CHAPTER 8

Security Setup

This chapter describes how to set up your bridge's security features. This chapter contains the following sections:

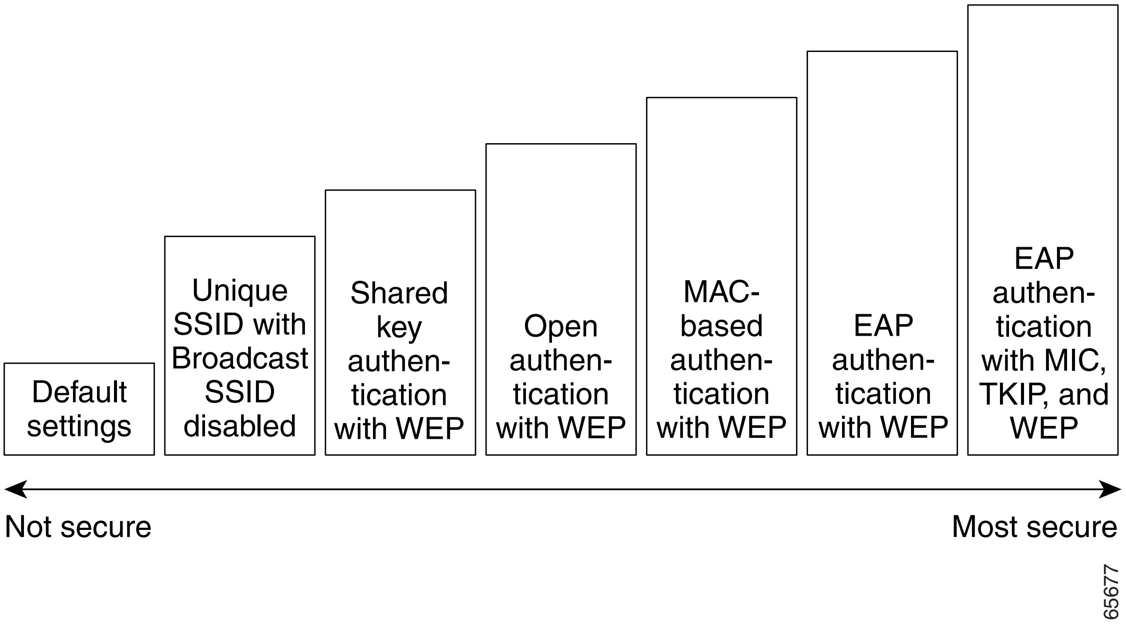
Security Overview

This section describes the types of security features you can enable on the bridge. The security features protect wireless communication between the bridge and other wireless devices, control access to your network, and prevent unauthorized entry to the bridge management system.

Levels of Security

Security is vital for any wireless network, and you should enable all the security features available on your network. Figure 8-1 shows possible levels of security on Cisco Aironet wireless networking equipment, from no security on the left to highest security on the right. The highest level of security, EAP authentication, interacts with a Remote Authentication Dial-In User Service (RADIUS) server on your network to provide authentication service for wireless client devices.

Figure 8-1 Wireless LAN Security Levels


Default settings
Unique SSID with Broadcast SSID disabled
Shared key authentication with WEP
Open authentication with WEP
MAC-based authentication with WEP
EAP authentication with WEP
EAP authentication with MIC, TKIP, and WEP
Not secure
Most secure
65677

If you don’t enable any security features on your bridge, anyone with a wireless networking device is able to join your network. If you enable open or shared-key authentication with WEP encryption, your network is safe from casual outsiders but vulnerable to intruders who use a hacking algorithm to calculate the WEP key. If you enable server-based EAP authentication with Message Integrity Check (MIC), Temporal Key Integrity Protocol (TKIP, also known as key hashing), and broadcast key rotation, your network is safe from all but the most sophisticated attacks against wireless security.

Encrypting Radio Signals with WEP

Just as anyone within range of a radio station can tune to the station’s frequency and listen to the signal, any wireless networking device within range of a bridge can receive the bridge’s radio transmissions. Because WEP (Wired Equivalent Privacy) is the first line of defense against intruders, Cisco recommends that you use full encryption on your wireless network.

WEP encryption scrambles the communication between the bridge and other wireless devices to keep the communication private. Both the bridge and devices with which it communicates use the same WEP key to encrypt and unencrypt radio signals. WEP keys encrypt both unicast and multicast messages. Unicast messages are addressed to just one device on the network. Multicast messages are addressed to multiple devices on the network.

Extensible Authentication Protocol (EAP) authentication provides dynamic WEP keys to wireless users. Dynamic WEP keys are more secure than static, or unchanging, WEP keys. If an intruder passively receives enough packets encrypted by the same WEP key, the intruder can perform a calculation to learn the key and use it to join your network. Because they change frequently, dynamic WEP keys prevent intruders from performing the calculation and learning the key.

Additional WEP Security Features

Three additional security features defend your wireless network's WEP keys:

- Message Integrity Check (MIC)—MIC prevents attacks on encrypted packets called *bit-flip* attacks. During a bit-flip attack, an intruder intercepts an encrypted message, alters it slightly, and retransmits it, and the receiver accepts the retransmitted message as legitimate. The MIC, implemented on both the bridge and all associated client devices, adds a few bytes to each packet to make the packets tamper-proof. See the "Enabling Message Integrity Check (MIC)" section on page 8-10 for instructions on enabling MIC.
- TKIP (Temporal Key Integrity Protocol, also known as WEP key hashing)—This feature defends against an attack on WEP in which the intruder uses the unencrypted initialization vector (IV) in encrypted packets to calculate the WEP key. TKIP removes the predictability that an intruder relies on to determine the WEP key by exploiting IVs. See the "Enabling Temporal Key Integrity Protocol (TKIP)" section on page 8-12 for instructions on enabling TKIP.
- Broadcast key rotation—EAP authentication provides dynamic unicast WEP keys for client devices but uses static broadcast, or multicast, keys. When you enable broadcast WEP key rotation, the bridge provides a dynamic broadcast WEP key and changes it at the interval you select. Broadcast key rotation is an excellent alternative to TKIP if your wireless LAN supports wireless client devices that are not Cisco devices or that cannot be upgraded to the latest firmware for Cisco client devices. See the "Enabling Broadcast WEP Key Rotation" section on page 8-13 for instructions on enabling broadcast key rotation.

Note The MIC, TKIP, and broadcast key rotation features are available in firmware versions 11.10T and later, which are available on Cisco.com. You can download Cisco Aironet firmware releases at http://www.cisco.com/cisco/software/navigator.html.

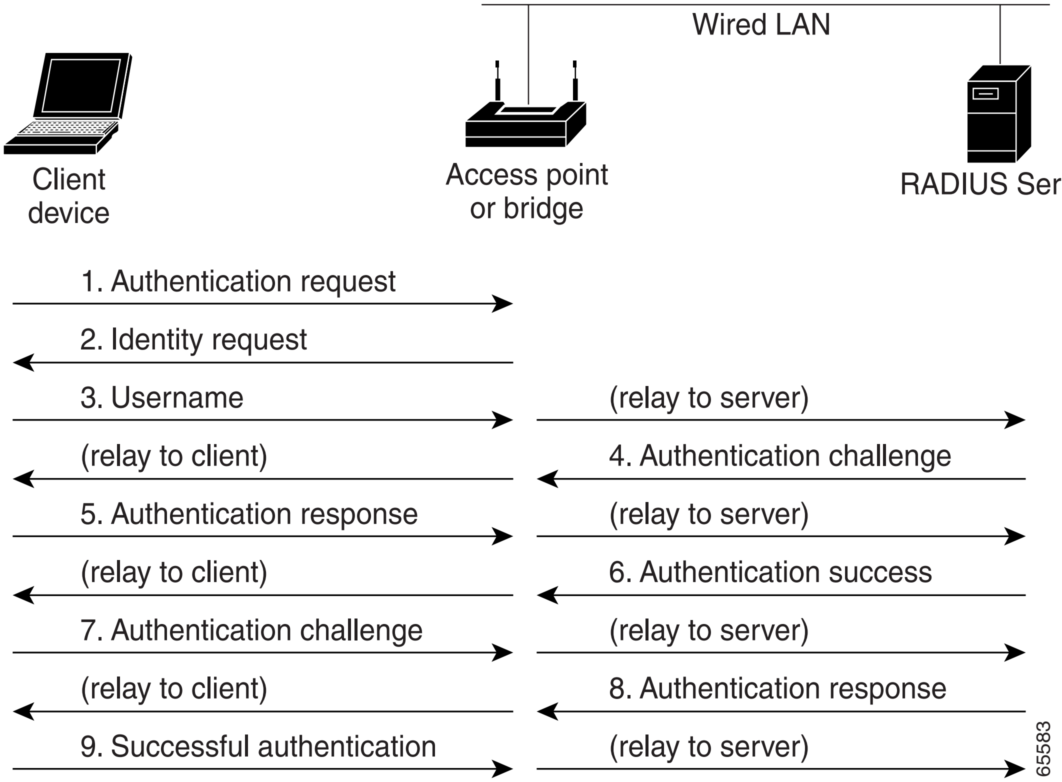
Network Authentication Types

Before a wireless client device can communicate on your network through the bridge, it must authenticate to the bridge and to your network. The bridge uses four authentication mechanisms or types and can use more than one at the same time:

- Network-EAP—This authentication type provides the highest level of security for your wireless network. By using the Extensible Authentication Protocol (EAP) to interact with an EAP-compatible RADIUS server, the bridge helps a wireless client device and the RADIUS server to perform mutual authentication and derive a dynamic unicast WEP key. The RADIUS server sends the WEP key to the bridge, which uses it for all unicast data signals that it sends to or receives from the client. The bridge also encrypts its broadcast WEP key (entered in the bridge's WEP key slot 1) with the client's unicast key and sends it to the client.

When you enable EAP on your bridges and client devices, authentication to the network occurs in the steps shown in Figure 8-2:

Figure 8-2 Sequence for EAP Authentication



In Steps 1 through 9 in Figure 8-2, a wireless client device and a RADIUS server on the wired LAN use 802.1x and EAP to perform a mutual authentication through the bridge. The RADIUS server sends an authentication challenge to the client. The client uses a one-way encryption of the user-supplied password to generate a response to the challenge and sends that response to the RADIUS server. Using information from its user database, the RADIUS server creates its own response and compares that to the response from the client. When the RADIUS server authenticates the client, the process repeats in reverse, and the client authenticates the RADIUS server.

When mutual authentication is complete, the RADIUS server and the client determine a WEP key that is unique to the client and provides the client with the appropriate level of network access, thereby approximating the level of security in a wired switched segment to an individual desktop. The client loads this key and prepares to use it for the logon session.

During the logon session, the RADIUS server encrypts and sends the WEP key, called a *session key*, over the wired LAN to the bridge. The bridge encrypts its broadcast key (entered in WEP key slot 1) with the session key and sends the encrypted broadcast key to the client, which uses the session key to decrypt it. The client and bridge activate WEP and use the session and broadcast WEP keys for all communications during the remainder of the session.

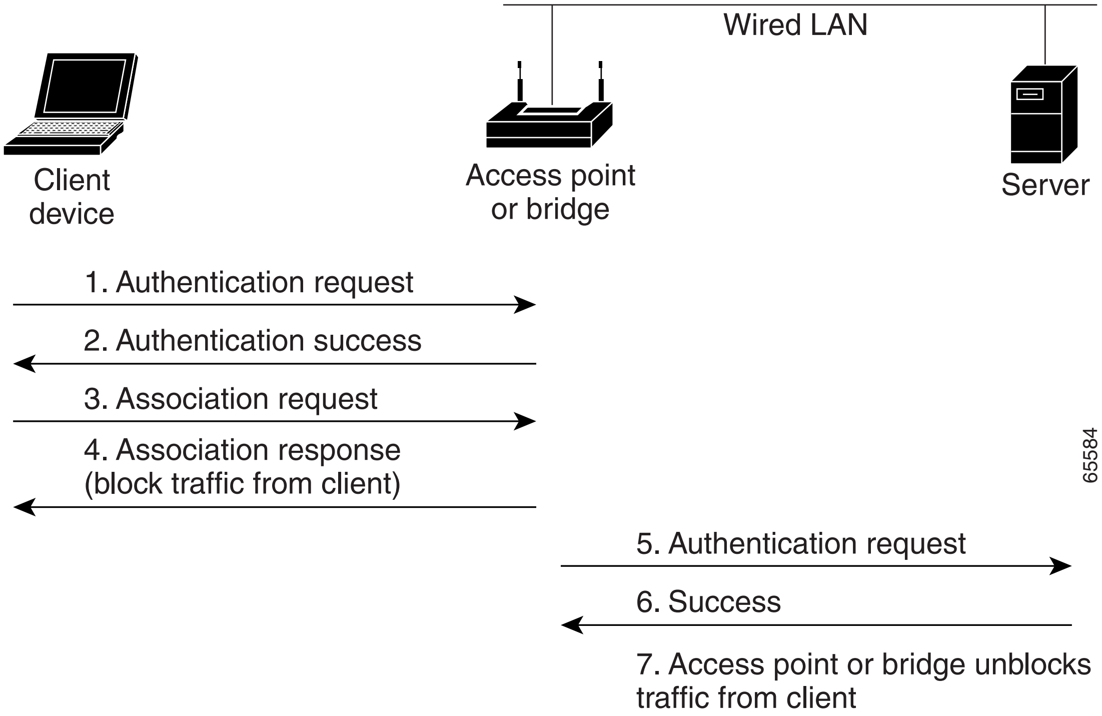
There is more than one type of EAP authentication, but the bridge behaves the same way for each type: it relays authentication messages from the wireless client device to the RADIUS server and from the RADIUS server to the wireless client device. See the "Setting Up EAP Authentication" section on page 8-14 for instructions on setting up EAP on the bridge.

Note If you use EAP authentication, you can select open or shared key authentication, but you don't have to. EAP authentication controls authentication both to your bridge and to your network.

- MAC address—The bridge relays the wireless client device's MAC address to a RADIUS server on your network, and the server checks the address against a list of allowed MAC addresses. If you don't have a RADIUS server on your network, you can create the list of allowed MAC addresses on the bridge's Address Filters page. Devices with MAC addresses not on the list are not allowed to authenticate. Intruders can create counterfeit MAC addresses, so MAC-based authentication is less secure than EAP authentication. However, MAC-based authentication provides an alternate authentication method for client devices that do not have EAP capability. See the "Setting Up MAC-Based Authentication" section on page 8-22 for instructions on enabling MAC-based authentication.

  Figure 8-3 shows the authentication sequence for MAC-based authentication.

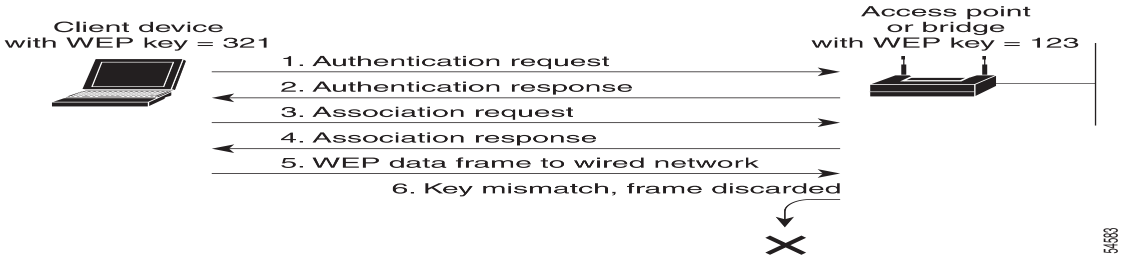
Figure 8-3 Sequence for MAC-Based Authentication


Wired LAN
Client device
Access point or bridge
Server
1. Authentication request
2. Authentication success
3. Association request
4. Association response (block traffic from client)
65584
5. Authentication request
6. Success
7. Access point or bridge unblocks traffic from client

- Open—Allows any device to authenticate and then attempt to communicate with the bridge. Using open authentication, any wireless device can authenticate with the bridge, but the device can only communicate if its WEP keys match the bridge's WEP keys. Devices not using WEP do not attempt to authenticate with a bridge or an access point that is using WEP. Open authentication does not rely on a RADIUS server on your network.

Figure 8-4 shows the authentication sequence between a device trying to authenticate and an access point or bridge using open authentication. In this example, the device's WEP key does not match the bridge's key, so it can authenticate but not pass data.

Figure 8-4 Sequence for Open Authentication

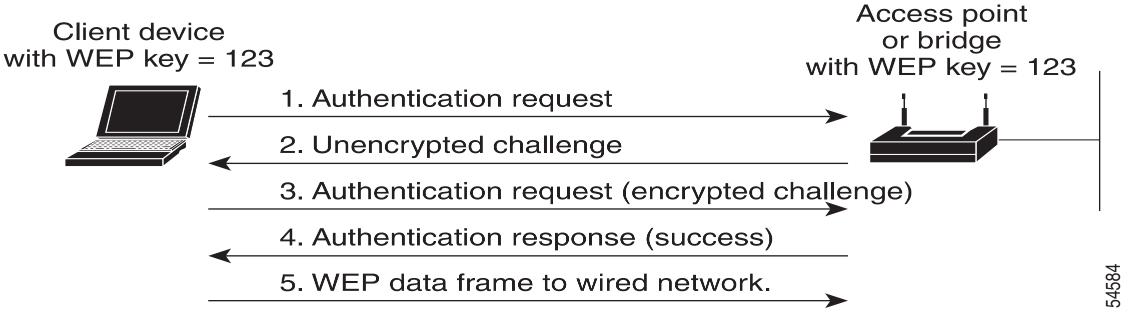


- Shared key—Cisco provides shared key authentication to comply with the IEEE 802.11b standard. However, because of shared key's security flaws, we recommend that you avoid using it.

  During shared key authentication, the bridge or access point sends an unencrypted challenge text string to any device attempting to communicate with the bridge. The device requesting authentication encrypts the challenge text and sends it back to the bridge. If the challenge text is encrypted correctly, the bridge allows the requesting device to authenticate. Both the unencrypted challenge and the encrypted challenge can be monitored, however, which leaves the bridge open to attack from an intruder who calculates the WEP key by comparing the unencrypted and encrypted text strings. Because of this weakness, shared key authentication can be less secure than open authentication. Like open authentication, shared key authentication does not rely on a RADIUS server on your network.

  Figure 8-5 shows the authentication sequence between a device trying to authenticate and a bridge using shared key authentication. In this example the device's WEP key matches the bridge's key, so it can authenticate and communicate.

Figure 8-5 Sequence for Shared Key Authentication


Client device
with WEP key = 123
Access point
or bridge
with WEP key = 123
1. Authentication request
2. Unencrypted challenge
3. Authentication request (encrypted challenge)
4. Authentication response (success)
5. WEP data frame to wired network.
54584

Combining MAC-Based, EAP, and Open Authentication

You can set up the bridge to authenticate client devices using a combination of MAC-based and EAP authentication. When you enable this feature, client devices that associate to the bridge using 802.11 open authentication first attempt MAC authentication; if MAC authentication succeeds, the client device joins the network. If MAC authentication fails, the bridge waits for the client device to attempt EAP authentication. See the "Authenticating Client Devices Using MAC Addresses or EAP" section on page 8-26 for more information on this feature.

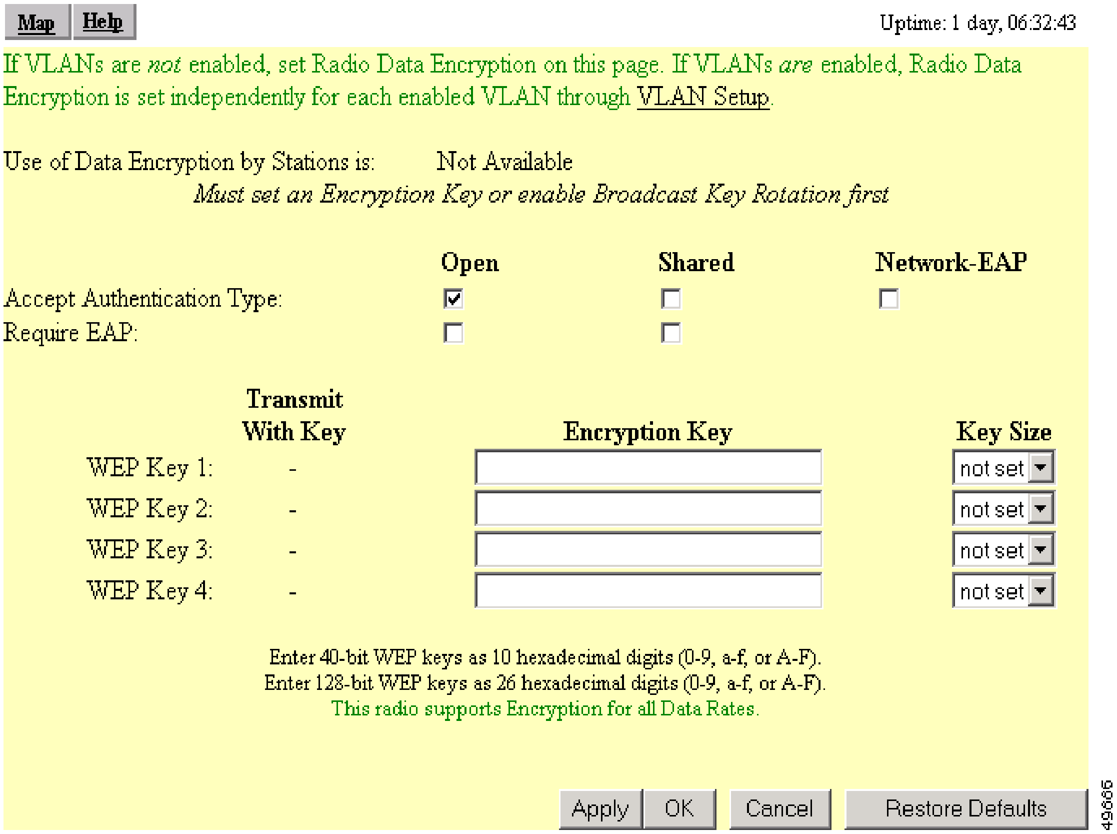
Protecting the Bridge Configuration with User Manager

The bridge's user manager feature prevents unauthorized entry to the bridge management system. You create a list of administrators authorized to view and adjust the bridge settings; unauthorized users are locked out. See the "Setting Up Administrator Authorization" section on page 8-33 for instructions on using the user manager.

Setting Up WEP

Use the Root Radio Data Encryption page to set up WEP. You also use the Root Radio Data Encryption page to select an authentication type for the bridge. Figure 8-6 shows the Root Radio Data Encryption page.

Figure 8-6 Root Radio Data Encryption Page



Uptime: 1 day, 06:32:43

If VLANs are *not* enabled, set Radio Data Encryption on this page. If VLANs *are* enabled, Radio Data Encryption is set independently for each enabled VLAN through VLAN Setup.

Use of Data Encryption by Stations is: Not Available

Must set an Encryption Key or enable Broadcast Key Rotation first

	Open	Shared	Network-EAP
Accept Authentication Type:	☑	□	□
Require EAP:	□	□	

	Transmit With Key	Encryption Key	Key Size
WEP Key 1:	-		not set
WEP Key 2:	-		not set
WEP Key 3:	-		not set
WEP Key 4:	-		not set

Enter 40-bit WEP keys as 10 hexadecimal digits (0-9, a-f, or A-F).
Enter 128-bit WEP keys as 26 hexadecimal digits (0-9, a-f, or A-F).
This radio supports Encryption for all Data Rates.

Follow this link path to reach the Root Radio Data Encryption page:

1. On the Summary Status page, click **Setup**.
2. On the Setup page, click **Security**.
3. On the Security Setup page, click **Radio Data Encryption (WEP)**.

Follow these steps to set up WEP keys and enable WEP:

Step 1 Follow the link path to the Root Radio Data Encryption page.

Step 2 Before you can enable WEP, you must enter a WEP key in at least one of the Encryption Key fields.

Note If you enable broadcast key rotation and EAP authentication to provide client devices with dynamic WEP keys, you can enable WEP without entering the keys.

For 40-bit encryption, enter 10 hexadecimal digits; for 128-bit encryption, enter 26 hexadecimal digits. Hexadecimal digits include the numbers 0 through 9 and the letters A through F. Your 40-bit WEP keys can contain any combination of 10 of these characters; your 128-bit WEP keys can contain any combination of 26 of these characters. The letters are not case-sensitive.

You can enter up to four WEP keys. The characters you type for a key's contents appear only when you type them. After you click **Apply** or **OK**, you cannot view the key's contents.

Note If you enable EAP authentication, you must select key 1 as the transmit key. The bridge uses the WEP key you enter in key slot 1 to encrypt multicast data signals it sends to EAP-enabled client devices. If you enable broadcast key rotation, however, you can select key 1 or key2 as the transmit key or you can enable WEP without entering any keys.

Step 3 Use the Key Size pull-down menu to select **40-bit** or **128-bit** encryption for each key. The **not set** option clears the key. You can disable WEP altogether by selecting **not set** for each key or by selecting **No Encryption** in Step 5.

Step 4 Select one of the keys as the transmit key. If you select Network-EAP as the authentication type, select key 1 as the transmit key.

Note Client devices that do not use EAP to authenticate to the bridge must contain the bridge's transmit key in the same key slot in the client devices' WEP key lists. If MIC is enabled on the bridge, the key must also be selected as the transmit key in the client devices' WEP key lists.

Table 8-1 shows an example WEP key setup that would work for the bridge and an associated device:

Table 8-1 WEP Key Setup Example

	Bridge		Associated Device	
Key Slot	Transmit?	Key Contents	Transmit?	Key Contents
1	x	`12345678901234567890abcdef`	—	`12345678901234567890abcdef`
2	—	`09876543210987654321fedcba`	x	`09876543210987654321fedcba`
3	—	not set	—	not set
4	—	not set	—	`FEDCBA09876543211234567890`

Because the bridge's WEP key 1 is selected as the transmit key, WEP key 1 on the other device must contain the same contents. WEP key 4 on the other device is set, but because it is not selected as the transmit key, WEP key 4 on the bridge does not need to be set at all.

The characters you type for the key contents appear only when you type them. After you click **Apply** or **OK**, you cannot view the key contents. Select **Not set** from the Key Size pull-down menu to clear a key.

Step 5 Select **Optional** or **Full Encryption** from the pull-down menu labeled *Use of Data Encryption by Stations is*.

Note You must set a WEP key before enabling WEP. The options in the *Use of Data Encryption by Stations is* pull-down menu do not appear until you set a key. However, if you enable broadcast key rotation and EAP authentication to provide client devices with dynamic WEP keys, you can enable WEP without entering the keys.

The three settings in the pull-down menu include:

- No Encryption (default)—The bridge communicates only with wireless devices that are not using WEP. Use this option to disable WEP.
- Optional—Wireless devices can communicate with the bridge either with or without WEP.

  Note If you select Optional, Cisco Aironet client devices associating to the bridge must be configured to allow association to mixed cells. See the *Cisco Aironet Wireless LAN Adapters Software Configuration Guide* for instructions on configuring Cisco Aironet client devices.

- Full Encryption—Wireless devices must use WEP when communicating with the bridge. Devices not using WEP are not allowed to communicate.

  Note You must select Full Encryption to enable Message Integrity Check (MIC). See the "Enabling Message Integrity Check (MIC)" section on page 8-10 for instructions on setting up MIC.

Step 6 Click **OK**. You return automatically to the Security Setup page.

Using SNMP to Set Up WEP

You can use SNMP to set the WEP level on the bridge. Consult the "Using SNMP" section on page 2-8 for details on using SNMP.

Bridges use the following SNMP variables to set the WEP level:

- dot11ExcludeUnencrypted.2
- awcDot11AllowEncrypted.2

Table 8-2 lists the SNMP variable settings and the corresponding WEP levels.

Table 8-2 SNMP Variable Settings and Corresponding WEP Levels

SNMP Variable	WEP Full	WEP Off	WEP Optional
dot11ExcludeUnencrypted.2	true	false	false
awcDot11AllowEncrypted.2	true	false	true

Note Bridges do not use the SNMP variable *dot11PrivacyInvoked*, so it is always set to disabled.

Enabling Additional WEP Security Features

You can enable three advanced security features to protect against sophisticated attacks on your wireless network's WEP keys. This section describes how to set up and enable these features:

- Enabling Message Integrity Check (MIC)
- Enabling Temporal Key Integrity Protocol (TKIP)
- Enabling Broadcast WEP Key Rotation

Note The MIC, TKIP, and broadcast key rotation features are available in firmware versions 11.10T and later, which are available on Cisco.com. You can download Cisco Aironet firmware releases at http://www.cisco.com/cisco/software/navigator.html.

Enabling Message Integrity Check (MIC)

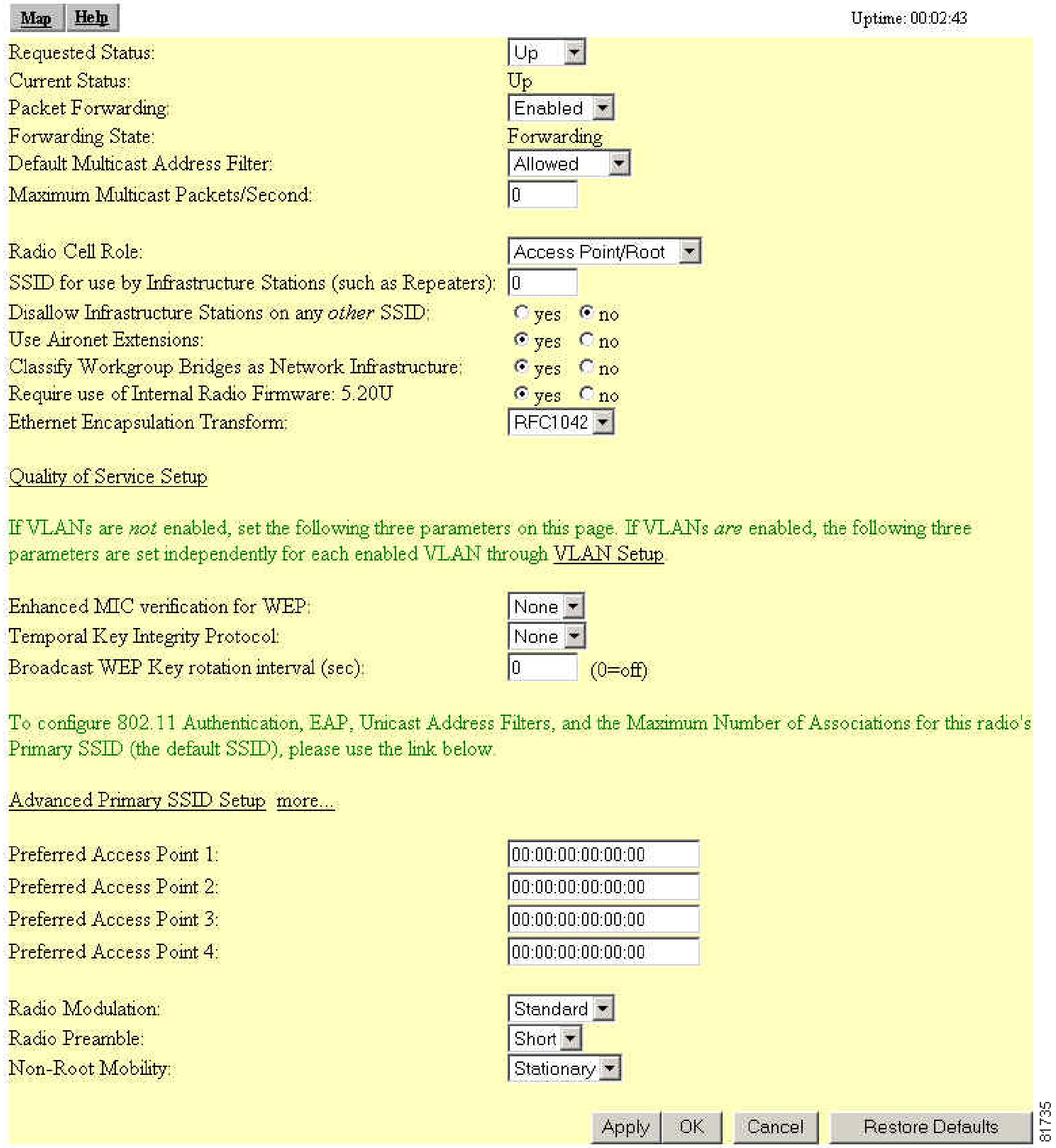
MIC prevents attacks on encrypted packets called *bit-flip* attacks. During a bit-flip attack, an intruder intercepts an encrypted message, alters it slightly, and retransmits it, and the receiver accepts the retransmitted message as legitimate. The MIC, implemented on both the bridge and all associated client devices, adds a few bytes to each packet to make the packets tamper-proof.

Note You must set up and enable WEP with full encryption before MIC takes effect.

Note To use MIC, the Use Aironet Extensions setting on the Root Radio Advanced page must be set to yes (the default setting).

Use the Root Radio Advanced page to enable MIC. Figure 8-7 shows the Root Radio Advanced page.

Figure 8-7 Root Radio Advanced Page



Uptime: 00:02:43

Requested Status: Up
Current Status: Up
Packet Forwarding: Enabled
Forwarding State: Forwarding
Default Multicast Address Filter: Allowed
Maximum Multicast Packets/Second: 0

Radio Cell Role: Access Point/Root
SSID for use by Infrastructure Stations (such as Repeaters): 0
Disallow Infrastructure Stations on any *other* SSID: ○ yes ● no
Use Aironet Extensions: ● yes ○ no
Classify Workgroup Bridges as Network Infrastructure: ● yes ○ no
Require use of Internal Radio Firmware: 5.20U ● yes ○ no
Ethernet Encapsulation Transform: RFC1042

Quality of Service Setup

If VLANs are *not* enabled, set the following three parameters on this page. If VLANs *are* enabled, the following three parameters are set independently for each enabled VLAN through VLAN Setup

Enhanced MIC verification for WEP: None
Temporal Key Integrity Protocol: None
Broadcast WEP Key rotation interval (sec): 0 (0=off)

To configure 802.11 Authentication, EAP, Unicast Address Filters, and the Maximum Number of Associations for this radio's Primary SSID (the default SSID), please use the link below.

Advanced Primary SSID Setup more...

Preferred Access Point 1: 00:00:00:00:00:00
Preferred Access Point 2: 00:00:00:00:00:00
Preferred Access Point 3: 00:00:00:00:00:00
Preferred Access Point 4: 00:00:00:00:00:00

Radio Modulation: Standard
Radio Preamble: Short
Non-Root Mobility: Stationary

Follow this link path to browse to the Root Radio Advanced page:

1. On the Summary Status page, click **Setup**.
2. On the Setup page, click **Advanced** in the Root Radio row under Network Ports.

Follow these steps to enable MIC:

Step 1 Follow the steps in the "Setting Up WEP" section on page 8-7 to set up and enable WEP. You must set up and enable WEP with full encryption before MIC becomes active. If WEP is off or if you set it to optional, MIC is not enabled.

Note If you enable MIC but you use static WEP (you do not enable any type of EAP authentication), both the bridge and any devices with which it communicates must use the same WEP key for transmitting data. For example, if MIC-enabled Bridge A uses the key in slot 1 as the transmit key, non-root bridges and client devices associated to Bridge A must use the same key in slot 1, and those keys must be selected as the transmit keys.

Step 2 Browse to the Root Radio Advanced page.

Step 3 Select **MMH** from the Enhanced MIC verification for WEP pull-down menu.

Step 4 Make sure **yes** is selected for the Use Aironet Extensions setting. MIC does not work if Use Aironet Extensions is set to no.

Step 5 Click **OK**. MIC is enabled, and only client devices with MIC capability can communicate with the bridge.

Enabling Temporal Key Integrity Protocol (TKIP)

Temporal Key Integrity Protocol (TKIP), also known as WEP key hashing, defends against an attack on WEP in which the intruder uses an unencrypted segment called the initialization vector (IV) in encrypted packets to calculate the WEP key. TKIP removes the predictability that an intruder relies on to determine the WEP key by exploiting IVs. TKIP protects both unicast and broadcast WEP keys.

Note When you enable TKIP, all WEP-enabled client devices associated to the bridge must support WEP key hashing. WEP-enabled devices that do not support key hashing cannot communicate with the bridge.

Note To use TKIP, the Use Aironet Extensions setting on the Root Radio Advanced page must be set to yes (the default setting).

Tip When you enable TKIP, you might not need to enable broadcast key rotation. Key hashing prevents intruders from calculating the static broadcast key, so you do not need to rotate the broadcast key.

Follow these steps to enable TKIP:

Step 1 Follow the steps in the "Setting Up WEP" section on page 8-7 to set up and enable WEP. Select either optional or full encryption for the WEP level.

Step 2 Follow this link path to browse to the Root Radio Advanced page:

a. On the Summary Status page, click **Setup**.

b. On the Setup page, click **Advanced** in the Root Radio row under Network Ports.

Step 3 Select **Cisco** from the Temporal Key Integrity Protocol pull-down menu.

Step 4 Make sure **yes** is selected for the Use Aironet Extensions setting. TKIP does not work if Use Aironet Extensions is set to no.

Step 5 Click **OK**. WEP key hashing is enabled.

Enabling Broadcast WEP Key Rotation

EAP authentication provides dynamic unicast WEP keys for client devices but uses static multicast keys. With broadcast or multicast, WEP key rotation enabled, the bridge provides a dynamic broadcast WEP key and changes it at the interval you select. Broadcast key rotation is an excellent alternative to TKIP if your wireless LAN supports wireless client devices that are not Cisco devices or that cannot be upgraded to the latest firmware for Cisco client devices.

Note When you enable broadcast key rotation, the bridge distributes dynamic broadcast WEP keys to associated client devices but not to other bridges. All traffic between bridges is unicast traffic, so bridges do not need broadcast keys for bridge-to-bridge communication.

Note When you enable broadcast key rotation, only wireless client devices using LEAP, EAP-TLS, or PEAP authentication can use the bridge. Client devices using static WEP (with open, shared key, or EAP-MD5 authentication) cannot use the bridge when you enable broadcast key rotation.

Tip You might not need to enable broadcast key rotation if you enable TKIP. You can use both key rotation and key hashing, but these features provide redundant protection.

When broadcast key rotation is enabled, you can configure the WEP keys so that the unicast key is overwritten when the keys are rotated. If no keys are set when broadcast key rotation is enabled, key 0 becomes the transmit key by default. This means that key 0 and key 1 are rotated as the broadcast keys and key 3 is used as the unicast key. This configuration poses no problem.

A key can also be explicitly set as the transmit key, meaning that the transmit key and transmit key index +1 are rotated as the broadcast keys. Setting key 0 or 1 works satisfactorily. But if you set key 2 or 3 as the transmit key then the unicast key, which is generated following LEAP authentication and set as key 3, is overwritten as the broadcast keys are rotated.

Therefore, you should specify only key 0 or 1 as the transmit key.

Follow these steps to enable broadcast key rotation:

Step 1 Follow the steps in the "Setting Up WEP" section on page 8-7 to set up and enable WEP.

Step 2 Follow this link path to browse to the Root Radio Advanced page:

a. On the Summary Status page, click **Setup**.

b. On the Setup page, click **Advanced** in the Root Radio row under Network Ports.

Step 3 On the Root Radio Advanced page, enter the rotation interval in seconds in the Broadcast WEP Key rotation interval entry field. If you enter 900, for example, the bridge sends a new broadcast WEP key to all associated client devices every 15 minutes. To disable broadcast WEP key rotation, enter **0**.

Note You must set the rotation interval on every bridge using broadcast key rotation. You cannot enter the rotation interval on your RADIUS server.

Tip Use a short rotation interval if the traffic on your wireless network contains numerous broadcast or multicast packets.

Step 4 Click **OK**. Broadcast key rotation is enabled.

Setting Up Open or Shared Key Authentication

Cisco recommends Open authentication as preferable to Shared Key authentication. The challenge queries and responses used in Shared Key leave the bridge particularly vulnerable to intruders.

Use the Root Radio Data Encryption page to select Open or Shared Key authentication. Figure 8-6 shows the Root Radio Data Encryption page.

Follow these steps to select Open or Shared Key authentication:

Step 1 Follow the instructions in the "Setting Up WEP" section on page 8-7 to set up and enable WEP.

You must enable WEP to use shared key authentication, but you do not have to enable WEP to use open authentication. However, Cisco strongly recommends that you enable WEP on all wireless networks.

Step 2 Select **Open** (default) or **Shared Key** to set the authentications the bridge recognizes. You can select all three authentication types.

Step 3 If you want to force all client devices to perform EAP authentication before joining the network, select the **Require EAP** check box under Open or Shared. Selecting the Require EAP check box also allows client devices using various types of EAP authentication, including EAP-TLS and EAP-MD5, to authenticate through the bridge. To allow LEAP-enabled client devices to authenticate through the bridge, you should also select **Network-EAP**. See the "Setting Up EAP Authentication" section on page 8-14 for details on the Require EAP and Network-EAP settings.

Step 4 Click **OK**. You return automatically to the Security Setup page.

Setting Up EAP Authentication

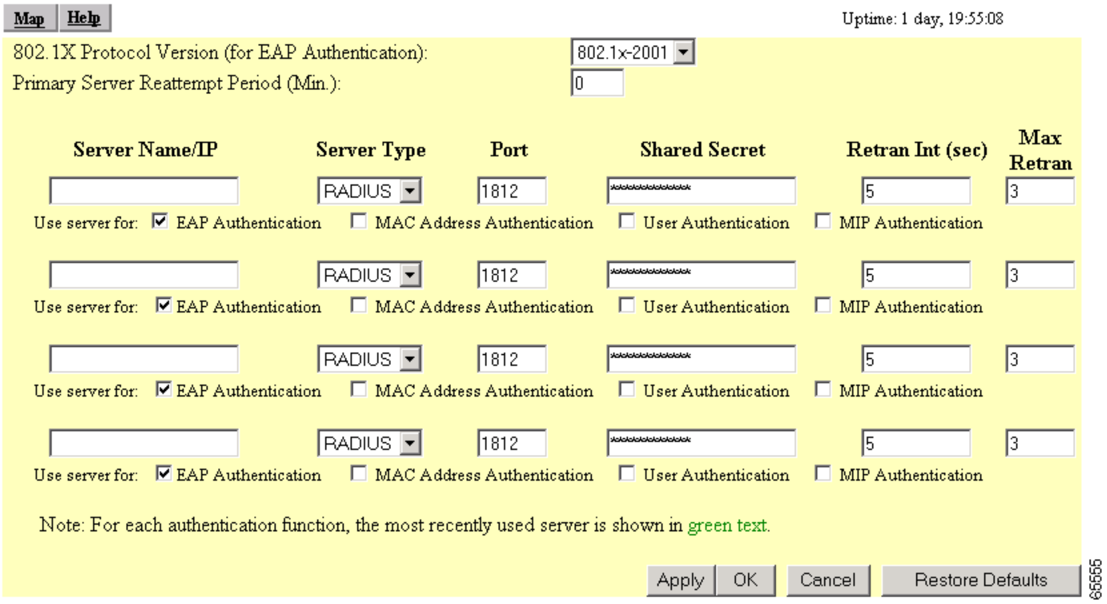
During EAP authentication, the bridge relays authentication messages between the RADIUS server on your network and the authenticating client device. This section provides instructions for:

- Enabling EAP on the Bridge
- Enabling EAP in Cisco Secure ACS
- Setting Up a Non-Root Bridge as a LEAP Client

Enabling EAP on the Bridge

You use the Authenticator Configuration page and the Root Radio Data Encryption page to set up and enable EAP authentication. Figure 8-6 shows the Root Radio Data Encryption page. Figure 8-8 shows the Authenticator Configuration page.

Figure 8-8 Authenticator Configuration Page



Uptime: 1 day, 19:55:08

802.1X Protocol Version (for EAP Authentication): 802.1x-2001

Primary Server Reattempt Period (Min.): 0

Server Name/IP	Server Type	Port	Shared Secret	Retran Int (sec)	Max Retran
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	

Note: For each authentication function, the most recently used server is shown in green text.

Follow this link path to reach the Authenticator Configuration page:

1. On the Summary Status page, click **Setup**.
2. On the Setup page, click **Security**.
3. On the Security Setup page, click **Authentication Server**.

Follow these steps to enable EAP on the bridge:

Step 1 Follow the link path to the Authenticator Configuration page.

You can configure up to four servers for authentication services, so you can set up backup authenticators. If you set up more than one server for the same service, the server first in the list is the primary server for that service, and the others are used in list order when the previous server times out.

Note You can use the same server for both EAP authentication and MAC-address authentication.

Step 2 Use the 802.1x Protocol Version (for EAP authentication) pull-down menu to select the draft of the 802.1x protocol the bridge's radio will use. EAP operates only when the radio firmware on client devices complies with the same 802.1x Protocol draft as the management firmware on the bridge. If the radio firmware on the client devices that will associate with the bridge is 4.16, for example, you should select **Draft 8**. Menu options include:

- Draft 7—No radio firmware versions compliant with Draft 7 have LEAP capability, so you should not need to select this setting.
- Draft 8—Select this option if LEAP-enabled client devices that associate with this bridge use radio firmware versions 4.13, 4.16, or 4.23.
- Draft 10—Select this option if client devices that associate with this bridge use Microsoft Windows XP authentication or if LEAP-enabled client devices that associate with this bridge use radio firmware version 4.25 or later.

Note Functionality in Draft 10 is equivalent to the functionality in Draft 11, the ratified draft of the 802.1X standard.

Table 8-3 lists the radio firmware versions and the drafts with which they comply.

Table 8-3 802.1x Protocol Drafts and Compliant Client Firmware

Firmware Version	Draft 7	Draft 8	Draft 10[1]
PC/PCI cards 4.13	—	x	—
PC/PCI cards 4.16	—	x	—
PC/PCI cards 4.23	—	x	—
PC/PCI cards 4.25 and later	—	—	x
WGB34x/352 8.58	—	x	—
WGB34x/352 8.61 or later	—	—	x
AP34x/35x 11.05 and earlier	—	x	—
AP34x/35x 11.06 and later[2]	—	x	x
BR352 11.06 and later[1]	—	x	x

[1] Functionality in Draft 10 is equivalent to the functionality in Draft 11, the ratified draft of the 802.1X standard.

[2] The default draft setting in access point and bridge firmware version 11.06 and later is Draft 10.

Note Draft standard 8 is the default setting in firmware version 11.05 and earlier, and it might remain in effect when you upgrade the firmware to version 11.06 or later. Check the setting on the Authenticator Configuration page in the management system to make sure the best draft standard for your network is selected.

Step 3 Enter the name or IP address of the RADIUS server in the Server Name/IP entry field.

Step 4 Select the server type (RADIUS or TACAS) in the Server Type field.

Step 5 Enter the port number your RADIUS server uses for authentication. The default setting, *1812*, is the port setting for Cisco's RADIUS server, the Cisco Secure Access Control Server (ACS), and for many other RADIUS servers. Check your server's product documentation to find the correct port setting.

Note The port setting for Cisco Secure ACS version 2.6 is 1645.

Step 6 Enter the shared secret used by your RADIUS server in the Shared Secret entry field. The shared secret on the bridge must match the shared secret on the RADIUS server. The shared secret can contain up to 64 alphanumeric characters.

Step 7 Enter the number of seconds the bridge should wait before authentication fails. If the server does not respond within this time, the bridge tries to contact the next authentication server in the list if one is specified. Other backup servers are used in list order when the previous server times out.

Step 8 Enter the number of times the access point should attempt to contact the primary server before giving up in the Max Retran field.

Step 9 Select **EAP Authentication** under the server. The EAP Authentication check box designates the server as an authenticator for any EAP type, including LEAP, PEAP, EAP-TLS, EAP-SIM, and EAP-MD5.

Step 10 On the Security Setup page, click **Radio Data Encryption (WEP)** to browse to the AP Radio Data Encryption page (Figure 8-6).

Step 11 Select **Network-EAP** for the Authentication Type setting to allow EAP-enabled client devices to authenticate through the access point.

a. For LEAP authentication only, select **Network-EAP** and deselect the Open and Shared check boxes.

b. To allow LEAP and Static WEP authentication, select **Network-EP** and the Open and Shared check boxes.

c. For other authentication types (EAP-TLS, MD5) select **Require EAP** and the Open and Shared check box, as appropriate.

Note When you select Require EAP, you block client devices that are not using EAP from authenticating through the bridge.

Table 8-4 lists the bridge settings that provide authentication for various client devices.

Table 8-4 Bridge EAP Settings for Various Client Configurations

Bridge Configuration	Client Devices Allowed to Authenticate
Network-EAP authentication	• Client devices with LEAP enabled • Repeater bridges with LEAP enabled
Open authentication with Require EAP check box selected	• Client devices with EAP enabled • Cisco Aironet devices with EAP-TLS or EAP-MD5 enabled through Windows XP **Note** Selecting Require EAP on the bridge blocks non-EAP client devices from using the bridge.

Step 12 Check that a WEP key has been entered in key slot 1. If a WEP key has been set up in slot 1, skip to Step 16. If no WEP key has been set up, proceed to Step 13.

Note You can use EAP without enabling WEP, but packets sent between the bridge and the client device will not be encrypted. To maintain secure communications, use WEP at all times.

Step 13 Enter a WEP key in slot 1 of the Encryption Key fields. The bridge uses this key for multicast data signals (signals sent from the bridge to several client devices at once). This key does not need to be set on client devices.

Step 14 Select **128-bit** encryption from the Key Size pull-down menu.

Step 15 If the key in slot 1 is the only WEP key set up, select it as the transmit key.

Step 16 Click **OK**. You return automatically to the Security Setup page.

Enabling EAP in Cisco Secure ACS

Cisco Secure Access Control Server for Windows NT/2000 Servers (Cisco Secure ACS) is network security software that helps authenticate users by controlling access to a network access server (NAS) device, such as an access server, PIX Firewall, router, or wireless access point or bridge.

Cisco Secure ACS operates as a Windows NT or Windows 2000 service and controls the authentication, authorization, and accounting (AAA) of users accessing networks. Cisco Secure ACS operates with Windows NT 4.0 Server and Windows 2000 Server.

Note You must use ACS version 2.6 or later to set up the bridge in ACS.

Follow these steps to include the bridge as a Network Access Server (NAS) in Cisco Secure ACS:

Step 1 On the ACS main menu, click **Network Configuration**.

Step 2 Click **Add New Access Server**.

Step 3 In the **Network Access Server Hostname** entry field, type the name you want to assign to the bridge as an access server.

Note This field does not appear if you are configuring an existing NAS.

Step 4 In the **Network Access Server IP address** box, type the bridge's IP address.

Step 5 In the **Key** box, type the shared secret that the TACACS+ or RADIUS NAS and Cisco Secure ACS use to encrypt the data. For correct operation, the identical key (case sensitive) must be configured on the bridge's Authenticator Configuration page and in Cisco Secure ACS.

Step 6 From the **Authenticate Using** drop-down menu, select **RADIUS (Cisco Aironet)**.

Step 7 To save your changes and apply them immediately, click the **Submit + Restart** button.

Tip To save your changes and apply them later, click **Submit**. When you are ready to implement the changes, select **System Configuration > Service Control** and click **Restart**.

Note Restarting the service clears the Logged-in User Report, refreshes the Max Sessions counter, and temporarily interrupts all Cisco Secure ACS services.

Setting a Session-Based WEP Key Timeout

You can set a timeout value for the session-based WEP key. When the timeout value elapses, the server issues a new dynamic WEP key for authenticated client devices.

Note If you enable TKIP on the bridge, you do not need to set up a session-based WEP key timeout. You can use both TKIP and a session key timeout, but these features provide redundant protection.

You should consider several factors when determining the best session key timeout value for your wireless network. Consult *Product Bulletin 1515: Cisco Wireless LAN Security Bulletin* for guidelines on selecting timeout values. Use this URL to browse the product bulletins:

http://www.cisco.com/en/US/products/hw/wireless/ps458/prod_bulletins_list.html

Follow these steps to set a timeout value for session-based WEP keys:

Step 1 On the ACS main menu, click **Group Setup**.

Step 2 In the Group drop-down menu, select the group for which you want to modify the WEP key/session timeout. The **Default** group is usually the group you need to modify.

Step 3 Click **Edit Settings**.

Step 4 Scroll down to the IETF RADIUS Attributes settings.

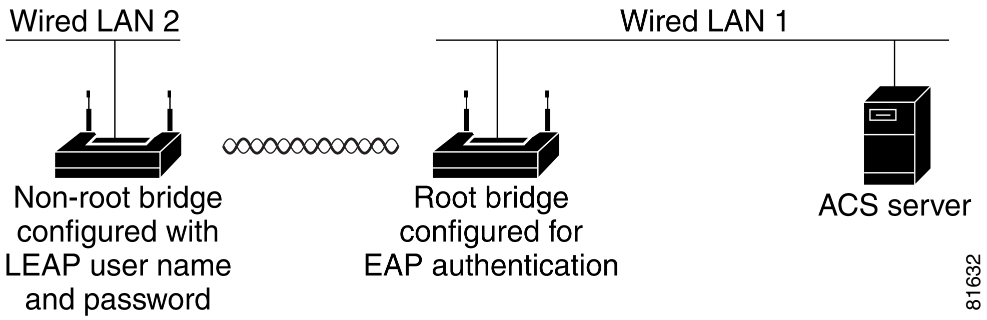
Step 5 Select the check box for [027] Session-Timeout and enter the number of seconds for your timeout value in the [027] Session-Timeout entry field.

Step 6 Click **Submit + Restart**. The timeout value is enabled.

Setting Up a Non-Root Bridge as a LEAP Client

If you use Network-EAP authentication on your network, you can set up non-root bridges to authenticate to your network like other wireless client devices. After you provide a network username and password for the bridge, it authenticates to your network using LEAP, Cisco's wireless authentication method, and receives and uses dynamic WEP keys. Figure 8-9 shows a typical network configuration in which a non-root bridge is a LEAP client.

Figure 8-9 Non-Root Bridge, Root Bridge, and ACS Server


Wired LAN 2
Wired LAN 1
Non-root bridge configured with LEAP user name and password
Root bridge configured for EAP authentication
ACS server
81632

Setting up a non-root bridge as a LEAP client consists of three main tasks:

1. Set up a LEAP user name and password for the non-root bridge on your network.
2. Enter the non-root bridge's LEAP user name and password on the non-root bridge, select Network-EAP as the non-root bridge's authentication type, and enable WEP on the non-root bridge.
3. On the root bridge to which the non-root bridge associates, select Network-EAP authentication, enable WEP, and specify the RADIUS server that performs authentication. If the non-root bridge will acept associations from EAP-enabled client devices, follow the same steps to configure the non-root bridge for EAP authentication, also.

Follow these steps to enable LEAP authentication on a non-root bridge:

Step 1 Set up a username and password on your network just as you would for a new user. The bridge will use this username and password to authenticate.

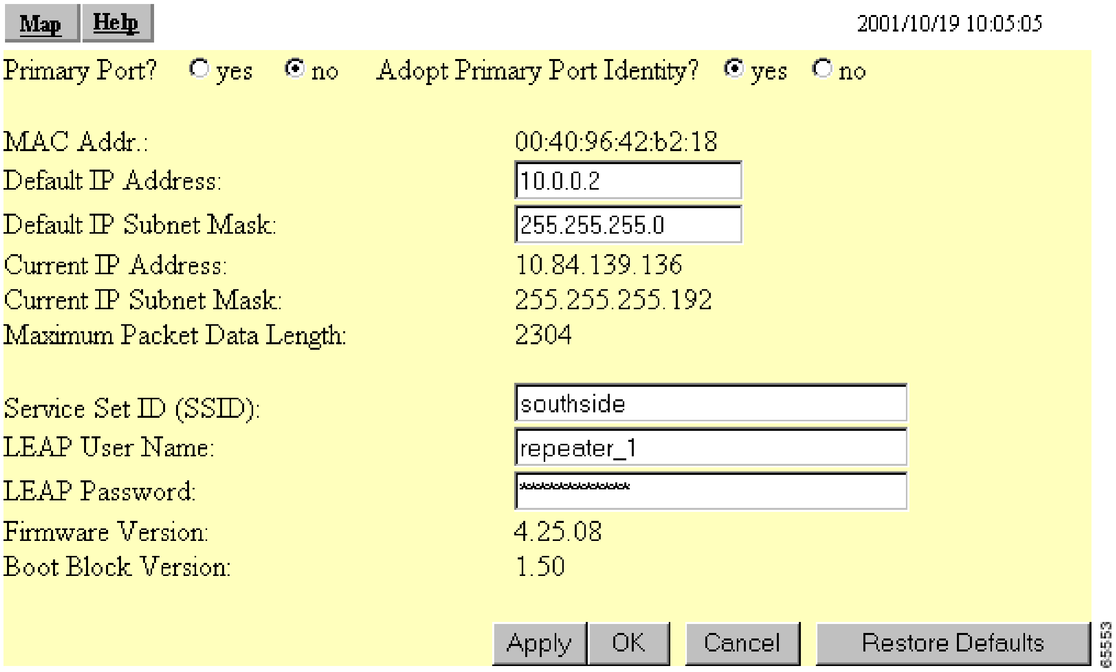
Step 2 Follow this link path to browse to the Root Radio Identification page:

a. On the Summary Status page, click **Setup**.

b. On the Setup page, click **Identification** in the Bridge Radio row under Network Ports.

Figure 8-10 shows the Bridge Radio Identification page.

Figure 8-10 Bridge Radio Identification Page



2001/10/19 10:05:05

Primary Port? ○ yes ● no Adopt Primary Port Identity? ● yes ○ no

MAC Addr.:	00:40:96:42:b2:18
Default IP Address:	10.0.0.2
Default IP Subnet Mask:	255.255.255.0
Current IP Address:	10.84.139.136
Current IP Subnet Mask:	255.255.255.192
Maximum Packet Data Length:	2304
Service Set ID (SSID):	southside
LEAP User Name:	repeater_1
LEAP Password:	************
Firmware Version:	4.25.08
Boot Block Version:	1.50

Step 3 Enter the network username you set up for the bridge in Step 1 in the LEAP User Name entry field.

Step 4 Enter the network password you set up for the bridge in Step 1 in the LEAP Password entry field.

Step 5 Click **OK**. You return automatically to the Security Setup page.

Step 6 On the bridge's Security Setup page, click **Radio Data Encryption (WEP)** to browse to the Bridge Radio Data Encryption page.

Step 7 Select **Network-EAP** for the Authentication Type setting. This setting enables the non-root bridge to carry out LEAP authentication through the root bridge.

Note If EAP-enabled client devices will associate to this non-root bridge, follow Step 2 through Step 11 in the "Enabling EAP on the Bridge" section on page 8-15. Carry out these instructions on the non-root bridge. When you configure the non-root bridge to accept associations from EAP-enabled client devices, the non-root bridge relays the authentication messages from the clients to the ACS server.

Step 8 Check that a WEP key has been entered in key slot 1. If a WEP key has been set up in slot 1, skip to Step 13. If no WEP key has been set up, proceed to Step 9.

Step 9 Enter a WEP key in slot 1 of the Encryption Key fields. The bridge uses this key for multicast data signals.

Step 10 Select **128-bit** encryption from the Key Size pull-down menu.

Step 11 If the key in slot 1 is the only WEP key set up, select it as the transmit key.

Step 12 Click **OK**. You return automatically to the Security Setup page.

Step 13 Follow the steps in the "Enabling EAP on the Bridge" section on page 8-15 to enable Network-EAP on the root bridge to which this bridge associates.

The next time the non-root bridge reboots, it performs LEAP authentication and associates to the root bridge.

Note If the non-root bridge fails to authenticate because the root bridge or the RADIUS server is not set up correctly, you must perform a cold boot or cycle the power on the non-root bridge after correcting the problem. The non-root bridge does not attempt to reauthenticate until it reboots.

Setting Up MAC-Based Authentication

MAC-based authentication allows only client devices with specified MAC addresses to associate and pass data through the bridge. Client devices with MAC addresses not in a list of allowed MAC addresses are not allowed to associate with the bridge.You can create a list of allowed MAC addresses in the bridge management system and on a server used for MAC-based authentication.

This section provides instructions for:

- Enabling MAC-Based Authentication on the Bridge
- Authenticating Client Devices Using MAC Addresses or EAP
- Enabling MAC-Based Authentication in Cisco Secure ACS

Enabling MAC-Based Authentication on the Bridge

Follow these steps to set up and enable MAC-based authentication on the bridge:

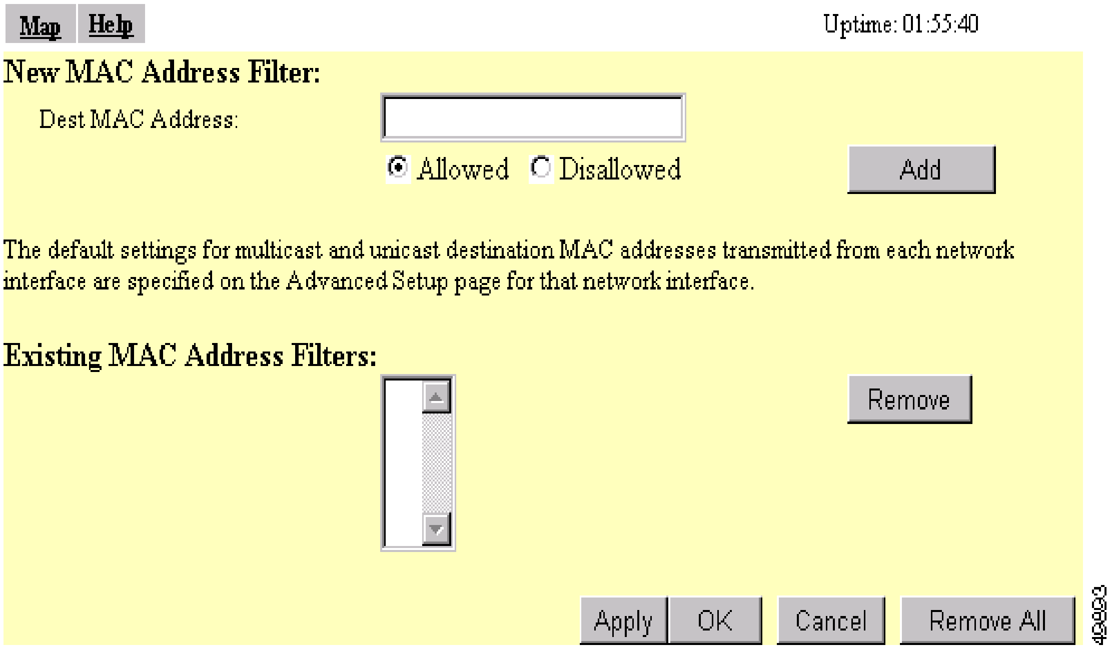
Step 1 Follow this link path to reach the Address Filters page:

a. On the Summary Status page, click **Setup**.

b. On the Setup page, click **Address Filters** under Associations.

Figure 8-11 shows the Address Filters page.

Figure 8-11 Address Filters Page



Uptime: 01:55:40

New MAC Address Filter:

Dest MAC Address:

● Allowed ○ Disallowed

The default settings for multicast and unicast destination MAC addresses transmitted from each network interface are specified on the Advanced Setup page for that network interface.

Existing MAC Address Filters:

Note Step 2 and Step 3 describe entering MAC addresses in the bridge management system. If you will enter MAC addresses only in a list used by the authentication server, skip to Step 4.

Step 2 Type a MAC address in the Dest MAC Address field. You can type the address with colons separating the character pairs (00:40:96:12:34:56, for example) or without any intervening characters (004096123456, for example).

Make sure the **Allowed** option is selected under the Dest MAC Address field.

Step 3 Click **Add**. The MAC address appears in the Existing MAC Address Filters list. The MAC address remains in the management system until you remove it. To remove the MAC address from the list, select it and click **Remove**.

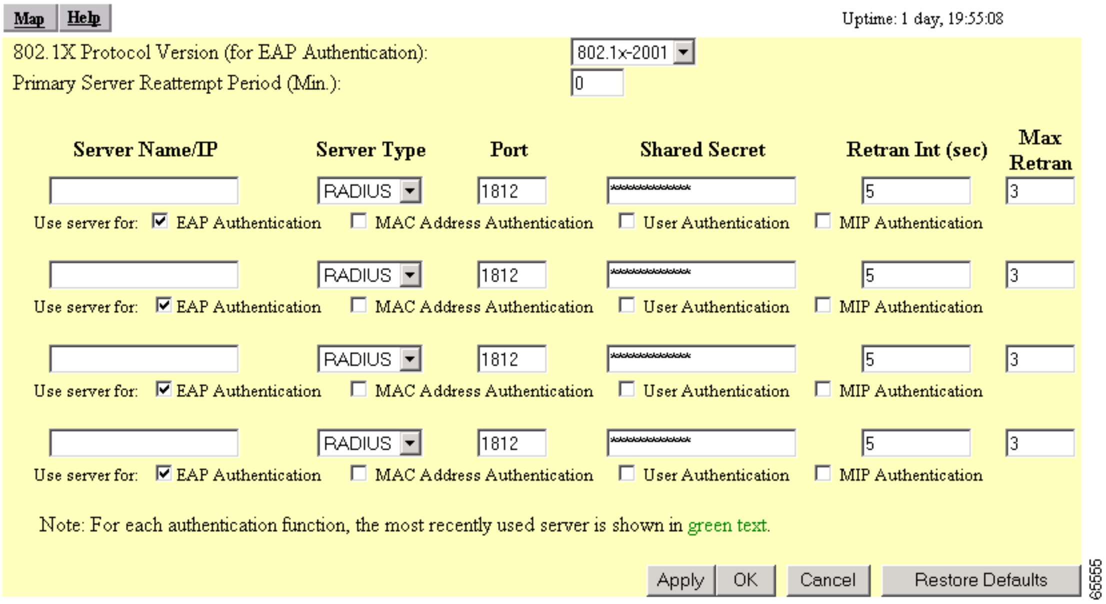
Note Be sure to enter your own MAC address in the list of allowed addresses.

Step 4 If you plan to create a MAC address list that will be checked by the authentication server, select **Yes** for the option called Lookup MAC Address on Authentication Server if not in Existing Filter List. With this option enabled, the bridge checks the authentication server's MAC address list when a client device attempts to authenticate.

Step 5 Click **Apply** to save the list of MAC addresses in the bridge management system.

Step 6 Click the **Authentication Server** link to go to the Authenticator Configuration page. Figure 8-12 shows the Authenticator Configuration page.

Figure 8-12 Authenticator Configuration Page



Uptime: 1 day, 19:55:08

802.1X Protocol Version (for EAP Authentication): 802.1x-2001

Primary Server Reattempt Period (Min.): 0

Server Name/IP	Server Type	Port	Shared Secret	Retran Int (sec)	Max Retran
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	

Note: For each authentication function, the most recently used server is shown in green text.

You can configure up to four servers for authentication services, so you can set up backup authenticators. If you set up more than one server for the same service, the server first in the list is the primary server for that service, and the others are used in list order when the previous server times out.

Step 7 Enter the name or IP address of the authentication server in the Server Name/IP entry field.

Step 8 Select the server type (RADIUS or TACAS) in the Server Type field.

Step 9 Enter the port number the server uses for authentication. The default setting, *1812*, is the port setting for Cisco's RADIUS server, the Cisco Secure Access Control Server (ACS), and for many other RADIUS servers. Check your server's product documentation to find the correct port setting.

Step 10 Enter the shared secret used by the server in the Shared Secret entry field. The shared secret on the bridge must match the shared secret on the server.

Step 11 Enter the number of seconds the bridge should try contacting the primary authentication server in the Timeout entry field. If the primary authentication server does not respond within this time, the bridge tries to contact the backup authentication server if one is specified.

Step 12 Enter the number of times the access point should attempt to contact the primary server before giving up in the Max Retran field.

Step 13 Select **MAC Address Authentication** under the server. If you set up a backup authentication server, select **MAC Address Authentication** under the backup server, also.

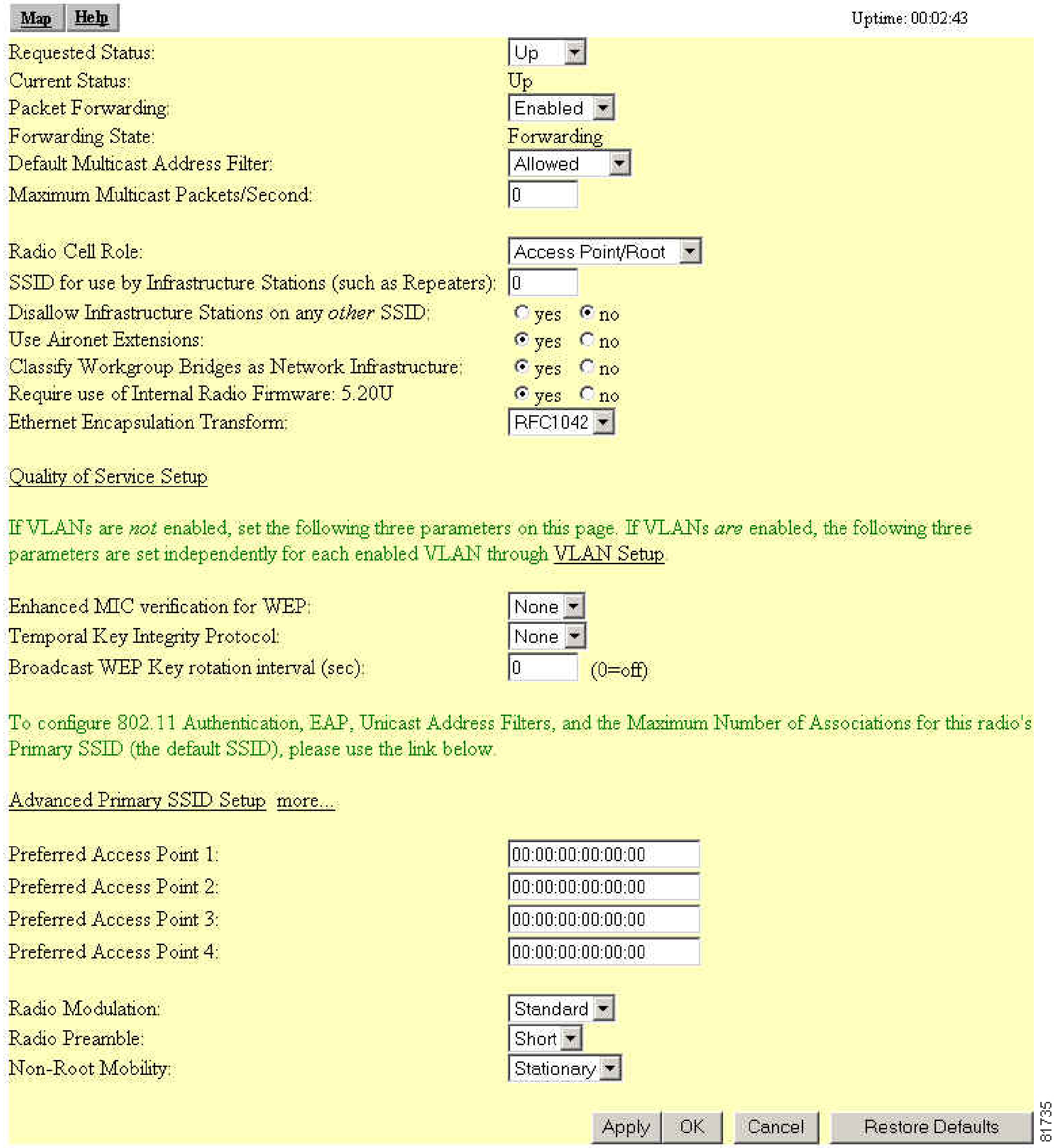
Step 14 Click **OK**. You return automatically to the Setup page.

Step 15 Create a list of allowed MAC addresses for your authentication server. Enter the MAC addresses of all allowed clients as users in the server's database. The "Enabling MAC-Based Authentication in Cisco Secure ACS" section on page 8-27 describes how to create a list of MAC addresses for your RADIUS server.

Note Be sure to include your own MAC address in the authentication server's list.

Step 16 Click **Advanced** in the Root Radio row of the Network Ports section at the bottom of the Setup page. The Root Radio Advanced page appears. Figure 8-13 shows the Root Radio Advanced page.

Figure 8-13 Root Radio Advanced Page



Uptime: 00:02:43

Requested Status: Up
Current Status: Up
Packet Forwarding: Enabled
Forwarding State: Forwarding
Default Multicast Address Filter: Allowed
Maximum Multicast Packets/Second: 0

Radio Cell Role: Access Point/Root
SSID for use by Infrastructure Stations (such as Repeaters): 0
Disallow Infrastructure Stations on any *other* SSID: ○ yes ● no
Use Aironet Extensions: ● yes ○ no
Classify Workgroup Bridges as Network Infrastructure: ● yes ○ no
Require use of Internal Radio Firmware: 5.20U ● yes ○ no
Ethernet Encapsulation Transform: RFC1042

Quality of Service Setup

If VLANs are *not* enabled, set the following three parameters on this page. If VLANs *are* enabled, the following three parameters are set independently for each enabled VLAN through VLAN Setup

Enhanced MIC verification for WEP: None
Temporal Key Integrity Protocol: None
Broadcast WEP Key rotation interval (sec): 0 (0=off)

To configure 802.11 Authentication, EAP, Unicast Address Filters, and the Maximum Number of Associations for this radio's Primary SSID (the default SSID), please use the link below.

Advanced Primary SSID Setup more...

Preferred Access Point 1: 00:00:00:00:00:00
Preferred Access Point 2: 00:00:00:00:00:00
Preferred Access Point 3: 00:00:00:00:00:00
Preferred Access Point 4: 00:00:00:00:00:00

Radio Modulation: Standard
Radio Preamble: Short
Non-Root Mobility: Stationary

Step 17 Select **Disallowed** from the pull-down menu for Default Unicast Address Filter for each authentication type requiring MAC-based authentication.

For example, if the bridge is configured for both open and Network-EAP authentication, you could set Default Unicast Address Filter under Open to Disallowed but leave Default Unicast Address Filter under Network-EAP set to Allowed. This configuration forces client devices using open authentication to authenticate using MAC addresses but does not force LEAP-enabled client devices to authenticate using MAC addresses. To force all client devices to authenticate using MAC addresses, select **Disallowed** for all the enabled authentication types.

When you set Default Unicast Address Filter to disallowed, the bridge discards all unicast traffic except packets sent to the MAC addresses listed as allowed on the authentication server or on the bridge's Address Filters page.

Note Client devices associated to the bridge are not immediately affected when you set Default Unicast Address Filter to disallowed.

Step 18 Click **OK**. You return automatically to the Setup page. Client devices that associate with the bridge will not be allowed to authenticate unless their MAC addresses are included in the list of allowed addresses.

Authenticating Client Devices Using MAC Addresses or EAP

You can set up the bridge to authenticate client devices using a combination of MAC-based and EAP authentication. When you enable this feature, client devices that associate to the bridge using 802.11 open authentication first attempt MAC authentication. If MAC authentication succeeds, the client device joins the network; if the client is also using EAP authentication, it attempts to authenticate using EAP. If MAC authentication fails, the bridge waits for the client device to attempt EAP authentication.

Follow these steps to combine MAC-based and EAP authentication for client devices using 802.11 open authentication:

Step 1 Follow the steps in the "Setting Up EAP Authentication" section on page 8-14 to set up EAP. You must select **Require EAP** under Open authentication on the AP Radio Data Encryption page to force client devices to perform EAP athentication if they fail MAC authentication. If you do not select **Require EAP**, client devices that fail MAC authentication might be able to join the network without performing EAP authentication.

Step 2 Follow the steps in the "Setting Up MAC-Based Authentication" section on page 8-22 to set up MAC-based authentication.

Step 3 Follow this link path to reach the Address Filters page:

a. On the Summary Status page, click **Setup**.

b. On the Setup page, click **Address Filters** under Associations.

Step 4 Select **yes** for the option called *Is MAC Authentication alone sufficient for a client to be fully authenticated?*

Step 5 Click **Apply**. When you enable this feature, the bridge follows these steps to authenticate all clients that associate using 802.11 open authentication:

a. When a client device sends an authentication request to the bridge, the bridge sends a MAC authentication request in the RADIUS Access Request Packet to the RADIUS server using the client's user ID and password as the MAC address of the client.

b. If the authentication succeeds, the client joins the network. If the client is also using EAP authentication, it attempts to authenticate using EAP.

c. If MAC authentication fails for the client, the bridge allows the client to attempt to authenticate using EAP authentication. The client cannot join the network until EAP authentication succeeds.

Enabling MAC-Based Authentication in Cisco Secure ACS

Cisco Secure Access Control Server for Windows NT/2000 Servers (Cisco Secure ACS) can authenticate MAC addresses sent from the bridge. The bridge works with ACS to authenticate MAC addresses using Secure Password Authentication Protocol (Secure PAP). You enter a list of approved MAC addresses into the ACS as users, using the client devices' MAC addresses as both the username and password. The authentication server's list of allowed MAC addresses can reside on the authentication server or at any network location to which the server has access.

Follow these steps to create a list of allowed MAC addresses in Cisco Secure ACS:

Step 1 On the ACS main menu, click **User Setup**.

Step 2 When the User text box appears, enter the MAC address you want to add to the list.

Note The bridge sends MAC address queries to the server using lower-case characters. If your server allows case-sensitive usernames and passwords, you must enter MAC addresses in the server's database using lower-case characters.

Step 3 When the User Setup screen appears, enter the MAC address in the Cisco Secure PAP Password and Confirm Password entry fields.

Step 4 Enter the MAC address in the CHAP/MS-CHAP/ARAP Password and Confirm Password entry fields.

Step 5 Select the Separate (CHAP/MS-CHAP/ARAP) check box.

Step 6 Click **Submit**. Repeat these steps for each MAC address you want to add to the list of allowed MAC addresses.

MAC addresses that you enter in the authentication server's list appear in the bridge's address filter list when the client device is associated to the bridge. MAC addresses in the server's list disappear from the bridge's list when the client devices disassociate or when the bridge is reset.

Note Be sure to include your own MAC address in the authentication server's list.

Summary of Settings for Authentication Types

Table 8-5 lists the bridge settings required to enable each authentication type and combinations of authentication types.

Table 8-5 Settings for Authentication Types

Authentication Types	Required Settings
LEAP	On the Authenticator Configuration page (shown in Figure 8-14): • Select an 802.1x protocol draft that matches the protocol draft used by client devices that associate with the bridge. • Enter the name or IP address, type, port, shared secret, and timeout value for your RADIUS server. • Select the **EAP** check box under the server. On the AP Radio Data Encryption page (shown in Figure 8-6): • Select the **Network-EAP** check box. • Enter a WEP key in key slot 1 and select **128-bit** from the key size menu.
LEAP and static WEP under 802.11 Open	• Enter all the settings for LEAP authentication. On the AP Radio Data Encryption page (shown in Figure 8-6): • Select the **Open** check box.
EAP-TLS and EAP-MD5	On the Authenticator Configuration page (shown in Figure 8-14): • Select an 802.1x protocol draft that matches the protocol draft used by client devices that associate with the bridge. • Enter the name or IP address, type, port, shared secret, and timeout value for your RADIUS server. • Select the **EAP** check box under the server. On the AP Radio Data Encryption page (shown in Figure 8-6): • Select the **Open** and **Network-EAP** check boxes. • Select the **Require EAP** check box under Open. **Note** Selecting **Require EAP** blocks non-EAP client devices from using the bridge. • Enter a WEP key in key slot 1 and select **128-bit** from the key size pull-down menu.
EAP-TLS, EAP-MD5, and static WEP under 802.11 Open	The bridge does not support this combination of authentication types. When you select **Require EAP** on the Authenticator Configuration page to authenticate clients using EAP-TLS and EAP-MD5, non-EAP client devices are blocked from using the bridge. However, the bridge can serve client devices using 802.11 open authentication if the bridge is set up for MAC-based authentication and EAP authentication. See the "Authenticating Client Devices Using MAC Addresses or EAP" section on page 8-26 for instructions on setting up this combination of authentications.

Table 8-5 Settings for Authentication Types (continued)

Authentication Types	Required Settings
MAC-based	On the Address Filters page (shown in Figure 8-11): • Select **yes** for the “Look up MAC address on authentication server if not in existing filter list” setting. On the Authenticator Configuration page (shown in Figure 8-14): • Select an 802.1x protocol draft that matches the protocol draft used by client devices that associate with the bridge. • Enter the name or IP address, type, port, shared secret, and timeout value for your RADIUS server. • Select the **MAC Address Authentication** check box under the server. **Note** You can use the same server for both EAP authentication and MAC-based authentication. On the AP Radio Advanced page (shown in Figure 8-13): • Select **Disallowed** from the pull-down menu for Default Unicast Address Filter for each authentication type requiring MAC-based authentication.
MAC-based and EAP-TLS and EAP-MD5	• Enter the settings for the EAP authentication types you need to support; select **Require EAP** on the AP Radio Data Encryption page under Open. • Enter the settings for MAC-based authentication. On the Address Filters page (shown in Figure 8-11): • Select **yes** for the setting called “Is MAC Authentication alone sufficient for a client to be fully authenticated?”
MAC-based and LEAP	• Enter the settings for LEAP. • Enter the settings for MAC-based authentication.

RADIUS Attributes Sent By the Bridge

Tables 8-6 through 8-10 identify the attributes sent by a bridge to a client in access-request, access-accept, and accounting-request packets.

Table 8-6 Attributes Sent in Access-Request Packets

Attribute ID	Description
1	User-Name
4	NAS-IP-Address
5	NAS-Port
6	Service-Type
12	Framed-MTU
30	Called-Station-ID (MAC address)
31	Calling-Station-ID (MAC address)
32	NAS-Identifier
61	NAS-Port-Type
79	EAP-Message[1]
80	Message-Authenticator[1]
VSA (attribute 26)	SSID

[1] RFC2869

Table 8-7 Attributes Honored in Access-Accept Packets

Attribute ID	Description
27	Session-Timeout
64	Tunnel-Type[1]
65	Tunnel-Medium-Type[1]
79	EAP-Message (for 802.1x authentication)
80	Message-Authenticator (for 802.1x authentication)
81	Tunnel-Private-Group-ID[1]
VSA (attribute 26)	LEAP session-key
VSA (attribute 26)	SSID

[1] RFC2868

Table 8-8 Attributes Sent in Accounting-Request (start) Packets

Attribute ID	Description
1	User-Name
4	NAS-IP-Address
5	NAS-Port
31	Calling-Station-ID (MAC address)
32	NAS-Identifier
41	Acct-Delay-Time
44	Acct-Session-Id
45	Acct-Authentic
VSA (attribute 26)	SSID
VSA (attribute 26)	nas-location
VSA (attribute 26)	vlan-id
VSA (attribute 26)	auth-algo-type

Table 8-9 Attributes Sent in Accounting-Request (update) Packets

Attribute ID	Description
1	User-Name
4	NAS-IP-Address
5	NAS-Port
41	Acct-Delay-Time
42	Acct-Input-Octets
43	Acct-Output-Octets
44	Acct-Session-Id
45	Acct-Authentic
46	Acct-Session-Time
47	Acct-Input-Packets
48	Acct-Output-Packets

Table 8-10 Attributes Sent in Accounting-Request (stop) Packets

Attribute ID	Description
1	User-Name
4	NAS-IP-Address
5	NAS-Port
41	Acct-Delay-Time
42	Acct-Input-Octets
43	Acct-Output-Octets
44	Acct-Session-Id
45	Acct-Authentic
46	Acct-Session-Time
47	Acct-Input-Packets
48	Acct-Output-Packets
49	Acct-Terminate-Cause

Setting Up Backup Authentication Servers

You can configure up to four servers for authentication services on the Authenticator Configuration page, so you can set up backup authenticators. If you set up more than one server for the same service, the server first in the list is the primary server for that service, and the other servers are used in list order when the previous server times out. If a backup server responds after the primary server fails, the bridge continues to use the backup server for new transactions.

Follow these steps to set up a backup authentication server:

Step 1 Complete the steps in the "Setting Up EAP Authentication" section on page 8-14 or the "Setting Up MAC-Based Authentication" section on page 8-22 to set up your primary authentication server.

Step 2 On the Authenticator Configuration page, enter information about your backup server in one of the entry field groups under the completed entry fields for your primary server:

a. Enter the name or IP address of the backup server in the Server Name/IP entry field.

b. Select the server type (RADIUS or TACAS) in the Server Type field.

c. Enter the port number the server uses for authentication. The default setting, *1812*, is the port setting for Cisco's RADIUS server, the Cisco Secure Access Control Server (ACS), and for many other RADIUS servers. Check your server's product documentation to find the correct port setting.

d. Enter the shared secret used by the server in the Shared Secret entry field. The shared secret on the bridge must match the shared secret on the server.

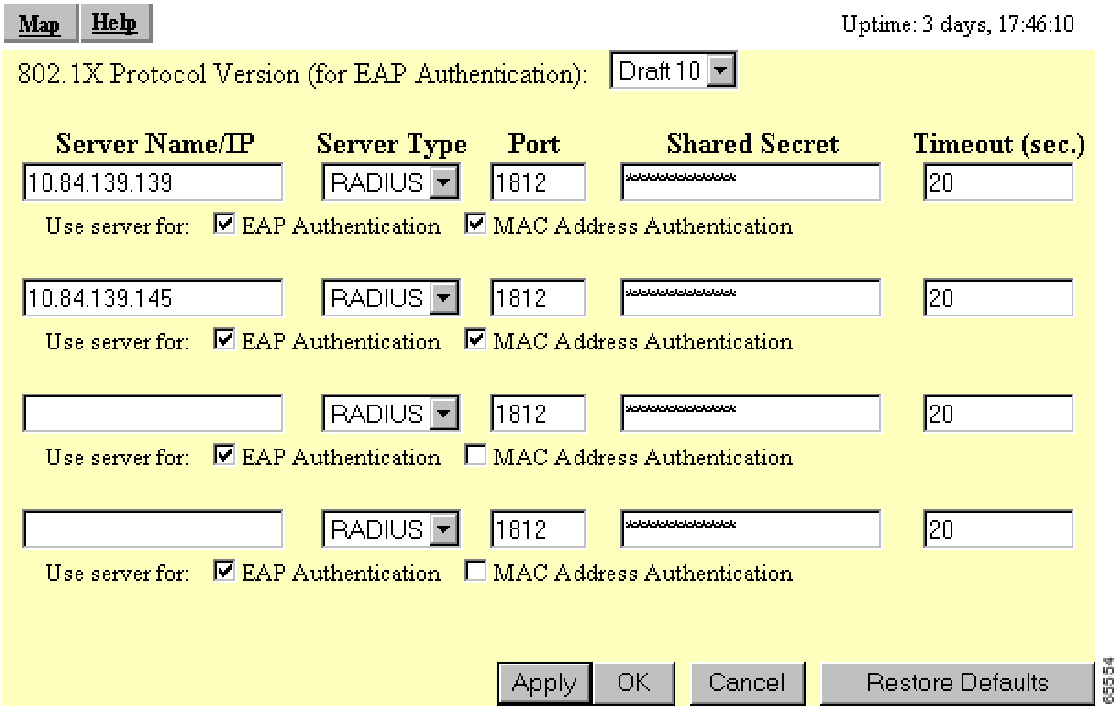
e. Enter the number of seconds the bridge should try contacting the backup server in the Timeout entry field. If this backup server does not respond within this time, the bridge tries to contact the next backup server on the list. If you don't have another backup server configured, the bridge tries to contact the original primary authentication server.

f. Enter the number of times the access point should attempt to contact the backup server before giving up in the Max Retran field.

g. Select the same authentication methods as those selected on the primary server.

Step 3 Click **OK**. You return automatically to the Setup page. Figure 8-14 shows a primary authentication server and a backup server configured on the Authenticator Configuration page.

Figure 8-14 Authenticator Configuration Page with Primary and Backup Servers



Uptime: 3 days, 17:46:10

802.1X Protocol Version (for EAP Authentication): Draft 10

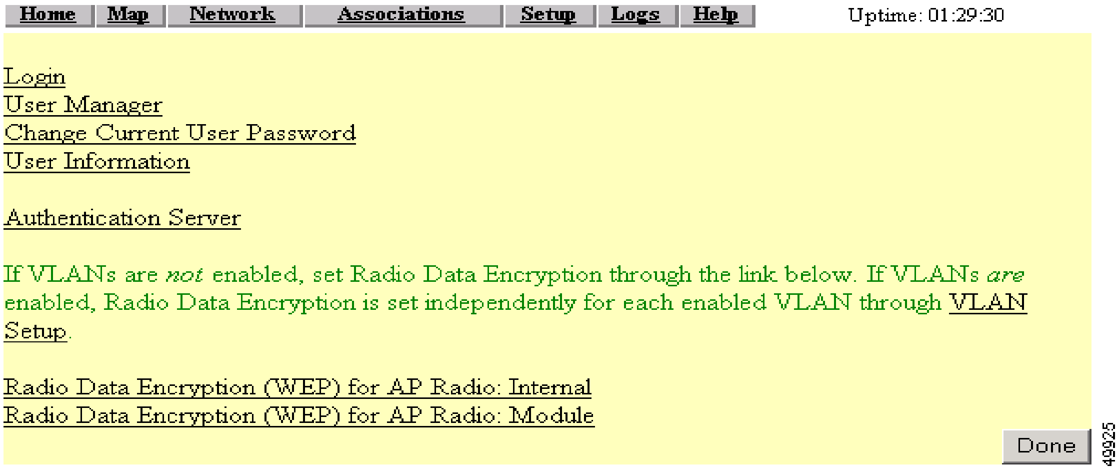
Server Name/IP	Server Type	Port	Shared Secret	Timeout (sec.)
10.84.139.139	RADIUS	1812	************	20
Use server for:	☑ EAP Authentication	☑ MAC Address Authentication		
10.84.139.145	RADIUS	1812	************	20
Use server for:	☑ EAP Authentication	☑ MAC Address Authentication		
	RADIUS	1812	************	20
Use server for:	☑ EAP Authentication	□ MAC Address Authentication		
	RADIUS	1812	************	20
Use server for:	☑ EAP Authentication	□ MAC Address Authentication		

Setting Up Administrator Authorization

Administrator authorization protects the bridge management system from unauthorized access. Use the bridge's user management pages to define a list of users who are authorized to view and change the bridge management system. Use the Security Setup page to reach the user management pages. Figure 8-15 shows the Security Setup page.

Note Creating a list of users authorized to view and change the bridge management system does not affect the ability of client devices to associate with the bridge.

Figure 8-15 Security Setup Page



Uptime: 01:29:30

Login
User Manager
Change Current User Password
User Information

Authentication Server

If VLANs are *not* enabled, set Radio Data Encryption through the link below. If VLANs *are* enabled, Radio Data Encryption is set independently for each enabled VLAN through VLAN Setup.

Radio Data Encryption (WEP) for AP Radio: Internal
Radio Data Encryption (WEP) for AP Radio: Module

Follow this link path to reach the Security Setup page:

1. On the Summary Status page, click **Setup**.
2. On the Setup page, click **Security**.

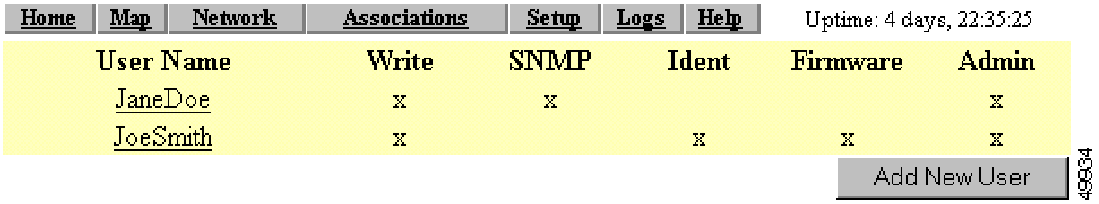
Creating a List of Authorized Management System Users

Follow these steps to create a list of users authorized to view and change the bridge management system:

Step 1 Follow the link path to the Security Setup page.

Step 2 On the Security Setup page, click **User Information**. Figure 8-16 shows the User Information page.

Figure 8-16 User Information Page

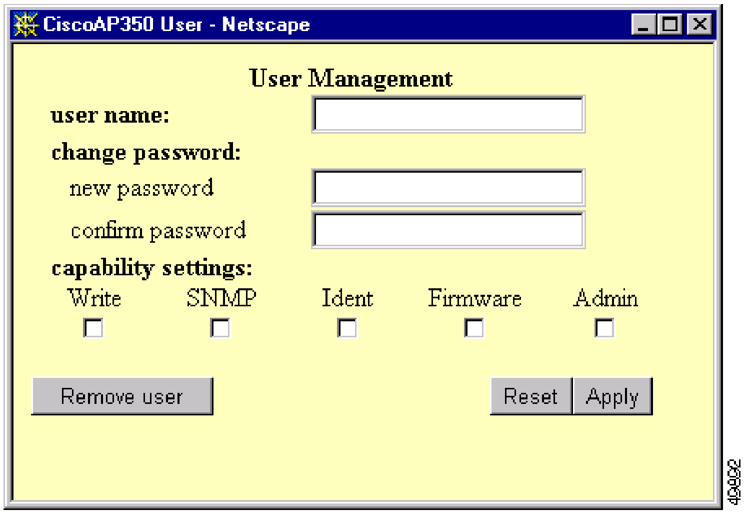


Uptime: 4 days, 22:35:25

User Name	Write	SNMP	Ident	Firmware	Admin
JaneDoe	x	x			x
JoeSmith	x		x	x	x

Step 3 Click **Add New User**. The User Management window appears. Figure 8-17 shows the User Management window.

Figure 8-17 User Management Window



CiscoAP350 User - Netscape

User Management

user name:

change password:

new password

confirm password

capability settings:

Write □ SNMP □ Ident □ Firmware □ Admin □

Step 4 Enter a username and password for the new user.

Step 5 Select the capabilities you want to assign to the new user. Capabilities include:

- Write—The user can change system settings. When you assign Write capability to a user, the user also automatically receives Admin capability.
- SNMP—Designates the username as an SNMP community name. SNMP management stations can use this SNMP community name to perform SNMP operations. The User Manager does not have to be enabled for SNMP communities to operate correctly.

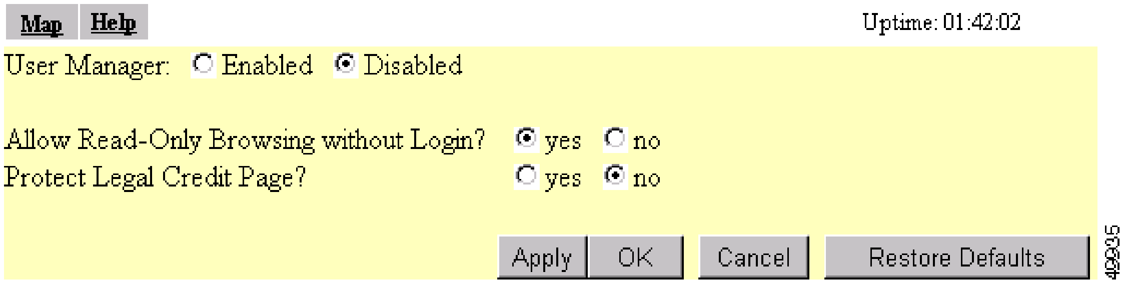
Note Selecting the SNMP check box does not grant SNMP write capability to the user; it only designates the username as an SNMP community name. SNMP operations performed under the username are restricted according to the username’s other assigned capabilities.

- Ident—The user can change the bridge's identity settings (IP address and SSID). When you assign Ident capability to a user, the user also automatically receives Write and Admin capabilities.
- Firmware—The user can update the bridge's firmware. When you assign Firmware capability to a user, the user also automatically receives Write and Admin capabilities.
- Admin—The user can view most system screens. To allow the user to view all system screens and make changes to the system, select Write capability.

Step 6 Click **Apply**. The User Management window disappears, and the new user appears in the user list on the User Information page.

Step 7 Click the browser’s **Back** button to return to the Security Setup page. On the Security Setup page, click **User Manager**. The User Manager Setup page appears. Figure 8-18 shows the User Manager Setup page.

Figure 8-18 User Manager Setup Page



Uptime: 01:42:02

User Manager: ○ Enabled ● Disabled

Allow Read-Only Browsing without Login? ● yes ○ no

Protect Legal Credit Page? ○ yes ● no

Step 8 Select **User Manager: Enabled** to restrict use of the bridge management system to users in the user list.

Note You must define a full administrator user—a user with write, identity, and firmware capabilities—before you can enable the user manager.

Use the other settings on the User Manager Setup page to add more restrictions for the management system:

- Allow Read-Only Browsing without Login—Select **yes** to allow any user to view the bridge's basic screens. Select **no** to restrict access to all of the bridge's screens to only the users in the user list.
- Protect Legal Credit Page—Select **yes** to restrict access to the Legal Credits page to users in the user list. Select **no** to allow any user to view the Legal Credits page.

Step 9 Click **OK**. You return automatically to the Security Setup page.

Setting Up Centralized Administrator Authentication

The Centralized Administrator Authentication feature on the bridge allows the use of an AAA server (RADIUS or TACACS) services to authenticate users when the User Manager function is enabled on the bridge. The AAA server verifies the user login and passes back the appropriate privileges for the user (or administrator) when a login attempt is successful.

Note You must have at least one user configured on the bridge before you can enable the user manager feature.

Follow these steps to set up Centralized Administrator Authentication on the bridge.

Step 1 From Services section of the Setup page, click **Security**. The Security Setup page appears.

Step 2 Click **User Information**. The User Information page appears.

Step 3 Click **Add New User**. The User Management window appears.

Step 4 Add a new user with full administrative capabilities (all capability settings checked).

Step 5 Click **Apply**. You are returned to the User Information page.

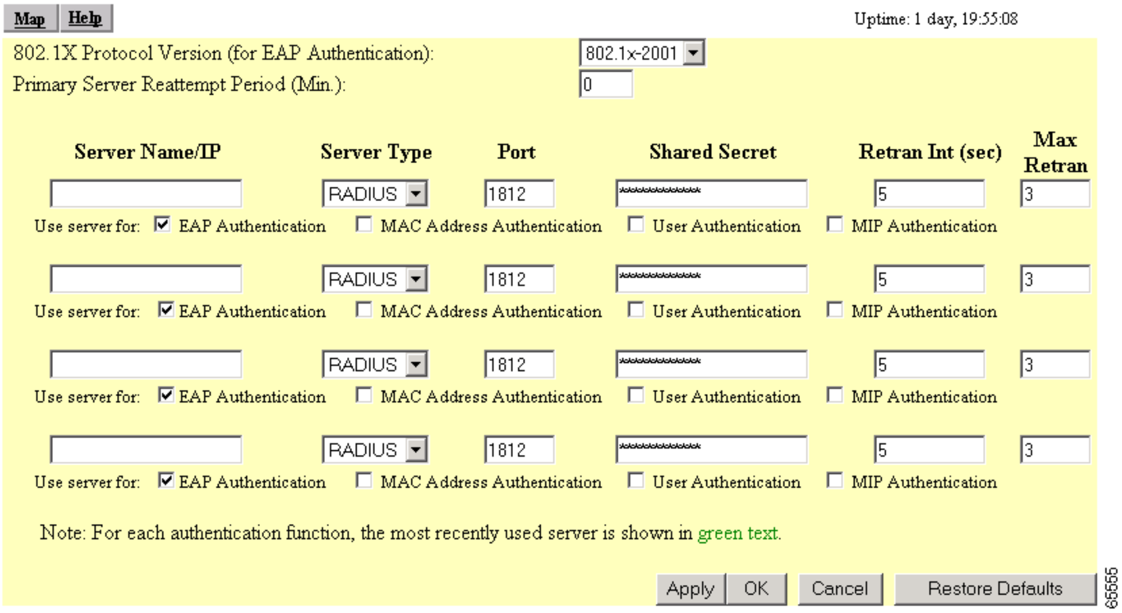
Step 6 Click **Back**. You are returned to the Security Setup page.

Step 7 Click **User Manager**. The User Manager Setup page appears.

Step 8 Enable User Manager and click **OK**. You are returned to the Security Setup page.

Step 9 Click **Authentication Server**. The Authenticator Configuration page appears. See Figure 8-19.

Figure 8-19 Authenticator Configuration page



Uptime: 1 day, 19:55:08

802.1X Protocol Version (for EAP Authentication): 802.1x-2001

Primary Server Reattempt Period (Min.): 0

Server Name/IP	Server Type	Port	Shared Secret	Retran Int (sec)	Max Retran
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	
	RADIUS	1812	************	5	3
Use server for: ☑ EAP Authentication	☐ MAC Address Authentication		☐ User Authentication	☐ MIP Authentication	

Note: For each authentication function, the most recently used server is shown in green text.

Step 10 Configure the server as follows:

a. Assign an IP address or name in the Server Name/IP field.

b. Select the server type your network is using, either RADIUS or TACACS.

c. Assign a port number for the server.

> **Note** The default port settings are 1812 for RADIUS servers and 49 for TACACS servers. Check your server's product documentation for the correct port setting.

d. Enter the shared secret used by your RADIUS or TACACS server in the Shared Secret entry field. The shared secret can contain up to 64 alphanumeric characters.

e. Enter the number of seconds the bridge should wait before it attempts to contact the server after a failed attempt.

f. Enter the number of times the bridge should attempt to contact the server before authentication fails in the Max Retran field.

g. Select **User Authentication** in the Use server for line.

h. Click **Apply** or **OK** to save your settings.

Step 11 Configure other servers as required.

System Flow Notes

The following notes help to identify and describe the flow between the bridge and its authentication server.

- The authentication server is initialized to listen for socket requests on the pre-determined UDP or TCP ports specified on the Authenticator Configuration page (UDP 1812 for RADIUS servers or TCP 49 for TACACS+ servers).
- The authentication server must be pre-configured with valid user names and passwords along and the shared secret key the server uses for secure authentication between it and the bridge.
- No remote server authentication is possible with a new bridge unless it has been configured by the user.
- The bridge requires the following parameters to access the remote authentication servers, which were described in the procedure above:
  - Remote server authentication—accomplished by configuring or not configuring the authentication server to send requests
  - IP address of the authentication server(s)
  - Secret key to be shared with the authentication server(s)
  - Selection of RADIUS or TACACS+ server indication
  - Default UDP or TCP port ID used for authentication
  - Timeout value while waiting for a server response

The administrator attempts to log in to the bridge using any HTML capable browser on a wireless or wired network. The bridge receives the authentication request and checks the local database of users to verify that the request is accompanied by a valid user name and password.

If the user is not found on the local list, or if local authentication fails (User found, but incorrect password), the bridge determines if a remote authentication server has been configured to handle authentication requests. If it has, the bridge sends an authentication request to the the first remote authentication server and waits for the server to reply or timeout. This asynchronous request is sent to either a TACACS+ or RADIUS server using a client interface and protocol appropriate for the target server. The password for the administrator requesting authentication is encrypted using an MD5 hash function and sent to the server. The password is never sent to the server in clear text.

If the server does not respond, a timeout occurs, prompting the bridge to check for the an additional configured authentication server. If it finds a server, the bridge sends an authentication request to that server. Additional servers are attempted until one of the following events occur:

- A configured server responds accepting or rejecting the request.
- A final timeout occurs on the last configured server.

When the authentication server responds to a successful request, the authorization parameters (described in the Authorization Parameters section below) are extracted and processed to a local database cache entry. This entry is kept in the cache for five minutes and is used to authenticate the user for subsequent authentication requests.

The cache speeds up the administrative configuration process by not forcing the subsequent requests to require a transaction with an authentication server within the five minute time period. The following applies:

- If the user is accessed using an authentication request within the 5 minute period, the cache timer resets to 5 minutes.

- If the user entry is not accessed within 5 minutes, the next access causes a new server request to be sent to the authentication server so the user and new privileges are cached again.

If the response is a rejection, a reject response is issued just as if the local database entry was not found. the administrator is also rejected in the case where they exist on the the authentication server but do not have administrative capabilities configured.

Authorization Parameters

The following authentication server attribute value (AV) pair is returned to the bridge for an administrator login request:

This is RADIUS attribute #26, Cisco Vendor ID #9, type #1 --- string.

Cisco:Avpair = “aironet:admin-capability=write+snmp+ident+firmware+admin”

Any combination of capabilities are returned with this attribute, for example:

- Cisco:Avpair = “aironet:admin-capability=ident+admin”
- Cisco:Avpair = “aironet:admin-capability=admin”

The following is an example of a Livingston RADIUS server users file entry:

```
User password = “aironet”
    Service-Type = Outbound
    cisco-avpair = “aironet:admin-capability-ident+admin”
```

The following is an example of a TACACS+ server users file entry:

```
Service - Aironet
Protocol - Shell
cisco-avpair = “aironet:admin-capability=ident+admin”
```

See the “Creating a List of Authorized Management System Users” section on page 8-34 or click **Help** on the Authenticator Configuration page for an explanation of the attributes returned by the server.