEAR	Temperature sensor is operational.
POE_CONTROLLER_FAILURE	Check ports — possible serious failure detected.
MAX_ROGUE_COUNT_EXCEEDED	The current number of active rogue access points has exceeded system threshold.
SWITCH_UP	Controller is responding to SNMP polls.
SWITCH_DOWN	Controller is not responding to SNMP polls, check controller and SNMP settings.
RADIUS_SERVERS_FAILED	Check network connectivity between RADIUS and the controller.
CONFIG_SAVED	Running configuration has been saved to flash - will be active after reboot.
MULTIPLE_USERS	Another user with the same username has logged in.
FAN_FAILURE	Monitor Cisco Wireless LAN Controller temperature to avoid overheating.
POWER_SUPPLY_CHANGE	Check for power-supply malfunction.
COLD_START	Cisco Wireless LAN Controller may have been rebooted.
WARM_START	Cisco Wireless LAN Controller may have been rebooted.

Interpreting LEDs

Interpreting Controller LEDs

Refer to the quick start guide for your specific controller for a description of the LED patterns. You can find the guides at this URL:

http://www.cisco.com/en/US/products/hw/wireless/index.html

Interpreting Lightweight Access Point LEDs

Refer to the hardware installation guide for your specific access point for a description of the LED patterns. You can find the guides at this URL:

http://www.cisco.com/en/US/products/hw/wireless/index.html

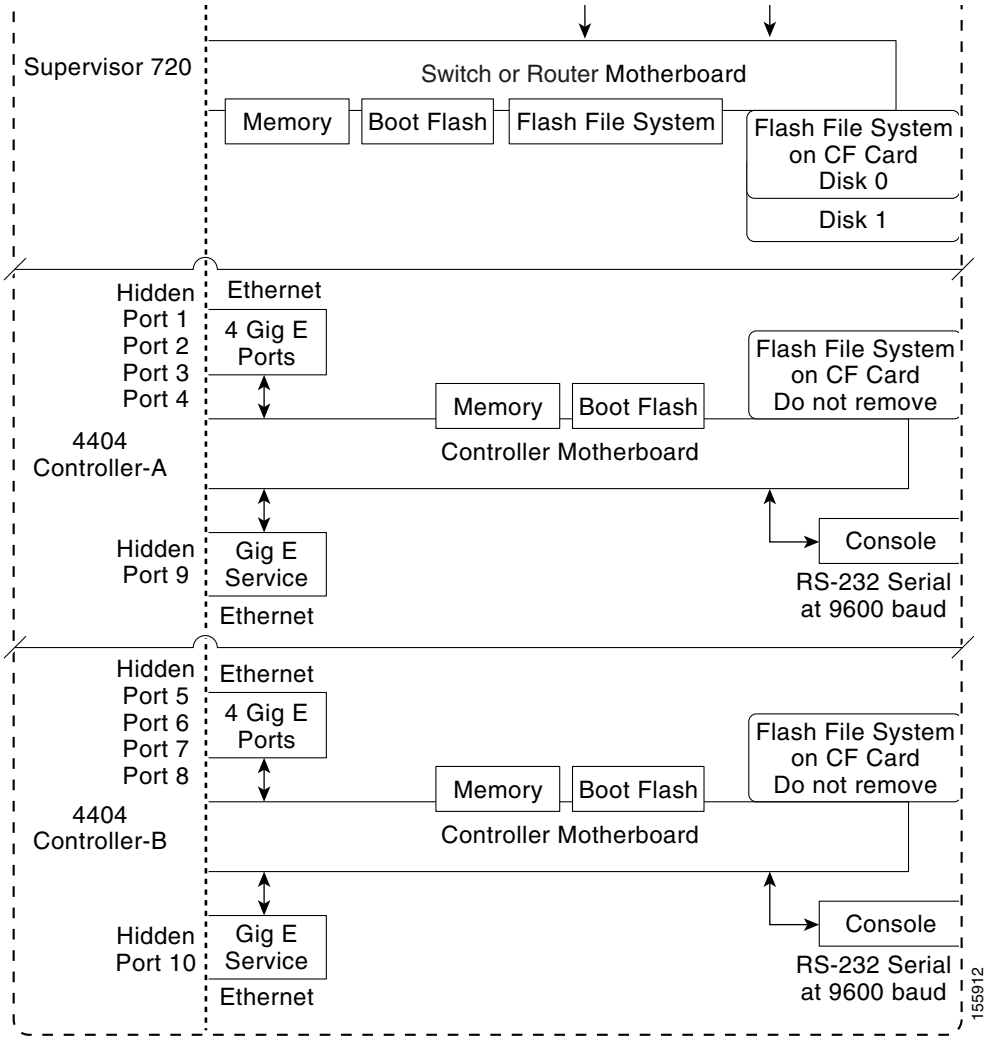
Logical Connectivity Diagrams

This appendix provides logical connectivity diagrams and related software commands for integrated controllers. It contains these sections:

This section provides logical connectivity diagrams for the controllers integrated into other Cisco products, specifically the Catalyst 3750G Integrated Wireless LAN Controller Switch, the Cisco WiSM and the Cisco 28/37/38xx Series Integrated Services Router. These diagrams show the internal connections between the switch or router and the controller. The software commands used for communication between the devices are also provided.

Cisco WiSM

Figure E-1 Logical Connectivity Diagram for the Cisco WiSM

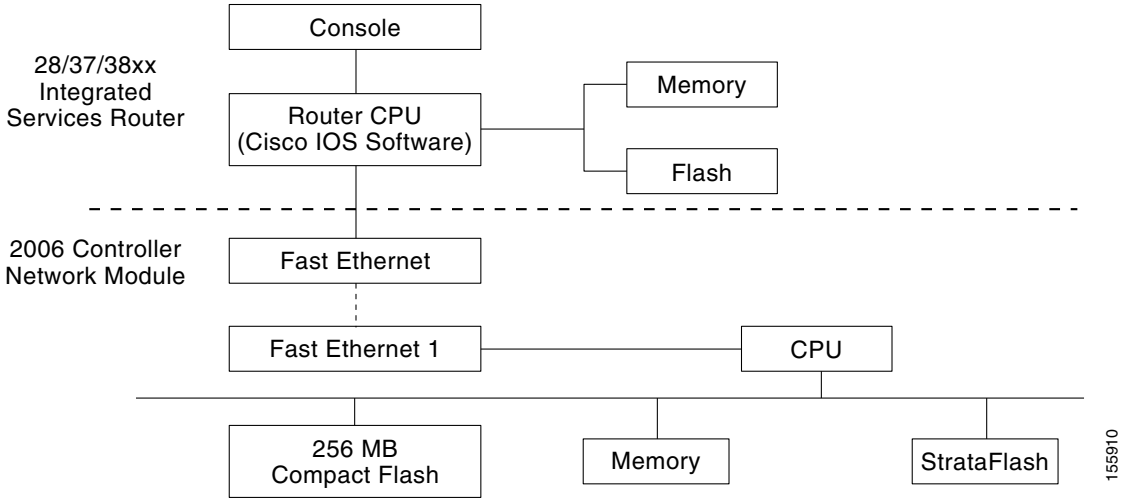


The commands used for communication between the Cisco WiSM, the Supervisor 720, and the 4404 controllers will be added to this section in a future release of the document.

Note Refer to the *Catalyst 6500 Series Switch Wireless Services Module Installation and Configuration Note* for more information. You can find this document at this URL: http://www.cisco.com/en/US/products/hw/switches/ps708/products_installation_and_configuration_guides_list.html

Cisco 28/37/38xx Integrated Services Router

Figure E-2 Logical Connectivity Diagram for the Cisco 28/37/38xx Integrated Services Router



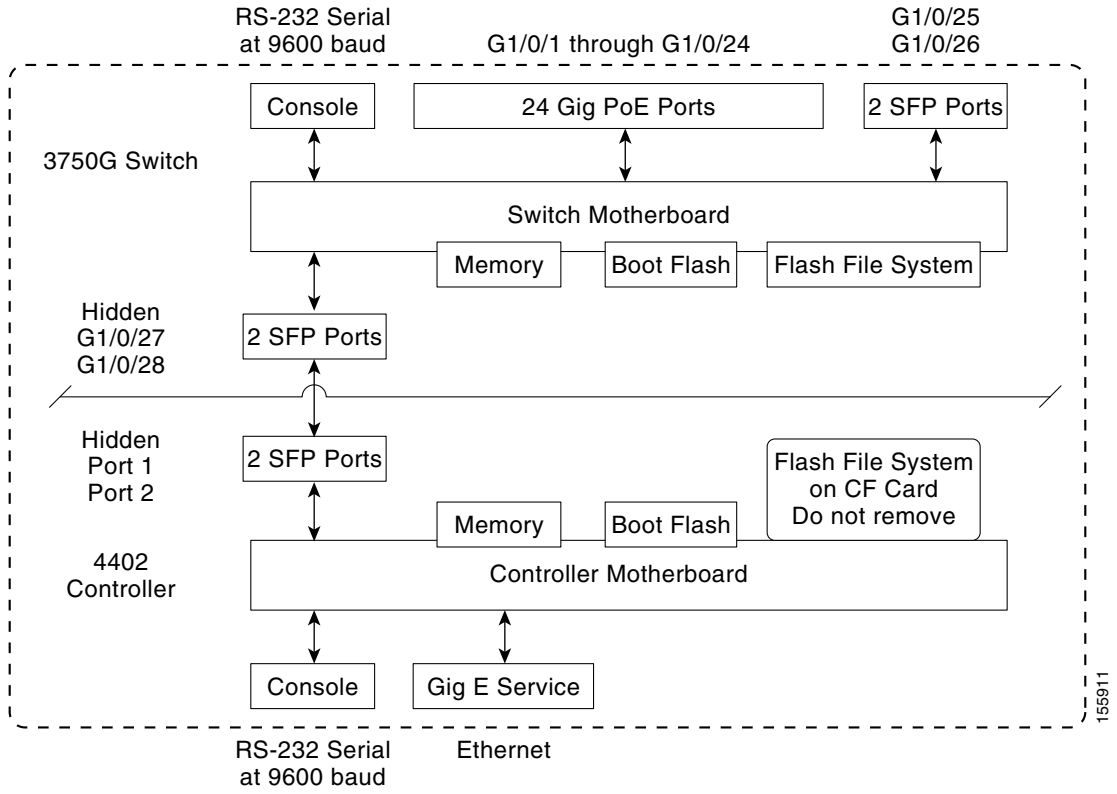
These commands are used for communication between the Integrated Services Router and the 2006 controller network module. They are initiated from the router.

- **interface wlan-controller** *slot/unit* (and support for subinterfaces with **dot1q encap**)
- **show interfaces wlan-controller** *slot/unit*
- **show controllers wlan-controller** *slot/unit*
- **test service-module wlan-controller** *slot/unit*
- **test HW-module wlan-controller** *slot/unit* **reset** {**enable** | **disable**}

Note Refer to the *Cisco Wireless LAN Controller Module Feature Guide* for more information. You can find this document at this URL:
http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124newft/124limit/124x/124xa2/boxernm.htm#wp2033271

Catalyst 3750G Integrated Wireless LAN Controller Switch

Figure E-3 Logical Connectivity Diagram for the Catalyst 3750G Integrated Wireless LAN Controller Switch



These commands are used for communication between the Catalyst 3750G switch and the 4402 controller.

Login Command

This command is used to initiate a telnet session from the switch to the controller:

session *switch_number* **processor 1**

Because there can be several switches in a stack, the *switch_number* parameter is used to indicate to which controller in the stack this session should be directed. Once a session is established, the user interacts with the controller CLI. Entering **exit** terminates the session and returns the user to the switch CLI.

Show Commands

These commands are used to view the status of the internal controller. They are initiated from the switch.

- **show platform wireless-controller** *switch_number* **summary**

  Information similar to the following appears:

```
Switch  Status  State
1       up      operational
2       up      operational
```

- **show platform wireless-controller** *switch_number* **status**

  Information similar to the following appears:

```
Switch  Service IP      Management IP   SW Version      Status
------+---------------+---------------+---------------+-------
 1      127.0.1.1       70.1.30.1       4.0.52.0        operational
 2      127.0.1.2       70.1.31.1       4.0.45.0        operational
```

- **show platform wireless-controller** *switch_number* **management-info**

```
sw vlan ip                gateway         http https mac            version
1  0    70.1.30.1/16       70.1.1.1        1    1     0016.9dca.d963 4.0.52.0
2  0    70.1.31.1/16       70.1.1.1        0    1     0016.9dca.dba3 4.0.45.0
```

Debug Commands

The Wireless Control Protocol (WCP) is an internal keep-alive protocol that runs between the switch and the controller. It enables the switch to monitor the health of the controller and to report any problems. It uses UDP and runs over the two internal Gigabit ports, but it creates an internal VLAN 4095 to separate control traffic from data traffic. Every 20 seconds the switch sends a keep-alive message to the controller. If the controller does not acknowledge 16 consecutive keep-alive messages, the switch declares the controller dead and sends a reset signal to reboot the controller.

These commands are used to monitor the health of the internal controller.

This command is initiated from the controller.

- **debug wcp** *?*

  where *?* is one of the following:

  packet—Debugs WCP packets.

  events—Debugs WCP events.

  Information similar to the following appears:

```
Tue Feb  7 23:30:31 2006: Received WCP_MSG_TYPE_REQUEST
Tue Feb  7 23:30:31 2006: Received WCP_MSG_TYPE_REQUEST,of type WCP_TLV_KEEP_ALIVE
Tue Feb  7 23:30:31 2006: Sent WCP_MSG_TYPE_RESPONSE,of type WCP_TLV_KEEP_ALIVE
Tue Feb  7 23:30:51 2006: Received WCP_MSG_TYPE_REQUEST
Tue Feb  7 23:30:51 2006: Received WCP_MSG_TYPE_REQUEST,of type WCP_TLV_KEEP_ALIVE
Tue Feb  7 23:30:51 2006: Sent WCP_MSG_TYPE_RESPONSE,of type WCP_TLV_KEEP_ALIVE
Tue Feb  7 23:31:11 2006: Received WCP_MSG_TYPE_REQUEST
Tue Feb  7 23:31:11 2006: Received WCP_MSG_TYPE_REQUEST,of type WCP_TLV_KEEP_ALIVE
Tue Feb  7 23:31:11 2006: Sent WCP_MSG_TYPE_RESPONSE,of type WCP_TLV_KEEP_ALIVE
```

This command is initiated from the switch.

- **debug platform wireless-controller** *switch_number ?*

  where *?* is one of the following:

  all—All

  errors—Errors

  packets—WCP packets

  sm—State machine

  wcp—WCP protocol

Reset Commands

These two commands (in this order) are used to reset the controller from the switch. They are not yet available but will be supported in a future release.

- **test wireless-controller stop** *switch_number*
- **test wireless-controller start** *switch_number*

Note A direct console connection to the controller does not operate when hardware flow control is enabled on the PC. However, the switch console port operates with hardware flow control enabled.

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