# Configuring RADIUS

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This chapter describes the Remote Authentication Dial-In User Service (RADIUS) security system, defines its operation, and identifies appropriate and inappropriate network environments for using RADIUS technology.

## Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the "Feature Information for Configuring RADIUS" section on page 34.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

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This chapter includes the following sections:



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# Information About RADIUS

RADIUS is a distributed client/server system that secures networks against unauthorized access. In the Cisco implementation, RADIUS clients run on Cisco routers and send authentication requests to a central RADIUS server that contains all user authentication and network service access information.

RADIUS is a fully open protocol, distributed in source code format, that can be modified to work with any security system currently available on the market.

Cisco supports RADIUS under its AAA security paradigm. RADIUS can be used with other AAA security protocols, such as TACACS+, Kerberos, and local username lookup. RADIUS is supported on all Cisco platforms, but some RADIUS-supported features run only on specified platforms.

RADIUS has been implemented in a variety of network environments that require high levels of security while maintaining network access for remote users.

Use RADIUS in the following network environments that require access security:

- Networks with multiple-vendor access servers, each supporting RADIUS. For example, access servers from several vendors use a single RADIUS server-based security database. In an IP-based network with multiple vendors' access servers, dial-in users are authenticated through a RADIUS server that has been customized to work with the Kerberos security system.
- Turnkey network security environments in which applications support the RADIUS protocol, such as in an access environment that uses a "smart card" access control system. In one case, RADIUS has been used with Enigma's security cards to validate users and grant access to network resources.
- Networks already using RADIUS. You can add a Cisco router with RADIUS to the network. This might be the first step when you make a transition to a Terminal Access Controller Access Control System Plus (TACACS+) server.
- Networks in which a user must only access a single service. Using RADIUS, you can control user access to a single host, to a single utility such as Telnet, or to a single protocol such as Point-to-Point Protocol (PPP). For example, when a user logs in, RADIUS identifies this user as having authorization to run PPP using IP address 10.2.3.4 and the defined access list is started.
- Networks that require resource accounting. You can use RADIUS accounting independent of RADIUS authentication or authorization. The RADIUS accounting functions allow data to be sent at the start and end of services, indicating the amount of resources (such as time, packets, bytes, and so on) used during the session. An Internet service provider (ISP) might use a freeware-based version of RADIUS access control and accounting software to meet special security and billing needs.
- Networks that wish to support preauthentication. Using the RADIUS server in your network, you can configure AAA preauthentication and set up the preauthentication profiles. Preauthentication enables service providers to better manage ports using their existing RADIUS solutions, and to efficiently manage the use of shared resources to offer differing service-level agreements.

RADIUS is not suitable in the following network security situations:

- Multiprotocol access environments. RADIUS does not support the following protocols:
  - AppleTalk Remote Access (ARA)
  - NetBIOS Frame Control Protocol (NBFCP)
  - NetWare Asynchronous Services Interface (NASI)
  - X.25 PAD connections

- Router-to-router situations. RADIUS does not provide two-way authentication. RADIUS can be used to authenticate from one router to a non-Cisco router if the non-Cisco router requires RADIUS authentication.
- Networks using a variety of services. RADIUS generally binds a user to one service model.

## RADIUS Operation

When a user attempts to log in and authenticate to an access server using RADIUS, the following steps occur:

1. The user is prompted for and enters a username and password.
2. The username and encrypted password are sent over the network to the RADIUS server.
3. The user receives one of the following responses from the RADIUS server:
   a. ACCEPT—The user is authenticated.
   b. REJECT—The user is not authenticated and is prompted to reenter the username and password, or access is denied.
   c. CHALLENGE—A challenge is issued by the RADIUS server. The challenge collects additional data from the user.
   d. CHANGE PASSWORD—A request is issued by the RADIUS server, asking the user to select a new password.

The ACCEPT or REJECT response is bundled with additional data that is used for EXEC or network authorization. You must first complete RADIUS authentication before using RADIUS authorization. The additional data included with the ACCEPT or REJECT packets consists of the following:

- Services that the user can access, including Telnet, rlogin, or local-area transport (LAT) connections, and PPP, Serial Line Internet Protocol (SLIP), or EXEC services.
- Connection parameters, including the host or client IP address, access list, and user timeouts.

# RADIUS Attributes

The network access server monitors the RADIUS authorization and accounting functions defined by RADIUS attributes in each user-profile. For a list of supported RADIUS attributes, refer to the appendix "RADIUS Attributes."

This section includes the following sections:



## Vendor-Proprietary RADIUS Attributes

An Internet Engineering Task Force (IETF) draft standard for RADIUS specifies a method for communicating vendor-proprietary information between the network access server and the RADIUS server. Some vendors, nevertheless, have extended the RADIUS attribute set in a unique way. Cisco IOS XE software supports a subset of vendor-proprietary RADIUS attributes. For a list of supported vendor-proprietary RADIUS attributes, refer to the appendix "RADIUS Attributes."

# RADIUS Tunnel Attributes

RADIUS is a security server authentication, authorization, and accounting (AAA) protocol originally developed by Livingston, Inc. RADIUS uses attribute value (AV) pairs to communicate information between the security server and the network access server. RFC 2138 and RFC 2139 describe the basic functionality of RADIUS and the original set of Internet Engineering Task Force (IETF)-standard AV pairs used to send AAA information. Two draft IETF standards, "RADIUS Attributes for Tunnel Protocol Support" and "RADIUS Accounting Modifications for Tunnel Protocol Support," extend the IETF-defined set of AV pairs to include attributes specific to virtual private networks (VPNs); these attributes are used to carry the tunneling information between the RADIUS server and the tunnel initiator. RFC 2865 and RFC 2868 extend the IETF-defined set of AV pairs to include attributes specific to compulsory tunneling in VPNs by allowing the user to specify authentication names for the network access server and the RADIUS server.

Cisco routers and access servers now support new RADIUS IETF-standard VPDN tunnel attributes. These new RADIUS IETF-standard attributes are listed in the "RADIUS Attributes" appendix. Refer to the following three configuration examples later in this chapter:

- RADIUS User Profile with RADIUS Tunneling Attributes Example
- L2TP Access Concentrator Examples
- L2TP Network Server Examples

For more information about L2TP, VPN, or VPDN, refer to the *Cisco IOS XE VPDN Configuration Guide*, Release 2.

# How to Configure RADIUS

To configure RADIUS on your Cisco router or access server, you must perform the following tasks:

- Use the **aaa new-model** global configuration command to enable AAA. AAA must be configured if you plan to use RADIUS. For more information about using the **aaa new-model** command, refer to the "AAA Overview" chapter.
- Use the **aaa authentication** global configuration command to define method lists for RADIUS authentication. For more information about using the **aaa authentication** command, refer to the "Configuring Authentication" chapter.
- Use **line** and **interface** commands to enable the defined method lists to be used. For more information, refer to the "Configuring Authentication" chapter.

The following configuration tasks are optional:

- You may use the **aaa group server** command to group selected RADIUS hosts for specific services. For more information about using the **aaa group server** command, refer to the "Configuring AAA Server Groups" section in this chapter.
- You may use the **aaa dnis map** command to select RADIUS server groups based on DNIS number. To use this command, you must define RADIUS server groups using the **aaa group server** command. For more information about using the **aaa dnis map** command, refer to the section "Configuring AAA Server Group Selection Based on DNIS" in this chapter.
- You may use the **aaa authorization** global command to authorize specific user functions. For more information about using the **aaa authorization** command, refer to the chapter "Configuring Authorization."

- You may use the **aaa accounting** command to enable accounting for RADIUS connections. For more information about using the **aaa accounting** command, refer to the chapter "Configuring Accounting."
- You may use the **dialer aaa** interface configuration command to create remote site profiles that contain outgoing call attributes on the AAA server. For more information about using the **dialer aaa** command, refer to the section "Configuring Suffix and Password in RADIUS Access Requests" in this chapter.

This section describes how to set up RADIUS for authentication, authorization, and accounting on your network, and includes the following sections:

- Configuring Router to RADIUS Server Communication (Required)
- Configuring Router to Use Vendor-Specific RADIUS Attributes (Optional)
- Configuring Router for Vendor-Proprietary RADIUS Server Communication (Optional)
- Configuring Router to Query RADIUS Server for Static Routes and IP Addresses (Optional)
- Configuring Router to Expand Network Access Server Port Information (Optional)
- Configuring AAA Server Groups (Optional)
- Configuring AAA Server Groups with Deadtime (Optional)
- Configuring AAA DNIS Authentication
- Configuring AAA Server Group Selection Based on DNIS (Optional)
- Configuring AAA Preauthentication
- Configuring a Guard Timer
- Specifying RADIUS Authentication
- Specifying RADIUS Authorization (Optional)
- Specifying RADIUS Accounting (Optional)
- Configuring RADIUS Login-IP-Host (Optional)
- Configuring RADIUS Prompt (Optional)
- Configuring Suffix and Password in RADIUS Access Requests (Optional)

For RADIUS configuration examples using the commands in this chapter, refer to the section "RADIUS Configuration Examples" at the end of this chapter.

# Configuring Router to RADIUS Server Communication

The RADIUS host is normally a multiuser system running RADIUS server software from Cisco (CiscoSecure ACS), Livingston, Merit, Microsoft, or another software provider. Configuring router to RADIUS server communication can have several components:

- Host name or IP address
- Authentication destination port
- Accounting destination port
- Timeout period
- Retransmission value
- Key string

RADIUS security servers are identified on the basis of 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, allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. In other words, this unique identifier 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, accounting—the second host entry configured acts as fail-over backup to the first one. Using this example, if the first host entry fails to provide accounting services, the network access server will try the second host entry configured on the same device for accounting services. (The RADIUS host entries will be tried in the order they are configured.)

A RADIUS server and a Cisco router use a shared secret text string to encrypt passwords and exchange responses.To configure RADIUS to use the AAA security commands, you must specify the host running the RADIUS server daemon and a secret text (key) string that it shares with the router.

The timeout, retransmission, and encryption key values are configurable globally for all RADIUS servers, on a per-server basis, or in some combination of global and per-server settings. To apply these settings globally to all RADIUS servers communicating with the router, use the three unique global commands: **radius-server timeout**, **radius-server retransmit**, and **radius-server key**. To apply these values on a specific RADIUS server, use the **radius-server host** command.

**Note** You can configure both global and per-server timeout, retransmission, and key value commands simultaneously on the same Cisco network access server. If both global and per-server functions are configured on a router, the per-server timer, retransmission, and key value commands override global timer, retransmission, and key value commands.

To configure per-server RADIUS server communication, use the following command in global configuration mode:

| Command | Purpose |
|---|---|
| `Router(config)# radius-server host {hostname \| ip-address} [auth-port port-number] [acct-port port-number] [timeout seconds] [retransmit retries] [key string] [alias {hostname \| ip address}]` | Specifies the IP address or host name of the remote RADIUS server host and assign authentication and accounting destination port numbers. Use the **auth-port** *port-number* option to configure a specific UDP port on this RADIUS server to be used solely for authentication. Use the **acct-port** *port-number* option to configure a specific UDP port on this RADIUS server to be used solely for accounting. Use the **alias** keyword to configure up to eight multiple IP addresses for use when referring to RADIUS servers.<br><br>To configure the network access server to recognize more than one host entry associated with a single IP address, simply repeat this command as many times as necessary, making sure that each UDP port number is different. Set the timeout, retransmit, and encryption key values to use with the specific RADIUS host.<br><br>If no timeout is set, the global value is used; otherwise, enter a value in the range 1 to 1000. If no retransmit value is set, the global value is used; otherwise enter a value in the range 1 to 1000. If no key string is specified, the global value is used.<br><br>**Note** The key is a text string that must match the encryption key used on the RADIUS server. Always configure the key as the last item in the **radius-server host** command syntax because the leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks themselves are part of the key. |

To configure global communication settings between the router and a RADIUS server, use the following **radius-server** commands in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# radius-server key {0 string \| 7 string \| string}` | Specifies the shared secret text string used between the router and a RADIUS server. Use the **0** *line* option to configure an unencrypted shared secret. Use the **7** *line* option to configure an encrypted shared secret. |
| **Step 2** | `Router(config)# radius-server retransmit retries` | Specifies how many times the router transmits each RADIUS request to the server before giving up (the default is 3). |

| | Command | Purpose |
|---|---|---|
| **Step 3** | `Router(config)# radius-server timeout seconds` | Specifies for how many seconds a router waits for a reply to a RADIUS request before retransmitting the request. |
| **Step 4** | `Router(config)# radius-server deadtime minutes` | Specifies for how many minutes a RADIUS server that is not responding to authentication requests is passed over by requests for RADIUS authentication. |

# Configuring Router to Use Vendor-Specific RADIUS Attributes

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific information between the network access server and the RADIUS server by using the vendor-specific attribute (attribute 26). Vendor-specific attributes (VSAs) allow vendors to support their own extended attributes not suitable for general use. The Cisco RADIUS implementation supports one vendor-specific option using the format recommended in the specification. Cisco's vendor-ID is 9, and the supported option has vendor-type 1, which is named "cisco-avpair." The value is a string of the following format:

```
protocol : attribute sep value *
```

"Protocol" is a value of the Cisco "protocol" attribute for a particular type of authorization; protocols that can be used include IP, IPX, VPDN, VOIP, SHELL, RSVP, SIP, AIRNET, OUTBOUND. "Attribute" and "value" are an appropriate attribute-value (AV) pair defined in the Cisco TACACS+ specification, and "sep" is "=" for mandatory attributes and "*" for optional attributes. This allows the full set of features available for TACACS+ authorization to also be used for RADIUS.

For example, the following AV pair causes Cisco's "multiple named ip address pools" feature to be activated during IP authorization (during PPP's IPCP address assignment):

```
cisco-avpair= ″ip:addr-pool=first″
```

If you insert an "*", the AV pair "ip:addr-pool=first" becomes optional. Note that any AV pair can be made optional.

```
cisco-avpair= ″ip:addr-pool*first″
```

The following example shows how to cause a user logging in from a network access server to have immediate access to EXEC commands:

```
cisco-avpair= ″shell:priv-lvl=15″
```

Other vendors have their own unique vendor-IDs, options, and associated VSAs. For more information about vendor-IDs and VSAs, refer to RFC 2138, Remote Authentication Dial-In User Service (RADIUS).

To configure the network access server to recognize and use VSAs, use the following command in global configuration mode:

| Command | Purpose |
|---|---|
| `Router(config)# radius-server vsa send [accounting \| authentication]` | Enables the network access server to recognize and use VSAs as defined by RADIUS IETF attribute 26. |

For a complete list of RADIUS attributes or more information about vendor-specific attribute 26, refer to the appendix "RADIUS Attributes."

# Configuring Router for Vendor-Proprietary RADIUS Server Communication

Although an Internet Engineering Task Force (IETF) draft standard for RADIUS specifies a method for communicating vendor-proprietary information between the network access server and the RADIUS server, some vendors have extended the RADIUS attribute set in a unique way. Cisco IOS XE software supports a subset of vendor-proprietary RADIUS attributes.

As mentioned earlier, to configure RADIUS (whether vendor-proprietary or IETF draft-compliant), you must specify the host running the RADIUS server daemon and the secret text string it shares with the Cisco device. You specify the RADIUS host and secret text string by using the **radius-server** commands. To identify that the RADIUS server is using a vendor-proprietary implementation of RADIUS, use the **radius-server host non-standard** command. Vendor-proprietary attributes will not be supported unless you use the **radius-server host non-standard** command.

To specify a vendor-proprietary RADIUS server host and a shared secret text string, use the following commands in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# radius-server host {hostname \| ip-address} non-standard` | Specifies the IP address or host name of the remote RADIUS server host and identifies that it is using a vendor-proprietary implementation of RADIUS. |
| **Step 2** | `Router(config)# radius-server key {0 string \| 7 string \| string}` | Specifies the shared secret text string used between the router and the vendor-proprietary RADIUS server. The router and the RADIUS server use this text string to encrypt passwords and exchange responses. |

# Configuring Router to Query RADIUS Server for Static Routes and IP Addresses

Some vendor-proprietary implementations of RADIUS let the user define static routes and IP pool definitions on the RADIUS server instead of on each individual network access server in the network. Each network access server then queries the RADIUS server for static route and IP pool information.

To have the Cisco router or access server query the RADIUS server for static routes and IP pool definitions when the device first starts up, use the following command in global configuration mode:

| Command | Purpose |
|---|---|
| `Router(config)# radius-server configure-nas` | Tells the Cisco router or access server to query the RADIUS server for the static routes and IP pool definitions used throughout its domain. |

**Note** Because the **radius-server configure-nas** command is performed when the Cisco router starts up, it will not take effect until you issue a **copy system:running config nvram:startup-config** command.

# Configuring Router to Expand Network Access Server Port Information

There are some situations when PPP or login authentication occurs on an interface different from the interface on which the call itself comes in. For example, in a V.120 ISDN call, login or PPP authentication occurs on a virtual asynchronous interface "ttt" but the call itself occurs on one of the channels of the ISDN interface.

The **radius-server attribute nas-port extended** command configures RADIUS to expand the size of the NAS-Port attribute (RADIUS IETF attribute 5) field to 32 bits. The upper 16 bits of the NAS-Port attribute display the type and number of the controlling interface; the lower 16 bits indicate the interface undergoing authentication.

To display expanded interface information in the NAS-Port attribute field, use the following command in global configuration mode:

| Command | Purpose |
|---|---|
| `Router(config)# radius-server attribute nas-port format` | Expands the size of the NAS-Port attribute from 16 to 32 bits to display extended interface information. |

**Note** This command replaces the **radius-server extended-portnames** command and the **radius-server attribute nas-port extended** command.

On platforms with multiple interfaces (ports) per slot, the Cisco RADIUS implementation will not provide a unique NAS-Port attribute that permits distinguishing between the interfaces. For example, if a dual PRI interface is in slot 1, calls on both Serial1/0:1 and Serial1/1:1 will appear as NAS-Port = 20101.

Once again, this is because of the 16-bit field size limitation associated with RADIUS IETF NAS-Port attribute. In this case, the solution is to replace the NAS-Port attribute with a vendor-specific attribute (RADIUS IETF attribute 26). Cisco's vendor-ID is 9, and the Cisco-NAS-Port attribute is subtype 2. Vendor-specific attributes (VSAs) can be turned on by entering the **radius-server vsa send** command. The port information in this attribute is provided and configured using the **aaa nas port extended** command.

To replace the NAS-Port attribute with RADIUS IETF attribute 26 and to display extended field information, use the following commands in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# radius-server vsa send [accounting \| authentication]` | Enables the network access server to recognize and use vendor-specific attributes as defined by RADIUS IETF attribute 26. |
| **Step 2** | `Router(config)# aaa nas port extended` | Expands the size of the VSA NAS-Port field from 16 to 32 bits to display extended interface information. |

The standard NAS-Port attribute (RADIUS IETF attribute 5) will continue to be sent. If you do not want this information to be sent, you can suppress it by using the **no radius-server attribute nas-port** command. When this command is configured, the standard NAS-Port attribute will no longer be sent.

For a complete list of RADIUS attributes, refer to the "RADIUS Attributes" section of the *Cisco IOS XE Security Configuration Guide: Securing User Services*, Release 2.

For information about configuring RADIUS port identification for PPP, see the *Cisco IOS XE Wide-Area Networking Configuration Guide*, Release 2.

# Configuring AAA Server Groups

Configuring the router to use AAA server groups provides a way to group existing server hosts. This allows you to select a subset of the configured server hosts and use them for a particular service. A server group is used in conjunction with a global server-host list. The server group lists the IP addresses of the selected server hosts.

Server groups also can include multiple host entries for the same server, as long as each entry has a unique identifier. The combination of an IP address and a UDP port number creates a unique identifier, allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. In other words, this unique identifier enables RADIUS requests to be sent to different 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, accounting—the second host entry configured acts as failover backup to the first one. Using this example, if the first host entry fails to provide accounting services, the network access server will try the second host entry configured on the same device for accounting services. (The RADIUS host entries will be tried in the order in which they are configured.)

To define a server host with a server group name, enter the following commands in global configuration mode. The listed server must exist in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# radius-server host {hostname \| ip-address} [auth-port port-number] [acct-port port-number] [timeout seconds] [retransmit retries] [key string] [alias {hostname \| ip address}]` | Specifies and defines the IP address of the server host before configuring the AAA server-group. Refer to the section "Configuring Router to RADIUS Server Communication" of this chapter for more information on the **radius-server host** command. |
| **Step 2** | `Router(config-if)# aaa group server {radius \| tacacs+} group-name` | Defines the AAA server group with a group name. All members of a group must be the same type; that is, RADIUS or TACACS+. This command puts the router in server group subconfiguration mode. |
| **Step 3** | `Router(config-sg)# server ip-address [auth-port port-number] [acct-port port-number]` | Associates a particular RADIUS server with the defined server group. Each security server is identified by its IP address and UDP port number.<br>Repeat this step for each RADIUS server in the AAA server group.<br>**Note** Each server in the group must be defined previously using the **radius-server host** command. |

# Configuring AAA Server Groups with Deadtime

After you have configured a server host with a server name, you can use the **deadtime** command to configure each server per server group. Configuring deadtime within a server group allows you to direct AAA traffic to separate groups of servers that have different operational characteristics.

Configuring deadtime is no longer limited to a global configuration. A separate timer has been attached to each server host in every server group. Therefore, when a server is found to be unresponsive after numerous retransmissions and timeouts, the server is assumed to be dead. The timers attached to each server host in all server groups are triggered. In essence, the timers are checked and subsequent requests to a server (once it is assumed to be dead) are directed to alternate timers, if configured. When the network access server receives a reply from the server, it checks and stops all configured timers (if running) for that server in all server groups.

If the timer has expired, only the server to which the timer is attached is assumed to be alive. This becomes the only server that can be tried for later AAA requests using the server groups to which the timer belongs.

**Note** Since one server has different timers and may have different deadtime values configured in the server groups, the same server may in the future have different states (dead and alive) at the same time.

**Note** To change the state of a server, you must start and stop all configured timers in all server groups.

The size of the server group will be slightly increased because of the addition of new timers and the deadtime attribute. The overall impact of the structure depends on the number and size of the server groups and how the servers are shared among server groups in a specific configuration.

To configure deadtime within a server group, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# aaa group server radius group1` | Defines a RADIUS type server group. |
| **Step 2** | `Router(config-sg)# deadtime 1` | Configures and defines deadtime value in minutes.<br>**Note** Local server group deadtime will override the global configuration. If omitted from the local server group configuration, the value will be inherited from the master list. |
| **Step 3** | `Router(config-sg)# exit` | Exits server group configuration mode. |

# Configuring AAA DNIS Authentication

DNIS preauthentication enables preauthentication at call setup based on the number dialed. The DNIS number is sent directly to the security server when a call is received. If authenticated by AAA, the call is accepted.

To configure DNIS authentication, perform the following tasks in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router# config term` | Enters global configuration mode. |
| **Step 2** | `Router(config)# aaa preauth` | Enters AAA preauthentication mode. |

| | Command | Purpose |
|---|---|---|
| Step 3 | `Router(config-preauth)# group {radius \| tacacs+ \| server-group}` | (Optional) Selects the security server to use for AAA preauthentication requests. The default is RADIUS. |
| Step 4 | `Router(config-preauth)# dnis [password string]` | Enables preauthentication using DNIS and optionally specifies a password to use in Access-Request packets. |

# Configuring AAA Server Group Selection Based on DNIS

Cisco IOS XE software allows you to assign a Dialed Number Identification Service (DNIS) number to a particular AAA server group so that the server group can process authentication, authorization, and accounting requests for users dialing in to the network using that particular DNIS. Any phone line (a regular home phone or a commercial T1/PRI line) can be associated with several phone numbers. The DNIS number identifies the number that was called to reach you.

For example, suppose you want to share the same phone number with several customers, but you want to know which customer is calling before you pick up the phone. You can customize how you answer the phone because DNIS allows you to know which customer is calling when you answer.

Cisco routers with either ISDN or internal modems can receive the DNIS number. This functionality allows users to assign different RADIUS server groups for different customers (that is, different RADIUS servers for different DNIS numbers). Additionally, using server groups you can specify the same server group for AAA services or a separate server group for each AAA service.

Cisco IOS XE software provides the flexibility to implement authentication and accounting services in several ways:

- Globally—AAA services are defined using global configuration access list commands and applied in general to all interfaces on a specific network access server.
- Per Interface—AAA services are defined using interface configuration commands and applied specifically to the interface being configured on a specific network access server.
- DNIS mapping—You can use DNIS to specify an AAA server to supply AAA services.

Because each of these AAA configuration methods can be configured simultaneously, Cisco has established an order of precedence to determine which server or groups of servers provide AAA services. The order of precedence is as follows:

- Per DNIS—If you configure the network access server to use DNIS to identify/determine which server group provides AAA services, then this method takes precedence over any additional AAA selection method.
- Per interface—If you configure the network access server per interface to use access lists to determine how a server provides AAA services, this method takes precedence over any global configuration AAA access lists.
- Globally—If you configure the network access server by using global AAA access lists to determine how the security server provides AAA services, this method has the least precedence.

**Note** Prior to configuring AAA Server Group Selection Based on DNIS, you must configure the list of RADIUS server hosts and configure the AAA server groups. See the sections "Configuring Router to RADIUS Server Communication" and "Configuring AAA Server Groups" of this chapter.

To configure the router to select a particular AAA server group based on the DNIS of the server group, configure DNIS mapping. To map a server group with a group name with DNIS number, use the following commands in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# aaa dnis map enable` | Enables DNIS mapping. |
| **Step 2** | `Router(config)# aaa dnis map` *dnis-number* `authentication ppp group server-`*group-name* | Maps a DNIS number to a defined AAA server group; the servers in this server group are being used for authentication. |
| **Step 3** | `Router(config)# aaa dnis map dnis-number authorization network group server-group-name` | Maps a DNIS number to a defined AAA server group; the servers in this server group are being used for authorization. |
| **Step 4** | `Router(config)# aaa dnis map` *dnis-number* `accounting network [none \| start-stop \| stop-only] group` *server-group-name* | Maps a DNIS number to a defined AAA server group; the servers in this server group are being used for accounting. |

# Configuring AAA Preauthentication

Configuring AAA preauthentication with channel-associated signalling (CAS) allows service providers to better manage ports using their existing RADIUS solutions and efficiently manage the use of shared resources to offer differing service-level agreements. With CAS, information about an incoming call is available to the network access server (NAS) before the call is connected. The available call information includes the following:

- The Dialed Number Identification Service (DNIS) number, also referred to as the called number
- The Calling Line Identification (CLID) number, also referred to as the calling number
- The call type, also referred to as the bearer capability

This feature allows a Cisco NAS to decide—on the basis of the DNIS number, the CLID number, or the call type—whether to connect an incoming call. (With CAS, the call must be answered; however, the call can be dropped if preauthentication fails.)

When an incoming call arrives from the public network switch, but before it is connected, AAA preauthentication enables the NAS to send the DNIS number, CLID number, and call type to a RADIUS server for authorization. If the server authorizes the call, then the NAS accepts the call. If the server does not authorize the call, then the NAS sends a disconnect message to the public network switch to reject the call.

In the event that the RADIUS server application becomes unavailable or is slow to respond, a guard timer can be set in the NAS. When the timer expires, the NAS uses a configurable parameter to accept or reject the incoming call that has no authorization.

This feature supports the use of attribute 44 by the RADIUS server application and the use of RADIUS attributes that are configured in the RADIUS preauthentication profiles to specify preauthentication behavior. They may also be used, for instance, to specify whether subsequent authentication should occur and, if so, what authentication method should be used.

The following restrictions apply to AAA preauthentication with CAS:

- Attribute 44 is available for CAS calls only when preauthentication or resource pooling is enabled.

**Note** Prior to configuring AAA preauthentication, you must enable the **aaa new-model** command and make sure the supporting preauthentication application is running on a RADIUS server in your network.

To configure AAA preauthentication, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# aaa preauth` | Enters AAA preauthentication configuration mode. |
| **Step 2** | `Router(config-preauth)# group server-group` | Specifies the AAA RADIUS server group to use for preauthentication. |
| **Step 3** | `Router(config-preauth)# clid [if-avail \| required] [accept-stop] [password string]` | Preauthenticates calls on the basis of the CLID number. |
| **Step 4** | `Router(config-preauth)# ctype [if-avail \| required] [accept-stop] [password string]` | Preauthenticates calls on the basis of the call type. |
| **Step 5** | `Router(config-preauth)# dnis [if-avail \| required] [accept-stop] [password string]` | Preauthenticates calls on the basis of the DNIS number. |
| **Step 6** | `Router(config-preauth)# dnis bypass {dnis-group-name}` | Specifies a group of DNIS numbers that will be bypassed for preauthentication. |

To configure DNIS preauthentication, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# aaa preauth` | Enters AAA preauthentication mode. |
| **Step 2** | `Router(config-preauth)# group {radius \| tacacs+ \| server-group}` | (Optional) Selects the security server to use for AAA preauthentication requests. The default is RADIUS. |
| **Step 3** | `Router(config-preauth)# dnis [password string]` | Enables preauthentication using DNIS and optionally specifies a password to use in Access-Request packets. |

In addition to configuring preauthentication on your Cisco router, you must set up the preauthentication profiles on the RADIUS server. For information on setting up the preauthentication profiles, see the following sections:

- Setting Up the RADIUS Profile for DNIS or CLID Preauthentication
- Setting Up the RADIUS Profile for Call Type Preauthentication
- Setting Up the RADIUS Profile for Preauthentication Enhancements for Callback
- Setting Up the RADIUS Profile for a Remote Host Name Used for Large-Scale Dial-Out
- Setting Up the RADIUS Profile for Modem Management
- Setting Up the RADIUS Profile for Subsequent Authentication

- Setting Up the RADIUS Profile for Subsequent Authentication Type
- Setting Up the RADIUS Profile to Include the Username
- Setting Up the RADIUS Profile for Two-Way Authentication
- Setting Up the RADIUS Profile to Support Authorization

## Setting Up the RADIUS Profile for DNIS or CLID Preauthentication

To set up the RADIUS preauthentication profile, use the DNIS or CLID number as the username, and use the password defined in the **dnis** or **clid** command as the password.

**Note** The preauthentication profile must have "outbound" as the service type because the password is predefined on the NAS. Setting up the preauthentication profile in this manner prevents users from trying to log in to the NAS with the username of the DNIS number, CLID number, or call type and an obvious password. The "outbound" service type is also included in the access-request packet sent to the RADIUS server.

## Setting Up the RADIUS Profile for Call Type Preauthentication

To set up the RADIUS preauthentication profile, use the call type string as the username, and use the password defined in the **ctype** command as the password. The following table shows the call type strings that may be used in the preauthentication profile:

| Call Type String | ISDN Bearer Capabilities |
|---|---|
| digital | Unrestricted digital, restricted digital. |
| speech | Speech, 3.1 kHz audio, 7 kHz audio.<br>**Note** This is the only call type available for CAS. |
| v.110 | Anything with V.110 user information layer. |
| v.120 | Anything with V.120 user information layer. |

**Note** The preauthentication profile must have "outbound" as the service type because the password is predefined on the NAS. Setting up the preauthentication profile in this manner prevents users from trying to log in to the NAS with the username of the DNIS number, CLID number, or call type and an obvious password. The "outbound" service type is also included in the access-request packet sent to the RADIUS server and should be a check-in item if the RADIUS server supports check-in items.

## Setting Up the RADIUS Profile for Preauthentication Enhancements for Callback

Callback allows remote network users such as telecommuters to dial in to the NAS without being charged. When callback is required, the NAS hangs up the current call and dials the caller back. When the NAS performs the callback, only information for the outgoing connection is applied. The rest of the attributes from the preauthentication access-accept message are discarded.

**Note** The destination IP address is not required to be returned from the RADIUS server.

The following example shows a RADIUS profile configuration with a callback number of 555-1111 and the service type set to outbound. The cisco-avpair = “preauth:send-name=<string>” uses the string “user” and the cisco-avpair = “preauth:send-secret=<string>” uses the password “cisco.”

```
5551111 password = “cisco”, Service-Type = Outbound
    Service-Type = Callback-Framed
    Framed-Protocol = PPP,
    Dialback-No = “5551212”
    Class = “ISP12”
    cisco-avpair = “preauth:send-name=user”
    cisco-avpair = “preauth:send-secret=cisco”
```

## Setting Up the RADIUS Profile for a Remote Host Name Used for Large-Scale Dial-Out

The following example adds to the previous example by protecting against accidentally calling a valid telephone number but accessing the wrong router by providing the name of the remote, for use in large-scale dial-out:

```
5551111 password = "cisco", Service-Type = Outbound
       Service-Type = Callback-Framed
       Framed-Protocol = PPP,
       Dialback-No = "5551212"
       Class = "ISP12"
       cisco-avpair = "preauth:send-name=user"
       cisco-avpair = "preauth:send-secret=cisco"
       cisco-avpair = "preauth:remote-name=Router2"
```

## Setting Up the RADIUS Profile for Modem Management

When DNIS, CLID, or call type preauthentication is used, the affirmative response from the RADIUS server may include a modem string for modem management in the NAS through vendor-specific attribute (VSA) 26. The modem management VSA has the following syntax:

```
cisco-avpair = “preauth:modem-service=modem min-speed <x> max-speed <y>
modulation <z> error-correction <a> compression <b>”
```

The modem management string within the VSA may contain the following:

| Command | Argument |
|---|---|
| min-speed | <300 to 56000>, any |
| max-speed | <300 to 56000>, any |
| modulation | K56Flex, v22bis, v32bis, v34, v90, any |
| error-correction | lapm, mnp4 |
| compression | mnp5, v42bis |

When the modem management string is received from the RADIUS server in the form of a VSA, the information is passed to the Cisco IOS XE software and applied on a per-call basis. Modem ISDN channel aggregation (MICA) modems provide a control channel through which messages can be sent during the call setup time. Hence, this modem management feature is supported only with MICA modems and newer technologies. This feature is not supported with Microcom modems.

## Setting Up the RADIUS Profile for Subsequent Authentication

If preauthentication passes, you may use vendor-proprietary RADIUS attribute 201 (Require-Auth) in the preauthentication profile to determine whether subsequent authentication is to be performed. If attribute 201, returned in the access-accept message, has a value of 0, then subsequent authentication will not be performed. If attribute 201 has a value of 1, then subsequent authentication will be performed as usual.

Attribute 201 has the following syntax:

```
cisco-avpair = "preauth:auth-required=<n>"
```

where <*n*> has the same value range as attribute 201 (that is, 0 or 1).

If attribute 201 is missing in the preauthentication profile, then a value of 1 is assumed, and subsequent authentication is performed.

**Note** To perform subsequent authentication, you must set up a regular user profile in addition to a preauthentication profile.

## Setting Up the RADIUS Profile for Subsequent Authentication Type

If you have specified subsequent authentication in the preauthentication profile, you must also specify the authentication types to be used for subsequent authentication. To specify the authentication types allowed in subsequent authentication, use the following VSA:

```
cisco-avpair = "preauth:auth-type=<string>"
```

where <*string*> can be one of the following:

| String | Description |
|---|---|
| chap | Requires username and password of CHAP for PPP authentication. |
| ms-chap | Requires username and password of MS-CHAP for PPP authentication. |
| pap | Requires username and password of PAP for PPP authentication. |

To specify that multiple authentication types are allowed, you can configure more than one instance of this VSA in the preauthentication profile. The sequence of the authentication type VSAs in the preauthentication profile is significant because it specifies the order of authentication types to be used in the PPP negotiation.

This VSA is a per-user attribute and replaces the authentication type list in the **ppp authentication** interface command.

**Note** You should use this VSA only if subsequent authentication is required because it specifies the authentication type for subsequent authentication.

## Setting Up the RADIUS Profile to Include the Username

If only preauthentication is used to authenticate a call, the NAS could be missing a username when it brings up the call. RADIUS may provide a username for the NAS to use through RADIUS attribute 1 (User-Name) or through a VSA returned in the access-accept packet. The VSA for specifying the username has the following syntax:

```
cisco-avpair = "preauth:username=<string>"
```

If no username is specified, the DNIS number, CLID number, or call type is used, depending on the last preauthentication command that has been configured (for example, if **clid** was the last preauthentication command configured, the CLID number will be used as the username).

If subsequent authentication is used to authenticate a call, there might be two usernames: one provided by RADIUS and one provided by the user. In this case, the username provided by the user overrides the one contained in the RADIUS preauthentication profile; the username provided by the user is used for both authentication and accounting.

## Setting Up the RADIUS Profile for Two-Way Authentication

In the case of two-way authentication, the calling networking device will need to authenticate the NAS. The Password Authentication Protocol (PAP) username and password or Challenge Handshake Authentication Protocol (CHAP) username and password need not be configured locally on the NAS. Instead, username and password can be included in the access-accept messages for preauthentication.

**Note** The **ppp authentication** command must be configured with the **radius** method.

To apply for PAP, do not configure the **ppp pap sent-name password** command on the interface. The vendor-specific attributes (VSAs) “preauth:send-name” and “preauth:send-secret” will be used as the PAP username and PAP password for outbound authentication.

For CHAP, “preauth:send-name” will be used not only for outbound authentication, but also for inbound authentication. For a CHAP inbound case, the NAS will use the name defined in “preauth:send-name” in the challenge packet to the caller networking device. For a CHAP outbound case, both “preauth:send-name” and “preauth:send-secret” will be used in the response packet.

The following example shows a configuration that specifies two-way authentication:

```
5551111 password = "cisco", Service-Type = Outbound
    Service-Type = Framed-User
    cisco-avpair = "preauth:auth-required=1"
    cisco-avpair = "preauth:auth-type=pap"
    cisco-avpair = "preauth:send-name=andy"
    cisco-avpair = "preauth:send-secret=cisco"
    class = "<some class>"
```

**Note** Two-way authentication does not work when resource pooling is enabled.

### Setting Up the RADIUS Profile to Support Authorization

If only preauthentication is configured, then subsequent authentication will be bypassed. Note that because the username and password are not available, authorization will also be bypassed. However, you may include authorization attributes in the preauthentication profile to apply per-user attributes and avoid having to return subsequently to RADIUS for authorization. To initiate the authorization process, you must also configure the **aaa authorization network** command on the NAS.

You may configure authorization attributes in the preauthentication profile with one exception: the service-type attribute (attribute 6). The service-type attribute must be converted to a VSA in the preauthentication profile. This VSA has the following syntax:

```
cisco-avpair = "preauth:service-type=<n>"
```

where <*n*> is one of the standard RFC 2138 values for attribute 6. For a list of possible Service-Type values, refer to the appendix RADIUS Attributes.

**Note** If subsequent authentication is required, the authorization attributes in the preauthentication profile will not be applied.

## Configuring a Guard Timer

Because response times for preauthentication and authentication requests can vary, the guard timer allows you to control the handling of calls. The guard timer starts when the DNIS is sent to the RADIUS server. If the NAS does not receive a response from AAA before the guard timer expires, it accepts or rejects the calls on the basis of the configuration of the timer.

To set a guard timer to accept or reject a call in the event that the RADIUS server fails to respond to an authentication or preauthentication request, use one of the following commands in interface configuration mode:

| Command | Purpose |
|---|---|
| `Router(config-if)# isdn guard-timer` *milliseconds* `[on-expiry {accept \| reject}]` | Sets an ISDN guard timer to accept or reject a call in the event that the RADIUS server fails to respond to a preauthentication request. |
| `Router(control-config)# call guard-timer` *milliseconds* `[on-expiry {accept \| reject}]` | Sets a CAS guard timer to accept or reject a call in the event that the RADIUS server fails to respond to a preauthentication request. |

## Specifying RADIUS Authentication

After you have identified the RADIUS server and defined the RADIUS authentication key, you must define method lists for RADIUS authentication. Because RADIUS authentication is facilitated through AAA, you must enter the **aaa authentication** command, specifying RADIUS as the authentication method. For more information, refer to the chapter "Configuring Authentication."

# Specifying RADIUS Authorization

AAA authorization lets you set parameters that restrict a user's access to the network. Authorization using RADIUS provides one method for remote access control, including one-time authorization or authorization for each service, per-user account list and profile, user group support, and support of IP, IPX, ARA, and Telnet. Because RADIUS authorization is facilitated through AAA, you must issue the **aaa authorization** command, specifying RADIUS as the authorization method. For more information, refer to the chapter "Configuring Authorization."

# Specifying RADIUS Accounting

The AAA accounting feature enables you to track the services users are accessing as well as the amount of network resources they are consuming. Because RADIUS accounting is facilitated through AAA, you must issue the **aaa accounting** command, specifying RADIUS as the accounting method. For more information, refer to the chapter "Configuring Accounting."

# Configuring RADIUS Login-IP-Host

To enable the network access server to attempt more than one login host when trying to connect a dial in user, you can enter as many as three Login-IP-Host entries in the user's profile on the RADIUS server. The following example shows that three Login-IP-Host instances have been configured for the user *joeuser,* and that TCP-Clear will be used for the connection:

```
joeuser       Password = xyz
        Service-Type = Login,
        Login-Service = TCP-Clear,
        Login-IP-Host = 10.0.0.0,
        Login-IP-Host = 10.2.2.2,
        Login-IP-Host = 10.255.255.255,
        Login-TCP-Port = 23
```

The order in which the hosts are entered is the order in which they are attempted. Use the **ip tcp synwait-time** command to set the number of seconds that the network access server waits before trying to connect to the next host on the list; the default is 30 seconds.

Your RADIUS server might permit more than three Login-IP-Host entries; however, the network access server supports only three hosts in access-accept packets.

# Configuring RADIUS Prompt

To control whether user responses to access-challenge packets are echoed to the screen, you can configure the Prompt attribute in the user profile on the RADIUS server. This attribute is included only in access-challenge packets. The following example shows the Prompt attribute set to No-Echo, which prevents the user's responses from echoing:

```
joeuser Password = xyz
Service-Type = Login,
Login-Service = Telnet,
Prompt = No-Echo,
Login-IP-Host = 172.31.255.255
```

To allow user responses to echo, set the attribute to Echo. If the Prompt attribute is not included in the user profile, responses are echoed by default.

This attribute overrides the behavior of the **radius-server challenge-noecho** command configured on the access server. For example, if the access server is configured to suppress echoing, but the individual user profile allows echoing, then the user responses are echoed.

**Note** To use the Prompt attribute, your RADIUS server must be configured to support access-challenge packets.

## Configuring Suffix and Password in RADIUS Access Requests

Large-scale dial-out eliminates the need to configure dialer maps on every NAS for every destination. Instead, you can create remote site profiles that contain outgoing call attributes on the AAA server. The profile is downloaded by the NAS when packet traffic requires a call to be placed to a remote site.

You can configure the username in the access-request message to RADIUS. The default suffix of the username, "-out," is appended to the username. The format for composing the username attribute is IP address plus configured suffix.

To provide username configuration capability for large-scale dial-out, the **dialer aaa** command is implemented with the new **suffix** and **password** keywords.

| | Command | Purpose |
|---|---|---|
| **Step 1** | `Router(config)# aaa new-model` | Enables the AAA access control model. |
| **Step 2** | `Router(config)# aaa route download` *min* | Enables the download static route feature and sets the amount of time between downloads. |
| **Step 3** | `Router(config)# aaa authorization configuration default` | Downloads static route configuration information from the AAA server using TACACS+ or RADIUS. |
| **Step 4** | `Router(config)# interface dialer` *1* | Defines a dialer rotary group. |
| **Step 5** | `Router(config-if)# dialer aaa` | Allows a dialer to access the AAA server for dialing information. |
| **Step 6** | `Router(config-if)# dialer aaa suffix` *suffix* `password` *password* | Allows a dialer to access the AAA server for dialing information and specifies a suffix and nondefault password for authentication. |

# Monitoring and Maintaining RADIUS

To monitor and maintain RADIUS, use the following commands in privileged EXEC mode:

| Command | Purpose |
|---|---|
| `Router# debug radius` | Displays information associated with RADIUS. |
| `Router# show radius statistics` | Displays the RADIUS statistics for accounting and authentication packets. |

# RADIUS Configuration Examples

The following sections provide RADIUS configuration examples:



## RADIUS Authentication and Authorization Example

The following example shows how to configure the router to authenticate and authorize using RADIUS:

```
aaa authentication login use-radius group radius local
aaa authentication ppp user-radius if-needed group radius
aaa authorization exec default group radius
aaa authorization network default group radius
```

The lines in this sample RADIUS authentication and authorization configuration are defined as follows:

- The **aaa authentication login use-radius group radius local** command configures the router to use RADIUS for authentication at the login prompt. If RADIUS returns an error, the user is authenticated using the local database. In this example, **use-radius** is the name of the method list, which specifies RADIUS and then local authentication.
- The **aaa authentication ppp user-radius if-needed group radius** command configures the Cisco IOS XE software to use RADIUS authentication for lines using PPP with CHAP or PAP if the user has not already been authorized. If the EXEC facility has authenticated the user, RADIUS authentication is not performed. In this example, **user-radius** is the name of the method list defining RADIUS as the if-needed authentication method.
- The **aaa authorization exec default group radius** command sets the RADIUS information that is used for EXEC authorization, autocommands, and access lists.
- The **aaa authorization network default group radius** command sets RADIUS for network authorization, address assignment, and access lists.

# RADIUS Authentication, Authorization, and Accounting Example

The following example shows a general configuration using RADIUS with the AAA command set:

```
radius-server host 10.45.1.2
radius-server key myRaDiUSpassWoRd
username root password ALongPassword
aaa authentication ppp dialins group radius local
aaa authorization network default group radius local
aaa accounting network default start-stop group radius
aaa authentication login admins local
aaa authorization exec default local
line 1 16
 autoselect ppp
 autoselect during-login
 login authentication admins
 modem ri-is-cd
interface group-async 1
 encaps ppp
 ppp authentication pap dialins
```

The lines in this example RADIUS authentication, authorization, and accounting configuration are defined as follows:

- The **radius-server host** command defines the IP address of the RADIUS server host.
- The **radius-server key** command defines the shared secret text string between the network access server and the RADIUS server host.
- The **aaa authentication ppp dialins group radius local** command defines the authentication method list “dialins,” which specifies that RADIUS authentication and then (if the RADIUS server does not respond) local authentication will be used on serial lines using PPP.
- The **ppp authentication pap dialins** command applies the “dialins” method list to the lines specified.
- The **aaa authorization network default group radius local** command is used to assign an address and other network parameters to the RADIUS user.
- The **aaa accounting network default start-stop group radius** command tracks PPP usage.
- The **aaa authentication login admins local** command defines another method list, “admins,” for login authentication.
- The **login authentication admins** command applies the “admins” method list for login authentication.

# Vendor-Proprietary RADIUS Configuration Example

The following example shows a general configuration using vendor-proprietary RADIUS with the AAA command set:

```
radius-server host alcatraz non-standard
radius-server key myRaDiUSpassWoRd
radius-server configure-nas
username root password ALongPassword
aaa authentication ppp dialins group radius local
aaa authorization network default group radius local
aaa accounting network default start-stop group radius
aaa authentication login admins local
aaa authorization exec default local
line 1 16
```

```
autoselect ppp
autoselect during-login
login authentication admins
modem ri-is-cd
interface group-async 1
encaps ppp
ppp authentication pap dialins
```

The lines in this example RADIUS authentication, authorization, and accounting configuration are defined as follows:

- The **radius-server host non-standard** command defines the name of the RADIUS server host and identifies that this RADIUS host uses a vendor-proprietary version of RADIUS.
- The **radius-server key** command defines the shared secret text string between the network access server and the RADIUS server host.
- The **radius-server configure-nas** command defines that the Cisco router or access server will query the RADIUS server for static routes and IP pool definitions when the device first starts up.
- The **aaa authentication ppp dialins group radius local** command defines the authentication method list "dialins," which specifies that RADIUS authentication, and then (if the RADIUS server does not respond) local authentication will be used on serial lines using PPP.
- The **ppp authentication pap dialins** command applies the "dialins" method list to the lines specified.
- The **aaa authorization network default group radius local** command is used to assign an address and other network parameters to the RADIUS user.
- The **aaa accounting network default start-stop group radius** command tracks PPP usage.
- The **aaa authentication login admins local** command defines another method list, "admins," for login authentication.
- The **login authentication admins** command applies the "admins" method list for login authentication.

# RADIUS Server with Server-Specific Values Example

The following example shows how to configure server-specific timeout, retransmit, and key values for the RADIUS server with IP address 172.31.39.46:

```
radius-server host 172.31.39.46 timeout 6 retransmit 5 key rad123
```

# Multiple RADIUS Servers with Global and Server-Specific Values Example

The following example shows how to configure two RADIUS servers with specific timeout, retransmit, and key values. In this example, the **aaa new-model** command enables AAA services on the router, while specific AAA commands define the AAA services. The **radius-server retransmit** command changes the global retransmission value to 4 for all RADIUS servers. The **radius-server host** command configures specific timeout, retransmission, and key values for the RADIUS server hosts with IP addresses 172.16.1.1 and 172.29.39.46.

```
! Enable AAA services on the router and define those services.
aaa new-model
aaa authentication login default group radius
aaa authentication login console-login none
aaa authentication ppp default group radius
```

```
aaa authorization network default group radius
aaa accounting exec default start-stop group radius
aaa accounting network default start-stop group radius
enable password tryit1
!
! Change the global retransmission value for all RADIUS servers.
radius-server retransmit 4
!
! Configure per-server specific timeout, retransmission, and key values.
! Change the default auth-port and acct-port values.
radius-server host 172.16.1.1 auth-port 1612 acct-port 1616 timeout 3 retransmit 3 key
radkey
!
! Configure per-server specific timeout and key values. This server uses the global
! retransmission value.
radius-server host 172.29.39.46 timeout 6 key rad123
```

# Multiple RADIUS Server Entries for the Same Server IP Address Example

The following example shows how to configure the network access server to recognize several RADIUS host entries with the same IP address. Two different host entries on the same RADIUS server are configured for the same services—authentication and accounting. The second host entry configured acts as fail-over backup to the first one. (The RADIUS host entries will be tried in the order they are configured.)

```
! This command enables AAA.
aaa new-model
! The next command configures default RADIUS parameters.
aaa authentication ppp default group radius
! The next set of commands configures multiple host entries for the same IP address.
radius-server host 172.20.0.1 auth-port 1000 acct-port 1001
radius-server host 172.20.0.1 auth-port 2000 acct-port 2000
```

# RADIUS Server Group Examples

The following example shows how to create server group *radgroup1* with three different RADIUS server members, each using the default authentication port (1645) and accounting port (1646):

```
aaa group server radius radgroup1
 server 172.16.1.11
 server 172.17.1.21
 server 172.18.1.31
```

The following example shows how to create server group *radgroup2* with three RADIUS server members, each with the same IP address but with unique authentication and accounting ports:

```
aaa group server radius radgroup2
 server 172.16.1.1 auth-port 1000 acct-port 1001
 server 172.16.1.1 auth-port 2000 acct-port 2001
 server 172.16.1.1 auth-port 3000 acct-port 3001
```

# Multiple RADIUS Server Entries Using AAA Server Groups Example

The following example shows how to configure the network access server to recognize two different RADIUS server groups. One of these groups, group1, has two different host entries on the same RADIUS server configured for the same services. The second host entry configured acts as failover backup to the first one. Each group is individually configured for deadtime; deadtime for group 1 is one minute, and deadtime for group 2 is two minutes.

**Note** In cases where both global commands and server commands are used, the server command will take precedence over the global command.

```
! This command enables AAA.
aaa new-model
! The next command configures default RADIUS parameters.
aaa authentication ppp default group group1
! The following commands define the group1 RADIUS server group and associate servers
! with it and configures a deadtime of one minute.
aaa group server radius group1
 server 10.1.1.1 auth-port 1645 acct-port 1646
 server 10.2.2.2 auth-port 2000 acct-port 2001
 deadtime 1
! The following commands define the group2 RADIUS server group and associate servers
! with it and configures a deadtime of two minutes.
aaa group server radius group2
 server 10.2.2.2 auth-port 2000 acct-port 2001
 server 10.3.3.3 auth-port 1645 acct-port 1646
 deadtime 2
! The following set of commands configures the RADIUS attributes for each host entry
! associated with one of the defined server groups.
radius-server host 10.1.1.1 auth-port 1645 acct-port 1646
radius-server host 10.2.2.2 auth-port 2000 acct-port 2001
radius-server host 10.3.3.3 auth-port 1645 acct-port 1646
```

# AAA Server Group Selection Based on DNIS Example

The following example shows how to select RADIUS server groups based on DNIS to provide specific AAA services:

```
! This command enables AAA.
aaa new-model
!
! The following set of commands configures the RADIUS attributes for each server
! that will be associated with one of the defined server groups.
radius-server host 172.16.0.1 auth-port 1645 acct-port 1646 key cisco1
radius-server host 172.17.0.1 auth-port 1645 acct-port 1646 key cisco2
radius-server host 172.18.0.1 auth-port 1645 acct-port 1646 key cisco3
radius-server host 172.19.0.1 auth-port 1645 acct-port 1646 key cisco4
radius-server host 172.20.0.1 auth-port 1645 acct-port 1646 key cisco5

! The following commands define the sg1 RADIUS server group and associate servers
! with it.
aaa group server radius sg1
  server 172.16.0.1
  server 172.17.0.1
! The following commands define the sg2 RADIUS server group and associate a server
! with it.
aaa group server radius sg2
  server 172.18.0.1
```

```
! The following commands define the sg3 RADIUS server group and associate a server
! with it.
aaa group server radius sg3
  server 172.19.0.1
! The following commands define the default-group RADIUS server group and associate
! a server with it.
aaa group server radius default-group
  server 172.20.0.1
!
! The next set of commands configures default-group RADIUS server group parameters.
aaa authentication ppp default group default-group
aaa accounting network default start-stop group default-group
!
! The next set of commands enables DNIS mapping and maps DNIS numbers to the defined
! RADIUS server groups. In this configuration, all PPP connection requests using
! DNIS 7777 are sent to the sg1 server group. The accounting records for these
! connections (specifically, start-stop records) are handled by the sg2 server group.
! Calls with a DNIS of 8888 use server group sg3 for authentication and server group
! default-group for accounting. Calls with a DNIS of 9999 use server group
! default-group for authentication and server group sg3 for accounting records
! (stop records only). All other calls with DNIS other than the ones defined use the
! server group default-group for both authentication and stop-start accounting records.
aaa dnis map enable
aaa dnis map 7777 authentication ppp group sg1
aaa dnis map 7777 accounting network start-stop group sg2
aaa dnis map 8888 authentication ppp group sg3
aaa dnis map 9999 accounting network stop-only group sg3
```

# AAA Preauthentication Examples

The following example shows a simple configuration that specifies that the DNIS number be used for preauthentication:

```
aaa preauth
 group radius
 dnis required
```

The following example shows a configuration that specifies that both the DNIS number and the CLID number be used for preauthentication. DNIS preauthentication will be performed first, followed by CLID preauthentication.

```
aaa preauth
 group radius
 dnis required
 clid required
```

The following example specifies that preauthentication be performed on all DNIS numbers except the two DNIS numbers specified in the DNIS group called “hawaii”:

```
aaa preauth
 group radius
 dnis required
 dnis bypass hawaii

dialer dnis group hawaii
 number 12345
 number 12346
```

The following example shows a sample AAA configuration with DNIS preauthentication:

```
aaa new-model
aaa authentication login CONSOLE none
```

```
aaa authentication login RADIUS_LIST group radius
aaa authentication login TAC_PLUS group tacacs+ enable
aaa authentication login V.120 none
aaa authentication enable default enable group tacacs+
aaa authentication ppp RADIUS_LIST if-needed group radius
aaa authorization exec RADIUS_LIST group radius if-authenticated
aaa authorization exec V.120 none
aaa authorization network default group radius if-authenticated
aaa authorization network RADIUS_LIST if-authenticated group radius
aaa authorization network V.120 group radius if-authenticated
aaa accounting suppress null-username
aaa accounting exec default start-stop group radius
aaa accounting commands 0 default start-stop group radius
aaa accounting network default start-stop group radius
aaa accounting connection default start-stop group radius
aaa accounting system default start-stop group radius
aaa preauth
 dnis password Cisco-DNIS
aaa nas port extended
!
radius-server configure-nas
radius-server host 10.0.0.0 auth-port 1645 acct-port 1646 non-standard
radius-server host 10.255.255.255 auth-port 1645 acct-port 1646 non-standard
radius-server retransmit 2
radius-server deadtime 1
radius-server attribute nas-port format c
radius-server unique-ident 18
radius-server key MyKey
```

**Note** To configure preauthentication, you must also set up preauthentication profiles on the RADIUS server.

# RADIUS User Profile with RADIUS Tunneling Attributes Example

The following example shows a RADIUS user profile (Merit Daemon format) that includes RADIUS tunneling attributes.

```
cisco-avpair = vpdn:l2tp-cm-local-window-size=1024
cisco-avpair = vpdn:l2tp-nosession-timeout=30
cisco-avpair = vpdn:l2tp-cm-retransmit-retries=10
cisco-avpair = vpdn:l2tp-cm-min-timeout=2
cisco-avpair = vpdn:l2tp-hello-interval=60
Service-Type = outbound
Tunnel-Assignment-Id_tag1 = ISP1
Tunnel-Client-Auth-Id_tag1 = LAC1
Tunnel-Client-Endpoint_tag1 = 10.0.0.2
Tunnel-Medium-Type_tag1 = IPv4
Tunnel-Password_tag1 = tunnel1
Tunnel-Server-Auth-Id_tag1 = LNS1
Tunnel-Server-Endpoint_tag1 = 10.0.0.1
Tunnel-Type_tag1 = l2tp
```

# Guard Timer Examples

The following example shows an ISDN guard timer that is set at 8000 milliseconds. A call will be rejected if the RADIUS server has not responded to a preauthentication request when the timer expires.

```
interface serial1/0/0:23
```

```
 isdn guard-timer 8000 on-expiry reject

aaa preauth
 group radius
 dnis required
```

The following example shows a CAS guard timer that is set at 20,000 milliseconds. A call will be accepted if the RADIUS server has not responded to a preauthentication request when the timer expires.

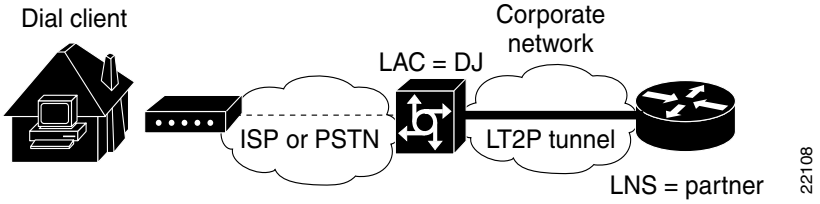
```
controller T1 0
 framing esf
 clock source line primary
 linecode b8zs
 ds0-group 0 timeslots 1-24 type e&m-fgb dtmf dnis
 cas-custom 0
 call guard-timer 20000 on-expiry accept

aaa preauth
group radius
dnis required
```

# L2TP Access Concentrator Examples

The following example shows a basic L2TP configuration for the L2TP access concentrator (LAC) for the topology shown in Figure 1. The local name is not defined, so the host name used is the local name. Because the L2TP tunnel password is not defined, the username password is used. In this example, VPDN is configured locally on the LAC and does not take advantage of the new RADIUS tunnel attributes.

***Figure 1 Topology for Configuration Examples***




```
! Enable AAA globally.
aaa new-model
! Enable AAA authentication for PPP and list the default method to use for PPP
! authentication.
aaa authentication ppp default local
! Define the username as "DJ."
username DJ password 7 030C5E070A00781B
! Enable VPDN.
vpdn enable
! Define VPDN group number 1.
vpdn-group 1
! Allow the LAC to respond to dialin requests using L2TP from IP address 172.21.9.13
! domain "cisco.com."
 request dialin
  protocol l2tp
  domain cisco.com
 initiate-ip to 172.21.9.13
 local name nas-1
```

The following example shows how to configure the LAC if RADIUS tunnel attributes are supported. In this example, there is no local VPDN configuration on the LAC; the LAC, instead, is configured to query the remote RADIUS security server.

```
! Enable global AAA securities services.
aaa new-model
! Enable AAA authentication for PPP and list RADIUS as the default method to use
! for PPP authentication.
aaa authentication ppp default group radius local
! Enable AAA (network) authorization and list RADIUS as the default method to use for
! authorization.
aaa authorization network default group radius
! Define the username as "DJ."
username DJ password 7 030C5E070A00781B
! Enable VPDN.
vpdn enable
! Configure the LAC to interface with the remote RADIUS security server.
radius host 171.19.1.1 auth-port 1645 acct-port 1646
radius-server key cisco
```

# L2TP Network Server Examples

The following example shows a basic L2TP configuration with corresponding comments on the L2TP network server (LNS) for the topology shown in Figure 1:

```
! Enable AAA globally.
aaa new-model
! Enable AAA authentication for PPP and list the default method to use for PPP
! authentication.
aaa authentication ppp default local
! Define the username as "partner."
username partner password 7 030C5E070A00781B
! Create virtual-template 1 and assign all values for virtual access interfaces.
interface Virtual-Template1
! Borrow the IP address from loopback interface.
 ip unnumbered loopback0
! Disable multicast fast switching.
 no ip mroute-cache
! Use CHAP to authenticate PPP.
 ppp authentication chap
! Enable VPDN.
vpdn enable
! Create vpdn-group number 1.
vpdn-group 1
! Accept all dialin l2tp tunnels from virtual-template 1 from remote peer DJ.
 accept dialin l2tp virtual-template 1 remote DJ
  protocol any
   virtual-template 1
  terminate-from hostname nas1
local name hgw1
```

The following example shows how to configure the LNS with a basic L2TP configuration using RADIUS tunneling attributes:

```
aaa new-model
aaa authentication login default none
aaa authentication login console none
aaa authentication ppp default local group radius
aaa authorization network default group radius if-authenticated
!
username l2tp-svr-auth-id password 0 l2tp-tnl-pass
!
```

```
vpdn enable
vpdn search-order domain
!
vpdn-group 1
accept-dialin
protocol l2tp
virtual-template 1
terminate-from hostname l2tp-cli-auth-id
local name l2tp-svr-auth-id
!
interface GigabitEthernet1/0/0
ip address 10.0.0.3 255.255.255.0
no ip route-cache
no ip mroute-cache
!
interface Virtual-Template1
ip unnumbered loopback0
ppp authentication pap
!
radius-server host 10.1.1.1 auth-port 1645 acct-port 1646
radius-server key <deleted>
```

# Additional References

## Related Documents

| Related Topic | Document Title |
|---|---|
| RADIUS commands | *Cisco IOS Security Command Reference* |
| Other configuration commands | *Cisco IOS Master Command List, All Releases* |
| L2TP, VPN, or VPDN | *Cisco IOS XE VPDN Configuration Guide*, Release 2 |

## Standards

| Standard | Title |
|---|---|
| None. | — |

## MIBs

| MIB | MIBs Link |
|---|---|
| None. | To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL:<br>http://www.cisco.com/go/mibs |

# RFCs

| RFC | Title |
|---|---|
| RFC 2138 | *Remote Authentication Dial-In User Service (RADIUS)* |
| RFC 2139 | *RADIUS Accounting* |
| RFC 2865 | *RADIUS* |
| RFC 2868 | *RADIUS Attributes for Tunnel Protocol Support* |

# Technical Assistance

| Description | Link |
|---|---|
| The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.<br><br>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.<br><br>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password. | http://www.cisco.com/cisco/web/support/index.html |

# Feature Information for Configuring RADIUS

Table 1 lists the features in this module and provides links to specific configuration information

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

**Note** Table 1 lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

*Table 1 Feature Information for Configuring RADIUS*

| Feature Name | Releases | Feature Information |
|---|---|---|
| AAA Server Group | Cisco IOS XE Release 2.1 | Configuring the router to use AAA server groups provides a way to group existing server hosts. This allows you to select a subset of the configured server hosts and use them for a particular service. A server group is used in conjunction with a global server-host list. The server group lists the IP addresses of the selected server hosts.<br>In Cisco IOS XE Release 2.1, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.<br>The following sections provide information about this feature:<br>• Configuring AAA Server Groups, page 11<br>• RADIUS Server Group Examples, page 26<br>The following commands were introduced or modified: **aaa group server radius**, **aaa group server tacacs+**, and **server (RADIUS)**. |
| AAA Server Group Enhancements | Cisco IOS XE Release 2.1 | AAA Server Group Enhancements enables the full configuration of a server in a server group.<br>In Cisco IOS XE Release 2.1, this feature is supported on the Cisco ASR 1000 Series Aggregation Services Routers. |
| RADIUS | Cisco IOS XE Release 2.1 | RADIUS is a distributed client/server system that secures networks against unauthorized access. In the Cisco implementation, RADIUS clients run on Cisco routers and send authentication requests to a central RADIUS server that contains all user authentication and network service access information.<br>In Cisco IOS XE Release 2.1, this feature is introduced on the Cisco ASR 1000 Series Aggregation Services Routers. |

*Table 1 Feature Information for Configuring RADIUS (continued)*

| Feature Name | Releases | Feature Information |
|---|---|---|
| AAA Server Group Deadtimer | Cisco IOS XE Release 2.1 | Configuring deadtime within a server group allows you to direct AAA traffic to separate groups of servers that have different operational characteristics. A separate timer has been attached to each server host in every server group. Therefore, when a server is found to be unresponsive after numerous retransmissions and timeouts, the server is assumed to be dead. The timers attached to each server host in all server groups are triggered. In essence, the timers are checked and subsequent requests to a server (once it is assumed to be dead) are directed to alternate timers, if configured. When the network access server receives a reply from the server, it checks and stops all configured timers (if running) for that server in all server groups.<br><br>In Cisco IOS XE Release 2.1, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.<br><br>The following sections provide information about this feature:<br><br>• Configuring AAA Server Groups with Deadtime, page 11<br><br>The following command was introduced or modified:<br><br>**deadtime**. |

*Table 1 Feature Information for Configuring RADIUS (continued)*

| Feature Name | Releases | Feature Information |
|---|---|---|
| AAA DNIS Map for Authorization | Cisco IOS XE Release 2.3 | Cisco IOS XE software allows you to assign a Dialed Number Identification Service (DNIS) number to a particular AAA server group so that the server group can process authentication, authorization, and accounting requests for users dialing in to the network using that particular DNIS. Any phone line (a regular home phone or a commercial T1/PRI line) can be associated with several phone numbers. The DNIS number identifies the number that was called to reach you.<br><br>In Cisco IOS XE Release 2.3, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.<br><br>The following sections provide information about this feature:<br><br>• Configuring AAA DNIS Authentication, page 12<br>• Setting Up the RADIUS Profile for DNIS or CLID Preauthentication, page 16<br>• AAA Server Group Selection Based on DNIS Example, page 27<br><br>The following commands were introduced or modified: **aaa dnis enable**, **aaa dnis map authentication group**, **aaa dnis map authorization network group**, and **aaa dnis map accounting network**. |
| RADIUS for Multiple User Datagram Protocol Ports | Cisco IOS XE Release 2.4 | RADIUS security servers are identified on the basis of 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, allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. In other words, this unique identifier enables RADIUS requests to be sent to multiple UDP ports on a server at the same IP address.<br><br>In Cisco IOS XE Release 2.4, this feature was introduced on the Cisco ASR 1000 Series Aggregation Services Routers.<br><br>The following sections provide information about this feature:<br><br>• Configuring Router to RADIUS Server Communication, page 5<br>• Multiple RADIUS Server Entries Using AAA Server Groups Example, page 27<br><br>The following command was introduced or modified:<br><br>**radius-server host**. |