CHAPTER 9

Configuring IEEE 802.1x Port-Based Authentication

This chapter describes how to configure IEEE 802.1x port-based authentication on the Catalyst 2950 or Catalyst 2955 switch. IEEE 802.1x authentication prevents unauthorized devices (clients) from gaining access to the network.

Note For complete syntax and usage information for the commands used in this chapter, see the command reference for this release and the "RADIUS Commands" section in the *Cisco IOS Security Command Reference, Release 12.1*.

This chapter consists of these sections:

Understanding IEEE 802.1x Port-Based Authentication

The IEEE 802.1x standard defines a client-server-based access control and authentication protocol that prevents unauthorized clients from connecting to a LAN through publicly accessible ports unless they are properly authenticated. The authentication server authenticates each client connected to a switch port before making available any services offered by the switch or the LAN.

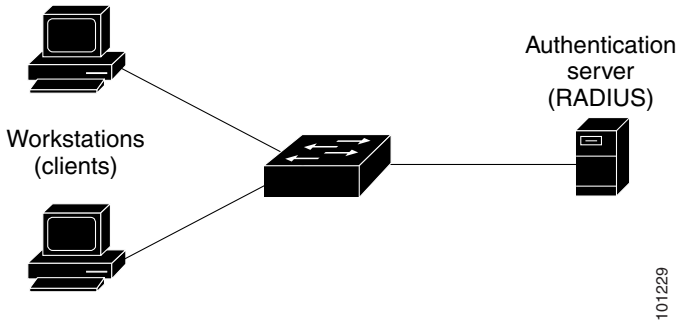
Until the client is authenticated, IEEE 802.1x access control allows only Extensible Authentication Protocol over LAN (EAPOL), Cisco Discovery Protocol (CDP), and Spanning Tree Protocol (STP) traffic through the port to which the client is connected. After authentication is successful, normal traffic can pass through the port.

These sections describe IEEE 802.1x port-based authentication:

Device Roles

With IEEE 802.1x port-based authentication, the devices in the network have specific roles as shown in Figure 9-1.

Figure 9-1 IEEE 802.1x Device Roles



- *Client*—the device (workstation) that requests access to the LAN and switch services and responds to requests from the switch.The workstation must be running IEEE 802.1x-compliant client software such as that offered in the Microsoft Windows XP operating system. (The client is the *supplicant* in the IEEE 802.1x standard.)

Note To resolve Windows XP network connectivity and IEEE 802.1x authentication issues, read the Microsoft Knowledge Base article at this URL: http://support.microsoft.com/support/kb/articles/Q303/5/97.ASP

- *Authentication server*—performs the actual authentication of the client. The authentication server validates the identity of the client and notifies the switch whether or not the client is authorized to access the LAN and switch services. Because the switch acts as the proxy, the authentication service is transparent to the client. In this release, the RADIUS security system with Extensible Authentication Protocol (EAP) extensions is the only supported authentication server. It is available in Cisco Secure Access Control Server Version 3.0 or later. RADIUS operates in a client/server model in which secure authentication information is exchanged between the RADIUS server and one or more RADIUS clients.
- *Switch* (edge switch or wireless access point)—controls the physical access to the network based on the authentication status of the client. The switch acts as an intermediary (proxy) between the client and the authentication server, requesting identity information from the client, verifying that

information with the authentication server, and relaying a response to the client. The switch includes the RADIUS client, which is responsible for encapsulating and decapsulating the EAP frames and interacting with the authentication server.

When the switch receives EAPOL frames and relays them to the authentication server, the Ethernet header is stripped, and the remaining EAP frame is re-encapsulated in the RADIUS format. The EAP frames are not modified during encapsulation, and the authentication server must support EAP within the native frame format. When the switch receives frames from the authentication server, the server frame header is removed, leaving the EAP frame, which is then encapsulated for Ethernet and sent to the client.

The devices that can act as intermediaries include the Catalyst 3750, 3560, 3550, 2970, 2955, 2950, 2940 switches, or a wireless access point. These devices must be running software that supports the RADIUS client and IEEE 802.1x authentication.

Authentication Initiation and Message Exchange

During IEEE 8021.x authentication, the switch or the client can initiate authentication. If you enable authentication on a port by using the **dot1x port-control auto** interface configuration command, the switch initiates authentication when the link state changes from down to up or periodically as long as the port remains up and unauthenticated. The switch sends an EAP-request/identity frame to the client to request its identity. Upon receipt of the frame, the client responds with an EAP-response/identity frame.

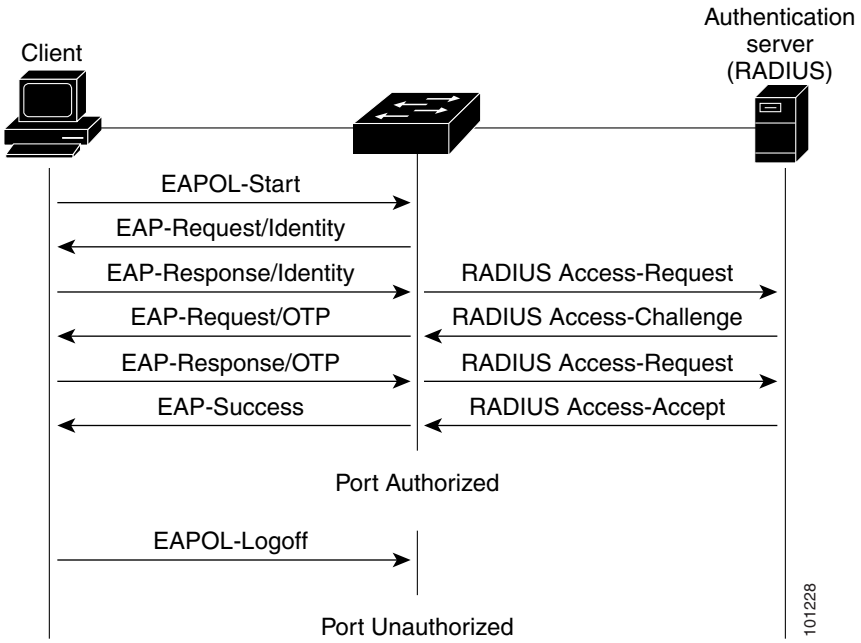
However, if during bootup, the client does not receive an EAP-request/identity frame from the switch, the client can initiate authentication by sending an EAPOL-start frame, which prompts the switch to request the client's identity.

Note If IEEE 802.1x authentication is not enabled or supported on the network access device, any EAPOL frames from the client are dropped. If the client does not receive an EAP-request/identity frame after three attempts to start authentication, the client sends frames as if the port is in the authorized state. A port in the authorized state effectively means that the client has been successfully authenticated. For more information, see the "Ports in Authorized and Unauthorized States" section on page 9-4.

When the client supplies its identity, the switch begins its role as the intermediary, passing EAP frames between the client and the authentication server until authentication succeeds or fails. If the authentication succeeds, the switch port becomes authorized. If the authentication fails, authentication can be retried, the port might be assigned to a VLAN that provides limited services, or network access is not granted. For more information, see the "Ports in Authorized and Unauthorized States" section on page 9-4.

The specific exchange of EAP frames depends on the authentication method being used. Figure 9-2 shows a message exchange initiated by the client when the client uses the One-Time-Password (OTP) authentication method with a RADIUS server.

Figure 9-2 Message Exchange



Ports in Authorized and Unauthorized States

During IEEE 802.1x authentication, depending on the switch port state, the switch can grant a client access to the network. The port starts in the *unauthorized* state. While in this state, the port that is not configured as a voice VLAN port disallows all ingress and egress traffic except for IEEE 802.1x authentication, CDP, and STP packets. When a client is successfully authenticated, the port changes to the *authorized* state, allowing all traffic for the client to flow normally. If the port is configured as a voice VLAN port, the port allows VoIP traffic and IEEE 802.1x protocol packets before the client is successfully authenticated.

If a client that does not support IEEE 802.1x authentication connects to an unauthorized IEEE 802.1x port, the switch requests the client's identity. In this situation, the client does not respond to the request, the port remains in the unauthorized state, and the client is not granted access to the network.

In contrast, when an IEEE 802.1x-enabled client connects to a port that is not running the IEEE 802.1x standard, the client initiates the authentication process by sending the EAPOL-start frame. When no response is received, the client sends the request for a fixed number of times. Because no response is received, the client begins sending frames as if the port is in the authorized state.

You control the port authorization state by using the **dot1x port-control** interface configuration command and these keywords:

- **force-authorized**—disables IEEE 802.1x authentication and causes the port to transition to the authorized state without any authentication exchange required. The port sends and receives normal traffic without IEEE 802.1x-based authentication of the client. This is the default setting.
- **force-unauthorized**—causes the port to remain in the unauthorized state, ignoring all attempts by the client to authenticate. The switch cannot provide authentication services to the client through the interface.

- **auto**—enables IEEE 802.1x authentication and causes the port to begin in the unauthorized state, allowing only EAPOL frames to be sent and received through the port. The authentication process begins when the link state of the port transitions from down to up or when an EAPOL-start frame is received. The switch requests the identity of the client and begins relaying authentication messages between the client and the authentication server. Each client attempting to access the network is uniquely identified by the switch by using the client's MAC address.

If the client is successfully authenticated (receives an Accept frame from the authentication server), the port state changes to authorized, and all frames from the authenticated client are allowed through the port. If the authentication fails, the port remains in the unauthorized state, but authentication can be retried. If the authentication server cannot be reached, the switch can resend the request. If no response is received from the server after the specified number of attempts, authentication fails, and network access is not granted.

When a client logs off, it sends an EAPOL-logoff message, causing the switch port to transition to the unauthorized state.

If the link state of a port transitions from up to down, or if an EAPOL-logoff frame is received, the port returns to the unauthorized state.

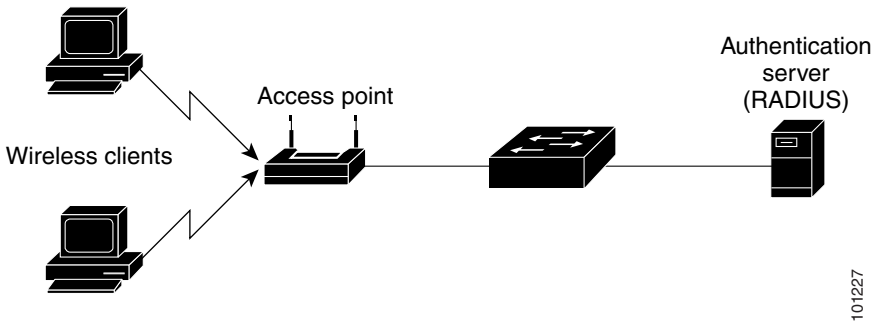
IEEE 802.1x Host Mode

You can configure an IEEE 802.1x port for single-host or for multiple-hosts mode. In single-host mode (see Figure 9-1 on page 9-2), only one client can be connected to the IEEE 802.1x-enabled switch port. The switch detects the client by sending an EAPOL frame when the port link state changes to the up state. If a client leaves or is replaced with another client, the switch changes the port link state to down, and the port returns to the unauthorized state.

In multiple-hosts mode, you can attach multiple hosts to a single IEEE 802.1x-enabled port. Figure 9-3 on page 9-5 shows IEEE 802.1x port-based authentication in a wireless LAN. In this mode, only one of the attached clients must be authorized for all clients to be granted network access. If the port becomes unauthorized (re-authentication fails or an EAPOL-logoff message is received), the switch denies network access to all of the attached clients. In this topology, the wireless access point is responsible for authenticating the clients attached to it, and it also acts as a client to the switch.

With the multiple-hosts mode enabled, you can use IEEE 802.1x authentication to authenticate the port and port security to manage network access for all MAC addresses, including that of the client.

Figure 9-3 Multiple Host Mode Example



IEEE 802.1x Accounting

The IEEE 802.1x standard defines how users are authorized and authenticated for network access but does not keep track of network usage. IEEE 802.1x accounting is disabled by default. You can enable IEEE 802.1x accounting to monitor this activity on IEEE 802.1x-enabled ports:

- User successfully authenticates.
- User logs off.
- Link-down occurs.
- Re-authentication successfully occurs.
- Re-authentication fails.

The switch does not log IEEE 802.1x accounting information. Instead, it sends this information to the RADIUS server, which must be configured to log accounting messages.

IEEE 802.1x Accounting Attribute-Value Pairs

The information sent to the RADIUS server is represented in the form of Attribute-Value (AV) pairs. These AV pairs provide data for different applications. (For example, a billing application might require information that is in the Acct-Input-Octets or the Acct-Output-Octets attributes of a RADIUS packet.)

AV pairs are automatically sent by a switch that is configured for IEEE 802.1x accounting. Three types of RADIUS accounting packets are sent by a switch:

- START–sent when a new user session starts
- INTERIM–sent during an existing session for updates
- STOP–sent when a session terminates

Table 9-1 lists the AV pairs and when they are sent are sent by the switch:

Table 9-1 Accounting AV Pairs

Attribute Number	AV Pair Name	START	INTERIM	STOP
Attribute[1]	User-Name	Always	Always	Always
Attribute[4]	NAS-IP-Address	Always	Always	Always
Attribute[5]	NAS-Port	Always	Always	Always
Attribute[8]	Framed-IP-Address	Never	Sometimes[1]	Sometimes[1]
Attribute[25]	Class	Always	Always	Always
Attribute[30]	Called-Station-ID	Always	Always	Always
Attribute[31]	Calling-Station-ID	Always	Always	Always
Attribute[40]	Acct-Status-Type	Always	Always	Always
Attribute[41]	Acct-Delay-Time	Always	Always	Always
Attribute[42]	Acct-Input-Octets	Never	Never	Always
Attribute[43]	Acct-Output-Octets	Never	Never	Always
Attribute[44]	Acct-Session-ID	Always	Always	Always
Attribute[45]	Acct-Authentic	Always	Always	Always

Table 9-1 Accounting AV Pairs (continued)

Attribute Number	AV Pair Name	START	INTERIM	STOP
Attribute[46]	Acct-Session-Time	Never	Never	Always
Attribute[49]	Acct-Terminate-Cause	Never	Never	Always
Attribute[61]	NAS-Port-Type	Always	Always	Always

1. The Framed-IP-Address AV pair is sent only if a valid Dynamic Host Control Protocol (DHCP) binding exists for the host in the DHCP snooping bindings table.

For more information about AV pairs, see RFC 3580, "IEEE 802.1X Remote Authentication Dial In User Service (RADIUS) Usage Guidelines."

Using IEEE 802.1x Authentication with VLAN Assignment

You can limit network access for certain users by using VLAN assignment. After successful IEEE 802.1x authentication of a port, the RADIUS server sends the VLAN assignment to configure the switch port. The RADIUS server database maintains the username-to-VLAN mappings, assigning the VLAN based on the username of the client connected to the switch port.

When configured on the switch and the RADIUS server, IEEE 802.1x authentication with VLAN assignment has these characteristics:

- If no VLAN is supplied by the RADIUS server or if IEEE 802.1x authentication is disabled, the port is configured in its access VLAN after successful authentication.
- If IEEE 802.1x authentication is enabled but the VLAN information from the RADIUS server is not valid, the port returns to the unauthorized state and remains in the configured access VLAN. This prevents ports from appearing unexpectedly in an inappropriate VLAN because of a configuration error.

  Configuration errors could include specifying a malformed VLAN ID, a nonexistent VLAN ID, or attempted assignment to a voice VLAN ID.
- If IEEE 802.1x authentication is enabled and all information from the RADIUS server is valid, the port is placed in the specified VLAN after authentication.
- If the multiple-hosts mode is enabled on an IEEE 802.1x port, all hosts are placed in the same VLAN (specified by the RADIUS server) as the first authenticated host.
- If IEEE 802.1x authentication and port security are enabled on a port, the port is placed in the RADIUS-server assigned VLAN.
- If IEEE 802.1x authentication is disabled on the port, it is returned to the configured access VLAN.

When the port is in the force authorized, force unauthorized, unauthorized, or shutdown state, it is placed in the configured access VLAN.

If an IEEE 802.1x port is authenticated and put in the RADIUS-server assigned VLAN, any change to the port access VLAN configuration does not take effect.

The IEEE 802.1x authentication with VLAN assignment feature is not supported on trunk ports, dynamic ports, or with dynamic-access port assignment through a VLAN Membership Policy Server (VMPS).

To configure VLAN assignment you need to perform these tasks:

- Enable authentication, authorization, and accounting (AAA) authorization.

- Enable IEEE 802.1x authentication (the VLAN assignment feature is automatically enabled when you configure IEEE 802.1x authentication on an access port).
- Assign vendor-specific tunnel attributes in the RADIUS server. The RADIUS server must return these attributes to the switch:
  - [64] Tunnel-Type = VLAN
  - [65] Tunnel-Medium-Type = IEEE 802
  - [81] Tunnel-Private-Group-ID = VLAN name or VLAN ID

  Attribute [64] must contain the value *VLAN* (type 13). Attribute [65] must contain the value *IEEE 802* (type 6). Attribute [81] specifies the *VLAN name* or *VLAN ID* assigned to the IEEE 802.1x-authenticated user.

For examples of tunnel attributes, see the "Configuring the Switch to Use Vendor-Specific RADIUS Attributes" section on page 8-29.

Using IEEE 802.1x Authentication with Guest VLAN

You can configure a guest VLAN for each IEEE 802.1x port on the switch to provide limited services to clients, such as downloading the IEEE 802.1x client. These clients might be upgrading their system for IEEE 802.1x authentication, and some hosts, such as Windows 98 systems, might not be IEEE 802.1x-capable.

When you enable a guest VLAN on an IEEE 802.1x port, the switch assigns clients to a guest VLAN when the switch does not receive a response to its EAP request/identity frame or when EAPOL packets are not sent by the client.

Before Cisco IOS Release 12.1(22)EA2, the switch did not maintain the EAPOL packet history and allowed clients that failed authentication access to the guest VLAN, regardless of whether EAPOL packets had been detected on the interface. You can enable this behavior by using the **dot1x guest-vlan supplicant** global configuration command.

With Cisco IOS Release 12.1(22)EA2 and later, the switch maintains the EAPOL packet history. If an EAPOL packet is detected on the interface during the lifetime of the link, the switch determines that the device connected to that interface is an 802.1x-capable supplicant, and the interface does not change to the guest VLAN state. EAPOL history is cleared if the interface link status goes down. If no EAPOL packet is detected on the interface, the interface changes to the guest VLAN state.

Note If an EAPOL packet is detected on the wire after the interface has changed to the guest VLAN, the interface reverts to an unauthorized state, and 802.1x authentication restarts.

Any number of IEEE 802.1x-incapable clients are allowed access when the switch port is moved to the guest VLAN. If an IEEE 802.1x-capable client joins the same port on which the guest VLAN is configured, the port is put into the unauthorized state in the user-configured access VLAN, and authentication is restarted.

Guest VLANs are supported on IEEE 802.1x ports in single-host or multiple-hosts mode.

You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x guest VLAN. The guest VLAN feature is not supported on trunk ports; it is supported only on access ports.

For configuration steps, see the "Configuring a Guest VLAN" section on page 9-23.

Using IEEE 802.1x Authentication with Restricted VLAN

You can configure a restricted VLAN for each IEEE 802.1x port on a switch to provide limited services to clients that cannot access the guest VLAN. These clients are IEEE 802.1x-compliant and cannot access another VLAN because they fail the authentication process. A restricted VLAN allows users without valid credentials in an authentication server (typically, visitors to an enterprise) to access a limited set of services. The administrator can control the services available to the restricted VLAN.

Note You can configure a VLAN to be both the guest VLAN and the restricted VLAN if you want to provide the same services to both types of users.

Without this feature, the client attempts and fails authentication indefinitely, and the switch port remains in the spanning-tree blocking state. With this feature, you can configure the switch port to be in the restricted VLAN after a specified number of authentication attempts (the default value is 3 attempts).

The authenticator keeps a count of failed authentication attempts for the client. When this count exceeds the configured maximum number of authentication attempts, the port moves to the restricted VLAN. The failed attempt count is incremented when RADIUS replies with either an *EAP failure* or an empty response that contains no EAP packet. When the port moves into the restricted VLAN, the failed attempt counter resets.

Users who fail authentication remain in the restricted VLAN until the next re-authentication attempt. A port in the restricted VLAN tries to re-authenticate at configured intervals (the default is 60 seconds). If re-authentication fails, the port remains in the restricted VLAN. If re-authentication is successful, the port moves to either the configured VLAN or to a VLAN sent by the RADIUS server. You can disable re-authentication. If you do this, the only way to start the authentication process again is for the port to receive a *link dow*n or *EAP logoff* event. We recommend that you keep re-authentication enabled if a client might connect through a hub. When a client disconnects from the hub, the port might not receive the *link down* or *EAP logoff* event.

After a port moves to the restricted VLAN, it sends a simulated EAP success message to the client. This prevents clients from attempting authentication indefinitely. Some clients (for example, devices running Windows XP) cannot implement DHCP without EAP success.

Restricted VLANs are supported only on IEEE 802.1x ports in single-host mode and on Layer 2 ports.

You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x restricted VLAN. The restricted VLAN feature is not supported on trunk ports; it is supported only on access ports.

This feature works with port security. As soon as the port is authorized, a MAC address is provided to port security. If port security does not permit the MAC address or if the maximum secure address count is reached, the port becomes unauthorized and error disabled.

Other port security features such as Dynamic ARP Inspection, DHCP snooping, and IP source guard can be configured independently on a restricted VLAN.

For more information, see the "Configuring a Restricted VLAN" section on page 9-24.

Using IEEE 802.1x Authentication with Voice VLAN Ports

A voice VLAN port is a special access port associated with two VLAN identifiers:

- VVID to carry voice traffic to and from the IP phone. The VVID is used to configure the IP phone connected to the port.
- PVID to carry the data traffic to and from the workstation connected to the switch through the IP phone. The PVID is the native VLAN of the port.

In single-host mode, only the IP phone is allowed on the voice VLAN. In multiple-hosts mode, additional clients can send traffic on the voice VLAN after a supplicant is authenticated on the PVID. When multiple-hosts mode is enabled, the supplicant authentication affects both the PVID and the VVID.

A voice VLAN port becomes active when there is a link, and the device MAC address appears after the first CDP message from the IP phone. Cisco IP phones do not relay CDP messages from other devices. As a result, if several Cisco IP phones are connected in series, the switch recognizes only the one directly connected to it. When IEEE 802.1x authentication is enabled on a voice VLAN port, the switch drops packets from unrecognized Cisco IP phones more than one hop away.

When IEEE 802.1x authentication is enabled on a port, you cannot configure a port VLAN that is equal to a voice VLAN.

For more information about voice VLANs, see Chapter 18, “Configuring Voice VLAN.”

Using IEEE 802.1x Authentication with Port Security

You can configure an IEEE 802.1x port with port security in either single-host or multiple-hosts mode. (You must also configure port security on the port by using the **switchport port-security** interface configuration command.) When you enable port security and IEEE 802.1x on a port, IEEE 802.1x authentication authenticates the port, and port security manages network access for all MAC addresses, including that of the client. You can then limit the number or group of clients that can access the network through an IEEE 802.1x port.

These are some examples of the interaction between IEEE 802.1x authentication and port security on the switch:

- When a client is authenticated, and the port security table is not full, the client’s MAC address is added to the port security list of secure hosts. The port then proceeds to come up normally.

  When a client is authenticated and manually configured for port security, it is guaranteed an entry in the secure host table (unless port security static aging has been enabled).

  A security violation occurs if the client is authenticated, but port security table is full. This can happen if the maximum number of secure hosts has been statically configured, or if the client ages out of the secure host table. If the client’s address is aged out, its place in the secure host table can be taken by another host.

  The port security violation modes determine the action for security violations. For more information, see the “Security Violations” section on page 21-7.

- When you manually remove an IEEE 802.1x client address from the port security table by using the **no switchport port-security mac-address** *mac-address* interface configuration command, you should re-authenticate the IEEE 802.1x client by using the **dot1x re-authenticate interface** *interface-id* privileged EXEC command.

- When an IEEE 802.1x client logs off, the port changes to an unauthenticated state, and all dynamic entries in the secure host table are cleared, including the entry for the client. Normal authentication then takes place.
- If the port is administratively shut down, the port becomes unauthenticated, and all dynamic entries are removed from the secure host table.
- Port security and a voice VLAN can be configured simultaneously on an IEEE 802.1x port that is in either single-host or multiple-hosts mode. Port security applies to both the voice VLAN identifier (VVID) and the port VLAN identifier (PVID).

For more information about enabling port security on your switch, see the "Configuring Port Security" section on page 21-6.

Using IEEE 802.1x Authentication with Wake-on-LAN

The IEEE 802.1x wake-on-LAN (WoL) feature allows dormant PCs to be powered when the switch receives a specific Ethernet frame, known as the *magic packet*. You can use this feature in environments where administrators need to connect to systems that have been powered down. This feature is also known as the *unidirectional controlled port* in the IEEE 802.1x standard.

When a host that uses WoL are attached through an IEEE 802.1x port and the host powers off, the IEEE 802.1x port becomes unauthorized. The port can only receive and send EAPOL packets, and WoL magic packets cannot reach the host. When the PC is powered off, it is not authorized, and the switch port is not opened.

When the switch uses IEEE 802.1x authentication with WoL, the switch forwards traffic to unauthorized IEEE 802.1x ports, including magic packets. While the port is unauthorized, the switch continues to block ingress traffic other than EAPOL packets. The host can receive packets but cannot send packets to other devices in the network.

Note If PortFast is not enabled on the port, the port is forced to the bidirectional state.

When you configure a port as unidirectional by using the **dot1x control-direction in** interface configuration command, the port changes to the spanning-tree forwarding state. The port can send packets to the host but cannot receive packets from the host.

When you configure a port as bidirectional by using the **dot1x control-direction both** interface configuration command, the port is access-controlled in both directions. The port does not receive packets from or send packets to the host.

Network Admission Control Layer 2 IEEE 802.1x Validation

In Cisco IOS Release 12.1(22)EA6 and later, the switch supports the Network Admission Control (NAC) Layer 2 IEEE 802.1x validation, which checks the antivirus condition or *posture* of endpoint systems or clients before granting the devices network access. With NAC Layer 2 IEEE 802.1x validation, you can do these tasks:

- Download the Session-Timeout RADIUS attribute (Attribute[27]) and the Termination-Action RADIUS attribute (Attribute[29]) from the authentication server.
- Set the number of seconds between re-authentication attempts as the value of the Session-Timeout RADIUS attribute (Attribute[27]) and get an access policy against the client from the RADIUS server.

- Set the action to be taken when the switch tries to re-authenticate the client by using the Termination-Action RADIUS attribute (Attribute[29]). If the value is *DEFAULT* or is not set, the session ends. If the value is RADIUS-Request, the re-authentication process starts.
- View the NAC posture token, which shows the posture of the client, by using the **show dot1x** privileged EXEC command.
- Configure secondary private VLANs as guest VLANs.

Configuring NAC Layer 2 IEEE 802.1x validation is similar to configuring IEEE 802.1x port-based authentication except that you must configure a posture token on the RADIUS server. For information about configuring NAC Layer 2 IEEE 802.1x validation, see the "Configuring NAC Layer 2 IEEE 802.1x Validation" section on page 9-27 and the "Enabling Periodic Re-Authentication" section on page 9-19.

For more information about NAC, see the *Network Admission Control Software Configuration Guide*.

Configuring IEEE 802.1x Authentication

These sections describe how to configure IEEE 802.1x port-based authentication on your switch:

Default IEEE 802.1x Authentication Configuration

Table 9-2 shows the default IEEE 802.1x authentication configuration.

Table 9-2 Default IEEE 802.1x Authentication Configuration

Feature	Default Setting
Switch IEEE 802.1x enable state	Disabled.
Per-interface IEEE 802.1x enable state	Disabled (force-authorized). The port sends and receives normal traffic without IEEE 802.1x-based authentication of the client.
AAA	Disabled.
RADIUS server • IP address • UDP authentication port • Key	 • None specified. • 1812. • None specified.
Host mode	Single-host mode.
Control direction	Bidirectional control.
Periodic re-authentication	Disabled.
Number of seconds between re-authentication attempts	3600 seconds.
Quiet period	60 seconds (number of seconds that the switch remains in the quiet state following a failed authentication exchange with the client).
Retransmission time	30 seconds (number of seconds that the switch should wait for a response to an EAP request/identity frame from the client before resending the request).
Maximum retransmission number	2 times (number of times that the switch will send an EAP-request/identity frame before restarting the authentication process).
Client timeout period	30 seconds (when relaying a request from the authentication server to the client, the amount of time the switch waits for a response before resending the request to the client.
Authentication server timeout period	30 seconds (when relaying a response from the client to the authentication server, the amount of time the switch waits for a reply before resending the response to the server. This setting is not configurable.)
Guest VLAN	None specified.
Restricted VLAN	None specified.

IEEE 802.1x Authentication Configuration Guidelines

These section has configuration guidelines for these features:

- IEEE 802.1x Authentication, page 9-14
- VLAN Assignment, Guest VLAN, and Restricted VLAN, page 9-14

IEEE 802.1x Authentication

These are the IEEE 802.1x authentication configuration guidelines:

- When IEEE 802.1x authentication is enabled, ports are authenticated before any other Layer 2 features are enabled.
- The IEEE 802.1x protocol is supported on Layer 2 static-access ports and voice VLAN ports, but it is not supported on these port types:
  - Trunk port—If you try to enable IEEE 802.1x authentication on a trunk port, an error message appears, and IEEE 802.1x authentication is not enabled. If you try to change the mode of an IEEE 802.1x-enabled port to trunk, the port mode is not changed.
  - Dynamic ports—A port in dynamic mode can negotiate with its neighbor to become a trunk port. If you try to enable IEEE 802.1x authentication on a dynamic port, an error message appears, and IEEE 802.1x authentication is not enabled. If you try to change the mode of an IEEE 802.1x-enabled port to dynamic, the port mode is not changed.
  - Dynamic-access ports—If you try to enable IEEE 802.1x authentication on a dynamic-access (VLAN Query Protocol [VQP]) port, an error message appears, and IEEE 802.1x authentication is not enabled. If you try to change an IEEE 802.1x-enabled port to dynamic VLAN assignment, an error message appears, and the VLAN configuration is not changed.
  - EtherChannel ports—Do not configure a port that is an active or a not-yet-active member of an EtherChannel as an IEEE 802.1x port. If you try to enable IEEE 802.1x authentication on an EtherChannel port, an error message appears, and IEEE 802.1x authentication is not enabled.
  - Switched Port Analyzer (SPAN) and Remote SPAN (RSPAN) destination ports—You cannot enable IEEE 802.1x authentication on a port that is a SPAN or RSPAN destination port or that is an RSPAN reflector port. However, you can enable IEEE 802.1x authentication on a SPAN or RSPAN source port.
  - LRE switch ports—802.1x is not supported on an LRE switch interface that is connected to a Cisco 585 LRE CPE device.
- Before globally enabling IEEE 802.1x authentication on a switch by entering the **dot1x system-auth-control** global configuration command, remove the EtherChannel configuration from the interfaces on which IEEE 802.1x authentication and EtherChannel are configured.
- If you are using a device running the Cisco Access Control Server (ACS) application for IEEE 802.1x authentication with EAP-Transparent LAN Services (TLS) and EAP-MD5 and your switch is running Cisco IOS Release 12.1(14)EA1, make sure that the device is running ACS Version 3.2.1 or later.

VLAN Assignment, Guest VLAN, and Restricted VLAN

These are the configuration guidelines for VLAN assignment, guest VLAN, and restricted VLAN:

- When IEEE 802.1x authentication is enabled on a port, you cannot configure a port VLAN that is equal to a voice VLAN.
- The IEEE 802.1x authentication with VLAN assignment feature is not supported on trunk ports, dynamic ports, or with dynamic-access port assignment through a VMPS.
- You can configure any VLAN, except an RSPAN VLAN or a voice VLAN, as an IEEE 802.1x guest VLAN. The guest VLAN feature is not supported on trunk ports; it is supported only on access ports.
- After you configure a guest VLAN for an IEEE 802.1x port to which a DHCP client is connected, you might need to get a host IP address from a DHCP server. You can also change the settings for restarting the IEEE 802.1x authentication process on the switch before the DHCP process on the

client times out and tries to get a host IP address from the DHCP server. Decrease the settings for the IEEE 802.1x authentication process (**dot1x timeout quiet-period** and **dot1x timeout tx-period** interface configuration commands). The amount to decrease the settings depends on the connected IEEE 802.1x client type.

- When a PC is attached to a switch through a hub, is authenticated on an IEEE 802.1x multiple-hosts port, is moved to another port, and is then attached through another hub, the switch does not authenticate the PC. The workaround is to decrease the number of seconds between re-authentication attempts by entering the **dot1x timeout reauth-period** *seconds* interface configuration command.
- You can configure any VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x authentication restricted VLAN. The restricted VLAN feature is not supported on trunk ports; it is supported only on access ports.

Upgrading from a Previous Software Release

In Cisco IOS Release 12.1(14)EA1, the implementation for IEEE 802.1x authentication changed from the previous release. Some global configuration commands became interface configuration commands, and new commands were added.

If you have IEEE 802.1x authentication configured on the switch and you upgrade to Cisco IOS Release 12.1(14)EA1 or later, the configuration file will not contain the new commands, and IEEE 802.1x authentication will not operate. After the upgrade is complete, make sure to globally enable IEEE 802.1x authentication by using the **dot1x system-auth-control** global configuration command. If IEEE 802.1x authentication was running in multiple-hosts mode on an interface in the previous release, make sure to reconfigure it by using the **dot1x host-mode multi-host** interface configuration command.

Configuring IEEE 802.1x Authentication

To configure IEEE 802.1x port-based authentication, you must enable AAA and specify the authentication method list. A method list describes the sequence and authentication methods to be queried to authenticate a user.

The software uses the first method listed to authenticate users. If that method fails to respond, the software selects the next authentication method in the method list. This process continues until there is successful communication with a listed authentication method or until all defined methods are exhausted. If authentication fails at any point in this cycle, the authentication process stops, and no other authentication methods are attempted.

To allow VLAN assignment, you must enable AAA authorization to configure the switch for all network-related service requests.

This is the IEEE 802.1x AAA process:

Step 1 A user connects to a port on the switch.

Step 2 Authentication is performed.

Step 3 VLAN assignment is enabled, as appropriate, based on the RADIUS server configuration.

Step 4 The switch sends a start message to an accounting server.

Step 5 Re-authentication is performed, as necessary.

Step 6 The switch sends an interim accounting update to the accounting server that is based on the result of re-authentication.

Step 7 The user disconnects from the port.

Step 8 The switch sends a stop message to the accounting server.

Beginning in privileged EXEC mode, follow these steps to configure IEEE 802.1x port-based authentication. This procedure is required.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**aaa new-model**	Enable AAA.
Step 3	**aaa authentication dot1x** {**default**} *method1*	Create an IEEE 802.1x authentication method list. To create a default list that is used when a named list is *not* specified in the **authentication** command, use the **default** keyword followed by the method that is to be used in default situations. The default method list is automatically applied to all ports. For *method1*, enter the **group radius** keyword to use the list of all RADIUS servers for authentication. **Note** Though other keywords are visible in the command-line help string, only the **default** and **group radius** keywords are supported.
Step 4	**dot1x system-auth-control**	Enable IEEE 802.1x authentication globally on the switch.
Step 5	**aaa authorization network** {**default**} **group radius**	(Optional) Configure the switch for user RADIUS authorization for all network-related service requests, such as VLAN assignment.
Step 6	**radius-server host** *ip-address*	(Optional) Specify the IP address of the RADIUS server.
Step 7	**radius-server key** *string*	(Optional) Specify the authentication and encryption key used between the switch and the RADIUS daemon running on the RADIUS server.
Step 8	**interface** *interface-id*	Specify the port connected to the client that is to be enabled for IEEE 802.1x authentication, and enter interface configuration mode.
Step 9	**swtichport mode access**	(Optional) Set the port to access mode only if you configured the RADIUS server in Step 6 and Step 7.
Step 10	**dot1x port-control auto**	Enable IEEE 802.1x authentication on the interface. For feature interaction information, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 11	**end**	Return to privileged EXEC mode.
Step 12	**show dot1x**	Verify your entries. Check the Status column in the IEEE 802.1x Port Summary section of the display. An *enabled* status means the port-control value is set to either **auto** or to **force-unauthorized**.
Step 13	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable AAA, use the **no aaa new-model** global configuration command. To disable IEEE 802.1x AAA authentication, use the **no aaa authentication dot1x** {**default** | *list-name*} global configuration command. To disable IEEE 802.1x AAA authorization, use the **no aaa authorization** global configuration command. To disable IEEE 802.1x authentication on the switch, use the **no dot1x system-auth-control** global configuration command.

This example shows how to enable AAA and IEEE 802.1x authentication on a port:

```
Switch# configure terminal
Switch(config)# aaa new-model
Switch(config)# aaa authentication dot1x default group radius
Switch(config)# dot1x system-auth-control
Switch(config)# interface fastethernet0/1
Switch(config-if)# switchport mode access
Switch(config-if)# dot1x port-control auto
Switch(config-if)# end
```

Configuring the Switch-to-RADIUS-Server Communication

RADIUS security servers are identified by their host name or IP address, host name and specific UDP port numbers, or IP address and specific UDP port numbers. The combination of the IP address and UDP port number creates a unique identifier, which enables RADIUS requests to be sent to multiple UDP ports on a server at the same IP address. If two different host entries on the same RADIUS server are configured for the same service—for example, authentication—the second host entry configured acts as the fail-over backup to the first one. The RADIUS host entries are tried in the order that they were configured.

Beginning in privileged EXEC mode, follow these steps to configure the RADIUS server parameters on the switch. This procedure is required.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**radius-server host** {*hostname* | *ip-address*} **auth-port** *port-number* **key** *string*	Configure the RADIUS server parameters on the switch. For *hostname* | *ip-address,* specify the host name or IP address of the remote RADIUS server. For **auth-port** *port-number*, specify the UDP destination port for authentication requests. The default is 1812. For **key** *string*, specify the authentication and encryption key used between the switch and the RADIUS daemon running on the RADIUS server. The key is a text string that must match the encryption key used on the RADIUS server. **Note** Always configure the key as the last item in the **radius-server host** command syntax because leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in the key, do not enclose the key in quotation marks unless the quotation marks are part of the key. This key must match the encryption used on the RADIUS daemon. If you want to use multiple RADIUS servers, re-enter this command.
Step 3	**end**	Return to privileged EXEC mode.

	Command	Purpose
Step 4	**show running-config**	Verify your entries.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To delete the specified RADIUS server, use the **no radius-server host** {*hostname* | *ip-address*} global configuration command.

This example shows how to specify the server with IP address 172.20.39.46 as the RADIUS server, to use port 1612 as the authorization port, and to set the encryption key to *rad123*, matching the key on the RADIUS server:

```
Switch(config)# radius-server host 172.120.39.46 auth-port 1612 key rad123
```

You can globally configure the timeout, retransmission, and encryption key values for all RADIUS servers by using the **radius-server host** global configuration command. If you want to configure these options on a per-server basis, use the **radius-server timeout**, **radius-server retransmit**, and the **radius-server key** global configuration commands. For more information, see the "Configuring Settings for All RADIUS Servers" section on page 8-28.

You also need to configure some settings on the RADIUS server. These settings include the IP address of the switch and the key string to be shared by both the server and the switch. For more information, see the RADIUS server documentation.

Configuring the Host Mode

Beginning in privileged EXEC mode, follow these steps to allow multiple hosts (clients) on an IEEE 802.1x-authorized port that has the **dot1x port-control** interface configuration command set to **auto**. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to which multiple hosts are indirectly attached, and enter interface configuration mode.
Step 3	**dot1x host-mode multi-host**	Allow multiple hosts (clients) on an IEEE 802.1x-authorized port. Make sure that the **dot1x port-control** interface configuration command set is set to **auto** for the specified interface.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable multiple hosts on the port, use the **no dot1x host-mode multi-host** interface configuration command.

This example shows how to enable IEEE 802.1x authentication and to allow multiple hosts:

```
Switch(config)# interface fastethernet0/1
Switch(config-if)# dot1x port-control auto
Switch(config-if)# dot1x host-mode multi-host
```

Enabling Periodic Re-Authentication

You can enable periodic IEEE 802.1x client re-authentication and specify how often it occurs. If you do not specify a time period before enabling re-authentication, the number of seconds between re-authentication attempts is 3600.

Beginning in privileged EXEC mode, follow these steps to enable periodic re-authentication of the client and to configure the number of seconds between re-authentication attempts. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode.
Step 3	**dot1x reauthentication**	Enable periodic re-authentication of the client, which is disabled by default.
Step 4	**dot1x timeout reauth-period** {*seconds* | **server**}	The keywords have these meanings: • *seconds*—Sets the number of seconds from 1 to 65535; the default is 3600 seconds. • **server**—Sets the number of seconds based on the value of the Session-Timeout RADIUS attribute (Attribute[27]) and Termination-Action RADIUS attribute (Attribute [29]). **Note** The **server** keyword is not supported on Catalyst 2950 LRE switches. This command affects the behavior of the switch only if periodic re-authentication is enabled.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show dot1x interface** *interface-id*	Verify your entries.
Step 7	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable periodic re-authentication, use the **no dot1x reauthentication** interface configuration command. To return to the default number of seconds between re-authentication attempts, use the **no dot1x timeout reauth-period** global configuration command.

This example shows how to enable periodic re-authentication and set the number of seconds between re-authentication attempts to 4000:

```
Switch(config-if)# dot1x reauthentication
Switch(config-if)# dot1x timeout reauth-period 4000
```

Manually Re-Authenticating a Client Connected to a Port

You can manually re-authenticate the client connected to a specific port at any time by entering the **dot1x re-authenticate interface** *interface-id* privileged EXEC command. This step is optional. If you want to enable or disable periodic re-authentication, see the "Enabling Periodic Re-Authentication" section on page 9-19.

This example shows how to manually re-authenticate the client connected to a port:

```
Switch# dot1x re-authenticate interface fastethernet0/1
```

Changing the Quiet Period

When the switch cannot authenticate the client, the switch remains idle for a set period of time, and then tries again. The idle time is determined by the quiet-period value. A failed authentication of the client might occur because the client provided an invalid password. You can provide a faster response time to the user by entering a smaller number than the default.

Beginning in privileged EXEC mode, follow these steps to change the quiet period. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode.
Step 3	**dot1x timeout quiet-period** *seconds*	Set the number of seconds that the switch remains in the quiet state following a failed authentication exchange with the client. The range is 1 to 65535 seconds; the default is 60.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default quiet time, use the **no dot1x timeout quiet-period** interface configuration command.

This example shows how to set the quiet time on the switch to 30 seconds:

```
Switch(config-if)# dot1x timeout quiet-period 30
```

Changing the Switch-to-Client Retransmission Time

The client responds to the EAP-request/identity frame from the switch with an EAP-response/identity frame. If the switch does not receive this response, it waits a set period of time (known as the retransmission time) and then resends the frame.

Note You should change the default value of this command only to adjust for unusual circumstances such as unreliable links or specific behavioral problems with certain clients and authentication servers.

Beginning in privileged EXEC mode, follow these steps to change the amount of time that the switch waits for client notification. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode.

	Command	Purpose
Step 3	**dot1x timeout tx-period** *seconds*	Set the number of seconds that the switch waits for a response to an EAP-request/identity frame from the client before resending the request. The range is 1 to 65535 seconds; the default is 30.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default retransmission time, use the **no dot1x timeout tx-period** interface configuration command.

This example shows how to set 60 as the number of seconds that the switch waits for a response to an EAP-request/identity frame from the client before resending the request:

```
Switch(config-if)# dot1x timeout tx-period 60
```

Setting the Switch-to-Client Frame-Retransmission Number

In addition to changing the switch-to-client retransmission time, you can change the number of times that the switch sends an EAP-request/identity frame (assuming no response is received) to the client before restarting the authentication process.

Note You should change the default value of this command only to adjust for unusual circumstances such as unreliable links or specific behavioral problems with certain clients and authentication servers.

Beginning in privileged EXEC mode, follow these steps to set the switch-to-client frame-retransmission number. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode.
Step 3	**dot1x max-req** *count*	Set the number of times that the switch sends an EAP-request/identity frame to the client before restarting the authentication process. The range is 1 to 10; the default is 2.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default retransmission number, use the **no dot1x max-req** interface configuration command.

This example shows how to set 5 as the number of times that the switch sends an EAP-request/identity request before restarting the authentication process:

```
Switch(config-if)# dot1x max-req 5
```

Configuring IEEE 802.1x Accounting

Enabling AAA system accounting with IEEE 802.1x accounting allows system reload events to be sent to the accounting RADIUS server for logging. The server can then infer that all active IEEE 802.1x sessions are closed.

Because RADIUS uses the unreliable UDP transport protocol, accounting messages might be lost due to poor network conditions. If the switch does not receive the accounting response message from the RADIUS server after a configurable number of retransmissions of an accounting request, this system message appears:

```
Accounting message %s for session %s failed to receive Accounting Response.
```

When the stop message is not sent successfully, this message appears:

```
00:09:55: %RADIUS-3-NOACCOUNTINGRESPONSE: Accounting message Start for session
172.20.50.145 sam 11/06/03 07:01:16 11000002 failed to receive Accounting Response.
```

Note You must configure the RADIUS server to perform accounting tasks, such as logging start, stop, and interim-update messages and time stamps. To turn on these functions, enable logging of "Update/Watchdog packets from this AAA client" in your RADIUS server Network Configuration tab. Next, enable "CVS RADIUS Accounting" in your RADIUS server System Configuration tab.

Beginning in privileged EXEC mode, follow these steps to configure IEEE 802.1x accounting after AAA is enabled on your switch. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode.
Step 3	**aaa accounting dot1x default start-stop group radius**	Enable IEEE 802.1x accounting using the list of all RADIUS servers.
Step 4	**aaa accounting system default start-stop group radius**	(Optional) Enables system accounting (using the list of all RADIUS servers) and generates system accounting reload event messages when the switch reloads.
Step 5	**end**	Return to privileged EXEc mode.
Step 6	**show running-config**	Verify your entries.
Step 7	**copy running-config startup-config**	(Optional) Saves your entries in the configuration file.

Use the **show radius statistics** privileged EXEC command to display the number of RADIUS messages that do not receive the accounting response message.

This example shows how to configure IEEE 802.1x accounting. The first command configures the RADIUS server, specifying 1813 as the UDP port for accounting:

```
Switch(config)# radius-server host 172.120.39.46 auth-port 1812 acct-port 1813 key rad123
Switch(config)# aaa accounting dot1x default start-stop group radius
Switch(config)# aaa accounting system default start-stop group radius
```

Configuring a Guest VLAN

When you configure a guest VLAN, clients that are not IEEE 802.1x-capable are put into the guest VLAN when the server does not receive a response to its EAPOL request/identity frame. Clients that are IEEE 802.1x-capable but fail authentication are not granted access to the network. The switch supports guest VLANs in single-host or multiple-hosts mode.

You can enable optional guest VLAN behavior by using the **dot1x guest-vlan supplicant** global configuration command. When enabled, the switch does not maintain the EAPOL packet history and allows clients that fail authentication to access the guest VLAN, regardless of whether EAPOL packets had been detected on the interface. Clients that fail authentication can access the guest VLAN.

Note Depending on the switch configuration, assigning the client to a guest VLAN can take up to several minutes.

Beginning in privileged EXEC mode, follow these steps to configure a guest VLAN. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode. For the supported interface types, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 3	**switchport mode access**	Set the port to access mode.
Step 4	**dot1x port-control auto**	Enable IEEE 802.1x authentication on the port.
Step 5	**dot1x guest-vlan** *vlan-id*	Specify an active VLAN as an IEEE 802.1x guest VLAN. The range is 1 to 4094. You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x guest VLAN.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show dot1x interface** *interface-id*	Verify your entries.
Step 8	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable and remove the guest VLAN, use the **no dot1x guest-vlan** interface configuration command. The port returns to the unauthorized state.

This example shows how to enable VLAN 9 as an IEEE 802.1x guest VLAN on a port:

```
Switch(config)# interface fastethernet0/1
Switch(config-if)# dot1x guest-vlan 9
```

This example shows how to set 3 as the quiet time on the switch, to set 15 as the number of seconds that the switch waits for a response to an EAP-request/identity frame from the client before resending the request, and to enable VLAN 2 as an IEEE 802.1x guest VLAN when an IEEE 802.1x port is connected to a DHCP client:

```
Switch(config-if)# dot1x timeout quiet-period 3
Switch(config-if)# dot1x timeout tx-period 15
Switch(config-if)# dot1x guest-vlan 2
```

You can enable optional guest VLAN behavior by using the **dot1x guest-vlan supplicant** global configuration command. When enabled, the switch does not maintain the EAPOL packet history and allows clients that fail authentication access to the guest VLAN, regardless of whether EAPOL packets had been detected on the interface.

Beginning in privileged EXEC mode, follow these steps to enable the optional guest VLAN behavior and to configure a guest VLAN. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**dot1x guest-vlan supplicant**	Enable the optional guest VLAN behavior globally on the switch.
Step 3	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode. For the supported port types, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 4	**switchport mode access**	Set the port to access mode.
Step 5	**dot1x port-control auto**	Enable IEEE 802.1x authentication on the port.
Step 6	**dot1x guest-vlan** *vlan-id*	Specify an active VLAN as an IEEE 802.1x guest VLAN. The range is 1 to 4094. You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x guest VLAN.
Step 7	**end**	Return to privileged EXEC mode.
Step 8	**show dot1x interface** *interface-id*	Verify your entries.
Step 9	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable the optional guest VLAN behavior, use the **no dot1x guest-vlan supplicant** global configuration command. To remove the guest VLAN, use the **no dot1x guest-vlan** interface configuration command. If the port is currently authorized in the guest VLAN, the port returns to the unauthorized state.

This example shows how enable the optional guest VLAN behavior and to specify VLAN 5 as an IEEE 802.1x guest VLAN:

```
Switch(config)# dot1x guest-vlan supplicant
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# dot1x guest-vlan 5
```

Configuring a Restricted VLAN

When you configure a restricted VLAN on a switch, clients that are IEEE 802.1x-compliant are moved into the restricted VLAN when the authentication server does not receive a valid username and password. The switch supports restricted VLANs only in single-host mode.

Beginning in privileged EXEC mode, follow these steps to configure a restricted VLAN. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode. For the supported port types, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 3	**switchport mode access**	Set the port to access mode.
Step 4	**dot1x port-control auto**	Enable IEEE 802.1x authentication on the port.
Step 5	**dot1x auth-fail vlan** *vlan-id*	Specify an active VLAN as an IEEE 802.1x restricted VLAN. The range is 1 to 4094. You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x restricted VLAN.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show dot1x interface** *interface-id*	(Optional) Verify your entries.
Step 8	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable and remove the restricted VLAN, use the **no dot1x auth-fail vlan** interface configuration command. The port returns to the unauthorized state.

This example shows how to enable VLAN 2 as an IEEE 802.1x restricted VLAN:

```
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# dot1x auth-fail vlan 2
```

You can configure the maximum number of authentication attempts allowed before a user is assigned to the restricted VLAN by using the **dot1x auth-fail max-attempts** interface configuration command. The range of allowable authentication attempts is 1 to 3. The default is 3 attempts.

Beginning in privileged EXEC mode, follow these steps to configure the maximum number of allowed authentication attempts. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode. For the supported port types, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 3	**switchport mode access**	Set the port to access mode.
Step 4	**dot1x port-control auto**	Enable IEEE 802.1x authentication on the port.
Step 5	**dot1x auth-fail vlan** *vlan-id*	Specify an active VLAN as an IEEE 802.1x restricted VLAN. The range is 1 to 4094. You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x restricted VLAN.
Step 6	**dot1x auth-fail max-attempts** *max attempts*	Specify a number of authentication attempts to allow before a port moves to the restricted VLAN. The range is 1 to 3, and the default is 3.
Step 7	**end**	Return to privileged EXEC mode.

	Command	Purpose
Step 8	**show dot1x interface** *interface-id*	(Optional) Verify your entries.
Step 9	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default value, use the **no dot1x auth-fail max-attempts** interface configuration command.

This example shows how to set 2 as the number of authentication attempts allowed before the port moves to the restricted VLAN:

```
Switch(config-if)# dot1x auth-fail max-attempts 2
```

Configuring IEEE 802.1x Authentication with WoL

Beginning in privileged EXEC mode, follow these steps to enable IEEE 802.1x authentication with WoL. This procedure is optional.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode. For the supported port types, see the "IEEE 802.1x Authentication Configuration Guidelines" section on page 9-13.
Step 3	**dot1x control-direction** {**both** | **in**}	Enable IEEE 802.1x authentication with WoL on the port, and use these keywords to configure the port as bidirectional or unidirectional. • **both**—Sets the port as bidirectional. The port cannot receive packets from or send packets to the host. By default, the port is bidirectional. • **in**—Sets the port as unidirectional. The port can send packets to the host but cannot receive packets from the host.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable IEEE 802.1x authentication with WoL, use the **no dot1x control-direction** interface configuration command.

This example shows how to enable IEEE 802.1x authentication with WoL and set the port as bidirectional:

```
Switch(config-if)# dot1x control-direction both
```

Configuring NAC Layer 2 IEEE 802.1x Validation

In Cisco IOS Release 12.1(22)EA6 or later, you can configure NAC Layer 2 IEEE 802.1x validation, which is also referred to as IEEE 802.1x authentication with a RADIUS server.

Beginning in privileged EXEC mode, follow these steps to configure NAC Layer 2 IEEE 802.1x validation. The procedure is optional.

Note On Catalyst 2950 LRE switches, you cannot configure IEEE 802.1x authentication using a RADIUS server.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to be configured, and enter interface configuration mode.
Step 3	**dot1x guest-vlan** *vlan-id*	Specify an active VLAN as an IEEE 802.1x guest VLAN. The range is 1 to 4094. You can configure any active VLAN except an RSPAN VLAN or a voice VLAN as an IEEE 802.1x guest VLAN.
Step 4	**dot1x reauthentication**	Enable periodic re-authentication of the client, which is disabled by default.
Step 5	**dot1x timeout reauth-period** {*seconds* | **server**}	Set the number of seconds between re-authentication attempts. The keywords have these meanings: • *seconds*—Sets the number of seconds from 1 to 65535; the default is 3600 seconds. • **server**—Sets the number of seconds as the value of the Session-Timeout RADIUS attribute (Attribute[27]) and the Termination-Action RADIUS attribute (Attribute [29]). This command affects the behavior of the switch only if periodic re-authentication is enabled.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show dot1x interface** *interface-id*	Verify your IEEE 802.1x authentication configuration.
Step 8	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

This example shows how to configure NAC Layer 2 IEEE 802.1x validation:

```
Switch# configure terminal
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# dot1x reauthentication
Switch(config-if)# dot1x timeout reauth-period server
```

Resetting the IEEE 802.1x Configuration to the Default Values

Beginning in privileged EXEC mode, follow these steps to reset the IEEE 802.1x configuration to the default values.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the interface to be configured, and enter interface configuration mode.
Step 3	**dot1x default**	Reset the configurable IEEE 802.1x parameters to the default values.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show dot1x interface** *interface-id*	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Displaying IEEE 802.1x Statistics and Status

To display IEEE 802.1x statistics for all interfaces, use the **show dot1x all statistics** privileged EXEC command. To display IEEE 802.1x statistics for a specific interface, use the **show dot1x statistics interface** *interface-id* privileged EXEC command.

To display the IEEE 802.1x administrative and operational status for the switch, use the **show dot1x all** privileged EXEC command. To display the IEEE 802.1x administrative and operational status for a specific interface, use the **show dot1x interface** *interface-id* privileged EXEC command.

For detailed information about the fields in these displays, see the command reference for this release.