Cisco Access Registrar User Guide, 4.1

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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Cisco Access Registrar User Guide, 4.1

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About This Guide

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The Cisco Access Registrar User's Guide provides information about how to use Cisco AR 4.1. This preface contains the following sections:

How This Book Is Organized

The Cisco AR User Guide is organized as follows:

Chapter 1, "Overview," provides an overview of Cisco AR.

Chapter 2, "Using the aregcmd Commands," provides information about using **aregcmd** commands.

Chapter 3, "Using the Graphical User Interface," provides information about using the Cisco AR GUI.

Chapter 4, "Access Registrar Server Objects," provides information about Cisco AR server objects.

Chapter 5, "Using the radclient Command," provides information about using **radclient** commands to test Cisco AR.

Chapter 6, "Configuring Local Authentication and Authorization," provides information about how to configure local authentication and authorization and helpful examples.

Chapter 7, "RADIUS Accounting," provides information about RADIUS accounting and how to configure Cisco AR 4.1 to perform accounting.

Chapter 8, "Extensible Authentication Protocols," provides information about Cisco AR 4.1 support of EAP authentication methods.

Chapter 9, "Using Extension Points," provides information about how to use Cisco AR scripting to customize your RADIUS server.

Chapter 10, "Using Replication," provides information about how to use the replication feature.

Chapter 11, "Using On-Demand Address Pools," provides information about using On-Demand Address Pools.

Chapter 12, "Using Identity Caching," provides information about using the Identity Caching feature.

Chapter 13, "Using Trusted ID Authorization with SESM," describes how to use Cisco AR with SESM, and how to configure Cisco AR to use the Trusted ID feature.

Chapter 14, "Using Prepaid Billing," provides information about how to use the Cisco AR prepaid billing feature.

Chapter 15, "Using Cisco Access Registrar Server Features," provides information about using Cisco AR features.

Chapter 16, "Directing RADIUS Requests," provides information about using the Cisco AR Policy Engine.

Chapter 17, "Wireless Support," provides information about Cisco AR support for wireless features.

Chapter 18, "Using LDAP," provides information about using an LDAP remote server with Cisco AR.

Chapter 19, "Using Open Database Connectivity," provides information about a new type of RemoteServer object and a new service to support ODBC.

Chapter 21, "Backing Up the Database," describes the Cisco AR shadow backup facility, which ensures a consistent snapshot of Cisco AR's database for backup purposes.

Chapter 22, "Using the REX Accounting Script," describes how to use the REX Accounting scripts.

Chapter 23, "Logging Syslog Messages," provides information about logging messages via syslog and centralized error reporting for Cisco AR.

Chapter 24, "Troubleshooting Cisco Access Registrar," provides information about techniques used when troubleshooting Cisco AR and highlights common problems.

Appendix A, "Cisco Access Registrar Tcl and REX Dictionaries," describes the Tcl and REX dictionaries that are used when writing Incoming or Outgoing scripts for use with Cisco AR.

Appendix B, "Environment Dictionary," describes the environment variables the scripts use to communicate with Cisco AR or to communicate with other scripts.

Appendix C, "RADIUS Attributes," lists the RFC 2865 RADIUS attributes with their names and values.

An index is also provided.

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For information on obtaining documentation, obtaining support, providing documentation feedback, security guidelines, and also recommended aliases and general Cisco documents, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

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CHAPTER 1

Overview

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The chapter provides an overview of the RADIUS server, including connection steps, RADIUS message types, and using Cisco Access Registrar as a proxy server.

Cisco AR is a RADIUS (Remote Authentication Dial-In User Service) server that enables multiple dial-in Network Access Server (NAS) devices to share a common authentication, authorization, and accounting database.

Cisco AR handles the following tasks:

- Authentication—determines the identity of users and whether they can be allowed to access the network
- Authorization—determines the level of network services available to authenticated users after they are connected
- Accounting—keeps track of each user's network activity
- Session and resource management—tracks user sessions and allocates dynamic resources

Using a RADIUS server allows you to better manage the access to your network, as it allows you to store all security information in a single, centralized database instead of distributing the information around the network in many different devices. You can make changes to that single database instead of making changes to every network access server in your network.

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Cisco AR Hierarchy

Cisco AR's operation and configuration is based on a set of *objects*. These objects are arranged in a hierarchical structure much like the Windows 95 Registry or the UNIX directory structure. Cisco AR's objects can themselves contain subobjects, just as directories can contain subdirectories. These objects include the following:

- Radius— the root of the configuration hierarchy
- UserLists—contains individual UserLists which in turn contain users
- UserGroups—contains individual UserGroups
- Clients—contains individual Clients
- Vendors—contains individual Vendors
- Scripts—contains individual Scripts

- Services—contains individual Services
- SessionManagers—contains individual Session Managers
- ResourceManagers—contains individual Resource Managers
- Profiles—contains individual Profiles
- RemoteServers—contains individual RemoteServers
- Advanced—contains Ports, Interfaces, Reply Messages, and the Attribute dictionary.

UserLists and Groups

Cisco AR lets you organize your user community through the configuration objects **UserLists**, **users**, and **UserGroups**.

- Use **UserLists** to group users by organization, such as Company A and Company B. Each list contains the actual names of the users.
- Use **users** to store information about particular users, such as name, password, group membership, base profile, and so on.
- Use **UserGroups** to group users by function, such as PPP, Telnet, or multiprotocol users. Groups allow you to maintain common authentication and authorization requirements in one place, and have them referenced by many users.

For more information about **UserLists** and **UserGroups**, refer to UserLists and Groups in Chapter 4, “Access Registrar Server Objects.”

Profiles

Cisco AR uses **Profiles** that allow you to group RADIUS attributes to be included in an Access-Accept packet. These attributes include values that are appropriate for a particular user class, such as PPP or Telnet user. The user’s base profile defines the user’s attributes, which are then added to the response as part of the authorization process.

Although you can use Group or Profile objects in a similar manner, choosing whether to use one rather than the other depends on your site. If you require some choice in determining how to authorize or authenticate a user session, then creating specific profiles, and specifying a group that uses a script to choose among the profiles is more flexible. In such a situation, you might create a default group and then write a script that selects the appropriate profile based on the specific request. The benefit to this technique is each user can have a single entry, and use the appropriate profile depending on the way they log in.

For more information about **Profiles**, refer toProfiles in Chapter 4, “Access Registrar Server Objects.”

Scripts

Cisco AR allows you to create scripts you can execute at various points within the processing hierarchy.

- Incoming scripts—enable you to read and set the attributes of the request packet, and set or change the Environment dictionary variables. You can use the environment variables to control subsequent processing, such as specifying the use of a particular authentication service.
- Outgoing scripts—enable you to modify attributes returned in the response packet.

For more information about **Scripts**, refer to Scripts in the Chapter 4, "Access Registrar Server Objects."

Services

Cisco AR uses *Services* to let you determine how authentication, authorization, and/or accounting are performed.

For example, to use Services for authentication:

- When you want the authentication to be performed by the Cisco AR RADIUS server, you can specify the **local** service. In this, case you must specify a specific **UserList**.
- When you want the authentication performed by another server, which might run an independent application on the same or different host than your RADIUS server, you can specify either a **radius**, **ldap**, or **tacacs-udp** service. In this case, you must list these servers by name.

When you have specified more than one authentication service, Cisco AR determines which one to use for a particular Access-Request by checking the following:

- When an incoming script has set the Environment dictionary variable **Authentication-Service** with the name of a Service, Cisco AR uses that service.
- Otherwise, Cisco AR uses the default authentication service. The default authentication service is a property of the **Radius** object.

Cisco AR chooses the authentication service based on the variable **Authentication-Service**, or the default. The properties of that Service, specify many of the details of that authentication service, such as, the specific user list to use or the specific application (possibly remote) to use in the authentication process.

For more information about Services, refer to Services in the Chapter 4, "Access Registrar Server Objects."

Session Management Using Resource Managers

Cisco AR lets you track user sessions, and/or allocate dynamic resources to users for the lifetime of their session. You can define one or more Session Managers, and have each one manage the sessions for a particular group or company.

Session Managers use Resource Managers, which in turn manage resources of a particular type as described below.

- IP-Dynamic—manages a pool of IP addresses and allows you to dynamically allocate IP addresses from that pool
- IP-Per-NAS-Port—allows you to associate ports to specific IP addresses, and thus ensure each NAS port always gets the same IP address
- IPX-Dynamic—manages a pool of IPX network addresses
- Group-Session-Limit—manages concurrent sessions for a group of users; that is, it keeps track of how many sessions are active and denies new sessions once the configured limit has been reached
- User-Session-Limit—manages per-user concurrent sessions; that is, it keeps track of how many sessions each user has and denies the user a new session once the configured limit has been reached
- USR-VPN—manages Virtual Private Networks (VPNs) that use USR NAS Clients.

For more information about Session Managers, refer to Session Managers in Chapter 4, "Access Registrar Server Objects."

If necessary, you can create a complex relationship between the Session Managers and the Resource Managers.

When you need to share a resource among Session Managers, you can create multiple Session Managers that refer to the same Resource Manager. For example, if one pool of IP addresses is shared by two departments, but each department has a separate policy about how many users can be logged in concurrently, you might create two Session Managers and three Resource Managers. One dynamic IP Resource Manager that is referenced by both Session Managers, and two concurrent session Resource Managers, one for each Session Manager.

In addition, Cisco AR lets you pose queries about sessions. For example, you can query Cisco AR about which session (and thus which NAS-Identifier, NAS-Port and/or User-Name) owns a particular resource, as well as query Cisco AR about how many resources are allocated or how many sessions are active.

Cisco AR Directory Structure

The installation process populates the **/opt/CSCOar** directory with the subdirectories listed in Table 1-1.

Table 1-1 /opt/CSCOar Subdirectories

Subdirectory	Description
.system	Contains ELFs, or binary SPARC executables that should not be run directly
bin	Contains shell scripts and programs frequently used by a network administrator; programs that can be run directly
conf	Contains configuration files
data	Contains the **radius** directory, which contains session backing files; and the **db** directory, which contains configuration database files
examples	Contains documentation, sample configuration scripts, and shared library scripts
lib	Contains Cisco AR software library files
logs	Contains system logs and is the default directory for RADIUS accounting
odbc	Contains Cisco AR ODBC files
scripts	Contains sample scripts that you can modify to automate configuration, and to customize your RADIUS server
temp	Used for temporary storage
ucd-snmp	Contains the UCD-SNMP software Cisco Access Registrar uses
usrbin	Contains a symbolic link that points to **bin**.

Program Flow

When a NAS sends a request packet to Cisco AR with a name and password, Cisco AR performs the following actions. Table 1-2 describes the flow without regard to scripting points.

Table 1-2 From Access-Request to Access-Accept

Cisco AR Server Action	Explanation
Receives an Access-Request	The Cisco AR server receives an Access-Request packet from a NAS
Determines whether to accept the request	The Cisco AR server checks to see if the client's IP address is listed in **/Radius/Clients/**<*Name*>/<*IPAddress*>
Invokes the policy SelectPolicy if it exists	The Cisco ARPolicy Engine provides an interface to define and configure a policy and to apply the policy to the corresponding access-request packets
Performs authentication and/or authorization	Directs the request to the appropriate service, which then performs authentication and/or authorization according to the type specified in **/Radius/Services/**<*Name*>/<*Type*>
Performs session management	Directs the request to the appropriate Session Manager
Performs resource management for each Resource Manager in the SessionManager	Directs the request to the appropriate resource manager listed in **/Radius/SessionManagers/**<*Name*>/<*ResourceManagers*>/<*Name*>, which then allocates or checks the resource according to the type listed in **/Radius/**<*ResourceManagers*>/<*Name*>/<*Type*>
Sends an Access-Accept	Creates and formats the response, and sends it back to the client (NAS)

Scripting Points

Cisco AR lets you invoke scripts you can use to affect the Request, Response, or Environment dictionaries.

Client or NAS Scripting Points

Table 1-3 shows the location of the scripting points within the section that determines whether to accept the request from the client or NAS. Note, the scripting points are indicated with the asterisk (*) symbol.

Table 1-3 Client or NAS Scripting Points

Action	Explanation
Receives an Access-Request.	The Cisco AR RADIUS server receives an Access-Request packet from a NAS.
Determines whether to accept the request.	The client's IP address listed in **/Radius/Clients/**<*Name*>**/IPAddress**.
***Executes the server's incoming script.	A script referred to in **/Radius/IncomingScript**.
***Executes the vendor's incoming script.	The vendor listed in /Radius/Clients/*Name*/Vendor, and is a script referred to in **/Radius/Vendors/**<*Name*>**/IncomingScript**.
***Executes the client's incoming script.	A script referred to in **/Radius/Clients/**<*Name*>**/IncomingScript**.
Determines whether to accept requests from this specific NAS.	

Table 1-3 Client or NAS Scripting Points (continued)

Action	Explanation
	/Radius/Advanced/RequireNASsBehindProxyBeInClientList set to TRUE.
	The NAS's Identifier listed in **/Radius/Clients/**<*Name*>, or its NAS-IP-Address listed in **/Radius/Clients/**<*Name*>**/IPAddress**.
If the client's IP address listed in /Radius/Clients/<*Name*>**/IPAddress is different:**	
***Executes the vendor's incoming script.	The vendor listed in **/Radius/Clients/***Name*/Vendor, and is a script referred to in **/Radius/Vendors/**<*Name*>**/IncomingScript**.
***Executes the client's incoming script.	The client listed in the previous /Radius/Clients/*Name*, and is a script referred to in /Radius/Clients/*Name*/IncomingScript.

Authentication and/or Authorization Scripting Points

Table 1-4 shows the location of the scripting points within the section that determines whether to perform authentication and/or authorization.

Table 1-4 Authentication and Authorization Scripting Points

Action	Explanation
Determines Service to use for authentication and/or authorization.	The Service name defined in the Environment dictionary variable **Authentication-Service**, and is the same as the Service defined in the Environment dictionary variable **Authorization-Service**.
	The Service name referred to by **/Radius/DefaultAuthenticationService**, and is the same as the Service defined in **/Radius/DefaultAuthorizationService**.
Performs authentication and/or authorization.	If the Services are the same, perform authentication and authorization.
	If the Services are different, just perform authentication.
***Executes the Service's incoming script.	A script referred to in **/Radius/Services/**<*Name*>**/IncomingScript**.
Performs authentication and/or authorization.	Based on the Service type defined in **/Radius/Services/**<*Name*>/<*Type*>.
***Executes the Service's outgoing script.	A script referred to in **/Radius/Services/**<*Name*>**/OutgoingScript**.
Determines whether to perform authorization.	The Service name defined in **/Radius/DefaultAuthorizationService**, if different than the Authentication Service.

Table 1-4 Authentication and Authorization Scripting Points (continued)

Action	Explanation
***Executes the Service's incoming script.	A script referred to in **/Radius/Services/**<*Name*>**/IncomingScript**.
Performs authorization.	Checks that the Service type is defined in **/Radius/Services/**<*Name*>/<*Type*>.
***Executes the Service's outgoing script.	A script referred to in **/Radius/Services/**<*Name*>**/OutgoingScript**.

Session Management

The Session Management feature requires the client (NAS or proxy) to send all RADIUS accounting requests to the Cisco AR server performing session management. (The only exception is if the clients are USR/3Com Network Access Servers configured to use the USR/3Com RADIUS resource management feature.) This information is used to keep track of user sessions, and the resources allocated to those sessions.

When another accounting RADIUS server needs this accounting information, the Cisco AR server performing session management might proxy it to this second server.

Table 1-5 describes how Cisco AR handles session management.

Table 1-5 Session Management Processing

Action	Explanation
Determines whether to perform session management.	The session management defined in the Environment dictionary variable **Session-Manager**.
	The session management name referred to in **/Radius/DefaultSessionManager**.
Performs session management.	Selects Session Manager as defined in **/Radius/SessionManagers/**<*Name*>.

Failover by the NAS and Session Management

When a Network Access Server's primary RADIUS server is performing session management, and the NAS determines the server is not responding and begins sending requests to its secondary RADIUS server, the following occurs:

- The secondary server will not know about the current active sessions that are maintained on the primary server. Any resources managed by the secondary server must be distinct from those managed by the primary server, otherwise it will be possible to have two sessions with the same resources (for example, two sessions with the same IP address).
- The primary server will miss important information that allows it to maintain a correct model of what sessions are currently active (because the authentication and accounting requests are being sent to the secondary server). This means when the primary server comes back online and the NAS begins using it, its knowledge of what sessions are active will be out-of-date and the resources for those sessions are allocated even if they are free to allocate to someone else.

For example, the user-session-limit resource might reject new sessions because the primary server does not know some of the users using the resource logged out while the primary server was off-line. It might be necessary to release sessions manually using the **aregcmd** command **release-session**.

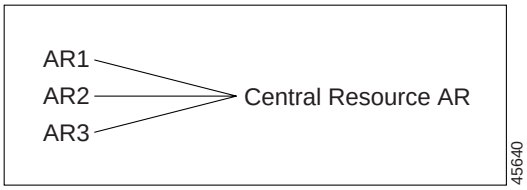
Note It might be possible to avoid this situation by having a disk drive shared between two systems with the second RADIUS server started up once the primary server has been determined to be off-line. For more information on this setup, contact Technical Support.

Cross Server Session and Resource Management

Prior to AR 1.6, sessions and resources were managed locally, meaning that in a multi-AR server environment, resources such as IP addresses, user-based session limits, and group-based session limits were divided between all the AR servers. It also meant that, to ensure accurate session tracking, all packets relating to one user session were required to go to the same AR server.

Access Registrar 1.6 and above can manage sessions and resources across AAA server boundaries. A session can be created by an Access-Request sent to AR1, and it can be removed by an Accounting-Stop request sent to AR2, as shown in Figure 1-1. This enables accurate tracking of User and Group session limits across multiple AAA servers, and IP addresses allocated to sessions are managed in one place.

Figure 1-1 Multiple AR Servers



All resources that must be shared cross multiple front line ARs are configured in the Central Resource AR. Resources that are not shared can still be configured at each front line AR as done prior to the AR 1.6 release.

When the front line AR receives the access-request, it does the regular AA processing. If the packet is not rejected and a Central Resource AR is also configured, the front line AR will proxy the packet[1] to the configured Central Resource AR. If the Central Resource AR returns the requested resources, the process continues to the local session management (if local session manager is configured) for allocating any local resources. If the Central Resource AR cannot allocate the requested resource, the packet is rejected.

When the Accounting-Stop packet arrives at the frontline AR, AR does the regular accounting processing. Then, if the front line AR is configured to use Central Resource AR, a proxy packet will be sent to Central Resource AR for it to release all the allocated resources for this session. After that, any locally allocated resources are released by the local session manager.

Session-Service Service Step and Radius-session Service

A new Service step has been added in the processing of Access-Request and Accounting packets. This is an additional step after the AA processing for Access packet or Accounting processing for Accounting packet, but before the local session management processing. The Session-Service should have a service type of radius-session.

1. The proxy packet is actually a resource allocation request, not an Access Request.

An environment variable Session-Service is introduced to determine the Session-Service dynamically. You can use a script or the rule engine to set the Session-Service environment variable.

Configure Front Line Access Registrar

To use a Central Resource server, the DefaultSessionService property must be set or the Session-Service environment variable must be set through a script or the rule engine. The value in the Session-Service variable overrides the DefaultSessionService.

The configuration parameters for a Session-Service service type are the same as those for configuring a radius service type for proxy, except the service type is ***radius-session***.

The configuration for a Session-Service Remote Server is the same as configuring a proxy server.

```
[ //localhost/Radius ]
    Name = Radius
    Description =
    Version = 1.6R0
    IncomingScript =
    OutgoingScript =
    DefaultAuthenticationService = local-users
    DefaultAuthorizationService = local-users
    DefaultAccountingService = local-file
    DefaultSessionService = Remote-Session-Service
    DefaultSessionManager = session-mgr-1

[ //localhost/Radius/Services ]
    Remote-Session-Service/
       Name = Remote-Session-Service
       Description =
       Type = radius-session
       IncomingScript =
       OutgoingScript =
       OutagePolicy = RejectAll
       OutageScript =
       MultipleServersPolicy = Failover
       RemoteServers/
        1. central-server

[ //localhost/Radius/RemoteServers ]
    central-server/
       Name = central-server
       Description =
       Protocol = RADIUS
       IPAddress = 209.165.200.224
       Port = 1645
       ReactivateTimerInterval = 300000
       SharedSecret = secret
       Vendor =
       IncomingScript =
       OutgoingScript =
       MaxTries = 3
       InitialTimeout = 2000
       AccountingPort = 1646
```

Configure Central AR

Resources at the Central Resource server are configured the same way as local resources are configured. These resources are local resources from the Central Resource server's point of view.

Script Processing Hierarchy

For request packets, the script processing order is from the most general to the most specific. For response packets, the processing order is from the most specific to the most general.

Table 1-6, Table 1-7, and Table 1-8 show the overall processing order and flow: (1-6) Incoming Scripts, (7-11) Authentication/Authorization Scripts, and (12-17) Outgoing Scripts.

Note The client and the NAS can be the same entity, except when the immediate client is acting as a proxy for the actual NAS.

Table 1-6 Cisco AR Processing Hierarchy for Incoming Scripts

Overall Flow Sequence	Incoming Scripts
1)	Radius
2)	Vendor of the immediate client.
3)	Immediate client.
4)	Vendor of the specific NAS.
5)	Specific NAS
6)	Service

Table 1-7 Cisco AR Processing Hierarchy for Authentication/Authorization Scripts

Overall Flow Sequence	Authentication/Authorization Scripts
7)	Group Authentication.
8)	User Authentication.
9)	Group Authorization.
10)	User Authorization.
11)	Session Management.

Table 1-8 Cisco AR Processing Hierarchy for Outgoing Script

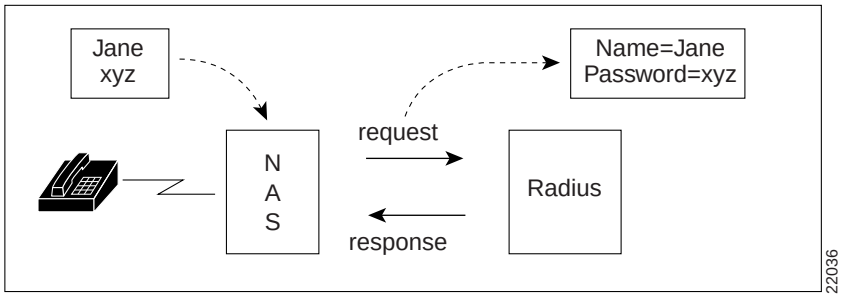
Overall Flow Sequence	Outgoing Scripts
12)	Service
13)	Specific NAS.
14)	Vendor of the specific NAS.
15)	Immediate client.
16)	Vendor of the immediate client.
17)	Radius

RADIUS Protocol

Cisco AR is based on a client/server model, which supports AAA (authentication, authorization, and accounting). The *client* is the Network Access Server (NAS) and the *server* is Cisco AR. The client passes user information on to the RADIUS server and acts on the response it receives. The *server*, on the other hand, is responsible for receiving user access requests, authenticating and authorizing users, and returning all of the necessary configuration information the client can then pass on to the user.

The protocol is a simple packet exchange in which the NAS sends a request packet to the Cisco AR with a name and a password. Cisco AR looks up the name and password to verify it is correct, determines for which dynamic resources the user is authorized, then returns an accept packet that contains configuration information for the user session (Figure 1-2).

Figure 1-2 Packet Exchange Between User, NAS, and RADIUS



Cisco AR can also reject the packet if it needs to deny network access to the user. Or, Cisco AR can issue a challenge that the NAS sends to the user, who then creates the proper response and returns it to the NAS, which forwards the challenge response to Cisco AR in a second request packet.

In order to ensure network security, the client and server use a *shared secret*, which is a string they both know, but which is never sent over the network. User passwords are also encrypted between the client and the server to protect the network from unauthorized access.

Steps to Connection

Three participants exist in this interaction: the user, the NAS, and the RADIUS server. The following steps describe the receipt of an access request through the sending of an access response.

Step 1 The user, at a remote location such as a branch office or at home, dials into the NAS, and supplies a name and password.

Step 2 The NAS picks up the call and begins negotiating the session.

- **a.** The NAS receives the name and password.
- **b.** The NAS formats this information into an Access-Request packet.
- **c.** The NAS sends the packet on to the Cisco AR server.

Step 3 The Cisco AR server determines what hardware sent the request (NAS) and parses the packet.

- **d.** It sets up the Request dictionary based on the packet information.

e. It runs any incoming scripts, which are user-written extensions to Cisco AR. An incoming script can examine and change the attributes of the request packet or the environment variables, which can affect subsequent processing.

f. Based on the scripts or the defaults, it chooses a service to authenticate and/or authorize the user.

Step 4 Cisco AR's authentication service verifies the username and password is in its database. Or, Cisco AR delegates the authentication (as a proxy) to another RADIUS server, an LDAP, or TACACS server.

Step 5 Cisco AR's authorization service creates the response with the appropriate attributes for the user's session and puts it in the Response dictionary.

Step 6 If you are using Cisco AR session management at your site, the Session Manager calls the appropriate Resource Managers that allocate dynamic resources for this session.

Step 7 Cisco AR runs any outgoing scripts to change the attributes of the response packet.

Step 8 Cisco AR formats the response based on the Response dictionary and sends it back to the client (NAS).

Step 9 The NAS receives the response and communicates with the user, which might include sending the user an IP address to indicate the connection has been successfully established.

Types of RADIUS Messages

The client/server packet exchange consists primarily of the following types of RADIUS messages:

- Access-Request—sent by the client (NAS) requesting access
- Access-Reject—sent by the RADIUS server rejecting access
- Access-Accept—sent by the RADIUS server allowing access
- Access-Challenge—sent by the RADIUS server requesting more information in order to allow access. The NAS, after communicating with the user, responds with another Access-Request.

When you use RADIUS accounting, the client and server can also exchange the following two types of messages:

- Accounting-Request—sent by the client (NAS) requesting accounting
- Accounting-Response—sent by the RADIUS server acknowledging accounting

Packet Contents

The information in each RADIUS message is encapsulated in a UDP (User Datagram Protocol) data packet. A packet is a block of data in a standard format for transmission. It is accompanied by other information, such as the origin and destination of the data.

Table 1-9 lists a description of the five fields in each message packet.

Table 1-9 RADIUS Packet Fields

Fields	Description
Code	Indicates message type: Access-Request, Access-Accept, Access-Reject, Access-Challenge, Accounting-Request, or Accounting-Response.
Identifier	Contains a value that is copied into the server's response so the client can correctly associate its requests and the server's responses when multiple users are being authenticated simultaneously.
Length	Provides a simple error-checking device. The server silently drops a packet if it is shorter than the value specified in the length field, and ignores the octets beyond the value of the length field.
Authenticator	Contains a value for a Request Authenticator or a Response Authenticator. The Request Authenticator is included in a client's Access-Request. The value is unpredictable and unique, and is added to the client/server shared secret so the combination can be run through a one-way algorithm. The NAS then uses the result in conjunction with the shared secret to encrypt the user's password.
Attribute(s)	Depends on the type of message being sent. The number of attribute/value pairs included in the packet's attribute field is variable, including those required or optional for the type of service requested.

The Attribute Dictionary

The Attribute dictionary contains a list of preconfigured authentication, authorization, and accounting attributes that can be part of a client's or user's configuration. The dictionary entries translate an attribute into a value Cisco AR uses to parse incoming requests and generate responses. Attributes have a human-readable name and an enumerated equivalent from 1-255.

Sixty three standard attributes exist, which are defined in RFC 2138 and 2139. There also are additional vendor-specific attributes that depend on the particular NAS you are using. For a complete list of attributes, see Chapter 5 of the Cisco Access Registrar Concepts and Reference Guide.

Some sample attributes include:

- User-Name—the name of the user
- User-Password—the user's password
- NAS-IP-Address—the IP address of the NAS
- NAS-Port—the NAS port the user is dialed in to
- Framed Protocol—such as SLIP or PPP
- Framed-IP-Address—the IP address the client uses for the session

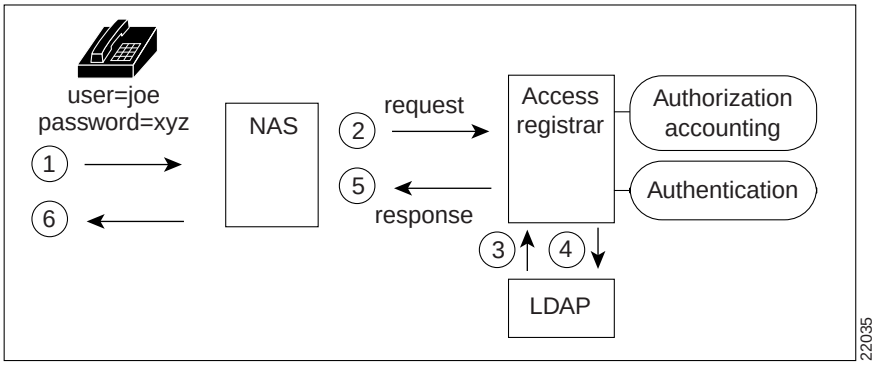
- Filter-ID—vendor-specific; identifies a set of filters configured in the NAS
- Callback-Number—the actual callback number.

Proxy Servers

Any one or all of the RADIUS server's three functions: authentication, authorization, or accounting can be subcontracted to another RADIUS server. Cisco AR then becomes a *proxy server*. Proxying to other servers enables you to delegate some of the RADIUS server's functions to other servers.

You could use Cisco AR to "proxy" to an LDAP server for access to directory information about users in order to authenticate them. Figure 1-3 shows user `joe` initiating a request, the Cisco AR server proxying the authentication to the LDAP server, and then performing the authorization and accounting processing in order to enable `joe` to log in.

Figure 1-3 Proxying to an LDAP Server for Authentication



CHAPTER 2

Using the aregcmd Commands

Revised: April 6, 2008, OL-8558-04

This chapter describes how to use each of the **aregcmd** commands. The Cisco Access Registrar **aregcmd** command is a command-line based configuration tool. It allows you to set any Cisco AR configurable option, as well as, start and stop the server and check statistics.

General Command Syntax

Cisco AR stores its configuration information in a hierarchy. Using the **aregcmd** command **cd** (change directory) you can move through this information in the same manner as you would through any hierarchical file system. Or you can supply full path names to these commands to affect another part of the hierarchy, and thus avoid explicitly using the **cd** command to change to that part of the tree.

aregcmd command parsing is case *insensitive*, which means you can use upper or lowercase letters to designate elements. In addition, when you reference existing elements in the configuration, you need only specify enough of the element's name to distinguish it from the other elements at that level. For example, instead of typing **cd Administrators**, you can type **cd ad** when no other element at the current level begins with **ad**.

aregcmd command parsing is command-line order *dependent*; that is, the arguments are interpreted based on their position on the command line. To indicate an empty string as a place holder on the command line, use either single (') or double quotes (""). In addition, when you use any arguments that contain spaces, you must quote the arguments. For example, when you use the argument, "**Local Users**," you must enclose the phrase in quotes.

The **aregcmd** command can contain a maximum of 255 characters when specifying a parameter and 511 characters for the entire command.

The **aregcmd** command syntax is:

aregcmd [**-C** <*clustername*>] [**-N** <*adminname*>] [**-P** <*adminpassword*>] [**-V**] [**-f** <*scriptfile*>] [**-l** <*directoryname*>] [**-n**] [<*command*> [<*args*>]] [**-p**] [**-q**] [**-v**]

- **-C**—Specifies the name of the cluster to log into by default
- **-N**—Specifies the name of the administrator
- **-P**—Specifies the password
- **-V**—Specifies view-only mode
- **-f**—Specifies a file that can contain a series of commands
- **-l**—Specifies a directory where the Cisco AR license file is stored and returns information about licensed components

- **-n**—Turns off prefix mode
- **-p**—Specifies prefix mode
- **-q**—Turns off verbose mode
- **-v**—Specifies verbose mode

Note The verbose (**-v**) and prefix (**-p**) modes are on by default when you run **aregcmd** interactively (for example, not entered on the command line or not running commands from a script file). Otherwise, verbose and prefix modes are off.

When you include a command (with the appropriate arguments) on the command line, **aregcmd** runs only that one command and saves any changes.

View-Only Administrator Mode

Previous releases of Cisco AR provided only *super-user* administrative access. If you were able to log in to **aregcmd**, you could do anything to the system, including starting and stopping the system and changing the configuration. Cisco AR provides view-only administrative access. View-only access restricts an administrator to only being able to observe the system and prevents that user from making changes.

View-only access can be encountered in three ways:

- Specific administrators can be restricted to view-only access whenever they log in.
- Administrators not restricted to view-only access can choose to start **aregcmd** in a view-only mode. This might be used when an administrator wants to ensure that he or she does not make any changes.
- When an administrator who is not view-only logs in to a slave server, they will be unable to make changes to any parts of the configuration other than **/Radius/Replication**, **/Radius/Advanced/Ports, /Radius/Advanced/Interfaces** or the properties in **/Radius/Advanced**. This is because the rest of theconfiguration is replicated from the master server and changes directly to the slave will cause problems.

Note When a user logs in, the system determines whether a user's session is view-only or not. If the configuration is changed after a user has logged in, that change does not take effect until the affected user logs out and logs back in.

ViewOnly Property

The ViewOnly property has been added to the Administrators configuration. The default setting for the ViewOnly property is FALSE. The following shows the default setting for the **admin** user:

cd /Administrators/admin

```
[ //localhost/Administrators/admin ]
    Name = admin
    Description =
    Password = <encrypted>
    ViewOnly = FALSE
```

You can designate specific administrators to be view-only administrators by setting the new ViewOnly property to TRUE. If that property is set to TRUE, any time the administrator logs in to **aregcmd** the session will be in view-only mode. If set to FALSE, when the administrator logs in to a master server, the session will be full super-user capability.

If the administrator logs in to a slave, they only part of the configuration they will be able to modify is that part under **/Radius/Replication**, **/Radius/Advanced/Ports**, **/Radius/Advanced/Interfaces** or the properties in **/Radius/Advanced**.

When in a view-only session, the following commands will cause an error: **add**, **delete**, **set**, **unset**, **insert**, **validate**, **save**, **start**, **stop**, **reload**, **reset-stats**, **release-sessions**, and **trace**. The following error message will be displayed:

```
316 Command failed: session is ViewOnly
```

When in a slave server session, the following commands will cause an error when the object or property being operated on is not under **/Radius/Replication**, **/Radius/Advanced/Ports**, **/Radius/Advanced/Interfaces** or the properties in **/Radius/Advanced**: **add**, **delete**, **set**, **unset**, and **insert**. The following error message will be displayed:

```
317 Command failed: session is ViewOnly
```

Configuration Objects

The Cisco AR **aregcmd** command lets you manipulate configuration objects, that define properties or the behavior of the RADIUS server, such as valid administrators and types of services. For descriptions of the those objects, see Chapter 4, “Access Registrar Server Objects.”

aregcmd Command Performance

You can impact **aregcmd** command performance and server response time by having Cisco AR userlists that contain more than 10,000 users. Cisco AR userlists were not designed to contain 10,000 users in any one list.

If you must provide service for groups greater than 10000 users, Cisco recommends that you use an external data store such as an LDAP directory or an Oracle database. If you are unable to use an external data store, create multiple userlists instead, keeping each userlist under 10,000 users.

Multiple userlists require multiple services (one for each userlist), because a service cannot reference more than one userlist. The multiple services can then be combined using the Service Grouping feature with ResultRule, OR, as follows:

```
[ //localhost/Radius/Services/GroupService ]
    Name = GroupService
    Description =
    Type = group
    IncomingScript~ =
    OutgoingScript~ =
    ResultRule = OR
    GroupServices/
    1. UserService1
    2. UserService2
    3. UserService3
```

RPC Bind Services

The Cisco AR server and the **aregcmd** CLI requires RPC services to be running before the server is started. If the RPC services are stopped, you must restart RPC services, then restart the Cisco AR server. Use the following commands to restart RPC services:

arserver stop

/etc/init.d/rpc start

arserver start

If RPC services are not running, the following message is displayed when you attempt to start aregcmd:

```
Login to aregcmd fails with the message:
400 Login failed
```

aregcmd Commands

This section contains the complete list of **aregcmd** commands. You can use them on the command line or insert them into scripts. The commands are listed alphabetically.

add

Use the **aregcmd** command **add** to create new elements in the configuration. The **add** command is context sensitive, which means the type of element added is determined by the current context, or the path specified as the first parameter. The **add** command has one required argument; the name of the element you wish to add. You can also provide other parameters, or you can supply this information after **aregcmd** has added the new element. The optional second argument is a description of the element.

The syntax is:

add [<*path*>/]<*name*> *[...]*

cd

Use the **aregcmd** command **cd** to change the working context, or level in the configuration hierarchy. When you use the **cd** command without any parameters, it returns you to the root of the tree. When you use the optional path argument, you can specify a new context. To change to a higher level in the tree hierarchy, use the ".." syntax (as you would in a UNIX file system). When you change to a new context, **aregcmd** displays the contents of the new location, when you are using the command in interactive mode, or if verbose mode is on.

The syntax is:

cd [<*path*>]

delete

Use the **aregcmd** command **delete** to remove an element from the configuration hierarchy. You cannot remove properties on an element; you can only remove entire elements. The **delete** command is recursive; that is, it will remove any subelements contained within an element being removed. When the element is in the current context, you need only provide the name of the element to be deleted. You can optionally provide a complete path to an element elsewhere in the configuration hierarchy.

The syntax is:

delete [<*path*>/]<*name*>

exit

Use the **aregcmd** command **exit** to terminate your **aregcmd** session. If you have any unsaved modifications, Cisco AR asks if you want to save them before exiting. Any modifications you don't choose to save are lost.

The syntax is:

exit

filter

Use the **aregcmd** command **filter** to display a selected view of a list. You can use the **filter** command to present only the elements of a list that have properties equal to the value you specify. You can also use the **filter** command to restore the view of the list after it has been filtered.

When using the **filter** command, you must provide a property name and a value, and you can optionally provide the path to the list. Cisco AR displays a list with only those elements that have a value equal to the specified value. When you want to filter the current context, you can omit the path argument.

The **filter** command is *sticky*, in that, after you have filtered a list, you must explicitly unfilter it before you can view the complete list again. To restore the unrestricted view of the list, use the **filter** command and specify the string **all**. To restore the list in current context, you can omit the path name.

The syntax is:

filter [<*path*>] <*property*> <*value*>

or

filter [<*path*>] **all**

find

Use the **aregcmd** command **find** to locate a specific item in a list. The **find** command takes one required argument, which is a full or partial pathname. After you use the command, Cisco AR displays a page beginning with the entry that most closely matches the pathname you provided.

The syntax is:

find <*path*>

help

Use the **aregcmd** command **help** (with no argument specified) to display a brief overview of the command syntax. When you specify the name of a command, Cisco AR displays help for only that command.

The syntax is:

help [<*command*>]

insert

Use the **aregcmd** command **insert** to add an item anywhere in ordered list. The required parameters are the numeric index of the position in the list in which you want to insert the new item, and the item value. When the list to which you are adding is not the current context, you can specify the complete path to the position in the list by prepending the path for the list to the numeric index. After the new value has been inserted into the list, Cisco AR appropriately renumbers the list.

The syntax is:

insert [<*path*>/]<*index*> <*value*>

This command applies to lists of servers by index and the Resource Managers list in Session Managers.

login

Use the **aregcmd** command **login** to connect to a cluster, which contains the RADIUS server and definition of the authorized administrators. When you do not specify the cluster, admin name, and password, **aregcmd** prompts you for them.

When you are currently logged in to a cluster, the **login** command allows you to connect to another cluster. When you have changes in the current cluster that you have not saved, **aregcmd** asks if you want to save them before logging into another cluster. Any changes you do not save are lost.

After you successfully log in, and if the server is running, Cisco AR displays the cluster server's health. Note, to log in to a cluster, the AR Server Agent for that cluster must be running.

The syntax is:

login [<*cluster*> [<*name*> [<*password*>]]]

logout

Use the **aregcmd** command **logout** to log out of the current cluster. After you log out, you have to log in to make any modifications to the configuration hierarchy, or to manage the server(s). When you have any unsaved modifications, Cisco AR asks if you want to save them before logging out. Any modifications you do not choose to save are lost.

The syntax is:

logout

ls

Use the **aregcmd** command **ls** to list the contents of a level in the configuration hierarchy. This command works much like the UNIX **ls** command. When you use it without any parameters, it lists the items in the current context. When you specify a path, it lists the elements found in that context. When you use the **-R** argument, it recursively lists all of the elements in and below the specified (or current) context.

For similar commands, refer to the **next** and **prev** commands.

The syntax is:

ls [**-R**] [<*path*>]

next

Use the aregcmd **next** command to review the remaining pages produced from the **ls** command. Every time you use the **cd** command, it automatically invokes the **ls** command to display the contents of the location. When the output from the **ls** command is more than one page (a page is about 24 lines) in length, Cisco AR displays only the first page.

Note **ls** pages only user-added objects such as Users, UserLists, and attributes.

The **next** command takes an optional path and count. The path specifies the context in which you wish to see the next page and the count specifies the number of lines you wish to see. When you use the **next** command without the path, Cisco AR uses the current context. When you do not specify a count, Cisco AR uses the last count value you used with the **next** or **prev** command. If you never specify a count, Cisco AR uses the default value, which is 20.

Note, the current page for a context is *sticky*. This means, for example, when you use the **next** command to view entries 20 through 30, until you use the **next** or **prev** command on the same context, you will continue to see these entries even if you use the **cd** command to change to a different context, then return to the original.

The syntax is:

next [<*path*>] [<*count*>]

prev

Use the **aregcmd** command **prev** to page backwards through the output of the **ls** command. It behaves much like the **next** command, in that it takes an optional path identifying a context to display and a count parameter indicating how many lines to display.

The syntax is:

prev [<*path*>] [<*count*>]

pwd

Use the **aregcmd** command **pwd** to display the absolute pathname of the current context (level in the configuration hierarchy).

The syntax is:

pwd

query-sessions

Use the **aregcmd** command **query-sessions** to query the server about the currently active user sessions. You can request information about all of the active sessions or just those sessions that match the type you specify.

The syntax is:

query-sessions <*path*> [**all**]

or

query-sessions <*path*> **with-**<*type*> <*value*> **[send-CoA [with-profile <profile name>]]**

or

query-sessions <*path*> **with-Attribute** <*name*> <*value*> **[send-CoA [with-profile <profile name>]]**

Where <*path*> is the path to the server, Session Manager, or Resource Manager to query and **with-**<*type*> is one of the following: **with-NAS**, **with-User**, **with-IP-Address**, **with-IPX-Network**, **with-USR-VPN**, **with-Key, with-ID** or **with-Age**. The optional **[with-profile <profile name>]** parameter indicates a profile name as configured in **/Radius/Profiles**.

The **query-sessions** command with an optional [**send-CoA**] at the end causes the Cisco AR server to send a Change of Authorization (CoA) request to the client. The CoA request includes the CoA attributes configured for the client. When the optional profile name is also included in the command, the Cisco AR server includes the attribute-value (AV) pairs from the corresponding profile in **/Radius/Profiles** in the CoA request.

quit

Use the **aregcmd** command **quit** to terminate your **aregcmd** session. You can use it interchangeably with the **exit** command.

The syntax is:

quit

When you quit the **aregcmd** command, if you've made changes, the Cisco AR server asks if you want to save the changes. Any unsaved changes are lost.

release-sessions

Use the **aregcmd** command **release-sessions** to request the server to release one or more currently active user sessions. This command might be useful, for example, in the case where you have taken a NAS off-line, however, the server believes user sessions for that NAS are still active.

The syntax is one of:

release-sessions <*path*> **all**

or

release-sessions <*path*> **with-** <*type*> <*value*> [**send-pod**] [**send-notification**]

or

release-sessions <*path*> **with-Attribute** <*name*> <*value*> [**send-pod**] [**send-notification**]

Where <*path*> is the path to the server, Session Manager, or Resource Manager to query and **with-**<*type*> is one of the following: **with-NAS**, **with-User**, **with-IP-Address**, **with-IPX-Network**, **with-USR-VPN**, **with-Key,** or **with-ID**.

The optional **[send-pod <send notification>]** parameter sends the disconnect packet to the NAS to clear sessions and an Accounting-Stop notification to the client listed in the session record.

The optional **with-Attribute** parameter enables release a session based on a specific attribute and value.

reload

Use the **aregcmd** command **reload** to stop the server (when it is running), and then immediately start the server, forcing it to reread its configuration information. When you have modified the configuration hierarchy, Cisco AR asks you if you want to save your changes before restarting the server. Note, you *must* save your changes in order for the reloaded server to be able to use them.

The syntax is:

reload

reset-stats

Use the **aregcmd** command **reset-stats** to reset all server statistics displayed with the **stats** command. The **reset-stats** command also resets SNMP counters.

The **reset-stats** command provides a way of resetting the server statistics without having to reload or restart the server.

The syntax is:

reset-stats

save

Use the **aregcmd** command **save** to validate the changes you made and commit them to the configuration database, if no errors are found.

Note Using the **save** command does not automatically update the running server. To update the server, you must use the **reload** command.

The syntax is:

save

Table 2-1 lists the RADIUS server objects and the effect of Dynamic Updates upon them.

Table 2-1 Dynamic Updates Effect on Radius Server Objects

Object	Add	Modify or Delete
Radius	Yes	Yes
UserLists	Yes	Yes
UserGroups	Yes	Yes
Policies	Yes	Yes
Clients	Yes	Yes
Vendors	Yes	Yes
Scripts	Yes	Yes
Services	Yes	Yes
SessionManagers	Yes	**No**
ResourceManagers	Yes	**No**
Profiles	Yes	Yes
Rules	Yes	Yes
Translations	Yes	Yes
TranslationGroups	Yes	Yes
RemoteServers	Yes	**No**
Replication	Yes	Yes
Advanced	Yes	Yes
SNMP	**No**	**No**
Ports	**No**	**No**
Interfaces	**No**	**No**

set

Use the **aregcmd** command **set** to provide values for properties on existing configuration elements. You only need to provide the **set** command with the name of the property you wish to set (or just enough of the name to distinguish it from other properties) and the new value for that property. It also applies to the **Profiles** attribute list, the Rules attributes list, the enumeration list in the Attribute dictionary, and the **LDAPtoRadiusMappings** and **LDAPtoEnvironmentMappings** mappings.

The **set** command can also be used to order servers in a list. To specify a new position in a list for a server, use the **set** command and provide the numeric position of the server and the server's name.

The syntax is:

set [<*path*>/]<*property*> <*value*>

When the list is a list of servers by index, the syntax is:

set [<*path*>/]<*index*> <*server name*>

Note If the index is already in use, the old server name will be replaced by the new server name.

To remove a value from a property (make a property equal to NULL), use a pair of single or double quotes as the value, as shown below:

set <*property*> ““

When you need to set an attribute to a value that includes a space, you must double-quote the value, as in the following:

set Framed-Route “192.168.1.0/24 192.168.1.1”

start

Use the **aregcmd** command **start** to enable the server to handle requests. When the configuration hierarchy has been modified, Cisco AR asks you if you want to save the changes before starting the server.

The syntax is:

start

stats

Use the **aregcmd** command **stats** to provide statistical information on the specified server. You can only issue this command when the server is running.

Note that **aregcmd** supports the **PAGER** environment variable. When the **aregcmd stats** command is used and the **PAGER** environment variable is set, the **stats** command output is displayed using the program specified by the **PAGER** environment variable.

The syntax is:

stats

The following is an example of the statistical information provided after you issue the **stats** command:

```
RemoteServer statistics for:ServerA, 209.165.201.1, port 1645
    active = TRUE
    maxTries = 3
    RTTAverage = 438ms
    RTTDeviation = 585ms
    TimeoutPenalty = 0ms
    totalRequestsPending = 0
    totalRequestsSent = 14
    totalRequestsOutstanding = 0
    totalRequestsTimedOut = 0
    totalRequestsAcknowledged = 14
    totalResponsesDroppedForNotInCache = 0
    totalResponsesDroppedForSignatureMismatch = 0
    totalRequestsDroppedAfterMaxTries = 0
    lastRequestTime = Mon Feb 18 17:19:46 2002
    lastAcceptTime = Mon Feb 18 17:18:11 2002
```

Table 2-2 lists the statistics displayed by the stats command and the meaning of the values.

Table 2-2 aregcmd stats Information

Stats Value	Meaning
RemoteServer statistics for:	Provides server's type, name, IP address, and port used
active	Indicates whether the server was active (not in a down state)
maxTries	Number of retry attempts to be made by the RemoteServer Object based on the RemoteServer's *maxTries* property setting
RTTAverage	Average round trip time since the last server restart
RTTDeviation	Indicates a standard deviation of the RTTAverage
TimeoutPenalty	Indicates any change made to the initial timeout default value
totalRequestsPending	Number of requests currently queued
totalRequestsSent	Number of requests sent since the last server restart **Note** totalRequestsSent should equal the sum of totalRequestsOutstanding and totalRequestsAcknowledged.
totalRequestsOutstanding	Number of requests currently proxied that have not yet returned
totalRequestsTimedOut	Number of requests that have timed out since last server restart or number requests not returned from proxy server within the [configured] initial timeout interval
totalRequestsAcknowledged	Number of responses received since last server restart
totalResponsesDroppedForNotInCache	Number of responses dropped because their ID did not match the ID of any Pending requests
totalResponsesDroppedForSignatureMismatch	Number of responses dropped because their response authenticator did not decode to the correct shared secret
totalRequestsDroppedAfterMaxTries	Number of requests dropped because no response was received after retrying the configured number of times. This value is different from totalRequestsTimedOut because using the default configuration values, no response within 2000 ms bumps the TimedOut counter, but it waits 14000 ms (2000 + 4000 + 8000) to bump this counter.

Table 2-2 aregcmd stats Information (continued)

Stats Value	Meaning
lastRequestTime	Date and time of last proxy request
lastAcceptTime	Date and time of last ACCEPT response to a client

status

Use the **aregcmd** command **status** to learn whether or not the specified server has been started. When the server is running, Cisco AR displays its health.

The syntax is:

status

stop

Use the **aregcmd** command **stop** to cause the server to no longer accept requests.

The syntax is:

stop

trace

Use the **aregcmd** command **trace** to set the trace level in the specified server to a new value. The trace level governs how much information is displayed about the contents of a packet. When the trace level is zero, no tracing is performed. The higher the trace level, the more information displayed. The highest trace level currently used by the CAR server is trace level 5.

Note Although the highest **trace** level supported by the CAR server is **trace** level 5, an extension point script might use a higher level. There is no harm in setting the **trace** to a level higher than 5.

The **trace** levels are inclusive, meaning that if you set **trace** to level 3, you will also get the information reported for **trace** levels 1 and 2. If you set trace level 4, you also get information reported for **trace** levels 1, 2, and 3.

When you do not specify a server, Cisco AR sets the **trace** level for all of the servers in the current cluster. When you do not specify a value for the **trace** level, Cisco AR displays the current value of the **trace** level. The default is 0.

The syntax for setting the **trace** level is:

trace [<*server*>] [<*level*>]

Table 2-3 lists the different **trace** levels and the information returned.

Table 2-3 Trace Levels and Information Returned

Trace Level	Information Returned by Trace Command
0	No trace performed
1	Reports when a packet is sent or received or when there is a change in a remote server's status.
2	Indicates the following: • Which services and session managers are used to process a packet • Which client and vendor objects are used to process a packet • Detailed remote server information for LDAP and RADIUS, such as sending a packet and timing out • Details about poorly formed packets • Details included in trace level 1
3	Indicates the following: • Error traces in TCL scripts when referencing invalid RADIUS attributes. • Which scripts have been executed • Details about local UserList processing • Details included in trace levels 1 and 2
4	Indicates the following: • Information about advanced duplication detection processing • Details about creating, updating, and deleting sessions • Trace details about all scripting APIs called • Details included in trace levels 1, 2, and 3
5	Indicates the following: • Details about use of the policy engine including: – Which rules were run – What the rules did – If the rule passed or failed – Detailed information about which policies were called • Details included in trace levels 1, 2, 3, and 4

trace-file-count

Use the **aregcmd** command **trace-file-count** to change the trace log file count dynamically without requiring a server reload. The syntax is:

trace-file-count ***n***

Where *n* is a number that specifies the number of trace log files. This function is helpful for debugging situations when you do not want to perform a **reload**.

unset

Use the **aregcmd** command **unset** to remove items from an ordered list. Specify the numeric index of the element to remove. When the ordered list is not the current context, specify the path to the list before specifying the numeric index.

When you remove an item from the list, Cisco AR renumbers the list.

The syntax is:

unset [<*path*>/]<*index*>

This command applies to lists of servers by index, the **Profiles** attribute list, the Rules Attributes list, the enumeration list in the Attribute dictionary, and the **LDAPtoRadiusMappings** and **LDAPtoEnvironmentMappings** mappings.

validate

Use the **aregcmd** command **validate** to check the consistency and validity of the specified server's configuration. If Cisco AR discovers any errors, it displays them.

The syntax is:

validate

aregcmd Command Logging

aregcmd now records the commands that are either entered interactively, on the command line, or executed in batch mode. The recorded commands are saved in the **aregcmd_log** file, which resides in the **logs** directory within the Cisco AR installation directory.

For security reasons, **aregcmd** blocks out the actual password that is entered as part of the command and replaces it with <*passwd*>.

In interactive mode, **aregcmd** logs the actions that are taking place in the exit/logout dialog box. The action can be **save** or **not save** if the configuration database has been modified after the last execution of the **save** command.

In non-interactive (batch or command-line) mode, **aregcmd** replaces the empty field with a NULL string.

aregcmd is now installed as a **setgid** program where the group is set to **staff**. This allows a non-root user to run **aregcmd** while still being able to write to the **aregcmd_log** log file. During the installation of the Cisco AR software, you are prompted whether you want to install **aregcmd** with **setuid/setgid** permissions. You must reply "yes" unless you only run **aregcmd** as user **root**.

The following is the format of an entry in the exit/logout dialog box when **not save** has been specified:

```
Mm/dd/yyyy HH:MM:SS aregcmd Info Configuration 0 [<clustername> <username>] ( exit )
Mm/dd/yyyy HH:MM:SS aregcmd Info Configuration 0 [<clustername> <username>] ( *** New
                                        config is not saved! ...proceed to logout.)
```

The following is sample output of an entry in the exit/logout dialog box when **not save** has been specified:

```
09/23/1999 16:18:56 aregcmd Info Configuration 0 [localhost admin] --> quit
09/23/1999 16:19:02 aregcmd Info Configuration 0 [localhost admin] --> *** New config is
                                                          not saved! ...proceed to logout.
```

The following is the format of an entry in the exit/logout dialog box when **save** has been specified:

```
Mm/dd/yyyy HH:MM:SS aregcmd Info Configuration 0 [<clustername> <username>] ( exit )
Mm/dd/yyyy HH:MM:SS aregcmd Info Configuration 0 [<clustername> <username>] ( *** New
                                                    config saved!...proceed to logout.)
```

aregcmd Command Line Editing

Commands entered at the **aregcmd** prompt can be edited with a subset of the standard EMACS-style keystrokes. In addition, the command history can be accessed using the arrow keys on the keyboard. Use the Up arrow to retrieve the previous command and the Down arrow to retrieve the next command. A description of the supported key strokes are shown in Table 2-4.

Table 2-4 aregcmd Command Line Editing Keystrokes

Key Stroke	Description
Ctrl A	Go to the beginning of the line.
Ctrl B	Move back one character.
Ctrl D	Delete the character at the cursor.
Ctrl E	Go to the end of the line.
Ctrl F	Move forward one character.
Ctrl N	Retrieve the next line.
Ctrl P	Retrieve the previous line.

aregcmd Error Codes

Table 2-5 lists the error codes used in **aregcmd**.

Table 2-5 aregcmd Error Codes

Error Code	Meaning
200	OK
300	Command failed to parse; usually an unbalanced quotation
301	Unknown command; usually caused by a misspelled command
302	Ambiguous command; characters you have entered select more than one command
303	Not logged in; you have logged out of **aregcmd** and attempted another **aregcmd** command
304	Too few arguments
305	Too many arguments

Table 2-5 aregcmd Error Codes (continued)

Error Code	Meaning
306	Invalid argument
307	Object not found or path ambiguous; you have tried to set an unknown object or provided a partial name that matches multiple objects
308	Object already exists
309	Confirmation password did not match; when setting a user password, the re-entered password did not match the initial entry
310	Command failed; a generic response for a command that failed for a reason other than those listed here
311	Command is interactive; possibly due to attempting to batch mode with an interactive command
312	Validation failed; a new or modified object is not valid
313	Failed to reread; an error occurred while synchronizing changes from another **aregcmd** session; occurs only when using multiple **aregcmd** instances
314	Failed to open the pager; the PAGER environment variable is set to something that does not exist and the **stats** command is entered
315	Property is not modifiable; an administrator has attempted to modify a read-only property
316	Command failed: session is ViewOnly; an view-only administrator has attempted to modify a property
317	Command failed: server is a Replication Slave; an administrator has attempted to modify a replicated property on a slave of an SMDBR network
400	Login failed; an incorrect username or password was given during **aregcmd** log in
401	Unable to access server; **aregcmd** was unable to communicate with the **radius** process usually because the process is not running or is otherwise unresponsive
402	Login failed: version of aregcmd is incompatible with server; a new version of **aregcmd** has tried to connect with an older version of Cisco AR
500	Internal error; a generic **aregcmd** error

CHAPTER 3

Using the Graphical User Interface

This chapter describes how to use the stand-alone graphical user interface (GUI) to configure Cisco Access Registrar. Cisco AR requires you to use the following browser versions:

- Microsoft Internet Explorer 6.0 SP1 (Windows 2000 & Windows XP)
- Netscape 7.02 (Windows 2000 & Windows XP)

This chapter contains the following sections:

Note Replication is not supported when using the GUI. If you plan to use replication, use the **aregcmd** command-line interface to make configuration changes to the Cisco AR server.

Launching the GUI

You start the GUI by pointing your browser to the Cisco AR server and port 8080, as in the following:

http://ar_server_name:8080

To start a secure socket layer (SSL) connection, use **https** to connect to the Cisco AR server and port 8443, as in the following:

https://ar_servr_name:8443

By default, both HTTP and HTTPS are enabled. The following sections describe how to disable HTTP and HTTPS:

Disabling HTTP

To disable HTTP access, you must edit the **server.xml** file in the **/cisco-ar/jakarta-tomcat-4.0.6/conf** directory. You must have root privileges to edit this file.

Use a text editor such as **vi** to open the **server.xml** file, and comment out lines 59-62. Use the **<!--** character sequence to begin a comment. Use the **-->** character sequence to end a comment.

The following are lines 57-62 of the **server.xml** file:

```
<!-- Define a non-SSL HTTP/1.1 Connector on port 8080 -->
    <!-- CHANGE MADE: Note: to disable HTTP, comment out this Connector -->
<Connector className="org.apache.catalina.connector.http.HttpConnector"
               port="8080" minProcessors="5" maxProcessors="75"
               enableLookups="true" redirectPort="8443"
               acceptCount="10" debug="0" connectionTimeout="60000"/>
```

The following example shows these lines with beginning and ending comment sequences to disable HTTP:

```
<!-- Define a non-SSL HTTP/1.1 Connector on port 8080 -->
    <!-- CHANGE MADE: Note: to disable HTTP, comment out this Connector -->
<!--
<Connector className="org.apache.catalina.connector.http.HttpConnector"
               port="8080" minProcessors="5" maxProcessors="75"
               enableLookups="true" redirectPort="8443"
               acceptCount="10" debug="0" connectionTimeout="60000"/>
-->
```

After you modify the **server.xml** file, you must restart the Cisco AR server for the changes to take effect. Use the following command line to restart the server:

/opt/CSCOar/bin/arserver restart

Disabling HTTPS

To disable HTTPS access, you must edit the **server.xml** file in the **/cisco-ar/jakarta-tomcat-4.0.6/conf** directory. You must have root privileges to edit this file.

Use a text editor such as **vi** to open the **server.xml** file, and comment out lines 69-77. Use the **<!--** character sequence to begin a comment. Use the **-->** character sequence to end a comment.

The following are lines 66-77 of the **server.xml** file:

```
<!-- Define an SSL HTTP/1.1 Connector on port 8443 -->
    <!-- CHANGE MADE: enabled HTTPS.
        Note: to disable HTTPS, comment out this Connector -->
    <Connector className="org.apache.catalina.connector.http.HttpConnector"
               port="8443" minProcessors="5" maxProcessors="75"
               enableLookups="true"
               acceptCount="10" debug="0" scheme="https" secure="true">
      <Factory className="org.apache.catalina.net.SSLServerSocketFactory"
               keystoreFile="/cisco-ar/certs/tomcat/server-cert.p12"
               keystorePass="cisco" keystoreType="PKCS12"
               clientAuth="false" protocol="TLS"/>
    </Connector>
```

The following example shows these lines with beginning and ending comment sequences to disable HTTPS.

```
<!-- Define an SSL HTTP/1.1 Connector on port 8443 -->
    <!-- CHANGE MADE: enabled HTTPS.
        Note: to disable HTTPS, comment out this Connector -->
<!--
<Connector className="org.apache.catalina.connector.http.HttpConnector"
               port="8443" minProcessors="5" maxProcessors="75"
               enableLookups="true"
               acceptCount="10" debug="0" scheme="https" secure="true">
      <Factory className="org.apache.catalina.net.SSLServerSocketFactory"
               keystoreFile="/cisco-ar/certs/tomcat/server-cert.p12"
               keystorePass="cisco" keystoreType="PKCS12"
               clientAuth="false" protocol="TLS"/>
    </Connector>
-->
```

After you modify the **server.xml** file, you must restart the Cisco AR server for the changes to take effect. Use the following command line to restart the server:

/opt/CSCOar/bin/arserver restart

Login Page

The login page has fields for a username and password. This page displays when you first attempt to log into the system, if a session times out, or after you logout of the system.

Logging In

Only users who are configured as administrators can log into the Cisco AR server. To log into the Cisco AR GUI, enter a username and password for a configured administrator in the fields provided, then click **Login**.

Logging Out

To log out of the Cisco AR GUI, click **Logout** in the upper right portion of the Cisco AR GUI window.

Overview Page

The Overview page is the top-level of the Cisco AR server GUI and provides links to the Configure page and the Monitor page.

Configure Page

The Configure page enables you to configure the following:

- Administrators
- Clients

- Profiles
- Userlists and Users

Note Replication is not supported when you use the GUI to configure the Cisco AR server.

The Configure page shows subareas where you can click to configure administrators, Clients, Profiles, UserLists, and Users.

Administrators

The Administrators page displays an alphabetical list of names and descriptions of the administrators known to the system. Click **Add Admin** to add a new administrator. Click on an administrator's name to edit or delete that administrator.

To locate an administrator, enter a partial name in the field provided, then click **Apply Filter**. The **Previous Page** and **Next Page** links take you to a previous page or the next page of administrators if available. Each administrator's name in the list is a link to the Edit page for that administrator.

Adding Administrators

Enter the attributes of a new administrator in the available fields and click **Submit** to add the new administrator. Click **Cancel** to return to the Administrators page without adding the administrator.

Table 3-1 provides the administrator properties and their descriptions.

Table 3-1 Administrator Properties

Property	Description
Name	Required; administrator's user ID
Password	Required; encrypted password of the administrator
Confirm Password	Required; encrypted password of the administrator and must match Password
Description	Optional description of the administrator
ViewOnly	Default value (FALSE) indicates that the administrator is able to modify the configuration. When set to TRUE, the administrator can only view the server configuration and set the change the server trace level.

After you successfully add a new administrator, Cisco AR returns you to the Administrators page. If the add is not successful, Cisco AR displays an error message and a link back to the Add Administrator page.

Editing Administrators

The Edit Administrator page enables you to modify administrator attributes.

To modify administrator attributes, enter new information in the editable fields and click **Submit**. If the modification is successful, Cisco AR returns you to the Administrators page. If the modification is not successful, Cisco AR displays an error message and a link back to the Edit Administrator page.

Click **Delete** to remove an administrator from the list of administrators. Click **Cancel** to return to the Administrators page.

Clients

The Clients page displays an alphabetical list of names of the clients known to the system and includes the client's IP address and shared secret. Click **Add Client** to add a new client.

To locate a client, enter a partial name in the field provided, then click **Apply Filter**. The **Previous Page** and **Next Page** links take you to a previous page or the next page of data if available. Each client's name in the list is a link to the Edit page for that client.

Adding Clients

Enter the required attributes of a new client in the Name, IP Address, and Shared Secret fields. If you check the **Enable Dynamic Auth Server** check box, provide values for Dynamic Auth Shared Secret, Max Tries, Port, Initial Timeout, and COA Attribute. Use the pull-down menus to select Incoming and Outgoing scripts and to select a Vendor type. Click **Submit** to add the new client. Click **Cancel** to return to the Clients page without adding the client.

If Enable Dynamic Auth Server check box is unchecked (disabled), the fields to enter Dynamic Auth Shared Secret, Port, Initial Timeout, Max Tries, and DOA Attribute are grayed out and you cannot enter values. If Enable Dynamic Auth Server check box is checked, you must enter appropriate values in these fields.

After you successfully add a new client, Cisco AR returns you to the Clients page. If the add is not successful, Cisco AR displays an error message and a link back to the Add Client page.

Table 3-2 provides the **Client** object properties.

Table 3-2 Client Properties

Property	Description
Name	Required and should match the Client identifier specified in the standard RADIUS attribute, **NAS-Identifier**. The name must be unique within the Clients list.
Description	Optional description of the client.

Table 3-2 Client Properties (continued)

Property	Description
IPAddress	Required; must be a valid IP address and unique in the Clients list. Cisco AR uses this property to identify the Client that sent the request, either using the source IP address to identify the immediate sender or using the **NAS-IP-Address** attribute in the Request dictionary to identify the NAS sending the request through a proxy. When a range is configured for a Client's IPAddress property, any incoming requests whose source address belongs to the range specified, will be allowed for further processing by the server. Similarly when a wildcard (an asterisk '*' in this case) is specified, any incoming requests whose source address matches the wildcard specification will be allowed. In both the cases, the configured client properties like SharedSecret, and Vendor are used to process the requests. You can specify a range of IP addresses using a hyphen as in: 100.1.2.11-20 You can use an asterisk wildcard to match all numbers in an IP address octet as in: 100.1.2.* You can specify an IPAddress and a subnet mask together using Classless Inter-Domain Routing (CIDR) notation as in: 100.1.2.0/24 You can use the IPAddress property to set a base address and use the NetMask property to specify the number of clients in the subnet range.
SharedSecret	Required; must match the secret configured in the Client.
Type	Required; accept the default (NAS), or set it to ATM, Proxy, or NAS+Proxy.
Vendor	Optional; you can use this property when you need special processing for a specific vendor's NAS. To use this property, you must configure a **Vendor** object and include a Script. Cisco AR provides five Scripts you can use: one for Ascend, Cisco, Cabletron, Altiga, and one for USR. You can also provide your own Script.
IncomingScript	Optional; you can use this property to specify a Script you can use to determine the services to use for authentication, authorization, and/or accounting.
OutgoingScript	Optional; you can use this property to specify a Script you can use to make any Client-specific modifications when responding to a particular Client.
EnableDynamicAuthorization	Optional; when set to TRUE, this property enables Change of Authorization (CoA) and Packet of Disconnect (PoD) features.
DynamicAuthorizationServer	This subdirectory is only present in a client with EnableDynamicAuthorization set to TRUE and contains properties required for CoA and PoD requests.
Port	Located under the DynamicAuthorizationServer subdirectory, the default port is 3799.
InitialTimeout	Located under the DynamicAuthorizationServer subdirectory, the default is 5000.
MaxTries	Located under the DynamicAuthorizationServer subdirectory, the default is 3.
DynamicAuthSharedSecret	Located under the DynamicAuthorizationServer subdirectory, this is the shared secret used for communicating CoA and PoD packets with the client.
PODAttributeGroup	This property is found under the DynamicAuthorizationServer subdirectory and points to a group of attributes to be included in a POD request sent to this client. These attribute groups are created and configured under the AttributeGroups subdirectory in **/Radius/Advanced**.

Table 3-2 Client Properties (continued)

Property	Description
COAAttributeGroup	This property is found under the DynamicAuthorizationServer subdirectory and points to a group of attributes to be included in a CoA request sent to this client. These attribute groups are created and configured under the AttributeGroups subdirectory in **/Radius/Advanced**.
NetMask	Specifies the subnet mask used with the network address setting configured for the IPAdress property when configuring a range of IP addresses. This property is not used for a single client with an IP address only. The NetMask property is used to configure multiple clients when you configure a base IP address in the IPAddress property. You can set the NetMask property for a range of 256 clients using the following example: **set NetMask 255.255.255.0** **Note** If you set the NetMask property, validation will fail if you attempt to specify a subnet mask using CIDR notation with the IPAddress property (described above).
EnableNotifications	Required; the default value is FALSE and indicates the client is not capable of receiving Accounting-Stop notifications from the Cisco AR server. When set to TRUE, the client can receive Accounting-Stop notifications from the Cisco AR server and additional properties must be configured under a new sub-directory named NotificationProperties.
NotificationProperties	When the EnableNotifications property is set to TRUE, this subdirectory contains additional properties required to support the Query-Notify feature.
Port	Located under the NotificationProperties subdirectory, specifies the port used by the Cisco AR server to receive Accounting-Stop packets. Required when EnableNotifications is set to TRUE; the default value is 1813.
InitialTimeout	Located under the NotificationProperties subdirectory, specifies the timeout value in milliseconds the Cisco AR server waits for an Accounting-Response packet before attempting a retry (sending another Accounting-Stop packet to the client). Required when EnableNotifications is set to TRUE; the default value is 5000.
MaxTries	Located under the NotificationProperties subdirectory, specifies the number of times the Cisco AR server sends an Accounting-Stop packet to a client. Required when EnableNotifications is set to TRUE; the default value is 3.
NotificationAttributeGroup	Located under the NotificationProperties subdirectory, specifies the name of an attribute group under **/Radius/Advanced/AttributeGroups** that contains the attributes to be included when sending an the Accounting-Stop packet to this client. Required when EnableNotifications is set to TRUE; there is no default value. You must provide the name of a valid AttributeGroup and the named AttributeGroup must contain at least one valid attribute, or validation will fail.

Editing Clients

The Edit Client page provides fields for the client attributes you can modify. Click **Delete** to remove a client from the list of administrators. Click **Cancel** to return to the Client page.

To modify client attributes, enter new information in the editable fields. If you uncheck the Enable Dynamic Auth Server check box, Cisco AR clears the Port, Dynamic Auth Shared Secret, Initial Timeout, Max Tries, and COA Attribute fields.

Click **Submit** to modify the client. If the modification is successful, Cisco AR returns you to the Clients page. If the modification is not successful, Cisco AR displays an error message and a link back to the Edit Client page.

Profiles

The Profiles page displays an alphabetical list of names and descriptions of the profiles known to the system. Click **Add Profile** to add a new profile. Click **Delete** to remove a profile from the list of profiles. Click **Cancel** to return to the Profiles page.

To locate an profile, enter a partial name in the field provided, then click **Apply Filter**. The **Previous Page** and **Next Page** links take you to a previous page or the next page of data if available. Each profile name in the list is a link to the Edit page for that profile.

Adding Profiles

Enter the name of a new profile in the Name field and an optional description. In the RADIUS Attribute to Value Mappings area, click **Add** to provide an attribute value (AV) pair.

The Add Profile page then displays fields for the **RADIUS Attribute** and **Maps To Attribute Value**. Click **Apply** to add the AV pair, or click **Cancel** to hide the fields without adding the AV pair. You can add as many AV pairs as is required. Click **Submit** to add the new profile. Click **Cancel** to return to the Profiles page without adding the profile.

Table 3-3 provides the profile properties and their definitions.

Table 3-3 Profile Properties

Property	Description
Name	Required profile name
Description	Optional description of the profile
RADIUS Attributes to Value	Optional list of attribute/value pairs

After you successfully add a new profile, Cisco AR returns you to the Profiles page. If the add is not successful, Cisco AR displays an error message and a link back to the Add Profiles page.

Click Add to add AV pairs to the profile

The Submit button submits the new profile and the Cancel button returns the user to the Profiles page without submitting the information. When the new profile is submitted, you are returned to the Profiles page on a successful submit or taken to an error page with an error message and a link back to the Add Profile page.

Editing Profiles

To modify an profile's attributes, enter new information in the editable fields and click **Submit**. If the modification is successful, Cisco AR returns you to the Profiles page. If the modification is not successful, Cisco AR displays an error message and a link back to the Edit Profile page.

Userlists and Users

The UserLists page displays an alphabetical list of all UserLists and descriptions of the UserLists known to the system. The Cisco AR GUI does not support adding, editing, or deleting UserLists; you must use the CLI to add new UserLists.

To locate a UserList, enter a partial name in the field provided, then click **Apply Filter**. The **Previous Page** and **Next Page** links take you to a previous page or the next page of data if available. Each UserList name in the list is a link to the Edit page for that UserList.

List User Page

The List Users page displays an alphabetic list of the Users of a selected UserList. The name of the displayed UserList displays in white at the top of the content area. Click **Add User** to add a new user to this list.

To locate a user in this list, enter a partial name in the field provided, then click **Apply Filter**. The **Previous Page** and **Next Page** links take you to a previous page or the next page of data if available. Each username in the list is a link to the Edit page for that user.

Adding Users

Table 3-4 lists and describes the **Users** fields the GUI provides to add a new user. Enter values for the new user in the appropriate fields. In the RADIUS Attribute to Value Mappings area, click **Add** to provide one or more AV pairs.

Table 3-4 Users Properties

Property	Description
Name	Required; must be unique.
Description	Optional description of the user.
Password	Required; length must be between 0-253 characters.
Confirm Password	Required; must match Password
Enabled	Required; must be checked to allow user access. If Enabled is not checked, user is denied access.
UserGroup	Use pull-down menu to select a UserGroup and use the properties specified in the UserGroup to authenticate and/or authorize the user. The default is none.
Profile	Use pull-down menu to select a Profile. If the service-type is not equal to Authenticate Only, Cisco AR adds the properties in the Profile to the Response dictionary as part of the authorization. This field is optional for the CLI, but required for the GUI. Use the menu to select a profile other than the default None.
AuthenticationScript	Use pull-down menu to select the name of a script to perform additional authentication checks to determine whether to accept or reject the user. This field is optional for the CLI, but required for the GUI. Use the menu to select an AuthenticationScript other than the default None.

Table 3-4 Users Properties (continued)

Property	Description
AuthorizationScript	Use pull-down menu to select the name of a script to add, delete, or modify the attributes of the Response dictionary. This field is optional for the CLI, but required for the GUI. Use the menu to select an AuthorizationScript other than the default None.
RADIUS attribute to value mappings	RADIUS attributes and their assigned value that Cisco AR returns in the Access-Accept response packet.

The Add User page then displays fields for the **RADIUS Attribute** and **Maps To Attribute Value**. Click **Apply** to add the AV pair, or click **Cancel** to hide the fields without adding the AV pair. You can add as many AV pairs as is required.

Click Add to provide RADIUS Attributes and their values

Click **Submit** to add the new user. Click **Cancel** to return to the UserLists page without adding the user. After you successfully add a new user, Cisco AR returns you to the UserLists page. If the add is not successful, Cisco AR displays an error message and a link back to the Add User page.

Editing Users

To modify user attributes, enter new information in the editable fields. Use the Edit User page to provide additional AV pairs. Click **Submit** to change the user attributes. If the modification is successful, Cisco AR returns you to the Users page. If the modification is not successful, Cisco AR displays an error message and a link back to the Edit User page.

Click **Delete** to delete the selected user. If the delete is successful, Cisco AR displays the Users page. If the delete is unsuccessful, Cisco AR displays an error message and a link back to the Edit User page.

Click **Cancel** to return to the previous UserList page.

Monitor Page

The Monitor page provides subareas where you can click to monitor the trace level and server status, view server logs, and monitor and release sessions.

The subareas of Monitor page are:

- Trace Level
- Logs
- Status and Sessions

Trace Level

The Cisco AR GUI provides two options in the Table of Contents (TOC) under **Monitor** > **Trace**:

- AAA Server Trace Level
- View AAA Server Trace

The Set AAA Server Trace Level page is the default view.

Related Topics

- Logs

AAA Server Trace Level

The AAA Server Trace Level page displays the current trace level for the Cisco AR server and provides a pull-down menu that enables you to change the trace level. Cisco AR provides six levels of tracing from zero to five (0-5).

The trace level determines how much information is displayed about the contents of a packet. When the trace level is zero, no tracing is performed. The higher the trace level, the more information displayed. The highest trace level currently used by the Cisco AR server is trace level 5.

The **trace** levels are inclusive, meaning that if you set **trace** to level 3, you will also get the information reported for **trace** levels 1 and 2. If you set trace level 4, you also get information reported for **trace** levels 1, 2, and 3.

Use the pull-down menu to select a trace level, then click **Submit** to set the new trace level. After you set a new trace level, the Cisco AR server returns the AAA Server Trace Level page and displays the selected value.

If an error occurs, the Cisco AR server displays an error page with the error message and a link back to the AAA Server Trace Level page.

Table 3-5 lists the different **trace** levels and the information returned.

Table 3-5 Trace Levels and Information Returned

Trace Level	Information Returned by Trace Command
0	No trace performed
1	Reports when a packet is sent or received or when there is a change in a remote server's status.
2	Indicates the following: • Which services and session managers are used to process a packet • Which client and vendor objects are used to process a packet • Detailed remote server information for LDAP and RADIUS, such as sending a packet and timing out • Details about poorly formed packets • Details included in trace level 1
3	Indicates the following: • Error traces in TCL scripts when referencing invalid RADIUS attributes. • Which scripts have been executed • Details about local UserList processing • Details included in trace levels 1 and 2

Table 3-5 Trace Levels and Information Returned (continued)

Trace Level	Information Returned by Trace Command
4	Indicates the following: • Information about advanced duplication detection processing • Details about creating, updating, and deleting sessions • Trace details about all scripting APIs called • Details included in trace levels 1, 2, and 3
5	Indicates the following: • Details about use of the policy engine including: – Which rules were run – What the rules did – If the rule passed or failed – Detailed information about which policies were called • Details included in trace levels 1, 2, 3, and 4

View AAA Server Trace

The Server Trace log shows a sequence of significant events logged by the Cisco AR server.

Logs

The Table of Contents for the Log subarea provides four options:

- Server Log Page
- Server Accounting Log Page
- Server CLI aregcmd Log Page
- Server Statistics Log Page

The default TOC entry is Server Log.

Server Log Page

The Server Log page displays the server log of events with dates, timestamps, and a short description of the event.

Server Accounting Log Page

The Server Accounting Log page shows the accounting log history with dates, timestamps, and accounting status types.

Server CLI aregcmd Log Page

The Server CLI **aregcmd** log page displays a log of **aregcmd** events with dates and timestamps.

Server Statistics Log Page

The Server Statistics log page displays the current global statistics for the Cisco AR server.

Status and Sessions

The Table of Contents for the Status and Sessions subarea provides two options:

- AAA Server Status and Sessions Page
- Sessions List and Query Page

The default TOC entry is Server Status.

AAA Server Status and Sessions Page

The AAA Server Status and Sessions page lists the status of the AR Server Agent, the AR GUI, and the health of the server.

Sessions List and Query Page

The Session List and Query page lists currently running sessions and provides fields where you can specify a username or Session ID for which to query. Use the **Release All** button to release all sessions.

Query Session

After you provide a username or SessionID on the Session List and Query page and click **Submit**, the GUI displays the Query Session Result page

The Query Session Result page displays the username, Time, and SessionID of the session found during the query. A message displays to indicate if no sessions were found. Click **Release** to release the session and return to the Sessions page. Click **Cancel** to return to the Session page without releasing the session.

Read-Only GUI

Cisco AR provides a read-only GUI that enables an administrator to observe the system but prevents that administrator from making changes.

When you configure a user to be an administrator, check the View-Only check box to limit the administrator to view-only operation. You can also use the CLI by setting the View-Only property to TRUE under **/Administrator/admin_name**.

When using the Read-Only GUI, the Monitor section displays the same as a fully-enabled administrator, but the Release and Release All buttons do not display. The Configure section displays the same as a fully-enabled administrator, but the Add buttons do not display. When you click the name links, the edit pages display, but in text format without forms or controls.

CHAPTER 4

Access Registrar Server Objects

This chapter describes the objects you use to configure and operate your Cisco Access Registrar RADIUS server.

Cisco AR is configured and operated through a set of *objects*. These objects are arranged in a hierarchy, with some of the objects containing subobjects; just as in a UNIX file system, in which directories can contain subdirectories. All of the objects, except those that are merely lists, contain properties that define the attributes or behavior of the object.

This chapter describes the following Cisco AR objects:

- Radius— root of the configuration hierarchy
- UserLists—contains individual UserLists, which in turn contain users
- UserGroups—contains individual UserGroups
- Policies—contains individual Policies
- Clients—contains individual Clients
- Vendors—contains individual Vendors
- Scripts—contains individual Scripts
- Services—contains individual Services
- Session Managers—contains individual Session Managers
- Resource Managers—contains individual Resource Managers
- Profiles—contains individual Profiles
- Rules—contains individual Rules
- Translations—contains individual Translations
- TranslationGroups—contains individual Translation Groups
- Remote Servers—contains individual RemoteServers
- Advanced—contains advanced properties, Ports, Interfaces, Reply Messages, and the Attribute dictionary

Radius

The **Radius** object is the root of the hierarchy. For each installation of the Cisco AR server, there is one instance of the **Radius** object. You reach all other objects in the hierarchy from the **Radius**. The following is a listing of the RADIUS server object:

```
[ //localhost/Radius ]
    Name = Radius
    Description =
    Version = 1.7R0
    IncomingScript~ =
    OutgoingScript~ =
    DefaultAuthenticationService~ = local-users
    DefaultAuthorizationService~ = local-users
    DefaultAccountingService~ = local-file
    DefaultSessionService~ =
    DefaultSessionManager~ = session-mgr-1
    UserLists/
    UserGroups/
    Policies/
    Clients/
    Vendors/
    Scripts/
    Services/
    SessionManagers/
    ResourceManagers/
    Profiles/
    Rules/
    Translations/
    TranslationGroups/
    RemoteServers/
    Advanced/
    Replication/
```

Table 4-1 lists the **Radius** properties. You you can set or change Radius properties using the Cisco AR **aregcmd** commands.

Note When a field is listed as required, it means a value must be supplied; that is, the value must be set. You can use the default (if it is supplied) or you can change it to something else, but you cannot unset it. You *must* supply values for the required fields and for which no defaults exist.

Table 4-1 Radius Properties

Property	Description
Name	Required; must be unique in the list of servers in the cluster
Description	Optional description of the server
Version	Required; the currently installed version of Cisco AR
IncomingScript	Optional; if there is a script, it is the first script Cisco AR runs when it receives a request from any client and/or for any service
OutgoingScript	Optional; if there is a script, it is the last script Cisco AR runs before it sends a response to any client

Table 4-1 Radius Properties (continued)

Property	Description
DefaultAuthenticationService	Optional; Cisco AR uses this property when none of the incoming scripts sets the environment dictionary variable **Authentication-Service**
DefaultAuthorizationService	Optional; Cisco AR uses this property when none of the incoming scripts sets the environment dictionary variable **Authorization-Service**
DefaultAccountingService	Optional; Cisco AR uses this property when none of the incoming scripts sets the environment dictionary variable **Accounting-Service**
DefaultSessionService	Optional; Cisco AR uses this property when none of the incoming scripts sets the environment dictionary variable **Session-Service**.
DefaultSessionManager	Optional; Cisco AR uses this property if none of the incoming scripts sets the environment dictionary variable **Session-Manager**.

The remaining Cisco AR objects are subobjects of the **Radius** object.

UserLists

The **UserLists** object contains all of the individual UserLists, which in turn, contain the specific users stored within Cisco AR. Cisco AR references each specific UserList by **name** from a Service whose type is set to **local**. When Cisco AR receives a request, it directs it to a Service. When the Service has its type property set to **local**, the Service looks up the user's entry in the specific UserList and authenticates and/or authorizes the user against that entry.

Note User names might not include the forward slash (/) character. If the Cisco AR server receives an access request packet with a User-Name attribute containing a forward slash character and the Cisco AR server uses an internal UserList to look up users, the server produces an error (AX_EINVAL) and might fail. If user names require a forward slash, use a script to translate the slash to an acceptable, unused character.

You can have more than one UserList in the **UserLists** object. Therefore, use the **UserLists** object to divide your user community by organization. For example, you might have separate **UserLists** objects for Company A and B, or you might have separate **UserLists** objects for different departments within a company.

Using separate **UserLists** objects allows you to have the same name in different lists. For example, if your company has three people named `Bob` and they work in different departments, you could create a UserList for each department, and each Bob could use his own name. Using UserLists lets you avoid the problem of `Bob1`, `Bob2`, and so on.

If you have more than one UserList, you can have a script Cisco AR can run in response to requests. The script chooses the Service, and the Service specifies the actual UserList which contains the user. The alternative is dynamic properties.

The subobjects are the Users listed by name. Table 4-2 lists the **UserLists** object properties.

Table 4-2 UserLists Properties

Property	Description
Name	Required; must be unique in UserLists.
Description	Optional description of the UserList.

Users

The **Users** object contains all of the information necessary to authenticate a user or authorize a user. Users in local UserLists can have multiple profiles. Table 4-3 lists the **Users** object properties.

Table 4-3 Users Properties

Property	Description
Name	Required; must be unique in the specific UserList.
Description	Optional description of the user.
Password	Required; length must be between 0-253 characters.
Enabled	Required; default is TRUE, which means the user is allowed access. Set to FALSE to cause Cisco AR to deny the user access.
Group (Overridden by User-Group)	Optional; when you set this to the name of a UserGroup, Cisco AR uses the properties specified in that UserGroup to authenticate and/or authorize the user.
BaseProfile (Overridden by User-Profile)	Optional; when you set this to the name of a Profile and the service-Type is not equal to Authenticate Only, Cisco AR adds the properties in the Profile to the Response dictionary as part of the authorization.
AuthenticationScript	Optional; when you set this property to the name of a script, you can use the script to perform additional authentication checks to determine whether to accept or reject the user.
AuthorizationScript	Optional; when you set this property to the name of a script, you can use the script to add, delete, or modify the attributes of the Response dictionary.
UserDefined1	Optional; you can use this property to store notational information, which you can then use to filter the UserList. This property also sets the environment variable for UserDefined1.

HiddenAttributes Property

The HiddenAttributes property in the user object provides a concatenation of all user-level reply attributes. The Cisco AR server uses the HiddenAttributes property to construct and populate a virtual attributes directory.

The HiddenAttributes property is, in fact, hidden. It is not displayed and cannot be set or modified using **aregcmd**, but when an administrator issues a **save**, all values from the user's Attributes directory go into the HiddenAttributes property and the persistent storage.

The attributes are added in a replace-if-present-add-if-not manner as used in the UserGroup-Base-Profile and User-Base-Profile. The order of application of the attributes is as follows:

- UserGroup Base Profile

- UserGroup Attributes
- User Base Profile
- User Attributes

UserGroups

The **UserGroups** objects allow you to maintain common authentication and authorization attributes in one location, and then have many users reference them. By having a central location for attributes, you can make modifications in one place instead of having to make individual changes throughout your user community.

For example, you can use several **UserGroups** to separate users by the services they use, such as a group specifying PPP and another for Telnet.

Table 4-4 lists the **UserGroups** properties.

Table 4-4 UserGroups Properties

Property	Description
Name	Required; must be unique in the **UserGroup** list.
Description	Optional description of the group.
BaseProfile	Optional; when you set this to the name of a Profile, Cisco AR adds the properties in the Profile to the response dictionary as part of the authorization.
AuthenticationScript	Optional; when you set this property to the name of a Script, you can use the Script to perform additional authentication checks to determine whether to accept or reject the user.
AuthorizationScript	Optional; when you set this property to the name of a Script, you can use the Script to add, delete, or modify the attributes of the Response dictionary.

Policies

A Policy is a set of rules applied to an Access-Request. If you are using **Policies**, the first one that must be created is SelectPolicy.

Table 4-5 lists the properties required for a given **Policy**.

Table 4-5 Policies Properties

Property	Description
Name	Required; must be unique in the **Policies** list
Description	Optional description of the Policy
Grouping	Optional grouping of rules

Clients

All NASs and proxy clients that communicate directly with Cisco AR must have an entry in the **Clients** list. This is required because NAS and proxy clients share a secret with the RADIUS server which is used to encrypt passwords and to sign responses. Table 4-6 lists the **Client** object properties.

Table 4-6 Client Properties

Property	Description
Name	Required and should match the Client identifier specified in the standard RADIUS attribute, **NAS-Identifier**. The name must be unique within the Clients list.
Description	Optional description of the client.
IPAddress	Required; must be a valid IP address and unique in the Clients list. Cisco AR uses this property to identify the Client that sent the request, either using the source IP address to identify the immediate sender or using the **NAS-IP-Address** attribute in the Request dictionary to identify the NAS sending the request through a proxy. When a range is configured for a Client's IPAddress property, any incoming requests whose source address belongs to the range specified, will be allowed for further processing by the server. Similarly when a wildcard (an asterisk '*' in this case) is specified, any incoming requests whose source address matches the wildcard specification will be allowed. In both the cases, the configured client properties like SharedSecret, and Vendor are used to process the requests. You can specify a range of IP addresses using a hyphen as in: 100.1.2.11-20 You can use an asterisk wildcard to match all numbers in an IP address octet as in: 100.1.2.* You can specify an IPAddress and a subnet mask together using Classless Inter-Domain Routing (CIDR) notation as in: 100.1.2.0/24 You can use the IPAddress property to set a base address and use the NetMask property to specify the number of clients in the subnet range.
SharedSecret	Required; must match the secret configured in the Client.
Type	Required; accept the default (NAS), or set it to ATM, Proxy, or NAS+Proxy.
Vendor	Optional; you can use this property when you need special processing for a specific vendor's NAS. To use this property, you must configure a **Vendor** object and include a Script. Cisco AR provides five Scripts you can use: one for Ascend, Cisco, Cabletron, Altiga, and one for USR. You can also provide your own Script.

Table 4-6 Client Properties (continued)

Property	Description
IncomingScript	Optional; you can use this property to specify a Script you can use to determine the services to use for authentication, authorization, and/or accounting.
OutgoingScript	Optional; you can use this property to specify a Script you can use to make any Client-specific modifications when responding to a particular Client.
EnableDynamicAuthorization	Optional; when set to TRUE, this property enables Change of Authorization and Packet of Disconnect features.
DynamicAuthorizationServer	This subdirectory is only present in a client with EnableDynamicAuthorization set to TRUE and contains properties required for CoA and PoD requests.
Port	Located under the DynamicAuthorizationServer subdirectory, the default port is 3799.
InitialTimeout	Located under the DynamicAuthorizationServer subdirectory, the default is 5000.
MaxTries	Located under the DynamicAuthorizationServer subdirectory, the default is 3.
DynamicAuthSharedSecret	Located under the DynamicAuthorizationServer subdirectory, this is the shared secret used for communicating CoA and PoD packets with the client.
PODAttributeGroup	This property is found under the DynamicAuthorizationServer subdirectory and points to a group of attributes to be included in a POD request sent to this client. These attribute groups are created and configured under the AttributeGroups subdirectory in **/Radius/Advanced**.
COAAttributeGroup	This property is found under the DynamicAuthorizationServer subdirectory and points to a group of attributes to be included in a CoA request sent to this client. These attribute groups are created and configured under the AttributeGroups subdirectory in **/Radius/Advanced**.

Table 4-6 Client Properties (continued)

Property	Description
NetMask	Specifies the subnet mask used with the network address setting configured for the IPAdress property when configuring a range of IP addresses. This property is not used for a single client with an IP address only. The NetMask property is used to configure multiple clients when you configure a base IP address in the IPAddress property. You can set the NetMask property for a range of 256 clients using the following example: **set NetMask 255.255.255.0** When the NetMask property indicates a pool of 256 address (255.255.255.0), the range of addresses reserved for clients is 0-255, as in 100.1.1.0-100.1.1.255. **Note** If you set the NetMask property, validation will fail if you attempt to specify a subnet mask using CIDR notation with the IPAddress property (described above).
EnableNotifications	Required; the default value is FALSE and indicates the client is not capable of receiving Accounting-Stop notifications from the Cisco AR server. When set to TRUE, the client can receive Accounting-Stop notifications from the Cisco AR server and additional properties must be configured under a new sub-directory named NotificationProperties.
NotificationProperties	When the EnableNotifications property is set to TRUE, this subdirectory contains additional properties required to support the Query-Notify feature.
Port	Located under the NotificationProperties subdirectory, specifies the port used by the Cisco AR server to receive Accounting-Stop packets. Required when EnableNotifications is set to TRUE; the default value is 1813.
InitialTimeout	Located under the NotificationProperties subdirectory, specifies the timeout value in milliseconds the Cisco AR server waits for an Accounting-Response packet before attempting a retry (sending another Accounting-Stop packet to the client). Required when EnableNotifications is set to TRUE; the default value is 5000.

Table 4-6 Client Properties (continued)

Property	Description
MaxTries	Located under the NotificationProperties subdirectory, specifies the number of times the Cisco AR server sends an Accounting-Stop packet to a client. Required when EnableNotifications is set to TRUE; the default value is 3.
NotificationAttributeGroup	Located under the NotificationProperties subdirectory, specifies the name of an attribute group under **/Radius/Advanced/AttributeGroups** that contains the attributes to be included when sending an the Accounting-Stop packet to this client. Required when EnableNotifications is set to TRUE; there is no default value. You must provide the name of a valid AttributeGroup and the named AttributeGroup must contain at least one valid attribute, or validation will fail.

Vendors

The **Vendor** object provides a central location for specifying all of the request and response processing a particular NAS or Proxy vendor requires. Depending on the vendor, it might be necessary to map attributes in the request from one set to another, or to filter out certain attributes before sending the response to the client. For more information about standard RADIUS attributes, see Appendix C, "RADIUS Attributes."

Note When you have also set **/Radius/IncomingScript**, Cisco AR runs that script before the vendor's script. Conversely, when you have set a **/Radius/Outgoing** script, Cisco AR runs the vendor's script before that script.

Table 4-7 lists the **Vendor** object properties.

Table 4-7 Vendor Properties

Property	Description
Name	Required; must be unique in the Vendors list.
Description	Optional description of the vendor.
IncomingScript	Optional; when you specify an IncomingScript, Cisco AR runs the script on all requests from clients that specify that vendor.
OutgoingScript	Optional; when you specify an OutgoingScript, Cisco AR runs the script on all responses to the Client.

Scripts

The **Script** objects define the function Cisco AR invokes whenever the **Script** is referenced by name from other objects in the configuration.

You can write three types of scripts:

- REX (RADIUS EXtension) scripts are written in C or C++, and thus are compiled functions that reside in shared libraries
- Tcl scripts are written in Tcl, and are interpreted functions defined in source files.
- Java scripts

Note For more information about how to write scripts and how to incorporate them into Cisco AR, see Chapter 9, "Using Extension Points."

Table 4-8 lists the **Script** object properties.

Table 4-8 Script Object Properties

Property	Description
Name	Required; must be unique in the Scripts list.
Description	Optional description of the script.
Language	Required; specify either REX, Tcl, or Java.
Filename	Required; specifies either a relative or absolute path. When you specify a relative path, the path must be relative to the **$INSTALL/scripts/radius/$Language** directory. When you specify an absolute path, the server must be able to reach it.
EntryPoint	Optional; when not set, Cisco AR uses the value specified in the **Name** property.
InitEntryPoint	Optional; if set, it must be the name of the global symbol Cisco AR should call when it initializes the shared library at system start up, and just before it unloads the shared library.
InitEntryPointArg	Optional; when set, it provides the arguments to be passed to the **InitEntryPoint** in the environmental variable **Arguments**.
ClassName	For Java language scripts, the name of the class that implements the extension interface; the **.class** file should be placed in **/cisco-ar/scripts/radius/java**
InitializeArg	Optional for Java language scripts; set to a string to be passed to the Initialize method if the class implements the optional ExtensionWithInitialization interface.

The **InitEntryPoint** properties allow you to perform initialization before processing and then cleanup before stopping the server. For example, when Cisco AR unloads the script (when it stops the RADIUS server) it calls the **InitEntryPoint** again to allow it to perform any clean-up operations as a result of its initialization. One use of the function might be to allow the script to close an open Accounting log file before stopping the RADIUS server.

Note When you use a Cisco AR file service, Cisco AR automatically closes any opened files. However, if you write scripts that manipulate files, you are responsible for closing them.

Note If you have more than one extension point script (defined under **/Radius/Scripts**) using the same Java class, only one instance of the class is created and used for all the extension point scripts.

Services

Cisco AR supports authentication, authorization, and accounting (AAA) services. In addition to the variety of built-in AAA services (specified in the **Type** property), Cisco AR also enables you to add new AAA services through custom shared libraries.

Table 4-9 lists the common **Services** properties. There are additional properties depending on the type of service.

Table 4-9 Common Service Properties

Property	Description
Name	Required; must be unique in the Services list.
Description	Optional description of the service.
Type	Required, must set it to a valid Cisco AR service.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; when set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.

Note **OutagePolicy** also applies to Accounting-Requests. If an Accounting-Request is directed to an unavailable Service, then the values in Table 4-10 apply.

Table 4-10 OutagePolicy Request Packets

Property	Description	Accounting-Request Description
AcceptAll	Continues processing the packet as if the Service was successful.	The Accounting-Request will continue through the server and a response will be sent.
DropPacket	Immediately drops the packet, no further processing, and does not send any response to the client for this packet.	The packet will be discarded and it will not be processed any further.
RejectAll	Rejects the packet, but continues processing it and sends the client a reject response.	The request will be dropped and no more processing will be done.

Types of Services

This section lists the types of services available in Cisco AR 4.1 with their required and optional properties. The service you specify determines what additional information you must provide.

Domain Authentication

The Domain Authentication service type, domain-auth, is used with a Remote Server of the same type to provide support for authentication against Windows Domain Controller/Active Directory (WDC/AD). The following example lists the default configuration for a domain-auth service which are all common service properties described in Table 4-9:

```
[ //localhost/Radius/Services/wdc ]
    Name = wdc
    Description =
    Type = domain-auth
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
```

EAP Services

Cisco AR supports Extensible Authentication Protocol (EAP) and Protected EAP (PEAP) to provide a common protocol for differing authentication mechanisms. EAP enables the dynamic selection of the authentication mechanism at authentication time based on information transmitted in the Access-Request. Cisco AR provides the following EAP services:

- EAP-FAST
- EAP-GTC
- EAP-LEAP
- EAP-MD5
- EAP-MSChapV2
- EAP-Negotiate
- EAP-SIM
- EAP-Transport Level Security (TLS)
- EAP-Tunneled TLS (TTLS)
- PEAP Version 0 (Microsoft PEAP)
- PEAP Version 1 (Cisco PEAP)

Refer to Chapter 8, "Extensible Authentication Protocols," for detailed information about properties used in EAP-type services.

File

Specify the **file** service when you want Cisco AR's RADIUS Server to perform local accounting using a specific file. Every **file** Service in your configuration will cause a file with the configured name to be created when the server is started, even if the service is not being invoked by any request packets. Table 4-11 lists the properties used for a **file** service.

Table 4-11 File Service Properties

Property	Description
Type	Required; must be set to **group** for a group service.
IncomingScript	Name of script to run when the service starts.
OutgoingScript	Name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
FilenamePrefix	Required; a string that specifies where Cisco AR writes the account records. It must be either a relative or absolute path. When you specify a relative path, it must be relative to the **$INSTALL/logs** directory. When you specify an absolute path, the server must be able to reach it. The default is **Accounting**.
MaxFileSize	Optional; stored as a string, but is composed of two parts, a number and a units indicator (<n> <units>) in which the unit is one of: K, Kilobyte, Kilobytes, M, Megabyte, Megabytes, G, Gigabyte, Gigabytes. The default is ten megabytes.
MaxFileAge	Optional; stored as a string, but is composed of two parts, a number and a units indicator (*<n> <units>*) in which the unit is one of: H, Hour, Hours, D, Day, Days, W, Week, Weeks. The default is one day.
RolloverSchedule	Indicates the exact time including the day of the month or day of the week, hour and minute to roll over the accounting log file.
UseLocalTimeZone	When set to TRUE, indicates the accounting records' TimeStamp is in local time. When set to FALSE, the default, accounting records' TimeStamp is in GMT.

Cisco AR opens the file when it starts the RADIUS server and closes the file when you stop the server. You can depend on Cisco AR flushes the accounting record to disk before it acknowledges the request.

Based on the maximum file size and age you have specified, Cisco AR closes the accounting file, moves it to a new name, and reopens the file as a new file. The name Cisco AR gives this accounting file depends on its creation and modification dates.

- If the file was created and modified on the same date, the file name is **FileNamePrefix-***<yyyymmdd>***-***<n>***.log**. The date is displayed as year, month, day, number.
- If the file was created on one day and modified on another, the file name is **FileNamePrefix-***<yyyymmdd>***-***<yyyymmdd>***-***<n>***.log**. The dates are creation, modification, and number.

Group

A group service contains a list of references to other services and specifies whether the responses from each of the services should be handled as a logical AND or a logical OR function. You specify AND or OR in the Result-Rule attribute of Group Services. The default value is AND.

Table 4-12 lists the properties used to configure a **group** service.

Table 4-12 Group Service Properties

Property	Description
Type	Required; must set it to group.
IncomingScript	Optional; name of script to run when the service starts.
OutgoingScript	Optional; name of script to run when the service ends.
ResultRule	When set to AND (the default), the response from the GroupService is positive if each of the services referenced return a positive result. The response is negative if any of the services reference return a negative result. When set to OR, the response from the GroupService is positive if any of the services referenced return a positive result. The response is negative if all the referenced services return a negative result. The settings parallel-AND or parallel-OR are similar to AND and OR settings, except that each referenced service processes requests simultaneously instead of asking each reference service sequentially to save processing time.
GroupServices	Use the GroupServices subdirectory to specify the subservices in an indexed list to provide specific ordering control of which services to apply first. Each subservice listed must be defined in the Services section of the Radius configuration and cannot be a of type *g*roup, eap-leap, or eap-md5.

If Result-Rule is set to AND, the response from the Group Service is positive if each of the services referenced return a positive result. The response is negative if any of the services reference return a negative result. If Result-Rule is set to OR, the response from the Group Service is positive if any of the services referenced return a positive result. The response is negative if all the referenced services return a negative result.

When the Result-Rule attribute is set to AND or OR, each referenced service is accessed sequentially, and the Group Service waits for a response from the first referenced service before moving on to the next service (if necessary). If a service takes a long time to respond, that causes a delay in sending the request to the next referenced server.

The ResultRule settings parallel-and and parallel-or are similar to the AND and OR settings except that they ask each referenced service to process the request simultaneously instead of asking each referenced server sequentially, thereby saving processing time.

A parallel-and setting might respond with its own reply as soon as it receives a negative response, but otherwise must wait for all responses before it can respond with a positive reply. Likewise, a parallel-or might respond as soon as it receives a positive response, but otherwise must wait for all responses before it can reply with a negative response.

If a service referenced from a Group Service is of type RADIUS and if Accounting-Requests are being processed by the Group Service, setting the AckAccounting property in the remote server will affect the behavior of the parallel-or Group Service. This is because if AckAccounting is set to FALSE, the RADIUS Remote Server will not wait for the response from the remote server but returns a response immediately. Since the Group Service is set to parallel-or, once it receives the response from the

RADIUS service, it is free to send a response itself. This will have the effect that a response is sent very quickly from the Group Service acknowledging the Accounting-Request and responses from the other referenced services are handled as the arrive.

Note that since AckAccounting was set to FALSE, there is no guarantee that the Remote Server successfully processed the request. Since it is a RADIUS Remote Server, the Cisco AR server attempts for MaxTries to send the request to the server and to get back an acknowledgement, but if that fails, there will be no indication to the client about that event. The acknowledgement to the client has been sent long before.

Java

Specify the **java** service type when you want to create a custom service and use a script for authentication, authorization, or accounting. Table 4-13 lists the properties required to configure a java service.

A java service uses an extension point script to provide the service's functionality and handles both RADIUS and TACACS requests for authentication, authorization, and accounting.

Table 4-13 Java Service Properties

Property	Description
Type	Required; must set it to java.
IncomingScript	Name of script to run when the service starts.
OutgoingScript	Name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
ClassName	Set to the name of a class that implements the Extension interface.
InitializeArg	Optional; set to a string to be passed to the Initialize method if the class implements the optional ExtensionWithInitialization interface.

LDAP

Specify the **ldap** service type when you want to use a particular LDAP remote server for authentication and/or authorization. Table 4-14 lists the properties used to configure an LDAP service.

When using LDAP for authentication and a local database for authorization, ensure that the usernames in both locations are identical with regard to case sensitivity.

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Table 4-14 LDAP Service Properties

Property	Description
Type	Required, must set it to **ldap**
IncomingScript	Name of script to run when the service starts.
OutgoingScript	Name of script to run when the service ends.

Table 4-14 LDAP Service Properties (continued)

Property	Description
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
MultipleServersPolicy	Required; must be set to either **Failover** or **RoundRobin**. When you set it to **Failover**, Cisco AR directs requests to the first server in the list until it determines the server is off-line. At which time, Cisco AR redirects all requests to the next server in the list until it finds a server that is on-line. When you set it to **RoundRobin**, Cisco AR directs each request to the next server in the RemoteServers list in order to share the resource load across all of the servers listed in the RemoteServers list.
RemoteServers	Required; an indexed list from 1 to <*n*>. Each entry in the list is the name of a RemoteServer.

Local

Specify **local** when you want the Cisco AR server to perform the authentication and authorization using a specific UserList. For more information, see the "UserLists" section on page 4-3. Table 4-15 lists the properties used to configure a **local** service.

Table 4-15 Local Service Properties

Property	Description
Type	Required, must set it to **local**.
IncomingScript	Optional; name of script to run when the service starts.
OutgoingScript	Optional; name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
FilenamePrefix	Required; a string that specifies where Cisco AR writes the account records. It must be either a relative or absolute path. When you specify a relative path, it must be relative to the **$INSTALL/logs** directory. When you specify an absolute path, the server must be able to reach it. The default is **Accounting**.

Table 4-15 Local Service Properties (continued)

Property	Description
MaxFileSize	Optional; stored as a string, but is composed of two parts, a number and a units indicator (<n> <units>) in which the unit is one of: K, Kilobyte, Kilobytes, M, Megabyte, Megabytes, G, Gigabyte, Gigabytes. The default is ten megabytes.
MaxFileAge	Optional; stored as a string, but is composed of two parts, a number and a units indicator (*<n> <units>*) in which the unit is one of: H, Hour, Hours, D, Day, Days, W, Week, Weeks. The default is one day.
RolloverSchedule	Indicates the exact time including the day of the month or day of the week, hour and minute to roll over the accounting log file.
UseLocalTimeZone	When set to TRUE, indicates the accounting records' TimeStamp is in local time. The default, FALSE, indicates accounting records TimeStamp in GMT.

ODBC

Specify **odbc** when you want to use an ODBC service for authentication, authorization and accounting through an ODBC data store. Use an ODBC service to authenticate and authorize an access requests by querying user information through ODBC and to insert accounting records into a data store through ODBC. Table 4-16 lists the properties used to configure an ODBC service.

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Table 4-16 ODBC Service Properties

Property	Description
Type	Required; must set it to **odbc**.
IncomingScript	Optional; name of script to run when the service starts.
OutgoingScript	Optional; name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
MultipleServersPolicy	Required; must be set to either **Failover** or **RoundRobin**. When you set it to **Failover**, Cisco AR directs requests to the first server in the list until it determines the server is off-line. At which time, Cisco AR redirects all requests to the next server in the list until it finds a server that is on-line. When you set it to **RoundRobin**, Cisco AR directs each request to the next server in the RemoteServers list in order to share the resource load across all of the servers listed in the RemoteServers list.
RemoteServers	Required; an indexed list from 1 to *<n>*. Each entry in the list is the name of a RemoteServer.

RADIUS

Specify the **radius** service type when you want to use a particular RADIUS remote server for authentication and authorization. Table 4-17 lists the properties used to configure a RADIUS service.

Table 4-17 RADIUS Service Properties

Property	Description
Type	Required; must set it to **radius**.
IncomingScript	Optional; name of script to run when the service starts.
OutgoingScript	Optional; name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
MultipleServersPolicy	Required; must be set to either **Failover** or **RoundRobin**. When you set it to **Failover**, Cisco AR directs requests to the first server in the list until it determines the server is off-line. At which time, Cisco AR redirects all requests to the next server in the list until it finds a server that is on-line. When you set it to **RoundRobin**, Cisco AR directs each request to the next server in the RemoteServers list in order to share the resource load across all of the servers listed in the RemoteServers list.
RemoteServers	Required; an indexed list from 1 to <*n*>. Each entry in the list is the name of a RemoteServer.

Radius Query

Cisco AR 4.1 supports a new service type called radius-query that can be used to query cached data through Radius packets. This radius-query service contains a list of session managers to be queried from and a list of (cached) attributes to be returned in the Access-Accept packet in response to a Radius Query request. Cisco AR 4.1 also supports caching and querying of multi-valued attributes.

The Radius Query service should be selected through an extension point script or through the Rule and Policy Engine by setting it to a new environment variable named Query-Service. The reason for this is that the Radius Query request comes in as an Access-Request and the server has no way of knowing whether it is a Radius Query request or normal authentication request. Setting the Query-Service environment variable tells the Cisco AR server that the request is a Radius Query request so the Cisco AR server can process the request with the radius-query service set in the Query-Service environment variable.

When a Radius Query service is selected to process an Access-Request, it queries the configured list of Session Managers for a matching record using the QueryKey value configured in the session-cache Resource Manager referenced under these Session Managers as key. If a matching record is found, an Access-Accept containing a list of cached attributes present (based on the configuration) in the matched record is sent back to the client. If the session cache contains a multi-valued attribute, all values of that attribute are returned in the response as a multi-valued attribute. If there is no matching record, an Access-Reject packet is sent to the client.

Cisco AR 4.1 introduces scripting points at the Session Manager level along with automated programmable interfaces (APIs) to access cached information present in the session record. You can use these scripting points and APIs to write extension point scrips to modify the cached information.

The following example shows the default configuration of a radius-query service:

```
[ //localhost/Radius/Services/radius-query ]
    Name = radius-query
    Description =
    Type = radius-query
    IncomingScript~ =
    OutgoingScript~ =
    SessionManagersToBeQueried/
    AttributesToBeReturned/
```

Table 4-18 lists the properties used to configure a Radius Query service.

Table 4-18 Radius Query Service Properties

Property	Description
Type	Required; must set it to **radius query**.
IncomingScript	Optional; name of script to run before this service starts processing on the request.
OutgoingScript	Optional; name of script to run after this service completes processing on the request.

Table 4-18 Radius Query Service Properties (continued)

Property	Description
SessionManagersToBeCached	Lists Session Managers to be queried for the target record. If this list is empty, all Session Managers having session-cache Resource Managers will be queried for the target record. Otherwise, only those SessionManagers configured under SessionManagerToBeQueried are queried. If the targeted record is found in a Session Manager, the query stops and the response is returned to the client.
AttributesToBeReturned	Lists attributes to be returned if present in a matched record. If this list is empty, all attributes cached in a matched session are returned. If a configured attribute is not present in the matched record, that attribute is ignored. **Note** The User-Password attribute will not be returned in query responses and cannot be configured under AttributesToBeReturned.

When an Access-Request packet is received by the Cisco AR server, the session-cache Resource Manager caches the configured attributes in the session with the configured QueryKey as the key to the cached data. In the TAL solution, the QueryKey will usually be Framed-IP-Address. If an Accounting-Requestor Accounting-Start packet is received for the same session, the cached data is updated if necessary. If there is a multi-valued attribute in the Access-Request packet or Accounting-Request packet, the Cisco AR server caches all the values of that attributes.

In TAL, when the SSG receives an IP packet originating from a user unknown to the SSG, it sends an Access-Request packet to the Cisco AR server in which the User-Name and Framed-IP-Address attributes both contain the user's source IP address, and the Service-Type is set to Outbound, among other attributes. These attributes and their values distinguish Radius Query requests from normal authentication requests in TAL.

Note In solutions other than TAL, the criterion that distinguishes Radius Query requests from normal authentication requests might be different.

A new environment variable, Query-Service, can be set to the name of a radius-query service, in an extension point script, or through the Rule and Policy engine so the Cisco AR server knows the current request is a Radius Query request and processes it with the radius-query service value set in the Query-Service environment variable.

API Calls

Cisco AR 4.1 provides several new API calls you can use to get, put, and delete the cached attributes present in the session record. The entry point function changes slightly to take a fifth argument which is a pointer to a structure containing the new API calls:

```
typedef int (REXAPI * RexEntryPointFunction)
(
    int iScriptingPoint,
    rex_AttributeDictionary_t* pRequest,
    rex_AttributeDictionary_t* pResponse,
    rex_EnvironmentDictionary_t* pRadius,
    rex_SessionRecord_t* pSession
);
```

However, you can continue to write extension point scripts with four arguments as well, for example without the pSession argument.

The following are API calls and their functionality. All these API calls fail gracefully when they are invoked from any scripting point other than the Session Manager scripting points.

const char* get

```
const char* get(
    rex_SessionRecord_t* pSession,
    const char* pszAttribute,
    int <iIndex>,
    abool_t* <pbMore>
    )
```

This API returns the value of the <iIndex>'d instance of the attribute cached in the session, represented as a string. When the session does not contain the attribute, an empty string is returned. When <pbMore> is non-zero, this method sets <pbMore> to TRUE when more instances of the same attribute exist after the one returned and to FALSE otherwise. This can be used to determine whether another call to get() method should be made to retrieve other instances of the same attribute.

abool_t put

```
abool_t put(
    rex_SessionRecord_t* pSession,
    const char* pszAttribute,
    const char* <pszValue>,
    int <iIndex>
    )
```

When <iIndex> equals the special value REX_REPLACE, this method replaces any existing instances of <pszAttribute> with a single value in the session. When <iIndex> equals the special value REX_APPEND, it appends a new instance of <pszAttribute> to the end of the list of existing instances of <pszAttribute>. When <iIndex> equals the special value REX_AUGMENT, this method only puts <pszAttribute> when it does not already exist. Otherwise, a new instance of <pszAttribute> is inserted/replaced at the position indicated. This method returns TRUE if it is able to cache the attribute successfully and FALSE otherwise.

abool_t remove

```
abool_t remove(
    rex_SessionRecord_t* pSession,
    const char* pszAttribute,
```

```
int <iIndex>
)
```

This method removes the <pszAttribute> from the session. When <iIndex> equals the special value REX_REMOVE_ALL, this method removes any existing instances of <pszAttribute>. Otherwise, it removes the instance of <pszAttribute> at the position indicated. It returns FALSE when <pszAttribute> is not present at any index in the session record and returns TRUE otherwise.

rex_SessionInfo_t*

```
rex_SessionInfo_t* getSessionInfo(rex_SessionRecord_t* pSession )
```

This method returns the pointer to a structure that contains the other session-related information, like Session Id, Session Start time, Session Last Accessed Time, present in the session record. The structure that holds this information will appear as follows:

```
typedef  struct rex_SessionInfo_s
{
    auint32_t iSessionId;
    auint32_t tSessionStartTime;
    auint32_t tSessionLastAccessedTime;
} rex_SessionInfo_t;
```

Tcl API calls

To use the extension point scripts written in Tcl, define the procedure at the session manager level as shown below:

```
proc test { request response environ session } {
}
```

There is a fourth argument *session* that needs to be passed to the Tcl procedure and the API calls that are intended to operate on the session record need to use this *session* dictionary.

API calls in Tcl have the same meaning with same number arguments and return values as described in Rex. The only difference is that the API getSessionInfo will not return a structure as in Rex but it will return the info as a string, as in the following example:

```
Session-ID=1, Session-Start-Time=1102099334, Session-Last-Accessed-Time=1102099334
```

Java API calls

There are two new interfaces ExtensionForSession and ExtensionForSessionWithInitialization and the customers whishing to use the extension point scripts written in Java at the session manager level needs to implement one of these interfaces.

The runExtension method of these interfaces will look as below:

```
public int runExtension
    ( int iExtensionPoint,
    AttributeDictionary request,
    AttributeDictionary response,
    EnvironmentDictionary environment,
    SessionRecord session
```

);

API calls that are intended to operate on session record needs to use this 'session' dictionary.

API calls in Java have the same meaning with same number arguments and return values as described in Rex. The only difference is that the API getSessionInfo will not return a structure as in Rex but it will return the info as a string. For example:

Session-ID=1, Session-Start-Time=1102099334, Session-Last-Accessed-Time=1102099334

Existing scripts written in any of these three languages will not be affected with the introduction of the new 'session dictionary' argument. And the customers can use a script with any number of arguments (i.e with or without the last 'session dictionary' argument) at any extension point script. If there is no session to operate on, for example when the customer is trying to use session dictionary argument at an extension point other than session manager's, the Cisco AR gracefully returns an error logging the appropriate message.

The simple *replace or add if it does not exist* model can still be used for simple modifications as before without the need to write a script. If the cached attributes are updated in the IncomingScript and if customers do not want them to be touched or updated again when the processing reaches session-cache resource manager, they can set the OverwriteAttributes property of the session-cache resource manager to FALSE so that the session-cache resource manager will not operate on this packet.

Rex

Specify the **rex** service type when you want to create a custom service and use a script for authentication, authorization, or accounting. Table 4-19 lists the properties required to configure a **rex** service.

Table 4-19 rex Service Properties

Property	Description
Type	Required; must be set to **rex**.
IncomingScript	Optional; name of script to run when the service starts.
OutgoingScript	Optional; name of script to run when the service ends.
OutagePolicy	Required; the default is **RejectAll**. This property defines how Cisco AR handles requests if all servers listed in the **RemoteServers** properties are unavailable (that is, all remote RADIUS servers are not available). You must set it to one of the following: **AcceptAll**, **DropPacket**, or **RejectAll**.
OutageScript	Optional; if you set this property to the name of a script, Cisco AR runs it when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
Filename	Required; must be either a relative or an absolute path to the shared library containing the Service. When the path name is relative, it must be relative to **$INSTALL/Scripts/Radius/rex**.
EntryPoint	Required; must be set to the function's global symbol.
InitEntryPoint	Required; must be the name of the global symbol Cisco AR should call when it initializes the shared library and just before it unloads the shared library. **Note** A rex service must have an InitEntryPoint even if the service only returns REX_OK.
InitEntryPointArgs	Optional; when set, it provides the arguments to be passed to the **InitEntryPoint** in the environmental variable **Arguments**.

For more information about scripting, see Chapter 9, "Using Extension Points." For more information about using the REX Attribute dictionary, see Appendix A, "Cisco Access Registrar Tcl and REX Dictionaries."

Session Managers

You can use Session Managers to track user sessions. The Session Managers monitor the flow of requests from each NAS and detect the session state. When requests come through to the Session Manager, it creates sessions, allocates resources from appropriate Resource Managers, and frees and deletes sessions when users log out.

The Session Manager enables you to allocate dynamic resources to users for the lifetimeof their session. You can define one or more Session Managers and have each one manage the sessions for a particular group or company.

Note Session record size is limited by the operating system (OS) paging size (8 KB in Solaris and 4 KB in Linux). If a request triggers creation of a session that exceeds the OS paging size, the request will be dropped and the session will not be created.

Note If the disk partition where Cisco AR stores session backing store data (usually the disk partition where Cisco AR is installed, such as **/opt/CSCOar**) is full, the subsequent packets that try to create sessions will be dropped and no sessions will be created due to lack of disk space.

Session Managers use Resource Managers, which in turn, manage a pool of resources of a particular type. Table 4-20 lists the Session Manager properties.

Cisco AR 4.1 adds the IncomingScript and OutGoingScript properties. The IncomingScript is run as soon as the session is acquired. The OutGoingScript is run just before the session is written to backing store.

Table 4-20 Session Manager Properties

Property	Description
Name	Required; must be unique in the Session Managers list.
Description	Optional description of the Session Manager.
IncomingScript	Optional; name of script to run when the service starts. This script is run as soon as the session is acquired in Cisco AR 4.1.
OutgoingScript	Optional; script to be run just before the session is written to backing store.

Table 4-20 Session Manager Properties (continued)

Property	Description
SessionTimeOut	The SessionTimeOut property is optional; no value for this property means the session timeout feature is disabled. Used in conjunction with **/Radius/Advanced/SessionPurgeInterval** for the session timeout feature. Enables the session timeout feature for a Session Manager. If the SessionTimeOut property is set to a value under a session manager, all sessions that belong to that session manager will be checked for timeouts at each SessionPurgeInterval. If any sessions have timed out, they will be released, and all resources associated with those sessions are also released. The SessionTimeOut property determines the timeout for a session. If the time difference between the current time and the last update time is greater than this property's value, the session is considered to be stale. The last update time of the session is the time at which the session was created or updated. The SessionTimeOut value is comprised of a number and a units indicator, as in *n units*, where a unit is one of minutes, hours, days, or weeks.
AllowAccountingStartToCreateSession	Set to TRUE by default; start the session when the Cisco AR server receives an Access Accept or an Accounting-Start. When set to FALSE, start the session when the Cisco AR server receives an Access Accept.
Resource Managers	Ordered list of Resource Managers.
PhantomSessionTimeOut	Optional; no value for this property means the phantom session timeout feature is disabled. The PhantomSessionTimeOut property is used in conjunction with **/Radius/Advanced/SessionPurgeInterval** to enable the phantom session timeout feature for Session Manager. If the PhantomSessionTimeOut property is set to a value under a session manager, all sessions that belong to that session manager will be checked for receipt of an Accounting-Start packet. Sessions that do not receive an Accounting-Start packet from creation until its timeout will be released. The PhantomSessionTimeOut value comprises a number and a units indicator, as in *n* units, where a unit is one of minutes, hours, days, or weeks.

You can manage sessions with the two **aregcmd** session management commands: **query-sessions** and **release-sessions**. For more information about these two commands, see the "query-sessions" section on page 2-8 and the "release-sessions" section on page 2-8.

Session Creation

Cisco AR Sessions can be created by two types of RADIUS packets:

- Access-Requests
- Accounting-Requests with an **Acct-Status-Type** attribute with a value of **Start**.

This allows Cisco AR to monitor Sessions even when it is not allocating resources. For example, when Cisco AR is being used as an "Accounting-Only" server (only receiving Accounting requests), it can create a Session for each Accounting "Start" packet it successfully processes. The corresponding Accounting "Stop" request will clean up the Session. Note, if a Session already exists for that NAS/NAS-Port/User (created by an Access-Request), Cisco AR will not create a new one.

When you do not want Cisco AR to create Sessions for Accounting "Start" requests, simply set the **AllowAccountingStartToCreateSession** property on the SessionManager to FALSE.

Session Notes

Session Notes are named text messages attached to a Session and are stored with the Session data, including resources allocated for a specific user session. This data, including Session Notes, can be retrieved and viewed using the **aregcmd** command **query-sessions**.

--> **query-sessions /Radius/SessionManagers/session-mgr-2**

```
sessions for /Radius/SessionManagers/session-mgr-2:
S257 NAS: localhost, NAS-Port:1, User-Name: user1, Time: 00:00:08,
  IPX 0x1, GSL 1, USL 1, NOTES: "Date" "Today is 12/14/98.", "Requested
  IP Address" "1.2.3.4", "Framed-IP-Address" "11.21.31.4"
```

Session Notes can be created by Scripts using the Environment dictionary passed into each or by the Cisco AR server. When more than one Session Note is added, the **Session-Notes** entry should be a comma-separated list of entry names.

For a TCL script:

Step 1 The Script should create an Environment dictionary entry using the Session Note name as the entry name, and the Session Note text as the entry value. For example:

```
$environ put "Date" "Today is 12/15/98"
$environ put "Request IP Address" "1.2.3.4"
```

Step 2 The Script should create or set an Environment dictionary entry with the name **Session-Notes** with a value that contains the name of the entries created. For example:

```
$environ put "Session-Notes" "Date, Requested_IP_Address"
```

For a REX script:

Step 1 The Script should create an Environment dictionary entry using the Session Note name as the entry name, and the Session Note text as the entry value. For example:

```
pEnviron-->put(pEnviron, Date, "Today is 12/15/98.");
pEnviron-->put(pEnviron, Request_IP_Address, "1.2.3.4");
```

Step 2 The Script should create/set an Environment dictionary entry with the name **Session-Notes** with a value that contains the name of the first entry created. For example:

```
pEnviron-->put(pEnviron, "Session-Notes", "Date, Requested_IP_Address");
```

Note Scripts creating Session Notes must be executed before the Session Management step takes place while processing a packet.

Cisco AR will automatically create a Session Note if a packet is passed to a SessionManager and it already contains a **Framed-IP-Address** attribute in the packet's Response dictionary. This IP address could come from a Profile, RemoteServer response, or from a previously executed script. For example, a Session output containing Session Notes when using the **aregcmd** command **query-session** would be as follows:

```
sessions for /Radius/SessionManagers/session-mgr-2:
  S257 NAS: localhost, NAS-Port:1, User-Name: user1, Time: 00:00:08,
  IPX 0x1, GSL 1, USL 1, NOTES: "Date" "Today is 12/14/98.", "Requested
  IP Address" "1.2.3.4", "Framed-IP-Address" "11.21.31.4"
```

Session Notes are also copied into the Environment dictionary after Session Management. The **Session-Notes** Environment dictionary entry will contain the names of all the Environment dictionary entries containing Session Notes.

Soft Group Session Limit

Two new environment variables, **Group-Session-Limit** and **Current-Group-Count** (see rex.h), are set if the group session limit resource is allocated for a packet. These variables allow a script to see how close the group is to its session limit; one way to use this information is to implement a script-based soft limit. For example, you could use the Class attribute to mark sessions that have exceeded a soft limit of 80% -- as hard coded in the script (in a Tcl script called from /Radius/OutgoingScript):

```
set softlimit [ expr 0.8 * [ $environ get Group-Session-Limit ] ]
if { [ $environ get Current-Group-Count ] < $softlimit } {
$response put Class 0
} else {
$response put Class 1
}
```

Note The soft limit itself is hard coded in the script; soft limits are not directly supported in the server. The action to be taken when the soft limit is exceeded (for example, Class = 1, and then the accounting software branches on the value of Class) is also the responsibility of the script and/or external software.

Session Correlation Based on User-Defined Attributes

All the session objects are maintained in one dictionary keyed by a string. You can define the keying material to the session dictionary through a newly introduced environment variable, **Session-Key**.

If the **Session-Key** is presented at the time of session manager process, it will be used as the key to the session object for this session. The **Session-Key** is of type string. By default, the **Session-Key** is not set. Its value should come from attributes in the incoming packet and is typically set by scripts. For example, CLID can be used to set the value of **Session-Key**.

Use the function UseCLIDAsSessionKey as defined in the script **rexscript.c** to specify that the **Calling-Station-Id** attribute that should be used as the session key to correlate requests for the same session. This is a typical case for 3G mobile user session correlation. You can provide your own script to define other attributes as the session key.

In the absence of the **Session-Key** variable, the key to the session will be created based on the string concatenated by the value of the **NAS-Identifier** and the **NAS-Port**.

There is a new option *with-key* available in **aregcmd** for query-sessions and release-sessions to access sessions by **Session-Key**.

Resource Managers

Resource Managers allow you to allocate dynamic resources to user sessions. The following lists the different types of Resource Managers.

- **IP-Dynamic**—manages a pool of IP addresses that allows you to dynamically allocate IP addresses from a pool of addresses
- **IP-Per-NAS-Port**—allows you to associate ports to specific IP addresses, and thus ensure each NAS port always gets the same IP address
- **IPX-Dynamic**—manages a pool of IPX network addresses
- **Subnet-Dynamic**—manages a pool of subnet addresses
- **Group-Session-Limit**—manages concurrent sessions for a group of users; that is, it keeps track of how many sessions are active and denies new sessions once the configured limit has been reached
- **User-Session-Limit**—manages per-user concurrent sessions; that is, it keeps track of how many sessions each user has and denies the user a new session once the configured limit has been reached
- **Home-Agent**—manages a pool of on-demand IP addresses
- **USR-VPN**—manages Virtual Private Networks (VPNs) that use USR NAS Clients.

Each Resource Manager is responsible for examining the request and deciding whether to allocate a resource for the user, do nothing, or cause Cisco AR to reject the request.

Table 4-21 lists the Resource Manager properties.

Table 4-21 Resource Manager Properties

Property	Description
Name	Required; must be unique in the Resource Managers list.
Description	Optional; description of the Resource Manager.
Type	Required; must be either **IP-Dynamic**, **IP-Per-NAS-Port**, **IPX-Dynamic**, **Group-Session-Limit**, **Home-Agent**, **User-Session-Limit**, or **USR-VPN**.

Types of Resource Managers

A number of different types of Resource Managers exist that allow you to manage IP addresses dynamically or statically, limit sessions on a per group or per user basis, or manage a Virtual Private Network. See Appendix A, "Cisco Access Registrar Tcl and REX Dictionaries," for information on how to override these individual Resource Managers.

Gateway Subobject

The **Gateway** subobject includes a list of names of the Frame Relay Gateways for which to encrypt the session key.

If you use this Resource Manager, supply the information listed in Table 4-22.

Table 4-22 Gateway Properties

Property	Description
Name	Required; must be unique in the Gateways list.
Description	Optional description of the gateway.
IPAddress	Required; IP address of the gateway.
SharedSecret	Required; must match the shared secret of the gateway.
TunnelRefresh	Optional; if specified it is the number of seconds the tunnel stays active before a secure "keepalive" is exchanged between the tunnel peers in order to maintain the tunnel open.
LocationID	Optional; if specified it is a string indicating the physical location of the gateway.

Group-Session-Limit

Group-Session-Limit allows you to manage concurrent sessions for a group of users; that is, it keeps track of how many sessions are active and denies new sessions once the configured limit has been reached.

When you use this Resource Manager, you must set the GroupSessionLimit property to the maximum number of concurrent sessions for all users.

Home-Agent

Home-Agent is a new resource manager that supports dynamic HA assignment. You configure the home-agent resource manager with a list of IP addresses. The AR server assigns those addresses to clients whose request dictionary has the right attributes to indicate that an assignment should be done. This is similar to the **ip-dynamic** resource manager.

Unlike the **ip-dynamic** resource manager, HAs are not exclusively allocated to an individual session but are shared among a set of sessions.

Detailed configuration information for the Home-Agent resource manager is found in Chapter 17, "Wireless Support." When you use this Resource Manager, you must set the Home-Agent-IPAddresses property to a single IP address or a range of IP addresses.

IP-Dynamic

IP-Dynamic allows you to manage a pool of IP addresses from which you dynamically allocate IP addresses.

When you use the IP-Dynamic Resource Manager, provide values for the properties listed in Table 4-23.

Table 4-23 IP-Dynamic Properties

Property	Description
NetMask	Required; must be set to a valid net mask.
IPAddresses	Required; must be a list of IP address ranges.
AllowOverlappedIPAddresses	When set to TRUE, this property supports overlapping IP addresses between session managers for VPN users. Default value is FALSE.
ReuseIPForSameSessionKeyAndUser	When set to FALSE, this property does not reuse IP address resources for a session. Default value is TRUE.

IP-Per-NAS-Port

IP-Per-NAS-Port allows you to associate specific IP addresses with specific NAS ports and thus ensures each NAS port always gets the same IP address.

When you use this Resource Manager, provide values for the properties listed in Table 4-24.

Note You must have the same number of IP addresses and ports.

Table 4-24 IP-Per-NAS-Port Properties

Property	Description
NetMask	Required; if used, must be set to a valid net mask.
NAS	Required; must be the name of a known Client.This value must be the same as the NAS-Identifier attribute in the Access-Request packet.
IPAddresses	Required; must be a list of IP address ranges.
NASPorts	Required list of NAS ports.

IPX-Dynamic

An **IPX-Dynamic** Resource Manager allows you to dynamically manage a pool of IPX networks. When you use the IPX-Dynamic Resource Manager, you must set the Networks property to a valid set of numbers which correspond to your networks.

Note You cannot use IPX network number 0x0. If you attempt to configure a Resource Manager with an IPX network number of 0x0, validation will fail.

Session-Cache

The **session-cache** Resource Manager supports the Identity Cache feature. You use session-cache Resource Managers to define the RADIUS attributes to store in cache. Set the QueryKey property to the XML attribute you want to key on such as XML-Address-format-IPv4 and list all attributes to be cached in the AttributesToBeCached subdirectory. Use the QueryMappings subdirectory to map XML attributes to RADIUS attributes.

Table 4-25 Session-Cache Resource Manager Properties

Property	Description
QueryKey	Required; set the QueryKey to the a RADIUS attribute you want to key on, such as Framed-IP-Address. A change made in Cisco AR 4.0 requires that this attribute not be an XML attribute, even if this session-cache resource manager is being used for an XML query. **Note** Any existing session-cache resource managers using an XML attribute for the Query Key must be changed to a RADIUS attribute that this XML attribute is mapped to under QueryMappings.
PendingRemovalDelay	Required; length of time information remains in the cache after the session ends (defaults to 10 seconds)
AttributesToBeCached	Required; use this subdirectory to provide a list of RADIUS attributes you want to store in cache
QueryMappings	Required; list of attribute pairs, mapping the XML attributes on the left-hand side to the RADIUS attribute on the right-hand side.

Note Session record size is limited by the operating system (OS) paging size (8 KB in Solaris and 4 KB in Linux). If a request triggers creation of a session that exceeds the OS paging size, the request will be dropped and the session will not be created.

If the disk partition where Cisco AR stores session backing store data (usually the disk partition where Cisco AR is installed, such as **/opt/CSCOar**) is full, the subsequent packets that try to create sessions will be dropped and no sessions will be created due to lack of disk space.

Subnet-Dynamic

The **subnet-dynamic** Resource Manager supports the On Demand Address Pool feature. You use subnet-dynamic resource managers to provide pools of subnet addresses. Following is an example of the configuration of a subnet dynamic resource manager:

```
/Radius/ResourceManagers/newResourceMgr
Name = newResourceMgr
Description =
Type = subnet-dynamic
Subnet-Mask = 255.255.255.0
SubnetAddresses/
    10.1.0.0-10.1.10.0
    11.1.0.0-11.1.10.0
```

When you use the subnet-dynamic Resource Manager, provide values for the properties listed in Table 4-26.

Table 4-26 Subnet-Dynamic Properties

Property	Description
Type	Required
Subnet mask	Required; must be set to the size of the managed subnets
SubnetAddresses	Required; must be a valid range of IP addresses

User-Session-Limit

User-Session-Limit allows you to manage per-user concurrent sessions; that is, it keeps track of how many sessions each user has and denies the user a new session once the configured limit has been reached.

When you use the user-session-limit Resource Manager, set the user-session-limit property to the maximum number of concurrent sessions for a particular user.

USR-VPN

USR-VPN allows you to set up a Virtual Private Network (VPN) using a US Robotics NAS.

When you use this Resource Manager, provide values for the properties listed in Table 4-27.

Table 4-27 USR-VPN Properties

Property	Description
Identifier	Required; must be set to the VPN ID the USR NAS will use to identify a VPN.
Neighbor	Optional; if set, should be the IP address of the next hop router for the VPN.
FramedRouting	Optional; if set, should be **RIP V2 Off** or **RIP V2 On** if the USR NAS is to run RIP Version 2 for the user.
Gateways	Required to set up a tunnel between the NAS and the Gateways.

Profiles

You use Profiles to group RADIUS attributes that belong together, such as attributes that are appropriate for a particular class of PPP or Telnet user. You can reference profiles by name from either the **UserGroup** or the **User** properties. Thus, if the specifications of a particular profile change, you can make the change in a single place and have it propagated throughout your user community.

Although you can use UserGroups or Profiles in a similar manner, choosing whether to use one rather than the other depends on your site. When you require some choice in determining how to authorize or authenticate a user session, then creating specific profiles, and creating a group that uses a script to choose among them is more flexible.

In such a situation, you might create a default group, and then write a script that selects the appropriate profile based on the specific request. The benefit to this technique is each user can have a single entry, and use the appropriate profile depending on the way they log in.

Table 4-28 lists the **Profile** properties.

Table 4-28 Profile Properties

Property	Description
Name	Required; must be unique in the Profiles list.
Description	Optional; description of the profile.
Attributes	Profiles include specific RADIUS attributes that Cisco AR returns in the Access-Accept response.

Attributes

Attributes are specific RADIUS components of requests and responses defined in the Request and Response Attribute dictionaries. Use the **aregcmd** command **set** to assign values to attributes.

For a complete list of the attributes, see Appendix C, "RADIUS Attributes." When setting a value for a STRING-type attribute such as Connect-Info (which starts with an integer), you must use the hexadecimal representation of the integer. For example, to set the attribute Connect-Info to a value of 7:7, use a set command like the following:

set Connect-Info 37:3A:37

Translations

Translations add new attributes to a packet or change an existing attribute from one value to another. The **Translations** subdirectory lists all definitions of **Translations** the RADIUS server can apply to certain packets.

Under the **/Radius/Translations** directory, any translation to insert, substitute, or translate attributes can be added. The following is a sample configuration under the **/Radius/Translations** directory:

```
cd /Radius/Translations
Add T1
cd T1
Set DeleAttrs Session-Timeout,Called-Station-Id
cd Attributes
Set Calling-Station-Id 18009998888
```

DeleAttrs is the set of attributes to be deleted from the packet. Each attribute is comma separated and no spaces are allowed between attributes. All attribute value pairs under the attributes subdirectory are the attributes and values that are going to be added or translated to the packet.

Under the **/Radius/Translations/T1/Attributes** directory, inserted or translated attribute value pairs can be set. These attribute value pairs are either added to the packet or replaced with the new value.

If a translation applies to an Access-Request packet, by referencing the definition of that translation, the CAR server modifies the Request dictionary and inserts, filters and substitutes the attributes accordingly. You can set many translations for one packet and the CAR server applies these translations sequentially.

Note Later translations can overwrite previous translations.

Table 4-29 lists the Translation properties.

Table 4-29 Translations Properties

Property	Description
Name	Required; must be unique in the Translations list.
Description	Optional; description of the Translation
DeleteAttrs	Optional; lists attributes to be filtered out

TranslationGroups

You can add translation groups for different user groups under **TranslationGroups**. All Translations under the Translations subdirectory are applied to those packets that fall into the groups. The groups are integrated with the CAR Rule engine.

The CAR Administrator can use any RADIUS attribute to determine the **Translation Group**. The incoming and outgoing translation group can be different translation groups. For example, you can set one translation group for incoming translations and one for outgoing translations.

Under the **/Radius/TranslationGroups** directory, translations can be grouped and applied to certain sets of packets, which are referred to in a rule. The following is a sample configuration under the **/Radius/TranslationGroups** directory:

```
cd /Radius/TranslationGroups
Add CiscoIncoming
cd CiscoIncoming
cd Translations
Set 1 T1
```

The translation group is referenced through the Cisco AR Policy Engine in the **/Radius/Rules/**<*RuleName*>**/Attributes** directory. **Incoming-Translation-Groups** are set to a translation group (for example `CiscoIncoming`) and **Outgoing-Translation-Groups** to another translation group (for example `CiscoOutgoing`). Table 4-30 lists the Translation Group properties.

Table 4-30 TranslationGroups Properties

Property	Description
Name	Required; must be unique in the Translations list.
Description	Optional; description of the Translation Group
Translations	Lists of translation

Remote Servers

Cisco AR 4.1 provides the following RemoteServer protocol types:

- Domain Authentication
- Dynamic DNS
- LDAP
- Map-Gateway
- ODBC
- ODBC-Accounting
- Prepaid-CRB
- Prepaid-IS835C
- RADIUS

You can use the **RemoteServers** object to specify the properties of the remote servers to which Services proxy requests. **RemoteServers** are referenced by name from the **RemoteServers** list in either the **radius**, **ldap** or **tacacs-udp** Services.

Table 4-31 lists the common **RemoteServers** properties.

Table 4-31 Common RemoteServer Properties

Property	Description
Name	Required; must be unique in the RemoteServers list.
Description	Optional; description of the remote server.
Protocol	Required; specifies the remote server protocol which can be **radius**, **ldap**, or **tacacs-udp**.
IPAddress	Required; this property specifies where to send the proxy request. It is theaddress of the remote server. You must set it to a valid IP address.
Port	Required; the port to which Cisco AR sends proxy requests. You must specify a number greater than zero. If there is no default port number, you must supply the correct port number for your remote server. If you set a port to zero, Cisco AR sets the port to the default value for the type of remote server being configured. For example, the following remote servers have these default port values: dynamic-dns—53 radius—1645 ldap—389 accounting—1646
ReactivateTimerInterval	Required; the amount of time (in milliseconds) to wait before retrying a remote server that was offline. You must specify a number greater than zero. The default is 300,000 (5 minutes).

Types of Protocols

The Remote Server protocol you specify determines what additional information you must provide. The following are the protocols available in Cisco AR 4.1 with their required and optional fields.

Domain Authentication

The domain-auth Remote Server is used with the Windows Domain Authentication feature. Cisco AR 4.1 supports the Windows Domain Controller/Active Directory (WDC/AD) and enables you to authenticate users present in a WDC/AD using the CiscoSecure Remote Agent (CSRA).

Note You can download the CiscoSecure Remote Agent from http://www.cisco.com/cgi-bin/tablebuild.pl/acs-soleng-3des. The file to download is **Remote-Agent-ACSse-win-v3.3.2.2-K9.zip**, described as Remote Agent for Windows for Solution Engine, 3.3.2.2, dated 28-OCT-2004.

During authentication, the user credentials are sent to the CSRA, which authenticates the credentials with the WDC/AD. The user optionally can specify the domain name along with their UserID when they log in. If the domain is not specified, authentication is first performed with the local WDC/AD (default domain as specified in the remote server configuration), then with all the other trusted domain controllers, one by one until the user is found in any of the trusted WDC/ADs.

This *failover* to other domains is taken care by the local (default) WDC/AD. The local WDC/AD maintains a list of trusted domains and when the user is not found in the local AD, the WDC queries the trusted WDC/ADs, to see if any one those had the user in it. If any of the WDC/ADs has the user, those credentials would be used to authenticate the user.

The WDC/AD authentication stops at the first *hit* and does not check other domains even if the user credentials do not match (resulting in an authentication failure). When a domain is specified, authentication is performed only on that domain. This domain should be either the local WDC/AD or one of the trusted WDC/ADs.

A 128-bit Blowfish (variant) encryption algorithm secures the communication between the Cisco AR and CSRA. The session key for this encryption is negotiated when the connection is established.

The following is the default configuration of a domain-auth Remote Server.

```
[ //localhost/Radius/RemoteServers/domain-auth ]
    Name = newone
    Description =
    Protocol = domain-auth
    HostName =
    Port = 2004
    ReactivateTimerInterval = 300000
    DefaultDomain =
    Timeout = 15
    AgentConnections = 15
    DefaultUserGroup =
    GroupMaps/
```

Table 4-32 lists and defines the domain-auth RemoteServer properties.

Table 4-32 Domain Authentication RemoteServer Properties

Property	Description
HostName	Required; hostname or IP address of the remote server.
Port	Required; port used for communication with WDC/AD; defaults to 2004.
ReactivateTimerInterval	Required; default is 300,000 milliseconds. Specifies the length of time to wait before attempting to reconnect if a thread is not connected to a data source.
DefaultDomain	Species the default domain for authentication if the user does not include a domain during log in. Otherwise, authentication is performed on the local domain.
Timeout	Required; defaults to 15.
AgentConnections	Required; default is 15. Represents the total number of connections Cisco AR can open with the CSRA.
DefaultUserGroup	User group to be used when no mapping is found in the list of maps in the GroupMap property or when there is no hit in the groups listed in GroupMaps. The DefaultUserGroup is used to authorize users that are authenticated by this domain-auth RemoteServer.
GroupMaps	A list of groups to which the user belongs in the WDC/AD mapped to an internal group in the Cisco AR server. Entries are of the form: 1. "InternalGroup1 = ExternalGroup1, ExternalGroup2, ..." 2. "InternalGroup2 = ExternalGroup3, ExternalGroup4, ..." To configure group mappings, use the following syntax: **set 1 "Group1 = ExternalGroup1,ExternalGroup2, ExternalGroup3"**

Users can optionally be authorized using WDC/AD using a list of groups the user belongs to in WDC/AD. This list of groups is mapped to an internal group in the Cisco AR server using the GroupMaps property. An optional default group can also be configured using the DefaultUserGroup property.

When a hit is made, the corresponding group is taken, even if there might be a better match further down the list. For example, if the user is part of groups A, B, C, and D, and if a map for Groups A, B, and C is listed before a map for Groups A, B, C, and D, the map for Groups A, B, and C will be taken. This requires the administrator to configure more specific mapping before the general mapping.

The list of groups from the WDC/AD is copied to a new environment variable named Windows-Domain-Groups to permit mapping to a more appropriate group at the next relevant scripting point.

Dynamic DNS

The **dynamic-dns** RemoteServer is used with the Dynamic DNS feature. The following is the default configuration of a dynamic-dns RemoteServer.

```
[ //localhost/Radius/RemoteServers/ddns ]
    Name = ddns
    Description =
    Protocol = dynamic-dns
```

```
IPAddress =
Port = 53
MaxTries = 3
InitialTimeout = 2000
MaxDNSRenamingRetries = 3
TrimHostName = TRUE
ForwardZoneTSIGKey =
ReverseZoneTSIGKey =
```

Table 4-33 lists and defines the dynamic-dns RemoteServer properties.

Table 4-33 Dynamic-DNS RemoteServer Properties

Property	Description
IPAddress	The IPAddress address of the DNS server
Port	Port 53 is the port that most DNS servers will use as a default
MaxTries	Number of times the server tries to send dynamic updates to a DNS server
InitialTimeout	Time, in milliseconds, that the server waits for a response before retrying a dynamic DNS request
MaxRenamingRetries	Number of times that the dynamic-dns resource managers can try to add a host in DNS even if it detects that the host's name is already present. This controls the number of times Cisco AR tries to modify a host's name to resolve a conflict on each failed update.
TrimHostName	Controls whether Cisco AR trims the hostname string to the first period character (used to update dynamic DNS update records and to return the hostname option to clients). If this attribute is enabled, the hostname is truncated before the period. If disabled, the server retains the period characters in the hostname.
ForwardZoneTSIGKey	Server-wide security key to process all forward zone dynamic DNS updates. This is used if a ForwardZoneTSIGKey was not specified on the Resource Manager.
ForwardZoneTSIGKey	Server-wide security key to process all forward zone dynamic DNS updates. This is used if a ForwardZoneTSIGKey was not specified on the Resource Manager.
ReverseZoneTSIGKey	Server-wide security key to process all reverse zone dynamic DNS updates. This is used if a ReverseZoneTSIGKey was not specified on the Resource Manager.

LDAP

ldap specifies an LDAP server. When you specify the **ldap** protocol, provide the information listed in Table 4-34.

For any LDAP remote service, the server might perform the environment mappings at any time. This means that if the service is set to either authentication and authorization, authentication-only, or authorization-only, environment mappings will take place. RADIUS mappings will take place only if the service is set to perform authorization. Checkitem mappings will take place only if the service is set to perform authentication. Previously environment mappings only occurred when the service was set for both authentication and authorization.

Table 4-34 ldap RemoteServer Properties

Property	Description
Port	Required; defaults to port 389.
Timeout	Required; the default is 15. The timeout property indicates how many seconds the RADIUS server will wait for a response from the LDAP server. **Note** Use InitialTimeout from above as a template, except this is timeout is specified in seconds.
HostName	Required; the LDAP server's hostname or IP address.
BindName	Optional; the distinguished name (dn) to use when establishing a connection between the LDAP and RADIUS servers.
BindPassword	Optional; the password associated with the **BindName**.
SearchPath (Overridden by Search-Path environment variable)	Required; the path that indicates where in the LDAP database to start the search for user information.
Filter	Required; this specifies the search filter Cisco AR uses when querying the LDAP server for user information. When you configure this property, use the notation "%s" to indicate where the user ID should be inserted. For example, a typical value for this property is "(uid=%s)," which means that when querying for information about user `joe`, use the filter `uid=joe`.
UserPasswordAttribute	Required; this specifies which LDAP field the RADIUS server should check for the user's password.
LimitOutstandingRequests	Required; the default is FALSE. Cisco AR uses this property in conjunction with the **MaxOutstandingRequests** property to tune the RADIUS server's use of the LDAP server. When you set this property to TRUE, the number of outstanding requests for this RemoteServer is limited to the value you specified in **MaxOutstandingRequests**. When the number of requests exceeds this number, Cisco AR queues the remaining requests, and sends them as soon as the number of outstanding requests drops to this number.
MaxOutstandingRequests	Required when you have set the **LimitOutstandingRequests** to TRUE. The number you specify, which must be greater than zero, determines the maximum number of outstanding requests allowed for this remote server.

Table 4-34 ldap RemoteServer Properties (continued)

Property	Description
MaxReferrals	Required; must be a number equal to or greater than zero. This property indicates how many referrals are allowed when looking up user information. When you set this property to zero, no referrals are allowed. Cisco AR manages referrals by allowing the RADIUS server's administrator to indicate an LDAP "referral attribute," which might or might not appear in the user information returned from an LDAP query. When this information is returned from a query, Cisco AR assumes it is a referral and initiates another query based on the referral. Referrals can also contain referrals. **Note** This is an LDAP v2 referral property.
ReferralAttribute	Required when you have specified a **MaxReferrals** value. This property specifies which LDAP attribute, returned from an LDAP search, to check for referral information. **Note** This is an LDAP v2 referral property.
ReferralFilter	Required when you have specified a **MaxReferral** value. This is the filter Cisco AR uses when processing referrals. When checking referrals, the information Cisco AR finds in the referral itself is considered to be the search path and this property provides the filter. The syntax is the same as that of the **Filter** property. **Note** This is an LDAP v2 referral property.
PasswordEncryptionStyle	The default is **None**. You can also specify **crypt**, **dynamic**, **SHA-1**, and **SSHA-1**.
EscapeSpecialCharInUserName	FALSE by default
DNSLookupAndLDAPRebindInterval	Specifies the timeout period after which the Cisco AR server will attempt to resolve the LDAP hostname to IP address (DNS resolution); 0 by default
DataSourceConnections	Specifies the number of concurrent connections to the LDAP server. The default value is 8.
SearchScope	Specifies how deep to search within a search path; default is *SubTree* which indicates a search of the base object and the entire subtree of which the base object distinguished name is the highest object. *Base* indicates a search of the base object only. *OneLevel* indicates a search of objects immediately subordinate to the base object, but does not include the base object.

Table 4-34 ldap RemoteServer Properties (continued)

Property	Description
LDAPToRadiusMappings	A list of name/value pairs in which the name is the name of the **ldap** attribute to retrieve from the user record, and the value is the name of the RADIUS attribute to set to the value of the **ldap** attribute retrieved. For example, when the **LDAPToRadiusMappings** has the entry: **FramedIPAddress = Framed-IP-Address**, the RemoteServer retrieves the **FramedIPAddress** attribute from the **ldap** user entry for the specified user, uses the value returned, and sets the Response variable **Framed-IP-Address** to that value.
LDAPToEnvironmentMappings	A list of name/value pairs in which the name is the name of the **ldap** attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the **ldap** attribute retrieved. For example, when the **LDAPToEnvironmentMappings** has the entry: **group = User-Group**, the RemoteServer retrieves the **group** attribute from the **ldap** user entry for the specified user, uses the value returned, and sets the Environment variable **User-Group** to that value.
LDAPToCheckItemMappings	A list of LDAP *attribute/value* pairs which must be present in the RADIUS access request and must match, both name and value, for the check to pass. For example, when the **LDAPToCheckItemMappings** has the entry: **group = User-Group**, the Access Request must contain the attribute **group**, and it must be set to **User-Group**.
UseSSL	A boolean field indicating whether you want Cisco AR to use SSL (Secure Socket Layer) when communicating with this RemoteServer. When you set it to TRUE, be sure to specify the **CertificateDBPath** field in the **Advanced** section, and be sure the port you specified for this RemoteServer is the SSL port used by the LDAP server.
UseBinaryPasswordComparison	A boolean field that enables binary password comparison for authentication. This property when set to TRUE, enables binary password comparison. By default, this property is set to FALSE.

Map-Gateway

The following is the default configuration of a map gateway RemoteServer.

```
[ //localhost/Radius/RemoteServers/map-gateway ]
    Name = map-gateway
    Description =
    Protocol = map-gateway
    IPAddress =
    Port = 0
    ReactivateTimerInterval = 300000
    SharedSecret =
    MaxTries = 3
    InitialTimeout = 2000
```

ODBC

odbc specifies an ODBC server. Cisco AR provides a RemoteServer object (and a service) to support Open Database Connectivity (ODBC), an open specification that provides application developers a vendor-independent API with which to access data sources. Table 4-35 lists the **odbc** server attributes.

For any ODBC remote service, the server might perform the environment mappings at any time. This means that if the service is set to either authentication and authorization, authentication-only, or authorization-only, environment mappings will take place. RADIUS mappings will take place only if the service is set to perform authorization. Checkitem mappings will take place only if the service is set to perform authentication. Previously environment mappings only occurred when the service was set for both authentication and authorization.

Table 4-35 odbc Properties

Property	Description
Timeout	Required; the default is 15. The timeout property indicates how many seconds the RADIUS server will wait for a response from the LDAP server. **Note** Use InitialTimeout from above as a template, except this is timeout is specified in seconds.
Protocol	Must be set to **odbc**.
ReactivateTimerInterval	Required; default is 300,000 milliseconds. Length of time to wait before attempting to reconnect if a thread is not connected to a data source.
Data Source Connections	Required; default is 8. This represents the total number of connections Cisco AR can open with the ODBC server; total number of threads Cisco AR can create for the ODBC server.
ODBCDataSource	Required; defines all items required for the **odbc.ini** file. The Cisco AR server automatically creates the **odbc.ini** file based on these settings.
SQLDefinition	SQLDefinition properties define the SQL you want to execute. Type—**query** (Cisco AR supports only type **query**). SQL—SQL query used to acquire the password UserPasswordAttribute—Defines the database column name for the user's password. MarkerList—Defines all markers for the query. MarkerList uses the format UserName/SQL_DATA_TYPE.

Table 4-35 odbc Properties (continued)

Property	Description
ODBCToRadiusMappings	A list of name and value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the RADIUS attribute to set to the value of the data store attribute retrieved. The data store attributes must match those defined in the external SQL file.
ODBCToEnvironmentMappings	A list of name/value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the ODBC attribute retrieved.

ODBC-Accounting

If you use the Oracle Accounting feature, you must configure an ODBC-Accounting RemoteServer object. Table 4-36 lists and defines the ODBC-Accounting RemoteServer properties.

Table 4-36 ODBC-Accounting RemoteServer Properties

Property	Description
Name	Name of the remote server; this property is mandatory, and there is no default
Description	Optional description of server
Protocol	Must be set to odbc-accounting
ReactivateTimerInterval	Mandatory time interval (in milliseconds) to activate an inactive server; defaults to 300000 ms.
Timeout	Mandatory time interval (in seconds) to wait for SQL operation to complete; defaults to 15 seconds
DataSourceConnections	Mandatory number of connections to be established; defaults to 8
ODBCDataSource	Name of the ODBCDataSource to use and must refer to one entry in the list of ODBC datasources configured under **/Radius/Advanced/ODBCDataSources**. Mandatory; no default
KeepAliveTimerInterval	Mandatory time interval to send akeepalive to keep the idle connection active; defaults to zero (0) meaning the option is disabled
BufferAccountingPackets	Mandatory, TRUE or FALSE, determines whether to buffer the accounting packets to local file, defaults to TRUE which means that packet buffering is enabled. **Note** When set to TRUE, a constant flow of incoming accounting packets can fill the buffer backing store files in **/cisco-ar/data/odbc** beyond the size configured in MaximumBufferFileSize. Configure BackingStoreDiscThreshold in **/Radius/Advanced** when using ODBC accounting. See Advanced, page 4-46 for information about how to configure BackingStoreDiscThreshold.

Table 4-36 ODBC-Accounting RemoteServer Properties (continued)

Property	Description
MaximumBufferFileSize	Mandatory if BufferAccountingPackets is set to TRUE, determines the maximum buffer file size, defaults to 10 Megabyte)
NumberOfRetriesForBufferdPacket	Mandatory if BufferAccountingPackets is set to TRUE. A number greater than zero determines the number of attempts to be made to insert the buffered packet into Oracle. Defaults to 3.

Prepaid-CRB

The following is the default configuration of a prepaid-crb RemoteServer. The Filename property is the name of the required shared library provided by the billing vendor.

```
[ //localhost/Radius/RemoteServers/prepaid-crb ]
    Name = prepaid-crb
    Description =
    Protocol = prepaid-crb
    IPAddress =
    Port = 0
    Filename =
    Connections = 8
```

Prepaid-IS835C

The following is the default configuration of a prepaid-is835c RemoteServer. The Filename property is the name of the required shared library provided by the billing vendor.

```
[ //localhost/Radius/RemoteServers/prepaid-is835c ]
    Name = prepaid-is835c
    Description =
    Protocol = prepaid-is835c
    IPAddress =
    Port = 0
    Filename =
    Connections = 8
```

RADIUS

radius specifies a RADIUS server. When you specify the **radius** protocol, supply the information in Table 4-37.

Table 4-37 RADIUS Properties

Property	Description
SharedSecret	Required; the secret shared between the remote server and the RADIUS server.
IncomingScript	Optional; when set, must be the name of a known incoming script. Cisco AR runs the IncomingScript after it receives the response.
OutgoingScript	Optional; when set, must be the name of a known outgoing script. Cisco AR runs the OutgoingScript just before it sends the proxy request to the remote server.

Table 4-37 RADIUS Properties (continued)

Property	Description
Vendor	Optional; when set, must be the name of a known Vendor.
MaxTries	Required; the number of times to send a proxy request to a remote server before deciding the server is off-line. You must specify a number greater than zero. The default is 3.
InitialTimeout	Required: represents the number of milliseconds used as a timeout for the first attempt to send a specific packet to a remote server. For each successive retry on the same packet, the previous timeout value used is doubled. You must specify a number greater than zero. The default value is 2000 (or 2 seconds).
ACKaccounting	When ACKAccounting is TRUE, the Cisco AR server waits for the Accounting-Response from the remote RADIUS server before sending the corresponding Accounting-Response to the client. When ACKAccounting is FALSE, the Cisco AR server does not wait for the Accounting-Response and immediately returns an Accounting-Response to the client.

Rules

A Rule is a function that selects services based on all input information used by the function.

Advanced

Advanced objects let you configure system-level properties and the Attribute dictionary. Under normal system operation, you should not need to change the system-level properties.

Note The notation *required* means Cisco AR needs a value for this property. For most of these properties, you can use system defaults.

Table 4-38 lists the **Advanced** properties.

Table 4-38 Advanced Object Properties

Property	Description
LogServerActivity	Required; the default is FALSE, which means Cisco AR logs all responses except Access-Accepts and Access-Challenges. Accepting the default reduces the load on the server by reducing that amount of information it must log. Note, the client is probably sending accounting requests to an accounting server, so the Access-Accept requests are being indirectly logged. When you set it to TRUE, Cisco AR logs all responses to the server log file.
MaximumNumberOfRadiusPackets	Required; the default is 1024. This is a *critical property* you should set high enough to allow for the maximum number of simultaneous requests. When more requests come in than there are packets allocated, Cisco AR will drop those additional requests.
PerPacketHeapSize	Required; the default is 6500. This property sets the size of the initial *heap* for each packet. The heap is the dynamic memory a request can use during its lifetime. By preallocating the heap size at the beginning of request processing, we can minimize the cost of memory allocations. If PerPacketHeapSize is too low, Cisco AR will ask the system for memory more often. If PerPacketHeapSize is too high, Cisco AR will allocate too much memory for the request causing the system to use more memory than required.
UDPPacketSize	Required; the default is 4096. RFC 2138 specifies the maximum packet length can be 4096 bytes. Do not change this value.
RequireNASsBehindProxyBeInClientList	Required; the default is FALSE. If you accept the default, Cisco AR only uses the source IP address to identify the immediate client that sent the request. Leaving it FALSE is useful when this RADIUS Server should only know about the proxy server and should treat requests as if they came from the proxy server. This might be the case with some environments that buy bulk dial service from a third party and thus do not need to, or are unable to, list all of the NASs behind the third party's proxy server. When you set it to TRUE, you must list all of the NASs behind the Proxy in the Clients list. For more information about this property, see "Using the RequireNASsBehindProxyBeInClientList Property" section on page 4-56.

Table 4-38 Advanced Object Properties (continued)

Property	Description
AAAFileServiceSyncInterval	Required; specified in milliseconds, the default is 75. This property governs how often the file AAA service processes accounting requests and writes the accounting records to the file. You can lower the number to reduce the delay in acknowledging the **Account-Request** at the expense of more frequent flushing of the accounting file to disk. You can raise the number to reduce the cost of flushing to disk, at the expense of increasing the delays in acknowledging the **Accounting-Request**s. The default value was determined to provide a reasonable compromise between the two alternatives.
SessionBackingStoreSynchronizationInterval	Required; specified in milliseconds, the default is 100. If you change this value it must be a number greater than zero. This property governs how often the Session Manager backing store writes updated session information to disk. You can lower the number to reduce the delay in acknowledging requests at the expense of more frequent flushing of the file containing the session data to disk. You can raise the number to reduce the cost of flushing to disk at the expense of increasing delays in acknowledging requests. The default value was determined to provide a reasonable compromise between the two alternatives.
BackingStoreDiscThreshold	Required; the default is 10 gigabytes. The value of BackingStoreDisc- Threshold is made up of a number of units which can be K, kilobyte, or kilobytes, M, megabyte, or megabytes, or G, gigabyte, or gigabytes. BackingStoreDiscThreshold is used with session management and ODBC accounting and ensures that any data log files generated will not cross the BackingStoreDiscThreshold.
SessionBackingStorePruneInterval	Required; specifies the sleep time interval of the session backing store pruning thread. The recommended and default value is 6 hours, but you can modify this based on the traffic patterns you experience. With SessionBackingStorePruneInterval set to 6 hours, pruning will occur 6 hours after you restart or reload the Cisco AR server and recur every 6 hours. You can set a very low value for this property to make pruning continuous, but there might not be enough data accumulated for the pruning to occur and pruning might be less effective compared to the default setting.

Table 4-38 Advanced Object Properties (continued)

Property	Description
PacketBackingStorePruneInterval	Required; specifies the sleep time interval of the packet backing store pruning thread. The recommended value is 6 hours, but you can modify this based on the traffic patterns you experience. When PacketBackingStorePruneInterval is set to 6 hours, pruning will occur 6 hours after you restart or reload the Cisco AR server and recur every 6 hours. You can set a very low value for this property to make pruning continuous, but there might not be enough data accumulated for the pruning to occur and pruning might be less effective compared to the default setting.
RemoteLDAPServiceThreadTimerInterval	Required; specified in milliseconds, the default is 10. This property governs how often the **ldap** RemoteServer thread checks to see if any results have arrived from the remote LDAP server. You can modify it to improve the throughput of the server when it proxies requests to a remote LDAP server.
InitialBackgroundTimerSleepTime	Required; the default is 5. This property specifies the amount of time the time queue should initially sleep before beginning processing. This property is only used for initial synchronization and should not be changed.
MinimumSocketBufferSize	Required; the default is 65536 (64 K). This property governs how deep the system's buffer size is for queueing UDP datagrams until Cisco AR can read and process them. The default is probably sufficient for most sites. You can, however, raise or lower it as necessary.
CertificateDBPath	Required if you are using an LDAP RemoteServer and you want Cisco AR to use SSL when communicating with that LDAP RemoteServer. This property specifies the path to the directory containing the client certificates to be used when establishing an SSL connection to an LDAP RemoteServer. This directory must contain the **cert7.db** and **cert5.db** certificates and the **key3.db** and **key.db** files database used by Netscape Navigator 3.x (and above) or the **ServerCert.db** certificate database used by Netscape 2.x servers.

Table 4-38 Advanced Object Properties (continued)

Property	Description
LogFileSize	Required; the default is 1 Megabyte. This property specifies the maximum size of the RADIUS server log file. The value for the **LogFileSize** field is a string composed of two parts; a number, and a units indicator (<n> <units>) in which the unit is one of: K, kilobyte, kilobytes, M, megabyte, megabytes, G, gigabyte, or gigabytes. The **LogFileSize** property does not apply to the **config_mcd_1_log** or **agent_server_1_log** files. See Modifying File Sizes for Agent Server and MCD Server Logs, page 24-3 to configure these files. **Note** This does not apply to the trace log.
LogFileCount	Required; the default is 2. This property specifies the number of log files to be kept on the system. A new log file is created when the log file size reaches **LogFileCount**. The **LogFileCount** property does not apply to the **config_mcd_1_log** or **agent_server_1_log** files. See Modifying File Sizes for Agent Server and MCD Server Logs, page 24-3 to configure these files.
TraceFileSize	Required; the default is 1 GB. This property specifies the size of the trace files to be kept on the system. A new trace file is created when the trace file size reaches **TraceFileSize**. The value for the **TraceFileSize** field is a string composed of two parts; a number, and a units indicator (<n> <units>) in which the unit is one of: K, kilobyte, kilobytes, M, megabyte, megabytes, G, gigabyte, or gigabytes.
TraceFileCount	Required; this value can be set from 1-100, and the default is 2. This property specifies the number of trace files to maintain. A value of 1 indicates that no file rolling occurs.
UseAdvancedDuplicateDetection	Required; the default is FALSE. Set this property to TRUE when you want Cisco AR to use a more robust duplicate request filtering algorithm. For more information on this property, see the "Advance Duplicate Detection Feature" section on page 4-56.
AdvancedDuplicateDetectionMemoryInterval	Required when the Advanced Duplicate Detection feature is enabled. This property specifies how long (in milliseconds) Cisco AR should remember a request. You must specify a number greater than zero. The default is 10,000.

Table 4-38 Advanced Object Properties (continued)

Property	Description
DetectOutOfOrderAccountingPackets	Optional; used to detect accounting packets that arrive out of sequential order. The default is FALSE. This property is useful when using accounting and session management in a RADIUS proxy service. **Note** The following functionality is introduced in Cisco AR 4.1.4. When the DetectOutOfOrderAccountingPacket property is enabled (set to TRUE), a new *Class* attribute is included in all outgoing Accept packets. The value for this Class attribute will contain the session magic number. The client will echo this value in the accounting packets, and this will be used for comparison. The session magic number is a unique number created for all sessions when the session is created or reused and the DetectOutOfOrderAccountingPacket property is set to TRUE. The DetectOutOfOrderAccountingPacket property is used to detect out-of-order Accounting-Stop packets in roaming scenarios by comparing the session magic number value in the session with the session magic number value contained in the Accounting packet. The value of 0xffffffff is considered by the Cisco AR server to be a wild card magic number. If any accounting stop packets contain the value of 0xffffffff, it will pass the session magic validation even if the session's magic number is some thing else. The format of the class attribute is as follows: <4-byte Magic Prefix><4-byte server IP address><4-byte Magic value>
DefaultReturnedSubnetSizeIfNoMatch	Optional; used with the ODAP feature and reflects the returned size of the subnet if no matched subnet is found. There are three options to select if an exactly matched subnet does not exist: Bigger, Smaller, and Exact. The default is Bigger.
ClasspathForJavaExtensions	A string which is the classpath to be used to locate Java classes and jar files containing the classes required for loading the Java extensions, either Java extension points or services. **Note** The classpath will always contain the directory **$INSTALLDIR/scripts/radius/java** and all of the jar files in that directory.
JavaVMOptions	A string that can contain options to be passed to the JRE upon startup. JavaVMOptions should be used only when requested by Cisco TAC.

Table 4-38 Advanced Object Properties (continued)

Property	Description
MaximumODBCResultSize	Specifies maximum size in bytes for an ODBC mapping. This parameter affects both ODBC result sizes and the trace log buffer for tracing script calls that access any of the dictionaries. (Default value is 256.)
ARIsCaseInsensitive	When set to FALSE, requires that you provide exact path names with regard to upper and lower case for all objects, subobjects, and properties. The default setting, TRUE, allows you to enter paths such as **/rad/serv** instead of **/Rad/Serv**. **Note** Cisco AR always authenticates the RADIUS attribute User-Name with regard to upper and lower case, regardless of the setting of this flag.
RemoteRadiusServerInterface	When set, specifies the local interface to bind to when creating the RemoteRadiusServer socket. If not set, the Cisco AR binds to IPADDR_ANY.
ODBCEnvironmentMultiValueDelimiter	Optional; allows you to specify a character that separates multi-valued attributes in the marker list when using Oracle (or ODBC) accounting
PacketBackingStoreSyncInterval	The minimum value is 1 and the maximum is a 32-bit unsigned integer. The default is 75.
ListenForDynamicAuthorizationRequests	Must be set to TRUE when using the Change of Authorization (CoA) feature or Packet of Disconnect (POD) feature. Default is FALSE.
MaximumNumberOfXMLPackets	Required when using identity caching. Indicates the maximum number of XML packets to be sent or received. The minimum value is 1 and the maximum is a 32-bit unsigned integer. The default is 1024.
XMLUDPPacketSize	Required when using identity caching. Indicates the maximum size of XML packets to be sent or received. The minimum value is 1 and the maximum is a 32-bit unsigned integer. The default is 4096.

Table 4-38 Advanced Object Properties (continued)

Property	Description
RollingEncryptionKeyChangePeriod	Used in conjunction with the session-cache ResourceManager, this property specifies the length of time a given EncryptionKey will be used before a new one is created. When the session-cache ResourceManager caches User-Password attributes, Cisco AR encrypts the User-Password so it is not stored in memory or persisted on disk in clear text. Cisco AR uses up to 255 encryption keys, using a new one after each RollingEncryptionKeyChangePeriod expires. If RollingEncryptionKeyChangePeriod is set to *2 days*, Cisco AR will create and begin using a new EncryptionKey every two days. The oldest key will be retired, and Cisco AR will re-encrypt any User-Passwords that used the old key with the new key. This way, if the RollingEncryptionKeyChangePeriod is set to *1 day*, no key will be older than 255 days.
SessionPurgeInterval	Optional; the SessionPurgeInterval property determines the time interval at which to check fortimed-out sessions. If no value is set, the session timeout feature is disabled. The checks are performed in the background when system resources are available, so checks might not always occur at the exact time set. The minimum recommended value for SessionPurgeInterval is 60 minutes. The SessionPurgeInterval value is comprised of a number and a units indicator, as in n units, where a unit is one of minutes, hours, days, or weeks.
EapBadMessagePolicy	Set to one of two values: SilentDiscard (the default) or RejectFailure. When set to SilentDiscard, the Cisco AR server silently discards and ignores bad EAP messages unless the protocol specification explicitly requires a failure message. When set to RejectFailure, the Cisco AR server sends RADIUS Access-Rejects messages with embedded EAP-Failure in response to bad EAP messages asdescribed in Internet RFC 3579.

Table 4-38 Advanced Object Properties (continued)

Property	Description
StaleSessionTimeout	Required; the default value is "1 hour." Specifies the time interval to maintain a session when a client does not respond to Accounting-Stop notification. When the Cisco AR server does not receive an Accounting-Response from a client after sending an Accounting-Stop packet, Cisco AR maintains the session for the time interval configured in this property before releasing the session. This property is stored as a string composed of two parts: a number and a unit indicator (<n> <units>) similar to the MaxFileAge property where the unit is one of: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, or Weeks.
Ports/	Optional; allows you to use ports other than the default, 1645 and 1646. You can use this option to configure Cisco AR to use other ports,. If you add additional ports, however, Access Registrar will use the added ports and no longer use ports 1645 and 1646. These ports can still be used by adding them to the list of ports to use. For more information, refer to "Ports" section on page 4-57.
Interfaces	Optional; refer to "Interfaces" section on page 4-57
ReplyMessages	Optional; refer to "Reply Messages" section on page 4-57.
AttributeDictionary	Optional; refer to "Attribute Dictionary" section on page 4-59.
SNMP	Optional; refer to "SNMP" section on page 4-60.
RFC Compliance/	Optional; enables you to modify the Cisco AR server to behave in a way that might deviate from RFC compliance in a special use case scenario. When AllowRejectAttrs is set to FALSE, Reply-Message attributes will not be passed in an Access Reject packet. When AllowRejectAttrs is set to TRUE, attributes will be allowed to pass in an Access Reject packet. When AllowEAPRejectAttrs is set to FALSE, Reply-Message attributes will not be passed in an Access Reject packet if the packet contains EAP-Message attribute. When AllowEAPRejectAttrs is set to TRUE, attributes will be allowed to pass in an Access Reject packet even if the packet contains EAP-Message attribute. **Note** Changing the state of either of these properties requires you to **reload** the Cisco AR server.
DDNS	This subdirectory holds the SynthesizeReverseZone property and a list of Transaction Signatures (TSIG) keys.

Table 4-38 Advanced Object Properties (continued)

Property	Description
SynthesizeReverseZone	This property exists under DDNS and controls whether Cisco AR automatically generates the name of the reverse zone (**in-addr.arpa**) that is updated with PTR records. If this attribute is enabled and the resource manager does not have an explicit ReverseZoneName property configured, the server uses the IP address and DNSHostBytes property to generate the reverse zone name. The default value is TRUE.
ODBCDataSources	A list of ODBC data sets andtheir associated environments including operating system, DBMS, and network platform used to access the DBMS an application wants to access. Required when using Oracle (or ODBC) accounting.
AttributeGroups	Includes a Default subdirectory with an Attributes subdirectory that contains commonly-used attributes for Change of Authorization (CoA) and Packet of Disconnect (POD). You can add new attributes to the default group or create a new group as necessary.
KeyStores	Used to protect the security and integrity of the PACs it issues. • NumberOfKeys—Number (from 1-1024) that specifies the maximum number of keys stored for EAP-FAST. • RolloverPeriod—Specifies the amount of time between key updates.
NumberOfRemoteUDPServerSockets	Required; the default value for this property is 4. The NumberOfRemoteUDPServerSockets property allows you to configure the number of source ports used while proxying requests to a remote radius server. If the NumberOfRemoteUDPServerSockets property is set to a value *n*, all remote servers share and use *n* sockets. The NumberOfRemoteUDPServerSockets value comprises a number, as in *n*, where *n* should be less than or equal to the current process file descriptor limit divided by 2.
MaximumIncomingRequestRate	Optional; the default value for this property is 0. The MaximumIncomingRequestRate property is used to limit the incoming traffic in terms of “allowed requests per second”. Serves as a soft limit. The MaximumIncomingRequestRate property comprises a number *n*, where *n* can be any nonzero value.
MaximumOutstandingRequests	Optional; the default value for this property is 0. The MaximumOutstandingRequests property is used to limit the incoming traffic in terms of “requests processed”. Serves as a hard limit. The MaximumOutstandingRequests property comprises a number *n*, where *n* can be any nonzero value.

Using the RequireNASsBehindProxyBeInClientList Property

You can use the property **RequireNASsBehindProxyBeInClientList** to require NASs that send requests indirectly through a proxy to be listed in the Clients list or to allow the proxy to represent them all.

- When you want to ensure the proxy is only sending requests from NASs known to this server, set the property to TRUE, and list all of the NASs using this proxy. This increases memory usage.
- When it is impossible to know all of the NASs using this proxy or when you do not care, set the property to FALSE. Cisco AR will use the proxy's IP address to identify the origin of the request.

Advance Duplicate Detection Feature

Cisco AR automatically detects and handles duplicate requests it is currently working on. It also provides an optional, more complex mechanism to handle duplicate requests that can be received by the server after it has completed processing the original request. These duplicate requests can consume extra processing power, and, if received out of order (as RADIUS is a UDP-based protocol) might cause Session Management problems.

One solution is the Advanced Duplicate Detection feature which causes Cisco AR to *remember* requests it has seen, as well as the response sent to that request, for a configurable amount of time.

To enable this feature, perform the following:

- Set the **UseAdvancedDuplicateDetection** property in the **/Radius/Advanced** section of the configuration to **TRUE**.
- Set the **AdvancedDuplicateDetectionMemoryInterval** in the **/Radius/Advanced** section to specify how long (in milliseconds) Cisco AR should remember a request.

Note Enabling this feature causes Cisco AR to keep more of its preallocated packet buffers in use for a longer period of time. The number of preallocated buffers is controlled by the **MaximumNumberOfRadiusPackets** property in the **/Radius/Advanced** section of the configuration. This property might need to be increased (which will increase the amount of memory used by Cisco AR) when the Advanced Duplicate Detection feature is enabled.

Invalid EAP Packet Processing

Cisco AR 3.5.4 has been enhanced to implement *fatal error* packet handling for Extensible Authentication Protocol (EAP) messages as described in section 2.2 of Internet RFC 3579 which states the following:

> A RADIUS server determining that a fatal error has occurred must send an Access-Reject containing an EAP-Message attribute encapsulating EAP-Failure.

Because this enhancement is a deviation from various EAP specifications, you must explicitly enable this feature through a new configuration property in **/Radius/Advanced** named *EapBadMessagePolicy*.

You can set the EapBadMessagePolicy property to one of two values: SilentDiscard (the default) or RejectFailure. When set to SilentDiscard, the Cisco AR server silently discards and ignores bad EAP messages unless the protocol specification explicitly requires a failure message. When set to RejectFailure, the Cisco AR server sends RADIUS Access-Rejects messages with embedded EAP-Failure in response to bad EAP messages as described in Internet RFC 3579.

The implementation of EAP authentication methods in Cisco AR 3.5.3 (and earlier releases) behaves as described in Internet RFC 2284 (EAP) and related EAP method specifications. These specify *silent discard* as the standard way to handle all EAP error conditions. Any EAP response message from the client that contains an error or is received in an invalid authenticator state is discarded and there is no error response.

In a configuration where EAP requests are proxied between RADIUS servers using RADIUS messages (EAP over RADIUS), the silent discard of an EAP message means that no RADIUS response message is sent back to the originating RADIUS server. Because of this, the RADIUS server originating the request eventually declares the destination RADIUS server *dead* and fails over to a backup server (if so configured).

Ports

The Ports list specifies which ports to listen to for requests. When you specify a port, Cisco AR makes no distinction between the port used to receive Access-Requests and the port used to receive Accounting-Requests. Either request can come in on either port.

Most NASs send Access-Requests to port 1645 and Accounting-Requests to 1646, however, Cisco AR does not check.

When you do not specify any ports, Cisco AR reads the **/etc/services** file for the ports to use for access and accounting requests. If none are defined, Cisco AR uses the standard ports (1645 and 1646).

Interfaces

The Interfaces list specifies the interfaces on which the RADIUS server receives and sends requests. You specify an interface by its IP address.

- When you list an IP address, Cisco AR uses that interface to send and receive Access-Requests.
- When no interfaces are listed, the server performs an interface discover and uses all interfaces of the server, physical and logical (virtual).

Reply Messages

The Reply Messages list allows you to choose the reply message based on the reason the request was rejected. Each of the following properties (except **Default**) corresponds to a reason why the packet was rejected. The Reply Message properties allows you to substitute your own text string for the defined errors. After you set the property (with the **set** command) and the reason occurs, Cisco AR sends the NAS that message in the Access-Reject packet as a **Reply-Message** attribute.

You might want to substitute your own messages to prevent users from getting too much information about why their requests failed. For example, you might not want users to know the password was invalid to prevent hackers from accessing your system. In such a case, you might specify the text string "`unauthorized access`" for the property **UserPasswordInvalid**.

Table 4-39 lists the **Reply Message** properties.

Table 4-39 Reply Message Properties

Property	Description
Default	Optional; when you set this property, Cisco AR sends this value when the property corresponding to the reject reason is not set.
UnknownUser	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever Cisco AR cannot find the user specified by **User-Name**.
UserNotEnabled	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever the user account is disabled.
UserPasswordInvalid	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever the password in the Access-Request packet did not match the password in the database.
UnableToAcquireResource	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever one of the Resource Managers was unable to allocate the resource for this request.
ServiceUnavailable	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever a service the request needs (such as a RemoteServer) is unavailable.
InternalError	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever an internal error caused the request to be rejected.
MalformedRequest	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever a required attribute (such as **User-Name**) is missing from the request.
ConfigurationError	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever the request is rejected due to a configuration error. For example, if a script sets an environment variable to the name of an object such as **Authentication-Service**, and that object does not exist in the configuration, the reason reported is ConfigurationError.
IncomingScriptFailed	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever one of the **IncomingScripts** fails to execute.
OutgoingScriptFailed	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever one of the **OutgoingScripts** fails to execute.
IncomingScriptRejectedRequest	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever one of the **IncomingScripts** rejects the Access-Request.
OutgoingScriptRejectedRequest	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever one of the **OutgoingScripts** rejects the Access-Request.
TerminationAction	Optional; when you set this property, Cisco AR sends back this value in the **Reply-Message** attribute whenever Cisco AR processes the Access-Request as a Termination-Action and is being rejected as a safety precaution.

Attribute Dictionary

The Attribute dictionary allows you to specify the attributes to the RADIUS server. Cisco AR comes with the standard RADIUS attributes (as defined by the RFC 2865) as well as the attributes required to support the major NASs. For more information about the standard attributes, see Appendix C, "RADIUS Attributes."

All RADIUS requests and responses consist of one or more *attributes*, such as the user's name, the user's password, the type of service the NAS should provide to the user, or the IP address the user should use for the session.

In the request and response packets, an attribute is composed of a number (between 1-255) that specifies the type of attribute to use, a length that specifies the entire attribute length, and a value. How the value is interpreted depends on its type. When it is a username, the value is a string. When it is the NAS's IP address, the value is an IP address, and so on.

Table 4-40 lists the Attribute dictionary properties.

Table 4-40 Attribute Dictionary Properties

Property	Description
Name	Required; must be unique in the Attribute dictionary list within the same context. Although it should be an attribute defined in the RFC, the name can be any attribute defined by your client. The NAS typically comes with a list of attributes it uses. Attributes are referenced in the Profile and by Scripts by this name. The accounting file service also uses this name when printing the attribute.
Description	Optional description of the attribute.
Attribute	Required; must be a number between 1-255. It must be unique within the Attribute dictionary list.
Type	Required; must be set to one of the types listed in Table 4-41. The type governs how the value is interpreted and printed.

Types

Types are required and must be one of the following listed in Table 4-41.

Table 4-41 Types Attributes

Property	Description
UNDEFINED	Treated as a sting of binary bytes.
UINT32	Unsigned 32-bit integer.
STRING	Character string.
IPADDR	A valid IP address in dotted-decimal format.
CHAP_PASSWORD	17-byte value representing the password.

Table 4-41 Types Attributes (continued)

Property	Description
ENUM	Enums allow you to specify the mapping between the value and the strings. Once you have established this mapping, Cisco AR then replaces the number with the appropriate string. The min/max properties represent the lowest to highest values of the enumeration.
VENDOR_SPECIFIC	Vendor Specific Attribute (VSAs) are a special class of attribute. VSAs were created to extend the standard 256 attributes to include attributes required by specific manufacturers. VSAs add new capabilities for the value field in an attribute. Rather than being a simple integer string, or IP address, the value of a VSA can be one or more subattributes whose meaning depends on the vendor's definition. The Vendors list allows you to add, delete, or modify the definitions of the vendors and the subattributes they specify.

Vendor Attributes

Table 4-42 lists the **Vendor** properties.

Table 4-42 Vendor Properties

Property	Description
Name	Required; must be unique in the Vendors attribute list.
Description	Optional; description of the subattribute list.
VendorID	Required; must be a valid number and unique within the entire attribute dictionary.
Type	Required; must be one of the following: UNDEFINED, UINT32, STRING, IPADDR, CHAP_PASSWORD, ENUM, or SUB_ATTRIBUTES.

SNMP

Table 4-43 lists the five properties of the SNMP directory.

Table 4-43 SNMP Properties

Property	Description
Enabled	Either TRUE or FALSE; default is FALSE
TracingEnabled	Either TRUE or FALSE; default is FALSE
InputQueueHighThreshold	An integer; default is 90
InputQueueLowThreshold	An integer; default is 60
MasterAgentEnabled	Either TRUE or FALSE; default is TRUE

If Enabled and MasterAgentEnabled are both TRUE, **arservagt** will start and stop the SNMP daemon (**snmpd**). If either of these properties is FALSE, if the AR server is not using SNMP or if your site uses a different master agent, **arservagt** will not start your master agent.

CHAPTER 5

Using the radclient Command

This chapter describes how to use **radclient**, a RADIUS server test tool you run from the command line to test your Cisco Access Registrar RADIUS server. You can use **radclient** to create packets, send them to a specific server, and examine the response.

Because the **radclient** command is Tcl-based, you can use it interactively or you can execute it as a Tcl script file.

To run the **radclient** command, type:

radclient

After you enter the **radclient** command, you must log in to the RADIUS server and provide an administrator's username, such as admin, and the administrator's password.

radclient Command Syntax

The **radclient** command syntax is:

radclient [**-C** <*clustername*>] [**-N** <*adminname*>] [**-P** <*adminpassword*>] [**-i**] [**-n**] [**-p** <*load_path*>] **[-v] [-z debug_flags]**

Valid flags are:

- **-C** <*clustername*>
- **-N** <*adminname*>
- **-P** <*adminpassword*>
- **-i**—Forces interactive mode
- **-n**—Skips loading **radclient.tcl**
- **-p <path>**—Specifies the load_path
- **-s**—Uses default cluster, admin user, and password

  If you delete the admin user or modify the admin user's password, this option will no longer work.
- **-S <file>**—Sources specified file
- **-v**—Prints version and exits

  -z debug_flags—Specify debug levels. Debug flags must be of the format *X*=*n*, where *X* is the letter corresponding to the type of debug information you want to see, and *n* is the value. The higher the value, the more output. *X* can also be a string or a range of letters. For example, the following command line sets the debug levels for A, B, and C to 3:

radclient -z ABC=3

The following example command line sets the debug levels for everything between A and Z inclusive and l to 5:

radclient -z A-Zl=5

Working with Packets

Using the **radclient** command, you can create packets (default or specific packets), view packets, send packets, read the value of packets, and delete packets.

Creating Packets

To create a basic RADIUS Access-Request packet, use the **radclient** command **simple**. This function creates a packet and fills in basic attributes. The syntax of the **simple** command is:

simple <*user_name*> <*user_password*>

For example, to create an Access-Request packet for user **bob** whose password is **bigDog**, type:

simple bob bigDog

```
p001
```

The **radclient** command responds with `p001`, which is the identifier (name) of the newly created packet.

Creating CHAP Access-Request Packets

To create a CHAP Access-Request packet, use the **radclient** command **simple_chap**. The syntax of the **simple_chap** command is:

simple_chap <*user_name*> <*user_password*> <*use_challenge*>

<*use_challenge*> is a boolean that indicates whether to use the **CHAP-Challenge** attribute.

For example, to create a CHAP packet and use a <*use_challenge*>, type:

simple_chap bob bigDog 1

```
p002
```

Viewing Packets

To view a packet or any other object, type the object identifier at the **radclient** prompt. For example, to display packet `p001`, type:

p001

```
Packet: code=Access-Request,id=0,length=0, attributes =
User-Name = bob
```

```
User-Password = bigDog
NAS-Identifier = localhost
NAS-Port = 0
```

Sending Packets

To send a packet, specify the packet identifier and enter the word **send**.

p001 send

You can optionally specify the host and port to which to send the packet. The default host is **localhost**, and the default port is **1645**.

When you want to send a packet to a different host and different port, you must specify them on the command line. For example, to send a packet to the RADIUS server `amazon`, at port number `1812`, type:

p001 send amazon 1812

```
p002
```

When Cisco AR receives a response to the packet you sent, it prints the response packet's object identifier before the **radclient** prompt returns.

The TCL variable *tries* determines how many times **radclient** retries to send the packet.

Creating Empty Packets

You can use **radclient** to **c**reate empty packets, them modify the p**a**ckets to contain theappropriate fields. To create an empty packet, the syntax is:

packet <*packet-type*>

The optional <*packet-type*> argument can be the numerical RADIUS packet type identifier, such as `2`, or the string representation, such as `Access-Accept`:

packet 2

```
p00d
```

p00d

```
Packet: code = Access-Accept, id = 0, length = 0, attributes =
```

Setting Packet Fields

You can modify the value of a packet field using the following syntax:

<*packet-identifier*> **set** <*field*> <*value*>

<*packet-identifier*> is the packet number, such as `p001`.

<*field* > is the packet field you want to modify and can be one of the following:

- attrib—Set attributes in the packet; <*value*> is the attribute identifier.

- code— The packet type (such as Access-Request); <*value*> is either a numeric packet-type or the string representation (for example, 1 or Access Request).
- identifier— Set the packet ID; <*value*> is the numeric ID.
- length—Set the packet length; <*value*> is the numeric length.
- requestAuthenticator—Set the request authenticator; <*value*> is a hex string with a colon separating each byte.

<*value*> is either a numeric packet-type, the string representation, or the hex string with a colon separating each byte.

For example, to set the identifier field to `99`, type:

p001 set identifier 99

```
99
```

p001

```
Packet: code = Access-Request, id = 99, length = 0, attributes =
        User-Name = bob
        User-Password = bigDog
        NAS-Identifier = localhost
        NAS-Port = 0
```

Reading Packet Fields

You can read (**get**) the value of any of the packet fields by using the syntax:

<*packet-identifier*> **get** <*attrib*>

For example, to **get** the **identifier** field, type:

p001 get identifier

```
99
```

Deleting Packets

When you are writing long-running or iterating scripts, you might want to conserve memory by deleting packets when you are finished with them.

To delete a packet, type:

<*packet-identifier*> **delete**

To delete all resources referred to by the packet `p001`, type:

p001 delete

Attributes

Using the **radclient** command you can create specific RFC-defined attributes of requests and responses.

Creating Attributes

To create an attribute object, the syntax is:

<attrib> **name** *<value>*

<attrib> is a recognized RADIUS attribute name. *<value>* is the value of the attribute.

For example, to create the attribute **User-Name** and set its value to `bob`, type:

attrib User-Name bob

```
a001
```

Note **a001** is the object identifier for the newly created attribute.

Setting Multivalued Attributes

Cisco AR supports setting multivalued attributes (MVAs) in **radclient**. Use the set **mattrib** command to set multivalued attributes, as shown in the following example:

simple bob bob

```
p001
```

attrib cisco-avpair blah

```
a005
```

attrib cisco-avpair boo

```
a006
```

p001 set mattrib a005

p001

```
Packet: code = Access-Request, id = 0, length = 0, attributes =
User-Name = bob
User-Password = bob
NAS-Identifier = localhost
NAS-Port = 1
Cisco-AVPair = blah
```

p001 set mattrib a006

p001

```
Packet: code = Access-Request, id = 0, length = 0, attributes =
User-Name = bob
User-Password = bob
NAS-Identifier = localhost
NAS-Port = 1
Cisco-AVPair = blah
Cisco-AVPair = boo
```

Viewing Attributes

To view an attribute, or any other object, type the object identifier at the **radclient** prompt. For example, to display attribute `a001` created in the example above, type:

a001

```
User-Name = bob
```

Getting Attribute Information

You can get the name and value of an attribute in various formats:

- get name—gets the name as a string
- get value—gets the value as a string
- get type—gets the name as an integer
- get valueAsInt—gets the value as an integer
- get valueAsIPAddress—gets the value as an IP address.

The following examples show how to get an attribute's name, type, value, and value as integer:

a001 get name

```
User-Name
```

a001 get type

```
1
```

a001 get value

```
bob
```

a001 get valueAsInt

```
a001: the value is not an int
```

Deleting Attributes

When you are writing long running or iterating scripts, you might want to conserve memory by deleting attributes when you are finished with them (be sure not to delete attributes being referred to by other objects, like packets.)

To delete all resources referred to by the attribute `a001`, type:

a001 delete

Using the radclient Command

The following three examples show how to use **radclient** to create, send, and modify packets.

Example 1

This example creates an Access-Request packet for user `jane` with password `jane`, and sends it to the default RADIUS server (**localhost**).

simple jane jane

```
p001
```

The command **simple jane jane** creates the packet; the packet object identifier is **`p001`**. When you enter the packet object identifier, **radclient** displays the contents of the packet.

p001

```
Packet: code = Access-Request, id = 0, length = 0, attributes =
    User-Name = jane
    User-Password = jane
    NAS-Identifier = localhost
    NAS-Port = 0
```

When you enter the packet identifier and the command **send**, **radclient** sends the packet to the RADIUS server and prints the response packet object identifier.

p001 send

```
p002
```

When you enter the packet object identifier of the response, **radclient** displays the contents of the response packet.

p002

```
Packet: code = Access-Accept, id = 1, length = 38, attributes =
Login-IP-Host = 204.253.96.3
Login-Service = Telnet
Login-TCP-Port = 541
```

Example 2

The following example creates a simple Access-Request packet, then adds other attributes to it.

simple jane jane

```
p003
```

The command line above shows creation of the packet `p003` using user-ID `jane` and password `jane`.

attrib Service-Type Framed

```
a00c
```

The line above shows creating the **Service-Type** attribute (with the object identifier `a00c`).

a00c

```
Service-Type = Framed
```

Entering the attribute object identifier `a00c` displays the attribute object.

p003 set attrib a00c

The line above adds the newly set attribute to the packet. The following line creates another attribute.

attrib NAS-Port 99

```
a00d
```

a00d

```
NAS-Port = 99
```

p003 set attrib a00d

The same steps add the **NAS-Port** attribute to the packet, and finally, the packet contents are displayed.

p003

```
Packet: code = Access-Request, id = 0, length = 0, attributes =

User-Name = jane
User-Password = jane
NAS-Identifier = localhost
Service-Type = Framed
NAS-Port = 99
```

Example 3

Example 3 performs the same tasks as Example 2 using the command substitution feature of Tcl which allows you to use the results of one command as an argument to another command. Square brackets invoke command substitution. The statement inside the brackets is evaluated, and the result is used in place of the bracketed command.

simple jane jane

```
p004
```

p004 set attrib [attrib Service-Type Framed]

p004 set attrib [attrib NAS-Port 99]

p004

```
Packet: code = Access-Request, id = 0, length = 0, attributes =
        User-Name = jane
        User-Password = jane
        NAS-Identifier = localhost
        Service-Type = Framed
        NAS-Port = 99
```

Using radclient Test Commands

You can use the **radclient** commands **timetest** and **callsPerSecond** to test the RADIUS server.

radclient Variables

You control how **timetest** and **callsPerSecond** work using **radclient** variables. To set a **radclient** variable, use the **set** command as follows:

set *variable value*

Table 5-1 lists the **radclient** variables used in **timetest** and **callsPerSecond** and their description.

Table 5-1 radclient Variables

Variable	Description
host	Destination host to send the packets (default is localhost)
num_packets	Number of packets to send at once (default is 256)
num_users	Modulus for the username pattern (default is 10000)
port	Port where **radclient** sends access-request packets (default is 1645). Changing this port does not affect the accounting_port.
retry_timeout	Length of time to wait after a timeout occurs before retrying
secret	Shared secret configured on the RADIUS server for the client (default is secret)
timeout	Length of time to wait before a timeout occurs
tries	Number of times to attempt to send
UserNamePattern	Pattern of the usernames (default is user%d%%PPP)
UserPasswordPattern	Pattern of the user passwords (default is user%d)

Using timetest

The **timetest** command sends a number of requests to the RADIUS server then waits for a response. When a response arrives, **timetest** immediately sends another request. **timetest** can keep up to 256 requests outstanding all the time.

The syntax of the **timetest** command is:

timetest <*testtype*> [<*cycles*> [<*repetitions*> [<*starting user number*> [<*increment user number*>]]]]

Table 5-2 lists the applicable test types.

Table 5-2 Test Types

Test Type	Description
1	Access-Request
2	Access-Request + Accounting-Start + Accounting-Stop
3	Accounting-Start + Accounting-Stop
4	Ascend-IPA-Allocate + Ascend-IPA-Release
5	Access-Request + Ascend-IPA-Allocate + Ascend-IPA-Release
6	Access-Request + Ascend-IPA-Allocate + Accounting-Start + Ascend-IPA-Release + Accounting-Stop
7	Access-Request + USR-Resource-Free-Request
8	LEAP Identity + LEAP-Challenge Response + LEAP Challenge
9	LEAP Identity + LEAP-Challenge Response + LEAP Challenge + Accounting-Start + Accounting-Stop
10	Access-Request + Accounting-Start + Accounting-Stop with Home-Agent request
11	Access-Request + Accounting-Start + Accounting-Stop with ODAP request

Consider this **timetest** example with **radclient** variables set to the following:

host—1.1.1.2

port—1812

secret—cisco

UserNamePattern—user%d

UserPasswordPattern—puser%d

num_users—100,000

num_packets—128

In this example, **timetest** sends packets directly to the host at IP address 1.1.1.2 on port 1812 with a shared secret `cisco`. There are 100,000 users in the server's user database with the name pattern *user#* and password pattern *puser#*, where # ranges from 0-99,999, inclusive. The number of outstanding requests are limited to 128.

Before starting the timing test, **timetest** sends an Accounting-On packet to the AAA server and waits for a response to make sure that any session management being performed on the AAA server is reset before running the test. Once a response is received, the **timetest** can begin.

Using callsPerSecond

The **callsPerSecond** command is a smart throttle that sends packets at a rate you set. If you set **callsPerSecond** to two transactions per second (TPS), **callsPerSecond** sends a packet every 0.5 seconds.

The syntax of the **callsPerSecond** command is:

callsPerSecond <*callsPerSecond*> <*testtype*> [<*cycles*> [<*repetitions*> [<*starting user number*> [<*increment user number*>]]]]

Additional radclient Variables

Table 5-3 lists additional **radclient** variables and their description.

Table 5-3 Additional radclient Variables

Variable	Description
accounting_port	Port where the RADIUS server sends accounting packets (default is 1646). **Note** Changing accounting_port value does not affect the authentication port.
host	Name of host where Cisco AR is installed
ignore_signature_errs	Causes server to ignore signature in the response
load_path	Search path to load source files with user processes
NASIdentifier	Value to set NAS-Identifier attribute
NASIPAddress	Value to set NAS-IP-Address attribute
NASPort	Value to set NAS-Port attribute
num_packets	Number of packets to send at once (default is 256)
num_users	Modulus for the username pattern (default is 10000)
port	Port where **radclient** sends access-request packets (default is 1645). Changing this port does not affect the accounting_port.
retry_timeout	Length of time to wait before attempting a retry
secret	Shared secret configured on the RADIUS server for the client (default is secret)
tclDefaultLibrary	Tclsh default library
tcl_patchLevel	Tclsh version with patch level
tcl_pkgPath	Tclsh install path
tcl_traceExec	Tclsh boolean to activate tracing
tcl_platform	Tclsh platform array
tcl_version	Tclsh version
tries	Number of retry attempts
UserNamePattern	Pattern of the user names (default is user%d%%PPP)
UserPasswordPattern	Pattern of the user passwords (default is user%d)
verbose	Verbose flag for Tclsh

CHAPTER 6

Configuring Local Authentication and Authorization

Revised: April 6, 2008, OL-8558-04

Cisco CNS Access Registrar (AR) allows user information to be stored in its own internal database or external stores such as an LDAP directory or Oracle database. This chapter describes how to configure Cisco AR to perform authentication and authorization using the Cisco AR internal database and how to verify and troubleshoot a local service and userlist configuration.

In RADIUS, an Access Request packet is a request for authentication and authorization (AA). Authentication checks username and password credentials, while authorization typically involves returning the correct information to allow the service a user is authorized to have. Cisco AR performs AA and returns the appropriate RADIUS attributes in an Access Accept packet.

Configuring a Local Service and UserList

Cisco AR uses services configured under **/Radius/Services** to process RADIUS requests. To process RADIUS access requests locally, you must configure a service and set its type to **local**. A local service references an AR userlist.

The following sections show the commands you enter and the expected responses from the Cisco AR server to do the following:

- Configuring a Local Service
- Configuring a Userlist
- Configuring Cisco AR to Use the Local Service For AA
- Activating the Configuration

Throughout this chapter, the **aregcmd** commands you enter are shown in **bold** font, and the server responses are shown in `smaller plain font` as shown in the following:

command you enter

```
server response
```

Configuring a Local Service

Cisco AR maintains **Services** under **/Radius**. To configure a local service, complete the following steps:

Step 1 Use the **add** command at **/Radius/Services** to create a Service.

cd /Radius/Services

```
[ //localhost/Radius/Services ]
```

add SouthBay

```
Added SouthBay
```

Step 2 Change directory to the new service and set its type to local.

cd SouthBay

```
[ //localhost/Radius/Services/SouthBay ]
```

set type local

```
Set Type local
```

Step 3 Use the **set** command to associate a userlist with the service.

set userlist SouthUsers

```
Set UserList SouthUsers
```

Configuring a Userlist

Cisco AR maintains **UserLists** under **/Radius**. To configure a userlist, complete the following steps:

Step 1 Use the **add** command at **/Radius/UserLists** to create a userlist.

cd /Radius/UserLists

```
[ //localhost/Radius/UserLists ]
```

add SouthUsers

```
Added SouthUsers
```

Step 2 Change directory to the userlist and add users.

cd SouthUsers

```
[ //localhost/Radius/UserLists/SouthUsers ]
```

add user1

```
Added user1
```

Step 3 Change directory to each user you add and set the user's password.

cd user1

```
[ //localhost/Radius/UserLists/SouthUsers/user1 ]
```

set Password test

```
Retype password to confirm:

Set Password <encrypted>
```

Configuring Cisco AR to Use the Local Service For AA

To configure Cisco AR to use the local service for authentication and authorization, enter commands to set the DefaultAuthenticationService and DefaultAuthenticationService to the service you created, as shown in the following:

cd /Radius

```
[ //localhost/Radius ]
```

set DefaultAuthenticationService SouthBay

```
Set DefaultAuthenticationService SouthBay
```

set DefaultAuthorizationService SouthBay

```
Set DefaultAuthorizationService SouthBay
```

Activating the Configuration

To activate the configuration changes you have made, enter the **save** command:

save

```
Validating //localhost...

Saving //localhost...
```

After you issue the **save** command, Cisco AR attempts to validate the configuration, checks for all required properties, and ensures there are no logic errors. If the validation is successful, Cisco AR saves the configuration to the MCD database.

Troubleshooting the Local Service and UserList Configuration

Before you begin troubleshooting, ensure that the current configuration is valid and active. To ensure that any configuration changes you have made are valid and stored in the database, you must issue the **save** command.

save

```
Validating //localhost...
Saving //localhost...
```

To ensure that the current configuration is active, issue the **reload** command.

reload

```
Reloading Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10
```

Verifying the Configuration

This section lists steps you can take to verify the configuration changes you have made.

Step 1 Check to see that the UserList exists under the service.

ls /Radius/Services/SouthBay

```
[ /Radius/Services/SouthBay ]
    Name = SouthBay
        Description =
        Type = local
        IncomingScript~ =
        OutgoingScript~ =
        OutagePolicy~ = RejectAll
        OutageScript~ =
        UserList = SouthUsers
```

Step 2 Check to see that user **user1** exists under the SouthUsers userlist.

ls /Radius/UserLists/SouthUsers

```
[ /Radius/UserLists/SouthUsers ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>
    Name = SouthUsers
    Description =
    user1/
```

Step 3 Turn on debugging.

trace /r 5

```
Traced "/Radius: Trace level is set to 5"
```

Step 4 Use **radclient** to send an Access-Request for user **user1**.

simple user1 test

The debugging output will be sent to the file **name_radius_1_log** in the **/opt/CSCOar/ logs** directory. The following example shows items you should expect in a successful Access-Request.

Note Lines of interest are in **bold** font.

```
04/23/2003 18:34:35: P1144: Packet received from 127.0.0.1
04/23/2003 18:34:35: P1144: Trace of Access-Request packet
04/23/2003 18:34:35: P1144:    identifier = 4
04/23/2003 18:34:35: P1144:    length = 62
04/23/2003 18:34:35: P1144:    reqauth = f5:37:f7:04:99:85:c7:63:8f:bc:f4:44:ab:03:4e:1a
04/23/2003 18:34:35: P1144:    User-Name = user1
04/23/2003 18:34:35: P1144:    User-Password = 59:fb:2e:a9:34:de:0e:15:60:8d:4b:64:77:6a:57:d8
04/23/2003 18:34:35: P1144:    NAS-Port = 2
04/23/2003 18:34:35: P1144:    NAS-Identifier = localhost
04/23/2003 18:34:35: P1144: Using Client: localhost (127.0.0.1)
04/23/2003 18:34:35: P1144: Using NAS: localhost (127.0.0.1)
04/23/2003 18:34:35: P1144: Request is directly from a NAS: TRUE
04/23/2003 18:34:35: P1144: Authenticating and Authorizing with Service SouthBay
04/23/2003 18:34:35: P1144: Getting User user1's UserRecord from UserList SouthUsers
04/23/2003 18:34:35: P1144: User user1's password matches
04/23/2003 18:34:35: P1144: No default Remote Session Service defined.
04/23/2003 18:34:35: P1144: Trace of Access-Accept packet
04/23/2003 18:34:35: P1144:    identifier = 4
04/23/2003 18:34:35: P1144:    length = 20
04/23/2003 18:34:35: P1144:    reqauth = 36:88:34:0c:cc:ea:9e:d8:6d:f5:14:f7:ab:26:e7:f6
04/23/2003 18:34:35: P1144: Sending response to 127.0.0.1
04/23/2003 18:34:35: Log: Request from localhost (127.0.0.1): User user1 accepted
```

The following example shows a trace for an unsuccessful Access-Request due to an invalid password.

Note Lines of interest are in **bold** font.

```
04/23/2003 19:05:13: P1527: Packet received from 127.0.0.1
04/23/2003 19:05:13: P1527: Trace of Access-Request packet
04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:
04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:
04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527: Using Client: localhost
(127.0.0.1)
04/23/2003 19:05:13: P1527: Using NAS: localhost (127.0.0.1)
04/23/2003 19:05:13: P1527: Request is directly from a NAS: TRUE
04/23/2003 19:05:13: P1527: Authenticating and Authorizing with Service SouthBay
04/23/2003 19:05:13: P1527: Getting User user1's UserRecord from UserList SouthUsers
04/23/2003 19:05:13: P1527: User user1's password does not match
04/23/2003 19:05:13: P1527: Rejecting request
04/23/2003 19:05:13: P1527: Rejecting request
04/23/2003 19:05:13: P1527: Trace of Access-Reject packet
04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527:
04/23/2003 19:05:13: P1527:04/23/2003 19:05:13: P1527: Sending response to 127.0.0.1
04/23/2003 19:05:13: Log: Request from localhost (127.0.0.1): User user1 rejected (UserPasswordInvalid)
```

If a user's password is invalid, reset the password to ensure it was entered correctly. Also check that the shared secret being used by the RADIUS client and the Cisco AR server match.

Configuring Return Attributes and Check-Items

Cisco AR supports RADIUS check item attributes at the user and group levels. You can configure Cisco AR to check for attributes that must be present or attributes that must not be present in the Access-Request packet for successful authentication. For a complete list of attributes supported in Cisco AR, refer to Appendix C, "RADIUS Attributes".

When using check item attributes, Cisco AR rejects Access-Requests if either of the following conditions exist:

- Any configured check item attributes are not present in the Access-Request packet
- Any Access-Request packet's check item attribute values do not match with those configured check item attribute values

Configuring Per User Return Attributes

User return attributes are attributes that are specific for a given user each time they log in. To configure a user's return attributes, change directory to the user's Attributes subdirectory and configure the desired attributes.

cd /Radius/UserLists/SouthUsers/User1/Attributes

```
[ //localhost/Radius/UserLists/SouthUsers/user1/Attributes ]
```

set Session-Timeout 60

```
Set Session-Timeout  60
```

set Callback-Number 5551234

```
Set Callback-Number  5551234
```

Configuring Per User Check-Items

Check Items are a way to check that certain attribute/values exist in a user's access-request. If the attribute/values are not present in the access-request, the Cisco AR server rejects the access-request.

To check that an access-request for `user1` has the Calling-Station-Id attribute set to 5555678, enter the following:

cd /Radius/UserLists/SouthUsers/User1/CheckItems

```
[ //localhost/Radius/UserLists/SouthUsers/user1/CheckItems ]
```

set Calling-Station-Id 5555678

```
Set Calling-Station-Id  5555678
```

Be sure to **save** your configuration to preserve your changes.

Verifying the Per User Return Attributes and Check-Items Configuration

A successful request will produce a trace similar to the following:

```
04/24/2003 14:08:07: P1539: Packet received from 127.0.0.1
04/24/2003 14:08:07: P1539: Trace of Access-Request packet
04/24/2003 14:08:07: P1539:    identifier = 1
04/24/2003 14:08:07: P1539:    length = 71
04/24/2003 14:08:07: P1539:    reqauth = d6:86:c5:1e:0e:a0:20:4f:9a:1a:2c:35:27:16:23:36
04/24/2003 14:08:07: P1539:    User-Name = user1
04/24/2003 14:08:07: P1539:    User-Password = 99:dc:4a:22:ef:f6:8b:90:a2:3a:50:f0:a6:03:6e:b3
04/24/2003 14:08:07: P1539:    NAS-Port = 1
04/24/2003 14:08:07: P1539:    Calling-Station-Id = 5555678
04/24/2003 14:08:07: P1539:    NAS-Identifier = localhost
04/24/2003 14:08:07: P1539: Using Client: localhost (127.0.0.1)
04/24/2003 14:08:07: P1539: Using NAS: localhost (127.0.0.1)
04/24/2003 14:08:07: P1539: Request is directly from a NAS: TRUE
04/24/2003 14:08:07: P1539: Authenticating and Authorizing with Service SouthBay
04/24/2003 14:08:07: P1539: Getting User user1's UserRecord from UserList SouthUsers
04/24/2003 14:08:07: P1539: User user1's password matches
04/24/2003 14:08:07: P1539: Processing User user1's check items
04/24/2003 14:08:07: P1539: Merging User user1's Attributes into response Dictionary
04/24/2003 14:08:07: P1539: Merging attributes into the Response Dictionary:
04/24/2003 14:08:07: P1539:   Adding attribute Callback-Number, value = 5551234
04/24/2003 14:08:07: P1539:   Adding attribute Session-Timeout, value = 60
04/24/2003 14:08:07: P1539: No default Remote Session Service defined.
04/24/2003 14:08:07: P1539: Trace of Access-Accept packet
04/24/2003 14:08:07: P1539:    identifier = 1
04/24/2003 14:08:07: P1539:    length = 35
04/24/2003 14:08:07: P1539:    reqauth = cc:2d:51:71:b5:49:0e:e6:f1:eb:1c:61:51:7a:f1:cb
04/24/2003 14:08:07: P1539:    Callback-Number = 5551234
04/24/2003 14:08:07: P1539:    Session-Timeout = 60
04/24/2003 14:08:07: P1539: Sending response to 127.0.0.1
04/24/2003 14:08:07: Log: Request from localhost (127.0.0.1): User user1 accepted
```

Configuring Profiles to Group Attributes

You can use theCisco AR profile object to group attributes. For example, you might want to group attributes for all PPP users. All PPP users could then be assigned the profile and the attributes contained in the profile would be returned in their access-accepts.

Step 1 Change directory to **/Radius/Profiles** and add a profile.

cd /Radius/Profiles

```
[ //localhost/Radius/Profiles ]
```

add PPP-Profile

```
Added PPP-Profile
```

Step 2 Change directory to the new profile, then change directory to the profile's Attributes subdirectory.

cd PPP-Profile

```
[ //localhost/Radius/Profiles/PPP-Profile ]
```

cd Attributes

```
[ //localhost/Radius/Profiles/PPP-Profile/Attributes ]
```

Step 3 Configure the desired attributes for the profile.

set Service-Type Framed

```
Set Service-Type  Framed
```

set Framed-Protocol PPP

```
Set Framed-Protocol  PPP
```

Note When you need to set an attribute to a value that includes a space, you must double-quote the value, as in the following: *set Framed-Route "192.168.1.0/24 192.168.1.1"*

Step 4 Assign the profile to a user by setting the user's BaseProfile attribute to the desired profile.

cd /Radius/UserLists/SouthUsers/User1

```
[ //localhost/Radius/UserLists/SouthUsers/user1 ]
```

set BaseProfile PPP-Profile

```
Set BaseProfile PPP-Profile
```

Configuring Return Attributes and Check-Items Using UserGroup

A profile can also be assigned to a UserGroup. You assign a profile to a group by setting the group's BaseProfile attribute to the desired profile.

Step 1 Change directory to **/Radius/UserGroups** and add a UserGroup.

cd /Radius/UserGroups

```
[ //localhost/Radius/UserGroups ]
```

add PPP-Group

```
Added PPP-Group
```

Step 2 Change directory to the new UserGroup and add Return Attributes.

cd PPP-Group

```
[ //localhost/Radius/UserGroups/PPP-Group ]
```

cd Attributes

```
[ //localhost/Radius/UserGroups/PPP-Group/Attributes ]
```

set Service-Type Outbound

```
Set Service-Type Outbound
```

Step 3 Change directory to the UserGroups' Check-Items subdirectory and add CheckItems.

cd ../CheckItems/

```
[ //localhost/Radius/UserGroups/PPP-Group/CheckItems ]
```

set Service-Type Framed

```
Set Service-Type  Framed
```

Step 4 Assign the UserGroup to a User.

cd /Radius/UserLists/SouthUsers/User2

```
[ //localhost/Radius/UserLists/SouthUsers/user2 ]
```

set Group PPP-Group

```
Set Group PPP-Group
```

Return Attribute Precedence

Because there are multiple ways of returning attributes, you might at some time have an attribute clash. In case of an attribute clash, the attribute precedence is as follows (from highest to lowest):

1. User attribute
2. User profile
3. UserGroup attribute
4. UserGroup profile

aregcmd Command Performance

You can impact **aregcmd** command performance and server response time by having Cisco AR userlists that contain more than 10,000 users. Cisco AR userlists were not designed to contain 10,000 users in any one list.

If you must provide service for groups greater than 10000 users, Cisco recommends that you use an external data store such as an LDAP directory or an Orade database. If you are unable to use an external data store, create multiple userlists instead, keeping each userlist under 10,000 users.

Multiple userlists require multiple services (one for each userlist), because a service cannot reference more than one userlist. The multiple services can then be combined using the Service Grouping feature with ResultRule, OR, as follows:

```
[ //localhost/Radius/Services/GroupService ]
    Name = GroupService
    Description =
    Type = group
    IncomingScript~ =
    OutgoingScript~ =
    ResultRule = OR
    GroupServices/
    1. UserService1
    2. UserService2
    3. UserService3
```

UserDefined1 Property

The UserDefined1 property of a user object is a free text field. You can use the UserDefined1 property to store additional user information much like the Description property, but its most powerful use is to pass information to an extension point script. The value set in the UserDefined1 property is automatically set to the environment variable of the same name during authentication. Any extension point script that subsequently runs has access the value in that property.

```
[ //localhost/Radius/UserLists/Default/bob ]
    Name = bob
    Description =
    Password = <encrypted>
    AllowNullPassword = FALSE
    Enabled = TRUE
    Group~ =
    BaseProfile~ =
    AuthenticationScript~ =
    AuthorizationScript~ =
    UserDefined1 =
    Attributes/
    CheckItems/
```

Access-Request Logging

By default, Cisco AR logs all dropped and rejected requests in the name_radius_1_log file. The following are examples of log entries for dropped or rejected requests.

```
04/25/2003 17:38:11 name/radius/1 Warning Protocol 0 Request from localhost (127.0.0.1):
User user1 rejected (UserPasswordInvalid)
```

```
04/25/2003 18:05:12 name/radius/1 Warning Protocol 0 Packet from 128.107.132.106: that
address is not in the Clients list <unknown user>
```

To log all accepted requests as well, set the LogServerActivity advanced property to TRUE:

set /Radius/Advanced/LogServerActivity TRUE

Set /Radius/Advanced/LogServerActivity TRUE

save

```
Validating //localhost...

Saving //localhost...
```

reload

```
Reloading Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10

Access-Accept packets are now logged as well:
04/25/2003 18:22:32 name/radius/1 Activity Protocol 0 Request from localhost (127.0.0.1):
User user2 accepted
```

CHAPTER 7

RADIUS Accounting

This chapter describes RADIUS Accounting in Cisco Access Registrar as defined in Internet RFC 2866. This chapter contains the following sections:

Understanding RADIUS Accounting

RADIUS accounting is the process of collecting and storing the information contained in Accounting-Start and Accounting-Stop messages. Internet RFC 2866 describes the protocol for sending accounting information between a Network Access Server (NAS) and a RADIUS server (or shared accounting server).

Note Cisco AR uses UDP port number 1646 as its default port for RADIUS accounting messages. RFC 2866 defines UDP port number 1813 as the accounting port number.

When a NAS that uses accounting begins a session, it sends an Accounting-Start packet describing the type of service and the user being connected to the Cisco AR server. When the session ends, the NAS sends the RADIUS server an Accounting Stop packet describing the type of service that was delivered. The Accounting Stop packet might also contain statistics such as elapsed time, input and output octets, or input and output packets.

Setting Up Accounting

To configure Cisco AR to perform accounting, you must do the following:

1. Create a service
2. Set the service type to file

3. Set the DefaultAccountingService field in **/Radius** to the name of the service you created

After you **save** and **reload** the Cisco AR server configuration, the Cisco AR server writes accounting messages to the **accounting.log** file in the **/opt/CSCOar/logs** directory. The Cisco AR server stores information in the **accounting.log** file until a rollover event occurs. A rollover event is caused by the **accounting.log** file exceeding a pre-set size, a period of time transpiring, or on a scheduled date.

When the rollover event occurs, the data in **accounting.log** is stored in a file named by the prefix *accounting*, a date stamp (*yyyymmdd*), and the number of rollovers for that day. For example, **accounting-20010619-14** would be the 14th rollover on June 19, 2001.

The following shows the properties for a service called CiscoAccounting:

```
[ //localhost/Radius/Services/CiscoAccounting ]
    Name = CiscoAccounting
    Description =
    Type = file
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    FilenamePrefix = accounting
    MaxFileSize = "10 Megabytes"
    MaxFileAge = "1 Day"
    RolloverSchedule =
    UseLocalTimeZone = FALSE
```

Accounting Log File Rollover

The Cisco AR accounting functionality provides flexibility in managing the accounting log. You can configure the Cisco AR server to rollover the accounting log using any combination of the following Cisco AR accounting service properties:

- MaxFileSize— Indicates the maximum size of the accounting log file in KB, MB, or GB
- MaxFileAge— Indicates the maximum age of the log file in minutes, hours, days, or weeks
- RolloverSchedule— Indicates the exact time including the day of the month or day of the week, hour and minute to roll over the accounting log file

You can configure an accounting service using any combination of MaxFileSize, MaxFileAge, and RolloverSchedule. For example, you might configure RolloverSchedule and MaxFileAge at the same time. This would be useful if you wanted to have an age-based rollover, but also synchronize to an absolute clock at specified times. The following would set a rollover every twelve hours at 11:59 and 23:59.

set MaxFileAge “12 H”

set RolloverSchedule “59 11,23 * * *”

You might also consider scheduling MaxFileAge to be six minutes and set RolloverSchedule to the top of the hour. The following would create ten six-minute long files starting anew every hour.

set MaxFileAge “6 Minutes”

set RolloverSchedule “0 * * * *”

Although you specify an exact time with the RolloverSchedule property, the Cisco AR server only checks the rollover schedule when an accounting event occurs. If your Cisco AR server receives a steady flow of packets (at least one per minute), the times you specify are accurate. However, if the Cisco AR server does not receive any packets for a period of time, no rollovers will occur until the next packet is received. The same is true for MaxFileAge and MaxFileSize.

Based on the maximum file size and the age specified, Cisco AR closes the accounting file, moves it to a new name, and reopens the file as a new file. The name given to this accounting file depends on its creation and modification dates.

For example, if the file was created and modified on the same date, the file name will be of the format *FileNamePrefix-<yyyymmdd>-<n>.log*, and the suffix will have year, month, day, and number. If the file was created on some day and modified on another, the file name will be of the format *FileNamePrefix-<yyyymmdd>-<yyyymmdd>-<n>.log*, and the suffix will have creation date, modification date, and number.

FilenamePrefix

The FileNamePrefix property enables you to specify a path to the file system in which you store the log files. If you do not manage your log files regularly, they might use the system resources, which will affect the performance of Cisco AR server. Cisco recommends that you store the log files in a file system different from the file system where you installed the Cisco AR software by specifying the path in the FilenamePrefix property. By doing so, the Cisco AR server continues to run, even if the accounting logs fill the file system. The following example specifies the **/usr/arlogs/accounting** as the FilenamePrefix:

```
set /Radius/Services/CiscoAccounting/FilenamePrefix /usr/arlogs/accounting
```

You can also set up a *cron job* to check the size of the log files and mail the administrator if the file system is full.

MaxFileSize

Use MaxFileSize to indicate the maximum size of the **accounting.log** file in minutes, hours, days, or weeks. MaxFileAge measures the age of the **accounting.log** file from the time the previous file rollover occurred.

You can specify the following (case insensitive) file sizes:

- K, Kilobytes, Kilobytes
- M, Megabyte, Megabytes
- G, Gigabyte, Gigabytes

The following are examples of valid commands to set MaxFileSize:

set MaxFileSize “500 kilobytes”

The example above sets a MaxFileSize of 500 kilobytes

set maxfilesize “1 G”

The example above sets a MaxFileSize of one gigabyte

set maxfilesize “200 megabyte”

The example above sets a MaxFileSize of 200 megabytes

MaxFileAge

Use MaxFileAge to indicate the maximum age of the log file in minutes, hours, days, or weeks. MaxFileAge measures the age of the **accounting.log** file from the time the previous file rollover occurred.

You can specify the following (case insensitive) periods of time:

- M, Minute, or Minutes preceded by a number from 0 to 59
- H, Hour, or Hours preceded by a number from 0 to 23
- D, Day, or Days preceded by a number from 1 to 31
- W, Week, or Weeks preceded by a number from 1 to 52

The following are examples of valid commands to set MaxFileAge:

set MaxFileAge “6 Minutes”

The example above sets a MaxFileAge of 6 minutes.

set maxfileage “2 d”

The example above sets a MaxFileAge of two days.

set maxfileage “1 H”

The example above sets a MaxFileAge of one hour.

RolloverSchedule

You set RolloverSchedule using the following crontab-style time format:

minute hour "day of month" "month of year" "day of week"

Where:

Minute is a value from 0-59

Hour is a value from 0-23

Day (of the month) is a value from 1-31

Month is a value from 1-12

Day (of the week) is a value from 0-6, where 0 is Sunday

UseLocalTimeZone

When set to TRUE, the Cisco AR server stores the accounting records in the log using the local system time. When set to FALSE (the default), Cisco AR stores the accounting records in the log using Greenwich Mean Time (GMT).

Oracle Accounting

Previous releases of Cisco AR supported accessing user data from an Oracle database using Open Database Connectivity (ODBC), but this feature was limited to performing authentication and authorization (AA). You could only write the accounting records to local file or proxy to another RADIUS server. Cisco AR supports writing accounting records into Oracle database enabling integration between billing systems and Oracle.

Cisco AR adds a new type of service and remote server called *odbc-accounting* that enables inserting accounting records into Oracle. You can write accounting records into Oracle by referring this service in **/Radius/DefaultAccountingService** or in the Accounting-Service environment variable.

There is no specified schema structure to use the Oracle accounting feature. You can use your own table design and configure insert statements using standard SQL in theCisco AR configuration. The Cisco AR server executes the insert statements to write the accounting record into Oracle. This feature is similar to the existing ODBC feature which performs authentication and authorization.

To improve latency for writing accounting records into database, packet buffering can be used. This option is enabled using the *BufferAccountingPackets* property under the odbc-accounting remote server definition.

Configuring Oracle Accounting

To use the Oracle accounting feature, you must configure a service of type *odbc-accounting* under **/Radius/Services**. You must also configure at least one remote servers of type *odbc-accounting* under **/Radius/RemoteServers**.

ODBC-Accounting Service

The following is an example of an ODBC-Accounting service:

```
[ //localhost/Radius/Services/oracle_accounting ]
    Name = oracle_accounting
    Description =
    Type = odbc-accounting
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
        1. accounting_server
```

ODBC RemoteServers

Create a remote server under **/Radius/RemoteServers**, and set its protocol to odbc-accounting. The following is an example of an ODBC-Accounting RemoteServer's configuration:

```
[ //localhost/Radius/RemoteServers/accounting_server ]
    Name = accounting_server
    Description =
    Protocol = odbc-accounting
    ReactivateTimerInterval = 300000
    Timeout = 15
    DataSourceConnections = 8
```

```
ODBCDataSource =
KeepAliveTimerInterval = 0
BufferAccountingPackets = TRUE
MaximumBufferFileSize = "10 Megabytes"
NumberOfRetriesForBufferedPacket = 3
BackingStoreEnvironmentVariables =
UseLocalTimeZone = FALSE
AttributeList =
Delimiter =
SQLDefinition/
```

Table 7-1 describes the ODBC RemoteServer properties.

Table 7-1 ODBC RemoteServer Properties

Property	Description
Name	Name of the remote server; this property is mandatory, and there is no default
Description	Optional description of server
Protocol	Must be set to odbc-accounting
ReactivateTimerInterval	Mandatory time interval (in milliseconds) to activate an inactive server; defaults to 300000 ms.
Timeout	Mandatory time interval (in seconds) to wait for SQL operation to complete; defaults to 15 seconds
DataSourceConnections	Mandatory number of connections to be established; defaults to 8
ODBCDataSource	Name of the ODBCDataSource to use and must refer to one entry in the list of ODBC datasources configured under **/Radius/Advanced/ODBCDataSources**. Mandatory; no default
KeepAliveTimerInterval	Mandatory time interval to send a keepalive to keep the idle connection active; defaults to zero (0) meaning the option is disabled
BufferAccountingPackets	Mandatory, TRUE or FALSE, determines whether to buffer the accounting packets to local file, defaults to TRUE which means that packet buffering is enabled)
MaximumBufferFileSize	Mandatory if BufferAccountingPackets is set to TRUE, determines the maximum buffer file size, defaults to 10 Megabyte)
NumberOfRetriesForBufferedPacket	Mandatory if BufferAccountingPackets is set to TRUE. A number greater than zero determines the number of attempts to be made to insert the buffered packet into Oracle. Defaults to 3.
BackingStoreEnvironmentVariables	Optional; when BufferAccountingPackets is set to TRUE, contains a comma-separated list of environment variable names to be stored into a local file along with buffered packet. No default. BackingStoreEnvironmentVariables can also be specified in scripts using the BackingStoreEnvironmentVariables environment variable.
UseLocalTimeZone	Set to TRUE or FALSE, determines the timezone of accounting records' TimeStamp (defaults to FALSE).
AttributeList	List of comma-separated attribute names.
Delimiter	Character used to separate the values of the attributes given in AttributeList property.
SQLDefinition	List of insert statements to be executed to insert the accounting record.

It is mandatory to set MaximumBufferFileSize property if BufferAccountingPackets property is set to TRUE. MaximumBufferFileSize can be specified in Kilobytes, Megabytes and Gigabytes. All values "512 KB", "512 kilobytes", "512 k", "512 K" are valid for specifying 512 kilobytes.

If buffering is enabled, incoming packets will be accepted and logged to local file until the configured buffer file size is reached even if the database is off-line. Attempts to insert them into Oracle will be made when database becomes available. This remote server will be marked as down only when the buffer gets full. So, having two odbc-accounting remote servers in the service, first one with buffering enabled and multiple server policy of FailOver will make the other remote servers to receive packets only when the first remote server's buffer gets full.

AttributeList is to specify the list of attribute names separated with comma. When this 'AttributeList' is given in the MarkerList, these attributes' values will be appended together with delimiter specified in 'Delimiter' property and will be supplied as input to that marker.

Attributes from the Cisco AR environment and request dictionaries can be specified in the MarkerList. Request dictionary will be looked up first for the attributes. Other than the standard attributes in the Cisco AR dictionaries, two new marker variables are supported inside the marker list. They are:

TimeStamp —Used to insert the timestamp into Oracle from Cisco AR. Specifying this will supply the timestamp of that accounting record as a value to the insert statement. Time zone of this timestamp will be local if UseLocalTimeZone property is set to TRUE, otherwise GMT. This functionality could also be achieved by employing a trigger on the accounting table in the database. However, using this marker variable is recommended because the use of triggers negatively affects performance.

The format of the timestamp marker variable supplied by Cisco AR is *YYYYMMDDHH24MMSS*. For example, a timestamp of 20031010211050 represents 21:10:50, October 10, 2003.

RawAcctRecord—Used to insert the entire accounting record into the database as a single text field. Contents of this will be whatever is sent by the NAS in the accounting packet and the format is *name=value* pairs delimited with the string specified in Delimiter property. If the delimiter property is not set, the default delimiter is a new line character. RawAcctRecord can be used with the other marker variables.

If multi-valued attributes are specified in the marker list, the multiple values are concatenated together with delimiters, and the resulting value will be passed to the insert statement. This delimiter can be specified using the ODBCEnvironmentMultiValueDelimiter property under **/Radius/Advanced**.

Configuration Examples

This section provides common Oracle accounting configuration examples most likely to be used.

Inserting Selected Attributes into Separate Columns

Use the following SQL and MarkerList properties statement to insert selected attributes into separate Oracle columns. The Oracle table definition will have separate columns for each attribute.

```
SQL: "insert into ar_acct (username,nasinfo,packet_type,timestamp) values (?,?,?,?)"
MarkerList: "UserName/SQL_CHAR NAS-Identifier/SQL_CHAR Acct-Status-Type/SQL_CHAR
TimeStamp/SQL_TIMESTAMP"
```

In this example, all the column data types are CHAR/VARCHAR except the timestamp which is DATE. If packet buffering option is disabled, instead of TimeStamp marker, you can also use Oracle's **sysdate** as a value for the timestamp column. The insert statement will look like the following:

```
"insert into ar_acct (username,nasinfo,packet_type,timestamp) values (?,?,?,sysdate)"
```

Inserting Complete Accounting Packets into One Column

Use SQL and MarkerList properties in the SQLStatement like the following to insert the complete accounting packet into one Oracle column.

```
SQL: "insert into ar_acct (timestamp,raw_packet) values (?,?)"
MarkerList: "TimeStamp/SQL_TIMESTAMP RawAcctRecord/SQL_VARCHAR"
```

Inserting Selected Attributes into One Column

To insert selected attribute values into one Oracle column delimited by a comma (,), you must configure the AttributeList and Delimiter properties of the odbc-accounting RemoteServer object like the following:

```
AttributeList = "NAS-Identifier,NAS-Port,Acct-Status-Type,Acct-Session-Id"
Delimiter = ,
```

The SQL and MarkerList properties in the SQLStatement will look like the following:

```
SQL: "insert into ar_acct (username,timestamp,attributes) values (?,?,?)"
MarkerList: "UserName/SQL_CHAR TimeStamp/SQL_TIMESTAMP AttributeList/SQL_VARCHAR"
```

Packet Buffering

You can optionally use packet buffering to improve latency when writing accounting records into database. To enable packet buffering, set the BufferAccountingPackets property in the odbc-accounting remote server to TRUE.

When Using Packet Buffering

When BufferAccountingPackets is set to TRUE, the Cisco AR 4.1 server's Accounting-Response is returned as soon as the accounting record is successfully written to the local file. To accomplish the queuing of accounting records to a local file, a variant of the existing session backing store is used.

Buffered packets will be inserted into Oracle by a set of background worker threads. The Cisco AR server tries to insert the buffered packet into Oracle for the number of retries configured in the NumberOfRetriesForBufferedPacket property (remote odbc accounting server definition). After the configured number of retries, the buffered packets are discarded from the local file.

Incoming packets will be buffered to local file until the configured MaximumBufferFileSize is reached. Once this limit is reached, no more packets will be addressed. When the database is off-line, this remote server will continue to take incoming packets until MaximumBufferFileSize reaches. Cisco AR tries to insert these buffered packets when database becomes available.

When using packet buffering, the Cisco AR server can process more incoming packets and can reduce the bottleneck that could occur if the number of simultaneous incoming packets is large and the number of connections to the database is less.

With Packet Buffering Disabled

When BufferAccountingPackets is set to FALSE, Accounting-Response is returned after writing the accounting record into Oracle. Oracle write timing is immediate.

Incoming packets are acknowledged by the remote server only after completing the write into Oracle.

When the database is off-line, no incoming packets are addressed. A slow database server impacts the packet processing rate.

MySQL Support

Cisco AR 4.1 provides support for MySQL to query user records from a MySQL database and enables you to write accounting records into MySQL when using ODBC accounting. Cisco AR 4.1 has been tested with MySQL 4.0.18 and MyODBC 3.51.06 (reentrant).

For the Cisco AR server to use MySQL, you must create and configure an ODBCDataSource object of type myodbc and a RemoteServer object set to protocol odbc.

Configuring MySQL

To configure the Cisco AR server to query records form a MySQL database, complete the following configuration:

Step 1 Log in to the Cisco AR server and launch **aregcmd**.

Log in as a user with administrative rights such as user **admin**.

Step 2 Change directory to the **/Radius/Advanced/ODBCDataSources** and add a new ODBCDataSource.

cd /Radius/Advanced/ODBCDataSources

add mysql

Step 3 Set the new ODBCDatasource type to myodbc.

cd mysql

set type myodbc

Step 4 Set the Driver property to the path of the MyODBC library.

Step 5 Set the UserID property to a valid username for the MyODBC database and provide a valid password for this user.

Step 6 Provide a DataBase name and the name of the Cisco AR RemoteServer object to associate with the ODBCDataSource.

Step 7 Change directory to **/Radius/RemoteServers** and add a RemoteServer object to associate with the new ODBCDatasource.

cd /Radius/RemoteServers

add mysql

Step 8 Change directory to the new RemoteServer and set its protocol to odbc-accounting.

cd mysql

set protocol odbc-accounting

Step 9 Set the ODBCDataSource property to the name of the ODBCDataSource to associate with this RemoteServer object.

set ODBCDataSource mysql

Example Configuration

The following shows an example configuration for a MySQL ODBC data source.

```
[ //localhost/Radius/Advanced/ODBCDataSources/mysql ]
    Name = mysql
    Type = myodbc
    Driver = /tmp/libmyodbc3_r.so
    UserID = mysql
    Password = <encrypted>
    DataBase = test
    Server = mysql-a
    Port = 3306
```

The following shows an example configuration for a RemoteServer

```
[ //localhost/Radius/RemoteServers/mysql-a ]
    Name = mysql
    Description =
    Protocol = odbc-accounting
    ReactivateTimerInterval = 300000
    Timeout = 15
    DataSourceConnections = 8
    ODBCDataSource = mysql
    KeepAliveTimerInterval = 0
    SQLDefinition/
    ODBCToRadiusMappings/
    ODBCToEnvironmentMappings/
    ODBCToCheckItemMappings/
```

Proxying Accounting Records

You can configure Cisco AR to store accounting records locally and to proxy the accounting records to a remote RADIUS server thereby maintaining multiple accounting logs.

Configuring the Local Cisco AR Server

This type of setup requires you to configure the following on the local Cisco AR server:

- A local accounting service of type file
- A remote accounting service of type radius
- An accounting service of type group
- A RemoteServer object

Configuring the Local Accounting Service

The following example shows the configuration required for a local accounting service. This service must be of type file.

```
[//localhost/Radius/Services/accserv1/ ]
    Name = accserv1
    Description =
    Type = file
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    FilenamePrefix = accounting
    MaxFileSize = "10 Megabytes"
    MaxFileAge = "1 Day"
    RolloverSchedule =
    UseLocalTimeZone = FALSE
```

Configuring the Remote Accounting Service

The following example shows the configuration required for a remote accounting service. This service must be of type *radius*, and the name of the remote server must be listed under the RemoteServers subdirectory.

```
[//localhost/Radius/Services/accserv2/
    Name = accserv2
    Description =
    Type = radius
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
        1. RemoteRADIUS
```

Configuring the Group Accounting Service

The following example shows the configuration required for a grouping accounting service. This service must be of type group and the local and remote accounting services, accserv1 and accserv2 in the previous examples, should be added under the GroupServices subdirectory.

The CiscoAccounting service groups these two services. The type property should be set to group. The services *accserv1* and *accserv2* should be added under GroupServices subdirectory of CiscoAccounting service.

```
[//localhost/Radius/Services/GroupAccounting/
    Name = GroupAccounting
    Description =
    Type = group
    IncomingScript~ =
    OutgoingScript~ =
    RolloverSchedule =
    ResultRule = AND
    GroupServices/
        1. accserv1
        2. accserv2
```

Refer to Service Grouping Feature, page 15-13, for more information about the Cisco AR Service Grouping feature.

Configuring the RemoteServer Object

The following example shows the configuration required for the RemoteServer object in the local Cisco AR server.

```
[ //localhost/Radius/RemoteServers ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>

    RemoteRADIUS/
        Name = RemoteRADIUS
        Description =
        Protocol = radius
        IPAddress = aa.bb.cc.dd
        Port = 1645
        ReactivateTimerInterval = 300000
        SharedSecret = secret
        Vendor =
        IncomingScript~ =
        OutgoingScript~ =
        MaxTries = 3
        InitialTimeout = 2000
        AccountingPort = 1646
        ACKAccounting = TRUE
```

If the ACKAccounting property is set to FALSE, Cisco AR disregards the accounting acknowledgement and continues with the packet processing rather than waiting for the accounting acknowledgement from the Remote server.

The group service, CiscoAccounting in this example, should be defined as the default accounting service for any accounting packets received by the local Cisco AR server, as in the following:

set /Radius/DefaultAccountingService CiscoAccounting

Accounting Log Examples

This section provides examples of accounting log information recorded in an accounting log file.

Accounting-Start Packet

The Accounting-Start packet describes the type of service and the user attempting to login.

```
Mon, 19 May 2003 05:23:02
    User-Name = bob%ppp
    NAS-Port = 71
    NAS-Identifier = localhost
    Acct-Status-Type = Start
    Acct-Session-Id = S209524
```

Accounting Stop Packet

When the session ends, the NAS sends an Accounting Stop packet that describe the type of service that was delivered. The Accounting Stop packet might also contain statistics such as elapsed time, input and output octets, or input and output packets.

```
Thu, 29 May 2003 04:45:30
    User-Name = bob%PPP
    NAS-Port = 181
    NAS-Identifier = localhost
    Acct-Status-Type = Stop
    Acct-Session-Id = S209524
```

Trace of Successful Accounting

The following is a trace example of a a successful accounting sequence.

```
05/18/2003 21:27:58: P6699: Packet received from 10.1.9.204
05/18/2003 21:27:58: P6699: Trace of Accounting-Request packet
05/18/2003 21:27:58: P6699:    identifier = 237
05/18/2003 21:27:58: P6699:    length = 45
05/18/2003 21:27:58: P6699:    reqauth = ed:d6:a6:ae:57:09:b8:55:a8:d4:c4:0d:f7:be:06:2a
05/18/2003 21:27:58: P6699:    User-Name = bob
05/18/2003 21:27:58: P6699:    NAS-Identifier = localhost
05/18/2003 21:27:58: P6699:    Acct-Status-Type = Start
05/18/2003 21:27:58: P6699:    Acct-Session-Id = 1
05/18/2003 21:27:58: P6699: Using Client: cubone (10.1.9.204)
05/18/2003 21:27:58: P6699: Using NAS: localhost (127.0.0.1)
05/18/2003 21:27:58: P6699: Request is directly from a NAS: FALSE
05/18/2003 21:27:58: P6699: Running NAS localhost (127.0.0.1) IncomingScript: Pa seServiceHints
05/18/2003 21:27:58: P6699:     Rex: environ->get( "Request-Type" ) -> "Accounting-Request"
05/18/2003 21:27:58: P6699:     Rex: environ->get( "User-Name" ) -> ""
05/18/2003 21:27:58: P6699:     Rex: request->get( "User-Name", 0 ) -> "bob"
05/18/2003 21:27:58: P6699: Accounting with Service accserv1
05/18/2003 21:27:58: P6699: Trace of Accounting-Response packet
05/18/2003 21:27:58: P6699:    identifier = 237
05/18/2003 21:27:58: P6699:    length = 20
05/18/2003 21:27:58: P6699:    reqauth = a6:40:45:02:4c:8b:6f:00:4f:18:4a:b8:fe:28:9d:f4
05/18/2003 21:27:58: P6699: Sending response to 10.1.9.204
```

Sample Error Messages

The following are sample accounting error messages:

Error message logged in name_radius_1_log file when the disk is full and AR is trying to record an accounting request.

```
05/29/2003  2:52:29 name/radius/1 Error System 0 Failed to write records to the accounting report file
'/usr/accounting.log' - accounting records lost
```

Note An Accounting-Response packet is sent only if the accounting record is written to the file in the disk. If the disk is full, an Accounting-Response packet is not sent.

Error message logged in name_radius_1_log file when the path specified in the FilenamePrefix property is not valid.

```
05/29/2003  4:11:12 name/radius/1 Error Configuration 0 Error in property
/Radius/Services/CiscoAccounting/FilenamePrefix: Unable to write to the specified report file prefix
(/tmp/AR/accounting)
```

CHAPTER 8

Extensible Authentication Protocols

Revised: April 6, 2008, OL-8558-04

Cisco Access Registrar supports the Extensible Authentication Protocol (EAP) to provide a common protocol for differing authentication mechanisms. EAP enables the dynamic selection of the authentication mechanism at authentication time based on information transmitted in the Access-Request. (This type of EAP authentication mechanism is called an authentication exchange.)

Extensible Authentication Protocols (EAP) provide for support of multiple authentication methods. Cisco AR 4.1 supports the following EAP authentication methods:

In general, you enable each EAP method by creating and configuring a service of the desired type. Use the **radclient** test tool to confirm that the EAP service has been properly configured and is operational.

Both versions of Protected EAP (PEAP) are able to use other EAP methods as the authentication mechanism that is protected by PEAP encryption. For PEAP Version 0, the supported authentication methods are EAP-MSChapV2, EAP-SIM, EAP-TLS and EAP-Negotiate. For PEAP Version 1, the supported authentication methods are EAP-GTC, EAP-SIM, EAP-TLS and EAP-Negotiate.

The PEAP protocol consists of two phases: an authentication handshake phase and a tunnel phase where another complete EAP authentication exchange takes place protected by the session keys negotiated by phase one. Cisco AR 4.1 supports the tunneling of other EAP methods within the PEAP phase two exchange.

EAP-FAST

Cisco AR 4.1 supports the EAP-FAST authentication method. EAP-FAST uses the EAP-MSChapV2 method for credential provisioning and EAP-GTC for authentication. Credential provisioning typically occurs only during the client's initial EAP-FAST authentication. Subsequent authentications rely on the provisioned credential and will usually omit the provisioning step.

EAP-FAST is an authentication protocol designed to address the performance shortcomings of prior TLS-based EAP methods while retaining features such as identity privacy and support for password-based protocols. The EAP-FAST protocol is described by the IETF draft *draft-cam-winget-eap-fast-00.txt*.

The EAP-FAST credential is known as a Protected Access Credential (PAC) and contains information used to secure the authentication operations. Parts of the PAC are encrypted by the server and are not visible to other entities. Clients are expected to securely store PACs locally for use during authentication.

Configuring EAP-FAST involves creating and configuring the required EAP-MSChapV2 and EAP-GTC services as well as the EAP-FAST service with the appropriate parameters.

You can use the **radclient** test tool to confirm that the EAP services are properly configured and operational.

Configuring EAP-FAST

To enable EAP-FAST, use **aregcmd** to create and configure a service of type *eap-fast*.

Step 1 Launch **aregcmd** and create an EAP-FAST service.

cd /Radius/Services

add eap-fast-service

Step 2 Change directory to the service and set its type to eap-fast.

cd eap-fast-service

set type eap-fast

Step 3 Set the AuthorityIdentifier:

set AuthorityIdentifier *authority-identifier*

Step 4 : Set the AuthorityInformation:

set AuthorityInformation *authority-information*

Step 5 : Set the AuthentitcationService:

set AuthenticationService *eap-gtc-service*

Step 6 : Set the ProvisionService:

set ProvisionService *eap-mschapv2-service*

The follow example shows the default configuration for an EAP-FAST service:

```
[ //localhost/Radius/Services/eap-fast ]
    Name = eap-fast
    Description =
    Type = eap-fast
    IncomingScript~ =
    OutgoingScript~ =
    AuthorityIdentifier =
    AuthorityInformation =
    MaximumMessageSize = 1024
    PrivateKeyPassword =
    ServerCertificateFile =
    ServerRSAKeyFile =
    CACertificateFile =
    CACertificatePath =
    ClientVerificationMode = Optional
    VerificationDepth = 4
    EnableSessionCache = True
    SessionTimeout = "5 Minutes"
    AuthenticationTimeout = 120
    CredentialLifetime = Forever
    AuthenticationService =
    ProvisionMode = Anonymous
    ProvisionService =
    AlwaysAuthenticate = True
```

Table 8-1 lists and describes the EAP-FAST service properties.

Table 8-1 EAP-FAST Service Properties

Property	Description
IncomingScript	Optional script Cisco AR server runs when it receives a request from a client for EAP-FAST service.
OutgoingScript	Optional script Cisco AR server runs before it sends a response to a client using EAP-FAST.
AuthorityIdentifier	A string that uniquely identifies the credential (PAC) issuer. The client uses this value to select the correct PAC to use with a particular server from the set of PACs it might have stored locally. Ensure that the AuthorityIdentifier is globally unique and that it does not conflict with identifiers used by other EAP-FAST servers or PAC issuers.
AuthorityInformation	A string that provides a descriptive text for this credential issuer. The value can be displayed to the client for identification purposes and might contain the enterprise or server names.
MaximumMessageSize	Indicates the maximum length in bytes that a PEAP or EAP-TLS message can have before it is fragmented.
PrivateKeyPassword	The password used to protect the server's private key.
ServerCertificateFile	The full pathname of the file containing the server's certificate or certificate chain used during the TLS exchange. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are PEM and DER. If an encoding prefix is not present, the file is assumed to be in PEM format.

Table 8-1 EAP-FAST Service Properties (continued)

Property	Description
ServerRSAKeyFile	The full pathname of the file containing the server's RSA private key. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are "PEM" and "DER". If an encoding prefix is not present, the file is assumed to be in PEM format. The following example assumes that the subdirectory **pki** under **/cisco-ar** contains the server's certificate file. The file **server-key.pem** is assumed to be in PEM format. The file extension ***.pem*** is not significant. **set ServerRSAKeyFile PEM:/cisco-ar/pki/server-key.pem**
CACertificateFile	The full pathname of the file containing trusted CA certificates used for client verification. The file can contain more than one certificate, but all certificates must be in PEM format. DER encoding is not allowed.
CACertificatePath	The name of a directory containing trusted CA certificates (in PEM format) used for client verification. This parameter is optional, and if it is used there are some special preparations required for the directory it references. Each certificate file in this directory must contain exactly one certificate in PEM format. The server looks up the certificate files using the MD5 hash value of the certificate's subject name as a key. The directory must therefore also contain a set of symbolic links each of which points to an actual certificate file. The name of each symbolic link is the hash of the subject name of the certificate. For example, if a certificate file named **ca-cert.pem** is located in the CACertificatePath directory, and the MD5 hash of the subject name contained in **ca-cert.path.pem** is 1b96dd93, then a symbolic link named 1b96dd93 must point to **ca-cert.pem**. If there are subject name collisions such as multiple certificates with the same subject name, each link name must be indexed with a numeric extensions as in 1b96dd93.0 and 1b96dd93.1.
ClientVerificationMode	Specifies the type of verification used for client certificates. Must be set to one of RequireCertificate, None, or Optional. • RequireCertificate causes the server to request a client certificate and authentication fails if the client refuses to provide one. • None will not request a client certificate. • Optional causes the server to request a client certificate but the client is allowed to refuse to provide one.
VerificationDepth	Specifies the maximum length of the certificate chain used for client verification.
EnableSessionCache	Specifies whether TLS session caching (fast reconnect) is enabled or not. Set to True to enable session caching; otherwise set to False.

Table 8-1 EAP-FAST Service Properties (continued)

Property	Description
SessionTimeout	If TLS session caching (fast reconnect) is enabled, SessionTimeout specifies the maximum lifetime of a TLS session. Expired sessions are removed from the cache and will require a subsequent full authentication. SessionTimeout is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks, as in the following: **Set SessionTimeout "1 Hour 45 Minutes"**
AuthenticationTimeout	Mandatory; specifies time (in seconds) to wait before an authentication request times out; defaults to 120.
CredentialLifetime	Specifies the maximum lifetime of a Protected Access Credential (PAC). Clients that successfully authenticate with an expired PAC will be re-provisioned with a new PAC. CredentialLifetime is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks. Credentials that never expire should be specified as Forever.
AuthenticationService	Specifies the name of the EAP-GTC service is used for authentication. The named service must have the UseLabels parameter set to True.
ProvisionMode	Specifies the TLS mode used for provisioning. Clients only support the default Anonymous mode.
ProvisionService	Specifies the name of the EAP-MSChapV2 service used for provisioning.
AlwaysAuthenticate	Indicates whether provisioning should always automatically rollover into authentication without relying on a separate session. Most environments, particularly wireless, will perform better when this parameter is set to True, the default value.

EAP-FAST Keystores

The EAP-FAST service manages a set of keys used to protect the security and integrity of the PACs it issues. The keys are stored in **/Radius/Advanced/KeyStores/EAP-FAST** and are maintained automatically requiring minimal administration. Administrators can specify the maximum number of keys that are stored and the frequency of key updates.

The following is the default KeyStores settings:

```
[ //localhost/Radius/Advanced/KeyStores/EAP-FAST ]
        NumberOfKeys = 256
        RolloverPeriod = "1 Week"
```

Table 8-2 defines the KeyStores properties.

Table 8-2 KeyStores Properties

Property	Description
NumberOfKeys	Number (from 1-1024) that specifies the maximum number of keys stored for EAP-FAST.
RolloverPeriod	Specifies the amount of time between key updates.

Testing EAP-FAST with radclient

There are two distinct phases to testing EAP-FAST: provisioning and authentication. In the instructions below, Step 2 and Step 3 test provisioning and Steps 4 and Step 5 test authentication. At least one successful provisioning phase must be completed prior to testing authentication. Testing EAP-FAST with **radclient** requires that the EAP-MSChapV2 and EAP-GTC services be configured and functional.

The following instructions and examples assume that the AlwaysAuthenticate parameter has been set to False for testing purposes. This permits the provisioning and authentication steps to be tested separately. Most installations will set AlwaysAuthenticate to True for production use, and **radclient** works with that setting, but might display extra error messages that you can ignore.

Complete the following steps to test EAP-FAST using **radclient**:

Step 1 Start **radclient**.

cd /cisco-ar/usrbin

./radclient –s

Step 2 Specify the inner provisioning method

tunnel eap-mschapv2

The only allowable method for provisioning is eap-mschapv2.

Step 3 Provision a new PAC:

simple_eap_fast_test user-name password

Step 4 Specify the inner authentication method.

tunnel eap-gtc

The only allowable method for authentication is eap-gtc.

Step 5 Authenticate using the PAC.

simple_eap_fast_test user-name password

The **simple_eap_fast_test** command passes its arguments to the inner authentication mechanism which in turn treats the arguments as a username and a password. The command in Step 3 should result in provisioning a new PAC, and Step 5 should result in successful authentication using that PAC. The following examples demonstrate:

PAC Provisioning

The following example provisions a PAC for user bob.

pac show

```
No PAC(s) available to show
```

tunnel eap-mschapv2

```
PEAP tunnel method is eap-mschapv2
EAP-FAST tunnel method is eap-mschapv2
```

simple_eap_fast_test bob bob

```
EAP-FAST authentication status:
    [0x0e07] TLS authentication succeeded
Response to EAP-FAST message was not an Access-Accept
p012
```

pac show

```
PAC 1 version 1 (219 bytes)
    A-ID      : AR-4.0
    A-ID-Info : Cisco Systems Access Registrar
    I-ID      : bob
    Expires   : Never (0)
    Key#      : 12
    TLV  1    : PAC-Key (1) mandatory (32 bytes)
    TLV  2    : PAC-Opaque (2) mandatory (120 bytes)
    TLV  3    : PAC-Info (9) mandatory (51 bytes)
```

In this example the **simple_eap_fast_test** command indicates that it did not receive an AccessAccept. This is normal because the provisioning step always results in an AccessReject even when a new PAC has been successfully provisioned. The last **pac show** command displayed some status information from the new PAC and is used toverify that provisioning succeeded and authentication can now be tested. The PAC information displayed will vary and depends on how EAP-FAST is configured.

Authentication

The following example authenticates user bob (continuing from the PAC Provisioning example).

tunnel eap-gtc

```
PEAP tunnel method is eap-gtc
EAP-FAST tunnel method is eap-gtc
```

simple_eap_fast_test bob bob

```
EAP-FAST authentication status :
    [0x0e07] TLS authentication succeeded
SUCCESS : Correctly formatted Session Keys received from the server
p01e
```

In this example, the EAP_FAST authentication using the PAC from the previous provisioning step succeeded. The AccessAccept packet received from Cisco AR can be displayed to confirm that it contains the expected attributes including the MS-MPPE session keys.

Parameters Used for Certificate-Based Authentication

EAP-FAST might optionally use RSA certificates to securely create the tunnel that is used for PAC provisioning. However, the Cisco client does not support the use of certificates and the following parameters will be ignored and should be left at their default values:

PrivateKeyPassword

ServerCertificateFile

ServerRSAKeyFile

CACertificateFile

CACertificatePath

ClientVerificationMode

VerificationDepth

EnableSessionCache

SessionTimeout

The parameters for configuring certificate-based operation are identical to those used for PEAP and EAP-TLS.

Table 8-3 describes the parameters used for certificate-based authentication.

Table 8-3 Certificate-Based Authentication Parameters

Parameter	Description
AuthorityIdentifier	A string that uniquely identifies the credential (PAC) issuer. The client uses this value to select the correct PAC to use with a particular server from the set of PACs it might have stored locally. Care should be taken to ensure that the AuthorityIdentifier is globally unique, that is, is distinct from other PAC issuers
AuthorityInformation	A string that provides some descriptive text for this credential issuer. The value can bedisplayed to the client for identification purposes. It cancontain the enterprise and/or server names.
MaximumMessageSize	Indicates the maximum length in bytes that a EAP-FAST message can have before it is fragmented. If certificates are not used for authentication, fragmentation should not be an issue.
AuthenticationTimeout	Indicates the maximum number of seconds before an authentication operation times out and is rejected.
CredentialLifetime	Specifies the maximum lifetime of a PAC (Protected Access Credential). Clients that successfully authenticate with an expired PAC will be re-provisioned with a new PAC.
AuthenticationService	Specifies the name of the EAP-GTC service that is used for authentication. The named service must have the UseLabels parameter set to True.

Table 8-3 Certificate-Based Authentication Parameters (continued)

Parameter	Description
ProvisionMode	Specifies the TLS mode that is used for provisioning. As of this writing, clients only support the default Anonymous mode.
ProvisionService	Specifies the name of the EAP-MSChapV2 service that is used for provisioning.
AlwaysAuthenticate	Indicates whether provisioning should always automatically rollover into authentication without relying on a separate session. Most environments, particularly wireless, will perform better when this parameter is set to True (the default value).

radclient Command Reference

This section describes the **radclient** commands you can use to test EAP-FAST.

eap-trace

Use the **eap-trace** command to display additional client protocol trace information for EAP methods. Level is a number from 1 to 5 inclusively. Level 5 shows detailed hex dumps of all messages, level 4 shows a message trace without hex dumps, and levels 3 and below show status and error information. To turn off trace displays, set the level to 0.

Set the trace level for all EAP methods.

eap-trace *level*

For example, the following command sets the trace level to 4 for all EAP methods.

eap-trace 4

Set the trace level for the specified EAP method.

eap-trace *method level*

The following example sets the trace level to 5 for EAP-FAST only. The trace level for other EAP methods is not affected.

eap-trace eap-fast 5

Note The **eap-trace** command is for client-side trace information only and is independent of the server trace level that can be set using **aregcmd**.

tunnel

The **tunnel** command is used to specify the inner provisioning and authentication methods for EAP-FAST. The specified EAP method type must agree with the server's configured methods or authentication will fail.

tunnel eap-method

For EAP-FAST provisioning, the only allowable tunnel method is eap-mchavp2. For EAP-FAST authentication, the only allowable tunnel method is eap-gtc.

simple_eap_fast_test

The arguments are passed to the inner authentication method as its authentication parameters. If a PAC is not present, the tunnel method should be eap-mschapv2 and provisioning will occur. If a PAC is present, the tunnel method should be eap-gtc and authentication will occur.

simple_eap_fast_test ***username password***

There are also variants for the **simple** test command for other EAP methods as shown in the following examples:

simple_eap_mschapv2_test ***bob bob***

simple_eap_gtc_test ***bob bob***

pac

The **pac** command is used display, save, and delete PACs that are received from the server during testing. **radclient** maintains a cache of PACs that it knows about and that can be used for authentication testing. The current PAC cache can be displayed with the **pac show** command. PACs created during a test session can be stored to files with the **pac save** command, and reloaded in another session with the **pac load** command. The contents of the PAC cache are completely deleted with **pac delete**. If the optional parameter cache is included, PACs are also erased from disk.

pac ***load | save | show { hex } | delete { cache }***

The **pac show** command displays the currently cached PACs. If the optional parameter *hex* is included, additional detailed information including hex dumps are included in the display output.

pac show { hex }

The **pac load** command loads any previously saved PACS from disk into the active cache.

The **pac save** command saves all PACs from the active cache to disk. Any previously existing PACS for the same user will be over-written.

The **pac delete** command deletes all PACs from the active cache. If the optional cache parameter is included then PACs are also erased from disk.

pac delete { cache }

PAC—Credential Export Utility

You can manually provision EAP-FAST PACs to clients and avoid the use of the protocol provisioning phase. This might be desirable from a security perspective since the default provisioning protocol uses an anonymous (unauthenticated) method to construct the tunnel used to download the PAC to the client.

Manual provisioning involves exporting a PAC from Cisco AR to a file which is then copied to the client machine and used by the import utility. Once a PAC has been manually imported, the client should be able to authenticate via EAP-FAST while bypassing the initial provisioning phase. Care should be taken while storing and transporting PAC files since they contain information that potentially allows a client to authenticate via EAP-FAST.

PACs are exported from AR via the **pac** command which is a new utility for this release. (Note that this pac command is a stand-alone executable which is different from the Radclient pac command.) The **pac** command has two capabilities:

- Exports a PAC to a file
- Displays information about an existing PAC file

PAC Export

Use the **pac export** command to create a new PAC file. In the following example, *eap-fast* is the name of the Cisco AR service configured for EAP-FAST authentication, *bob* is the name of the user this PAC will be used for, and *password* is the password used to derive a key for encrypting the resulting file. (This password is not the same as the administrator's password). The PAC file will be named **bob.pac** by default. You can use the –f option to give the file a different name.

pac –s export *eap-fast bob password*

If you omit the password parameter, a default password will be used.

Note Using the default password is strongly discouraged for security reasons.

PAC Display

Use the **pac show** command to display information about a PAC file. In the following example, **bob.pac** is the name of the PAC file and *password* is the password used to decrypt the file contents.

pac –s show *bob.pac password*

Syntax Summary

The complete **pac** command syntax is as follows:

pac { options } export <service-name> <user-name> <file-password>

pac { options } show <file-name> file-<password>

Where:

-C <*cluster*>—Specifies the cluster to be used.

-N <*user*>—Specifies the user.

-P <*user-password*>—Specifies the password to be used.

-s —Logs in using defaults

-v—Enables verbose output

-f—Exports file name (default = {user-name}.pac)

EAP-GTC

EAP-GTC, defined in RFC 2284, is a simple method for transmitting a user's name and password to an authentication server. EAP-GTC should not be used except as an authentication method for PEAP Version 1 because the password is not protected.

Configuring EAP-GTC

To enable EAP-GTC, use **aregcmd** to create and configure a service of type *eap-gtc*.

Step 1 Launch **aregcmd** and create an EAP-GTC service.

cd /Radius/Services

add eap-gtc-service

Step 2 Change directory to the service and set its type to eap-gtc.

cd eap-gtc-service

set type eap-gtc

The follow example shows the default configuration for an EAP-GTC service:

```
[ //localhost/Radius/Services/eap-gtc-service ]
    Name = eap-gtc
    Description =
    Type = eap-gtc
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    UserService =
    UserPrompt = "Enter password:"
    UseLabels = False
```

Table 8-4 lists and describes the EAP-GTC specific properties for EAP-GTC authentication.

Table 8-4 EAP-GTC Properties

Property	Description
UserService	Required; name of service that can be used to authenticate using cleartext passwords.
UserPrompt	Optional string the client might display to the user; default is Enter password:" Use the **set** command to change the prompt, as in the following: **set UserPrompt "Admin Password:"**
UseLabels	Required; must be set to TRUE for EAP-FAST authentication and set to FALSE for PEAP authentication. Set to FALSE by default.

Step 3 Set the service's UserService to local-users or another local authentication service that is able to authenticate using clear-text passwords.

set UserService local-users

Step 4 If configuring for EAP-FAST, set the UseLabels property to TRUE.

Testing EAP-GTC with radclient

To test the EAP-GTC service, launch **radclient** and use the **simple_eap_gtc_test** command. The **simple_eap_gtc_test** command sends an Access-Request for the designated user with the user's password.

The response packet should indicate an Access-Accept if authentication was successful. View the response packet to ensure the authentication was successful.

simple_eap_gtc_test bob bob

```
Packet: code = Access-Accept, id = 2, length = 104, attributes =
        Service-Type = Framed
        Framed-Protocol = PPP
        Framed-IP-Address = 192.168.0.0
        Framed-IP-Netmask = 255.255.255.0
        Framed-Routing = None
        Framed-MTU = 1500
        Framed-Compression = VJ TCP/IP header compression
        Framed-IPX-Network = 1
        EAP-Message = 03:01:00:04
        Ascend-Idle-Limit = 1800
        Message-Authenticator = d3:4e:b1:7e:2d:0a:ed:8f:5f:72:e0:01:b4:ba:c7:e0
```

EAP-LEAP

Cisco AR 4.1 supports the new AAA Cisco-proprietary protocol called Light Extensible Authentication Protocol (LEAP), a proprietary Cisco authentication protocol designed for use in IEEE 802.11 wireless local area network (WLAN) environments. Important features of LEAP include:

- Mutual authentication between the network infrastructure and the user
- Secure derivation of random, user-specific cryptographic session keys
- Compatibility with existing and widespread network authentication mechanisms (e.g., RADIUS)
- Computational speed

Note Cisco AR supports a subset of EAP to support LEAP. This is not a general implementation of EAP for Cisco AR.

The Cisco-Wireless or Lightweight Extensible Authentication Protocol is an EAP authentication mechanism where the user password is hashed based on an MD4 algorithm and verified by a challenge from both client and server.

Configuring EAP-LEAP

To enable EAP-LEAP, use **aregcmd** to create and configure a service of type **eap-leap**. When you create an EAP-LEAP service type, you must also specify a UserService to perform AAA service. The UserService can be any configured authentication service.

Step 1 Launch **aregcmd** and create an EAP-LEAP service.

cd /Radius/Services

add eap-leap-service

Step 2 Set the service type to **eap-leap**.

cd eap-leap-service

set type eap-leap

```
[ //localhost/Radius/Services/eap-leap-service ]
    Name = newone
    Description =
    Type =
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    UserService =
```

Step 3 Set the UserService property to a configured authentication service.

EAP-MD5

Cisco AR 4.1 supports EAP-MD5, or MD5-Challenge, another EAP authentication exchange. In EAP-MD5 there is a CHAP-like exchange and the password is hashed by a challenge from both client and server to verify the password is correct. Once verified correct, the connection proceeds, although the connection is periodically re-challenged (per RFC 1994).

Configuring EAP-MD5

Specify type **eap-md5** when you create an EAP-MD5 service. When you create an EAP-MD5 service type, you must also specify a UserService to perform AAA service. The UserService can be any configured authentication service.

To enable EAP-MD5, use **aregcmd** to create and configure a service of type **eap-md5**. When you create an EAP-MD5 service type, you must also specify a UserService to perform AAA service. The UserService can be any configured authentication service.

Step 1 Launch **aregcmd** and create an EAP-LEAP service.

cd /Radius/Services

add eap-md5-service

Step 2 Set the service type to **eap-md5**.

cd eap-md5-service

set type eap-md5

```
[ //localhost/Radius/Services/eap-md5-service ]
    Name = newone
    Description =
    Type =
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    UserService =
```

Step 3 Set the UserService property to a configured authentication service.

EAP-Negotiate

EAP-Negotiate is a special service used to select at run-time the EAP service to be used to authenticate the client. EAP-Negotiate is configured with a list of candidate EAP services that represent the allowable authentication methods in preference order. When an EAP session begins, the EAP-Negotiate service tires the first service in the list. If the client does not support that method, it will respond with an EAP-Nak message which triggers EAP-Negotiate to try the next method on the list until a valid method is found or the list is exhausted in which case authentication fails.

EAP-Negotiate is useful when the client population has deployed a mix of different EAP methods that must be simultaneously supported by Cisco AR. It can be difficult or impossible to reliably distinguish which clients require which methods simply by examining RADIUS attributes or other packet properties. EAP-Negotiate solves this problem by using the method negotiation feature of the EAP protocol. Negotiation can be used to select the primary EAP method used for authentication and also to select the inner method for PEAP.

Configuring EAP-Negotiate

To enable EAP-Negotiate, first use **aregcmd** to create and configure the EAP services that will be used for authentication, then create and configure a service of type eap-negotiate.

Step 1 Launch **aregcmd** and create an EAP-LEAP service.

cd /Radius/Services

add eap-negotiate-service

Step 2 Set the service type to **eap-negotiate**.

cd eap-negotiate-service

set type eap-negotiate

```
[ //localhost/Radius/Services/negotiate ]
    Name = negotiate
    Description =
    Type = eap-negotiate
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    ServiceList =
```

Step 3 Set the ServiceList property to a list of pre-configured EAP authentication services.

The ServiceList property lists the names of the EAP services that can be negotiated with this instance of EAP-Negotiate. The ServiceList property is a space-separated list and must consist of valid EAP service name, *not service types*, in preference order from left to right. Each service and type on the list must be unique; duplicates are not allowed.

set ServiceList "eap-leap-service eap-md5-service peap-v1-service"

Negotiating PEAP Tunnel Services

EAP-Negotiate can also be used to negotiate the inner tunnel service used for phase two of PEAP-V0 or PEAP-V1. To do this, create and configure a service of type eap-negotiate. The ServiceList can only contain services that are legal for the version of PEAP that it is used with. Set the PEAP service's TunnelService parameter to the name of the eap-negotiate service.

Note Not all supplicants support negotiation of the PEAP inner method. EAP-Negotiate can only be used with supplicants that can use EAP-Nak to reject an unsupported inner method.

Testing EAP-Negotiate with radclient

You can test EAP-Negotiate using the same **radclient** commands used to test the other EAP services. For example, you can use the commands for testing eap-leap and peap-v1.

EAP-MSChapV2

EAP-MSChapv2 is based on **draft-kamath-pppext-eap-mschapv2-00.txt**, an informational IETF draft document. EAP-MSChapv2 encapsulates the MSChapV2 protocol (specified by RFC 2759) and can be used either as an independent authentication mechanism or as an inner method for PEAP Version 0 (recommended).

Configuring EAP-MSChapV2

To enable EAP-MSChapv2, use **aregcmd** to create and configure a service of type *eap-mschapv2*.

Step 1 Launch **aregcmd** and create an EAP-MSChapV2 service.

cd /Radius/Services

add eap-mschapv2

Note This example named the service eap-mschapv2, but you can use any valid name for your service.

Step 2 Set the service's type to eap-mschapv2.

cd eap-mschapv2

set Type eap-mschapv2

```
[ //localhost/Radius/Services/eap-mschapv2 ]
    Name = eap-mschapv2
    Description =
    Type = eap-mschapv2
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    UserService =
    SystemID =
```

Step 3 Set the service's UserService to local-users or another local authentication service that is able to authenticate using MSChapV2.

set UserService local-users

Step 4 You might (optionally) set a string for System ID that identifies the sender of the MSChapV2 challenge message, as in the following:

set SystemID system_ID_string

Testing EAP-MSChapV2 with radclient

To test the EAP-MSChapVersion 2 service using **radclient**, perform the following the steps:

Step 1 Launch **radclient**.

Step 2 Use the **simple_eap_mschapv2_test** command to authenticate using EAP-MSChapV2, as in the following:

simple_eap_mschapv2_test bob bob

```
p006
```

The **simple_eap_mschapv2_test** command above sends an Access-Request for user bob with the user's password. The response packet should indicate an Access-Accept if authentication was successful.

Step 3 View the response packet to ensure the authentication was successful.

p006

```
Packet: code = Access-Accept, id = 4, length = 104, attributes =
        Service-Type = Framed
        Framed-Protocol = PPP
        Framed-IP-Address = 192.168.0.0
        Framed-IP-Netmask = 255.255.255.0
        Framed-Routing = None
        Framed-MTU = 1500
        Framed-Compression = VJ TCP/IP header compression
        Framed-IPX-Network = 1
        EAP-Message = 03:01:00:04
        Ascend-Idle-Limit = 1800
        Message-Authenticator = 27:90:7e:20:78:34:43:2e:9d:cd:a8:75:82:53:03:65
```

EAP-SIM

Cisco AR 4.1supports EAP-SIMv16. In a GSM network a subscriber is issued a *smart card* called the subscriber identity module (SIM) that contains a secret key (Ki) and an International Mobile Subscriber Identity (IMSI). The key (Ki) is also stored in the GSM authentication center located with the Home Location Registry (HLR).

An access point uses the Cisco AR RADIUS server to perform EAP-SIM authentication of mobile clients. Cisco AR must obtain authentication information from the HLR. Cisco AR contacts the MAP gateway that performs the MAP protocol over SS7 to the HLR.

Configuring EAP-SIM

To enable EAP-SIM authentication, use **aregcmd** to create and configure a service of type *eap-sim*.

Step 1 Launch **aregcmd** and create an EAP-TLS service.

cd /Radius/Services

add eap-sim-service

Step 2 Change directory to the service and set its type to *eap-sim*.

cd eap-sim-service

set Type eap-sim

```
[ //localhost/Radius/Services/eap-sim-service ]
    Name = eap-sim
        Description =
        Type = eap-sim
        IncomingScript~ =
        OutgoingScript~ =
        OutageScript~ =
        MultipleServersPolicy = Failover
        NumberOfTriplets = 2
```

```
UseSimDemoTriplets = False
AlwaysRequestIdentity = False
EnableIdentityPrivacy = False
PseudonymSecret = secret
PseudonymRenewtime = "24 Hours"
PseudonymLifetime = Forever
EnableReauthentication = False
MaximumReauthentications = 16
ReauthenticationTimeout = 3600
ReauthenticationRealm =
TripletCacheTimeout = 120
AuthenticationTimeout = 120
UseProtectedResults = True
RemoteServers/
```

Table 8-5 EAP-SIM Service Properties

Property	Description
IncomingScript~	Optional script Cisco AR server runs when it receives a request from a client for an EAP-SIM service.
OutgoingScript~	Optional script Cisco AR server runs before it sends a response to a client using an EAP-SIM service.
OutageScript~	Optional. If set to the name of a script, Cisco AR runs the script when an outage occurs. This property allows you to create a script that notifies you when the RADIUS server detects a failure.
MultipleServersPolicy	Required. Must be set to either Failover or RoundRobin. When set to Failover, Cisco AR directs requests to the first server in the list until it determines the server is off-line. At which time, Cisco AR redirects all requests to the next server in the list until it finds a server that is on-line. When set to RoundRobin, Cisco AR directs each request to the next server in the RemoteServers list in order to share the resource load across all of the servers listed in the RemoteServers list.
NumberOfTriplets	Number of triplets (1, 2, or 3) to use for authentication; default is 2.
UseSimDemoTriplets	Set to TRUE to enable the use of demo triplets. This must be disabled for release builds.
AlwaysRequestIdentity	When True, enables the server to obtain the subscriber's identity via EAP/SIM messages instead of relying on the EAP messages alone. This might be useful in cases where intermediate software layers can modify the identity field of the EAP-Response/Identity message. The default value is False.
EnableIdentityPrivacy	When True, the identity privacy feature is enabled. The default value is False.
PseudonymSecret	The secret string that is used as the basis for protecting identities when identity privacy is enabled. This should be at least 16 characters long and have a value that is impossible for an outsider to guess. The default value is secret. **Note** It is very important to change PseudonymSecret from its default value to a more secure value when identity privacy is enabled for the first time.

Table 8-5 EAP-SIM Service Properties (continued)

Property	Description
PseudonymRenewtime	Specifies the maximum age a pseudonym can have before it is renewed. When the server receives a valid pseudonym that is older than this, it generates a new pseudonym for that subscriber. The value is specified as a string consisting of pairs of numbers and units, where the units might be of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks. The default value is “24 Hours”. Examples are: “8 Hours”, “10 Hours 30 Minutes”, “5 D 6 H 10 M”
PseudonymLifetime	Specifies the maximum age a pseudonym can have before it is rejected by the server, forcing the subscriber to authenticate using it’s permanent identity. The value is specified as a string consisting of pairs of numbers and units, where the units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks. It can also be Forever, in which case, pseudonyms do not have a maximum age. The default value is “Forever”. Examples are: “Forever”, “3 Days 12 Hours 15 Minutes”, “52 Weeks”
EnableReauthentication	When True, the fast re-authentication option is enabled. The default value is False.
MaximumReauthentications	Specifies the maximum number of times a re-authentication identity might be reused before it must be renewed. The default value is 16.
ReauthenticationTimeout	Specifies the time in seconds that re-authentication identities are cached by the server. Subscribers that attempt to re-authenticate using identities that are older than this value will be forced to use full authentication instead. The default value is 3600 (one hour).
ReauthenticationRealm	This information will be supplied later.
TripletCacheTimeout	Time in seconds an entry remains in the triplet cache. A zero (0) indicates that triplets are not cached. The maximum is 28 days; the default is 0 (no caching).
AuthenticationTimeout	Time in seconds to wait for authentication to complete. The default is 2 minutes; range is 10 seconds to 10 minutes.
UseProtectedResults	Enables or disables the use of protected results messages. Results messages indicate the state of the authentication but are cryptographically protected.
RemoteServers/	List of remote RADIUS servers which are map gateways. The remote server type must be set to map-gateway.

Note The EAP-SIM property OutagePolicy present in earlier versions of Cisco AR is no longer part of the EAP-SIM configuration.

EAP-Transport Level Security (TLS)

EAP-Transport Level Security (EAP-TLS), described in RFC 2716, is an authentication method designed to mitigate several weaknesses of EAP. EAP-TLS leverages TLS, described in RFC 2246, to achieve certificate-based authentication of the server and (optionally) the client. EAP-TLS provides many of the same benefits as PEAP but differs from it in the lack of support for legacy authentication methods.

Configuring EAP-TLS

To enable EAP-TLS authentication, use **aregcmd** to create and configure a service of type *eap-tls*.

Step 1 Launch **aregcmd** and create an EAP-TLS service.

cd /Radius/Services

add eap-tls-service

Step 2 Change directory to the service and set its type to eap-tls.

cd eap-tls-service

set Type eap-tls

```
[ //localhost/Radius/Services/eap-tls-service ]
    Name = eap-tls
    Description =
    Type = eap-tls
    IncomingScript~ =
    OutgoingScript~ =
    MaximumMessageSize = 1024
    PrivateKeyPassword =
    ServerCertificateFile =
    ServerRSAKeyFile =
    CACertificateFile =
    CACertificatePath =
    ClientVerificationMode = Optional
    VerificationDepth = 4
    EnableSessionCache = True
    SessionTimeout = "5 Minutes"
    AuthenticationTimeout = 120
```

Table 8-6 describes the EAP-TLS configuration properties:

Table 8-6 EAP-TLS Service Properties

Property	Description
IncomingScript	Optional script Cisco AR server runs when it receives a request from a client for PEAP-v0 service
OutgoingScript	Optional script Cisco AR server runs before it sends a response to a client using PEAP-v0
MaximumMessageSize	Indicates the maximum length in bytes that a PEAP or EAP-TLS message can have before it is fragmented.

Table 8-6 EAP-TLS Service Properties (continued)

Property	Description
PrivateKeyPassword	The password used to protect the server's private key.
ServerCertificateFile	The full pathname of the file containing the server's certificate or certificate chain used during the TLS exchange. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are PEM and DER. If an encoding prefix is not present, the file is assumed to be in PEM format.
ServerRSAKeyFile	The full pathname of the file containing the server's RSA private key. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are "PEM" and "DER". If an encoding prefix is not present, the file is assumed to be in PEM format. The following example assumes that the subdirectory **pki** under **/cisco-ar** contains the server's certificate file. The file **server-key.pem** is assumed to be in PEM format. The file extension ***.pem*** is not significant. **set ServerRSAKeyFile PEM:/cisco-ar/pki/server-key.pem**
CACertificateFile	The full pathname of the file containing trusted CA certificates used for client verification. The file can contain more than one certificate, but all certificates must be in PEM format. DER encoding is not allowed.
CACertificatePath	The name of a directory containing trusted CA certificates (in PEM format) used for client verification. This parameter is optional, and if it is used there are some special preparations required for the directory it references. Each certificate file in this directory must contain exactly one certificate in PEM format. The server looks up the certificate files using the MD5 hash value of the certificate's subject name as a key. The directory must therefore also contain a set of symbolic links each of which points to an actual certificate file. The name of each symbolic link is the hash of the subject name of the certificate. For example, if a certificate file named **ca-cert.pem** is located in the CACertificatePath directory, and the MD5 hash of the subject name contained in **ca-cert.path.pem** is 1b96dd93, then a symbolic link named 1b96dd93 must point to **ca-cert.pem**. If there are subject name collisions such as multiple certificates with the same subject name, each link name must be indexed with a numeric extensions as in 1b96dd93.0 and 1b96dd93.1.
ClientVerificationMode	Specifies the type of verification used for client certificates. Must be set to one of RequireCertificate, None, or Optional. • RequireCertificate causes the server to request a client certificate and authentication fails if the client refuses to provide one. • None will not request a client certificate. • Optional causes the server to request a client certificate but the client is allowed to refuse to provide one.

Table 8-6 EAP-TLS Service Properties (continued)

Property	Description
VerificationDepth	Specifies the maximum length **(in bytes?)** of the certificate chain used for client verification.
EnableSessionCache	Specifies whether TLS session caching (fast reconnect) is enabled or not. Set to True to enable session caching; otherwise set to False.
SessionTimeout	If TLS session caching (fast reconnect) is enabled, SessionTimeout specifies the maximum lifetime of a TLS session. Expired sessions are removed from the cache and will require a subsequent full authentication. SessionTimeout is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks, as in the following: **Set SessionTimeout "1 Hour 45 Minutes"**
AuthenticationTimeout	Mandatory; specifies time (in seconds) to wait before an authentication request times out; defaults to 120.

Testing EAP-TLS with radclient

To test the EAP-TLS service, launch **radclient** and use the **simple_eap_tls_test** command, as in the following:

```
simple_eap_tls_test arg1
```

The argument is arbitrary for the **simple_eap_tls_test** command and can be anything. (In the future, the argument can be used to select a client certificate.)

Testing EAP-TLS with Client Certificates

You can test EAP-TLS using client certificates verified by the server during the TLS exchange. The client certificate file and RSA key file must reside in **/cisco-ar/pki** and be named **client-cert.pem** and **client-key.pem** respectively. Both files must be in PEM format.

EAP-TTLS

Cisco AR supports the Extensible Authentication Protocol Tunneled TLS (EAP-TTLS). EAP-TTLS is an EAP protocol that extends EAP-TLS. In EAP-TLS, a TLS handshake is used to mutually authenticate a client and server. EAP- TTLS extends this authentication negotiation by using the secure connection established by the TLS handshake to exchange additional information between client and server.

EAP-TTLS leverages TLS (RFC 2246) to achieve certificate-based authentication of the server (and optionally the client) and creation of a secure session that can then be used to authentication the client using a legacy mechanism. EAP-TTLS provides several benefits:

- Industry standard authentication of the server using certificates (TLS)
- Standardized method for session key generation using TLS PRF
- Strong mutual authentication

- Identity privacy
- Fast reconnect using TLS session caching
- EAP message fragmentation
- Secure support for legacy client authentication methods

EAP-TTLS is a two-phase protocol. Phase 1 conducts a complete TLS session and derives the session keys used in Phase 2 to securely tunnel attributes between the server and the client. The attributes tunneled during Phase 2 can be used to perform additional authentication(s) via a number of different mechanisms.

The authentication mechanisms that can be used during Phase 2 include PAP, CHAP, MS-CHAP, MS-CHAPv2, and EAP. If the mechanism is EAP, then several different EAP methods are possible.

The Phase 2 authentication can be performed by the local AAA server (the same server running EAP-TTLS) or it can be forwarded to another server (known as the home AAA server). In the latter case, the home server has no involvement in the EAP-TTLS protocol and can be any AAA service that understands the authentication mechanism in use and is able to authenticate the user. It is not necessary for the home server to understand EAP-TTLS.

Configuring EAP-TTLS

Configuring EAP-TTLS involves two major tasks:

1. Configuring the TLS parameters used for Phase 1
2. Selecting the Phase 2 authentication methods and specifying whether authentication is performed locally or forwarded to the home server.

If authentication is forwarded, the configuration must include the identity of the remote home server and its shared secret.

You configure EAP-TTLS using the **aregcmd** CLI to create the appropriate services and specify their parameters. Use the **radclient** test tool to confirm that the services have been properly configured and are operational.

Creating an EAP-TTLS Service

To enable EAP-TTLS authentication, use **aregcmd** to create and configure a service of type *eap-ttls*.

Step 1 Launch **aregcmd** and create an EAP-TTLS service.

cd /Radius/Services

add eap-ttls-service

Step 2 Change directory to the service and set its type to eap-ttls.

cd eap-ttls-service

set Type eap-ttls

```
[ //localhost/Radius/Services/eap-ttls-service ]
    Name = eap-ttls
    Description =
    Type = eap-ttls
```

```
IncomingScript~ =
OutgoingScript~ =
MaximumMessageSize = 1024
PrivateKeyPassword =
ServerCertificateFile =
ServerRSAKeyFile =
CACertificateFile =
CACertificatePath =
ClientVerificationMode = Optional
VerificationDepth = 4
EnableSessionCache = True
SessionTimeout = "5 Minutes"
AuthenticationTimeout = 120
AuthenticationService =
```

Table 8-7 describes the EAP-TTLS configuration properties:

Table 8-7 EAP-TTLS Service Properties

Property	Description
IncomingScript	Optional script Cisco AR server runs when it receives a request from a client for PEAP-v0 service
OutgoingScript	Optional script CiscoAR server runs before it sends aresponse to aclient using PEAP-v0
MaximumMessageSize	Indicates the maximum length in bytes that a PEAP or EAP-TLS message can have before it is fragmented.
PrivateKeyPassword	The password used to protect the server's private key.
ServerCertificateFile	The full pathname of the file containing the server's certificate or certificate chain used during the TLS exchange. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are PEM and DER. If an encoding prefix is not present, the file is assumed to be in PEM format.
ServerRSAKeyFile	The full pathname of the file containing the server's RSA private key. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are "PEM" and "DER". If an encoding prefix is not present, the file is assumed to be in PEM format. The following example assumes that the subdirectory **pki** under **/cisco-ar** contains the server's certificate file. The file **server-key.pem** is assumed to be in PEM format. The file extension ***.pem*** is not significant. **set ServerRSAKeyFile PEM:/cisco-ar/pki/server-key.pem**
CACertificateFile	The full pathname of the file containing trusted CA certificates used for client verification. The file can contain more than one certificate, but all certificates must be in PEM format. **Note** DER encoding is not allowed.

Table 8-7 EAP-TTLS Service Properties (continued)

Property	Description
CACertificatePath	The name of a directory containing trusted CA certificates (in PEM format) used for client verification. This parameter is optional, and if used, there are some special preparations required for the directory it references. Each certificate file in this directory must contain exactly one certificate in PEM format. The server looks up the certificate files using the MD5 hash value of the certificate's subject name as a key. The directory must therefore also contain a set of symbolic links each of which points to an actual certificate file. The name of each symbolic link is the hash of the subject name of the certificate. For example, if a certificate file named **ca-cert.pem** is located in the CACertificatePath directory, and the MD5 hash of the subject name contained in **ca-cert.path.pem** is 1b96dd93, then a symbolic link named 1b96dd93 must point to **ca-cert.pem**. If there are subject name collisions such as multiple certificates with the same subject name, each link name must be indexed with a numeric extensions as in 1b96dd93.0 and 1b96dd93.1. See rehash-ca-certs Utility, page 8-31 for information about how to create the required certificate file hash links.
ClientVerificationMode	Specifies the type of verification used for client certificates. Must be set to one of RequireCertificate, None, or Optional. • RequireCertificate causes the server to request a client certificate and authentication fails if the client refuses to provide one. • None will not request a client certificate. • Optional causes the server to request a client certificate but the client is allowed to refuse to provide one.
VerificationDepth	Specifies the maximum length of the certificate chain used for client verification.
EnableSessionCache	Specifies whether TLS session caching (fast reconnect) is enabled or not. Set to True to enable session caching; otherwise set to False.
SessionTimeout	If TLS session caching (fast reconnect) is enabled, SessionTimeout specifies the maximum lifetime of a TLS session. Expired sessions are removed from the cache and require a subsequent full authentication. SessionTimeout is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks, as in the following: **Set SessionTimeout "1 Hour 45 Minutes"**

Table 8-7 EAP-TTLS Service Properties (continued)

Property	Description
AuthenticationTimeout	Mandatory; specifies time (in seconds) to wait before an authentication request times out. The default is 120.
AuthenticationService	Mandatory; specifies the authentication service to use to authenticate users. See Configuring an EAP-TTLS Authentication Service for more information. **Note** The authentication service must exist before you can save the EAP-TTLS service configuration.

Configuring an EAP-TTLS Authentication Service

The EAP-TTLS service can authenticate users by with either a legacy method such as PAP, CHAP, MSCHAP, or MSCHAPv2 or with an EAP method such as EAP-MSCHAPv2 or EAP-GTC. The authentication can be performed by the local server (the same server running EAP-TTLS) or it can be forwarded to a remote AAA server (the home server for the user's domain).

This section provides examples of several different ways to configure an EAP-TTLS authentication service. The following examples assume that you are using aregcmd and have already created the EAP-TTLS service.

Note After you make a configuration change, you must save the configuration before it can be used.

Authenticating Local Users with a Legacy Method

You can use a service like the local-users service (created as part of the example configuration) to authenticate users in the local UserList.

set AuthenticationService local-users

This service can be used to authenticate using PAP, CHAP, MSCHAP, and MSCHAPv2.

Authenticating Users with EAP-MSChapV2

This example uses a service named eap-mschapv2 for authentication. Attempts to authenticate using any other method than EAP-MSChapV2 (assuming the service type is also eap-mschapv2) will fail.

set AuthenticationService eap-mschapv2

Authenticating Users with EAP Negotiate

You can use the EAP-negotiate method to authenticate using more than one EAP type. The following example defines an EAP service named eap-negotiate that can negotiate EAP-MSChapV2 or EAP-GTC then configures an EAP-TTLS service to authenticate using that service.

Step 1 Create a service of type *eap-negotiate*.

cd /Radius/Services

add eap-nego

cd eap-nego

set Type eap-negotiate

set ServiceList “eap-mschapv2 eap-gtc”

Step 2 Configure the EAP-TTLS AuthenticationService.

cd /Radius/Services/eap-ttls

set AuthenticationService eap-nego

Authenticating Users with Legacy and EAP Methods

You can configure EAP-TTLS to authenticate using both legacy and EAP methods with a Group service using an OR result rule. A configuration like that shown in the following example first attempts to authenticate with the eap-negotiate service. If that fails, the server attempts to authenticate with the local-users service.

Step 1 Create the Group service

cd /Radius/Services

add local-or-eap

cd local-or-eap

set Type group

set ResultRule OR

cd GroupServices

add 1 eap-negotiate

add 2 local-users

Step 2 Configure the EAP-TTLS AuthenticationService.

cd /Radius/Services/eap-ttls

set AuthenticationService local-or-eap

Authenticating Using a Remote AAA Server

You can configure an EAP-TTLS service to forward authentication to a remote AAA server known (or the home server). The following configures a RADIUS service to use a remote server, then configures EAP-TTLS to use that service for authentication.

The first step in the following example configures a remote RADIUS server (aaa-remote) with its IP address and the shared secret that it shares with the local server. You might also specify other important parameters such as ports, timeouts, and maximum number of retries. See Services, page 4-12, for information about configuring RADIUS services.

Step 1 Configure a remote AAA server.

cd /Radius/RemoteServers

add aaa-remote

cd aaa-remote

set Protocol Radius

set IPAddress 10.1.2.3

set SharedSecret secret

The following step configures a RADIUS service to use the remote server created in the previous step. You might also configure other important parameters such as the failover strategy. See Services, page 4-12, for information about configuring RADIUS services.

Step 2 Configure an AAA service.

cd /Radius/Services

add home

cd home

set Type Radius

cd RemoteServers

add 1 aaa-remote

Step 3 Configure the EAP-TTLS AuthenticationService:

cd /Radius/Services/eap-ttls

set AuthenticationService home

Other configurations are also possible. For example, a group service can be used to perform some authentications locally and forward others to a remote server.

Testing EAP-TTLS with radclient

To test the EAP-TLS service, launch **radclient** and use the **simple_eap_ttls_test** command. The **simple_eap_ttls_test** command has the following syntax:

simple_eap_ttls_test ***identity password { method }***

Where:

identity is the user's name.

password is the user's password

method is one of: PAP, CHAP, MSChap, MSChapV2, or PEAP.

Note If the method parameter is EAP, the **tunnel** command must be used to specify the EAP method type.

Testing EAP-TTLS Using Legacy Methods

The following example uses EAP-TTLS with PAP as the Phase 2 method to authenticate a user named bob whose password is bob (from the example configuration).

Step 1 Launch **radclient**.

cd /cisco-ar/usrbin

./radclient –s

Step 2 Authenticate using EAP-TTLS PAP.

simple_eap_ttls_test bob bob pap

The following commands show how to test the other valid legacy methods.

simple_eap_ttls_test bob bob chap

simple_eap_ttls_test bob bob mschap

simple_eap_ttls_test bob bob mschapv2

Testing EAP-TTLS Using EAP Methods

The following example uses EAP-TTLS with EAP-MSChapV2 as the Phase 2 method to authenticate a user named bob whose password is bob (from the example configuration). Issue the **tunnel** command to specify the Phase 2 EAP method, then issue the **simple_eap_ttls_test** command with eap as a method type.

Step 1 Launch **radclient**

cd /cisco-ar/usrbin

./radclient –s

Step 2 Authenticate using EAP-TTLS and EAP-MSChapV2.

tunnel eap-mschapv2

simple_eap_ttls_test bob bob eap

To test with a different EAP method, use the **tunnel** command to specify the method as shown in the following command to specify EAP-TLS.

tunnel eap-tls

simple_eap_ttls_test bob bob eap

rehash-ca-certs Utility

The **rehash-ca-certs** utility works with the CACertificatePath property and enables you to create the required certificate file hash links (similar to those used with PEAP and EAP-TLS). The **rehash-ca-certs** utility is only used when the server is validating certificates from the client (which is optional and not a common case for EAP-TTLS).

The syntax for the **rehash-ca-certs** utility is:

rehash-ca-certs *{ -v } path1 { path2 … pathn }*

Each directory path specified on the command line is scanned by the **rehash-ca-certs** utility for filenames with the **pem** extension (such as **ca-cert.pem**) and the appropriate hash link is created as described above. Before creating links, **rehash-ca-certs** first removes all existing links in the directory, so each invocation creates fresh links. The *–v* option enables verbose output.

The following is an example of the **rehash-ca-certs** utility:

./rehash-ca-certs ../pki

```
start rehashing ../pki
client-key.pem does not contain a PEM certificate
finished rehashing
```

The **rehash-ca-certs** utility warns about PEM files that do not contain certificates.

radclient Command Reference

This section provides a summary of the **radclient** commands you can use to test PEAP and EAP-TLS.

eap-trace

Use the **eap-trace** command to display additional client protocol trace information for EAP methods. Set the level to a number from 1 to 5 inclusively. Level 5 shows detailed hexadecimal dumps of all messages. Level 4 shows a message trace without hexadecimal dumps. Levels 3 and below show status and error information. To turn off trace displays, set the level to 0.

Use **eap-trace level** to set the trace level for all EAP methods. The following example command sets the trace level to 4 for all EAP methods:

eap-trace 4

Use **eap-trace method level** to set the trace level for the specified EAP method. The following example command sets the trace level to 5 for PEAP Version0 only. The trace level for other EAP methods is not affected.

eap-trace peap-v0 5

Note The **eap-trace** command is for client-side trace information only and is independent of the server trace level you set using **aregcmd**.

tunnel

Use the **tunnel** command to specify the inner authentication method for PEAP. The specified EAP method type must agree with the server's configured authentication method or authentication will fail.

tunnel eap-method

For PEAP Version 0, the allowable tunnel methods are EAP-MSCHAPV2 and EAP-SIM. For PEAP Version 1, the allowable tunnel methods are EAP-GTC and EAP-SIM.

simple_eap_mschapv2_test username password

simple_eap_gtc_test username password

simple_eap_peapv0_test arg1 arg2

The arguments are passed to the inner authentication method as its authentication parameters. For EAP-MSChapv2 the arguments are username and password; for EAP-SIM they are IMSI and key.

simple_eap_peapv1_test arg1 arg2

The arguments are passed to the inner authentication method as its authentication parameters. For EAP-GTC the arguments are username and password; for EAP-SIM they are IMSI and key.

simple_eap_tls_test arg1

Protected EAP

Protected EAP (PEAP) is an authentication method designed to mitigate several weaknesses of EAP. PEAP leverages TLS (RFC 2246) to achieve certificate-based authentication of the server (and optionally the client) and creation of a secure session that can then be used to authenticate the client. PEAP provides several benefits:

- Industry standard authentication of the server using certificates (TLS)
- Standardized method for session key generation using TLS PRF
- Strong mutual authentication

- Identity privacy
- Fast reconnect using TLS session caching
- EAP message fragmentation
- Secure support for legacy client authentication methods

Cisco AR 4.1 supports the two major existing variants of PEAP, PEAP Version 0 (Microsoft PEAP) and PEAP Version 1 (Cisco PEAP). PEAP Version 0 is described in IETF drafts **draft-kamath-pppext-peapv0-00.txt** and **draft-josefsson-pppext-eap-tls-eap-02.txt**. This version of PEAP can use either EAP-MSChapV2 or EAP-SIM as an authentication method. PEAP Version 1 is described by IETF draft **draft-zhou-pppext-peapv1-00.txt**. PEAP Version 1 can use either EAP-GTC or EAP-SIM as an authentication method.

PEAP Version 0

This section describes configuring PEAP Version 0 and testing it with **radclient**.

Configuring PEAP Version 0

To enable PEAP Version 0, use **aregcmd** to create and configure a service of type *peap-v0*.

Step 1 Launch **aregcmd** and create a PEAP Version 0 service.

cd /Radius/Services

add peap-v0-service

Step 2 Set the service's type to peap-v0.

cd peap-v0-service

set Type peap-v0

```
[ //localhost/Radius/Services/peap-v0-service ]
    Name = peap-v0
    Description =
    Type = peap-v0
    IncomingScript~ =
    OutgoingScript~ =
    MaximumMessageSize = 1024
    PrivateKeyPassword =
    ServerCertificateFile =
    ServerRSAKeyFile =
    CACertificateFile =
    CACertificatePath =
    ClientVerificationMode = Optional
    VerificationDepth = 4
    EnableSessionCache = True
    SessionTimeout = "5 Minutes"
    AuthenticationTimeout = 120
    TunnelService =
    EnableWPS = FALSE
```

Step 3 Set the service's TunnelService property to the name of an existing EAP-MSCHAPV2 or EAP-SIM service.

set TunnelService name_of_EAP-MSCHAPv2_service

or

set TunnelService name_of_EAP-SIM_service

Table 8-8 describes the PEAP service properties for PEAP Version 0.

Table 8-8 PEAP Version 0 Service Properties

Property	Description
IncomingScript	Optional script Cisco AR server runs when it receives a request from a client for PEAP-v0 service
OutgoingScript	Optional script Cisco AR server runs before it sends a response to a client using PEAP-v0
MaximumMessageSize	Indicates the maximum length in bytes that a PEAP or EAP-TLS message can have before it is fragmented.
PrivateKeyPassword	The password used to protect the server's private key.
ServerCertificateFile	The full pathname of the file containing the server's certificate or certificate chain used during the TLS exchange. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are PEM and DER. If an encoding prefix is not present, the file is assumed to be in PEM format. The following example assumes that the subdirectory **pki** under **/cisco-ar** contains the server's certificate file. The file **server-cert.pem** is assumed to be in PEM format; note that the file extension ***.pem*** is not significant. **set ServerCertificateFile PEM:/cisco-ar/pki/server-cert.pem**
CACertificateFile	The full pathname of the file containing trusted CA certificates used for client verification. The file can contain more than one certificate, but all certificates must be in PEM format. DER encoding is not allowed.

Table 8-8 PEAP Version 0 Service Properties (continued)

Property	Description
CACertificatePath	The name of a directory containing trusted CA certificates (in PEM format) used for client verification. This parameter is optional, and if it is used there are some special preparations required for the directory it references. Each certificate file in this directory must contain exactly one certificate in PEM format. The server looks up the certificate files using the MD5 hash value of the certificate's subject name as a key. The directory must therefore also contain a set of symbolic links each of which points to an actual certificate file. The name of each symbolic link is the hash of the subject name of the certificate. For example, if a certificate file name **ca-cert.pem** is located in the CACertificatePath directory, and the MD5 hash of the subject name contained in **ca-cert.path.pem** is 1b96dd93, then a symbolic link named 1b96dd93 must point to the **ca-cert.pem** file. If there are subject name collisions such as multiple certificates with the same subject name, each link name must be indexed with a numeric extensions as in 1b96dd93.0 and 1b96dd93.1.
ClientVerificationMode	Specifies the type of verification used for client certificates. Must be set to one of RequireCertificate, None, or Optional. • RequireCertificate causes the server to request a client certificate and authentication fails if the client refuses to provide one. • None will not request a client certificate. • Optional causes the server to request a client certificate but the client is allowed to refuse to provide one.
VerificationDepth	Specifies the maximum length of the certificate chain used for client verification.
EnableSessionCache	Specifies whether TLS session caching (fast reconnect) is enabled or not. Set to True to enable session caching; otherwise set to False.
SessionTimeout	If TLS session caching (fast reconnect) is enabled, SessionTimeout specifies the maximum lifetime of a TLS session. Expired sessions are removed from the cache and will require a subsequent full authentication. SessionTimeout is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks, as in the following: **Set SessionTimeout "1 Hour 45 Minutes"**
AuthenticationTimeout	Mandatory; specifies time (in seconds) to wait before an authentication request times out; defaults to 120.
TunnelService	Mandatory; must be the name of an existing EAP-MSCHAPv2 or EAP-SIM service for PEAP Version 0.

Table 8-8 PEAP Version 0 Service Properties (continued)

Property	Description
EnableWPS	When set to TRUE, enables Windows Provisioning Service (WPS) and provides two other properties, MasterURL and WPSGuestUserProfile. The default value is FALSE.
MasterURL	When using WPS, specifies the URL of the provisioning server which is modified with the appropriate fragment and sent to the client.
WPSGuestUserProfile	When using WPS, specifies a profile to be used as a guest user profile; must be a valid profile under **/Radius/Profiles.** This profile is used for guests and users whose account has expired. This profile normally contains attributes denoting the VLAN-id of the guest network (which has the provisioning server alone) and might contain IP-Filters that would restrict the access of the guest (to only the provisioning server).

Testing PEAP Version 0 with radclient

To test the PEAP Version 0, complete the following steps:

Step 1 Launch **radclient**.

Step 2 Specify the inner authentication method, eap-mschapv2 or eap-sim, as in the following.

tunnel eap-mschapv2

or

tunnel eap-sim

Step 3 Use the **simple_eap_peapv0_test** command to authenticate using PEAP Version 0, as in the following:

simple_eap_peapv0_test arg1 arg2

The **simple_eap_peapv0_test** command passes its arguments to the inner authentication mechanism which treats the arguments as either a username and a password (for eap-mschapv2) or as an IMSI and a key (for eap-sim).

The following example tests PEAP Version 0 with EAP-MSCHAPV2 as the inner authentication mechanism using username bob and password bob:

tunnel eap-mschapv2

simple_eap_peapv0_test bob bob

The following example tests PEAP Version 0 with EAP-SIM as the inner authentication mechanism using IMSI 1234567891 and key 0123456789ABCDEF:

tunnel eap-sim

simple_eap_peapv0_test 1234567891 0123456789ABCDEF

Testing PEAP Version 0 with Client Certificates

You can test PEAP Version 0 using client certificates verified by the server during the TLS exchange. The client certificate file and RSA key file must reside in **/cisco-ar/pki** and be named **client-cert.pem** and **client-key.pem** respectively. Both files must be in PEM format.

PEAP Version 1

This section describes configuring PEAP Version 1 and testing it with **radclient**.

Configuring PEAP Version 1

To enable PEAP Version 1, use **aregcmd** to create and configure a service of type *peap-v1*.

Step 1 Launch **aregcmd** and create a PEAP Version 1 service.

cd /Radius/Services

add peap-v1-service

Step 2 Set the service's type to peap-v1.

cd peap-v1-service

set Type peap-v1

```
[ //localhost/Radius/Services/peap-v1-service ]
    Name = peap-v1-service
    Description =
    Type = peap-v1
    IncomingScript~ =
    OutgoingScript~ =
    MaximumMessageSize = 1024
    PrivateKeyPassword =
    ServerCertificateFile =
    ServerRSAKeyFile =
    CACertificateFile =
    CACertificatePath =
    ClientVerificationMode = Optional
    VerificationDepth = 4
    EnableSessionCache = True
    SessionTimeout = "5 Minutes"
    AuthenticationTimeout = 120
    TunnelService =
```

Step 3 Set the service's TunnelService property to the name of an existing EAP-GTC or EAP-SIM service.

set TunnelService name_of_EAP-GTC_service

or

set TunnelService name_of_EAP-SIM_service

Table 8-9 describes the PEAP service properties for both PEAP Version 1.

Table 8-9 PEAP Version 1 Service Properties

Property	Description
IncomingScript	Optional script Cisco AR server runs when it receives a request from a client for PEAP-v0 service
OutgoingScript	Optional script Cisco AR server runs before it sends a response to a client using PEAP-v0
MaximumMessageSize	Indicates the maximum length in bytes that a PEAP or EAP-TLS message can have before it is fragmented.
PrivateKeyPassword	The password used to protect the server's private key.
ServerCertificateFile	The full pathname of the file containing the server's certificate or certificate chain used during the TLS exchange. The pathname can be optionally prefixed with a special string that indicates the type of encoding used for the certificate. The two valid encoding prefixes are PEM and DER. If an encoding prefix is not present, the file is assumed to be in PEM format.
CACertificateFile	The full pathname of the file containing trusted CA certificates used for client verification. The file can contain more than one certificate but all certificates must be in PEM format. DER encoding is not allowed.
CACertificatePath	The name of a directory containing trusted CA certificates (in PEM format) used for client verification. This parameter is optional, and if it is used there are some special preparations required for the directory it references. Each certificate file in this directory must contain exactly one certificate in PEM format. The server looks up the certificate files using the MD5 hash value of the certificate's subject name as a key. The directory must therefore also contain a set of symbolic links each of which points to an actual certificate file. The name of each symbolic link is the hash of the subject name of the certificate. For example, if a certificate file named **ca-cert.pem** is located in the CACertificatePath directory, and the MD5 hash of the subject name contained in **ca-cert.path.pem** is 1b96dd93, then a symbolic link named 1b96dd93 must point to the **ca-cert.pem** file. If there are subject name collisions such as multiple certificates with the same subject name, each link name must be indexed with a numeric extensions as in 1b96dd93.0 and 1b96dd93.1.

Table 8-9 PEAP Version 1 Service Properties (continued)

Property	Description
ClientVerificationMode	Specifies the type of verification used for client certificates. Must be set to one of RequireCertificate, None, or Optional. • RequireCertificate causes the server to request a client certificate and authentication fails if the client refuses to provide one. • None will not request a client certificate. • Optional causes the server to request a client certificate but the client is allowed to refuse to provide one.
VerificationDepth	Specifies the maximum length of the certificate chain used for client verification.
EnableSessionCache	Specifies whether TLS session caching (fast reconnect) is enabled or not. Set to True to enable session caching; otherwise set to False.
SessionTimeout	If TLS session caching (fast reconnect) is enabled, SessionTimeout specifies the maximum lifetime of a TLS session. Expired sessions are removed from the cache and will require a subsequent full authentication. SessionTimeout is specified as a string consisting of pairs of numbers and units, where units might be one of the following: M, Minute, Minutes, H, Hour, Hours, D, Day, Days, W, Week, Weeks, as in the following: **Set SessionTimeout "1 Hour 45 Minutes"**
AuthenticationTimeout	Mandatory; specifies time (in seconds) to wait before an authentication request times out; defaults to 120.
TunnelService	Mandatory; must be the name of an existing EAP-GTC or EAP-SIM service for PEAP Version 0.

Testing PEAP Version 1 with radclient

To test the PEAP Version 1, complete the following steps:

Step 1 Launch **radclient**.

Step 2 Specify the inner authentication method, EAP-GTC or EAP-SIM, as in the following.

tunnel eap-gtc

or

tunnel eap-sim

Step 3 Use the **simple_eap_peapv1_test** command to authenticate using PEAP Version 1, as in the following:

simple_eap_peapv1_test arg1 arg2

The **simple_eap_peapv1_test** command passes its arguments to the inner authentication mechanism which treats the arguments as either a username and a password (for EAP-GTC) or as an IMSI and a key (for EAP-SIM).

Testing PEAP Version 1 with Client Certificates

You can test PEAP Version 1 using client certificates verified by the server during the TLS exchange. The client certificate file and RSA key file must reside in **/cisco-ar/pki** and be named **client-cert.pem** and **client-key.pem** respectively. Both files must be in PEM format.

CHAPTER 9

Using Extension Points

This chapter describes how to use Cisco Access Registrar scripting to customize your RADIUS server. This chapter contains the following sections:

You can write scripts to affect the way Cisco AR handles and responds to requests and to change the behavior of Cisco AR after a script is run.

All scripts reference the three dictionaries listed below, which are data structures that contain key/value pairs.

- Request dictionary—contains all of the attributes from the access-request or other incoming packets, such as the username, password, and service hints
- Response dictionary—contains all of the attributes in the access-accept or other response packets. As these are the attributes the server sends back to the NAS, you can use this dictionary to add or remove attributes.
- Environment dictionary—contains well-known keys whose values enable scripts to communicate with Cisco AR or to communicate with other scripts.

The process for creating and implementing a script involves:

- Determining the goal of the script
- Writing the script
- Adding the new script definition to Cisco AR
- Choosing a scripting point from within Cisco AR
- Testing the script using the **radclient** command

Determining the Goal of the Script

The goal of the script and its scripting point are tied together. For example, when you want to create a script that performs some special processing of a username before it is processed by the Cisco AR server, you would reference this script as an *incoming* script.

When on the other hand, you would like to affect the response, such as setting a specific timeout when there is not one, you would reference the script as an *outgoing* script.

In order to be able to create a script, you need to understand the way Cisco AR processes client requests. Cisco AR processes requests and responses in a hierarchical fashion; incoming requests are processed from the most general to the most specific levels, whereas, outgoing responses are processed from the most specific to the most general levels. Extension points are available at each level.

An incoming script can be referenced at each of the following extension points:

- RADIUS server
- Vendor (of the immediate client)
- Client (individual NAS)
- NAS-Vendor-Behind-the-Proxy
- Client-Behind-the-Proxy
- Remote Server (of type RADIUS)
- Service

An authentication or authorization script can be referenced at each of the following extension points:

- Group Authentication
- User Authentication
- Group Authorization
- User Authorization

The outgoing script can be referenced at each of the following extension points:

- Service
- Client-Behind-the-Proxy
- NAS-Vendor-Behind-the-Proxy
- Client (individual NAS)
- NAS Vendor
- RADIUS server

Writing the Script

You can write scripts in either Tcl or as shared libraries using C or C++. In this section, the scripts are shown in Tcl.

To write a script, do the following:

Step 1 Using an editor, create the Tcl source file.

Step 2 Give it a name.

Step 3 Define one or more procedures, using the following syntax:

```
proc name {request response environment}
{Body}
```

Step 4 Create the body of the script.

Step 5 Save the file and copy it to the **/opt/CSCOar/scripts/radius/tcl** directory, or to the location you chose when you installed Cisco AR.

Choosing the Type of Script

When you create a script you can use any one or all of the three dictionaries: Request, Response, or Environment.

- When you use the Request dictionary, you can modify the contents of a NAS request. Scripts that use the Request dictionary are usually employed as incoming scripts.
- When you use the Response dictionary, you can modify what the server sends back to the NAS. These scripts are consequently employed as outgoing scripts.
- When you use the Environment dictionary, you can do the following:
  - Affect the behavior of the server after the script is run. For example, you can use the Environment dictionary to decide which of the multiple services to use for authorization, authentication, and accounting.
  - Communicate among scripts, as the scripts all share these three dictionaries. For example, when a script changes a value in the Environment dictionary, the updated value can be used in a subsequent script.

The following examples show scripts using all three dictionaries.

Request Dictionary Script

The Request Dictionary script is referenced from the server's IncomingScript scripting point. It checks to see whether the request contains a **NAS-Identifier** or a **NAS-IP-Address**. When it does not, it sets the **NAS-IP-Address** from the request's source IP address.

```
proc MapSourceIPAddress {request response environment}
{
    if { ! ( [ $request containsKey NAS-Identifier ] ||
         [ $request containsKey NAS-IP-Address ] ) } {
         $request put NAS-IP-Address [ $environment get Source-IP-Address ]
    }
```

Tcl scripts interpret **$request** arguments as active commands that can interpret strings from the Request dictionary, which contains keys and values.

The **containsKey** method has the syntax: <*$dict*> **containsKey** <*attribute*>. In this example, <*$dict*> refers to the Request dictionary and the attributes **NAS-identifier** and **NAS-IP-Address**. The **containsKey** method returns **1** when the dictionary contains the attribute, and **0** when it does not. Using the **containsKey** method prevents you from overwriting an existing value.

The **put** method has the syntax: <*$dict*> **put** <*attribute value*>[<*index*>]. In this example, <*$request*> refers to the Request dictionary and the attribute is **NAS-IP-Address**. The **put** method sets the NAS's IP address attribute.

The **get** method has the syntax: <*$dict*> get <*attribute*>. In this example, <*$dict*> refers to the Environment dictionary and <*attribute*> is the **Source-IP-Address**. The **get** method returns the value of the attribute from the environment dictionary.

For a list of themethods you can use with scripts, seeAppendix A, "Cisco Access Registrar Tcl and REX Dictionaries." They include **get**, **put**, and others.

Response Dictionary Script

This script is referenced from either the user record for users whose sessions are always PPP, or from the script, **AuthorizeService**, which checks the request to determine which service is desired. The script merges the Profile named **default-PPP-users** into the Response dictionary.

```
proc AuthorizePPP {request response environment}
{
    $response addProfile default-PPP-users
```

The **addProfile** method has the syntax: <*$dict*> **addProfile** <*profile*>[<*mode*>]. In this example, <*$dict*> refers to the Response dictionary and the profile is **default-PPP-users**. The script copies all of the attributes of the Profile <*profile*> into the dictionary.

Environment Dictionary Script

This script is referenced from the NAS Incoming Script scripting point. It looks for a realm name on the username attribute to determine which AAA services should be used for the request. When it finds `@radius`, it selects a set of AAA services that will proxy the request to a remote RADIUS server. When it finds `@tacacs`, it selects the Authentication Service that will proxy the request to a TACACS server for authentication. For all of the remaining usernames, it uses the default Service (as specified in the configuration by the administrator).

Note the function, **regsub**, is a Tcl function.

```
proc ParseProxyHints {request response environment} {
    set userName [ $request get User-Name ]
    if { [ regsub "@radius" $userName "" newUserName ] } {
    $request put User-Name $newUserName
    $radius put Authentication-Service "radius-proxy"
    $radius put Authorization-Service "radius-proxy"
    $radius put Accounting-Service "radius-proxy"
    } else {
    if { [ regsub "@tacacs" $userName "" newUserName ] } {
    $request put User-Name
    $radius put Authentication-Service "tacacs-client"
```

Adding the Script Definition

After you have written the script, you must add the script definition to the Cisco AR's script Configuration directory so it can be referenced. Adding the script definition involves:

- Specifying the script definition; it must include the following:
  - **Name**—used in other places in the configuration to refer to the script. It must be unique among all other scripts.
  - **Language**—can be either Tcl or REX (shared libraries)
  - **Filename**—the name you used when you created the file
  - **EntryPoint**—the function name.

  The **Name** and the **EntryPoint** can be the same name, however they do not have to be.

- Choosing a scripting point; nine exist for incoming and outgoing scripts. These include:
  - the server
  - the vendor of the immediate client
  - the immediate client
  - the vendor of the specific NAS
  - the specific NAS
  - the service (only type rex)
  - the group (only AA scripts
  - the user record (only AA scripts)
  - remote server (only type RADIUS)

The rule of thumb to use in determining where to add the script is the most general scripts should be on the outermost points, whereas the most specific scripts should be on the innermost points.

Note The client and the NAS are the same entity, unless the immediate client is acting as a proxy for the actual NAS.

Adding the Example Script Definition

In the server configuration a **Scripts** directory exists. You must add the script you created to this directory. To add the **ParseProxyHints** script to the Cisco AR server, type the following command and supply the following information:

Name=**ParseProxyHints**
Description=**ParseProxyHints**
Language=**tcl**
Filename=**ParseProxyHints**
Entrypoint=**ParseProxyHints**

aregcmd add /Radius/Scripts/ParseProxyHints ParseProxyHints tcl ParseProxyHints ParseProxyHints

Choosing the Scripting Point

As the example script, **ParseProxyHints**, applies to a specific NAS (NAS1), the entry point should be that NAS. To specify the script at this scripting point, type:

aregcmd set /Radius/Clients/NAS1/IncomingScript ParseProxyHints

Testing the Script

To test the script, you can use the **radclient** command, which lets you create and send packets. For more information about the **radclient** command, see Chapter 2, “Using the aregcmd Commands.”.

About the Tcl/Tk 8.3 Engine

Cisco AR1.6 and above uses Tcl engine is version Tcl/Tk8.3. Since the Tcl/Tk8.3 engine supports a multi-threading application environment, it can achieve much better performance than Tcl/Tk7.6.

Note In this release, scripts that use Tcl global variables will not work across AR extension points. A future release will address script compatibility issues.

Tcl/Tk8.3 also performs ***byte-compile***, so no run-time interpretation is required.

Cisco AR Scripts

The Cisco AR scripts are stored in **/localhost/Radius/Scripts**. Most of the scripts are written in the RADIUS Extension language (REX). Some scripts are provided in both REX and Tcl. The scripts written in Tcl all begin with the letter **t** followed by their functional name. The Tcl scripts are listed below:

tACMEOutgoingScript
tAuthorizePPP
tAuthorizeService
tAuthorizeTelnet
tMapSourceIPAddress
tParseAARealm
tParseAASRealm
tParseProxyHints
tParseServiceAndAAARealmHints
tParseServiceAndAAASRealmHints
tParseServiceAndAARealmHints
tParseServiceAndAASRealmHints
tParstServiceAndProxyHints
tParseServiceHints

ACMEOutgoingScript

ACMEOutgoingScript is referenced from Vendor ACME for the outgoing script. If the Cisco AR server accepts this Access-Request and the response does not yet contain a Session-Timeout, set it to 3600 seconds.

AltigaIncomingScript

AltigaIncomingScript maps Altiga-proprietary attributes to Cisco AR's global attribute space.

AltigaOutgoingScript

AltigaOutgoingScript maps Altiga attributes from Cisco AR's global attribute space to the appropriate Altiga-proprietary attributes.

ANAAAOutgoing

ANAAAOutgoing can be referenced from either the client or vendor outgoing scripting point to be used in HRPD/EV-DO networks where Cisco AR is the Access Network (AN) AAA server. ANAAAOutgoing checks to see if the response contains the Callback-Id attribute. If the response contains the Callback-Id attribute and the value is less than 253 characters, ANAAAOutgoing prefixes a zero (0) to the value. For example, it changes "123" into "0123." The ANAAAOutgoing script always returns REX_OK.

AscendIncomingScript

AscendIncomingScript maps Ascend-proprietary attributes to Cisco AR's global attribute space.

AscendOutgoingScript

AscendOutgoingScript maps Ascend attributes from Cisco AR's global attribute space to the appropriate Ascend-proprietary attributes.

AuthorizePPP

AuthorizePPP is referenced from either the use record for users who's sessions are always PPP or from the from the script AuthorizeService, which checks the request to determine which service is desired. This script merges in the Profile named "default-PPP-users" into the response dictionary.

AuthorizeService

AuthorizeService is referenced from user record for users who's sessions might be PPP, SLIP or Telnet depending on how they are connecting to the NAS. This script checks the request to determine which service is desired. If it is telnet, it calls the script AuthorizeTelnet. If it is PPP, it calls the script AuthorizePPP. If it is SLIP, it calls the script AuthorizeSLIP. If it is none of these, it rejects the request.

AuthorizeSLIP

AuthorizeSLIP is referenced from either the user record for users who's sessions are always SLIP or from the from the script AuthorizeService, which checks the request to determine which service is desired. This script merges in the Profile named "default-SLIP-users" into the response dictionary.

AuthorizeTelnet

AuthorizeTelnet is referenced from either the user record for users who's sessions are always telnet or from the from the script AuthorizeService, which checks the request to determine which service is desired. This script merges in the Profile named "default-Telnet-users" into the response dictionary.

CabletronIncoming

CabletronIncoming maps Cabletron-proprietary attributes to Cisco AR's global attribute space.

CabletronOutgoing

Use CabletronOutgoing to map Cisco-proprietary attributes from Cisco AR's global attribute space to the appropriate Cabletron-proprietary attributes.

CiscoIncoming

Use CiscoIncoming to map Cisco-proprietary attributes to Cisco AR's global attribute space.

CiscoOutgoing

Use CiscoOutgoing to map Cisco-proprietary attributes from Cisco AR's global attribute space to the appropriate Cabletron-proprietary attributes.

CiscoWithODAPIncomingScript

Use CiscoWithODAPIncomingScript to map Cisco-proprietary attributes to Cisco AR's global attribute space and to map ODAP requests to the appropriate services and session managers.

CiscoWithODAPIncomingScript checks the incoming NAS-Identifier sent by the client. If the NAS-Identifier does not equal odap-dhcp, the request is not an ODAP request. If the request is not an ODAP request, the script does no more ODAP-specific processing, and calls CiscoIncomingScript to allow it to process the request.

If the request is an ODAP request, CiscoWithODAPIncomingScript removes the NAS-Identifier attribute because it is no longer required. The script then sets the Authentication-Service and the Authorization-Service to odap-users and sets the Accounting-Service to odap-accounting.

ExecCLIDRule

ExecCLIDRule is referenced from the policy engine to determine the authentication and authorization service and policy based on the CLID set in the policy engine.

ExecDNISRule

ExecDNISRule is referenced from the policy engine to determine the authentication and authorization service and policy based on the DNIS set in the policy engine.

ExecFilterRule

ExecFilterRule is referenced from the policy engine to determine whether a user packet should be rejected or not based on whether a special character like "*", "/", "\" or "?" shows up in the packet.

ExecNASIPRule

ExecNASIPRule is referenced from the policy engine to enable configuration of policies based on the incoming NAS-IP-Address. You can configure two attributes, *client-ip-address* and *subnetmask*, to match the incoming NAS-IP-Address and its subnet mask. If the attributes match, ExecNASIPrule sets the environment variables (if they are configured in that rule).

ExecRealmRule

ExecRealmRule is referenced from the policy engine to determine the authentication and authorization service and policy based on the realm set in the policy engine.

ExecTimeRule

ExecTimeRule either rejects or accepts Access Request packets based on the time range specified in a user's login profile. You can configure the TimeRange and AcceptedProfile attributes.

The format for the TimeRange is to set the allowable days followed by the allowable times, as in:

TimeRange = dateRange, timeRange

The dateRange can be in the form of a date, a range of allowable dates, a day, or a range of allowable days. The timeRange should be in the form of hh:mm-hh:mm.

Here are a few examples:

mon-fri,09:00-17:00

Allows access Monday through Friday from 9 AM until 5 PM.

mon,09:00-17:00;tue-sat,12:00-13:00

Allows access on Monday from 9 AM until 5 PM and from 12 noon until 1 PM on Tuesday through Saturday

mon,09:00-24:00;tue,00:00-06:00

Allows access on Monday from 9 AM until Tuesday at 6 AM

1-13,10-17:00; 15,00:00-24:00

Allows access from the first of the month until the thirteenth of the month from 10 AM until 5 PM and all day on the fifteenth of the month.

LDAPOutage

LDAPOutage is referenced from LDAP Services as OutageScript. LDAPOutage logs when the LDAP binding is lost.

MapSourceIPAddress

MapSourceIPAddress is referenced from the Cisco AR server's IncomingScript scripting point. MapSourceIPAddress checks to see ifthe request contains either a NAS-Identifier or a NAS-IP-Address. If not, this script sets the NAS-IP-Address from the request's source IP address.

The Tcl version of this script is tMapSourceIPAddress.

ParseAAARealm

ParseAAARealm is referenced from the NAS IncomingScript scripting point. It looks for a realm name on the user name attribute as a hint of which AAA service should be used for this request. If @<realm> is found, the AAA service is selected which has the same name as the realm.

ParseAAASRealm

ParseAAASRealm is referenced from the NAS incoming script extension point. ParseAAASRealm looks for a realm name on the user name attribute as a hint of which AAA service and which SessionManager should be used for this request. If @<realm> is found, the AAA service and SessionManager which have the same name as the realm are selected.

ParseAARealm

ParseAARealm is referenced from the NAS IncomingScript scripting point. It looks for a realm name on the user name attribute as a hint of which authentication and authorization service should be used for this request. If @<realm> isfound, it selects the AA service that has the same name as the realm and the DefaultAccountingService (as specified in the configuration by the administrator).

The Tcl version of this script is named tParseAARealm.

ParseAASRealm

ParseAASRealm is referenced from the NAS IncomingScript scripting point. It looks for a realm name on the user name attribute as a hint of which AA service and which SessionManager should be used for this request. If @<realm> is found, the AA service and the SessionManager which have the same name as the realm are selected. The Accounting service will be the DefaultAccountingService (as specified in the configuration by the administrator).

The Tcl version of this script is named tParseAASRealm.

ParseProxyHints

ParseProxyHints is referenced from the NAS IncomingScript scripting point. It looks for a realm name on the user name attribute as a hint of which AAA services should be used for this request. If @radius is found, a set of AAA services is selected which will proxy the request to a remote radius server. If @tacacs is found, the AuthenticationService is selected that will proxy the request to a tacacs server for authentication. For any services not selected, the default service (as specified in the configuration by the administrator) will be used.

The Tcl version of this script is named tParseProxyHints.

ParseServiceAndAAARealmHints

ParseServiceAndAAARealmHints is referenced from the NAS IncomingScript scripting point. It calls both ParseServiceHints and ParseAAARealm.

The Tcl version of this script is named tParseServiceAndAAARealmHints.

ParseServiceAndAAASRealmHints

ParseServiceAndAAASRealmHints is referenced from the NAS IncomingScript scripting point. It calls both ParseServiceHints and ParseAAASRealm.

The Tcl version of this script is named tParseServiceAndAAASRealmHints.

ParseServiceAndAARealmHints

ParseServiceAndAARealmHints is referenced from the NAS IncomingScript scripting point. It calls both ParseServiceHints and ParseAARealm.

The Tcl version of this script is named tParseServiceAndAARealmHints.

ParseServiceAndAASRealmHints

ParseServiceAndAASRealmHints is referenced from the NAS IncomingScript scripting point. It calls both ParseServiceHints and ParseAASRealm.

The Tcl version of this script is named tParseServiceAndAASRealmHints.

ParseServiceAndProxyHints

ParseServiceAndProxyHints is referenced from the NAS IncomingScript scripting point. It calls both ParseServiceHints and ParseProxyHints.

The Tcl version of this script is named tParseServiceAndProxyHints.

ParseServiceHints

ParseServiceHints is referenced from the NAS IncomingScript scripting point. Check to see if we are given a hint of the service type or the realm. If so, set the appropriate attributes in the request or radius dictionary to record the hint and rewrite the user name to remove the hint.

The Tcl version of this script is named tParseServiceHints.

ParseTranslationGroupsByCLID

ParseTranslationGroupsByCLID is referenced from the policy engine to determine the incoming and outgoing translation groups based on CLID set in the policy engine so that the attributes can be added and/or filtered out by the configuration data set in MCD.

ParseTranslationGroupsByDNIS

ParseTranslationGroupsByDNIS is referenced from the policy engine to determine the incoming and outgoing translation groups based on realm set in the policy engine so that the attributes can be added/filtered out by the configuration data set in MCD.

ParseTranslationGroupsByRealm

ParseTranslationGroupsByRealm is referenced from the policy engine to determine the incoming and outgoing translation groups based on the realm set in the policy engine.
ParseTranslationGroupsByRealm allows the attributes to be added or filtered out by the configuration data set in MCD.

UseCLIDAsSessionKey

UseCLIDAsSessionKey is used to specify that the Calling-Station-Id attribute should be used as the session key to correlate requests for the same session. This is a typical case for 3G mobile user session correlation.

USRIncomingScript

USRIncomingScript maps USR-proprietary attributes to Cisco AR's global attribute space.

USRIncomingScript-IgnoreAccountingSignature

USRIncomingScript-IgnoreAccountingSignature maps USR-proprietary attributes to Cisco AR's global attribute space and sets a flag to ignore the signature on Accounting-Request packets. Earlier versions of the USR RADIUS client did not correctly sign Accounting-Request packets.

USROutgoingScript

USROutgoingScript maps USR attributes from Cisco AR's global attribute space to the appropriate USR-proprietary attributes.

CHAPTER 10

Using Replication

This chapter provides information about how to use the replication feature in Cisco Access Registrar and includes the following sections:

Note When using replication, use the **aregcmd** command-line interface to make configuration changes to the Cisco AR server. Replication is not supported when using the GUI.

Replication Overview

Cisco AR replication feature can maintain identical configurations on multiple machines simultaneously. When replication is properly configured, changes an administrator makes on the primary or *master* machine are propagated by Cisco AR to a secondary or *slave* machine.

Replication eliminates the need to have administrators with multiple Cisco AR installations make the same configuration changes at each of their installations. Instead, only the master's configuration need be changed and the slave is automatically configured eliminating the need to make repetitive, error-prone configuration changes for each individual installation. In addition to enhancing server configuration management, using replication eliminates the need for a hot-standby machine.

Using a hot-standby machine is a common practice to provide more fault-tolerance where a fully-installed and configured system stands ready to takeover should the primary machine fail. However, a system setup for hot-standby is essentially an idle machine only used when the primary system fails. Hot-standby or secondary servers are expensive resources. Employing Cisco AR's replication feature, both servers can perform RADIUS request processing simultaneously, eliminating wasted resources.

The replication feature focuses on configuration maintenance only, not session information or installation-specific information such as Administrator, Interface, Replication or Advanced machine-specific configuration changes. These configuration items are not replicated because they are specific to each installation and are not likely to be identical between master and slave. While changes to Session Managers, Resource Manager, and Remote Servers are replicated to the slave and stored in the slave's configuration database, they are not hot-configured on the slave (see Hot Configuration Detailed below for more information)

Changes should be made only on the master server. Making changes on a slave server will not be replicated and might result in an unstable configuration on the slave. Any changes made using replication will not be reflected in existing **aregcmd** sessions. **aregcmd** only loads its configuration at start up; it is not dynamically updated. For example, if **aregcmd** is running on the slave, and on the master **aregcmd** is used to add a client, the new client, while correctly replicated and hot-configured, will not be visible in the slave's **aregcmd** until **aregcmd** is exited and restarted.

When there is a configuration change, the master server propagates the change set to all member servers over the network. All member servers have to update their configuration after receiving the change set notifications from master server. Propagating the change set to a member serve involves multiple packet transfer from the master server to the member because the master serve has to convey all the configuration changes to the member. The number of packets to be transferred depends on the size of the change set.

After receiving a change set notification, the member server will go off-line before applying the change set received from master server. This state is indicated by the log message `Radius Server is Off-line` in **name_radius_1_log** file. When the change set is successfully applied, the member server goes up automatically. This is indicated by the log message `Radius Server is On-Line` in **name_radius_1_log** file. When the member server goes off-line to apply the change set, no incoming packets are processed.

Due to the number of packets to be transferred in the change set and the amount of time the member server will be offline updating its databasepoints, Cisco recommends that you use multiple **save** commands rather than a large configuration change with one **save** command. You can also minimize the number of changes that occur in a replication interval by modifying either the RepTransactionArchiveLimit or the RepTransactionSyncInterval, or both of these properties. For example, instead of using the default value of 100 for the RepTransactionArchiveLimit, you might change it to 20.

How Replication Works

This section describes the flow of a simple replication as it occurs under normal conditions.

Replication Data Flow

The following sections describe data flow on the master server and the slave server.

Master Server

The following describes the data flow for the master server:

Step 1 The administrator makes a change to the master server's configuration using the **aregcmd** command line interface (CLI) and issues a **save** command.

Step 2 After the changes are successfully validated, the changes are stored in the AR database.

Step 3 **aregcmd** then notifies the AR server executing on the master of the configuration change.

Step 4 The AR server then updates its version of the configuration stored in memory. (This is called *hot-config* because it happens while the server is running and processing requests.)

Step 5 The AR server first copies the changes pertaining to the **aregcmd save**, also known as a transaction to its replication archive, then transmits the transaction to the slave server for processing.

Step 6 In **aregcmd**, the prompt returns indicating that the **save** has completed successfully, the transaction has been archived, and the transaction has been transmitted to the slaves.

Slave Server

Step 1 When the slave server receives the transaction, its contents are verified.

Step 2 Once verified, the changes are applied to the slave server's database

Step 3 The changes are then applied (hot-configured) in the slave server's in-memory configuration.

Step 4 The transaction is written to the slave server's replication archive.

Security

Replication has two primary security concerns:

- Security of the transactions transmitted to the slave server
- Storage of transactions in the replication archive

Both of these concerns use shared secret (MD5) encryption via the shared secret specified in the replication configuration on both master and slave servers. Replication data transmitted between master and slave is encrypted at the source and decrypted at the destination the same way as standard RADIUS packets between AR's clients and the AR server. Transactions written to the replication archive are also encrypted in the same manner and decrypted when read from the replication archive.

Replication Archive

The replication archive serves two primary purposes:

1. To provide persistent, or saved, information regarding the last successful transaction
2. To persist transactions in case the slave server requires re synchronization (see Ensuring Data Integrity below for more information on re synchronization).

The replication archive is simply a directory located in **../CSCOar/data/archive**. Each transaction replicated by the master is written to this directory as a single file. The name of each transaction file is of the form txn########## where ########## is the unique transaction number assigned by the master server. The replication archive size, that is the number of transaction files it might contain, is configured in the Replication configuration setting of TransactionArchiveLimit. When the TransactionArchive limit is exceeded, the oldest transaction file is deleted.

Ensuring Data Integrity

AR's configuration replication feature ensures data integrity through transaction data verification, transaction ordering, automatic resynchronization and manual full-resynchronization. With the single exception of a manual full-resynchronization, each of the following techniques help to automatically ensure that master and slave servers contain identical configurations. A detailed description of each technique follows.

Transaction Data Verification

When the master prepares a transaction for replication to a slave, the master calculates a 2's complement Cyclic Redundancy Check (CRC) for each element (individual configuration change) in the transaction and for the entire transaction and includes these CRC values in the transmitted transaction. When the slave receives the transaction, the slave calculates a CRC for each transaction element and for the entire transaction and compares its own calculated values with those sent with the message. If a discrepancy occurs from these comparisons, the transaction element or the entire transaction is discarded and a re-transmission of that particular transaction element or the entire transaction is requested by the slave from the master. This process is called automatic resynchronization. (described in more detail below)

Transaction Order

When the master prepares a transaction for replication, it assigns the transaction a unique transaction number. This number is used to ensure the transactions are processed by the slave in exactly the same order as they were processed on the master. Transactions are order dependent. Since the functionality of AR's configuration replication feature is to maintain identical configurations between master and slave, if transaction order were not retained, master and slave would not contain identical configurations. Consider where two transactions modify the same thing (a defined client's IP address for example). If the first transaction was a mistake and the second was the desired result, the client configuration on the master would contain the second setting; however, if the transactions were processed in the reverse order on the slave, the client configuration on the slave would contain the mistaken IP Address. This example illustrates the critical need for transaction ordering to ensure data integrity.

Automatic Resynchronization

Automatic Resynchronization is the most significant feature with respect to data integrity. This feature ensures the configurations on both the master and slave are identical. If they are not, this feature automatically corrects the problem.

When the master and slave start-up, they determine the transaction number of the last replication transaction from their respective replication archives. The master immediately begins periodic transmission of a TransactionSync message to the slave. This message informs the slave of the transaction number of the transaction that the master last replicated.

If the transaction number in the TransactionSync message does not match the transaction number of the last received transaction in the slave's archive, then the slave will request resynchronization from the master. The resynchronization request sent by the slave will include the slave's last received transaction number.

The master will respond by retransmitting each transaction since the last transaction number indicated by the slave in the resynchronization request. The master obtains these transactions from its replication archive.

Should the slave's last received transaction number be less than the lowest transaction number in the master's replication archive, then automatic resynchronization cannot occur as the master's replication archive does not contain enough history to synchronize the slave. In this case, the slave must be resynchronized with a full-resynchronization.

Full Resynchronization

Full Resynchronization means that the slave has missed more transactions than are stored in the master's replication archive and cannot be resynchronized automatically. There is no automatic full-resynchronization mechanism in AR's configuration replication feature. To perform a full resynchronization, refer to the *Cisco Access Registrar User's Guide*.

Understanding Hot-Configuration

Hot-Configuration is the process of reflecting configuration changes made to AR's internal configuration database in the in-memory configuration of the executing AR server. Hot-Configuration is accomplished without interruption of RADIUS request processing. For example, if an administrator uses **aregcmd** to configure a new client and issues a **save** command, when the prompt returns, the newly configured client can send requests to AR.

Hot-Configuration minimizes the down-time associated with having to restart an AR server to put configuration changes into effect. With the Hot-Configuration feature, a restart is only necessary when a Session Manager, Resource Manager or Remote Server configuration is modified. These configuration elements might not be hot-configured because they maintain state (an active session, for example) and cannot be modified without losing the state information they maintain. Changes to these configuration elements require a restart of AR to put them into effect.

Hot-Configuration is not associated with the replication feature. Hot-Configuration's only connection to the replication feature is that when a change is replicated to the slave, the slave is hot-configured to reflect the replicated change as if an administrator had used **aregcmd** to make the changes directly on the slave server.

Replication's Impact on Request Processing

The replication feature was designed to perform replication of transactions with minimal impact on RADIUS request processing. When a transaction is received by a slave, RADIUS requests are queued while the transaction is applied to the slave. Once the transaction is complete, RADIUS request processing resumes.

The impact on RADIUS request processing is a direct result of the size of a transaction. The smaller the transaction the lesser the impact, and the larger the transaction, the greater the impact. In other words, when making changes to the master, frequent saves are better than making lots of changes and then saving. Each change is one transaction element and all changes involved in a **save** comprise a single transaction with one element per change. Since the replication feature only impacts RADIUS request processing when changes are made, the impact under normal operation (when changes are not being made) is virtually unmeasurable.

Replication Configuration Settings

This section describes each replication configuration setting. In **aregcmd**, replication settings are found in **//localhost/Radius/Replication**.

RepType

RepType indicates the type of replication. The choices available are SMDBR and NONE.

When RepType is set to NONE, replication is disabled. To enable replication, set RepType to SMDBR for Single Master DataBase Replication. RepType must be set to SMDBR on both the master and slave servers.

RepTransactionSyncInterval

Master

On the master server, RepTransactionSyncInterval is the duration between periodic transmission of the TransactionSync message expressed in milliseconds. The default is 60000 or 1 minute.

The purpose of RepTransactionSyncInterval is to indicate how frequently to check for an out-of -sync condition between the master and slave servers. When the slave received the TransactionSync message, it uses its contents to determine if it needs to resynchronize with the master.

The larger the setting for RepTransactionSyncInterval, the longer the period of time between out-of-sync detection. However, if RepTransactionSyncInterval is set too small, the slave can frequently request resynchronization when it is not really out of sync. If the duration is too small, the slave cannot completely receive a transaction before it receives the TransactionSync message. In this case, the servers will remain synchronized, but there will be unnecessary excess traffic that could affect performance.

Note Cisco recommends that you use smaller values for the RepTransactionSyncInterval to limit the time a slave server is offline applying change sets during automatic resynchronization.

Slave

On the slave, RepTransactionSyncInterval is used to determine if the slave has lost contact with the master and to alert administrators of a possible loss of connectivity between the master an slave. If the elapsed time since the last received TransactionSync message exceeds the setting of RepTransactionSyncInterval, the slave writes a log message indicating that it might have lost contact with the master. This log message is repeated each TransactionSyncInterval until a TransactionSync message is received.

RepTransactionArchiveLimit

On both master and slave, the RepTransactionArchiveLimit setting determines how many transactions can be stored in the archive. The default setting is 100. When the limit is exceeded, the oldest transaction file is deleted. If a slave requires resynchronization and the last transaction it received is no longer in the archive, a full resynchronization will be necessary to bring the slave back in sync with the master.

Note The value set for RepTransactionArchiveLimit should be the same on the master and the slave.

An appropriate value for RepTransactionArchiveLimit depends upon how much hard disk space an administrator can provide for resynchronization. If this value is large, say 10,000, then the last 10,000 transactions will be stored in the archive. This is like saying the last 10,000 saves from **aregcmd** will be stored in the archive. Large values are best. The size of each transaction depends upon how many configuration changes were included in the transaction, so hard disk space usage is difficult to estimate.

Note Cisco recommends that you use smaller values for the RepTransactionArchiveLimit to limit the time a slave server is offline applying change sets during automatic resynchronization.

If the slave should go down or otherwise be taken off line, the value of RepTransactionArchiveLimit and the frequency of **aregcmd** saves will determine how long the slave can be off-line before a full-resynchronization will be required.

There are two reasons why a slave server should have an archive:

1. The slave must save the last received transaction for resynchronization purposes (at a minimum).
2. Should the master go down, the slave can then be configured as the master and provide resynchronization services to other slaves.

RepIPAddress

The RepIPAddress value is set to the IP Address of the machine containing the AR installation.

RepPort

The RepPort is the port used to receive of replication messages. In most cases, the default value (1645) is sufficient. If another port is to be used, the interfaces must exist in the machine.

RepSecret

RepSecret is the replication secret shared between the master and slave. The value of this setting must be identical on both the master and the slave.

RepIPMaster

The RepIPMaster setting indicates whether the machine is a master or a slave. On the master, set RepIPMaster to TRUE. On the slave set it to FALSE. Only the master can have this value set to TRUE and there can be only one master.

RepMasterIPAddress

RepMasterIPAddress specifies the IP Address of the master. On the master, set RepMasterIPAddress to the same value used in RepIPAddress above. On the slave, RepMasterIPAddress must be set to the IP Address of the master.

RepMasterPort

RepMasterPort is the port to use to send replication messages to the master. In most cases, the default value (1645) is sufficient; however, if another is to be used, the interfaces must exist in the machine.

Rep Members Subdirectory

The Rep **Members** subdirectory contains the list of slaves to which the master will replicate transactions.

Rep Members/Slave1

Each slave is added much like a client is added. Each slave must have a configuration in the Rep Members directory to be considered part of the *replication network* by the master. The master will not transmit any messages or replications to servers not in this list, and any communication received by a server not in this list will be ignored.

Note Although it is possible to configure multiple slaves with the same master, we have only considered a single-master/single-slave configuration. This is the recommended configuration.

Name

This is the name of the slave. The name must be unique.

IPAddress

This is the IP Address of the slave.

Port

This is the port upon which the master will send replication messages to the slave.

Setting Up Replication

This section provides step-by-step instructions about how to configure replication on both the master and member servers. The following section, "Replication Example" section on page 10-11, shows an example of replication configuration.

If possible, open an **xterm** window on both the master and member. In each of these windows, change directory to **$INSTALL/logs** and run **xtail** to watch the logs. This allows you to watch replication log messages as they occur. If you are using a system which had a previous installation of Cisco AR, delete all files located in the **$INSTALL/data/archive** directory if it is present on either the master or member systems.

Configuring the Master

Use the following steps to configure the master server for replication:

Step 1 On the machine which is to be the master, using **aregcmd**, navigate to **//localhost/Radius/Replication**

Step 2 Set the RepType to SMDBR:

set RepType SMDBR

Step 3 Set the RepIPAddress to the IP address of the master:

set RepIPAddress 192.168.1.1

Step 4 Set the RepSecret to MySecret:

set RepSecret MySecret

Step 5 Set RepIsMaster to TRUE:

set RepIsMaster TRUE

Step 6 Set RepMasterIPAddress to the same value used in step 3:

set RepIPMaster 192.168.1.1

Step 7 Change directory to **/Radius/Advanced** and set the **MaximumNumberOfRadiusPackets** property to 8192:

cd /Radius/Advanced

set MaximumNumberOfRadiusPackets 8192

Step 8 Change directory to **Rep Members:**

cd "rep members"

Note You must enclose Rep Members in quotes due to the space in the name.

Step 9 Add **member1**:

add member1

Step 10 Change directory to **member1**:

cd member1

Step 11 Set the IPAddress to the IP Address of the machine to be the member:

set IPAddress 192.168.1.2

Note The RepPort and RepMasterPort properties on the Master must correspond to one of the ports configured in **/Radius/Advanced/Ports**, if one is configured. Otherwise, the default values for the RepPort and RepMasterPort properties are sufficient.

Step 12 Save the configuration:

save

Step 13 Reload the configuration:

reload

Configuring The Member

Use the following steps to configure the member server for replication:

Step 1 On the machine which is to be the member, using **aregcmd**, navigate to **//localhost/Radius/Replicatio**n.

Step 2 Set the RepType to SMDBR.

set RepType SMDBR

Step 3 Set the RepIPAddress to the IP address of the member.

set RepIPAddress 192.168.1.2

Step 4 Set the RepSecret to MySecret.

set RepSecret MySecret

Step 5 Set RepMasterIPAddress to IP Address of the master (the same value used in Step 3 on page 8-1).

set RepMasterIPAddress 192.168.1.1

Step 6 Change directory to **/Radius/Advanced** and set the **MaximumNumberOfRadiusPackets** property to 8192.

cd /Radius/Advanced

set MaximumNumberOfRadiusPackets 8192

Step 7 If the Master has been configured to use a port other than the well-known (and default) RADIUS ports, configure each Member to use the same port.

Note The RepPort and RepMasterPort properties on the Master must correspond to one of the ports configured in **/Radius/Advanced/Ports**, if one is configured. Otherwise, the default values for the RepPort and RepMasterPort properties are sufficient.

Step 8 Save the configuration:

save

Step 9 Reload the configuration:

reload

Verifying the Configuration

After both servers have successfully started, use **aregcmd** to make a small change to be replicated to the member server which you can easily verify. We recommend setting the description in **//localhost/Radius** to something like *Test1*. After you issue an **aregcmd save** and the prompt returns, run **aregcmd** on the member server and change directory to **//localhost/Radius**. Ensure that the description is set to Test1. If this was successful, then replication is properly configured and functional.

Replication Example

This section provides an example of replication and shows the actions that occur.

Adding a User

On the master server, use **aregcmd** to add a new user to the default user list. To add a new user, perform the following steps:

Step 1 Change directory to **//localhost/Radius/UserLists/Default**.

Step 2 Enter the following:

add testuser

Step 3 Change directory to testuser.

cd testuser

Step 4 Set the password for testuser.

set password testuser

Step 5 Confirm the password by entering ***testuser*** again.

Step 6 Enter save to save the configuration.

Master Server's Log

The log on the master shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:17:07 name/radius/1 Info Server 0 Initiating Replication of Transaction
1 with 2 Elements.
04/02/2001 23:17:07 name/radius/1 Info Server 0 Replication Transaction #1 With 2
Elements Initiated
```

Member Server's Log

The log on the member shows the following:

```
*** ./name_radius_1_log ***
4/02/2001 23:15:18 name/radius/1 Info Server 0 Radius Server is On-Line
04/02/2001 23:17:12 name/radius/1 Info Server 0 Committing Replication of Transaction
1 with 2 Elements.
04/02/2001 23:17:16 name/radius/1 Info Server 0 Replication Transaction #1 With 2
Elements Committed.
```

Verifying Replication

You can use one of two methods to verify that the new user testuser was properly replicated to the member:

- Run **aregcmd** on the member and look at the default userlist to see if it is there.
- Run **radclient** on the member and enter **simple testuser testuser** to create a simple access request packet (p001).

  Enter **p001 send** to send it. When it returns with p002, enter **p002** to see if it is an Access Accept packet or an Access Reject packet. If it is an Access Accept, the user was properly replicated to the member. Using **radclient** is the recommended method to validate that a user was properly replicated.

On the Master, use **aregcmd** to delete the user from the default user list and save the user list.

Master Server's Log

The log on the master shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:20:48 name/radius/1 Info Server 0 Initiating Replication of Transaction
2 with 1 Elements.
04/02/2001 23:20:48 name/radius/1 Info Server 0 Replication Transaction #2 With 1
Elements Initiated
```

Member Server's Log

The log on the member shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:20:53 name/radius/1 Info Server 0 Committing Replication of Transaction
2 with 1 Elements.
04/02/2001 23:20:57 name/radius/1 Info Server 0 Replication Transaction #2 With 1
Elements Committed.
```

Repeat the validation procedure above to ensure the user *testuser* is no longer present on the member.

Using aregcmd -pf Option

Cisco AR's replication feature works well using **aregcmd** input files. An **aregcmd** input file contains a list of **aregcmd** commands. For example, if the initial configuration of Cisco AR were constructed in an input file, the master and member could be configured for replication first, then the input file applied to the master will be automatically replicated to the member.

To illustrate replication using an **aregcmd** input file, do the following:

Step 1 Create a text file called **add5users** with the following commands:

add /Radius/UserLists/Default/testuser1

cd /Radius/UserLists/Default/testuser1

set password testuser1

add /Radius/UserLists/Default/testuser2

cd /Radius/UserLists/Default/testuser2

set password testuser2

add /Radius/UserLists/Default/testuser3

cd /Radius/UserLists/Default/testuser3

set password testuser3

add /Radius/UserLists/Default/testuser4

cd /Radius/UserLists/Default/testuser4

set password testuser4

add /Radius/UserLists/Default/testuser5

cd /Radius/UserLists/Default/testuser5

set password testuser5

save

Step 2 On the master server, run the following command:

aregcmd -pf add5users

Master Server's Log

The log on the master shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:27:08 name/radius/1 Info Server 0 Initiating Replication of Transaction
3 with 10 Elements.
04/02/2001 23:27:08 name/radius/1 Info Server 0 Replication Transaction #3 With 10
Elements Initiated
```

Member Server's Log

The log on the member shows the following:

```
*** ./name_radius_1_log ***
```

```
04/02/2001 23:27:12 name/radius/1 Info Server 0 Committing Replication of Transaction
3  with 10 Elements.
04/02/2001 23:27:17 name/radius/1 Info Server 0 Replication Transaction #3 With 10
Elements Committed.
```

When the prompt returns, go to the member and use **aregcmd** to view the **/radius/defaults/userlis**t. There should be five users there named *testuser1* through *testuser5*.

An Automatic Resynchronization Example

This example will illustrate resynchronization of the member. This will be accomplished by stopping the member, making changes on the master, then restarting the member forcing a resynchronization.

Step 1 At the member, stop the AR server:

/etc/init.d/arservagt stop

At the master, run **aregcmd** and change directory to **/radius/userlist/default**.

cd /radius/userlist/default

Step 2 Enter the following:

add foouser

Step 3 Change directory to **foouser**.

cd foouser

Step 4 Set the password for **foouser**.

set password foouser

Step 5 Confirm the password by entering ***foouser*** again.

Step 6 Save the configuration:

save

Master Server's Log

The log on the master shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:31:02 name/radius/1 Info Server 0 Initiating Replication of Transaction
5 with 2 Elements.
04/02/2001 23:31:02 name/radius/1 Info Server 0 Replication Transaction #5 With2
Elements Initiated
```

On the member, run **/etc/init.d/arservagt start**. Notice the following log messages in the Master's log:

```
*** ./name_radius_1_log ***
04/02/2001 23:33:19 name/radius/1 Info Server 0 Resynchronizing member1.
```

Member Server's Log

The log on the member shows the following:

```
*** ./name_radius_1_log ***
04/02/2001 23:33:14 name/radius/1 Info Server 0 Radius Server is Off-Line
04/02/2001 23:33:14 name/radius/1 Info Server 0 Starting Replication Manager
```

```
04/02/2001 23:33:24 name/radius/1 Info Server 0 Master Selected As Partner (DEFAULT)
04/02/2001 23:33:24 name/radius/1 Info Server 0 Radius Server is Off-Line
04/02/2001 23:33:24 name/radius/1 Warning Server 0 Requesting resynchronization from
Master: Last Txn#3
04/02/2001 23:33:24 name/radius/1 Info Server 0 Resynchronization from Master in
progress.
04/02/2001 23:33:24 name/radius/1 Info Server 0 Committing Replication of Transaction
4 with 2 Elements.
04/02/2001 23:33:28 name/radius/1 Info Server 0 Replication Transaction #4 With 2
Elements Committed.
04/02/2001 23:33:28 name/radius/1 Info Server 0 Radius Server is On-Line
```

As the log above shows, when the member started up, it validated its last received transaction number (#3) with the master's last replicated transaction number (#4). They did not match because a replication was initiated by the master which was not received by the member (because the member was stopped). When the member detected this discrepancy, the member made a resynchronization request to the master. The master responded by transmitting the missed transaction (#4) to the member. After it received and processed the retransmitted transaction, the member determined that it was then synchronized with the master and placed itself in an on-line status.

Full Resynchronization

Full Resynchronization means that the member has missed more transactions than are stored in the master's replication archive and can not be resynchronized automatically. There is no automatic full-resynchronization mechanism in Cisco AR's configuration replication feature. If a full resynchronization is required, you must export the master server's database and update the member configuration.

Note Before beginning, ensure there are no **aregcmd** sessions logged into the master server.

To perform a manual full-resynchronization, perform the following steps:

Step 1 On the master server, stop the Cisco AR server agent using the following command:

/etc/init.d/arserver stop

Step 2 On the master server, change directory to **$INSTALL/data/db**.

Step 3 Create a tarfile made up of the three database files, **mcddb.d01**, **mcddb.d02**, and **mcddb.d03**.

tar cvf /tmp/db.tar mcddb.d0*

Step 4 Create a tarfile of the archive.

tar cvf /tmp/archive.tar $INSTALL/data/archive

Step 5 On the master server, start the Cisco AR server agent using the following command:

/etc/init.d/arserver start

Step 6 On each member server requiring resynchronization, perform the following:

a. On the member server, stop the Cisco AR server agent using the following command:

/etc/init.d/arserver stop

b. Copy the tarfiles (**db.tar** and **archive.tar**) to **/tmp**.

c. Change directory to **$INSTALL/data/db**, then untar the compressed database files.

cd $INSTALL/data/db

tar xvf /tmp/db.tar

d. Rebuild the key files using the following command:

$INSTALL/bin/keybuild mcddb

Note This step might take several minutes.

e. Untar the archive.

cd $INSTALL/data/db

tar xvf /tmp/archive.tar

f. As a safety check, run the following UNIX command to verify the integrity of the database.

$INSTALL/bin/dbcheck mcddb

Note You must be user **root** to run **dbcheck**.

No errors should be detected.

g. Start the Cisco AR server agent using the following command:

/etc/init.d/arserver start

Note After you start the member server with the master server's database, you will probably see messages such as the following:

```
03/24/2005 23:21:23 name/radius/1 Error Server 0 TXN_SYNC: Failed to get master's
socket handle.
03/24/2005 23:21:49 name/radius/1 Warning Server 0 TXN_SYNC Received by Master
from unknown member 10.1.9.74. Validation Failed
```

These messages will likely continue until you complete steps **h** and **i**.

h. Change directory to **//radius/replication** and change the following attributes:

- Change the RepIPAddress to that of the member.
- Change RepIsMaster to FALSE.
- Remove any entries under Rep Members.

i. Save and reload the configuration.

save

```
Validating //localhost...
Saving //localhost...
```

reload

The member will start up and show on-line status in the log after it has verified it is synchronized with the master.

Frequently Asked Questions

Question: When I do a **save** in **aregcmd** and the validation fails, is anything replicated?

Answer: No; replication does not occur until **aregcmd** successfully saves the changes.

Question: Can I specify multiple masters with the same members?

Answer: No; the replication feature was designed to be used with a single-master. Also, it is not possible to specify more than one master in a member's configuration.

Question: Do I have to configure the master as a client on the member servers?

Answer: No. In-fact, it would be erroneous to do so. With the exception of Administrators, Interfaces, Replication, and Advanced machine-specific settings, the configuration between master and member must be identical. The replication feature's purpose is to maintain that relationship. Altering configuration settings on the member which are managed by the master will likely result in an unstable and possibly non-operational server.

Question: What configuration elements are replicated and what are not?

Answer: With the exception of Administrators, Interfaces, Replication, and Advanced machine-specific settings, all other settings are replicated.

Question: What configuration elements are hot-configured and what are not?

Answer: Session Managers, Resource Managers and Remote servers are not hot-configured because they maintain state, such as an active session, and cannot be manipulated dynamically.

Question: What is an appropriate TransactionSyncInterval setting?

Answer: This depends upon how long you want to allow an out-of-sync condition to persist. The shorter the interval, the more often an out-of-sync condition is checked. However, this results in added network traffic, additional processing by Cisco AR and, if the interval is too small, frequent unnecessary resynchronization requests. The default value of 60,000 milliseconds (1 minute) is usually sufficient; however, values of as little as 10,000 milliseconds (10 seconds) have been tested and have worked well.

Question: What is an appropriate TransactionArchiveLimit setting?

Answer: This depends upon two things:

1. How much hard disk space you are willing to devote to transaction archive storage
2. How often your configuration is changed (a save is issued through Aregcmd).

If you have limited hard disk space, then perhaps smaller values (less than 1000) are appropriate; however if you have sufficient hard disk space, values of 10,000 or greater are better. The primary reason for this preference is to limit the possibility of a full-resynchronization being required. A full-resynchronization is required when the member has missed so many transactions that the master no longer contains all the transaction necessary to resynchronize the member. The greater the limit, the longer the member can be down without requiring a full-resynchronization.

Question: Can I specify a member in the member configuration?

Answer: Yes, and this is recommended. In the member's replication configuration Rep Members list, specify another server, perhaps one which can be used in-case of critical failure of the master. If the master suffers a catastrophic failure (a hard disk crash, for example) the member can be reconfigured to be the master simply by setting the RepIsMaster to TRUE and changing the MasterIPAddress to its own IP Address and the member specified in its Rep Members list will perform as the member. Because the member has an archive of transactions, the new member can be automatically resynchronized. If the archive limit on the new master has been exceeded (the transaction file txn0000000001 is no longer present in the new master's archive directory), then the new member will require a full-resynchronization. Setting the member up in this manner prevents down-time if the master fails and allows configuration changes to be made on the new master.

Question: How can I prevent a full-resynchronization from ever being necessary?

Answer: You can't, but you can limit the possibility by setting the TransactionArchiveLimit to a large value (greater than 10000). Another technique is to periodically check the archive when the master and member are synchronized. If the number of transaction files is approaching 10,000, then you can stop the master and member servers, delete all files in the replication archive, and restart the master and member. The only side effect is that if the master or member suffers a catastrophic failure, a full resynchronization will be required.

Question: Can I use the member to process RADIUS requests along with the master?

Answer: Yes, and this was one of the goals of the replication feature. Keep in mind that session information is not replicated between master and member. To use session management in this environment, use Cisco AR's central session manager.

Replication Log Messages

This section contains typical replication log messages and explains what each means. This section include the following subsections:

- Information Log Messages
- Warning Log Messages
- Error Log Messages
- Log Messages You Should Never Receive

Information Log Messages

Error Message `Starting Replication Manager`

Displayed at start-up and indicates the Replication Manager is configured and enabled. (RepType=SMDBR)

Error Message `Replication Disabled`

Displayed at start-up and indicates that Replication is not enabled. (RepType=NONE)

Error Message `Radius Server is On-Line`

Displayed by the member at start-up to indicate the member is synchronized with the master and processing RADIUS requests. It is also displayed after a successfully completed resynchronization. This message is never displayed on the master.

Error Message `Radius Server is Off-Line`

Displayed by the member at start-up to indicate the radius server is not processing RADIUS requests until it can ensure synchronization with the master. When this is displayed after startup, it indicates the member is no longer synchronized with the master and is directly associated with a resynchronization request to the master. This message is never displayed on the master.

Error Message `Resynchronizing <member name>`

Displayed by the master to indicate that it is resynchronizing the specified member (member).

Error Message `Resynchronization from Master in progress.`

Displayed by the member to indicate the master is in the process of resynchronizing it.

Error Message `Resynchronization complete.`

Displayed by the member to indicate the resynchronization has completed successfully.

Error Message `Resynchronization did not complete before timeout. Retrying.`

Indicates the master did not complete the resynchronization before the member expected it to complete and that the member is re-requesting resynchronization from the master for the remaining missed transactions.

Error Message `Master Selected As Partner (DEFAULT)`

Displayed by the member to indicate it has successfully connected with the master.

Error Message `Initiating Replication of Transaction <transaction #> with <# of elements> Elements.`

Displayed by the master to indicate that it is beginning replication of a transaction to the member.

Error Message `Replication Transaction #<transaction #> With <# of elements> Elements Initiated`

Displayed by the master to indicate that it has completed sending the transaction to the member.

Error Message `Committing Replication of Transaction <transaction #> with <# of elements> Elements.`

Displayed by the member to indicate that it has received a transaction and is processing it.

Error Message `Replication Transaction #<transaction#> With <# of element> Elements Committed`

Displayed by the member to indicate that the transaction has been successfully processed.

Error Message `Stopping Replication Manager`

Displayed at shutdown by both the master and member to indicate the replication manager is being shut down.

Error Message `Stopping Replication Manager - waiting for replication to complete...`

Displayed by the member when a shutdown is attempted while received replications are being processed. Once the replications are complete, the shutdown will complete.

Error Message `Replication in progress. Please wait...`

Periodically displayed while a shutdown is pending and replications are being completed.

Error Message `Replication Manager Stopped`

Displayed by both the master and member to indicate the replication manager has been successfully shutdown.

Warning Log Messages

Error Message `Transaction Sync not received within configured TransactionSyncInterval. Communication with the Master may not be possible.`

The member displays this log messages to indicate that it has not received a TransactionSync message from the master within its configured TransactionSync interval.

Error Message `TXN_SYNC Received by Master from unknown member <ip address>. Validation Failed`

Displayed by the master when a TransactionSync message is received by the master. Since there can be only one configured master in a replication network, and the master is the only server who can send a TransactionSync message, this indicates there is another configured master in the replication network.

Error Message `TXN_SYNC Received from unknown Master <ip address>. Validation Failed`

Displayed by the member to indicate that a TransactionSync message was received from a server not configured as its master.

Error Message `Requesting resynchronization from Master: Last Txn#<transaction#>`

Displayed by the member to indicate that it is requesting resynchronization from the master. The LastTxn# is the last transaction number the member received and processed successfully.

Error Message `Resynchronization Request received from unknown member.`

Displayed by the master when a resynchronization request is received by a member who is not listed in its **/radius/replication/rep** members configuration.

Error Message `Resynchronization of <member name> requires Full Resynchronization.`

Displayed by the master to indicate that the member cannot be automatically resynchronized because its last transaction number is not within the configured history length of the archive (TransactionArchiveLimit). A manual resynchronization of the member is required to put the member back in-sync.

Error Message `MEMBER_SYNC Received from unknown Master at <ip address>. Validation Failed`

Displayed by a member indicating that a master, other than its configured master, is requesting partnership.

Error Message `MEMBER_SYNC Received by Master from unknown member <ip address>. Validation Failed`

Displayed by the master to indicate a member not listed in its **/radius/replication/rep** members configuration has requested partnership.

Error Message `TXN_EXPECT Received by Master from unknown <ip address>.`

Displayed by the master to indicate it has received a transaction which originated from another illegal master.

Error Message `TXN_EXPECT Received from unknown Master <ip address>.`

Displayed by the member to indicate it has received a transaction which originated from a master other than its configured master.

Error Message `TXN_EXPECT Broadcast failed.`

Indicates that the master could not initiate a replication.

Error Message `DATA_SYNC Received by Master from unknown <ip address>`

Displayed by the master to indicate that it received a replication transaction from another illegal master.

Error Message `DATA_SYNC Received from unknown <ip address>`

Displayed by the member to indicate that a transaction was received from a server external to the replication network.

Error Log Messages

Error Message `DATA_SYNC Validation failed - CRC Mismatch`

Displayed by the member to indicate a received transaction element is invalid.

Error Message
```
TXN_SYNC: Failed To Get Member Socket Handle.
TXN_SYNC: Failed to get master's socket handle.
MEMBER_SYNC could not get socket handle
TXN_EXPECT: Failed to get socket handle.
DATA_SYNC could not get socket handle.
These messages indicate an invalid interface configuration in Cisco Access
Registrar.
They could also be the result of specifying an invalid RepPort setting.
Failed To Create TXN_SYNC packet. (out of packets?)
Failed To Create TXN_SYNC packet.
MEMBER_SYNC Failed to create packet.(out of packets?)
MEMBER_SYNC Failed to create packet.
TXN_EXPECT Failed to create packet.(out of packets?)
TXN_EXPECT Failed to create packet.
DATA_SYNC Create packet failed.(out of packets?)
DATA_SYNC Create packet failed.
```

These message indicate that a packet could not be created. This could be the result of a low memory condition or the result of the /Radius/Advanced/ MaximumNumberOfRadiusPackets setting being set too low

Error Message
```
TXN_SYNC validation failed - Internal error (pTxnSync=NULL).
MEMBER_SYNC validate failed - Internal Error (pMemberSync=NULL)
DATA_SYNC Validation Failed - Internal (pDataSync = NULL).
TXN_EXPECT Could not add new datablock to pending transaction queue.
Replication Member could not be added to member list.
Replication Member could not be added to member list.
```

These messages are the result of a failed memory allocation possibly due to an out of memory condition.

Error Message
```
DATA_SYNC Packet creation failed - Invalid ordinal.
Attempt To Replicate Transaction With Zero Elements.
Internal Error - Selected member not valid
Internal Replication Error ChangeType <change type> For <element path>
Internal error - Replication manager is invalid
```

These messages indicate an internal application failure.

Error Message `Cannot archive transaction datablock`
`Could not archive transaction`

These messages are the result of a failed archive attempt. This could be the result of a low disk space condition.

Error Message `Could not commit transaction to MCD`
`Cannot Get Value For Unsupported DataType <data type id>`
`MCD Replication Cannot Delete Value <element path>`
`MCD Replication Cannot Delete Directory <element path>`
`MCD Replication Cannot Delete Value For <element path> With Unsupported DataType <data type id>`
`MCD Replication Cannot Create Dir For <element path>`
`MCD Replication Cannot Set Value For <element path>`
`MCD Replication Cannot Set Value For <element path>`
`MCD Replication Cannot Set Value For <element path>`
`MCD Replication Cannot Set Value For <element path>`
`MCD Replication Cannot Set Value For <element path> With Unsupported DataType <data type id>`
`MCD Replication Cannot Set Value For <element path> With UNKNOWN DataType <data type id>`

These messages are the result of a failed replication commit attempt.

Log Messages You Should Never See

The following list contains log messages which you should never see displayed in a log. If any of these messages are displayed in the log, contact Cisco AR technical support for assistance.

Error Message `<member name> Selected As Partner (DEFAULT)`
`DATA_SYNC Received from non-partner <ip address>`
`DATA_RE_SYNC CRC mismatch. Replying with NAK`
`DATA_RE_SYNC Commit Failed. Replying with NAK`
`EVAL_SYNC Validation failed. <ip address> is not a Master or Member of the Replication network`
`EVAL_SYNC Received from unknown member.`
`PARTNER_SYNC Received from unknown member <ip address>.`
`PARTNER_SYNC Received from unknown member <ip address>.`
`EVAL_SYNC Cannot get socket handle.`
`EVAL_SYNC Failed to create packet.(out of packets?)`
`EVAL_SYNC Failed to create packet.`
`EVAL_SYNC Validation failed - Internal Error (pEvalSync=NULL).`
`PARTNER_SYNC Failed to get socket handle.`
`PARTNER_SYNC Failed to create packet. (out of packets?)`
`PARTNER_SYNC Failed to create packet.`
`DATA_RE_SYNC Can't get socket handle`
`DATA_RE_SYNC Failed to create packet (out of packets?)`
`DATA_RE_SYNC Failed to create packet`
`DATA_RE_SYNC Failed validation - Internal Error (pReSync = NULL)`
`DATA_RE_SYNC Cannot Set Value For <element path>`
`DATA_RE_SYNC Cannot Set Value For <element path>`
`DATA_RE_SYNC Cannot Set Value For <element path>`
`DATA_RE_SYNC Cannot Set Value For <element path>`
`DATA_RE_SYNC Cannot Set Value For <element path> With Unsupported DataType <data`

```
type id>
DATA_RE_SYNC Cannot Set Value For <element path> With UNKNOWN DataType <data type
id>;
DATA_RE_SYNC Received by Master from unknown member <ip address>
DATA_RE_SYNC Received from unknown Master <ip address>DATA_RE_SYNC Reply received
by Master from unknown Member <ip address>
Could not replicate data element to partners.
Could not replicate to partners - Invalid Ordinal.
```

CHAPTER 11

Using On-Demand Address Pools

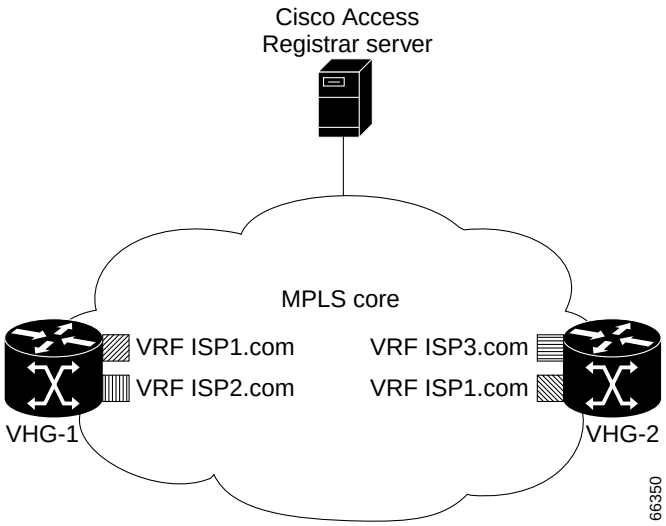
Cisco Access Registrar provides support for On-Demand Address Pools (ODAP). Using ODAP, the Cisco AR server manages pools of addresses. Each pool is divided into subnets of various sizes, and the Cisco AR server assigns the subnets to virtual home gateways (VHG) and Provider Edge (PE) routers. The VHG/PE router has one On-Demand Address Pool configured for each VPN supported by that VHG/PE.

Cisco AR has been enhanced to make ODAP functionality more accessible and to enable ODAP requests and normal user authentication to occur on the same Cisco AR server. To achieve this functionality, a new Cisco vendor script **CiscoWithODAPIncomingScript** was written to direct ODAP requests to particular services and session managers. **CiscoWithODAPIncomingScript** also provides the same functionality as the previous **CiscoIncomingScript**.

Additionally, Cisco AR has a new vendor type, **CiscoWithODAP** which references **CiscoWithODAPIncomingScript** as its IncomingScript and references the existing script, **CiscoOutgoingScript,** as its Outgoing Script.

Figure 11-1 shows a simple MPLS VPN network with two VHG/PE routers, VHG-1 and VHG-2. The Cisco AR server allocates IP subnets to the VHGs by way of VRFs which contain the subnets and addresses (address space) available.

Figure 11-1 MPLS Core



In Cisco AR, the VRFs are configured as users in an ODAP-users list under **/Radius/UserLists**. The VRF name is set in IOS for the ODAP pool. When a VRF requests a pool of addresses, Cisco AR directs the request to a Session-Manager configured with the name **odap-<*VRF name*>**. Cisco AR also directs ODAP accounting requests to the service odap-accounting.

In the example network shown in Figure 11-1, the VRFs are configured with the following address spaces:

- VRF-ISP1.com—consists of the address range 10.255.0.0 - 10.255.255.255 divided among the following subnets:
  - 10.255.0.0/24
  - 10.255.1.0/24
  - ...
  - 10.255.255.0/24
- VRF-ISP2.com—consists of the address ranges 10.0.0.0 - 10.10.255.255 and 10.255.0.0 - 10.255.10.255 divided among the following subnets:
  - 10.0.0.0/16
  - 10.1.0.0/16
  - ...
  - 10.10.0.0/16

  and:
  - 10.255.0.0/24
  - 10.255.1.0/24
  - ...
  - 10.255.10.0/24

Note VRF-ISPe.com requires two ResourceManagers because it has subnets of two different sizes.

- VRF-ISP3.com—consists of the address range 1172.21.0.0 - 172.21.255.255 divided among the following subnets:
  - 172.21.0.0/18
  - 172.21.64.0/18
  - 172.21.128.0/18

  and
  - 172.21.192.0/24
  - 172.21.193.0/24
  - ...
  - 172.21.255.0/24

Note VRF-ISP3.com requires two ResourceManagers because it also has subnets of two different sizes.

Cisco-Incoming Script

Cisco AR 1.7R1 includes a new Cisco AR script, **CiscoWithODAPIncomingScript**, that makes ODAP functionality more accessible. The script eases the configuration required to enable ODAP requests and normal user authentication to occur on the same Cisco AR server. **CiscoWithODAPIncomingScript** also provides the functionality of the original CiscoIncomingScript.

If the Cisco AR server receives an ODAP request, the server sets the Session-Key from the AcctSessionID and sets the services and session managers.

If the Cisco AR server receives a non-ODAP request, other scripts, rules or policies that you might already have in place on the Cisco AR server handle these requests.

How the Script Works

The following describes how the script **CiscoWithODAPIncomingScript** works.

1. The script examines the incoming NAS-Identifier sent by the client (VHG). If the NAS-Identifier does not equal ***odap-dhcp*** then this request is not an ODAP request. Since this is not an ODAP request, the script does not do any more ODAP-specific processing and just calls **CiscoIncomingScript** to allow that script to process the request. If this is an ODAP request, this script removes the NAS-Identifier attribute because it is no longer needed.
2. The script sets the Authentication-Service and the Authorization-Service to ***odap-users***, and it sets the Accounting-Service to ***odap-accounting***.
3. The Cisco AR server sends the request to the appropriate Session Manager based on the username. Session Managers with ***odap-<username>*** must be created and configured in Cisco AR.
4. The script then uses Session IDs to identify each ODAP request. The script uses the Acct-Session-Id attribute as the Session-Key.

CiscoWithODAPIncomingScript

The following is a Tcl script example of the script **CiscoWithODAPIncomingScript.**

Note **CiscoWithODAPIncomingScript** is written in C language. This example script is more easily understood in Tcl.

```
proc CiscoWithODAPIncomingScript {request response environ} {

  set RequestType [ $environ get Request-Type ]

  if { [ string compare $RequestType "Access-Request" ] == 0 ||
       [ string compare $RequestType "Accounting-Request" ] == 0 } {

       set NasID [ $request get NAS-Identifier ]

       if { [ string compare $NasID "odap-dhcp" ] == 0 } {
```

```
                # Remove the NAS-Identifier - it has done it's job
                $request remove NAS-Identifier

                set UserName [ $environ get User-Name ]
                if { [ string length $UserName ] == 0 } { set UserName [ $request get User-Name ] }

                # ODAP SUBNET ASSIGNMENT
                $environ put Authentication-Service "odap-users"
                $environ put Authorization-Service "odap-users"
                $environ put Accounting-Service "odap-accounting"
                $environ put Session-Manager "odap-$UserName"

                set AcctSessionId [ $request get Acct-Session-Id ]
                if { [ string length $AcctSessionId ] != 0 } { $environ put Session-Key $AcctSessionId
                } else {
                $environ log LOG_ERROR "Missing Acct-Session-Id attribute in request-unable to set Session-Key"
               }
     }
  }
CiscoIncomingScript $request $response $environ
}
```

Note The final line in the example above is not how the script really works because a Tcl script can't call a C script. This is one reason why **CiscoWithODAPIncomingScript** was written in C.

Vendor Type CiscoWithODAP

Cisco AR 1.7R1 includes a new vendor type, **CiscoWithODAP**. You must configure any Clients that might forward ODAP requests to the Cisco AR server as being of Vendor **CiscoWithODAP.**

This vendor type references the new script, **CiscoWithODAPIncomingScript**, as its IncomingScript and references the existing script, CiscoOutgoingScript, as its OutgoingScript.

After setting Vendor to **CiscoWithODAP,** ODAP requests are directed to the AA service, set to ***odap-users***, the accounting service is set to ***odap-accounting***, and the Session Manager is set to ***odap-username***, where username is filled from the request. The username received in the request is a VRF name, the request is directed to the appropriate Session Manager.

Configuring Cisco AR to Work with ODAP

This section provides information about how to configure Cisco AR to work with ODAP.

Configuration Summary

This section provides the steps required to configure Cisco AR to work with ODAP. For detailed information about configuring Cisco AR to work with ODAP, refer to the following section, Detailed Configuration.

1. Create and configure an ODAP-users UserList

   All ODAP users are configured under this UserList.

2. Add all ODAP users to the ODAP-users UserList

Usernames must be of the form *<vrf name>* with the AllowNullPassword property set to TRUE.

3. Create and configure a service for ODAP-users
4. Create and configure an ODAP accounting service

   Set the accounting service Type to ***file*** and FilenamePrefix ***odap-accounting***.
5. Create a Session Manager for each of the VRFs

   There must be a separate Session Manager for each VRF pool.
6. Create and configure Resource Managers to be referenced by the Session Managers

   Subnet pools of different sizes (different subnet masks) require separate Resource Managers.
7. Configure the Session Managers with the Resource Managers
8. Configure any Clients that might send ODAP requests to Vendor type CiscoWithODAP
9. Save your configuration

Detailed Configuration

The following steps provide a detailed description of configuring Cisco AR to work with ODAP.

Setting Up an ODAP UserList

Step 1 Create a UserList for ODAP users.

```
--> cd /radius/userlists

[ //localhost/Radius/UserLists ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>

    Default/

--> add odap-users

Added odap-users
```

Adding ODAP Users

Step 2 Add the ODAP users to the ODAP UserList and set the AllowNullPassword property to TRUE.

Each user is a VRF name set for each ODAP client.

```
[ //localhost/Radius/UserLists/odap-users ]

    Entries 0 to 0 from 0 total entries
    Current filter: <all>

    Name = odap-users
    Description =

--> add vrf-ISP1.com

Added vrf-ISP1.com
```

```
--> add vrf-ISP2.com

Added vrf-ISP2.com

--> add vrf-ISP3.com

Added vrf-ISP3.com

--> ls

[ //localhost/Radius/UserLists/odap-users ]
    Entries 1 to 3 from 3 total entries
    Current filter: <all>

    Name = odap-users
    Description =
    vrf-ISP1.com/
    vrf-ISP2.com/
    vrf-ISP3.com/
```

Step 3 Set the AllowNullPassword property to TRUE for each ODAP user.

```
--> cd vrf-ISP2.com

[ //localhost/Radius/UserLists/odap-users/vrf-ISP2.com ]
    Name = vrf-ISP2.com
    Description =
    Password =
    Enabled = TRUE
    Group~ =
    BaseProfile~ =
    AuthenticationScript~ =
    AuthorizationScript~ =
    UserDefined1 =
    AllowNullPassword = FALSE

--> set AllowNullPassword TRUE
```

Setting Up an ODAP-Users Service

Step 4 Add and configure a service for ODAP Users.

```
--> cd /radius/services

[ //localhost/Radius/Services ]
    Entries 1 to 2 from 2 total entries
    Current filter: <all>

    local-file/
    local-users/

--> add odap-users
```

```
Added odap-users

--> cd odap-users
[ //localhost/Radius/Services/odap-users ]
    Name = odap-users
    Description =
    Type =
    IncomingScript~ =
    OutgoingScript~ =

--> set type local

Set Type local

--> set userlist odap-users

Set UserList odap-users

--> ls

[ //localhost/Radius/Services/odap-users ]
    Name = odap-users
    Description =
    Type = local
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    UserList = odap-users
```

Setting Up an ODAP Accounting Service

Step 5 Add and configure an ODAP accounting service.

```
--> cd /radius/services

[ //localhost/Radius/Services ]
    Entries 1 to 3 from 3 total entries
    Current filter: <all>

    local-file/
    local-users/
    odap-users/

--> add odap-accounting

Added odap-accounting

--> cd odap-accounting

[ //localhost/Radius/Services/odap-accounting ]
    Name = odap-accounting
    Description =
    Type =
    IncomingScript~ =
    OutgoingScript~ =
```

```
--> set type file

Set Type file

--> ls

[ //localhost/Radius/Services/odap-accounting ]
    Name = odap-accounting
    Description =
    Type = file
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    FilenamePrefix = accounting
    MaxFileSize = "10 Megabytes"
    MaxFileAge = "1 Day"
    RolloverSchedule =

--> set FilenamePrefix odap-accounting

Set Filenameprefix odap-accounting
```

Adding Session Managers

Step 6 Create one Session Manager for each of the VRF pools.

Create one Session Manager for each of the users you specify in the odap-users UserList. The Session Managers must be called odap-*VRF_name* to meet the requirements of **CiscoWithODAPIncomingScript**.

```
--> cd /radius/sessionmanagers

[ //localhost/Radius/SessionManagers ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>

    session-mgr-1/

--> add odap-vrf-ISP1.com

Added odap-vrf-ISP1.com

--> add odap-vrf-ISP2.com

Added odap-vrf-ISP2.com

--> add odap-vrf-ISP3.com

Added odap-vrf-ISP3.com
```

Setting Up Resource Managers

Step 7 Set up subnet-dynamic Resource Managers that are to be referenced by the Session Managers.

Session Managers can manage multiple Resource Managers. One or more subnet pools can be set up of varying sizes to allocate the ranges of subnet addresses you have available. Subnets of different sizes require different Resource Managers.

```
--> cd /radius/resourcemanagers

[ //localhost/Radius/ResourceManagers ]
    Entries 1 to 5 from 5 total entries
    Current filter: <all>

    IPA-Pool/
    IPA-Pool-2/
    IPX-Pool/
    Per-Group/
    Per-User/

--> add odap-vrf-ISP1.com
```

Note The names of Resource Managers do not have to be related to VRFs.

```
Added odap-vrf-ISP1.com

--> cd odap-vrf-ISP1.com

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP1.com ]
    Name = odap-vrf-ISP1.com
    Description =
    Type =

--> set type subnet-dynamic

Set Type subnet-dynamic

--> ls

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP1.com ]
    Name = odap-vrf-ISP1.com
    Description =
    Type = subnet-dynamic
    NetMask =
    SubnetAddresses/

-> set netmask 255.255.255.0

Set NetMask 255.255.255.0

-> cd subnetaddresses

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP1.com/SubnetAddresses ]
    Entries 0 to 0 from 0 total entries
    Current filter: <all>

--> add 10.255.0.0-10.255.255.255

Added 10.255.0.0-10.255.255.255
```

Note Two Resource Managers are required for VRF-ISP3.com and VRF-ISP2.com because their address spaces are made up of subnets of the different sizes.

```
--> cd /radius/resourcemanagers

[ //localhost/Radius/ResourceManagers ]
    Entries 1 to 5 from 5 total entries
    Current filter: <all>

    IPA-Pool/
    IPA-Pool-2/
    IPX-Pool/
    odap-vrf-ISP1.com/
    Per-Group/
    Per-User/

--> add odap-vrf-ISP3-a.com

Added odap-vrf-ISP3-a.com

--> cd odap-vrf-ISP3-a.com

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-a.com  ]
    Name = odap-vrf-ISP3-a.com
    Description =
    Type =

--> set type subnet-dynamic

Set Type subnet-dynamic

--> ls

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-a.com  ]
    Name = odap-vrf-ISP3-a.com
    Description =
    Type = subnet-dynamic
    NetMask =
    SubnetAddresses/

-> set netmask 255.255.192.0

Set NetMask 255.255.192.0

-> cd subnetaddresses

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-a.com /SubnetAddresses ]
    Entries 0 to 0 from 0 total entries
    Current filter: <all>

--> add 171.21.0.0-172.21.191.255

Added 172.21.0.0-172.21.191.255

-> cd /radius/resourcemanagers
```

```
[ //localhost/Radius/ResourceManagers ]
    Entries 1 to 10 from 10 total entries
    Current filter: <all>

    IPA-Pool/
    IPA-Pool-2/
    IPX-Pool/
    odap-vrf-ISP1.com/
    odap-vrf-ISP3-a.com /
    Per-Group/
    Per-User/
```

--> add odap-vrf-ISP3-b.com

```
Added odap-vrf-ISP3-b.com
```

--> cd odap-vrf-ISP3-b.com

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-b.com  ]
    Name = odap-vrf-ISP3-b.com
    Description =
    Type =
```

--> set type subnet-dynamic

```
Set Type subnet-dynamic
```

--> ls

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-b.com  ]
    Name = odap-vrf-ISP3-b.com
    Description =
    Type = subnet-dynamic
    NetMask =
    SubnetAddresses/
```

-> set netmask 255.255.255.0

```
Set NetMask 255.255.255.0
```

-> cd subnetaddresses

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP3-b.com /SubnetAddresses ]
    Entries 0 to 0 from 0 total entries
    Current filter: <all>
```

--> add 172.21.191.0-172.21.255.255

```
Added 172.21.191.0-172.21.255.255
```

-> cd /radius/resourcemanagers

```
[ //localhost/Radius/ResourceManagers ]
    Entries 1 to 10 from 10 total entries
    Current filter: <all>

    IPA-Pool/
    IPA-Pool-2/
    IPX-Pool/
```

```
    odap-vrf-ISP1.com/
    odap-vrf-ISP3-a.com /
    odap-vrf-ISP3-b.com /
    Per-Group/
    Per-User/
```

--> add odap-vrf-ISP2-a.com

```
Added odap-vrf-ISP2-a.com
```

--> cd odap-vrf-ISP2-a.com

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-a.com  ]
    Name = odap-vrf-ISP2.com
    Description =
    Type =
```

--> set type subnet-dynamic

```
Set Type subnet-dynamic
```

--> ls

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-a.com  ]
    Name = odap-vrf-ISP2-a.com
    Description =
    Type = subnet-dynamic
    NetMask =
    SubnetAddresses/
```

-> set netmask 255.255.0.0

```
Set NetMask 255.255.0.0
```

-> cd subnetaddresses

```
[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-a.com /SubnetAddresses ]
    Entries 0 to 0 from 0 total entries
    Current filter: <all>
```

--> add 10.0.0.0-10.10.255.255

```
Added 10.0.0.0-10.255.255.255
```

-> cd /radius/resourcemanagers

```
[ //localhost/Radius/ResourceManagers ]
    Entries 1 to 10 from 10 total entries
    Current filter: <all>

    IPA-Pool/
    IPA-Pool-2/
    IPX-Pool/
    odap-vrf-ISP1.com/
    odap-vrf-ISP3-a.com /
    odap-vrf-ISP3-b.com /
    odap-vrf-ISP2-a.com /
    Per-Group/
    Per-User/
```

```
--> add odap-vrf-ISP2-b.com

Added odap-vrf-ISP2-b.com

--> cd odap-vrf-ISP2-b.com

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-b.com  ]
    Name = odap-vrf-ISP2-b.com
    Description =
    Type =

--> set type subnet-dynamic

Set Type subnet-dynamic

--> ls

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-b.com  ]
    Name = odap-vrf-ISP2-b.com
    Description =
    Type = subnet-dynamic
    NetMask =
    SubnetAddresses/

-> set netmask 255.255.255.0

Set NetMask 255.255.255.0

-> cd subnetaddresses

[ //localhost/Radius/ResourceManagers/odap-vrf-ISP2-b.com /SubnetAddresses ]
    Entries 0 to 0 from 0 total entries
    Current filter: <all>

--> add 10.255.0.0-10.255.10.255

Added 10.255.0.0-10.255.10.255
```

Configuring Session Managers

Note It is not necessary to configure Session Managers in two instances. All SessionManager configuration can be done at one time before configuring the Resource Managers.

Step 8 Configure the Session Managers to be referenced by the Resource Managers.

```
--> cd/radius/sessionmanagers

[ //localhost/Radius/SessionManagers ]
    Entries 1 to 4 from 4 total entries
    Current filter: <all>

    odap-vrf-ISP1.com/
```

```
    odap-vrf-ISP2.com/
    odap-vrf-ISP3.com/
    session-mgr-1/

--> cd odap-vrf-ISP2.com

[ //localhost/Radius/SessionManagers/odap-vrf-ISP2.com ]
    Name = odap-vrf-ISP2.com
    Description =
    AllowAccountingStartToCreateSession = FALSE
    ResourceManagers/

--> cd resourcemanagers

--> set 1 odap-vrf-ISP2-a.com

Set 1 odap-vrf-ISP2-a.com

--> set 2 odap-vrf-ISP2-b.com

Set 2 odap-vrf-ISP2-b.com

--> cd/radius/sessionmanagers

[ //localhost/Radius/SessionManagers ]
    Entries 1 to 4 from 4 total entries
    Current filter: <all>

    odap-vrf-ISP1.com/
    odap-vrf-ISP2.com/
    odap-vrf-ISP3.com /
    session-mgr-1/

--> cd odap-vrf-ISP3.com

[ //localhost/Radius/SessionManagers/odap-vrf-ISP3.com  ]
    Name = odap-vrf-ISP3.com
    Description =
    AllowAccountingStartToCreateSession = FALSE
    ResourceManagers/

--> cd resourcemanagers

--> set 1 odap-vrf-ISP3-a.com

Set 1 odap-vrf-ISP3-a.com

--> set 2 odap-vrf-ISP3-b.com

Set 2 odap-vrf-ISP3-b.com

--> cd/radius/sessionmanagers

[ //localhost/Radius/SessionManagers ]
    Entries 1 to 4 from 4 total entries
    Current filter: <all>
```

```
    odap-vrf-ISP1.com/
    odap-vrf-ISP2.com/
    odap-vrf-ISP3.com/
    session-mgr-1/

--> cd odap-vrf-ISP1.com

[ //localhost/Radius/SessionManagers/odap-vrf-ISP1.com ]
    Name = odap-vrf-ISP1.com
    Description =
    AllowAccountingStartToCreateSession = FALSE
    ResourceManagers/

--> cd resourcemanagers

--> set 1 odap-vrf-ISP1.com

Set 1 odap-vrf-ISP1.com
```

Configure Clients

Step 9 For any client that might forward ODAP requests to the Cisco AR server, set the Vendor property to CiscoWithODAP.

```
--> cd /radius/clients

[ //localhost/Radius/Clients ]
    Entries 1 to 2 from 2 total entries
    Current filter: <all>

    localhost/
    vhg-1/
    vhg-2/

--> cd vhg-1

[ //localhost/Radius/Clients/vhg-1 ]
        Name = vhg-1
        Description =
        IPAddress = 209.165.200.225
        SharedSecret = secret
        Type = NAS
        Vendor =
        IncomingScript~ =
        OutgoingScript~ =
        UseDNIS = FALSE
        DeviceName = a_name
        DevicePassword = password

--> set vendor CiscoWithODAP

Set Vendor CiscoWithODAP
```

Save Your Configuration

Step 10 After completing the configuration, save your changes.

```
--> save

Validating //localhost...
Saving //localhost...
```

CHAPTER 12

Using Identity Caching

Cisco Access Registrar software includes the identity caching feature. Cisco AR runs as application layer software and can be used standalone or in conjunction with other workstations running Cisco AR.

Note The identity caching feature is available on Cisco AR releases 3.5.2 and above.

Identity caching provides subscriber identity resolution services with fast access to associated subscriber identity data for service providers, enabling them to offer new services to their customers based on identity caching and context information management.

This chapter contains the following sections:

Overview

Identity caching enables Cisco equipment to gain context information about the operator's subscribers to support network functions or to enhance subscriber's experience on the operator's network. Figure 12-1 on page 12-2, Cisco AR System Overview, shows the network environment where Cisco AR identity caching might be used.

For example, Client Services Gateway (CSG) uses IP mapping information provided by identity caching to support post-paid content billing. Identity caching acquires subscriber information from other devices and information sources in the operator's network. The type of information provided is limited by the available information sources and is configurable by the operator, but might include information such as IP address, MSISDN, and IMSI. Identity caching does not duplicate the operator's persistent data stores. Identity caching provides a protocol-based interface through which Cisco network elements (Cisco AR identity caching clients) can access subscriber information.

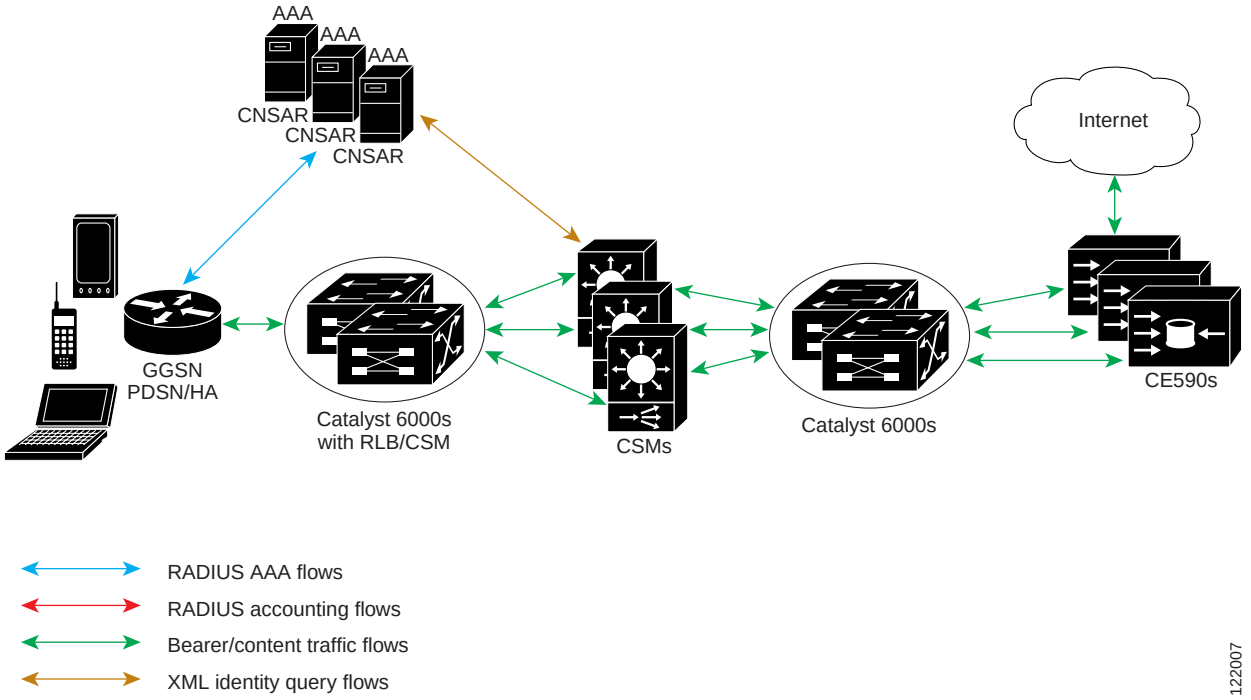
The Cisco AR servers receive RADIUS flows from the Gateway GPRS support Node (GGSN) which acts as a type of network access station (NAS). These flows perform full AAA (authentication, authorization and accounting). You can configure the Cisco AR servers to redirect the accounting information (only) to an identity caching server to be cached. The GGSN can also be configured to direct only the RADIUS accounting information directly to the Cisco AR server.

Cisco AR also receives XML identity query flows from the CSM which acts as a NAS. In the event that a CSM should fail or lose its information, the information can be refreshed from the information cached in the Cisco AR server.

Cisco AR acquires subscriber information such as the IP address, the mobile Subscriber ISDN number (MSISDN), and the International Mobile System Identifier (IMSI) from AAA requests the Cisco AR server receives, typically from the GGSN. The types of information provided is limited by the available information sources and is configurable by the operator.

Cisco AR 4.1.4 includes an XML Query Identity enhancement. Cisco AR previously supported User-Name lookup based on the Framed IP address of an existing session. The XML Query Identity enhancement enables Framed IP address lookup based on the User-Name in an existing session.

Figure 12-1 Cisco AR System Overview



Identity Caching Features

Cisco AR identity caching provides the following features:

- Supports GGSN subscriber data attributes from RADIUS authentication sequences
- Provides basic identity mapping services from IP address or username/APN to Mobile DN for one network presence at a time.
- Provide session management support for Content Switch Module (CSM)

  Cisco AR enables the CSM to keep the data session and content correlated to the same subscriber reconnecting, perhaps after an atach/detach sequence for a GPRS subscriber connecting again. This is done through the MSISDN identity to IP mapping in the identity caching function.

- Enhance redundancy with stateful fail-over support for applications by finding the right connection between subscriber identity and IP address using the Identity Cache function
- Uses an XML interface to make it easier for any network function or application to use without having to have detailed internal knowledge about the execution environment or programming methods.
- Provides user identity resolution with fast access to associated subscriber data
- Establishes an identity and Access Management solution that can be used in and across multiple network domains
- Provides a way to use identity resolution to manage the growth of 2.5G mobile data access services (GSM/GPRS) and to provide always-on mobile data access including the following:
  - Ties various IP addresses to a unique subscriber identifier
  - Dynamically assigning and reusing IP addresses and controlling services with consistent identification
  - Correlates previous content activity when a mobile subscriber reconnects
  - Correlates IP addresses, mobile numbers, user name, and identifiers to support customer billing
  - Correlates and identifies subscribers using both 2.5G and WLAN services and provides a way to control and manage operator network services
  - Provides subscriber privacy control
  - Provides a way to cache content with various customers and their networks

Configuring Cisco AR for Identity Caching

Use the command line interface **aregcmd** to configure Cisco AR 3.5 to perform identity caching.

To configure identity caching:

Step 1 Launch **aregcmd**.

Step 2 Define a client object for each client that will send either RADIUS or XML packets to the Cisco AR server performing identity caching.

There should be one client object for each GGSN, one for each CSM and one for each packet simulator (if used in a test environment).

For example, if a packet simulator will be used on the same server where you perform identity caching, add a client object as in the following:

cd /Radius/Clients

add xml-client

cd xml-client

```
[ //localhost/Radius/Clients/xml-client ]
    Name = xml-client
    Description =
    IPAddress =
    SharedSecret =
    Type = NAS
    Vendor =
    IncomingScript~ =
```

```
OutgoingScript~ =
EnablePOD = FALSE
```

This client object is very similar to the localhost object defined in the example configuration. The **SharedSecret** property will be ignored if the client is an XML client, but still must be set to a non-null value. The **Type** property is also ignored for XML clients.

Step 3 Define a port object for each RADIUS port and each XML port to be used. Two RADIUS ports, the second immediately following the first in numeric value, must be defined even if only one is needed. A typical identity caching installation requires the following port configuration:

cd /Radius/Advanced/Ports

add 1645

add 1646

add 8080

Note Although ports 1645 and 1646 are the default ports for Cisco AR, you must add them to **/Radius/Advanced/Ports** to also add port 8080.

Step 4 Change directory to the 1645 port and set its type to Radius-Access.

cd /Radius/Advanced/Ports/1645

set Type Radius-Access

Step 5 Change directory to the 1646 port and set its type to Radius-Accounting.

cd /Radius/Advanced/Ports/1646

set Type Radius-Accounting

Step 6 Change directory to the 8080 port and set its type to XML.

-cd /Radius/Advanced/Ports/8080

set Type XML

Step 7 Define and configure an accounting service of type file and set it as the DefaultAccountingService.

An accounting service is required for Cisco AR to cache identity information, even if no accounting service is needed otherwise. If you added the example configuration during installation, a local-file accounting service is already configured.

If you did not add the example configuration during software installation, refer to the following section in the RADIUS Accounting chapter of the *User Guide for Cisco Access Registrar, 4.1*:

Setting Up Accounting

Step 8 Define and configure a ResourceManager for identity caching.

cd /Radius/ResourceManagers

add cache

Step 9 Set the ResourceManager to type session-cache for identity caching.

cd cache

set type session-cache

The following shows the default properties of a session-cache ResourceManager:

```
[ //localhost/Radius/ResourceManagers/cache ]
    Name = cache
    Description =
    Type = session-cache
    OverwriteAttributes = FALSE
    QueryKey =
    PendingRemovalDelay = 10
    AttributesToBeCached/
    QueryMappings/
```

Step 10 Set the QueryKey to a RADIUS attribute you want to key on.

For example, use the following command to set the QueryKey to User-Name:

set QueryKey User-Name

The QueryKey must match the string on the right-hand side of one of the pairs you list in QueryMappings. It is not necessary for the QueryKey to be configured under **AttributesToBeCached** because the QueryKey will always be cached by default.

Note The QueryKey property must always be a RADIUS attribute. The Cisco AR server forces a NULL IP address (0.0.0.0) if it detects an incorrectly configured QueryKey.

Step 11 Change directory to **AttributesToBeCached** and use the **set** command to provide a list of RADIUS attributes you want to store in cache.

cd AttributesToBeCached

set 1 Calling-Station-ID

Set 2 User-Name

Set 3 Framed-IP-Address

The attributes a session-cache resource manager caches can be queried through both RADIUS Query and XML Query packets. When you cache attributes Framed-IP-Address or User-Name, or when you use XML-Address-format-IPv4 or XML-UserId-id_type-subscriber_id as the QueryKey, you must map the XML attributes to RADIUS attributes in the **QueryMappings** subdirectory.

Step 12 Change directory to **QueryMappings** and use the **set** command to list the attribute pairs, mapping the XML attributes on the left-hand side to the RADIUS attribute on the right-hand side.

set XML-Address-format-IPv4 Framed-IP-Address

set XML-UserId-id_type-subscriber_id User-Name

Step 13 Change directory to **/Radius/SessionManagers** and add a SessionManager for identity caching.

cd /Radius/SessionManagers

add IDcache

Step 14 Change directory to the new identity caching SessionManager, then change directory to the **ResourceManager** list.

cd IDcache/ResourceManagers

Step 15 Use the **set** command to associate the identity caching ResourceManager with this SessionManager.

set 1 cache

Step 16 Change directory to **/Radius** and set the DefaultSessionManager to the identity caching SessionManager.

cd /Radius

set DefaultSessionManager IDcache

Step 17 Run the **save**, **reload**, and **exit** commands:

save

reload

exit

Starting Identity Caching

To start identity caching, you must send an Accounting-Request to the specified accounting port (The default accounting port is 1646.) A minimal Accounting-Request will contain the following attributes:

- NAS-Identifier or NAS-IP-Address
- NAS-Port
- Framed-IP-Address
- User-Name
- Acct-Status-Type
- Acct-Session-Id

To start identity caching:

Step 1 Launch **radclient**:

cd /opt/CSCOar/bin

radclient -C localhost -N admin -P aicuser

Step 2 Enter the following **radclient** commands:

set p [acct_request Start joeuser@cisco.com]

$p set attrib [attrib Framed-IP-Address 123.123.123.123]

$p send

This assumes that you are running **radclient** on the same server and using 1646 as the accounting port.

Step 3 Send XML requests to the specified XML port (Cisco suggests port 8080 as shown above). A typical XML packet will look like the following:

```
<?xml version="1.0"?>
<Request>
    <UserIdRequest>
        <UserId id_type="subscriber_id">bob</UserId>
    </UserIdRequest>
</Request>
```

To do this using **xmlclient**, put the XML text into a file, then enter the following command:

cd /opt/CSCOar/bin

./xmlclient -srd <file>

Note This assumes that xmlclient is running on the same server as identity caching and that 8080 is the XML port. Use the command **xmlclient -H** for information about how to use a different port or how to run **xmlclient** from a different server.

Note For a successful query, xml response will have the IPAddress associated with the requested user-name and for failure query it returns 0.0.0.0 as the IPAddress.

XML Interface

The XML interface is used for subscriber context information queries and responses to those queries. The XML interface is on a UDP port (8080) and is configurable. Identity caching supports the XML data-type definition (DTD) supported by the CSG.

The mapping from queries to replies can be one to many. For example, a UDP datagram might contain several queries but each reply will be returned in a separate datagram. No single query or reply can exceed the configured MTU of a datagram. Any that does results in an error.

If a query result is negative, the reply will consist of a null subscriber ID. All other error conditions cause Cisco AR to drop the request. Errors are logged locally using the Cisco AR logging mechanism.

CHAPTER 13

Using Trusted ID Authorization with SESM

Cisco Access Registrar 4.1 can be used in a Service Selection Gateway (SSG) - Cisco Subscriber Edge Services Manager (SESM) deployment to enable the Trusted Identity (Trusted ID) Authorization feature. This chapter describes how to use Cisco AR with SESM, and how to configure Cisco AR to use the Trusted ID feature.

The Trusted ID feature provides transparent login capabilities for users based on a trusted ID instead of the user's name, enabling end users of an SSG to maintain an always-on connection without the need to authenticate on each connect. Using SSG's Transparent Auto-Login (TAL) feature, a TAL access-request packet contains a Trusted ID, such as a MAC address, that identifies the user without the user's real username and password.The *SESM Profile Management Guide* provides detailed information about Trusted ID authorization in SESM.

If Cisco AR knows the user associated with the Trusted ID, Cisco AR uses the Trusted ID to authenticate and authorize the user. If the authentication and authorization succeeds, Cisco AR returns the user's username in the Access-Accept so the SSG can include the user's identity in subsequent Accounting-Requests.

If Cisco AR does not know the user associated with the Trusted ID, Cisco AR returns an Access-Reject. The Access-Reject causes the SSG to redirect the user to a SESM web portal login page. When the user explicitly authenticates, Cisco AR captures the Trusted ID and maps it to a user association so subsequent attempts to authenticate with the Trusted ID succeed.

Note Although functionality for the Trusted ID Authorization feature was added to Cisco AR 3.5.3, this feature was tested only using Cisco AR 3.5.4 and SESM 3.3(1).

This chapter contains the following sections:

Trusted ID Operational Overview

This section describes the operation of the Trusted ID Authentication feature.

Configuration Overview

The Trusted ID features require two objects in Cisco AR, a UserService, a SessionManager, and a ResourceManager. The UserService references another service called to perform the authentication and authorization (AA). The SessionManager references a SessionManager that contains a reference to a session-cache Resource Manager. These objects are imported into the Cisco AR server configuration when you run the **TrustedIdInstall.bin** program. Configuration Imported by TrustedIdInstall Program, page 13-13 lists the configuration imported into the Cisco AR server by the **TrustedIdInstall.bin** program.

The Resource Manager is configured with the QueryKey property set to a RADIUS attribute that contains the Trusted ID such as the Calling-Station ID. The Query Key should be set to an attribute present in all appropriate AA requests that uniquely identifies the user such as Calling-Station ID. The Query Key can be set to only one RADIUS attribute.

The Resource Manager is also configured to cache the attributes required to identify the user, username, and the user's credentials, password or CHAP-Password and CHAP-Challenge. The attributes User-Name, User-Password, NAS-Identifier, NAS-Port, or NAS-Port-Type are not appropriate choices for Query Key because they do not uniquely identify users.

A new property has been added to **/Radius/Advanced** called RollingEncryptionKeyChangePeriod in Cisco AR 3.5.4. The RollingEncryptionKeyChangePeriod specifies the length of time a given EncryptionKey will be used before a new one is created. When the session-cache ResourceManager caches User-Password attributes, Cisco AR encrypts the User-Password so it is not stored in memory or persisted on disk in clear text. Cisco AR uses up to 255 encryption keys, using a new one after each RollingEncryptionKeyChangePeriod expires. If RollingEncryptionKeyChangePeriod is set to *2 days*, Cisco AR will create and begin using a new EncryptionKey every two days. The oldest key will be retired, and Cisco AR will re-encrypt any User-Passwords that used the old key with the new key. This way, if the RollingEncryptionKeyChangePeriod is set to *1 day*, no key will be older than 255 days.

The encryption keys are indirectly connected to Trusted ID. Since User-Passwords might be stored for a long time in memory and on disk, Cisco AR uses the RollingEncryptionKey to encrypt the User-Passwords. The RollingEncryptionKey makes it more difficult for someone to crack or decode the User-Passwords because the key used changes frequently. If someone were to break one key, that would only give them the ability to decrypt those User-Passwords that had been encrypted with that key. All others, including those yet to be encrypted after the key change period expires would not be vulnerable.

Request Processing

When the Trusted ID service processes Access-Requests, it queries the session-cache Resource Manager for a cache entry associated with the Trusted ID. If found, the Resource Manager returns the cached attributes. The Trusted ID service replaces the request's existing attributes with the cached attributes.

After the Resource Manager is queried (and the request's existing attributes are replaced with the cached attributes if the cache entry exists), the Trusted ID's UserService authenticates and authorizes the request. The UserService is always called whether the cache entry exists or not. The only attributes cached in the Resource Manager are the ones listed in AttributesToBeCached. The user profile is usually not cached and is retrieved each time by the UserService.

Whether the request succeeds or not, the request is passed on to the service referenced by the UserService property. When that service completes authentication and authorization, control returns to the Trusted ID service. The session-cache might be updated if AA is successful.

Session Cache Life Cycle

Session cache management comprises adding and deleting Trusted ID to user mapping to and from the cache and is initiated from the Trusted ID service. The mapping is one-to-one mapping. For each Trusted ID, there can be only one cache entry, and conversely for each cache entry, there can be only one Trusted ID.

If a user is not presently in the session cache (the query failed), the AA done by the UserService succeeded and the internal attribute (Implicit-Auth-Enabled) was returned with a value of *true*, Cisco AR adds the user to the cache. Since the AA succeeded, Cisco AR assumes this is an explicit authentication by the user and the attributes required by the session-cache are present in the Access-Request.

If the user is already in the session cache (the query succeeded) and the AA done by the UserService failed, the internal attributes Implicit-Auth-Enabled was not returned, or was returned with a value other than true, Cisco AR removes the user from the session cache.

If the user has enabled implicit authentication (and if that results in Implicit-Auth-Enabled being returned as *true*), after the first Explicit Auth (from the login page), the user will be in the cache and will always be implicitly authenticated and authorized. In this case, you can get them out of the cache three ways:

- Have the user disable implicit authentication, then reconnect
- Have the system administrator release the session using **aregcmd** commands
- Use the SessionTimeout property in the Session Manager

If the user's account becomes orphaned (the user no longer exists), the cache entry will persist until it is removed using **aregcmd**.

If you have disabled implicit authentication, you are forced to authenticate each time and the cache is not updated. If you subsequently enable implicit authentication, you must explicitly authenticate one more time to create the user's cache entry. After creating the user's cache entry, they will not need to explicitly authenticate again (with this instance of Cisco AR) as long as implicit authentication is enabled.

Configuration Restrictions

The Session Manager referenced by the TrustedID Service should not be used for general session management. The Trusted ID Session Manager should be a separate Session Manager used only for the Trusted ID session cache. The data in the session-cache must persist longer than the length of the session. If the Trusted ID Session Manager was used for general session management, the cache would be updated for the general session, overwriting the cache entry for the special session created for the Trusted ID service. When the general session ended it would delete that data and subsequent queries for implicit authentication would fail.

Software Requirements

The Trusted ID feature requires the following software to be installed:

- Cisco Subscriber Edge Services Manager (SESM) 3.3(1)
- Cisco Subscriber Policy Engine (SPE) 2.1.12
- Cisco AR 4.1.3

In addition to the software listed above, you must run the **TrustedIdInstall.bin** stand-alone, Java application that runs on the Solaris platform. **TrustedIdInstall.rpm** is an equivalent Java application that runs on the Linux platform.

Note The disk space required to run the **TrustedIdInstall** program is about 1.3 MB.

The **TrustedIdInstall** program verifies the software prerequisites, installs the required jar files, and extends the configuration for Cisco AR. The **TrustedIdInstall** program is only available on Cisco.com under the Cisco AR 4.1 download area at the following URL:

http://www.cisco.com/cgi-bin/tablebuild.pl/access-registrar-encrypted

Installing Cisco AR

See the *Cisco Access Registrar Installation and Configuration Guide* for detailed information about how to install Cisco AR software.

Note You must specify a Java Runtime Environment (JRE) when you install Cisco AR software.

Running the TrustedIdInstall Program

Cisco provides a Java-based program called **TrustedIdInstall** that installs required jar files, the configuration for Subscriber Policy Engine (SPE), and Cisco AR. The **TrustedIdInstall** program can be run as an InstallShield wizard using the graphical user interface (GUI) or from the command line.

Note Before running the TrustedIDInstall program, ensure that the SPE 2.1.12 software has been installed with SESM 3.3(1) (in SPE mode).

Using the TrustedIdInstall.bin GUI

You must run the **TrustedIdInstall** program on the workstation where Cisco AR 3.5.4 is installed with a Java Runtime Environment (JRE) up to and including 1.4.2 in the path.

Step 1 Log in as a user with root privileges.

Step 2 Enter the following from the Cisco AR server's command line:

TrustedIdInstall.bin (for the Solaris platform) or

TrustedIdInstall.rpm (for the Linux platform)

The following message appears after you enter the command line above:

```
# TrustedIdInstall.bin
InstallShield Wizard

Initializing InstallShield Wizard...

Searching for Java(tm) Virtual Machine...
.............running under 1.2
```

Figure 13-1 shows the welcome window of the Trusted ID Azn AR SESM Integration 1.0 Installer.

Figure 13-1 Trusted ID Azn AR SESM Integration 1.0 Installer Welcome

Step 3 Click **Next** to continue.

The **InstallIdInstall.bin** wizard displays the Prerequisites window.

Step 4 Check to ensure that Cisco SESM 3.3(1) is installed and available on the network, then click **Next**.

The **InstallIdInstall.bin** wizard checks for Cisco AR 3.5.4 software. You will need the SESM 3.3(1) configuration parameters later in this procedure.

Step 5 Select the vendor name of the LDAP data store you are using for SPE, then click **Next**.

The **InstallIdInstall.bin** wizard displays the Password Encryption Panel. This panel prompts you for a master password (entered twice to ensure accuracy) and a Password Encryption Algorithm which can be None, SHA, or SHA-1.

Note If you plan to use EAP-MD5 authentication, choose **None**. See Configuring EAP-MD5 Authentication, page 13-14 for information about configuring EAP-MD5 authentication.

Step 6 Enter the password in field provided, and select the password encryption type, then click **Next**.

Step 7 If in **Step 5** you selected iPlanet as the Data Store Type, continue with **Step 8**. If you chose any other Data Store Type, proceed to **Step 9**.

The iPlanet Data Store Type requires that you set the value for the naming variable in **ACNSchema.xml** and **DESSSchema.xml**, either for Uid or Cn as shown in Figure 13-2. You can set the naming variable to either Uid or Cn.

Figure 13-2 Selecting iPlanet Naming Variable

Step 8 Select either **Uid** or **Cn** as the inetOrgPerson naming variable, then click **Next**.

The **InstallIdInstall.bin** wizard displays the Service Type Selection panel.

Step 9 Accept the default Trusted ID Service Enable True or click to select False, then click **Next**.

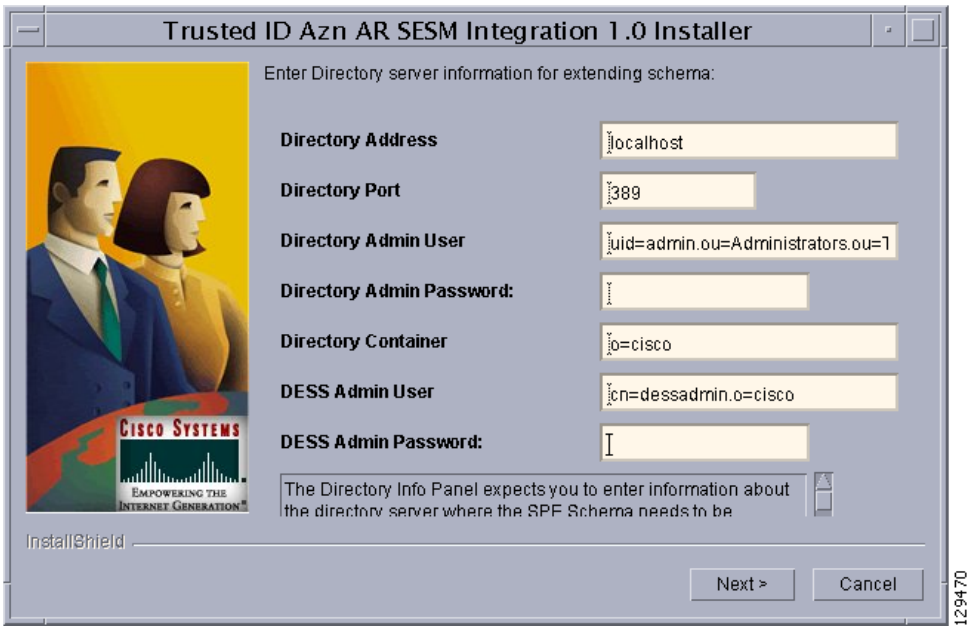
The TrustedIdInstall program displays a panel that indicates the following:

- Location where the Trusted ID Authorization SESM Integration files will be stored (/cisco-ar)
- Features to be stored (Admin Tool)
- Amount of space required (about 1.3 MB)

The **InstallIdInstall.bin** wizard displays the Directory Information panel, requesting information about the directory server required to extend the schema.

Step 10 Provide the requested Directory Server information as shown in Figure 13-3.

Figure 13-3 Directory Server Information



Contact the directory administrator if you are unsure about the information required.

a. Enter a **Directory Address**.

   The Directory Address field requires the directory server IP address or DNS hostname.

b. Enter a **Directory Port** number.

   Provide the TCP/IP port on which your directory server listens. (This is usually port 389.)

c. Enter a **Directory Admin User**.

   Provide the User ID of the directory server administrator with permissions to extend the schema in the form:

   `cn=admin`

d. Enter a **Directory Admin Password**.

   Provide the password for the directory administrator user.

e. Enter a **Directory Container**.

   Provide the container in which the default RBAC objects should be created in the form:

   `ou=sesm,o=cisco`

f. Enter a **DESS Admin User**.

   Provide the User ID of the DESS administrator in the form:

   `uid=admin,ou=sesm,o=cisco`

g. Enter a **DESS Admin Password**.

   Provide the password for the DESS administrator.

Step 11 Click **Next** to continue.

The **InstallIdInstall.bin** wizard begins the installation and displays a progress bar. When the installation completes, the wizard displays any warnings or errors it might have detected. Both boxes being empty indications a successful install.

Step 12 Click **Next** to continue.

A final window indicates a successful installation of the Trusted ID Authorization AR SESM Integration software.

Step 13 Click **Finish**.

Using the TrustedIdInstall Command Line

You can run the **TrustedIdInstall** program using the command line option on a workstation where Cisco AR 3.5.4 is installed with a JRE up to and including 1.4.2 in the path. The command line interface requires the same information as the GUI method.

Note You must be a root user to run the **TrustedIdInstall** program

Step 1 To run the **TrustedIdInstall** program using the command line interface, enter the following from the Cisco AR server's command line:

TrustedIdInstall.bin -console (for the Solaris platform)

TrustedIdInstall.rpm -console (for the Linux platform)

```
InstallShield Wizard

Initializing InstallShield Wizard...

Searching for Java (tm) Virtual Machine...
.............
-------------------------------------------------------------------------------

Welcome to the InstallShield Wizard for Trusted ID Azn AR SESM Integration.
The InstallShield Wizard will install Trusted ID Azn AR SESM Integration
 on your computer.
To continue, choose Next.
Trusted ID Azn AR SESM Integration1.0
Cisco Systems, Inc.
http://www.cisco.com

   Press 1 for Next panel, 3 to Cancel or 4 to Redisplay [1] 1
```

The line above provides a way for you to enter your selection. You can press **Enter** to go to the next panel. Enter 3 to cancel the installation, or enter 4 to redisplay the current panel.

Step 2 Press **Enter** to go to the next panel.

```
--------------------------------------------------------------------------------

Please read the information below.

Cisco Systems
 Prerequisites
Please ensure that minimally the following products are installed.
1 Check to ensure that Cisco SESM 3.3(1) is installed and available on the
network
2 Checking for Cisco AR 3.5.3 or later
 Please ensure the configuration parameter supplied during SESM installation
is used in this integration.

   Press 1 for Next panel, 2 for Previous panel, 3 to Cancel or 4 to
   Redisplay [1] 1
```

This panel lists prerequisites required for successful installation. Before continuing to the next panel, ensure that SESM 3.3(1) is installed and available or the network. The program checks for Cisco AR 3.5.3 (or later).

Step 3 After insuring that SESM 3.3(1) is installed and available on the network, press **Enter**.

```
[X]  1   -  Novell Directory Server
 [ ]      -  iPlanet
 [ ]      -  Data Communications Directory
 [ ]      -  IBM Directory Server
 [ ]      -  Active Directory Server
 [ ]      -  Open LDAP

   Choose the Vendor for Directory ,Select 0 to exit [0]

   Press 1 for Next panel, 2 for Previous panel, 3 to Cancel or 4 to
   Redisplay [1]
```

This panel requests the data store type selection and indicates the Novell Directory Server is the default selection.

Step 4 Press **Enter** to select the Novell Directory Server.

You can press **2** to select iPlanet, **3** to select Data Communications Directory, **4** to select IBM Directory Server, **5** to select Active Directory Server, or **6** to select Open LDAP.

```
--------------------------------------------------------------------------------

Enter the master password for SPE

   Master Password []
```

This panel requests a master password for SPE.

Step 5 Enter a password to be used as the master password for SPE and press **Enter**.

You are asked to re-enter the master password. The following panel requests an encryption algorithm and generates a secret key using the master password and selected algorithm.

```
[X]  1   -  NONE
 [ ]      -  SHA
 [ ]      -  SSHA

   Choose the installation type for SPE ,Select 0 to exit [0]

   Press 1 for Next panel, 2 for Previous panel, 3 to Cancel or 4 to
   Redisplay [1] 1
```

This panel indicates the default installation type as None. Type 2 and press **Enter** to select SHA, or type 3 and press **Enter** to select SSHA.

Note If you plan to use EAP-MD5 authentication, choose **None**. See Configuring EAP-MD5 Authentication, page 13-14 for information about configuring EAP-MD5 authentication.

Step 6 If in **Step 4** you selected iPlanet as the Data Store Type, continue with **Step 7**. If you chose any other Data Store Type, proceed to **Step 8**.

```
--------------------------------------------------------------------------------

 [X]  1   -  Uid
 [ ]      -  Cn
--------------------------------------------------------------------------------
```

The iPlanet Data Store Type requires that you set the value for the naming variable in **ACNSchema.xml** and **DESSSchema.xml**, either for Uid or Cn as shown above.

Step 7 Press **Enter** to use the naming variable to Uid, or press **2** to select Cn.

```
Service Type Selection panel

Trusted ID Service Enable
 [X]  1  -  True
 [ ]  2  -  False

   To select a choice enter its number, or 0 when you are finished [0]:

   Press 1 for Next panel, 2 for Previous panel, 3 to Cancel or 4 to
   Redisplay [1] 1
```

The Service Type Selection panel asks if you want to enable the Trusted ID service. Enter 2 to choose to not enable the Trusted ID service.

Step 8 Press **Enter** to enable the Trusted ID service.

```
Trusted ID Azn AR SESM Integration will be installed in the following
location:
/cisco-ar
with the following features:
Admin tool
for a total size:
 1.3 MB

   Press 1 for Next panel, 2 for Previous panel, 3 to Cancel or 4 to
   Redisplay [1] 1
```

This panel indicates the location where the TrustedIdInstall program will write data and the amount of storage required.

Step 9 Press **Enter** to begin writing data.

```
--------------------------------------------------------------------------------

Enter the IP Address (or) hostname of the system where the directory server is
running.
Please contact your directory administrator if you are not sure about this
information.

   Please enter the host address  [localhost]:
```

Step 10 Press **Enter** to use the current system as the directory server, or enter another directory server name or IP address.

```
Enter the TCP/IP Port on which your directory server listens. Usually, the
port is 389.
Please contact your directory administrator if you are not sure about this
information.

   Please enter the Port number  [389]:
```

Step 11 Press **Enter** to use the default port, 389, or enter a different port number.

Note Contact your directory server administrator if you are not sure about which port to use or other information required in the following steps.

```
Enter the User Id of the directory server with permissions to extend schema.
Please contact your directory administrator if you are not sure about this
information.

   Please enter directory user
   [uid=admin,ou=Administrators,ou=TopologyManagement,o=NetscapeRoot]:
```

Step 12 Enter the User ID of the directory server administrator with the necessary permissions to extend the schema.

```
Enter the password for the above user.
Please contact your directory administrator if you are not sure about this
information.

   Please enter the password  []: cisco
```

Step 13 Enter the password for the user provided in the previous step.

```
Enter the container in which the default RBAC objects should be created.
Please contact your directory administrator if you are not sure about this
information.

   Please enter the container  [o=cisco]:
```

Step 14 Press **Enter** to use the default container, or enter a different container and press **Enter**.

```
Enter the User Id of the DESS user.

   Please enter Dess user  [cn=dessadmin,o=cisco]:
```

Step 15 Press **Enter** to use the default DESS user, or enter a different user ID and press **Enter**.

```
Enter the password of the DESS user.
Please contact your directory administrator if you are not sure about this
information.

   Please enter the Dess user password  []: cisco
```

Step 16 Enter the DESS user password, then press **Enter**.

```
Press 1 for Next panel, 3 to Cancel or 4 to Redisplay [1] 1
```

At this point, the software installation is ready to begin.

Step 17 Press **Enter** to begin the software installation and extend the schema.

As the installation proceeds, status messages will be displayed. When the installation completes successfully, the following message displays:

```
Trusted ID Azn AR SESM Integration 1.0 installation completed

The InstallShield Wizard has successfully installed Trusted ID Azn AR SESM
Integration. Choose Finish to exit the wizard.

   Press 3 to Finish or 4 to Redisplay [3] 3
```

Step 18 Press **Enter** to end the program.

Configuring Cisco AR for Trusted Identity with SESM

Use the command line interface **aregcmd** to configure Cisco AR 4.1.3 (or later) to use Trusted ID authorization in SSG-SESM deployments.

Configuring the RADIUS Ports

By default, Cisco AR listens on ports 1645 and 1646 for any type of RADIUS request. It might be necessary to change the port assignments in the caseof a resource collision. For example, if the RADIUS Directory Enabled Service Selection (DESS) Proxy (RDP) component of SPE is using ports 1645 and 1646, a port assignment change would be required.

The following command sequence causes Cisco AR to listen on the explicitly defined ports, 1812 and 1813, for all types of RADIUS requests.

cd /Radius/Advanced/Ports

add 1812 “” radius

```
Added 1812
```

add 1813 “” radius

```
Added 1813
```

After changing the port assignments, Cisco AR no longer listens on the default ports. It might be necessary to add ports 1645 and 1646 if you are also using Cisco AR for other AAA functionality.

Note By default, Cisco AR listens on ports 1645 and 1646 on Solaris platforms and on ports 1812 and 1813 for the Linux platform.

Configuring NAS Clients

Change directory to **/Radius/Clients**, then add and configure the NAS clients required by SESM deployments:

cd /Radius/Clients

add SESM1 "" 10.3.3.2 cisco

```
Added SESM1
```

add SESM2 "" 10.3.3.101 cisco

```
Added SESM2
```

add SESM3 "" 10.3.3.102 cisco

```
Added SESM3
```

Configuring AAA and SPE Services

Step 1 Change directory to **/Radius/Services**, then add and configure an accounting service.

cd /Radius/Services

add SESMaccounting "" file

```
Added SESMaccounting
```

Step 2 Change directory to **/Radius**, then configure a DefaultAccountingService.

cd /Radius

set DefaultAccountingService SESMaccounting

```
Set DefaultAccountingService SESMaccounting
```

Configuration Imported by TrustedIdInstall Program

The following is a listing of the configuration imported into the Cisco AR server when you run the TrustedIdInstall program.

/Radius

```
DefaultAuthenticationService trusted-id
DefaultAuthorizationService trusted-id
```

/radius/services/spe

```
type java
ClassName com.cisco.cns.security.arspe.SPEExtension
```

/radius/services/trusted-id

```
type trusted-id
UserService spe
SessionManager session-cache
```

/Radius/SessionManagers/session-cache/

```
AllowAccountingStartToCreateSession FALSE
ResourceManagers/1 session-cache
```

/radius/ResourceManagers/session-cache

```
type session-cache
OverwriteAttributes TRUE
PendingRemovalDelay 10
QueryKey Calling-Station-ID
AttributesToBeCached/1 User-Name
AttributesToBeCached/2 User-Password
AttributesToBeCached/3 Calling-Station-ID
```

/radius/advanced/

```
ClasspathForJavaExtensions /cisco-ar/conf
```

/Radius/Scripts/ChangeServiceType

```
Language TCL
Filename ChangeServiceType.tcl
EntryPoint ChangeServiceType
IncomingScript ChangeServiceType
```

Configuring EAP-MD5 Authentication

EAP-MD5 authentication is an optional authentication configuration. The following configuration changes are required to support EAP-MD5 authentication.

Note If you configure Cisco AR to use EAP-MD5 authentication with the Trusted ID feature, you will not be able to use the Transparent Auto Login feature.

Creating the CheckEap.tcl Script

The **CheckEap.tcl** script must be created and stored in a file called **/cisco-ar/scripts/radius/tcl/CheckEap.tcl**. Use a text editor and copy the following lines into the **CheckEap.tcl** file:

```
proc CheckEap { request response environment } {
    if { [ $request containsKey EAP-Message ] } {
        $environ put Authentication-Service "EAP-MD5"
        $environ put Authorization-Service "spe"
    }
}
```

Adding the CheckEap.tcl Script

This section describes how to add the CheckEap.tcl script.

Step 1 Start **aregcmd**, then change directory to **/Radius/Scripts** and add the CheckEap script.

cd /Radius/Scripts

add EapCheck

Step 2 Change directory to **EapCheck**.

cd EapCheck

```
[ //localhost/Radius/Scripts/EapCheck ]
        Name = EapCheck
        Description =
        Language =
```

Step 3 Set the Language property to TCL.

set Language TCL

```
Set Language TCL
```

Step 4 Set the filename property to CheckEap.tcl.

set Filename CheckEap.tcl

```
Set Filename CheckEap.tcl
```

Step 5 Set the EntryPoint property to CheckEap.

set EntryPoint CheckEap

```
Set EntryPoint CheckEap
```

Note The following sections also require you to use **aregcmd**, the command line interface.

Using the CheckEap.tcl Script

This section describes how to configure Cisco AR to use the CheckEap script by setting the **/Radius/IncomingScript** property to CheckEap.

cd /Radius

set IncomingScript EapCheck

Adding the EAP-MD5 Authentication Service

This section describes how to add and configure the EAP-MD5 service.

Step 1 Change directory to **/Radius/Services** and add an EAP-MD5 service.

cd /Radius/Services

add EAP-MD5

Step 2 Change directory to the EAP-MD5 service and set the Type and UserService properties as shown below:

cd EAP-MD5

Step 3 Change directory to the EAP-MD5 service.

cd EAP-MD5

Step 4 Set the service Type property to eap-md5 and the UserService property to LDAP.

set Type eap-md5

set UserService LDAP

The following example shows the configuration of the EAP-MD5 service:

```
[ //localhost/Radius/Services/EAP-MD5 ]
    Name = EAP-MD5
    Description =
    Type = eap-md5
    IncomingScript~ =
    OutgoingScript~ =
    AuthenticationTimeout = 120
    UserService = LDAP
```

Adding an LDAP Remote Server

This section describes how to add and configure an LDAP remote server.

Step 1 Change directory to **/Radius/RemoteServers** and add a RemoteServer object.

cd /Radius/RemoteServers

add LDAP

Step 2 Change directory to the LDAP RemoteServer.

cd LDAP

```
[ //localhost/Radius/RemoteServers/LDAP ]
    Name = LDAP
    Description =
    Protocol =
```

Step 3 Set the RemoteServer protocol property to ldap.

set Protocol ldap

The following example shows the default configuration of an LDAP remote server:

```
[ //localhost/Radius/RemoteServers/LDAP ]
    Name = LDAP
    Description =
    Protocol = ldap
    Port = 389
    ReactivateTimerInterval = 300000
    Timeout = 15
    HostName =
    BindName =
    BindPassword =
    UseSSL = FALSE
    SearchPath~ =
    Filter~ = (uid=%s)
    UserPasswordAttribute = userpassword
    LimitOutstandingRequests = FALSE
    MaxOutstandingRequests = 0
    MaxReferrals = 0
    ReferralAttribute =
    ReferralFilter =
    PasswordEncryptionStyle = Dynamic
    EscapeSpecialCharInUserName = FALSE
    DNSLookupAndLDAPRebindInterval =
    LDAPToRadiusMappings/
    LDAPToEnvironmentMappings/
    LDAPToCheckItemMappings/
```

Step 4 Set the HostName property to the SPE/DESS directory IP address or hostname.

Step 5 Set the BindName property to the SPE/DESS administrator name.

Step 6 Set the BindPassword property to the SPE/DESS administrator password.

Step 7 Set the SearchPath property to the SPE/DESS directory container.

Step 8 Set the UserPasswordAttribute property type to clearpassword.

Adding an LDAP Service

This section describes how to add and configure an LDAP service.

Step 1 Change directory to **/Radius/Service** and add LDAP.

cd /Radius/Service

add LDAP

Step 2 Change directory to LDAP and set the type property to ldap.

cd LDAP

set Type ldap

The following shows the default configuration for an LDAP service:

```
[ //localhost/Radius/Services/LDAP ]
    Name = LDAP
    Description =
    Type = ldap
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
```

Step 3 Change directory to RemoteServers and associate the LDAP RemoteServer with the LDAP service.

cd RemoteServers

set 1 LDAP

Saving the Configuration and Reloading the Server

Use the **save** command to save the configuration, then **reload** the Cisco AR server.

save

```
Validating //localhost...
Saving //localhost...
```

reload

```
Reloading Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10
```

Cisco SSG VSAs in Cisco AR Dictionary

The following vendor-specific attributes (VSAs) are defined by default in the attribute dictionary after installing Cisco AR software:

- Cisco-AVPair
- Cisco-SSG-Account-Info
- Cisco-SSG-Service-Info
- Cisco-SSG-Command-Code
- Cisco-SSG-Control-Info

CHAPTER 14

Using Prepaid Billing

Cisco Access Registrar supports two types of prepaid billing, IS835C and Cisco Real-time Billing (CRB), a Cisco proprietary solution. The IS835C version adheres to industry standards and is the preferred version.

Three components are required to support a prepaid billing service:

- AAA client,
- Cisco AR server
- External prepaid billing server

The most important factor for an effective prepaid billing service is in developing a shared library to be configured under the prepaid RemoteServer object. The shared library should be developed to implement all specified API functions. You will have to provide a shared library that meets the needs of your environment. The shared library must implement the API functions to perform the various tasks required for your specific implementation of the prepaid billing service.

Note Cisco works with you to develop the prepaid billing service and implement the API. For more information, contact your Cisco systems engineer.

The chapter contains the following sections:

Overview

When a subscriber uses a prepaid billing service, each call requires a set of data about the subscriber. However, the AAA network has no previous knowledge of the subscriber's usage behavior. Cisco AR uses an iterative authorization paradigm over multiple sessions to support the prepaid billing solution.

Each time an authorization request is made, the billing server apportions a fraction of the subscriber's balance into a quota. When a subscriber uses multiple sessions, each session must obtain its own quota. When a previously allocated quota is depleted, a session must be reauthorized to obtain a new quota.

Note The granularity and the magnitude of the quota is in the design and implementation of the prepaid billing server and is beyond the scope of this document. In general, a smaller quota generates more network traffic, but allows more sessions per subscriber. When the quota is equal to a subscriber's total account balance, there is minimal network traffic, but only one session can be supported.

When a subscriber's current quota is depleted, the AAA client initiates a reauthorization request sending Access-Request packets. After the Cisco AR server receives the request, it forwards the request to the billing server. The billing server then returns the next quota to use. The new quota might not be the same as the previous, and the billing server might adjust the quota dynamically.

IS835C Prepaid Billing

Cisco AR acts as a RADIUS protocol head for all the requirements specified in the *cdma2000 Wireless IP Network Standard: PrePaid Packet Data Service* specification:

http://www.3gpp2.org/Public_html/specs/X.S0011-006-C-v1.0.pdf

As long as the prepaid client understands or accepts what the external billing server sends, the service should work. The Cisco AR server neither imposes nor is affected by the values of attributes returned from the external billing server.

For additional information, see *cdma2000 Wireless IP Network Standard: Accounting Services and 3GPP2 RADIUS VSAs* at the following URL:

http://www.3gpp2.org/Public_html/specs/X.S0011-005-C-v1.0.pdf

The IS835C specification requires that the Cisco AR server be able to determine that a particular user is a prepaid billing user. A user is accepted as a valid prepaid user when the response dictionary of the incoming packet contains the Cisco AR internal subattribute named *prepaid*.

The IS835C specification requires prepaid users to first be authenticated by the RADIUS server. This requires the configuration of a group service with an authentication service first, followed by the prepaid service that adds prepaid attributes as shown in Setting Up an Authentication Group Service, page 14-5. The group service configuration enables the AA service to add the prepaid subattribute to the response dictionary upon successful authentication, before the prepaid service is invoked.

Configuring IS835C Prepaid Billing

To configure an IS835C prepaid billing service, use the following sections to configure the required Cisco AR objects:

- Setting Up a Prepaid Billing RemoteServer
- Setting Up an IS835C Prepaid Service
- Setting Up Local Authentication
- Setting Up an Authentication Group Service

Setting Up a Prepaid Billing RemoteServer

Step 1 Use **aregcmd** to add a RemoteServer under **/Radius/RemoteServers**.

cd /radius/remoteserver

add prepaid-is835c

Step 2 Set remoteserver protocol to prepaid-is835c.

cd prepaid-is835c

set protocol prepaid-is835c

```
Set Protocol prepaid-is835c
```

The following is the default configuration of a prepaid-is835c RemoteServer.

```
[ //localhost/Radius/RemoteServers/prepaid-is835c ]
    Name = prepaid-is835c
    Description =
    Protocol =
    IPAddress =
    Port = 0
    Filename =
    Connections = 8
```

Table 14-1 lists and describes the properties required for an IS835C RemoteServer object.

Table 14-1 Prepaid-IS835C RemoteServer Properties

Property	Description
Filename	Name of the shared library provided by the billing server vendor, such as **libprepaid.so**
IPAddress	IP address of the billing server
Port	Port used on the billing server, such as port 66
Connections	Number of threads the prepaid service and billing server can each use (default is 8).

Setting Up an IS835C Prepaid Service

Cisco AR uses a service type **prepaid** to support the prepaid billing solution. The prepaid service mediates between the client NAS and the external prepaid billing server.

Step 1 Use **aregcmd** to add a prepaid service under **/Radius/Services**:

cd /radius/services

add prepaid

```
Added prepaid
```

Step 2 Set the service type to prepaid.

cd prepaid

set type prepaid

```
Set Type prepaid
```

A prepaid service has the following default properties:

```
[ //localhost/Radius/Services/prepaid ]
    Name = prepaid
    Description =
    Type = prepaid
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
```

Step 3 Add a reference to the is835c-prepaid RemoteServer.

cd RemoteServer

add 1 prepaid-is835c

```
Added 1
```

Setting Up Local Authentication

If you use the Cisco AR server for authentication and authorization in your prepaid billing solution, you should configure an AA service. For example, you might configure a service similar to **local-users** (in the example configuration) for authentication and authorization of local users.

If some of the users are non-prepaid users or if the prepaid users need to have RADIUS authorization attributes returned, you should configure an AA service to perform that authentication and authorization.

Step 1 Use **aregcmd** to set up a local authentication service.

cd /radius/services

add Prepaid-LocalAuthentication

```
Added prepaid-LocalAuthentication
```

cd prepaid-LocalAuthentication

```
[ //localhost/Radius/Services/prepaid-LocalAuthentication ]
    Name = prepaid-LocalAuthentication
    Description =
    Type =
```

Step 2 Set the service type to local.

set type local

```
Set Type local
```

Step 3 Set the UserList property to the userlist that contains IS835C prepaid users.

set UserList *userlist_name*

```
Set UserList userlist_name
```

Note You can use an LDAP or ODBC service in place of the local authentication service.

The authentication service must add the Cisco AR internal attribute ***prepaid*** (subattribute 22) to the response upon successful authentication.

Setting Up an Authentication Group Service

Your prepaid billing solution usually requires a group service to tie together an AA service with a prepaid service, a group service to tie together an accounting service with a prepaid service, or both.

If you are using an AA service with your prepaid billing solution, you must configure a group service, for example **prepaid-users**, that ties the requests to the AA service (**local-users** in our example) with the prepaid service.

If you are using Cisco AR for an accounting service with your prepaid billing solution, you must configure a group service, for example **prepaid-file**, that ties accounting requests to both the regular accounting service (**local-file** in our example) and the prepaid service.

Step 1 Use **aregcmd** to add a prepaid authentication group service under **/Radius/Services**.

cd /radius/services

add prepaid-groupAuthentication

```
Added prepaid-groupAuthentication
```

cd prepaid-groupAuthentication

```
[ //localhost/Radius/Services/prepaid-groupAuthentication ]
    Name = group-prepaidAuthentication
    Description =
    Type =
```

Step 2 Set the service type to group.

set type group

```
Set Type group
```

The group service requires the ResultRule to be set to AND, the default setting for a group service.

ls

```
[ //localhost/Radius/Services/group-prepaidAuthentication ]
    Name = group-prepaidAuthentication
    Description =
    Type = group
```

```
IncomingScript~ =
OutgoingScript~ =
ResultRule = AND
GroupServices/
```

Step 3 Change directory to GroupServices and add references to the prepaid service and the authentication service.

cd GroupServices

```
[ //localhost/Radius/Services/group-prepaidAuthentication/GroupServices ]
```

add 1 Prepaid-LocalAuthentication

```
Added 1
```

add 2 prepaid

```
Added 2
```

CRB Prepaid Billing

Cisco Real-Time Billing (CRB) is a Cisco proprietary method of providing prepaid billing service. Cisco AR uses vendor-specific attributes (VSA) to extend the standard RADIUS protocol to carry information not usually present in the standard RADIUS packet. Cisco AR uses a set of VSAs allocated to the Cisco VSA pool [26,9].

Cisco AR required several different types of measurements to support a prepaid billing solution. These measurements require the use of metering variables to perform usage accounting. Table 14-2 lists the different measurements and what the AAA client, Cisco AR server, and billing server do with them.

Table 14-2 Measurements and Component Actions

Measurement Type	Billing Server Action	AAA Server Action	AAA Client Action
Duration	Return duration quota	Convert duration quota to VSAs and pass along	Compare running duration quota with quota returned by Cisco AR server
Total volume	Return volume quota	Convert volume quota to VSAs and pass along	Compare running volume quota with quota returned by Cisco AR server
Uplink volume	Return volume quota	Convert volume quota to VSAs and pass along	Compare running volume quota with quota returned by Cisco AR server

Table 14-2 Measurements and Component Actions (continued)

Measurement Type	Billing Server Action	AAA Server Action	AAA Client Action
Downlink volume	Return volume quota	Convert volume quota to VSAs and pass along	Compare running volume quota with quota returned by Cisco AR server
Total packets	Return packet quota	Convert packet quota to VSAs and pass along	Compare running packet quota with quota returned by Cisco AR server
Uplink packets	Return packet quota	Convert packet quota to VSAs and pass along	Compare running packet quota with quota returned by Cisco AR server
Downlink packets	Return packet quota	Convert packet quota to VSAs and pass along	Compare running packet quota with quota returned by Cisco AR server
Logical OR of two measurements	Return quota of both measurements	Convert both to VSA and pass along	Monitor both quota and issue reauthorization packet when any one trips

Cisco AR provides maximum flexibility to billing servers by allowing the metering variable to be modified as the service is used. This requires network nodes to measure all parameters all the time, but to report values only after receiving a reauthorization request.

Note If you have been using an earlier implementation of CRB prepaid billing (from Cisco AR 3.5.2 or earlier), you must recompile the API implementation with the newer API due to the addition of the parameter ebs_context as the first parameter to all API methods. Contact your Cisco systems engineer for assistance with the new API.

Configuring CRB Prepaid Billing

To configure an CRB prepaid billing service, use the following sections to configure the required Cisco AR objects:

- Setting Up a Prepaid Billing RemoteServer
- Setting Up a CRB Prepaid Service
- Setting Up a Local Accounting Service
- Setting Up a Local Authentication Service
- Setting Up a Prepaid Accounting Group Service
- Setting Up an Authentication Group Service

If you are using CRB prepaid billing with Service Selection Gateway (SSG), you must also configure extension point scripts and prepaid clients. See Configuring CRB Prepaid Billing for SSG, page 14-14.

Setting Up a Prepaid Billing RemoteServer

Step 1 Use **aregcmd** to add a RemoteServer under **/Radius/RemoteServers**.

cd /radius/remoteservers

add prepaid-crb

```
Added prepaid-crb
```

Step 2 Set the RemoteServer protocol to prepaid-crb.

cd prepaid-crb

set protocol prepaid-crb

```
Set Protocol prepaid-crb
```

The following is the default configuration of a prepaid-crb RemoteServer.

```
[ //localhost/Radius/RemoteServers/prepaid-crb ]
    Name = prepaid-crb
    Description =
    Protocol =
    IPAddress =
    Port = 0
    Filename =
    Connections = 8
```

Table 14-3 lists and describes the properties required for an CRB RemoteServer object.

Table 14-3 Prepaid-CRB RemoteServer Properties

Property	Description
Filename	Name of the shared library provided by the billing server vendor, such as **libprepaid.so**
IPAddress	IP address of the billing server
Port	Port used on the billing server, such as port 66
Connections	Number of threads the prepaid service and billing server can each use (default is 8).

Setting Up a CRB Prepaid Service

Cisco AR uses a service type **prepaid** to support the prepaid billing solution. The prepaid service mediates between the client NAS and the external prepaid billing server.

The prepaid service must receive accounting requests to accurately charge the prepaid billing user. You can also set the prepaid service in a group service to log accounting requests locally or to proxy the accounting requests to another service or to both locations.

Step 1 Use **aregcmd** to add a prepaid service under **/Radius/Services**:

cd /radius/services

add prepaid

```
Added prepaid
```

Step 2 Set the service type to prepaid.

cd prepaid

set type prepaid

```
Set Type prepaid
```

A prepaid service has the following default properties:

```
[ //localhost/Radius/Services/prepaid ]
    Name = prepaid
    Description =
    Type = prepaid
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
```

Step 3 Add a reference to the prepaid-crb RemoteServer.

cd RemoteServers

add 1 prepaid-crb

```
Added 1
```

Note The following steps are required only when using Prepaid-CRB with SSG.

Step 4 Set the IncomingScript to **IncomingScript PPI-Parse-Prepaid-Incoming**.

set IncomingScript PPI-Parse-Prepaid-Incoming

```
Set IncomingScript PPI-Parse-Prepaid-Incoming
```

Step 5 Set the OutgoingScript to **OutgoingScript PPO-Parse-Prepaid-Outgoing**.

set OutgoingScript PPO-Parse-Prepaid-Outgoing

```
Set OutgoingScript PPO-Parse-Prepaid-Outgoing
```

Setting Up a Local Accounting Service

If you want to use the Cisco AR server to record the accounting records locally or to forward the accounting records to another RADIUS server, you must configure an accounting service. You might configure a service similar to **local-file** (in the example configuration) for accounting requests. Accounting requests can be logged locally (with an accounting service) or remotely (with a RADIUS service).

If you use the prepaid billing server to generate the accounting records, an accounting service is not necessary.

Step 1 Use **aregcmd** to add a local accounting service under **/Radius/Services**.

cd /radius/services

add prepaid-LocalFileAccounting

```
add prepaid-LocalFileAccounting
```

Step 2 Set the service type to file.

cd prepaid-LocalFileAccounting

set type file

```
Set Type file
```

The file type service has the following properties:

```
[ //localhost/Radius/Services/prepaid-LocalFileAccounting ]
    Name = prepaid-LocalFileAccounting
    Description =
    Type = file
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    FilenamePrefix = accounting
    MaxFileSize = "10 Megabytes"
    MaxFileAge = "1 Day"
    RolloverSchedule =
    UseLocalTimeZone = FALSE
```

Step 3 Set the FilenamePrefix to Prepaid-Accounting.

set FilenamePrefix Prepaid-Accounting

```
Set FilenamePrefix Prepaid-Accounting
```

Step 4 Set the MaxFileAge to one hour.

set MaxFileAge "1 Hour"

```
Set MaxFileAge "1 Hour"
```

The MaxFileSize should remain at the default value of 10 megabytes.

Step 5 Set UseLocalTimeZone to TRUE.

set UseLocalTimeZone TRUE

```
Set UseLocalTimeZone TRUE
```

Setting Up a Local Authentication Service

If you use the Cisco AR server for authentication and authorization in your prepaid billing solution, you should configure an AA service. For example, you might configure a service similar to **local-users** (in the example configuration) for authentication and authorization of local users.

If some of the users are non-prepaid users or if the prepaid users need to have RADIUS authorization attributes returned, you should configure an AA service to perform that authentication and authorization.

If all of the users in a realm are prepaid users and the prepaid billing client does not require normal RADIUS authorization attributes, an AA service is not necessary.

Step 1 Use **aregcmd** to set up a local authentication service.

cd /radius/services

add Prepaid-LocalAuthentication

```
Added prepaid-LocalAuthentication
```

cd prepaid-LocalAuthentication

```
[ //localhost/Radius/Services/prepaid-LocalAuthentication ]
    Name = prepaid-LocalAuthentication
    Description =
    Type =
```

Step 2 Set the service type to local.

set type local

```
Set Type local
```

Step 3 Set the UserList property to the userlist that contains IS835C prepaid users.

set UserList *userlist_name*

```
Set UserList userlist_name
```

Note You can use an LDAP or ODBC service in place of the local authentication service.

Setting Up a Prepaid Accounting Group Service

A prepaid billing solution usually requires a group service to tie together an AA service with a prepaid service, a group service to tie together an accounting service with a prepaid service, or both.

If you are using an AA service with your prepaid billing solution, you must configure a group service, for example **prepaid-users**, that ties the requests to the AA service (**local-users** in our example) with the prepaid service.

If you are using Cisco AR for an accounting service with your prepaid billing solution, you must configure a group service, for example **prepaid-file**, that ties accounting requests to both the regular accounting service (**local-file** in our example) and the prepaid service.

Step 1 Use aregcmd to create an accounting group service under **/Radius/Services**.

cd /radius/services

add Prepaid-Accounting

```
Added prepaid-accounting
```

Step 2 Set the service type to group.

cd prepaid-accounting

```
[ //localhost/Radius/Services/prepaid-accounting ]
    Name = prepaid-accounting
    Description =
    Type =
```

set type group

```
Set Type group
```

The group service has the following properties:

```
[ //localhost/Radius/Services/prepaid-accounting ]
    Name = prepaid-accounting
    Description =
    Type = group
    IncomingScript~ =
    OutgoingScript~ =
    ResultRule = AND
    GroupServices/
```

Step 3 Reference the Prepaid and Prepaid-LocalAccounting services under GroupServices.

cd GroupServices

```
[ //localhost/Radius/Services/prepaid-accounting/GroupServices ]
```

add 1 prepaid

```
Added 1
```

add 2 prepaid-LocalFileAccounting

```
Added 2
```

Setting Up an Authentication Group Service

A prepaid billing solution usually requires a group service to tie together an AA service with a prepaid service, a group service to tie together an accounting service with a prepaid service, or both.

If you are using an AA service with your prepaid billing solution, you must configure a group service, for example **prepaid-users**, that ties the requests to the AA service with the prepaid service.

If you are using Cisco AR for an accounting service with your prepaid billing solution, you must configure a group service, for example **prepaid-file**, that ties accounting requests to both the regular accounting service and the prepaid service.

Step 1 Use **aregcmd** to add a prepaid authentication group service under **/Radius/Services**.

cd /radius/services

add prepaid-groupAuthentication

```
Added group-prepaidAuthentication
```

cd group-prepaidAuthentication

```
[ //localhost/Radius/Services/group-prepaidAuthentication ]
    Name = group-prepaidAuthentication
    Description =
    Type =
```

Step 2 Set the service type to group.

set type group

```
Set Type group
```

The group service requires the ResultRule to be set to AND, the default setting for a group service.

ls

```
[ //localhost/Radius/Services/group-prepaidAuthentication ]
    Name = group-prepaidAuthentication
    Description =
    Type = group
    IncomingScript~ =
    OutgoingScript~ =
    ResultRule = AND
    GroupServices/
```

Step 3 Change directory to GroupServices and add references to the prepaid service and the authentication service.

cd GroupServices

```
[ //localhost/Radius/Services/group-prepaidAuthentication/GroupServices ]
```

add 1 Prepaid-LocalAuthentication

```
Added 1
```

add 2 prepaid

```
Added 2
```

Configuring CRB Prepaid Billing for SSG

In addition to the configuration described in CRB Prepaid Billing, page 14-6, when using CRB-Prepaid billing with SSG, you must also perform the following:

- Setting Up an Outgoing Script
- Setting Up an Incoming Script
- Setting Up a Prepaid Outgoing Script
- Add Prepaid Clients

Setting Up an Outgoing Script

Step 1 Use **aregcmd** to add the **PCO-Parse-Client-Outgoing** outgoing script under **/Radius/Scripts:**

cd /radius/scripts

add PCO-Parse-Client-Outgoing

```
Added PCO-Parse-Client-Outgoing
```

cd PCO-Parse-Client-Outgoing

```
[ //localhost/Radius/Scripts/PCO-Parse-Client-Outgoing ]
    Name = PCO-Parse-Client-Outgoing
    Description =
    Language =
```

Step 2 Set the language to tcl.

set language tcl

```
Set Language tcl
```

Step 3 Set the filename to **PCO-parse.client-outgoing.tcl**.

set filename PCO-parse.client-outgoing.tcl

```
Set Filename PCO-parse.client-outgoing.tcl
```

Step 4 Set the EntryPoint to PCO-parse-client-outgoing.

set EntryPoint PCO-parse-client-outgoing

```
Set EntryPoint PCO-parse-client-outgoing
```

Setting Up an Incoming Script

Step 1 Use **aregcmd** to add the **PPI-Parse-Prepaid-Incoming** script under **/Radius/Scripts**.

cd /radius/scripts

add PPI-Parse-Prepaid-Incoming

Step 2 Set the language to tcl.

cd PPI-Parse-Prepaid-Incoming

set language tcl

```
Set Language tcl
```

Step 3 Set the filename to **PPI-Parse-Prepaid-Incoming.tcl**.

set filename PPI-Parse-Prepaid-Incoming.tcl

```
Set Filename PPI-Parse-Prepaid-Incoming.tcl
```

Step 4 Set the EntryPoint to PPO-Parse-Prepaid-Outgoing.

set EntryPoint PPO-Parse-Prepaid-Outgoing

```
Set EntryPoint PPO-Parse-Prepaid-Outgoing
```

Setting Up a Prepaid Outgoing Script

Step 1 Use **aregcmd** to add the **PPO-Parse-Prepaid-Outgoing** outgoing script under **/Radius/Scripts:**

cd /radius/scripts

Step 2 Add the **PPO-Parse-Prepaid-Outgoing** outgoing script under **/Radius/Scripts**.

cd /radius/scripts

add PPO-Parse-Prepaid-Outgoing

```
Added PPO-Parse-Prepaid-Outgoing
```

Step 3 Set the language to tcl.

cd PPO-Parse-Prepaid-Outgoing

set language tcl

```
Set Language tcl
```

Step 4 Set the filename to **PPO-Parse-Prepaid-Outgoing.tcl**.

set filename PPO-Parse-Prepaid-Outgoing.tcl

```
Set Filename PPO-Parse-Prepaid-Outgoing.tcl
```

Step 5 Set the EntryPoint to PPO-Parse-Prepaid-Outgoing.

set EntryPoint PPO-Parse-Prepaid-Outgoing

```
Set EntryPoint PPO-Parse-Prepaid-Outgoing
```

Add Prepaid Clients

Step 1 Use **aregcmd** to add the prepaid clients under **/Radius/Clients**.

cd /radius/clients

add SSG

A RADIUS client has the following properties:

```
[ //localhost/Radius/Clients/ssg ]
    Name = ssg
    Description =
    IPAddress =
    SharedSecret =
    Type = NAS
    Vendor =
    IncomingScript~ =
    OutgoingScript~ =
    EnableDynamicAuthorization = FALSE
    NetMask =
```

Step 2 Set the IPAddress property to the client IP address.

set IPAddress *aaa.bbb.ccc.ddd*

```
Set IPAddress aaa.bbb.ccc.ddd
```

Step 3 Set the SharedSecret.

set sharedsecret cisco

```
Set SharedSecret cisco
```

Step 4 Set the OutgoingScript to **PCO-Parse-Client-Outgoing**.

set out PCO-Parse-Client-Outgoing

```
Set OutgoingScript PCO-Parse-Client-Outgoing
```

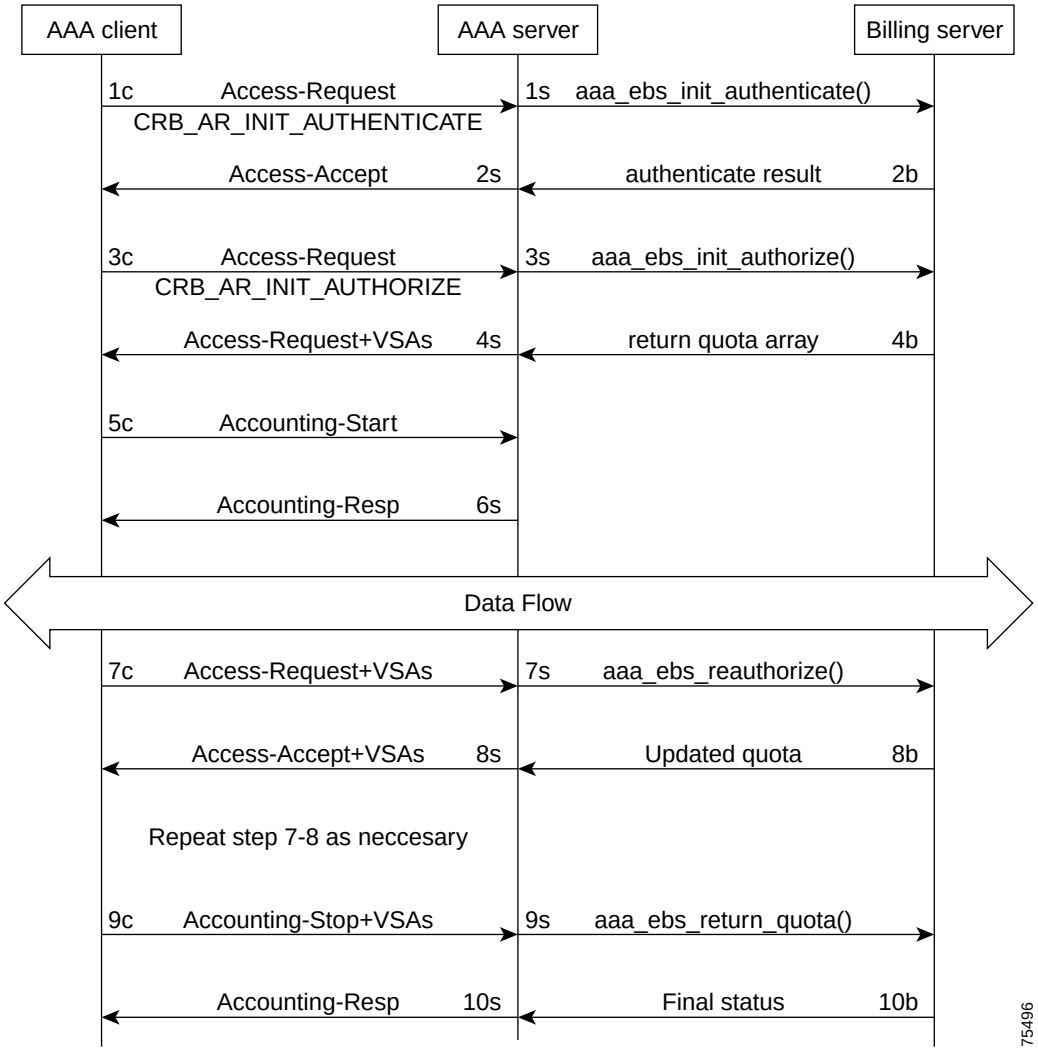
Generic Call Flow

This section describes the generic call flow for the Cisco AR CRB prepaid billing. The call flow is controlled by the AAA client. The Cisco AR server converts VSAs into calls to the billing server.

Note For information about call flows and attributes for IS835C, see IS835C Prepaid Billing, page 14-2.

The packet flows presented in Figure 14-1 are specific to the Cisco AR CRB prepaid billing only. The headlines in the packet flows are general and do represent all data transferred. The letters **c**, **s**, and **b** in Figure 14-1 designate the packet's source of **client**, **server**, or **billing server,** respectively.

Figure 14-1 Generic Call Flow Diagram



Access-Request (Authentication)

Flow 1c shows the client sending the Access-Request to AAA server, part of a normal authentication request. The exact nature of the message contents is dictated by the access technology, be it be CDMA1X-RTT, GPRS, or another. The Access-Request might involve other messages such as PAP/CHAP or another form of authentication.

The **Flow 1c** Access-Request might contain a prepaid specific VSA, CRB_AUTH_REASON. Table 14-4 lists the attributes included in the authentication Access-Request. This tells the Cisco AR server to authenticate the subscriber with the Prepaid server as well. If the value is CRB_AR_INIT_AUTHENTICATE, the initial quota must be obtained for a single service prepaid solution. If this VSA is not present, the Cisco AR server will not authenticate with the Prepaid billing server.

Table 14-4 Attributes Sent During Subscriber Authentication

Attribute Number	Attribute Name	Description	Notes
1	User-Name	APPL: Mobile Node Username	Required
2	NAS IP Address	Accounting Node IP Address	APPL: Required, POA
31	Calling-station-ID	APPL:MSISDN or IMSI	APPL: Conditional
26, 9	CRB_AUTH_REASON CRB_AR_INIT_AUTHENTICATE	Refer to VSA section	Required
26, 9	CRB_USER_ID	APPL:PDSN address or SSG address	APPL: Required, Address of the PDSN
26, 9	CRB_SERVICE_ID	APPL: Service ID such as Simple IP service, Mobile IP service, or VPN service	
26, 9	CRB_SESSION_ID	This VSA contains the session key ID information	Required; the session ID must be globally unique across all clients and across reboots of the client

In **Flow 1s**, the Cisco AR server sends a call to the billing server to authenticate the prepaid user and possibly determine more information about the subscriber's account. The Cisco AR server can be configured to generate this packet flow, using a subscriber profile parameter, if the request is from a prepaid subscriber.

Access-Accept (Authentication)

Flow 2b shows the billing server returning the authentication result. The billing server returns a failure if the prepaid subscriber has an inadequate balance.

Flow 2s shows the Cisco AR server sending the Access-Accept to the AAA client. This message flow contains at least one prepaid billing-specific VSA (listed in Table 14-5) and might contain other access technology-specific attributes.

Table 14-5 Attributes Sent to AAA client in Access-Accept (Authentication)

Attribute Number	Attribute Name	Description	Notes
26, 9	CRB__USER_TYPE CRB_AR_INIT_AUTHENTICATE	Refer to Vendor-Specific Attributes, page 14-23	Optional

Access-Request (Authorization)

In **Flow 3c**, the AAA client sends another Access-Request, this time to authorize the subscriber. Table 14-6 lists the attributes required by the Cisco AR server to authorize the subscriber. The session key ID used must be specified using a prepaid VSA pointing to the RADIUS attribute (standard or VSA).

Table 14-6 Attributes Sent During Subscriber Authorization

Attribute Number	Attribute Name	Description	Notes
1	User-Name	APPL: Mobile Node Username	Required
2	NAS IP Address	Accounting Node IP Address	APPL: Required, POA
31	Calling-station-ID	APPL:MSISDN or IMSI	APPL: Conditional
26, 9	CRB_AUTH_REASON CRB_AR_INIT_AUTHORIZE	Refer to Vendor-Specific Attributes, page 14-23	Required
26, 9	CRB_USER_ID	APPL:PDSN address or SSG address	APPL: Required, Address of the PDSN
26, 9	CRB_SERVICE_ID	APPL: Service ID such as Simple IP service, Mobile IP service, or VPN service	
26, 9	CRB_SESSION_ID	This VSA contains the session key ID information	Required; the session ID must be globally unique across all clients and across reboots of the client

.In **Flow 3s**, the Cisco AR server sends the Prepaid billing server to obtain a quota. The quota might contain several values depending on the number of measurement parameters chosen.

Access-Accept (Authorization)

Flow 4b shows the billing server returning the quota array for the subscriber.

In **Flow 4s**, the Cisco AR server converts the quota array received into VSAs and sends an Access-Accept with the assembled VSAs to the AAA client. Table 14-7 lists the prepaid-specific VSAs that might be included in the Access-Accept response message sent to the AAA client. For more detailed information about the VSAs, refer to Vendor-Specific Attributes, page 14-23.

Table 14-7 Attributes Sent to AAA client in Access-Accept (Authorization)

Attribute Number	Attribute Name
26, 9	CRB_DURATION
26, 9	CRB_TOTAL_VOLUME
26, 9	CRB_UPLINK_VOLUME
26, 9	CRB_DOWNLINK_VOLUME
26, 9	CRB_TOTAL_PACKETS
26, 9	CRB_UPLINK_PACKETS
26, 9	CRB_DOWNLINK_PACKETS

Flows 3c through **4s** are repeated for every service started or restarted by the AAA client.

However, if the return parameters indicate that the authorization is rejected, an Access-Accept message is generated and sent to the client as shown in Table 14-8. When this type of error condition occurs, no other VSA is included in the Access-Accept message.

Table 14-8 Attribute Sent to Report Error Condition to AAA client

Attribute Number	Attribute Name	Description	Notes
26, 9	CRB_TERMINATE_CAUSE	Identifies why a subscriber failed authentication: 1. Exceeded the balance 2. Exceeded the overdraft 3. Bad credit 4. Services suspended 5. Invalid User	Conditional; rejection might be returned with Access-Accept and zero (0) quota

Accounting-Start

In **Flow 5c**, the AAA client sends the Accounting-Start. In **Flow 6s**, the Cisco AR server replies with the Accounting-Response.

Data Flow

At this point, the data transfer begins. The AAA client monitors the subscriber's allocated quotas for metering parameters. A subscriber's Reauthorization request is generated when a quota for at least one of the metering parameters, is depleted.

Access-Request (Quota Depleted)

Flow 7c shows the client sending an Access-Request to the Cisco AR server because at least one quota has been depleted. The Access-Request includes different measurements of how much of the quotas were used in VSA format. This enables the billing server to account for the usage and manage the subscriber's balance before assigning a new quota. Table 14-9 lists the attributes returned to the Cisco AR server:

Table 14-9 Attributes Sent by NAS When Quota Depleted

Attribute Number	Attribute Name	Description	Notes
1	User-Name	APPL: Mobile Node Username	Conditional
2	NAS IP Address	Accounting Node IP Address	APPL: Required, POA address, or Home Node address
31	Calling-station-ID	APPL:MSISDN or IMSI	APPL: Conditional
26, 9	CRB_AUTH_REASON	Refer to VSA	Required
26, 9	CRB_USER_ID	APPL: PDSN address or SSG address	APPL: Required, address of SGSN
26, 9	CRB_DURATION	Refer to Vendor-Specific Attributes, page 14-23	Required
26, 9	CRB_TOTAL_VOLUME		Conditional
26, 9	CRB_UPLINK_VOLUME		
26, 9	CRB_DOWNLINK_VOLUME		
26, 9	CRB_TOTAL_PACKETS		
26, 9	CRB_UPLINK_PACKETS		
26, 9	CRB_DOWNLINK_PACKETS		

Accept-Accept (Quota Depleted)

Flow 7s shows the Cisco AR server returning the used quota array to the billing server. The call includes **aaa_ebs_reauthoriz().** The billing server sends an updated quota array for the next period to the Cisco AR server.

In **Flow 8s**, the Cisco AR server converts the quota array into VSAs and sends them to the AAA client.

Table 14-10 Attributes Sent to AAA Client in Access-Accept (Reauthorization)

Attribute Number	Attribute Name
26, 9	CRB_USER_TYPE
26, 9	CRB_DURATION
26, 9	CRB_TOTAL_VOLUME
26, 9	CRB_UPLINK_VOLUME
26, 9	CRB_DOWNLINK_VOLUME
26, 9	CRB_TOTAL_PACKETS
26, 9	CRB_UPLINK_PACKETS
26, 9	CRB_DOWNLINK_PACKETS

Accounting Stop (Session End)

In **Flow 9c**, the client sends an Accounting-Stop to the Cisco AR server to end the session. The Accounting-Stop message includes an updated quota array with the usage adjustments since the previous authorization in the VSA form.

Table 14-11 lists the attributes included in the Accounting-Stop message set to the Cisco AR server and forwarded to the billing server.

Accounting Response (Final Status)

In **Flow 9s**, the Cisco AR server sends the used quota array to the billing server in an Accounting-Stop message. Any values returned by the billing server in **Flow 10b** are discarded.

Flow 10s shows the Cisco AR server sending final Accounting-Response message to the AAA client.

Table 14-11 Attributes Sent in Accounting-Stop Message

Attribute Number	Attribute Name	Description	Notes
1	User-Name	APPL: Mobile Node Username	Conditional
2	NAS IP Address	Accounting Node IP Address	APPL: Required, POA
31	Calling-station-ID	APPL:MSISDN or IMSI	APPL: Conditional
40, 2	Acct_status_type	Indicates the accounting “Stop” for the service	Required; this value (2) indicates an Accounting-Stop request message
42	Acct-Input-Octets	The number of octets sent by the subscriber; uplink	Required
43	Acc_Output_Octets	The number of octets received by the subscriber; downlink	
46	Acct-Session-Time	Duration of the session	
47	Acct-Input-Packets	Number of packets sent by the subscriber	
48	Acct-Output-Packets	Number of packets received by the subscriber	
49	Acct-Terminate-Cause	This parameter, used for tracking, should remain the same for all accounting requests for a given service.	

Table 14-11 Attributes Sent in Accounting-Stop Message (continued)

Attribute Number	Attribute Name	Description	Notes
26, 9	CRB_DURATION	Refer to Vendor-Specific Attributes, page 14-23	Conditional
26, 9	CRB_TOTAL_VOLUME		
26, 9	CRB_UPLINK_VOLUME		
26, 9	CRB_DOWNLINK_VOLUME		
26, 9	CRB_TOTAL_PACKETS		
26, 9	CRB_UPLINK_PACKETS		
26, 9	CRB_DOWNLINK_PACKETS		
26, 9	CRB_SESSION_ID	Specifies the RADIUS attribute carrying the session ID information	Optional

Vendor-Specific Attributes

Vendor-specific attributes are included in specific RADIUS packets to communicate prepaid user balance information from the Cisco AR server to the AAA client, and actual usage, either interim or total, between the NAS and the Cisco AR Server.

Table 14-12 lists the VSAs that will be defined in the API. Table 14-12 also lists the string to be used with Cisco-AVPair below the VSA.

Note VSAs that start with CRB are used for Cisco Radius Billing prepaid service.

Table 14-12 Vendor-Specific Attributes for the Cisco Prepaid Billing Solution

VSA Name	Type	Source (Call Flow)	Description
CRB_AUTH_REASON crb-auth-reason	Int8	1c, 7c, 7'c	Passed with re-authorization: 1. Initial Authentication 2. Initial Authorization 3. Re-authorization 4. Return Quota 5. Query to EBS
CRB_USER_ID crb-user-id	String	1c, 7c, 7'c	APPL: In PDSN this can be Address of the PDSN.
CRB_SERVICE_ID crb-service-id	String	1c, 7c	Identifies the subscriber's service

Table 14-12 Vendor-Specific Attributes for the Cisco Prepaid Billing Solution (continued)

VSA Name	Type	Source (Call Flow)	Description
CRB_USER_TYPE crb-entity-type	Int8	4s	Type of user: 1. Prepaid user 2. Post-paid with no credit limit 3. Post-paid with credit limit 4. Invalid user The source for this VSA value could be from the Subscriber profile or from the billing server
CRB_DURATION crb-duration	Int32	4s, 8s	Downlink quota received by the AAA client
CRB_TOTAL_VOLUME crb-total-volume			Total Volume quota received by the AAA client
CRB_UPLINK_VOLUME crb-uplink-volume			Uplink volume quota received by the AAA client
CRB_DOWNLINK_VOLUME crb-downlink-volume			Uplink Volume quota received by the AAA client
CRB_TOTAL_PACKETS crb-total-packets			Downlink Packet quota received by the AAA client
CRB_UPLINK_PACKETS crb-uplink-packets			Uplink Packet quota received by the AAA client
CRB_DOWNLINK_PACKETS crb-downlink-packets			Uplink Volume quota received by the AAA client
CRB_SESSION_ID crb-session-id	String		Additional field if session ID is required. This VSA provides the real time billing-specific session ID. This VSA duplicates the contents of the technology-specific session ID or the contents of RADIUS attributes 44 or 50. The NAS can use this VSA to generate a unique session ID. If this VSA is not present, then RADIUS attribute 44 is used instead. If this is a string AV Pair-type attribute, the name is the string attribute name.

Table 14-12 Vendor-Specific Attributes for the Cisco Prepaid Billing Solution (continued)

VSA Name	Type	Source (Call Flow)	Description
CRB_TERMINATE_CAUSE crb-terminate-cause	Int8	4se	Identifies why a subscriber failed authentication: 1. Exceeded the balance 2. Exceeded the overdraft 3. Bad credit 4. Services suspended 5. Invalid User 6. Invalid Password 7. System Error 8. Disabled 9. Expired 10. Valid in Future 11. Used up 12. No Parallel sessions 13. Session Already closed 14. Invalid session
CRB_PRIVATE crb-private	String	n/a	Reserved for future use

Implementing the Prepaid Billing API

A shared library must implement the API functions to perform the various tasks given in the description of each of the function. This needs to be compiled as a shared library and then specified as part of the remote server configuration at the Filename property. See Setting Up a Prepaid Billing RemoteServer, page 14-2 or Setting Up a Prepaid Billing RemoteServer, page 14-8.

At startup, Cisco AR loads the library dynamically and registers the API functions, then calls out the library initialization API once at startup. The call to initialize functions initializes various data structures and connections with the billing server, as required.

Note Cisco works with you to develop the prepaid billing service and implement the API. For more information, contact your Cisco systems engineer.

At various times, according to the call flow described in the Prepaid Call Flow Specification (CRB or IS835C), Cisco AR calls out appropriate API functions present in the shared library. The values for the arguments passed to these API calls are purely derived from the incoming RADIUS packet and Cisco AR does not maintain any dynamic information related to the call flow. It is up to the API function to make use of the information passed to it as C structures to contact the Billing server, get appropriate data, and return the same to Cisco AR using the designated arguments.

Note Please refer to the API specifications for more details pertaining to the arguments and return values of the API.

CHAPTER 15

Using Cisco Access Registrar Server Features

Revised: April 6, 2008, OL-8558-04

This chapter provides information about how to use the following Cisco AR server features:

Incoming Traffic Throttling

Cisco AR 4.1.5 offers two new options you can use to tackle traffic bursts by limiting incoming traffic. In prior releases, a performance issue was detected that was caused by a huge incoming traffic.

You will find two new properties, MaximumIncomingRequestRate and MaximumOutstandingRequests, under **/Radius/Advanced** to limit the incoming traffic.

MaximumIncomingRequestRate

You can use the MaximumIncomingRequestRate property to limit incoming traffic in terms of "allowed requests per second".

For example, if you set the MaximumIncomingRequestRate to *n*, then at any given second, only *n* requests are accepted for processing. In the next second, another *n* requests are accepted regardless of whether the requests accepted earlier are processed or not. This condition serves as a soft limit.

The MaximumIncomingRequestRate property by default is zero (disabled).

MaximumOutstandingRequests

You can use the MaximumOutstandingRequests property to limit incoming traffic in terms of "requests processed".

For example, if you set the MaximumOutstandingRequests to *n*, *n* requests are accepted for processing. Further requests are accepted only after processing some of these requests and sending the replies back. This condition serves as a hard limit.

The MaximumOutstandingRequests property by default is zero (disabled).

Note You can enable either of these properties independent of the other.

You must follow the steps outlined below to configure the MaximumIncomingRequestRate or MaximumOutstandingRequests property:

Step 1 Log in to **aregcmd**.

Step 2 Change directory to **/Radius/Advanced**.

Step 3 Set the MaximumIncomingRequestRate or MaximumOutstandingRequests property to non-zero values.

```
set MaximumIncomingRequestRate n
```

or

```
set MaximumOutstandingRequests n
```

where *n* is any nonzero value.

Step 4 Save the configuration; enter:

```
save
```

Step 5 Reload the server; enter:

```
reload
```

Backing Store Parsing Tool

Cisco AR 4.1.5 offers you a new tool, **carbs.pl**, to analyze the session backing store files. You will find this tool under **/cisco-ar/bin** directory.

Using carbs.pl, you can:

- Get information about the active, stopped, and stale Radius sessions.
- Clear phantom sessions manually.
- Process the binary log files and get information in a user-readable format.

The syntax is:

carbs.pl [-a] [-d <dir>] [-f <logfile>] [-v] [p] [-o <output>] [-h]

-a—All session statistics (active, stale, stopped)

-d—<Directory> Default: .

-f—<Filename> Default: 00*.log

-v—verbose Default: off

-p—Clear phantom sessions

-o—<Filename> Output log to TEXT

-h—Help, usage

Table 15-1 lists the options available with carbs.pl and their description.

Table 15-1 Carbs.pl Options and Description

Option	Description
-d<directory>	Optional. Accepts a directory as parameter with no trailing slash. You can use this option to change the default directory to scan for BackingStore log files. Default is current directory.
-f<logfile>	Optional. Accepts a logfile as parameter with no leading or trailing slashes. You can use this option to change the default log files. Allows you to enter individual logfile name as well as wildcard characters surrounded by single quotes.
-v	Optional. No parameters.You can use this option to get total session count and phantom session count.
-p	Optional. No parameters. Generates a list of phantom sessions. You can usethis option to clear the stale sessions.
-o	Optional. Accepts <output file> as parameter. You can use this option to convert BackingStore log files to readable files and write the results to the output file specified.

Table 15-1 Carbs.pl Options and Description (continued)

Option	Description
-a	Optional. No parameters. You can use this option to print all session statistics, such as per-NAS stale session count, total active sessions, and total stale sessions.
-h	You can use this option to get help with usage of carbs.pl.

Configurable Worker Threads Enhancement

Cisco AR 4.1.4 provides a newly-configurable variable you can use to increase the number of worker threads to handle a greater number of RADIUS packets during peak operating periods. In releases prior to Cisco AR 4.1.3, a latency issue was detected that was caused by the Cisco AR processing a greater number of RADIUS packets than expected during peak operating periods.

The variable, RADIUS_WORKER_THREAD_COUNT, is found in the **arserver** file under **/cisco-ar/bin/arserver** and controls the number of worker threads the Cisco AR server creates. You can increase the number of worker threads to help make more efficient use of the server's CPU.

Note Before you increase the setting for RADIUS_WORKER_THREAD_COUNT , you should be certain that you are running into a worker thread starvation issue. If you use scripts that consume a lot of processing and memory, you might run out of memory if you create too many worker threads.

Increasing the number of worker threads also increases memory utilization.

The default value of RADIUS_WORKER_THREAD_COUNT for servers running a Solaris operating system is 256. The default value for servers running Red Hat Enterprise Linux (RHEL) is 64.

The purpose of this enhancement is to take advantage of spare CPU bandwidth which was not being used in earlier releases of Cisco AR due to a lower number of worker threads. At times, the worker threads would be stuck doing work that took a long time to complete, like running a script. Having more threads will help mitigate these situations and will help improve on the latency created due to lack of free worker threads.

Note Before modifying the RADIUS_WORKER_THREAD_COUNT variable, consult with a TAC representative to ensure that modifying the RADIUS_WORKER_THREAD_COUNT is warranted.

To modify the RADIUS_WORKER_THREAD_COUNT variable:

Step 1 Log in to the Cisco AR server as a root user and change directory to **/cisco-ar/bin**.

Step 2 Use a text editor and open the **arserver** file.

Step 3 Locate the line with the RADIUS_WORKER_THREAD_COUNT variable.

```
#change this to configure number of worker threads
RADIUS_WORKER_THREAD_COUNT=256
```

Step 4 Modify the number of RADIUS worker threads to the number you choose.

Note There is no upper limit to the number of RADIUS worker threads you can enable in your Cisco AR server, but you should take care not to exceed your server's memory capacity.

Step 5 Save the file and restart the Cisco AR server.

Session-Key Lookup

The Session-Key Lookup feature, introduced in Cisco AR 4.1.3, enables you to identify the Session Manager and Session Key of an existing session based on certain attributes associated with that session, such as the Mobile Station Integrated Services Digital Network (MSISDN) number.

The Session-Key Lookup feature required the following enhancements to Cisco AR software:

- Enabling a query service to be invoked for Ascend-IP-Allocate packets
- Enabling the setting of the Session-Key and Session-Manager environment variables by a query operation
- Performing session management after the query operation
- A new environment variable, Set-Session-Mgr-And-Key-Upon-Lookup, which when set to TRUE causes a session-cache Resource Manager to set the Session-Manager and Session-Key environment variables during the query lookup.

The Session-Key Lookup feature is useful in a scenario where an existing session requires an update from an incoming Ascend-IPA-Allocate packet (from a different NAS or device) with modified authorization attributes. Note that this Ascend-IPA-Packet might not have the exact set of attributes as the original packet that created the session. However, the Ascend-IPA-Allocate packet must contain at least one attribute that can uniquely identify the session (such as the MSISDN number) and should contain the same UserName of the original session.

The Session-Key Lookup feature works in tandem with the Radius Query feature, where a Radius Query service is defined with the unique attribute (such as the MSISDN number) as the query-key and is configured to query all session managers. The Query-Service environment variable is set to the defined Radius Query service and the new environment variable (Set-Session-Mgr-And-Key-Upon-Lookup) is set to TRUE for this Ascend-IPA-Allocate packet. This triggers a query operation on all the live sessions. If there is a match, the Session-Manager and Session-Key of that session is used for subsequent session management. During session management, the session cache is updated with the modified authorization attributes.

The Session-Manager OutgoingScript (or any outgoing script that executes after the Session-Manager Outgoing Script) should not reject the packet when doing a Session-Key lookup. Doing so causes the session to be deleted.

Query-Notify

The Query-Notify feature, introduced in Cisco AR 4.1, enables you to store information about Wireless Application Protocol (WAP) gateways that have queried for User Identity-IP Address mapping and send appropriate messages to the WAP gateway when the subscriber logs out of the network.

Cisco AR 4.1.4 has been enhanced to update the session cache with the attribute-value pairs of an interim accounting update packet. This ensures that Cisco AR server provides the most up-to-date information to the WAP gateway during the proxy of interim records or query of the session cache.

Cisco AR 4.1.3 was enhanced to also notify the WAP gateways that have queried a session with Interim accounting update packets. If a WAP gateway does not respond to the Interim accounting update packets, the Cisco AR server times out and retries by notifying the WAP gateways again. If there is no response after all the retries, the proxy packet is deleted and no change is made to the session or the WAP gateway's state in the Cisco AR server. You can configure the number of retries under **/Radius/Clients/notificationproperties**.

The accounting response packet from the Cisco AR server to the GPRS Gateway Support Node (GGSN) is independent of the proxy operation to the WAP gateways. The accounting response packet is sent back immediately without waiting for responses from the WAP gateways.

The Query-Notify feature also enables you to quarantine IP addresses for a configurable amount of time if a WAP gateway does not respond to Accounting-Stop packets sent by the Cisco AR server.

The Cisco AR server stores information about clients (usually the IP address) that queried for particular user information and send RADIUS Accounting-Stop packets to those clients when the Cisco AR server receives the Accounting-Stop packet. There is no intermediate proxy server between the Cisco AR server and the WAP gateway.

To support the Query-Notify feature, the Cisco AR server's *radius-query* service has been modified to also store information like the IP address about the clients queried for cached information. The information is stored in the user session record along with the cached information so it is available after a server reload.

To use the Query-Notify feature, you must make the following configuration changes:

Step 1 Configure the Clients object under **/Radius/Clients**.

Step 2 Set the EnableNotifications property to TRUE.

The EnableNotifications property indicates that a client can receive Accounting-Stop notifications from the Cisco AR server. When EnableNotifications is set to TRUE, a sub-directory named NotificationProperties appears in client object configuration.

Step 3 Configure the properties under the client's NotificationProperties subdirectory.

See Clients, page 4-6, for information about how to configure these properties.

Step 4 Configure a list of attributes to store under **/Radius/Advanced/Attribute Groups/<Notification Group>** where <*notification group*> is the name of an Attribute Group containing a list of attributes to be stored.

Call Flow

This section describes the call flow of the Query-Notify feature.

1. The Cisco AR server caches information from an from Accounting-Start.

This information is usually from a GGSN when a subscriber enters into the network.

2. When a WAP gateway receives a request to authenticate a subscriber, it queries the Cisco AR server using an Access-Request packet to retrieve the cached information for that subscriber.
3. The Cisco AR server responds with Access-Accept if an entry is found for the subscriber in its cache; otherwise the server returns an Access-Reject.

   The Cisco AR server sends an Access-Accept packet to the WAP gateway. The list of attributes sent in this Access-Accept will depends on radius-query service configuration.

Note You use **aregcmd** to configure the attributes for the Access-Accept packet in the AttributesToBeReturned subdirectory under a radius-query service type.

4. If the Cisco AR server finds a cache entry for the subscriber, it checks to see if the EnableNotifications property for that client. If EnableNotifications is set to TRUE, the Cisco AR server stores the client IP address in the subscriber's cache.
5. If the Cisco AR server receives an Accounting-Interim-Update packet from the GGSN, it responds by sending an Accounting-Response packet then sends the Accounting-Interim-Update packets to all the queried clients of the WAP Gateways.

   If the WAP gateway queried clients do not respond to the Accounting-Interim-Update packets, the Cisco AR server times out and retries by notifying the WAP gateways again. If there is no response after all the retries, the proxy packet is deleted and no change is made to the session or the WAP gateway's state in the Cisco AR server. The StaleSessionTimeout property under **/Radius/Advanced** is not applicable for Accounting-Interim-Update packets.
6. When the subscriber logs out of the network, the Cisco AR server receives an Accounting-Stop packet and responds by sending an Accounting-Response back to the client.

   Before releasing the subscriber's session, the Cisco AR server looks for any client IP addresses in the subscriber's cache. If it finds any, the Cisco AR server sends Accounting-Stop packets to those clients with the attributes configured in the NotificationAttributeGroup subdirectory for each client.

   The Cisco AR server forms the attributes with those attributes in the session cache and from the Accounting-Stop packet. The Cisco AR server uses the value configured for the Port property in the NotificationProperties subdirectory as the destination port for the Accounting-Stop packet and uses the client's shared secret.

   The Cisco AR server then waits for Accounting-Response packets from each client to which it has sent Accounting-Stop packets. The Cisco AR server waits for the time interval configured in the InitialTimeout property configured in the NotificationProperties subdirectory before sending another Accounting-Stop packet. If it does not receive an Accounting-Response packet, the Cisco AR server sends additional Accounting-Stop packets until the number of attempts reaches the value configured in the MaxTries property in the NotificationProperties subdirectory.
7. When the Cisco AR server receives an Accounting-Response packet from each client, the server releases the subscriber session.

   If the Cisco AR server does not receive Accounting-Response packets from all clients after the configured time and attempts, the server maintains the subscriber session for the time interval configured in the StaleSessionTimeout property in **/Radius/Advanced** then releases the subscriber session.

The Cisco AR server maintains the subscriber session to address the quarantine IP address requirement. The Cisco AR server must quarantine IP addresses if a WAP gateway does not respond to Accounting-Stop sent by the Cisco AR server. The length of time an IP address is quarantined depends on the value of the InitialTimeOut property under the **NotificationProperties** subdirectory of **/Radius/Clients/*wap_gateway***.

8. If the StaleSessionTimeout property is TRUE for a subscriber session, the Cisco AR server rejects any query requests from clients for this session cache. After the StaleSessionTimeout expires, the Cisco AR server will again send Accounting-Stop to all the clients listed in the session and proceeds to delete this subscriber session regardless of the status of the Accounting-Stop.

Configuration Examples

Note In addition to the following configuration, the StaleSessionTimeout property must be set in **/Radius/Advanced**. This property has a default value of 1 hour.

The following shows an example configuration for a Query-Notify client:

```
[ //localhost/Radius/Clients/wap-gateway1 ]
    Name = wap-gateway1
    Description =
    IPAddress = 10.100.10.1
    SharedSecret = secret
    Type = NAS
    Vendor =
    IncomingScript~ =
    OutgoingScript~ =
    EnableDynamicAuthorization = FALSE
    NetMask =
    EnableNotifications = TRUE
    NotificationProperties/
        Port = 1813
        InitialTimeout = 5000
        MaxTries = 3
        NotificationAttributeGroup = notifyGroup
```

The following shows an example configuration for a Query-Notify AttributeGroup:

```
[ //localhost/Radius/Advanced/AttributeGroups/notifyGroup ]
    Name = notifyGroup
    Description =
    Attributes/
        1. User-Name
        2. Acct-Session-Id
        3. NAS-Identifier
        4. NAS-Port
```

Memory and Performance Impact

Using the Query-Notify feature will have the following effects:

- There will be a memory impact because the Cisco AR server caches IP addresses of clients queried in the session record.
- There will be an impact on performance because the Cisco AR server has to persist the cached IP address information before responding to **radius-query** requests.

Support for Windows Provisioning Service

Cisco AR 4.1 introduces support for Microsoft's Windows Provisioning Service (WPS). WPS provides hotspot users with seamless service to public WLAN hotspots by using Microsoft Windows-based clients. The Microsoft WPS solution requires Microsoft-based software in the data center for the RADIUS server and the provisioning server.

Call Flow

The following is the WPS process and Wireless Internet Service Provider (WISP) packet sequence for a new wireless client login at a Wi-Fi hotspot location.

1. The client discovers the WISP network at a Wi-Fi hotspot.
2. The client authenticates as guest (with null username and credentials) to the Cisco AR server.
3. The client is provisioned and a new account is created.
4. The client is authenticated using the new account credentials and accesses the Internet.

The Cisco AR server performs the following functions during WPS:

1. Detects the guest subscriber login from the null username and null credentials during PEAPv0 (MS-PEAP) authentication.
2. Grants a successful login and returns a *sign-up* URL of the provisioning server as a PEAP-Type-Length-Value (TLV) in the next Access-Challenge Packet.

   The following is an example value for the URL PEAP-TLV:

   http://www.example.com/provisioning/master.xml#sign up

   Where *#sign up* is the parameter for this action and is a required element of the value.

   The sign-up URL value is passed when the user authenticates as guest. The sign-up URL is a fragment within the Master URL. You can also configure other fragments to be returned in the Master URL. See Master URL Fragments, page 15-11, for more information about the different fragments.
3. Sends a VLAN-ID or IP filter (or both) in the final Access-Accept packet to restrict the guest user's accessibility to only the Provisioning server.
4. Authenticates using the user configuration in the user database after the client is provisioned and a new account is created.

Example Configuration

The following shows an example configuration for the WPS feature:

```
[ //localhost/Radius/Services/peapv0 ]
    Name = peapv0
    Description =
    Type = peap-v0
    IncomingScript~ =
    OutgoingScript~ =
    MaximumMessageSize = 1024
    PrivateKeyPassword = <password>
    ServerCertificateFile = <path_to_ServerCertificateFile>
    ServerRSAKeyFile = <path_to_ServerRSAKeyFile>
    CACertificateFile = <path_to_CACertificateFile>
    CACertificatePath =<path_to_CACertificatePath>
    ClientVerificationMode = Optional
    VerificationDepth = 4
    EnableSessionCache = True
    SessionTimeout = "5 Minutes"
    AuthenticationTimeout = 120
    TunnelService = eap-mschapv2
    EnableWPS = True
    MasterURL = http://www.example.com/provisioning/master.xml
    WPSGuestUserProfile = WPS-Guest-User-Profile
```

When you set the EnableWPS property to TRUE, you must provide values for the properties MasterURL and WPSGuestUserProfile. See New Environment Variables for more information.

New Environment Variables

Cisco AR 4.1 adds two environment variables to support WPS:

- Send-PEAP-URI-TLV
- Master-URL-Fragment

Send-PEAP-URI-TLV

Send-PEAP-URI-TLV is a Boolean value and provides a way in which the authenticating user service can let the PEAP-V0 service know to send the URI PEAP-TLV along. Under different circumstances Cisco AR might send back different fragments within the MasterURL to the client, as described above.

The conditions under which this has to be sent is best known to the user authentication service (the service that is specified within the eap-mschapv2 service, which in turn is the tunnel service for PEAP-V0 service). So when it decides that it needs to send back the URL it can set this variable to TRUE. The default value for this is FALSE.

Master-URL-Fragment

The Cisco AR authenticating user service uses Master-URL-Fragment to set the fragment within the Master URL that needs to be sent back. The Cisco AR user authentication service sets the fragment to different values under different circumstances. While the Send-PEAP-URL-TLV indicates whether to send the URL or not, Master-URL-Fragment is used to intimate which fragment within the URL needs to be sent. If this variable is not set and if it is required to send the URL, '#signup' will be sent by default.

Master URL Fragments

This section describes the different fragments the RADIUS server might send to the AP in the Master URL.

Sign up

This value is passed when the user authenticates as guest. The following is an example value for the URL PEAP-TLV:

http://www.example.com/provisioning/master.xml#sign up

where #sign up is the parameter for this action and a required element of the value.

Renewal

This value is passed when the user's account is expired and needs renewal before network access can be granted. The following is an example value for the URL PEAP-TLV:

http://www.example.com/provisioning/master.xml#renewal

where #renewal is the parameter for this action and a required element of the value.

Password change

This value is passed when the user is required to change the account password. An example value for the URL PEAP-TLV is:

http://www.example.com/provisioning/master.xml#passwordchange

where #passwordchange is the parameter for this action and a required element of the value.

Force update

This value is passed when the WISP requires the Wireless Provisioning Services on the client to download an updated XML master file. This method of updating the XML master file on the client should be used only to correct errors; otherwise, the TTL expiry time in the XML master file is used to provide background updates. The following is an example value for the URL PEAP-TLV:

http://www.example.com/provisioning/master.xml#forceupdate

where #forceupdate is the parameter for this action and a required element of the value.

Unsupported Features

The following features are part of the Microsoft WPS functionality, but are not supported in the Cisco AR 4.1 release.

Account Expiration and Renewal

When the user creates an account and logs in with that account, the RADIUS server authenticates and authorizes the request and sends back an Access-Accept with a Session-Timeout attribute. The Access Point (AP) then forces the wireless client to reauthenticate for every timeout value. When there is one timeout duration left in the user account, the RADIUS server needs to send back a *renewal* URL (a URL fragment within the master URL) to the client for the user to renew the account.

Cisco AR does not support this feature because the interface the Cisco AR server has with the AD (through the CiscoSecure Remote Agent) does not have provisions to get the expiration information of user account. However, this release does provide an environment variable to copy the URL fragment and to control whether or not to send the URL using another environment variable. This can be used to send the renewal URL. There are some limitations, however.

Password Changing and Force Update

The Password Changing option is passed when the user is required to change the account password. Force Update option is passed when the WISP requires the Wireless Provisioning Services on the client to download an updated XML master file.

These functions are not possible in this release for the same reason mentioned above, the loose coupling between Cisco AR and the AD. Additionally, there is no known use case for this. As mentioned above, you can use the newly added environment variables to trigger these options.

Command Completion

Cisco AR's command completion feature provides online help by listing possible entries to the current command line when you press the Tab key after entering a partial command. The Cisco AR 4.1 server responds based on:

- The location of the cursor including the current directory
- Any data you have entered on the command line prior to pressing the Tab key

The command completion feature emulates the behavior of Cisco IOS and Kermit. When you press the Tab key after entering part of a command, the Cisco AR server provides any identifiable object and property names. For example, after you first issue **aregcmd** and log in to Cisco AR, enter the following:

cd <*Tab*>

```
Administrators/  Radius/
```

Pressing the Tab key consecutively displays possible context-sensitive choices.

In the following example, after changing directory to **/Radius/services/local-file** an administrator wants to see the possible types of authentication services that can set.

cd /Radius/services/local-file

```
//localhost/Radius/Services/local-file ]
    Name = local-file
    Description =
    Type = file
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    FilenamePrefix = accounting
    MaxFileSize = "10 Megabytes"
    MaxFileAge = "1 Day"
    RolloverSchedule =
```

set type <*Tab*>

```
eap-leap        file            local           radius-session
eap-md5         group           odbc            rex
eap-sim         ldap            radius          tacacs-udp
```

Values can also be tab-completed. For example, if you decide to set the local-file service's type to file, you can do the following:

set type f<*Tab*>

and the command line completes to:

set type file

Service Grouping Feature

The Service Grouping feature enables you to specify multiple services (called *subservices*) to be used with authentication, authorization, or accounting requests. The general purpose is to enable multiple Remote Servers to process requests.

Perhaps the most common use of this feature will be to send accounting requests to multiple Remote Servers thus creating multiple accounting logs. Another common use might be to authenticate from more than one Remote Server where, perhaps the first attempt is rejected, other Remote Servers can be attempted and an Access-Accept obtained.

Clearly, in the accounting request example, each request must be successfully processed by each subservice in order for the originator of the accounting request to receive a response. This is known as a ***logical AND*** of each of the subservice results. In the authenticate example, the first subservice which responds with an accept is returned to the client or if all subservices respond with ***reject***, then a reject is returned to the client. This is known as a ***logical OR*** of each of the subservice results.

A Service is specified as a Group Service by setting its type to ***group***, specifying the ResultRule (AND or OR) and specifying one or more subservices in the GroupServices subdirectory. The subservices are called in numbered order and as such are in an indexed list similar to Remote Server specification in a radius Service. Incoming and outgoing scripts for the Group Service can be optionally specified.

A subservice is any configured non-Group Service. When a Group Service is used, each subservice is called in exactly the same manner as when used alone (such as if specified as the DefaultAuthenticationService). Incoming and Outgoing scripts are executed if configured and Outage Policies are honored.

Configuration Example - AccountingGroupService

The following example shows how to configure an accounting Group Service to deliver accounting requests to multiple Remote Servers.

Step 1 The first task is to set up the subservices which are to be part of the AccountingGroupService. Since subservices are merely configured Services which have been included in a service group, you need only define two new Services.

For this example, we will define two new radius Services called ***OurAccountingService*** and ***TheirAccountingService***. A provider might want to maintain duplicate accounting logs in parallel with their bulk customer's accounting logs.

Step 2 Change directory to **/radius/services.** At the command line, enter the following:

cd /radius/services

```
[ //localhost/Radius/Services ]
    Entries 1 to 2 from 2 total entries
    Current filter: <all>
    local-file/
    local-users/
```

Step 3 At the command line, enter the following:

add OurAccountingService

add TheirAccountingService

The configuration of these Services is very similar to stand-alone Radius accounting service. Step-by-step configuration instructions are not provided, but the complete configuration is shown below:

```
[ //localhost/Radius/Services/OurAccountingService ]
    Name = OurAccountingService
    Description =
    Type = radius
    IncomingScript = OurAccountingInScript
    OutgoingScript = OurAccountingOutScript
    OutagePolicy = RejectAll
    OutageScript =
    MultipleServersPolicy = Failover
    RemoteServers/
        1. OurPrimaryServer
        2. OurSecondaryServer

[ //localhost/Radius/Services/TheirAccountingService ]
    Name = TheirAccountingService
    Description =
    Type = radius
    IncomingScript = TheirAccountingInScript
    OutgoingScript = TheirAccountingOutScript
    OutagePolicy = RejectAll
    OutageScript =
    MultipleServersPolicy = Failover
    RemoteServers/
        1. TheirPrimaryServer
        2. TheirSecondaryServer
```

The next step is to create the new **AccountingGroupService**. The purpose of this Service is to process Accounting requests through both OurAccountingService and TheirAccountingService.

Step 4 At the command line, enter the following:

add AccountingGroupService

```
Added AccountingGroupService
```

cd AccountingGroupService

```
[ //localhost/Radius/Services/AccountingGroupService ]
    Name = AccountingGroupService
    Description =
    Type =
    IncomingScript =
    OutgoingScript =
```

set type group

```
Set Type group
```

Step 5 Set the ResultRule to ***AND*** to ensure that both services process the accounting request successfully.

set ResultRule AND

```
Set ResultRule AND
```

ls

```
[ //localhost/Radius/Services/AccountingGroupService ]
    Name = AccountingGroupService
    Description =
    Type = group
    IncomingScript =
    OutgoingScript =
    ResultRule = AND
    GroupServices/
```

set IncomingScript AcctGroupSvcInScript

set OutgoingScript AcctGroupSvcOutScript

Now we must add the Services we created OurAccountingService and TheirAccountingService as subservices of the Group Service.

Step 6 At the command line, enter the following:

cd GroupServices

```
[ //localhost/Radius/Services/AccountingGroupService/GroupServices ]
```

set 1 OurAccountingService

```
Set 1 OurAccountingService
```

Set 2 TheirAccountingService

```
Set 2 TheirAccountingService
```

ls

```
[ //localhost/Radius/Services/AccountingGroupService ]
    Name = AccountingGroupService
    Description =
    Type = group
    IncomingScript = AcctGroupSvcInScript
    OutgoingScript = AcctGroupSvcOutScript
    ResultRule = AND
    GroupServices/
        1. OurAccountingService
        2. TheirAccountingService
```

This completes the setup of the AccountingGroupService. To use this Service simply set it as the DefaultAccountingService and/or configure a policy/rule set which will select this Service. Essentially, this can be used in the same manner as any other stand-alone service.

Summary of Events

The following describes the flow of what happens when a client sends an accounting request which is processed by the AccountingGroupService:

1. ActGroupSvcInScript is executed.
2. OurAccountingService is called.
3. OurAccountingService's Incoming Script, OurAccountingInScript is called.
4. The request is sent to the Remote Server OurPrimaryServer and/or OurSecondaryServer, if necessary.
5. If a response is not received, because we used the **AND** ResultRule, the request failed and no response is sent to the client and the request is dropped. If a response is received, then the process continues.
6. OurAccountingService's Outgoing Script, OurAccountingOutScript is called.
7. TheirAccountingService is called.
8. TheirAccountingService's Incoming Script, TheirAccountingInScript is called.
9. The request is sent to the Remote Server TheirPrimaryServer and/or TheirSecondaryServer, if necessary.
10. If a response is not received, because we used the **AND** ResultRule, the request failed and no response is sent to the client and the request is dropped. If a response is received, then the process continues.
11. TheirAccountingService's Outgoing Script, TheirAccountingOutScript is called.
12. AcctGroupSvcOutScript is executed.
13. Standard processing continues.

Configuration Example 2 - AuthenticationGroupService

In this example, we will configure a Group Service for the purposes of providing alternate Remote Servers for a single authentication. Simply put, if Service A rejects the request, try Service B.

Step 1 The first task is to set up the subservices which are to be part of the AuthenticationGroupService. Since subservices are merely configured Services which have been included in a service group, we will simply define two new Services. For simplicity, we will define two new radius Services called AuthenticationServiceA and AuthenticationServiceB.

Step 2 At the command line, enter the following:

cd /radius/services

```
[ //localhost/Radius/Services ]
```

```
Entries 1 to 2 from 2 total entries
Current filter: <all>
local-file/
local-users/
```

add AuthenticationServiceA

add AuthenticationServiceB

Step 3 The configuration of these Services is very similar to stand-alone Radius authentication service. Step-by-step configuration instructions are not provided, but the complete configuration is shown below:

```
[ //localhost/Radius/Services/AuthenticationServiceA ]
    Name = AuthentictionServiceA
    Description =
    Type = radius
    IncomingScript = AuthAInScript
    OutgoingScript = AuthAOutScript
    OutagePolicy = RejectAll
    OutageScript = AuthAOutageScript
    MultipleServersPolicy = Failover
    RemoteServers/
      1. PrimaryServerA
      2. SecondaryServerA

[ //localhost/Radius/Services/AuthenticationServiceB ]
    Name = AuthentictionServiceB
    Description =
    Type = radius
    IncomingScript = AuthBInScript
    OutgoingScript = AuthBOutScript
    OutagePolicy = RejectAll
    OutageScript = AuthBOutageScript
    MultipleServersPolicy = Failover
    RemoteServers/
      1. PrimaryServerB
      2. SecondaryServerB
```

The next step is to create the new "AuthenticationGroupService". The purpose of this Service is to process authentication requests through both AuthenticationServiceA and AuthenticationServiceB if AuthenticationServiceA rejects the request.

Step 4 At the command line, enter the following:

add AuthenticationGroupService

```
Added AuthenticationGroupService
```

cd AuthenticationGroupService

```
[ //localhost/Radius/Services/AuthenticationGroupService ]
    Name = AuthenticationGroupService
    Description =
    Type =
    IncomingScript =
    OutgoingScript =
```

set type group

```
    Set Type group
```

Next set the ResultRule to **OR** because we want to ensure that if the first subservice rejects the request, we then try the second subservice. If the second subservice rejects the request, then the response to the client is a reject.

Step 5 At the command line, enter the following:

set ResultRule OR

```
    Set ResultRule OR
```

Set IncomingScript AuthGroupSvcInScript

```
    Set OutgoingScript AuthGroupSvcOutScript
```

Set IncomingScript AuthGroupSvcInScript

```
    Set OutgoingScript AuthGroupSvcOutScript
```

ls

```
    [ //localhost/Radius/Services/AuthenticationGroupService ]
        Name = AuthenticationGroupService
        Description =
        Type = group
        IncomingScript = AuthGroupSvcInScript
        OutgoingScript = AuthGroupSvcOutScript
        ResultRule = OR
        GroupServices/
```

Now we must add the services we created "AuthenticationServiceA" and "AuthenticationServiceB" as subservices of the Group Service.

Step 6 At the command line, enter the following:

cd GroupServices

```
    [ //localhost/Radius/Services/AuthenticationGroupService/GroupServices ]
```

set 1 AuthenticationServiceA

```
Set 1 AuthenticationServiceA
```

Set 2 AuthenticationServiceB

```
Set 2 AuthenticationServiceB
```

ls

```
[ //localhost/Radius/Services/AuthenticationGroupService ]
    Name = AuthenticationGroupService
    Description =
    Type = group
    IncomingScript = AuthGroupSvcInScript
    OutgoingScript = AuthGroupSvcOutScript
    ResultRule = OR
    GroupServices/
        1.  AuthenticationServiceA
        2.  AuthenticationServiceB
```

This completes the setup of the AuthenticationGroupService. To use this Service simply set it as the DefaultAuthenticationService and/or configure a policy/rule set which will select this Service. Essentially, this can be used in the same manner as any other stand-alone Service.

Summary of Events

The following describes the flow of what happens when a client sends an Authentication request which is processed by the AuthenticationGroupService:

1. AuthGroupSvcInScript is executed.
2. AuthenticationServiceA is called.
3. AuthenticationServiceA's Incoming Script, AuthAInScript is called.
4. If the response is a reject or the request is dropped (due to an Outage Policy):
   a. AuthenticationServiceA's Outgoing Script, AuthAOutScript is called.
   b. Processing continues with the next service.
5. If the response is an Accept:
   a. AuthenticationServiceA's Outgoing Script, AuthAOutScript is called.
   b. Skip to step 9.
6. AuthenticationServiceB is called.
7. AuthenticationServiceB's Incoming Script, AuthBInScript is called.
8. Since this is the last subservice in our Group Service:
   a. AuthenticationServiceB's Outgoing Script, AuthBOutScript is called.

   b. Regardless of whether the request is Accepted or Rejected, processing will continue at step 9.

9. AuthGroupSvcOutScript is executed.
10. Standard processing continues.

SHA-1 Support for LDAP-Based Authentication

The Cisco AR server supports secure hash algorithm (SHA-1) for LDAP-based authentication. This feature enables the Cisco AR server to authenticate users whose passwords are stored in LDAP servers and hashed using the SHA-1 encoding scheme.

SHA-1 support actually adds functionality for the following three features to Cisco AR:

- Authentication of PAP access requests against an LDAP user entry that uses the SHA-algorithm to the hash password attribute
- Authentication of PAP access requests against an LDAP user entry that uses the SSHA algorithm to hash the password attribute
- Configuration of the Cisco AR server to dynamically determine how password attributes retrieved from LDAP are encrypted and process them accordingly

This enhancement is 100% backwards compatible. All previously supported values for the PasswordEncryptionStyle property are still supported and still provide the same behavior. The only noticeable change is that **dynamic** is now the default value for the PasswordEncryptionStyle property.

Remote LDAP Server Password Encryption

Prior to Cisco AR 1.7, the **PasswordEncryptionStyle** property on a Remote LDAP Server was limited to two values, none and crypt. SHA-1 supports adds three additional values for the PasswordEncryptionStyle property. Table 15-2 lists the valid values for this property and describes the corresponding behavior.

Table 15-2 Remote LDAP Server Password Encryption Style Values

PasswordEncryptionStyle	Access Registrar Behavior
none	All passwords retrieved from this LDAP server are assumed to be returned to Cisco AR as clear text. (There is no change in this functionality.)
crypt	All passwords retrieved from this LDAP server are assumed to be returned to Cisco AR as passwords encrypted using the UNIX *crypt* algorithm. (There is no change in this functionality.) Passwords can be preceded by the {crypt} prefix, which is stripped before comparing passwords.
SHA-1	All passwords retrieved from this LDAP server are assumed to be returned to Cisco AR as a Base64-encoded version of the user's password after it has been hashes using the SHA-1 mechanism (as defined by Netscape). Passwords can be preceded by the {sha} prefix, which is stripped before comparing passwords.

Table 15-2 Remote LDAP Server Password Encryption Style Values (continued)

PasswordEncryptionStyle	Access Registrar Behavior
SSHA-1	All passwords retrieved from this LDAP server are assumed to be encrypted/hashed using the SSHA mechanism (as defined by Netscape). Passwords can be preceded by the {ssha} prefix, which is stripped before comparing passwords. **Note** This is a Netscape/iPlanet-specific mechanism.
dynamic	The value instructs Cisco AR to choose the encryption mechanism on a case-by-case basis after it determines the presence of a known prefix, which the LDAP server prepends to the value of the password attribute. For example, if the following was returned from an LDAP server as a password attribute:{SHA}qZk+NkcGgWq6PiVxeFDCbJzQ2J0=, the password would be processed using the SHA-1 mechanism. This value will be the new default for the PasswordEncryptionStyle property.

Dynamic Password Encryption

When using the dynamic setting for the PasswordEncryptionStyle property on a Remote LDAP Server, the Cisco AR server looks for the prefixes listed in Table 15-3 to determine if encryption or a hash algorithm should be used during password comparison.

Note Password prefixes are not case sensitive.

Table 15-3 Remote LDAP Server Password Prefix Values

Password Prefix	Encryption/Hash Algorithm Used
none	None; when no known prefix is found, the password attribute is assumed to be in clear text.
{crypt}	UNIX crypt algorithm
{sha}	Secure Hash Algorithm, version 1 (SHA-1)
{ssha}	SSHA-1, as defined by Netscape.

The default value for the PasswordEncryptionStyle property on a Remote LDAP Server is **dynamic**.

Note Using the *dynamic* setting for the PasswordEncryptionStyle property will require a bit more processing for each password comparison. When using dynamic, the Cisco AR server must examine each password for a known prefix. This should have no visible impact on performance.

Logs

Turn on **trace** to level 4 to indicate (via the trace log) which password comparison method is being used.

Dynamic Attributes

Cisco AR 1.6 supports dynamic values for the configuration object properties listed below. Previous releases of Cisco AR only handles static values for all the object properties.

Dynamic attributes are similar to UNIX shell variables. With dynamic attributes, the value is evaluated at run time. All of the objects that support dynamic attributes will have validation turned off in **aregcmd**.

Object Properties with Dynamic Support

The following object properties support dynamic values:

Radius

DefaultAuthenticationService

DefaultAuthorizationService

DefaultAccountingService

DefaultSessionManager

IncomingScript

OutgoingScript

Note Do not use the following environment variables:
Accounting-Service for the **/Radius/DefaultAccountingService**,
Authentication-Service for the **/Radius/DefaultAuthenticationService**, or
Authorization-Service for the **/Radius/DefaultAuthorizationService**
User-Profile for the **BaseProfile**, User-Group for the **Group**, User-Authorization for the **AuthorizationScript**, Session-Manager for the **DefaultSessionManager**, or Session-Service for the **DefaultSessionService**.

/Radius/Clients

client1/

IncomingScript

OutgoingScript

/Radius/Userlist/Default

user1/

Group

BaseProfile

AuthenticationScript

AuthorizationScript

/Radius/UserGroup

Group1/

BaseProfile

AuthenticationScript

AuthorizationScript

/Radius/Vendor

Vendor1/

IncomingScript

OutgoingScript

/Radius/Service

Service1/

IncomingScript

OutgoingScript

OutageScript

OutagePolicy

/Radius/RemoteServers

remoteserver1/

IncomingScript

OutgoingScript

Remoteldapserver1/

Searchpath

Filter

Note To differentiate the properties that support dynamic attributes, we place a tilde (~) after each property, as in IncomingScript~. However, when the Cisco AR administrator is required to set values for those properties, continue to use the original property name, such as set IncomingScript ${elrealm}{Test}. The tilde is only for visual effect, and including the tilde will generate an error ("310 command Failed.")

Dynamic Attribute Format

The format of the dynamic attribute is:

${eqplattribute-name}{default-name}

where **e** stands for environment dictionary, **q** stands for request dictionary and **p** stands for response dictionary. You can use e, q and p in any order. The attribute name is the name for the attribute from environment dictionary, request dictionary, or response dictionary.

For example,

```
/Radius
DefaultAuthenticationService = ${eq|realm}{local-users}
```

The default Authentication Service is determined at run time. Cisco AR first checks to see if there is one value of ***realm*** in the environment dictionary. If there is, it becomes the value of DefaultAuthenticationService. If there is not, check the value of realm in the request dictionary. If there is one value, it becomes the value of DefaultAuthenticationService. Otherwise, local-users is the DefaultAuthenticationService. If we don't set local-users as the default value, the DefaultAuthenticationService is *null*. The same concept applies to all other attribute properties.

The validation for the dynamic values of the object property will only validate the default value. In the above example, Cisco AR will do validation to check whether local-users is one of services defined in the service subdirectory.

Note When setting specific property values, do not use the tilde (~) in the property name. Doing so generates a *310 Command Failed* error.

Tunneling Support Feature

Tunneling support is strictly based upon the IETF RFC: "RADIUS Attributes for Tunnel Protocol Support" (**http://www.ietf.org/rfc/rfc2868.txt**).

Table 15-4 lists the tunneling attributes supported in this Cisco AR release.

Table 15-4 Tunneling Attributes Supported by Cisco AR

Attribute Number	Attribute
64	Tunnel-Type
65	Tunnel-Medium-Type
66	Tunnel-Client-Endpoint
67	Tunnel-Server-Endpoint
69	Tunnel-Password
81	Tunnel-Private-Group-ID
82	Tunnel-Assignment-ID
83	Tunnel-Preference
90	Tunnel-Client-Auth-ID
91	Tunnel-Server-Auth-ID

The tunneling attribute has the following format:

(1 byte)	(1 byte)	(1 byte)	(variable number of bytes)
Type	Length	Tag	Value

Configuration

1. Configure the tag attributes as untagged attributes under the **/Radius/Advanced/Attribute Dictionary** directory (for example, **Tunnel-Type**).
2. Attach the "**_tag**" tag to these attributes when configuring the attributes under all of the other directories as tagged attributes (for example, **Tunnel-Type_tag10** under the **/Radius/Profiles/test** directory). Without the tag number, the default value is (**_tag = _tag0**).

Example

```
/Radius/Advanced/Attribute Dictionary
      /Tunnel-Client-ID
            Name = Tunnel-Client-Endpoint
```

```
            Description =
            Attribute = 66
            Type = STRING
               Min = 0
               Max = 253

/Radius/Profiles/test
            Name = test
            Description =
            /Attributes
                Tunnel-Client-Endpoint_tag3 = "129.56.123.1"
```

Notes

1. "**_tag**" is reserved for the tunneling attributes. No other attributes should include this suffix.
2. The tag number value can range from 0 through 31.

Validation

The Cisco AR server checks whether the tag attributes are defined under the **/Radius/Advanced/Attribute Dictionary** directory. The server also checks whether the tag number falls within the range (0-31).

xDSL VPI/VCI Support for Cisco 6400

To provide this support, a distinction must be made between device authentication packets and regular user authentication packets.

Using User-Name/User-Password for Each Cisco 6400 Device

This approach assumes that for every 6400 NAS, a device-name/device-password is created for each. Following are the required changes:

For each NAS in Cisco AR:

```
Name = test6400-1
     Description =
     IPAddress = 209.165.200.224
     SharedSecret = secret
     Type = NAS
     Vendor =
     IncomingScript =
     OutgoingScript =
     Device-Name = theDevice
     Device-Password = thePassword
```

When the 6400 sends out the device authentication packet, it might have different **User-Name/User-Password** attributes for each 6400 NAS. When Cisco AR receives the packet, it tries to obtain the **Device-Name/Device-Password** attributes from the NAS entry in the Cisco AR configuration database. When the **User-Name/User-Password** in the packet match the configured

Device-Name/Device-Password attribute values, Cisco AR assumes that it must get the device. The next step is to replace the **User-Name** attribute with the concatenated <*module*>/<*slot*>/<*port*> string. From this point, the packet is treated as a regular packet.

Note A user record with the name of the concatenated string must be created.

Format of the New User-Name Attribute

After the device is identified, the **User-Name** attribute is replaced with the new value. This new value is the concatenation of 6400 <*module*>/<*slot*>/<*port*> information from the NAS-Port attribute and the packet is treated as a regular user authentication from this point on.

Note This format only supports NAS Port Format D. Refer to Cisco IOS documentation for more information about NAS port formats.

The format of the new **User-Name** attribute is the **printf** of "%s-%d-%d-%d-%d" for the following values:

NAS-IP—in dot format of the **NAS-Ip-Address** attribute. For example, `10.10.10.10`.

slot—apply mask `0xF0000000` on **NAS-Port** attribute and shift right 28 bits. For example, **NAS-Port** is `0x10000000`, the slot value is `1`.

module—apply mask `0x08000000` on **NAS-Port** attribute and shift right 27 bits. For example, **NAS-Port** is `0x08000000`, the module value is `1`.

port—apply mask `0x07000000` on **NAS-Port** attribute and shift right 24 bits. For example, **NAS-Port** is `0x06000000`, the port value is `6`.

VPI—apply mask `0x00FF0000` on **NAS-Port** attribute and shift right 16 bits. For example, **NAS-Port** is `0x00110000`, the VPI value is `3`.

VCI—apply mask `0x0000FFFF` on **NAS-Port** attribute. For example, **NAS-Port** is `0x00001001`, the VCI value is `9`.

Apply Profile in Cisco AR Database to Directory Users

You can define the **User-Profile** and **User-Group** environment variables in the directory mapping and Cisco AR will apply the profiles defined in the Cisco AR database to each directory user having any of these two variables set.

User-Profile

This attribute is of type string with the format:

<*Value1*>::<*Value2*> …

The **User-Profile** attribute is intended to hold a list of profile names. <*Value1*> and <*Value2*> represent the names of the profiles. They are separated by the "::" character, therefore, the "::" can not be part of the profile name. The order of values in the string has significance, as the profiles are evaluated from left to right. In this example, profile <*Value2*> is applied after profile <*Value1*>.

Assume the user record has a field called `UserProfile` that holds the name of the profile that applies to this user. This field is mapped to the environment attribute **User-Profile**. Following is how the mapping is done with **aregcmd**:

```
QuickExample/
     Name = QuickExample
     Description =
     Protocol = ldap
     IPAddress = 209.165.200.224
     Port = 389
     ReactivateTimerInterval = 300000
     Timeout = 15
     HostName = QuickExample.company.com
     BindName =
     BindPassword =
     UseSSL = FALSE
     SearchPath = "o=Ace Industry, c=US"
     Filter = (uid=%s)
     UserPasswordAttribute = password
     LimitOutstandingRequests = FALSE
     MaxOutstandingRequests = 0
     MaxReferrals = 0
     ReferralAttribute =
     ReferralFilter =
     PasswordEncryptionStyle = None
     LDAPToEnvironmentMappings/
          UserProfile = User-Profile
     LDAPToRadiusMappings/
```

After Cisco AR authenticates the user, it checks whether **User-Profile** exists in the environment dictionary. If it finds **User-Profile**, for each value in **User-Profile**, Cisco AR looks up the profile object defined in the configuration database and adds all of the attributes in the profile object to the response dictionary. If any attribute is included in more than one profile, the newly applied profile overrides the attribute in the previous profile.

User-Group

You can use the **User-Group** environment variable to apply the user profile as well. In Cisco AR, a user can belong to a user group, and that user group can have a pointer to a user profile. When Cisco AR finds that a packet has **User-Group** set, it obtains the value of the **User-Profile** within the user group, and if the **User-Profile** exists, it applies the attributes defined in the user profile to that user.

Note that in Cisco AR, every user can also directly have a pointer to a user profile. Cisco AR applies profiles is in the following order:

1. If the user profile defined in the user group exists, apply it.
2. If the user profile defined in the user record exists, apply it.

The profile in **User-Group** is more generic than in **User-Profile**. Therefore, Cisco AR applies the profile from generic to more specific.

Example User-Profile and User-Group Attributes in Directory User Record

You can use an existing user attribute in the user record to store profile info. When this is a new attribute, we suggest you create a new auxiliary class **AR_UserRecord** for whichever user class is used. **AR_User_Profile** and **AR_User_Group** are two optional members in this class. They are of type string. The mapping is as follows:

```
LDAPToEnvironmentMappings/
      AR_User_Profile = User-Profile
      AR_User_Group = User-Group
```

Directory Multi-Value Attributes Support

If any attributes mapped from the LDAP directory to the Cisco AR response dictionary are multivalued, the attributes are mapped to multiple RADIUS attributes in the packet.

MultiLink-PPP (ML-PPP)

Cisco AR supports MultiLink-PPP (ML-PPP). ML-PPP is an IETF standard, specified by RFC 1717. It describes a Layer 2 software implementation that opens multiple, simultaneous channels between systems, providing additional bandwidth-on-demand, for additional cost. The ML-PPP standard describes how to split, recombine, and sequence datagrams across multiple B channels to create a single logical connection. The multiple channels are the ports being used by the Network Access Server (NAS).

During the AA process, Cisco AR authenticates the user connection for each of its channels, even though they belong to the same logical connection. The Authentication process treats the multilink connection as if it is multiple, single link connections. For each connection, Cisco AR creates a session dedicated for management purposes. The session stays active until you logout, which subsequently frees up all of the ports in the NAS assigned to each individual session, or until the traffic is lower than a certain threshold so that the secondary B channels are destroyed thereafter. Cisco AR has the responsibility of maintaining the active session list and discards any session that is no longer valid in the system, by using the accounting stop packet issued from NAS. The multiple sessions that were established for a single logical connection must be destroyed upon the user logging out.

In addition, the accounting information that was gathered for the sessions must be aggregated for the corresponding logical connection by the accounting software. Cisco AR is only responsible for logging the accounting start and accounting stop times for each session. As those sessions belong to the same bundle, IETF provides two standard RADIUS attributes to identify the related multilink sessions. The attributes are **Acct-Multi-Session-Id** (attribute **50**) and **Acct-Link-Count** (attribute **51**), where **Acct-Multi-Session-Id** is a unique Accounting identifier used to link multiple related sessions in a log file, and **Acct-Link-Count** provides the number of links known to have existed in a given multilink session at the time the Accounting record was generated. The Accounting software is responsible for calculating the amount of the secondary B channel's connection time.

The secondary B channel can go up and down frequently, based upon traffic. The Ascend NAS supports the **Target-Util** attribute, which sets up the threshold for the secondary channel. When the traffic is above that threshold the secondary channel is up, and when the traffic is below that threshold, the secondary B channel is brought down by issuing an Accounting stop packet to Cisco AR. On the other hand, if you bring down the primary channel (that is, log out), the secondary B channel is also destroyed by issuing another Accounting stop packet to Cisco AR.

Table 15-5 lists ML-PPP related attributes.

Table 15-5 ML-PPP Attributes

Number	Attribute	Cisco NAS (IOS 11.3 Release)	Ascend NAS
44	Acct-Session-Id	Supported	Supported
50	Acct-Multi-Session-Id	Supported	Supported
51	Acct-Link-Count	Supported	Supported
62	Port-Limit	Supported	Supported
234	Target-Util	Not Supported	Supported
235	Maximum-Channels	Supported	Supported

Following are sample configurations for ML-PPP:

```
/Radius
     /Profile
          /Default-ISDN-Users
               Name = Default-ISDN-Users
               Description =
               Attributes/
                    Port-Limit = 2
                    Target-Util = 70
                    Session-Timeout = 70

/Radius
     /UserGroups
          /ISDN-Users
               Name = ISDN-Users
               Description = " Users who always use ISDN"
               BaseProfile = Default-ISDN-Users
               Authentication-Script =
               Authorization-Script =
```

The **Port-Limit** attribute controls the number of concurrent sessions a user can have. The **Target-Util** attribute controls the threshold level at which the second B channel should be brought up.

Dynamic Updates Feature

The Dynamic Updates feature enables changes to server configurations made using **aregcmd** to take effect in the Cisco AR server after issuing the **save** command, eliminating the need for a server **reload** after making changes.

Table 15-6 lists the Radius object and its child objects. For each object listed, the **Add** and **Modify or Delete** columns indicate whether a dynamic update occurs after adding, modifying, or deleting an object or attribute. Entries in the **Add** and **Modify or Delete** columns also apply to child objects and child attributes of the objects listed, unless the child object is explicitly listed below the object, such as **/Radius/Advanced/Ports** or **/Radius/Advanced/Interfaces**.

Table 15-6 Dynamic Updates Effect on Radius Server Objects

Object	Add	Modify or Delete
Radius	Yes	Yes
UserLists	Yes	Yes

Table 15-6 Dynamic Updates Effect on Radius Server Objects (continued)

Object	Add	Modify or Delete
UserGroups	Yes	Yes
Policies	Yes	Yes
Clients	Yes	Yes
Vendors	Yes	Yes
Scripts	Yes	Yes
Services	Yes	Yes
SessionManagers	Yes	**No**
ResourceManagers	Yes	**No**
Profiles	Yes	Yes
Rules	Yes	Yes
Translations	Yes	Yes
TranslationGroups	Yes	Yes
RemoteServers	Yes	**No**
Replication	**No**	**No**
Advanced	Yes	Yes
SNMP	**No**	**No**
Ports	**No**	**No**
Interfaces	**No**	**No**

The Dynamic Updates feature is subject to the following limitations:

- Changes to the Ports or Interfaces objects are not dynamically updated. An **aregcmd reload** command must be issued for these changes to be propagated to the Cisco AR server.
- Changes (modifications and deletions) to existing Session Manager and Resource Manager objects are not dynamically updated. An **aregcmd reload** command must be issued for these changes to be propagated to the Cisco AR server. However, additions of new Session Manager and Resource Manager objects are dynamically updated. Active sessions and allocated resources are preserved in this case.
- Changes to the Cisco AR configuration might not be immediately propagated to the server. Dynamic updates are only carried out in a *safe* environment (that is, when packets are not being processed and when packet processing can be delayed until the changes can be made on the server safely). Dynamic updates will yield to packet processing when appropriate, thus not significantly impacting server performance.
- Changes to SNMP require the Cisco AR server to be restarted (**/etc/init.d/arservagt restart)**

NAS Monitor

The ability to monitor when a NAS is *down* (really only unreachable from AR) is provided by **nasmonitor**. This program will repeatedly query a TCP port at the specified IP address until the device (NAS) is reachable. If the NAS is not reachable after a period of time, a warning E-mail is sent; if the NAS is still not reachable after another period of time, a message is sent to Cisco AR to release all sessions associated with that NAS. The port to query, the query frequency, the first time interval, the back-off time interval, and the E-mail address to send to are all configurable (with defaults); the only required parameter is the NAS IP address. This program will work for any device that has a TCP port open; it can either be run by hand, when desired, or put in a **cron** job. See **nasmonitor -h** for details.

Note You must have **tclsh** installed in **/usr/local/bin** to use **nasmonitor**. **tclsh** is part of the standard Tcl installation that can be downloaded from **http://www.scriptics.com**.

Automatic Information Collection (arbug)

You can use the script **arbug** to collect information about your Cisco AR server. The results are collected into a tarball that can be E-mailed or **ftp**ed to Cisco as requested.

arbug collects all the relevant information needed to report a problem to Cisco AR support. The goal of the **arbug** script is to make sure all the necessary information is collected.

Note The **arbug** script neither updates nor replaces any system or Cisco AR-related configuration.

Running arbug

To run the **arbug** script, change directory to **/cisco-ar/bin** and enter the following:

./arbug

The following is a typical sequence.

```
Looking around...
Cluster:
User: admin
Password:
The report /tmp/arbug.10085/arbug.tar is ready to send; you
may want to compress it first using gzip or compress.
hostname user_name bin>
```

Files Generated

The **arbug** script generates five files that are compressed into a tarball. Table 15-7 provides a summary of the information found in each of the files.

Table 15-7 Files Generated by arbug

File	Description
car.debug.tar.*	Machine-specific information including OS type, RAM details, disk space information, swap space information, patch information and open file details.
car.config.tar.*	Cisco AR server configuration, server statistics, database dump by taking the administrator username and password as the input.
car.confini.tar.*	Information about ODBC **.ini** files and SNMP configuration
car.core.tar.*	Core files if any are present
car.logcerscr.tar.*	Information from scripts directory, certificate directory, license directory

Simultaneous Terminals for Remote Demonstration

Multiple people can view and interact in a single demonstration by using the ***share-access*** program, a standard GNU release with a special configuration for use with Cisco AR. To run **screen**, a technical support specialist (CSE or DE) will **telnet** to your server and log in as ***cisco.*** While you run **/opt/CSCOar/bin/share-access** (assuming **/opt/CSCOar** is the Cisco AR path) as ***root***, the CSE or DE runs **/opt/CSCOar/bin/share-access -r root**. Now both people (or more) can see what the other types, as well as the results of the commands entered. The special CiscoAR configuration only allows ***root*** and ***cisco*** to run screen. To end a **share-access** session, type Control-D.

Support for RADIUS Check Item Attributes

Cisco AR supports RADIUS check item attributes configuration at the user and group levels. You can configure the Cisco AR server to check for attributes that must be present or attributes that must not be present in the Access-Request packet for successful authentication.

When using check item attributes, the Cisco AR server will reject Access-Requests if:

- Any of the configured check item attributes are not present in the Access-Request packet
- Any of the Access-Request packet's check item attribute values do not match with those configured check item attribute values

For remote servers using either LDAP or ODBC, Cisco AR allows for mapping of certain LDAP or ODBC fields to check item attributes. The mapped attributes can be used as check item attributes while processing the Access-Request packets.

When you configure check item attributes at both the user and group levels, the Cisco AR 4.1 server first checks the attributes of the user level before those of the group level. The Cisco AR 4.1 server must first authenticate the user's password in the Access-Request before validating the check item attributes.

The Cisco AR 4.1 server logs details about any rejected Access-Requests as a result of check items processing.

Configuring Check Items

You use **aregcmd** to configure check item attributes.

Configuring User Check Items

The follow example shows how to configure UserList check item attributes.

Step 1 Log in to the Cisco AR 4.1 server, and use **aregcmd** to navigate to **//localhost/Radius/UserLists/default/bob**.

```
[ //localhost/Radius/UserLists/Default/bob ]
    Name = bob
    Description =
    Password = <encrypted>
    AllowNullPassword = FALSE
    Enabled = TRUE
    Group~ = PPP-users
    BaseProfile~ =
    AuthenticationScript~ =
    AuthorizationScript~ =
    UserDefined1 =
    Attributes/
    CheckItems/
```

Step 2 Change directory to CheckItems.

cd CheckItems

```
[ //localhost/Radius/UserLists/Default/bob/CheckItems ]
```

Step 3 Use set to add any attributes to be used as check items.

set calling-Station-Id 4085551212

save

Configuring Usergroup Check Items

The follow example shows how to configure UserGroups check item attributes.

Step 1 Log in to the Cisco AR 4.1 server, and use **aregcmd** to navigate to **//localhost/Radius/UserGroups/Default**.

cd /Radius/UserGroups/Default

```
[ //localhost/Radius/UserGroups/Default ]
    Name = Default
    Description = "Users who sometimes connect using PPP and sometimes connect "
    BaseProfile~ =
    AuthenticationScript~ =
    AuthorizationScript~ = AuthorizeService
    Attributes/
    CheckItems/
```

Step 2 Change directory to CheckItems.

cd CheckItems

```
[ //localhost/Radius/UserGroups/Default/CheckItems ]
```

Step 3 Use set to add any attributes to be used as check items.

set NAS-IP-Address 10.10.10.10

save

User-Specific Attributes

The Cisco AR 4.1 server supports user-specific attributes which enables the Cisco AR server to return attributes on a per-user or per-group basis without having to use profiles.

The Cisco AR 4.1 server includes a property called HiddenAttributes to the User and UserGroup object. The HiddenAttributes property contains a concatenation of all user-level reply attributes. The HiddenAttributes property is not displayed, nor can the value be set or unset using the command-line interface.

The order of application of attributes is as follows:

1. UserGroup Base Profile
2. UserGroup Attributes
3. User Base Profile
4. User Attributes

The value of the HiddenAttributes property is used dynamically to construct and populate a virtual *attributes* directory in the User object. All values from the Attributes directory will go into the HiddenAttributes property. This occurs transparently when the administrator issues a save command.

Packet of Disconnect

Cisco AR 4.0 supports the Packet of Disconnect (POD) feature that enables the Cisco AR server to send disconnect requests (PODs) to a NAS so that all the session information and the resources associated with the user sessions can be released. Cisco AR can also determine when to trigger and send the POD.

For example, when a PDSN handoff occurs during a mobile session, the new PDSN sends out a new access-request packet to Cisco AR for the same user. Cisco AR should detect this handoff by the change in NAS-Identifier in the new request and trigger sending a POD to the old PDSN if it supports POD. Cisco AR also provides an option for administrator to initiate sending POD requests through the command-line interface (CLI) for any user session. Cisco AR forwards POD requests from external servers to the destination NAS.

Configuring Packet of Disconnect

This section describes how to configure the POD feature.

Note Some of the properties used to configure POD in earlier releases of Cisco AR have been renamed in Cisco AR 4.1.

Configuring the Client Object

You should enable POD for each client object that might want to send disconnect requests to those clients. You enable POD in a client object using the EnableDynamicAuthorization property. This property is set to FALSE by default when you create a client object. The following example shows the default configuration for a new client object, NAS1.

```
[ //localhost/Radius/Clients/NAS1 ]
    Name = nas1
    Description =
    IPAddress =
    SharedSecret =
    Type = NAS
    Vendor =
    IncomingScript~ =
    OutgoingScript~ =
    EnableDynamicAuthorization = FALSE
```

If the Cisco AR server might send a POD to this client, set the EnableDynamicAuthorization property to TRUE. When you set this property to TRUE, the Cisco AR server creates a DynamicAuthorizationServer subdirectory under the client object. The following example shows a newly created DynamicAuthorizationServer subdirectory:

```
[ //localhost/Radius/Clients/NAS1/DyanamicAuthorizationServer ]
    Port = 3799
    DynamicAuthSharedSecret =
    InitialTimeout = 5000
    MaxTries = 3
    PODAttributeGroup =
    COAAttributeGroup =
```

The default port is 3799. You can change the port, if desired.

The property DynamicAuthSharedSecret is initially set to the same as value as the client's SharedSecret property when you set EnableDynamicAuthorization to TRUE. You can chose to configure a different secret for POD in this subdirectory.

The InitialTimeout property represents the number of milliseconds used as a timeout for the first attempt to send a POD packet to a remote server. For each successive retry on the same packet, the previous timeout value used is doubled. You must specify a number greater than zero, and the default value is 5000 (or 5 seconds).

The MaxTries property represents the number of times to send a proxy request to a remote server before deciding the server is off-line. You must specify a number greater than zero, and the default is 3.

The PODAttributeGroup property points to a group of attributes to be included in a disconnect-request packet sent to this client.

You can create and configure the PODAttributeGroup in the **/Radius/Advanced/AttributeGroups/** directory. The default group contains commonly used POD attributes NAS-Port and Acct-Session-Id.

The COAAttributeGroup property is used with the Change of Authorization (CoA) feature, also knows as hot-lining.

Configuring a Resource Manager for POD

Cisco AR 4.0 adds a new resource manager type called *session-cache*. When you set aresource manager to session-cache, the resource manager's configuration contains a subdirectory called ***AttributesToBeCached***. The following is an example Resource Manager set to type session-cache:

```
[ //localhost/Radius/ResourceManagers/PODresourceMgr ]
    Name = PODresourceMgr
    Description =
    Type = session-cache
    OverwriteAttributes = FALSE
    AttributesToBeCached/
    QueryMappings/
```

The attributes you configure under the **AttributesToBeCached** directory are cached in the session record during session management. The cached attributes are then sent in the disconnect-request for this session.

The OverwriteAttributes property indicates whether to overwrite the existing attributes if there are any in the session record. Since this resource manager can be invoked during Access-Request as well as Accounting-Start processing, the OverwriteAttributes can be used to control if the attributes cached during Access-Request processing can be overwritten with the attributes available during Accounting-Start processing.

The following is an example of a typical session-cache resource manager:

```
[ //localhost/Radius/ResourceManagers/RM-New ]
    Name = RM-New
    Description =
    Type = session-cache
    OverwriteAttributes = TRUE
    AttributesToBeCached/
        1. Framed-IP-Address
        2. CDMA-Correlation-ID
    QueryMappings/
```

The attributes used in the example can be added as an indexed list using **add** or **set** commands (in any order).

Proxying POD Requests from External Servers

Cisco AR can also proxy the disconnect requests received from external servers. To make Cisco AR listen for external POD requests, the ListenForDynamicAuthorizationRequests property under **/Radius/Advanced** should be set to TRUE. The default value for this is FALSE. The default POD listening port is 3799. However this can be changed by configuring a new port of type *pod* under **/Radius/Advanced/Ports** and setting the new port number accordingly.

For security reasons, the source of a POD request should be configured as a remote server in Cisco AR and the remote server should be configured to accept PODs. Set the property AcceptDynamicAuthorizationRequests to TRUE to do this. The default for this is FALSE. POD requests from unauthorized sources are silently discarded.

CLI Options for POD

Cisco AR 4.0 provides options for the **query-sessions** and **release-sessions** CLI commands that enable querying or releasing sessions based on the session's age. Another option enables querying or releasing sessions based on any valid RADIUS attribute available in the user's session record.

query-sessions

The syntax for using **query-sessions** *with-Age* option is the following:

query-sessions <path> with-Age <value>

Where <path> is the path to the server, session-manager or resource manager and <value> is the minimum age of the session specified in minutes or hours with options M, Minutes, H or Hours. This command returns all sessions that are older than the given age value.

The syntax for using **query-sessions** *with-Attribute* option is the following:

query-sessions <path> with-Attribute <name> <value>

Where <name> is the RADIUS attribute name and <value> is the value of the attribute to be matched. This command returns the sessions where a session record contains and matches the attribute value specified in <value> field.

release-sessions

The syntax for using **release-sessions** *with-Age* option is the following:

release-sessions <path> with-Age <value>

Where <path> is the path to the server, session-manager or resource manager and <value> is the minimum age of the session specified in minutes or hours with options M, Minutes, H or Hours. This command returns all sessions that are older than the given age value.

The syntax for using **release-sessions** *with-Attribute* option is the following:

release-sessions <path> with-Attribute <name> <value>

Where <name> is the RADIUS attribute name and <value> is the value of the attribute to be matched. This command returns the sessions where a session record contains and matches the attribute value specified in <value> field.

A new option is also available for **release-sessions** command to enable an administrator to trigger sending a POD for a user after the session is released.

release-sessions <path> with-<type> <value> [send-pod]

Where <path> is the path to the server, Session Manager, or Resource Manager and with-<type> is one of the following: with-NAS, with-User, with-IP-Address with-ID, or with-Age. The **release-sessions** command with an optional [send-pod] at the end results in Cisco AR sending a POD to the NAS (as determined from the session record) after the session is actually released.

Configuring Change of Authorization Requests

Cisco AR 4.1 supports Change of Authorization (CoA) requests as defined in Internet RFC 3576 that provides a way to change authorization status of users already logged on to the network. The CoA feature, also known as hot-lining, provides a wireless operator the ability to efficiently address issues with users that might otherwise be unauthorized to access packet data services. When a problem occurs that causes a user to be unauthorized to use the packet data service, a wireless operator can use the CoA feature to resolve the problem and return the user's packet data services.

When a user is hot-lined, their packet data service is redirected to a to a hot-line application that notifies the user of issues that might beblocking their access to normal packet data services. Hot-lining provides users with a way to address the issues blocking their access, such as billing issues, aprepaid account that has been depleted, or an expired credit card.

The CoA feature provides an option to the wireless operator administrator to send CoA packets to the client device when a user needs to be hot-lined. When to send a CoA request to a user depends on the wireless operator's site-specific policies.

Configuring the Client Object

You should enable CoA for each client object that might want to send CoA requests to those clients. You enable CoA in a client object using the EnableDynamicAuthorization property. This property is set to FALSE by default when you create a client object. The following example shows the default configuration for a new client object, NAS1.

```
[ //localhost/Radius/Clients/NAS1 ]
    Name = nas1
    Description =
    IPAddress =
    SharedSecret =
    Type = NAS
    Vendor =
    IncomingScript~ =
    OutgoingScript~ =
    EnableDynamicAuthorization = FALSE
```

If the Cisco AR server might send a CoA request to this client, set the EnableDynamicAuthorization property to TRUE. When you set this property to TRUE, the Cisco AR server creates a DynamicAuthorizationServer subdirectory under the client object. The following example shows a newly created DynamicAuthorizationServer subdirectory:

```
[ //localhost/Radius/Clients/NAS1/COA ]
    Port = 3799
    DynamicAuthSharedSecret =
    InitialTimeout = 5000
    MaxTries = 3
    PODAttributeGroup =
    COAAttributeGroup =
```

The default port is 3799. You can change the port, if desired.

The property DynamicAuthSharedSecret is initially set to the same as value as the client's SharedSecret property when you set EnableDynamicAuthorization to TRUE. You can chose to configure a different secret for CoA in this subdirectory.

The InitialTimeout property represents the number of milliseconds used as a timeout for the first attempt to send a CoA packet to a remote server. For each successive retry on the same packet, the previous timeout value used is doubled. You must specify a number greater than zero, and the default value is 5000 (or 5 seconds).

The MaxTries property represents the number of times to send a proxy request to a remote server before deciding the server is off-line. You must specify a number greater than zero, and the default is 3.

The COAAttributeGroup property points to a group of attributes to be included in a CoA request packet sent to this client.

You can create and configure the COAAttributeGroup in the **/Radius/Advanced/AttributeGroups/** directory. The default group is not set to any value by default. When an attribute group is configured, the Cisco AR server includes the attributes in this group in a CoA request. The values for these attributes are fetched from the user's session record.

The CoA attribute group configuration can be used with a session-cache Resource Manager. For example, any new attributes that are to be sent in a CoA request can be configured for caching by the session-cache Resource Manager so they will be available in the session record when it is to be sent in the CoA request.

The CoA request might also contain AV pairs from the optional profile name in the **query-session** CLI command used to send the CoA request. In a 3GPP2 scenario, a profile containing the Filter-Id attribute set to a value "Hot-Line Active" can be included when a user is to be hot-lined. This can be used as a hot-line profile possibly containing other attributes as desired by the wireless operator. Another profile might be defined containing the Filter-Id attribute with the value "Hot-Line Normal." This profile can be used with the **query-session** CLI command to bring the user back to normal.

The CoA request packet sent by the Cisco AR server conforms to internet RFC 3756. In response to a CoA request initiated by the Cisco AR server, the client should respond with a COA-ACK if it is able to hot-line the user based on credentials available in the CoA request. If the client is unable to hot-line the user for any reason, the client can include an error-cause attribute with the appropriate reason in a COA-NAK packet.

The Cisco AR server logs all CoA responses. If the Cisco AR server does not receive a response to a CoA request within the timeout period, it will retransmit for the configured number of retries, then logs an error if no response is received.

The Cisco AR server forwards proxied CoA requests sent by external servers to the destination NAS. The CoA requests are proxied based on the NAS-IP-Address in the incoming request. The proxied CoA requests from external servers ar forwarded to the destination NAS only if the source IP address is configured to accept dynamic authorization requests. The responses received from the NAS (either COA-ACK or COA-NAK) are forwarded back to the source where the Cisco AR server received the original proxy request.

Dynamic DNS

Cisco AR 4.0 supports the Dynamic DNS protocol providing the ability to update DNS servers. The dynamic DNS updates contain the hostname/IP Address mapping for sessions managed by Cisco AR.

You enable dynamic DNS updates by creating and configuring new Resource Managers and new Remote Servers, both of type *dynamic-dns*. The dynamic-dns Resource Managers specify which zones to use for the forward and reverse zones and which Remote Servers to use for those zones. The dynamic-dns Remote Servers specify how to access the DNS Servers.

Configuring Dynamic DNS

Before you configure Cisco AR you need to gather information about your DNS environment. For a given Resource Manager you must decide which forward zone you will be updating for sessions the resource manager will manage. Given that forward zone, you must determine the IP address of the primary DNS server for that zone. If the dynamic DNS updates will be protected with TSIG keys, you must find out the name and the base64 encoded value of the secret for the TSIG key. If the resource manager should also update the reverse zone (ip address to host mapping) for sessions, you will also need to determine the same information about the primary DNS server for the reverse zone (IP address and TSIG key).

If using TSIG keys, use **aregcmd** to create and configure the keys. You should set the key in the Remote Server or the Resource Manager, but not both. Set the key on the Remote Server if you want to use the same key for all of the zones accessed through that Remote Server. Otherwise, set the key on the Resource Manager. That key will be used only for the zone specified in the Resource Manager.

Step 1 Launch **aregcmd**.

Step 2 Create the dynamic-dns TSIG Keys:

cd /Radius/Advanced/DDNS/TSIGKeys

add foo.com

This example named the TSIG Key, **foo.com**, which is related to name of the example DNS server we use. You should choose a name for TSIG keys that reflects the DDNS client-server pair (for example, **foo.bar** if the client is **foo** and the server is **bar**), but you should use the name of the TSIG Key as defined in the DNS server.

Step 3 Configure the TSIG Key:

cd foo.com

set Secret <base64-encoded string>

The Secret should be set to the same base64-encoded string as defined in the DNS server. If there is a second TSIG Key for the primary server of the reverse zone, follow these steps to add it, too.

Step 4 Use **aregcmd** to create and configure one or more dynamic-dns Remote Servers.

Step 5 Create the dynamic-dns remote server for the forward zone:

cd /Radius/RemoteServers

add ddns

This example named the remote server *ddns* which is the related to the remote server type. You can use any valid name for your remote server.

Step 6 Configure the dynamic-dns remote server:

cd ddns

set Protocol dynamic-dns

set IPAddress 10.10.10.1 (ip address of primary dns server for zone)

set ForwardZoneTSIGKey foo.com

set ReverseZoneTSIGKey foo.com

If the reverse zone will be updated and if the primary server for the reverse zone is different than the primary server for the forward zone, you will need to add another Remote Server. Follow the previous two steps to do so. Note that the IP Address and the TSIG Key will be different.

You can now use **aregcmd** to create and configure a resource manager of type dynamic-dns.

Step 7 Create the dynamic-dns resource manager:

cd /Radius/ResourceManagers

add ddns

This example named the service ddns which is the related to the resource manager type but you can use any valid name for your resource manager.

Step 8 Configure the dynamic-dns resource manager.

cd ddns

set Type dynamic-dns

set ForwardZone foo.com

set ForwardZoneServer DDNS

Finally, reference the new resource manager from a session manager. Assuming that the example configuration was installed, the following step will accomplish this. If you have a different session manager defined you can add it there if that is appropriate.

Step 9 Reference the resource manager from a session manager:

cd /Radius/SessionManagers/session-mgr-1/ResourceManagers

set 5 DDNS

Note The Property AllowAccountingStartToCreateSession must be set to TRUE for dynamic DNS to work.

Step 10 Save the changes you have made.

Testing Dynamic DNS with radclient

After the Resource Manager has been defined it must be referenced from the appropriate Session Manager. You can use **radclient** to confirm that dynamic DNS has been properly configured and is operational.

To test Dynamic DNS using radclient, follow these steps:

Step 1 Launch **aregcmd** and set the trace to level 4.

aregcmd

Login to the Cisco AR 4.1 server as an administrative user.

trace 4

Step 2 Launch **radclient.**

cd /opt/CSCOar/bin

radclient

Step 3 Create an Accounting-Start packet

acct_request Start username

Example:

set p [acct_request Start bob]

Step 4 Add a Framed-IP-Address attribute to the Accounting-Start packet

Step 5 Send the Accounting-Start packet

$p send

Step 6 Check the **aregcmd** trace log and the dns server to verify that the host entry was updated in both the forward and reverse zones.

CHAPTER 16

Directing RADIUS Requests

You can use the policy engine to determine the AAA services for processing a request packet based on the User-Name suffix, User-Name prefix, Calling-Station-ID, Called-Station-ID and Nas-IP-Address. You configure the policy Engine through policies and rules.

A policy is a group of rules. Each rule consists of a set of conditions and corresponding services. A rule succeeds if all the conditions specified in the rule are satisfied. If a rule succeeds, the services indicated by its service attributes are used to process the packet. However, Cisco Access Registrar defers packet processing until the policy succeeds.

This chapter contains the following sections:

Configuring Policies and Rules

A policy is a group of rules. Each rule consists of a set of conditions and corresponding services. A rule succeeds if all the conditions specified in the rule are satisfied. If a rule succeeds, the services indicated by its service attributes are used to process the packet. However, Cisco AR defers packet processing until the policy succeeds.

Configuring Policies

You configure policies under **/Radius/Policies**. To enable the Cisco AR server to use policies, you must first configure policy named SelectPolicy.

```
[ //localhost/Radius/Policies/SelectPolicy ]
    Name = SelectPolicy
    Description =
    Grouping = rule1|rule2
```

The Grouping property of a policy determines which rules are to be evaluated and in which order. Rules are evaluated from left to right. Use the pipe (|) or ampersand (&) character to group rules.

Note Before you can provide rules in the Grouping property, the rules must first be added to the configuration under **/Radius/Rules**.

If rules are grouped with the pipe character (`rule1|rule2`), all rules in the group are evaluated in sequential order until one of the rules succeeds. If any one of the rules in the policy succeeds, the policy succeeds.

If rules are grouped with the ampersand character (`rule1&rule2&tule3`), all the rules listed are evaluated until one of the rules fails. For the policy to succeed, all the rules in the policy must succeed.

Configuring Rules

You configure rules under **/Radius/Rules**. When you add a rule, provide the script that should be executed for the rule and the attributes to use if the rule succeeds. The script you specify must be defined under **/Radius/Scripts**, as shown in the following:

```
[ //localhost/Radius/Rules/rule1 ]
    Name = rule1
        Description =
        Script~ =
        Attributes/
            Authentication-service = local-users
            Authorization-service = local-users
            Realm = @cisco.com

[ //localhost/Radius/Scripts/ExecRealmRule ]
    Name = ExecRealmRule
    Description =
    Language = Rex
    Filename = librexscript.so
    EntryPoint = ExecRealmRule
    InitEntryPoint =
    InitEntryPointArgs =
```

Wildcard Support

Cisco AR supports limited wildcard functionality in rules for Realm, DNIS, and CLID attributes, specifically the asterisk (*) and question mark (?) characters. The asterisk matches any number of characters, including the null character. The question mark matches any single character, not including the null character. Cisco AR also supports both wildcard characters in one pattern, as in CLID = 180098?87*.

Note The realms should start with either the @ or # character. For example, Realm=@cisco.com.

- For an exact matching of the realm, you should configure the rule with the exact realm. For example, for an exact match to abc@cisco.com, you should use Realm=@cisco.com.
- If you use Realm=cisco.com (without any valid character), values such as xyz@us.cisco.com, xyz@uk.cisco.com, abc#cisco.com, and so on can also match and return a success.

The following is an example using the asterisk wildcard character used in a Rule named *rule1*.

```
[ //localhost/Radius/Rules/rule1 ]
    Name=rule1
    Description =
    ScriptName = ExecRealmRule
    Attributes/
```

```
        Authentication-Service = Local-Users
        Authorization-Service = Local-Users
        Realm = ~/@*cisco.com/
```

Rule *rule1* succeeds when the domain of the user name in an access request matches the *@*cisco.com* pattern. Each of the following is a good match: ***@us.cisco.com***, ***@eng.cisco.com***, and ***@cisco.com***. With a match, the **ExecRealmRule** script sets Authentication-Service and Authorization-Service to Local-Users in the environment dictionary.

The following is an example using the "?" wildcard character in a Rule named *rule2*.

```
[ //localhost/Radius/Rules/rule2 ]
    Name = rule2
    Description =
    ScriptName = ExecDNISRule
    Attributes/
        Authentication-Service = Translation-Service
        Authorization-Service = Translation-Service
        DNIS = 1800345987?
```

Rule *rule2* succeeds if the Called-Station-Id attribute (DNIS) in the packet matches 1800345987?. Each of the following is a good match: 18003459876 and 18003459870, while 1800345987 is not. With a match, the **ExecDNISRule** script sets Authentication-Service and Authorization-Service to Translation-Service in the environment dictionary.

Script and Attribute Requirements

The following script and attribute requirements exist:

- **/Radius/Policies/SelectPolicy** is the first policy Cisco AR applies.
- The characters "|" and "&" are reserved as logical operands in a Grouping definition; they cannot be included in a **/Radius/Rules** name.
- A space is not permitted between the logical operands and the rules in a Grouping definition.
- The scripts included in the rules must be defined under the **/Radius/Scripts** directory.
- The attributes included in the rules must be defined under the **/Radius/Advanced/Attribute** Dictionary directory.

The rules included in the policies must be defined under the **/Radius/Rules** directory.

Validation

When policies are configured, Cisco AR performs the following validations:

- Ensures the scripts included in the rules are defined under the **/Radius/Scripts** directory.
- Ensures the attributes included in the rules are defined under the **/Radius/Advanced/Attribute Dictionary** directory.
- Ensures the rules included in the policies are defined under the **/Radius/Rule** directory.

Known Anomalies

The following anomalies currently exist:

- Grouping expressions are not checked for validity.
- The use of parentheses to denote precedence is not supported in a Grouping definition.
- A check is not performed to determine whether a policy that is included within another policy is defined under the /Radius/Policies directory.

Routing Requests

Using the policy engine, Cisco AR enables you to route requests based on attributes in access request packets. The following sections describe how to route requests based on different attributes.

Routing Requests Based on Realm

The Cisco AR policy engine can process request packets based on the realm in the User-Name attribute.

In the following example, request packets with the User-Name attribute containing *@abc.com* as the suffix should be processed locally and the request packets with User-Name attribute containing *@xyz.com* should be proxied to a remote AAA server.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = abcrule|xyzrule
```

The SelectPolicy refers to two rules, *abcrule* and *xyzrule*. When a request packet arrives, Cisco AR executes SelectPolicy beginning with abcrule to determine if the User-Name attribute contains @abc.com as the realm. If so, the abcrule is successful as is SelectPolicy, therefore the packet is processed locally. If the User-Name attribute does not contain @abc.com as the realm,Cisco AR executes xyzrule to determine if the User-Name attribute contains @xyz.com. If so, xyzrule issuccessful as is SelectPolicy. Hence the request is proxied to the remote server specified in xyz-service.

In this example, the rules are grouped using the | (or) operator. So all the rules specified in the grouping parameter will be executed until one of them succeeds.

```
[ //localhost/Radius/Rules ]
    abcrule/
        Name = abcrule
        Description =
        Script~ = ExecRealmRule
        Attributes/
            Authentication-Service = local-users
            Authorization-Service = local-users
            Realm = @abc.com

    xyzrule/
        Name = xyzrule
        Description =
        Script~ = ExecRealmRule
        Attributes/
            Authentication-Service = xyz-service
            Authorization-Service = xyz-service
            Realm = @xyz.com
```

The ExecRealmRule script matches the realm with the suffix in the User-Name attribute and sets the appropriate service for processing the packet. This is a standard script available with Cisco AR. Cisco AR can also be configured to set a particular kind of service for multiple realms. For example, the following configuration can be used if packets with *@pqr.com* or *@klm.com* should be processed using the same service klm-service.

```
[ //localhost/Radius/Rules ]
    rulex/
        Name = rulex
        Description =
        Script~ = ExecRealmRule
        Attributes/
             Authentication-Service = klm-service
             Authorization-Service = klm-service
             Realm = "@pqr.com"  "@klm.com"
```

Routing Requests Based on DNIS

The Cisco AR policy engine can process request packets differently based on the DNIS (Called-Station-Id) attribute in the request packet.

In the following example, request packets with the Calling-Station-Id attribute that contain 1111111 should be processed by abc-service, while request packets with the Called-Station-Id attribute that contain 2222222 or 3333333 should be processed using xyz-service.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = abcrule|xyzrule
```

The SelectPolicy refers to two rules, *abcrule* and *xyzrule*. When a request packet arrives, Cisco AR executes SelectPolicy beginning with abcrule to determine if the DNIS attribute contains 1111111. If so, the abcrule is successful as is SelectPolicy, and the packet is processed using abc-service. If the Called-Station-Id attribute does not contain 1111111, Cisco AR executes the xyzrule to determine if the Called-Station-Id attribute contains 2222222 or 3333333. If so, xyzrule is successful as is SelectPolicy, and the packet is processed using xyz-service.

```
[ //localhost/Radius/Rules ]
    abcrule/
        Name = abcrule
        Description =
        Script~ = ExecDNISRule
        Attributes/
            Authentication-Service = abc-service
            Authorization-Service = abc-service
            DNIS = 1111111

    xyzrule/
        Name = xyzrule
        Description =
        Script~ = ExecDNISRule
        Attributes/
            Authentication-Service = xyz-service
            Authorization-Service = xyz-service
            DNIS =  "2222222" "3333333"
```

The **ExecDNISRule** script matches the DNIS value configured in Cisco AR with the value in the Called-Station-Id attribute of the request packet and sets the appropriate service for processing the packet. **ExecDNISRule** is a standard script available with Cisco AR.

Routing Requests Based on CLID

The Cisco AR policy engine can process request packets differently based on the CLID value in arriving request packets.

In the following example, the request packets with a Calling-Station-Id (CLID) attribute value of 1111111 should be processed by abc-service and the request packets with the CLID attribute value of 2222222 or 3333333 should be processed using xyz-service.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = abcrule|xyzrule
```

The SelectPolicy refers to two rules, abcrule and xyzrule. When a request packet arrives, Cisco AR executes SelectPolicy beginning with abcrule to determine if the CLID attribute contains 1111111. If so, the abcrule is successful as is SelectPolicy, and the packet is processed using abc-service. If the CLID attribute does not contain 1111111, Cisco AR executes xyzrule to determine if the CLID attribute contains 2222222 or 3333333. If so, xyzrule is successful and hence SelectPolicy becomes successful and the packet is processed using xyz-service.

```
[ //localhost/Radius/Rules ]
    abcrule/
        Name = abcrule
        Description =
        Script~ = ExecCLIDRule
        Attributes/
            Authentication-Service = abc-service
            Authorization-Service = abc-service
            CLID = 1111111

    xyzrule/
        Name = xyzrule
        Description =
        Script~ = ExecCLIDRule
        Attributes/
            Authentication-Service = xyz-service
            Authorization-Service = xyz-service
            CLID =  "2222222" "3333333"
```

The **ExecCLIDRule** script matches the CLID value configured in Cisco AR with the value in the CLID attribute of the request packet and sets theappropriate service for processing the packet. **ExecCLIDRule** is a standard script available with Cisco AR.

Routing Requests Based on NASIP

The Cisco AR policy engine can process request packets differently based on the client IP address value in arriving request packets.

In the following example, arriving request packets with the NAS-IP-Address attribute value 1.1.1.1 should be processed by abc-service and arriving request packets with the NAS-IP-Address attribute value 2.2.2.2 should be processed using xyz-service.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = abcrule|xyzrule
```

The SelectPolicy refers to two rules, *abcrule* and *xyzrule*. When a request packet arrives, Cisco AR executes SelectPolicy beginning with abcrule to determine if the NAS-IP-Address attribute contains an IP address from the subnet 1.1.1.0/24. If so, the abcrule is successful as is SelectPolicy, and the packet is processed using abc-service. If the NAS-IP-Address attribute does not contain an IP address from the subnet 1.1.1.0/24, Cisco AR executes xyzrule to determine if the NAS-IP-Address attribute contains 2.2.2.2. If so, xyzrule is successful as is SelectPolicy, and the packet is processed using xyz-service.

```
[ //localhost/Radius/Rules ]
    abcrule/
        Name = abcrule
        Description =
        Script~ = ExecNASIPRule
        Attributes/
            Authentication-Service = abc-service
            Authorization-Service = abc-service
            Client-IP-Address = 1.1.1.0
            Subnet-mask = 255.255.255.0

    xyzrule/
        Name = xyzrule
        Description =
        Script~ = ExecNASIPRule
        Attributes/
            Authentication-Service = xyz-service
            Authorization-Service = xyz-service
            Client-IP-Address =  2.2.2.2
```

The **ExecNASIPRule** script matches the Client IP address configured in Cisco AR with the value in the NAS-IP-Address attribute of the request packet and sets the appropriate service for processing the packet. **ExecNASIPRule** is a standard script available with Cisco AR.

Routing Requests Based on User-Name Prefix

You can use the Cisco AR policy engine to select a service based on the prefix in the User-Name attribute.

In the following example, request packets with a User-Name attribute that contains @abc.com as the suffix and cisco as the prefix should be processed using the service abc-service. A request packet with User-Name attribute containing cisco/bob@abc.com will be processed using abc-service.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = suffixrule & prefixrule
```

The SelectPolicy refers to two rules, *suffixrule* and *prefixrule*. When a request packet arrives, Cisco AR executes SelectPolicy beginning with suffixrule to determine if the realm in the User-Name attribute contains @abc.com. If so, the suffixrule is successful. Since there is an "&" operator between the rules, the prefixrule must also succeed for the SelectPolicy to be successful. The prefixrule is now processed to determine if the prefix in the User-Name attribute contains cisco. If so, the prefixrule is successful which makes SelectPolicy successful, and the AA service is set to the service specified in the prefixrule.

```
[ //localhost/Radius/Rules ]
    abcrule/
        Name = suffixrule
        Description =
        Script~ = ExecRealmRule
        Attributes/
            Realm = @abc.com

    prefixrule/
        Name = prefixrule
        Description =
        Script~ = ExecPrefixRule
        Attributes/
            Authentication-Service = abc-service
            Authorization-Service = abc-service
            Delimiters = @#%&/
            Prefix = cisco
            StripPrefix = No
```

ExecPrefixRule script matches the prefix configured in Cisco AR with the prefix in the User-Name attribute of the request packet and sets the appropriate service for processing the packet. **ExecPrefixRule** is a standard script available with Cisco AR. See ExecPrefixRule for more information.

Attribute Translation

The attribute translation feature supports the RADIUS proxy enabling you to customize attribute filters so that RADIUS attribute value (AV) pairs can be inserted, deleted, or substituted.

For example, when a request is proxied from AAA server on ISP A to AAA server on ISP B, some AV pairs might be substituted (such as IP address) because they might not be valid on the ISP B network. Additionally, ISP B might return some vendor-specific attributes (VSAs) that are not applicable to ISP A's network. Therefore, ISP A will substitute ISP B's VSA value pairs for ISP A's VSAs.

Two configuration points under the **/Radius** directory support this feature: Translations and TranslationGroups. Under the **/Radius/Translations** directory, any translation to insert, substitute, or translate attributes can be added. The following is a sample configuration under the **/Radius/Translations** directory:

```
[ //localhost/Radius/Translations/T1 ]
    Name = T1
    Description =
    DeleteAttrs = Session-Timeout,Called-station-id
    Attributes/
        Calling-Station-id = 1232909
```

DeleteAttrs is the set of attributes to be deleted from the packet. Each attribute is comma separated and no spaces are allowed between attributes.

Under the **/Radius/Translations/T1/Attributes** directory, the attributes that should be inserted and the attributes that should be substituted are specified. These AV pairs are either added to the packet if not present already or replaced with the configured value.

Under the **/Radius/TranslationGroups** directory, translations can be grouped and applied to certain sets of packets, which are referred to in a rule. The following is a sample configuration under the **/Radius/TranslationGroups** directory:

```
[ //localhost/Radius/TranslationGroups/CiscoIncoming ]
        Name = CiscoIncoming
        Description =
        Translations/
        1. T1
```

The translation group is referenced through the Cisco AR policy engine in the **/Radius/Rules/<RuleName>/Attributes** directory. Incoming-Translation-Groups are set to a translation group (for example CiscoIncoming) and Outgoing-Translation-Groups to another translation group (for example CiscoOutgoing).

The following is an example of setting up a rule for a translation group.

```
[ //localhost/Radius/Rules/ciscotranslationrule ]
    Name = ciscotranslationrule
    Description =
    Script~ = ParseTranslationGroupsByRealm
    Attributes/
        Incoming-Translation-Groups = CiscoIncoming
        Outgoing-Translation-Groups = CiscoOutgoing
        Realm = @cisco.com
```

The ciscoTranslationRule rule must be referred to in the **/Radius/Policies** directory, so the Cisco AR policy engine can invoke this rule. If the pattern of Realm, DNIS, or CLID matches the one defined in the rule, Cisco AR sets the environment variable Incoming-Translation-Groups to CiscoIncoming. By looking up the definition of CiscoIncoming, Cisco AR applies all of the translations to the incoming packet (before it is proxied to the other server).

When the proxied packet comes back to the RADIUS server, Cisco AR sets the environment variable, Outgoing-Translation-Groups to CiscoOutgoing.

DNIS, CLID, and Realm are supported for filtering packets. Cisco AR provides the following scripts to facilitate filtering based on DNIS, CLID and Realm.

Parsing Translation Groups

Cisco AR provides three scripts that enable you to parse translation groups based on the DNIS, CLID or Realm attribute in an incoming packet. These scripts are:

- ParseTranslationGroupsByDNIS
- ParseTranslationGroupsByCLID
- ParseTranslationGroupsByRealm

In the following example, request packets containing @abc.com as the realm should be proxied to the remote server defined under abc-service. Before redirecting the request packet to the remote server, the Calling-Station-Id of the packet should be changed to 111.

```
[ //localhost/Radius/Policies ]
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = realmrule & translaterule
```

The SelectPolicy refers to two rules, *realmrule* and *translaterule*. When a request packet arrives, Cisco AR executes SelectPolicy beginning with “realmrule” to determine if the realm in the User-Name attribute contains 1.1.1.1. If so, the realmrule is successful and and the AA service is set to abc-service. Next Cisco AR executes the translaterule to change the CLID of the packet to 111.

```
[ //localhost/Radius/Rules/ciscotranslationrule ]
    Name = ciscotranslationrule
```

```
    Description =
    Script~ = ParseTranslationGroupsByRealm
    Attributes/
        Incoming-Translation-Groups = CiscoIncoming
        Realm = @cisco.com

[ //localhost/Radius/Translations ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>
    T1/
        Name = T1
        Description =
        Attributes/
            calling-station-id = 111

[ //localhost/Radius/TranslationGroups ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>
    CiscoIncoming/
        Name = CiscoIncoming
        Description =
        Translations/
            1. T1
```

Time of Day Access Restrictions

You can use the Cisco AR policy engine to implement access restriction on users based on the time of day. The **ExecTimeRule** script implements this functionality. **ExecTimeRule** can be used to check the time at which the request packet arrives and determine if access should be granted based on the authorization parameters for the user. If the rule succeeds, **ExecTimeRule** sets the Acceptedprofiles Environment dictionary variable to a profile or a set of profiles, as in the following:

```
Acceptedprofiles=Regularaccess::Highprivilegeaccess
```

Note If more than one profile is to be added to the Acceptedprofiles variable, use two colons to separate them (::).

If the user is authenticated, the Baseprofile of the user is compared with the Acceptedprofiles. All the profiles that are in the Baseprofile and in Acceptedprofiles will be used as profiles while sending the response for the user. For example, consider the following user configuration of user1:

```
[ //localhost/Radius/UserLists/new/user1 ]
    Name = user1
    Description =
    Password = <encrypted>
    AllowNullPassword = FALSE
    Enabled = TRUE
    Group~ = regularusers
    BaseProfile~ =highprivilegeaccess::readonlyaccess::regularaccess
    AuthenticationScript~ =
    AuthorizationScript~ =
    UserDefined1 =
    Attributes/
    CheckItems/
```

The Baseprofile of the user1 has highprivilegeaccess, readonlyaccess and regularaccess. If the Acceptedprofiles of the user has regularaccess and highprivilegeaccess, the profiles regularaccess and highprivilegeaccess will be used while sending the response packet.

Setting Time Ranges in ExecTimeRule

ExecTimeRule accepts time range in the following format.

Set timerange "* * * * *"

The first star indicates minutes and can be a value from 0-59. The second star indicates hours and can be a value from 0-23. The third star indicates day of the month and can be a value from 1-31. The fourth star indicates month and can be a value from 1-12. The fifth star indicates day of the week and can be a value from 0-6 where 0 indicates Sunday, 1 indicates Monday, and so on.

For example, to schedule a particular action to occur every Sunday during the month of December, use a command line like this:

Set timerange "* * * 12 0"

ExecTimeRule Example Configuration

This section provides a configuration example where a user, user1, is only authorized for PPP service between 10 AM and 6 PM. If a login occurs at any other time, user1 will be authorized only for telnet service.

Policies

```
[ //localhost/Radius/Policies ]
    Entries 1 to 1 from 1 total entries
    Current filter: <all>
    SelectPolicy/
        Name = SelectPolicy
        Description =
        Grouping = ppprule|telnetrule
```

Rules

```
[ //localhost/Radius/Rules ]
    Entries 1 to 2 from 2 total entries
    Current filter: <all>
    ppprule/
        Name = ppprule
        Description =
        Script~ = ExecTimeRule
        Attributes/
             acceptedprofiles = default-ppp-users
             timerange = "* 10-18 * * * "
    telnetrule/
        Name = telnetrule
        Description =
        Script~ = ExecTimeRule
        Attributes/
             acceptedprofiles = default-telnet-users
             timerange = "* 0-10,18-23 * * * "
```

Profiles

```
[ //localhost/Radius/Profiles ]
    Entries 1 to 5 from 5 total entries
    Current filter: <all>
    default-PPP-users/
        Name = default-PPP-users
        Description =
        Attributes/
            Ascend-Idle-Limit = 1800
            Framed-Compression = "VJ TCP/IP header compression"
            Framed-MTU = 1500
            Framed-Protocol = PPP
            Framed-Routing = None
            Service-Type = Framed
    default-Telnet-users/
        Name = default-Telnet-users
        Description =
        Attributes/
            Login-IP-Host = 204.253.96.3
             Login-Service = Telnet
             Login-TCP-Port = 541
```

User

```
[ //localhost/Radius/UserLists/new/user1 ]
    Name = user1
    Description =
    Password = <encrypted>
    AllowNullPassword = FALSE
    Enabled = TRUE
    Group~ = regularusers
    BaseProfile~ = default-telnet-users::default-ppp-users
    AuthenticationScript~ =
    AuthorizationScript~ =
    UserDefined1 =
    Attributes/
    CheckItems/
```

Reducing Overhead Using Policies to Group Rules

When you configure a large number of rules, the processing of request packets can be slow. For example, if you have 50 rules and only the last rule succeeds, the Cisco AR server will have to check the preceding 49 rules before executing the rule that succeeds. You can reduce this overhead by using policies to group rules.

The following sample configuration, Cisco AR must choose the AA service to be used for two domains, abc.com and xyz.com, based on the DNIS. You can do this by configuring different policies for different domains.

Policies

In the following configuration, SelectPolicy selects the policy to process packets with realm abc.com or xyz.com. Based on the realm that arrives in the request packet, abcrealmrule and xyzrealmrule decide whether to use abc-policy or xyz-policy to process the packets. abc-policy and xyz-policy are configured with rules to check for DNIS numbers in the respective domains and set the AA services appropriately.

```
[ //localhost/Radius/Policies ]
    Entries 1 to 3 from 3 total entries
    Current filter: <all>
    SelectPolicy/
        Name = selectpolicy
        Description =
        Grouping = abcrealmrule|xyzrealmrule
    abc-policy/
        Name = abc-policy
        Description =
        Grouping = abcDNISrule1|abcDNISrule2
    xyz-policy/
        Name = xyz-policy
        Description =
        Grouping = xyzDNISrule1|xyzDNISrule2
```

Rules

```
[ //localhost/Radius/Rules ]
    Entries 1 to 6 from 6 total entries
    Current filter: <all>

    abcrealmrule/
        Name = abcrealmrule
        Description =
        Script~ = ExecRealmRule
        Attributes/
            policy = abc-policy
            realm = @abc.com
    xyzrealmrule/
        Name = xyzrealmrule
        Description =
        Script~ = ExecRealmRule
        Attributes/
            policy = xyz-policy
            realm = @xyz.com
    abcDNISrule1/
        Name = abcDNISrule1
        Description =
        Script~ = ExecDNISRule
        Attributes/
            Authentication-Service = abc1-service
            Authorization-Service = abc1-service
            DNIS = 1111111
    abcDNISrule2/
        Name = abcDNISrule2
        Description =
        Script~ = ExecRealmRule
        Attributes/
            Authentication-Service = abc2-service
            Authorization-Service = abc2-service
            DNIS = 2222222
    xyzDNISrule1/
        Name = xyzDNISrule1
        Description =
        Script~ = ExecRealmRule
        Attributes/
            Authentication-Service = xyz1-service
            Authorization-Service = xyz2-service
            DNIS = 6666666
    xyzDNISrule2/
        Name = xyzDNISrule2
```

```
Description =
Script~ = ExecRealmRule
Attributes/
    Authentication-Service = xyz2-service
       Authorization-Service = xyz2-service
    DNIS = 7777777
```

Standard Scripts Used with Rules

Cisco AR software includes several scripts you can use with the rules. The following sections describe those scripts.

ExecRealmRule

Use the **ExecRealmRule** script to determine the Authentication service and Authorization service to be used to process the request packet based on the suffix (Realm) in the User-Name attribute. You configure the Realm for which the packet should be checked and the service to use in the Attributes subdirectory of a rule. The **ExecRealmRule** script supports multi-valued attributes with which you can configure to check for multiple Realms.

For example, the following statement checks the request packet for three realms. If one of these three realms is found in the request packet, the **ExecRealmRule** script sets the attributes to the values listed in the Attributes subdirectory of the rule that references the **ExecRealmRule** script.

set Realm "@cisco.com" "@foo.com" "#bar.com"

Note Only the characters @ and # can be used as delimiters in ExecRealmRule.

Prior to Cisco AR 4.1.4, ExecRealmRule was interpreted as a regular expression pattern and was evaluated accordingly. As of Cisco AR 4.1.4, ExecRealmRule now does a simple case insensitive comparison by default of the value specified for the realm attribute for the realm of a user name and optionally performs regular expression matching.

Beginning with the Cisco AR 4.1.4 release, you can also specify a pattern using the following notation:

~/pattern/

Where pattern is a string of alpha-numeric characters that might include wild card characters, as in "@*cisco.com" to match patterns (realms) that end in *cisco.com*.

Note The question mark (?) should not be used without a character pattern preceding it. Specifying ? as the first character might have undesirable results. (For regexp terminology, the question mark should be preceded by an *atom*.)

The **ExecRealmRule** script checks the request packet for the Realm and applies the values set for the following attributes:

- Authentication-Service
- Authorization-Service
- Policy

ExecDNISRule

Use the **ExecDNISRule** script to determine the Authentication service and Authorization service to be used to process the request packet based on the Called-Station-Id (DNIS) attribute. The DNIS for which the packet should be checked and the services can be configured through the Policy Engine. The **ExecDNISRule** script supports multi-valued attributes, by which you can configure multiple DNIS for checking.

For example, the following statement checks for a Calling-Station-Id of 1111111, 2222222, or 3333333. If one of the DNIS values is true, the script applies the values set for the Authentication-Service, Authorization-Service, and Policy attributes.

set DNIS “1111111” “2222222” “3333333”

ExecCLIDRule

Use the **ExecCLIDRule** script with the Policy Engine to determine the Authentication service and Authorization service to be used to process the request packet based on the Calling-Station-Id (CLID) attribute. The CLID for which the packet should be checked and the services can be configured through the Policy Engine. **ExecCLIDRule** supports multi-valued attributes by which you can configure multiple CLID for checking.

For example, the following statement checks for Calling-Station-ID and applies Authentication-Service, Authorization-Service, and Policy.

set CLID “1111111” “2222222” “3333333”

The **ExecCLIDRule** script checks the request packet for the Calling-Station-Id and applies the values set for the following attributes:

- Authentication-Service
- Authorization-Service
- Policy

ExecNASIPRule

The Policy Engine references the **ExecNASIPRule** script to determine the AAA Services, Policy and Session Manager based on the Client-IP-Address and Subnet-Mask set in the Policy Engine. The **ExecNASIPRule** script supports multi-value attributes by which multiple you can configure the Client-IP-Address and Subnet-Mask in **aregcmd** for checking.

For example, the following statements check for Client-IP-Address and Subnet-Mask and applies Authentication-Service, Authorization-Service, Accounting-Service, Policy, and Session-Manager.

set Client-IP-Address "1.1.1.1" "2.2.2.2" "3.3.3.3"

set Subnet-Mask “255.255.255.0" "255.255.0.0" "255.0.0.0"

The **ExecNASIPRule** script checks the request packet for the Client-IP-Address and Subnet-Mask and applies the values set for the following attributes:

- Authentication-Service
- Authorization-Service
- Accounting-Service
- Policy
- Session Manager

ExecPrefixRule

The Policy Engine references the **ExecPrefixRule** to determine the authentication and authorization services based on the prefix in the User-Name attribute of the request packet and assigns the appropriate service for processing the packet.

Table 16-1 lists the **ExecPrefixRule** script attributes.

Table 16-1 ExecPrefixRule Attributes

Attribute	Description
Delimiters	A list of valid delimiters; you can use any character as a delimiter, such as @#-/.
Prefix	List of valid prefixes.
StripPrefix	Option to strip or not to strip the prefix from the User-Name. If you configure this attribute to YES, the ExecPrefixRule strips the prefix from the User-Name. If you configure this attribute to NO, the ExecPrefixRule does not strip the prefix from the User-Name. By default, this attribute is set to YES.

For example, if cisco/bob@abc.com is the User-Name attribute, the **ExecPrefixRule** script sets the Authentication-Service to abc-service and User-Name to:

- bob@abc.com when the StripPrefix attribute is set to YES.
- cisco/bob@abc.com when the StripPrefix attribute is set to NO.

You can configure the Prefix attribute in AR using the aregcmd as follows:

set Prefix “cisco”

Beginning with the Cisco AR 4.1.4 release, the Cisco AR server does a case-insensitive comparison of the value specified for the prefix attribute of a user name.

Beginning with the Cisco AR 4.1.4 release, you can configure the Prefix by specifying a pattern using the following notation:

~/pattern/

```
[ //localhost/Radius/Rules/prefix/Attributes ]
    Delimiters = #@-/
    Prefix = ~/cis*/
```

Where a pattern is a string of alpha-numeric characters that can include wild card characters, as in "cis*" to match patterns (realms) that start with "cis".

Note The question mark (?) should not be used without a character pattern preceding it. Specifying ? as the first character might have undesirable results. (For regexp terminology, the question mark should be preceded by an atom.)

ExecSuffixRule

The Policy Engine references **ExecSuffixRule** to determine the AAA services, policy and session managers based on the suffix (or *realm*) set in the Policy Engine. You can use **aregcmd** to configure **ExecSuffixRule** to support multi-valued attributes, as in the following:

set Suffix "cisco.com" "abc.com" "domain.com"

In the User-Name *bob@abc.com*, **ExecSuffixRule** first checks for any of the configured delimiters in the User-Name. If there is a match, **ExecSuffixRule** checks for the configured suffix in the User-Name. If the suffix matches, **ExecSuffixRule** checks for the value of the StripSuffix variable. If StripSuffix is set to Yes, the suffix (including the delimiter) is stripped from the User-Name attribute of the Access Request.

Table 16-2 lists the **ExecSuffixRule** script attributes.

Table 16-2 ExecSuffixRule Attributes

Attribute	Description
Delimiters	A list of valid delimiters; you can use any character as a delimiter such as these: @#/
Suffix	List of valid suffixes to scan
StripSuffix	The default value (No) does not strip the suffix from the User-Name. When set to Yes, **ExecSuffixRule** does strip the suffix.

Beginning with the Cisco AR 4.1.4 release, the Cisco AR server does a case-insensitive comparison of the value specified for the suffix attribute for the suffix of a user name.

Beginning with the Cisco AR 4.1.4 release, you can also specify a pattern using the following notation:

~/pattern/

Where pattern is a string of alpha-numeric characters that might include wild card characters, as in "@*cisco.com" to match patterns (realms) that end in *cisco.com*.

Note The question mark (?) should not be used without a character pattern preceding it. Specifying ? as the first character might have undesirable results. (For regexp terminology, the question mark should be preceded by an *atom*.)

Consider the following sample configuration.

Policies

You activate the Policy Engine by configuring SelectPolicy. Because the testsuffixrule is the only rule listed in Grouping, it is the only rule run.

```
[ //localhost/Radius/Policies/SelectPolicy ]
    Name = SelectPolicy
    Description =
    Grouping = testsuffixrule
```

Rule

The testsuffixrule configuration does the following:

- points to the **ExecSuffixRule** script
- specifies the delimiters for which to scan
- specifies the suffixes for which to scan
- indicates whether to strip the suffix from the User-Name

```
[ //localhost/Radius/Rules/testsuffixrule ]
    Name = testsuffixrule
    Description =
    Script~ = ExecSuffixrule
    Attributes/
        Delimiters = @#/
        stripsuffix = yes
        suffix = cisco.com
        suffix = abc.com
        suffix = domain.com
```

In this example, if *bob@abc.com* is the User-Name attribute, **ExecSuffixRule** strips the User-Name bob@abc.com and sets the User-Name environment variable to bob because StripSuffix is configured as *yes*.

ExecTimeRule

Use the **ExecTimeRule** script to implement access restriction on users based on time. The **ExecTimeRule** script checks the time at which the request packet arrives and based on that the authorization parameters for the user can be decided. Based on the time of the request packet if the rule succeeds then **ExecTimeRule** sets the environment variable, Acceptedprofiles to a profile or a set of profiles.

For example, the following statement checks for Timerange and applies AcceptedProfiles.

Acceptedprofiles=Regularaccess::Highprivilegeaccess

ParseTranslationGroupsByRealm

The Policy Engine references the ParseTranslationGroupsByReal script to determine the incoming and outgoing translation groups based on realm set in the Policy Engine. Use the ParseTranslationGroupsByReal script to add or filter attributes in request and response packets. The ParseTranslationGroupsByReal script supports multi-value attributes enabling you to configure to check for multiple Realms.

For instance, the following statement checks for three Realms. If True, the Policy Engine applies the values set for the Incoming-Translation-Group and Outgoing-Translation-Groups attributes.

set Realm "@cisco.com" "@foo.com" "@bar.com"

ParseTranslationGroupsByDNIS

This script is referenced from the Policy Engine to determine the incoming and outgoing translation groups based on DNIS set in the Policy Engine. This script can be used to add/filter attributes in request/response packets. This script supports multi-value attributes, by which multiple DNIS can be configured for checking.

For example, the following statement checks for Calling-Station-ID and applies Incoming-Translation-Groups and Outgoing-Translation-Groups.

set DNIS “1111111” “2222222” “3333333”

ParseTranslationGroupsByCLID

The Policy Engine references the ParseTranslationGroupsByCLID script to determine the incoming and outgoing translation groups based on CLID set in the Policy Engine. You can use the ParseTranslationGroupsByCLID script to add and filter attributes in request and response packets. The ParseTranslationGroupsByCLID script supports multi-value attributes, by which you can configure multiple CLIDs for checking.

For example, the following statement checks for the Calling-Station-ID and applies Incoming-Translation-Groups and Outgoing-Translation-Groups.

set CLID “1111111” “2222222” “3333333”

ParseTranslationGroupsByDNIS

The **ParseTranslationGroupsByDNIS** script is referenced from the policy engine to determine the incoming and outgoing translation groups based on DNIS set in the policy engine. The **ParseTranslationGroupsByDNIS** script can be used to add and/or filter attributes in request and response packets. The **ParseTranslationGroupsByDNIS** script supports multi-value attributes, by which multiple DNIS can be configured for checking.

For example, the following statement checks for the Calling-Station-ID and applies Incoming-Translation-Groups and Outgoing-Translation-Groups.

set DNIS “1111111” “2222222” “3333333”

CHAPTER 17

Wireless Support

This chapter provides information about using Cisco Access Registrar for wireless support. The following topics are included in this chapter:

Mobile Node-Home Agent Shared Key

In a mobile wireless environment, a Home Agent (HA) can request a Mobile Node-Home Agent (MN-HA) shared key from the home Cisco AR RADIUS server during a mobile IP registration request (RRQ) from a Packet Data Serving Node (PDSN). Cisco AR supports distribution of the shared key in this environment. Cisco AR encrypts the shared key using MD5 encryption before sending the key back to the HA in an Access-Accept packet.

When an HA receives an RRQ from a PDSN, the HA authenticates the RRQ using a MN-HA shared key. If the HA does not have the MN-HA shared key, it retrieves the MN-HA shared key from the Cisco AR server by sending an Access-Request packet containing the 3GPP2 VSA CDMA-MN-HA-SPI (SPI attribute). Cisco AR then sends the CDMA-MN-HA-Shared-Key corresponding to the user if the user has been successfully authenticated.

Use Case Example

When HA receives an RRQ from a PDSN, it authenticates the RRQ by using a MN-HA shared key. If the HA does not have the MN-HA shared key, it retrieves the MN-HA shared key from the Cisco AR server by sending an Access-Request packet containing the 3GPP2 vendor-specific attribute (VSA) CDMA-MN-HA-SPI, the Security Parameter Index (SPI attribute).

The Cisco AR server then sends the CDMA-MN-HA-Shared-Key corresponding to the user if the user has successfully authenticated subject to the following rules:

1. If there is an incoming SPI and no configured SPI, the Cisco AR server authenticates the user as usual and does not include a configured shared-key (if there is one) in the reply.

2. If the incoming SPI does not match the configured SPI, the Cisco AR server authenticates the user as usual, but does not include the configured shared-key (if there is one) in the reply.
3. If the incoming SPI matches the configured SPI, but there is no shared-key configured, the Cisco AR server proceeds with normal authentication. Since there is no shared-key, it will not be included in the reply.
4. If the incoming SPI matches the configured SPI and a configured shared-key exists, the Cisco AR server proceeds to encrypt the MCD5 shared-key and include it in the Access-Accept.

The key to including the shared key in an Access-Accept is in matching the values of the SPI attribute.

Configuring User Attributes

To configure a user with the CDMA-MN-HA-SPI VSA to request a MN-HA shared key, complete the following steps:

Step 1 Log in to the Cisco AR server and launch **aregcmd**.

Log in as a user with administrative rights such as user **admin**.

Step 2 Change directory to the attribute directory of the user.

cd /Radius/UserLists/Default/bob/Attributes

Step 3 Set the CDMA-MN-HA-SPI VSA to the appropriate shared-key value.

set CDMA-MN-HA-SPI 1234

```
set CDMA-MN-HA-SPI 1234
```

Step 4 Set the CDMA-MN-HA-SPI VSA to the appropriate shared-key value.

set CDMA-MN-HA-Shared-Key secret123

```
set CDMA-MN-HA-Shared-Key secret123
```

Step 5 Validate and save your changes.

validate

save

3GPP2 Home Agent Support

The Cisco AR server supports 3GPP2 home agents. This support enables mobile IP clients that authenticate through a Cisco AR RADIUS server to be told which home agent they should use.

Every Mobile IP client has a home domain that is served by a group of Home Agents (HA). The Mobile IP client sets up a tunnel to one (and only one) HA during a session while it roams. Typically, the domain can be determined by the Mobile IP client's network access identifier (NAI).

Note The NAI is the userID submitted by the client during PPP authentication. In roaming, the purpose of the NAI is to identify the user as well as to assist in the routing of the authentication request.

During the authentication and authorization phase for each Mobile IP client, the RADIUS server must decide which HA from a group of HAs should be chosen to serve the client. This is called dynamic HA assignment.

Home-Agent Resource Manager

Cisco AR 1.7 and above supports dynamic HA assignment with a new resource manager type called home-agent. You configure the home-agent resource manager with a list of IP addresses. The CAR server assigns those addresses to clients whose request dictionary has the right attributes to indicate that an assignment should be done. This is similar to the *ip-dynamic* resource manager.

Unlike the ip-dynamic resource manager, HAs are not exclusively allocated to an individual session but are shared among a set of sessions.

Load Balancing

The goal of dynamic HA assignment is to have load balancing among HAs. The Cisco AR server achieves this by evenly distributing mobile clients among HAs. At the same time, the CAR server ensures that the same HA is always assigned to the same Mobile IP client for the same session.

Configuring the Home Agent Resource Manager

Use the **aregcmd** command **add** to create a new resource manager.

Step 1 Use the **cd** command to change to the **Radius /ResourceManagers** level.

--> **cd /Radius/ResourceManagers**

```
[ //localhost/Radius/ResourceManagers ]

    Entries 0 to 0 from 0 total entries
    Current filter: <all>
```

Step 2 Use the **add** command to specify the name of a resource manager to create.

--> **add home-agent-pool**

```
--> Added home-agent-pool
```

Step 3 Use the **cd** command to change to the **Radius /ResourceManagers/home-agent-pool** level.

--> **cd home-agent-pool**

```
[ //localhost/Radius/ResourceManagers/home-agent-pool ]

    Name = home-agent-pool
    Description =
    Type =
```

Step 4 Use the **set** command to set the resource manager type to **home-agent**.

--> **set type home-agent**

Step 5 Use the **ls** command to view the subdirectories under home-agent-pool.

--> ls

```
[ //localhost/Radius/ResourceManagers/home-agent-pool ]
```

```
Name = home-agent-pool
Description =
Type = home-agent
Home-Agent-IPAddresses/
```

Step 6 Use the **cd** command to change to the **Radius/ResourceManagers/home-agent-pool/Home-Agent-IPAddresses** level.

--> **cd Home-Agent-IPAddresses**

```
[ //localhost/Radius/ResourceManagers/home-agent-pool/Home-Agent-IPAddresses ]
```

Step 7 Use the **add** command to add a single IP address or a range of IP addresses.

--> **add 209.165.200.200-209.165.200.254**

```
--> Added 209.165.200.200-209.165.200.254
```

Querying and Releasing Sessions

The **aregcmd** program has been modified to support a new filter for **query-session** and **release-session**. You can use this filter to restrict a request (either query or release) to just the sessions with a given home-agent IP address. For example, consider the following command line.

--> **query-session /radius with-home-agent 10.10.10.1**

This command line will return all sessions that have a home-agent resource equal to the IP address 10.10.10.1.

Querying sessions using **aregcmd** displays the home-agent resource in each session as:

HA ddd.ddd.ddd.ddd

where each *ddd* is a decimal number from 0-255.

Access Request Requirements

When the home-agent resource manager receives an Access-Request that contains a CDMA-HA-IP-Addr attribute, the home-agent resource manager checks the response dictionary to see if it already has a CDMA-HA-IP-Addr attribute. If it does, then the Mobile IP client has been assigned a HA address already and the resource manager does not need to do anything.

If the value of the CDMA-HA-IP-Addr attribute in the request dictionary is 0.0.0.0, the home-agent resource manager assigns a HA and puts a new CDMA-HA-IP-Addr attribute whose value is the IP address of the HA in the response dictionary.

If the value of the CDMA-HA-IP-Addr attribute is not 0.0.0.0, the Mobile IP client has been assigned a HA address already. The home-agent resource manager copies the attribute (with its value) from the request dictionary into the response dictionary.

The CAR server might select the session manager based on the domain (using the rule engine, dynamic properties, or scripting), and it allows each session manager to have its own home-agent resource manager.

New 3GPP2 VSAs in the CAR Dictionary

Cisco AR 4.1 supports 3GPP2 vendor-specfic attributes (VSAs) in the vendor-specific dictionary in **/Radius/Advanced/Attribute Dictionary**.

Note There is no planned support for the Accounting-Container (3GPP2/6) attribute because it has different syntax than other vendor-specfic attributes (VSAs) and requires special processing.

Session Correlation Based on User-Defined Attributes

All the session objects are maintained in one dictionary keyed by a string.

You can define the keying material to the session dictionary through a newly introduced environment variable, Session-Key. If the Session-Key is presented at the time of session manager process, it will be used as the key to the session object for this session. The Session-Key is of type string. By default, the Session-Key is not set. It's value should come from attributes in the incoming packet and is typically set by scripts. For example, CLID can be used to set the value of Session-Key.

Use the script UseCLIDAsSessionKey as defined in the script **rexscript.c** to specify that the Calling-Station-Id attribute that should be used as the session key to correlate requests for the same session. This is a typical case for 3G mobile user session correlation. You can provide your own script to define other attributes as the session key.

In the absence of the Session-Key variable, the key to the session will be created based on the string concatenated by the value of the NAS and the NAS-Port.

There is a new option *with-key* available in **aregcmd** for query-sessions and release-sessions to access sessions by Session-Key.

Managing Multiple Accounting Start/Stop Messages

Since the PDSN is aware when it sends a RADIUS stop followed by a start record, it inserts the new Session Continue attribute (3GPP2/48) into the stop record. The existence of the Session Continue attribute denotes that a start record will immediately be sent and the packet data session continues on the PDSN.

When CAR 1.7 receives an accounting stop packet, the following two conditions trigger a release of a session and its resources.

- There is no 3GPP2/48 Session Continue attribute in the stop packet and the number of accounting stops received is greater or equal to the starts received for this session
- The 3GPP2/48 Session Continue attribute is present in the stop packet, but its value is zero (0)

Note One of the conditions above must be true to release the session and its resources.

NULL Password Support

CAR 1.7 defines a new CAR environment variable, *Allow-NULL-Password*. At authentication time, if the following three conditions are met, user authentication is bypassed.

1. Allow-NULL-Password environment variable is set to TRUE.
2. The User-Password or CHAP-Password must be NULL in the incoming request. (If it is not NULL, normal password checking will occur.)
3. A user record exists for this user.

By default, the *Allow-NULL-Password* environment variable is not set.

Note You should be aware of the security impact when using the NULL Password feature.

You can set this environment variable three different ways:

1. For the user in local database, one new field ***AllowNullPassword*** is added in the user record. When Cisco AR fetches a user record for authentication, if this field is set to TRUE and Allow-NULL-Password environment variable does not exist, it sets *Allow-NULL-Password* environment variable to TRUE.
2. If the user record is in LDAP database, then the *LDAPToEnvironmentMappings* must be defined to map an attribute in LDAP user record to *Allow-NULL-Password* environment variable.
3. Through scripting which allows the decision to be made based on run-time conditions, such as attributes in the access-request or policies.

CHAPTER 18

Using LDAP

This chapter provides information about using Lightweight Directory Access Protocol (LDAP) with Cisco Access Registrar to access information directories. You can use Cisco AR to authenticate and authorize access requests by querying user information through LDAP.

Note Cisco AR 4.1 requires an LDAP Version 3 directory server for any remote server used for LDAP.

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Configuring LDAP

To use LDAP in Cisco AR, use **aregcmd** to do the following:

1. Configure an LDAP Service.
2. Configure an LDAP RemoteServer object.
3. Set LDAP service as the default AA service.
4. Save your configuration.

After you issue the **save** command, Cisco AR attempts to validate the configuration, checks for all required properties, and ensures there is no logic error. If the validation is successful, Cisco AR saves the configuration to the MCD database. When Cisco AR is reloaded, it shuts down any current LDAP connections and builds new connections for the configured LDAP remote servers.

Configuring the LDAP Service

You configure an LDAP service under **/Radius/Services**. When you define an LDAP service under **/Radius/Services**, you must set its type to LDAP.

```
[ //localhost/Radius/Services/AR-LDAP ]
    Name = AR-LDAP
    Description =
    Type = ldap
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
    RemoteServers/
```

Table 18-1 describes the LDAP service properties.

Table 18-1 LDAP Service Properties

Parameter	Description
Name	Required; inherited from the upper directory
Description	An optional description of the service
Type	Must be set to LDAP for LDAP service
IncomingScript	Optional
OutgoingScript	Optional
OutagePolicy	Required; must be set to AcceptAll or Drop Packet, or defaults to RejectAll
OutageScript	Optional
MultipleServersPolicy	Required; must be set to RoundRobin or defaults to Failover.
RemoteServers	Required; list of one or more remote servers defined under **/Radius/Services/LDAP/RemoteServers**. These servers must be listed in order under **/Radius/RemoteServers.**

MultipleServersPolicy

Use the MultipleServersPolicy property to configure the LDAP remote servers in RoundRobin mode, or the default Failover mode applies. When set to Failover, Cisco AR directs requests to the first server in the **/Radius/Services/LDAP/RemoteServers** list. If that server should fail or go offline, Cisco AR redirects all requests to the next server in the list. The process continues until Cisco AR locates an on-line server.

When set to RoundRobin, Cisco AR directs each request to the next server in the RemoteServers list to share the resource load across all listed servers.

RemoteServers

Use the RemoteServers directory to list one or more remote servers to process access requests. The servers must also be listed in order under **/Radius/RemoteServers.**

The order of the RemoteServers list determines the sequence for directing access requests when MultipleServersPolicy is set to RoundRobin mode. The first server in the list receives all access requests when MultipleServersPolicy is set to Failover mode.

Configuring an LDAP RemoteServer

Use the **aregcmd** command **add** to add LDAP servers under **/Radius/RemoteServers**. You must configure an LDAP RemoteServer object for each RemoteServer object you list under **/Radius/Services/LDAP/RemoteServers**.

The following properties must be configured to use an LDAP remote server:

- Name
- Protocol
- Port

- HostName
- BindName
- BindPassword
- SearchPath

Table 18-2 describes the LDAP Remote Server properties.

Table 18-2 LDAP Remote Server Properties

Parameter	Description
Name	Required name you assign
Description	Optional description of the server
Protocol	Required and must be set to LDAP; no default value
Port	Required; port on which LDAP server listens, default is port 389. **Note** If port is not set or set to zero, LDAP remote server will automatically be set to port 389.
ReactivateTimerInterval	Required; default is 300000 (ms)
Timeout	Required; specifies length of time Cisco AR waits for a response from the LDAP server before noting the server as down; default is 15 (seconds)
HostName	Required; specifies the hostname, FQDN, or IP address of the LDAP server
BindName	Specifies the distinguished name (DN) in the LDAP server for Cisco AR to bind with the LDAP server
BindPassword	Specifies the password for the distinguished name
UseSSL	FALSE by default
SearchPath~	Specifies search base to the organization and domain; for example: o=cisco.com
Filter~	(uid=%s) by default
UserPasswordAttribute	Should be set to the attribute in the directory server which stores users' passwords; default is *userpassword*
LimitOutstandingRequests	FALSE by default
MaxOutstandingRequests	Limits the number of requests to the LDAP server; used to throttle the request load when the LDAP server does not function well under high TPS rates (default is 0)
MaxReferrals	Limits the number of referrals Cisco AR allows when working with LDAPv2 (default is 0)
ReferralAttribute	LDAP attribute that contains a referral for LDAPv2
ReferralFilter	Filter used when following a referral for LDAPv2

Table 18-2 LDAP Remote Server Properties (continued)

Parameter	Description
PasswordEncryptionStyle	Dynamic by default; must be set to one of the following depending on the algorithm used by the LDAP server to encrypt passwords: Dynamic Crypt None SHA-1 SSHA-1 When set to *Dynamic*, Cisco AR analyzes the password and detects the encryption algorithm used. *None* indicates that the LDAP server stores clear text passwords. **Note** If CHAP authentication is used with LDAP backing store, passwords in LDAP must be stored as clear text.
EscapeSpecialCharInUserName	FALSE by default
DNSLookupAndLDAPRebindInterval	Specifies the timeout period after which the Cisco AR server will attempt to resolve the LDAP hostname to IP address (DNS resolution); 0 by default
DataSourceConnections	Specifies the number of concurrent connections to the LDAP server. The default value is 8.
SearchScope	Specifies how deep to search within a search path; default is *SubTree* which indicates a search of the base object and the entire subtree of which the base object distinguished name is the highest object. *Base* indicates a search of the base object only. *OneLevel* indicates a search of objects immediately subordinate to the base object, but does not include the base object.
LDAPToRadiusMappings	Optional; a list of name/value pairs in which the name is the name of the **ldap** attribute to retrieve from the user record, and the value is the name of the RADIUS attribute to set to the value of the **ldap** attribute retrieved. For example, when the **LDAPToRadiusMappings** has the entry: **FramedIPAddress = Framed-IP-Address**, the RemoteServer retrieves the **FramedIPAddress** attribute from the **ldap** user entry for the specified user, uses the value returned, and sets the Response variable **Framed-IP-Address** to that value.

Table 18-2 LDAP Remote Server Properties (continued)

Parameter	Description
LDAPToEnvironmentMappings	Optional; a list of name/value pairs in which the name is the name of the **ldap** attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the **ldap** attribute retrieved. For example, when the **LDAPToEnvironmentMappings** has the entry: **group = User-Group**, the RemoteServer retrieves the **group** attribute from the **ldap** user entry for the specified user, uses the value returned, and sets the Environment variable **User-Group** to that value.
LDAPToCheckItemMappings	Optional; list of LDAP *attribute/value* pairs which must be present in the RADIUS access request and must match, both name and value, for the check to pass.

DNS Look Up and LDAP Rebind Interval

Cisco AR provides a DNS Look-up and LDAP Rebind feature that enables you to use a smart DNS server for LDAP hostname resolution, allows you to query a DNS server at set intervals to resolve the LDAP hostname, and optionally rebind to the LDAP server, if necessary.

When you configure Cisco AR to use an LDAP directory server, you can specify the hostname of the LDAP directory server. The hostname can be a qualified or an unqualified name. You can also specify a timeout period after which Cisco AR will again resolve the hostname. If the IP address returned is different from the previous, Cisco AR establishes a new LDAP bind connection.

The DNSLookupAndLDAPRebindInterval property specifies the timeout period after which the Cisco AR server will attempt to resolve the LDAP hostname to IP address (DNS resolution). When you do not modify DNSLookupAndLDAPRebindInterval, the default value zero indicates the server will perform normal connection and binding only at start-up time or during a reload. Unless you change the default to a value greater than zero, the server will not perform periodic DNS lookups.

Cisco AR maintains and uses the existing bind connection until a new one is established to minimize any performance impact during the transfer. Cisco AR ensures that no requests are dropped or lost during the transfer to a new LDAP binding.

Set the DNSLookupAndLDAPRebindInterval using a numerical value and the letter H for hours or M for minutes, such as in the following examples:

set DNSLookupAndLDAPRebindInterval 15M—performs DNS resolution every 15 minutes

Note We recommend that you do not set DNSLookupAndLDAPRebindInterval to a value less than 15 minutes to minimize its effect on server performance.

set DNSLookupAndLDAPRebindInterval 1h—performs DNS resolution every hour

The following shows an example configuration for the DNS Look-up and LDAP Rebind feature.

Step 1 Login to the Cisco AR server, and use **aregcmd** to navigate to **//localhost/Radius/Remoteservers**. If necessary, add the LDAP server, or change directory to it.

cd /Radius/RemoteServers/ldap-serv1/

Step 2 Set the DNSLookupAndLDAPRebindInterval property to the interval time desired.

set DNSLookupAndLDAPRebindInterval 30 M

LDAP Rebind Failures

Cisco AR records any name resolution failures, bind successes and failures, and the destination hostname and IP address in the log file. At trace level 3, Cisco AR also logs the time of any new bind connections and the closing of any old bind connections.

If either the name resolution or bind attempt fail, Cisco AR continues using the existing bind connection until the timeout has expired again. If there is no existing bind connection, Cisco AR marks the remote server object as *down*.

LDAPToRadiusMappings

Configure LDAPToRadiusMappings with a list of *name/value* pairs where name is the name of the data store attribute to retrieve from the user record and the value is the name of the RADIUS attribute to set to the value of the data store attribute retrieved.

Values stored in a multi-valued field in the LDAP directory are mapped to multiple RADIUS attributes, For example, if the LDAPToRadiusMappings has the following entry:

```
tunnel-info = Cisco-AVPair
```

The following LDAP fields in the user's record will create four Cisco-AVPair attributes in the user's Access-Accept RADIUS packet:

```
tunnel-info: vpdn:tunnel-id=ssg001
tunnel-info: vpdn:tunnel-type=12tp
tunnel-info: vpdn:ip-addresses=10.2.2.2
tunnel-info: vpdn:12tp-tunnel-password=secret
```

LDAPToEnvironmentMappings

LDAPToEnvironmentMappings comprises a list of attribute name/value pairs or AV pairs where the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the LDAP attribute retrieved.

For example, when the LDAPToEnvironmentMappings has the entry: group =User-Group, the RemoteServer retrieves the attribute from the LDAP user entry for the specified user, uses the value returned, and sets the Environment variable User-Group to that value.

LDAPToCheckItemMappings

LDAPToCheckItemMappings comprises a list of LDAP AV pairs which must be present in the RADIUS access request and must match, both name and value, for the check to pass. Cisco AR will first authenticate the user's password in the Access-Request before validating the check item attributes.

Setting LDAP As Authentication and Authorization Service

Use **aregcmd** to configure the LDAP Service as the default authentication and authorization service under **/Radius** as in the following:

set DefaultAuthenticationService *AR-LDAP*

set DefaultAuthorizationService *AR-LDAP*

Saving Your Configuration

When you use **aregcmd** to **save** your configuration, Cisco AR does the following:

- Attempts to validate the configuration
- Checks for all required parameters
- Ensures there are no logic errors

If the validation is successful, Cisco AR saves the configuration to the MCD database. When you **reload**, Cisco AR shuts down any current LDAP connections and builds new connections for the configured LDAP servers.

CHAP Interoperability with LDAP

If the you plan to use CHAP authentication with an LDAP backing store, the password in LDAP must be stored as clear text. This is due to the one-way hash used by the CHAP, crypt, SHA-1, and SSHA encryption algorithms.

Allowing Special Characters in LDAP Usernames

This feature allows you to use special characters in LDAP usernames. The allowable special characters are *****, **(**,**)**, and \. These special characters can be included in the string passed to LDAP as the LDAP username value (usually the RADIUS username attribute).

The default of EscapeSpecialCharInUserName is FALSE. To enable this feature, use **aregcmd** to set the EscapeSpecialCharInUserName attribute in **/Radius/RemoteServers/ldap-server** to TRUE, as shown in the following example.

cd /Radius/RemoteServers/ldap-server

set EscapeSpecialCharInUserName TRUE

```
/Radius/RemoteServers/Ldap-Server
EscapeSpecialCharinUserName = TRUE
```

Note This feature supports the LDAP V3 library.

Dynamic LDAP Search Base

A new environment variable, Dynamic-Search-Path (see **rex.h**), can be used to set the dynamic LDAP search base. If this environment variable is defined for an LDAP service, it will override the default LDAP search base defined in the LDAP Remote Server configuration. This allows the LDAP search base to be configured on a per-user basis.

For example, you could match the search base to the organization and domain (in a Tcl script called from **/Radius/IncomingScript**):

```
set user [ $request get User-Name ]
if { [ regexp {^[^@]+@([^\.]+)\.(.+)$} $user m org domain ] } {
$environ put Dynamic-Search-Path "ou=$org,ou=people,o=$domain"
```

Analyzing LDAP Trace Logs

Cisco AR records in the log files any name resolution failures, bind successes and failures, and the destination hostname and IP address. At trace level 3, Cisco AR logs the time of any new bind connections and the closure of any old bind connections and also information about user login requests and reply messages.

Successful Bind Message

The following message is logged in the **name_radius_1_trace** file, when the Cisco AR server successfully binds to the LDAP server. In this case, spatula-u5 is the LDAP server listening on port number 389.

```
04/23/2003 11:02:57: Log: Successfully bind to LDAP Server ldapserver (spatula-u5:389)
```

Bind Failure Messages

The following messages are logged in the **name_radius_1_trace** file, when AR server fails to bind to the LDAP server.

```
04/23/2003 11:10:50: Log: Write in LDAPClient returned an error (32)

04/23/2003 11:10:50: Log: Remote LDAP Server ldapserver (spatula-u5:387): Unable to
bind to LDAP Server: Can't contact LDAP server

04/23/2003 11:10:50: Log: Remote LDAP Server ldapserver (spatula-u5:387): Failed to
open the connection to the LDAP server
```

Messages like those above could indicate that the hostname specified does not resolve to the correct IP address of the LDAP server or the configured port number might not be the port on which the LDAP server listens.

The following messages are logged in the **name_radius_1_trace** file, when AR server fails to bind to the LDAP server.

```
04/23/2003 11:45:14: Log: Remote LDAP Server ldapserver (spatula-u5:389): Unable to
bind to LDAP Server: No such object ()
```

```
04/23/2003 11:45:14: Log: Remote LDAP Server ldapserver (spatula-u5:389): Failed to
open the connection to the LDAP server
```

The Distinguished Name (DN) provided in the BindName property was invalid. The DN provided in the BindName property should contain the exact string used in the directory server to define the object.

The following messages are logged in the **name_radius_1_trace** file, when AR server fails to bind to the LDAP server.

```
04/23/2003 11:51:55: Log: Remote LDAP Server ldapserver (spatula-u5:389): Unable to
bind to LDAP Server: Invalid credentials
04/23/2003 11:51:55: Log: Remote LDAP Server ldapserver (spatula-u5:389): Failed to
open the connection to the LDAP server
```

The messages above indicate that the password provided in the BindPassword property was incorrect.

Login Failure Messages

The following messages are logged in the **name_radius_1_trace** file, when user ***jane*** tries to login. These messages indicate that user *jane* does not have a record in the directory server or the SearchPath property has an incorrect value. The SearchPath property should have the directory where the user record is stored in the directory server.

Notice how the messages specify the service, remote LDAP server, user name, and contents of the Access-Reject packet.

```
04/23/2003 11:24:17: P8457: Authenticating and Authorizing with Service AR-LDAP
04/23/2003 11:24:17: id = 5
04/23/2003 11:24:17: P8457: Remote LDAP Server ldapserver (spatula-u5: 389): Querying
LDAP server, id = 5.
04/23/2003 11:24:17: P8457: Remote LDAP Server ldapserver (spatula-u5: 389): GotLDAP
response, id = 5.
04/23/2003 11:24:17: P8457: Remote LDAP Server ldapserver (spatula-u5: 389): No
matching entries returned from LDAP query.
04/23/2003 11:24:17: P8457: User jane was not found in the LDAP store
04/23/2003 11:24:17: P8457: Rejecting request
04/23/2003 11:24:17: P8457: Rejecting request
04/23/2003 11:24:17: P8457: Trace of Access-Reject packet
04/23/2003 11:24:17: P8457: identifier = 4
04/23/2003 11:24:17: P8457: length = 35
04/23/2003 11:24:17: P8457: reqauth = 01:ad:cf:c7:4f:8e:a4:38:b0:d8:0a:e5:3d:9f:64:16
04/23/2003 11:24:17: P8457: Reply-Message = Access Denied
```

The following messages are logged in the **name_radius_1_trace** file, when user ***bob*** tries to login. These messages indicate that user *bob* tried to login with an incorrect password.

```
04/23/2003 11:36:59: P8461: Authenticating and Authorizing with Service AR-LDAP
04/23/2003 11:36:59: id = 7
04/23/2003 11:36:59: P8461: Remote LDAP Server ldapserver (spatula-u5: 389): Querying
LDAP server, id = 7.
04/23/2003 11:36:59: P8461: Remote LDAP Server ldapserver (spatula-u5: 389): Got LDAP
response, id = 7.
04/23/2003 11:36:59: P8461: Remote Server ldapserver (spatula-u5:389): User bob's
password does not match
04/23/2003 11:36:59: P8461: User bob's password does not match
04/23/2003 11:36:59: P8461: Rejecting request
04/23/2003 11:36:59: P8461: Rejecting request
04/23/2003 11:36:59: P8461: Trace of Access-Reject packet
04/23/2003 11:36:59: P8461: identifier = 6
04/23/2003 11:36:59: P8461: length = 35
04/23/2003 11:36:59: P8461: reqauth = de:8d:4b:c4:f9:c0:06:a6:98:2d:8c:e9:f3:a9:a3:c2
```

```
04/23/2003 11:36:59: P8461: Reply-Message = Access Denied
```

The following messages are logged in the **name_radius_1_trace** file, when user ***bob*** tries to login. These messages indicate the user record for user *bob* does not contain an attribute called pass. The UserPasswordAttribute property has an incorrect value called *pass*. The UserPasswordAttribute property should have the attribute name in the directory records where the user password is stored.

```
04/23/2003 12:02:09: P9865: Authenticating and Authorizing with Service AR-LDAP
04/23/2003 12:02:09: id = 2
04/23/2003 12:02:09: P9865: Remote LDAP Server ldapserver (spatula-u5: 389): Querying
LDAP server, id = 2.
04/23/2003 12:02:09: P9865: Remote LDAP Server ldapserver (spatula-u5: 389): Got LDAP
response, id = 2.
04/23/2003 12:02:09: P9865: Remote LDAP Server ldapserver (spatula-u5: 389): LDAP
entry for user bob did not have a password (" pass") attribute
04/23/2003 12:02:09: P9865: User bob's password does not match
04/23/2003 12:02:09: P9865: Rejecting request
04/23/2003 12:02:09: P9865: Rejecting request
04/23/2003 12:02:09: P9865: Trace of Access-Reject packet
04/23/2003 12:02:09: P9865: identifier = 10
04/23/2003 12:02:09: P9865: length = 35
04/23/2003 12:02:09: P9865: reqauth = 0d:b6:83:f9:e8:3d:a4:ad:f1:c9:33:72:91:0b:29:1c
04/23/2003 12:02:09: P9865: Reply-Message = Access Denied
```

Note Remember to **reload** the Cisco AR server after any changes to the LDAP server configuration.

CHAPTER 19

Using Open Database Connectivity

Cisco Access Registrar supports Open Database Connectivity (ODBC), an open specification that provides application developers a vendor-independent API with which to access data sources. Cisco AR provides a new type of RemoteServer object and a new service to support ODBC. You can use Cisco AR to authenticate and authorize access requests by querying user information through ODBC.

ODBC is an application program interface (API). Real data exchange between an application and data store is still carried out by SQL through ODBC. To achieve the most flexibility, you are required to define your own SQL using **aregcmd**. Cisco AR will register the SQL statements and send them to the data store through ODBC when required. Because you can define your own SQL, Cisco AR supports sites that have their own data stores.

ODBC is configured using **.ini** files, specifically **odbc.ini** and **odbcinst.ini**. However, you cannot create or modify these files directly. Cisco AR creates the **.ini** files after you use **aregcmd** to configure the ODBC connection. The SQL is stored in the local database (MCD). During execution, the Cisco AR server reads the local database, prepares the SQL statements, and sends the SQL to the data source.

Note Cisco AR uses its own ODBC driver manager and does not share existing ODBC drivers (if you already have ODBC installed). If you are already using ODBC, you will have to maintain two separate ODBC installations.

The ODBC memory requirement depends on your configuration. The more datasources you configure, the more memory is required. Packet processing time might increase if you configure a large number of SQL statements under SQLDefinition.

The Cisco AR 4.1 package includes some ODBC Drivers, and you should use the included driver whenever possible. If a data store's ODBC driver is not included with Cisco AR, you are required to install it. You configure the driver library using **aregcmd** to modify the associated **ini** file.

This chapter has the following sections:

Oracle Software Requirements

The Cisco AR 4.1 ODBC feature requires that you have Oracle 8.1.6, 8.1.7 or 9.0 client software installed. All Oracle client software library files are expected under **$ORACLE_HOME/lib.**

When you install Cisco AR 4.1 software, the installation process prompts you for ORACLE_HOME variable and sets it in the Cisco AR start-up script, **/etc/init.d/arserver**. Two other environment variables (ODBCINI and ODBCSYSINI) are also set in the **arserver** script. To change any of these variables, modify the **/etc/init.d/arserver** script and restart the Cisco AR server.

The following changes have been made to support Oracle 9:

- The file **liboraodbc.so** has been renamed to **liboraodbc8.so**.
- The file **liboraodbc9.so** has been added.

Configuring ODBC

You use **aregcmd** to define your ODBC configuration and SQL statements. The Cisco AR server automatically creates the **ODBC.ini** file for your driver manager and driver based on how you configure ODBC.

To use ODBC in Cisco AR, you must do the following:

1. Configure an ODBC Service
2. Configure an ODBC RemoteServer object
3. Configure an ODBC DataSource
4. Set ODBC service as the default AA service
5. Save your configuration

After you **save** and validate your configuration, it is saved in the MCD database. If you have configured an ODBC service, Cisco AR will query the MCD database and create or modify the **odbc.ini** file before it builds a connection to the database. When you reload your configuration, Cisco AR shuts down any existing ODBC connections, then queries the MCD database to create or modify the **odbc.ini** file and build a new connection for any configured ODBC Data Sources.

Configuring an ODBC Service

You configure an ODBC service under **/Radius/Services**. When you define an ODBC service under **/Radius/Services**, you must set its type to ODBC and provide the following configuration options:

Note We will use ODBC as the ODBC service name in the following examples.

```
[ //localhost/Radius/Services/ODBC ]
        Name = ODBC
        Description =
        Type = odbc
        IncomingScript~ =
        OutgoingScript~ =
        OutagePolicy~ = RejectAll
        OutageScript~ =
        MultipleServersPolicy = Failover
        RemoteServers/
```

Table 19-1 describes the ODBC service parameters.

Table 19-1 ODBC Service Parameters

Parameter	Description
Name	Required; inherited from the upper directory
Description	An optional description of the service
Type	Must be set to ODBC for ODBC service
IncomingScript	Optional
OutgoingScript	Optional
OutagePolicy	Required; must be set to AcceptAll or Drop Packet, or defaults to RejectAll
OutageScript	Optional
MultipleServersPolicy	Required; must be set to RoundRobin or defaults to Failover. When set to Failover, Cisco AR directs requests to the first server in the list until it determines the server is off-line. If so, Cisco AR redirects all requests to the next server in the list until it finds an on-line server. When set to RoundRobin, Cisco AR directs each request to the next server in the RemoteServers list in order to share the resource load across all servers in the RemoteServers list.
RemoteServers	Required list of remote servers defined under **/Radius/Services/ODBC/RemoteServers** such as **ODBC-Primary** and **ODBC-Secondary**

Configuring an ODBC RemoteServer

You must configure an ODBC RemoteServer object for each RemoteServer object you list under **/Radius/Services/ODBC/RemoteServers**. Use the **aregcmd** command **add** to add ODBC servers under **/Radius/RemoteServers**.

Table 19-2 describes the ODBC service parameters.

Table 19-2 ODBC Remote Server Parameters

Parameter	Description
Name	Required; inherited from the upper directory
Description	An optional description of the server
Protocol	Required and must be set to ODBC; no default value
ReactivateTimerInterval	Required; default is 300000 (ms)
Timeout	Required; default is 15 (seconds)
DataSourceConnections	Required; number of concurrent connections to data source (default is 8)
ODBCDataSource	Required; no default value

Table 19-2 ODBC Remote Server Parameters (continued)

Parameter	Description
SQLDefinition	SQLDefinition/ (mandatory, no default); UserPasswordAttribute = (mandatory, no default; data store field for user password) SQLStatements/ SQLStatement1/ SQLStatement2/
ODBCToRadiusMappings	(optional) A list of name and value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the RADIUS attribute to set to the value of the data store attribute retrieved. The data store attributes must match those defined in the external SQL file.
ODBCToEnvironmentMappings	(optional) A list of name and value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the ODBC attribute retrieved.
ODBCToCheckItemMappings	(optional) A list of name and value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the RADIUS attribute to be checked against the value of the data store attribute retrieved.

ODBC Data Source

ODBCDataSource is the name of the datasource to be used by the remote server. An ODBCDataSource name can be reused by multiple remote servers. You configure ODBCDataSources under **/Radius/Advanced/ODBCDataSources**. Refer to Configuring an ODBC DataSource, page 19-6, for more information.

SQL Definitions

SQLDefinitions lists the UserPasswordAttribute and one or more SQL statements, listed numerically in the order to be run. The UserPasswordAttribute represents a column in the database that contains users' password information. Individual SQLStatements are numbered SQL1 through SQL*n* under SQLStatements, as shown in the following example:

```
SQLDefinition/
    UserPasswordAttribute = asdfjkl
    SQLStatements/
        SQL1/
        SQL2/
        SQL3/
        ...
```

The following example is an SQL statement used for Authentication and Authorization:

```
SQLStatements/
    SQL1
        Name = SQL1
        Type = query (mandatory, no default; must be query)
        SQL = SQL statement (mandatory, no default)
```

```
ExecutionSequenceNumber = Sequence number for SQLStatement execution.(mandatory,
no default and must be greater than zero).
MarkerList = UserName/SQL_DATA_TYPE …… (mandatory, UserName must be defined)
```

Table 19-3 describes the SQL Statement parameters.

Table 19-3 SQL Statement Parameters

Parameter	Description
Name	Name/number of SQL statement
Type	Query (mandatory, no default value)
SQL	SQL query statement
ExecutionSequenceNumber	Sequence number for SQLStatement execution, must be greater than zero (mandatory, no default)
MarkerList	Defines all markers for the query. MarkerList uses the format ***UserName/SQL_DATA_TYPE***.

SQL Syntax Restrictions

You must observe the following SQL syntax restrictions in SQL queries for Cisco AR 4.1.

1. The SQL statement must be in the format of SELECT ... FROM ... WHERE ..." (Statements might be in lower-case.)

Note 'WHERE' is compulsory in the SQL statement.

2. Any arguments to Oracle functions like ***distinct, count*** must be given within braces, as shown in the following example:

```
select distinct(attribute),password from profiles where username=?
```

   The resulted column from ***distinct(attribute)*** will be put into *attribute* which can be used for ODBC Mappings. The actual result set from Oracle for this column would be named *distinct(attribute)*.

3. The column list in the SQL statement must be delimited with a comma **(,)** and any extra spaces between statements are ignored. Aliasing for column names in SQL is not allowed. SQLDefinition properties define the SQL you want to execute, as shown in the following example.

Specifying More Than One Search Key

You can specify more than one search key for a table in the SQL SELECT. To do so, add another search criteria to the SQL statement and add the environment variable name to the MarkerList. For example, the following query and MarkerList can be used to look up a username and CLID match.

```
select password from user_table where username = ? and clid = ?
```

In this case, the marker list would look like this:

```
UserName/SQL_CHAR clid/SQL_CHAR
```

To configure the multiple entries in the MarkerList list, surround the entire string in double quotes like the following:

```
set MarkerList "UserName/SQL_CHAR CLID/SQL_CHAR"
```

To make this work, a variable called CLID must be in the environment dictionary. You can use a script to copy the appropriate value into the variable.

ODBCToRadiusMappings

You configure ODBCToRadiusMappings with a list of *name/value* pairs where name is the name of the data store attribute to retrieve from the user record and the value is the name of the RADIUS attribute to set to the value of the data store attribute retrieved.

For example, use the following **aregcmd** command to set a value for the variable *Framed-IP-Address*:

set FramedIPAddress Framed-IP-Address

When the ODBCToRadiusMappings has this entry, the RemoteServer retrieves the attribute from the data store user entry for the specified user, uses the value returned, and sets the response variable *Framed-IP-Address* to that value.

When an SQL select statement returns more than one row for a column mapped under ODBCToRadiusMappings, multiple Radius attributes are created.

For example, consider the following SQL *select* statement with ciscoavpair configured to Cisco-AVPair under ODBCToRadiusMappings. The table.column syntax requires an SQL alias for the mapping to work, as shown in the following example:

```
SQLStatements/
    SQL1/
        select table1.abc as t1abc, password from table2 where username = ?
        Mapping: t1abc = my_mapping
```

If two rows are returned for ciscoavpair column, two Cisco-AVPair attributes will be created.

ODBCToEnvironmentMappings

Under ODBCToEnvironmentMappings there is a list of name and value pairs in which the name is the name of the data store attribute to retrieve from the user record, and the value is the name of the Environment variable to set to the value of the ODBC attribute retrieved.

For example, when the ODBCToEnvironmentMappings has the entry: group =User-Group, the RemoteServer retrieves the attribute from the ODBC user entry for the specified user, uses the value returned, and sets the environment variable User-Group to that value. When an SQL select statement returns more than one row for a column mapped under ODBCToEnvironmentMappings, the value for all rows is concatenated and assigned to the environment variable.

Configuring an ODBC DataSource

ODBCDataSource is the name of the datasource to be used by the remote server. You configure ODBCDataSources under **/Radius/Advanced/ODBCDataSources**. Multiple remote servers can use the same ODBCDataSource.

Under the ODBCDataSource object definition, a list defines **ODBC.ini** file name/value pairs for a connection. The list includes a Type field and a Driver field, different for each Driver and Data Source, to indicate its Driver and Data Source. Cisco AR 4.1 currently supports only the Easysoft Open Source Oracle Driver.

Table 19-4 describes the Easysoft Open Source Oracle Driver options.

Table 19-4 Easysoft Open Source Oracle Driver Options

Parameter	Description
Name	Name of the ODBCDataSource
Type	Required; must be Oracle_es
Driver	Required; **liboarodbc.so** (default value)
Database	Required; Oracle Client configuration database name (no default value)
UserID	Required; database user name (no default value)
Password	Optional user password; shown encrypted

Setting ODBC As Authentication and Authorization Service

Use **aregcmd** to configure the ODBC Service as the default authentication and authorization service under **//localhost /Radius** as in the following:

set DefaultAuthenticationService *odbc-service*

set DefaultAuthorizationService *odbc-service*

Note When you use an ODBC service, configure the BackingStoreDiscThreshold property under **/Radius/Advanced** to ensure that the data generated by log files do not exceed the size limit configured.

Saving Your Configuration

When you use **aregcmd** to **save** your configuration, Cisco AR attempts to validate the configuration, checks for all required parameters, and ensures there is no logic error. If the validation is successful, the configuration is saved to the MCD database. When you **reload**, Cisco AR shuts down any current ODBC connections and builds new connections for the configured ODBC Data Sources.

MySQL Support

Cisco AR 4.1 provides support for MySQL to query user records from a MySQL database and enables you to write accounting records into MySQL when using Oracle accounting. Cisco AR 4.1 has been tested with MySQL 4.0.18 and MyODBC 3.51.06 (reentrant).

MySQL Driver

You can download the MySQL driver from the MySQL website at **http://mysql.com**. You can go directly to the driver download page using the following URL:

http://dev.mysql.com/downloads/connector/odbc/3.51.html

Save the downloaded file to a temporary location such as **/tmp**. Use commands like the following to unzip and install the driver:

gunzip -c MyODBC-3.51.06-sun-solaris2.8-sparc.tar.gz | tar xvf -

ln -s MyODBC-3.51.06-sun-solaris2.8-sparc myodbc

Configuring a MySQL Datasource

To configure the Cisco AR server to query records form a MySQL database, configure the following:

- ODBCDataSource object
- RemoteServer object
- ODBC service
- Default AA services

Step 1 Log in to the Cisco AR server and launch **aregcmd**.

Log in as a user with administrative rights such as user **admin**.

Step 2 Change directory to the **/Radius/Advanced/ODBCDataSources** and add a new ODBCDataSource.

cd /Radius/Advanced/ODBCDataSources

add mysql

Step 3 Set the new ODBCDatasource type to myodbc.

cd mysql

```
[ //localhost/Radius/Advanced/ODBCDataSources/mysql ]
    Name = mysql
    Description =
    Type =
```

set type myodbc

The following is the default configuration for an ODBCDataSource object of type myodbc:

```
[ //localhost/Radius/Advanced/ODBCDataSources/mysql ]
    Name = mysql
    Description =
    Type = myodbc
    Driver =
    UserID =
    Password =
    DataBase =
    Server =
    Port = 3306
```

Step 4 Set the Driver property to the path of the MyODBC library. Use a command like the following:

set driver /scratch/myodbc/libmyodbc3_r.so

Step 5 Set the UserID property to a valid username for the MyODBC database and provide a valid password for this user.

set userid ar-mysql-user

set password biscuit

Step 6 Provide a DataBase name and the name of the Cisco AR RemoteServer object to associate with the ODBCDataSource.

set database *database_name*

set server *remote_server_name*

Step 7 Change directory to **/Radius/RemoteServers** and add a RemoteServer object to associate with the new ODBCDatasource.

cd /Radius/RemoteServers

add mysql

Step 8 Change directory to the new RemoteServer and set its protocol to odbc.

cd mysql

set protocol odbc

Step 9 Set the ODBCDataSource property to the name of the ODBCDataSource to associate with this RemoteServer object.

set ODBCDataSource mysql

Step 10 Change directory to **/Radius/Services** and add an ODBC service as described in Configuring an ODBC Service, page 19-2.

Step 11 Change directory to **/Radius** and set the DefaultAuthenticationService and DefaultAuthorizationService properties to the ODBC service added in the previous step.

Example Configuration

The following shows an example configuration for a MySQL ODBC data source. See Configuring an ODBC DataSource, page 19-6 for more information.

```
[ //localhost/Radius/Advanced/ODBCDataSources/mysql ]
    Name = mysql
    Type = myodbc
    Driver = /tmp/libmyodbc3_r.so
    UserID = mysql
    Password = <encrypted>
    DataBase = test
    Server = mysql-a
    Port = 3306
```

The following shows an example configuration for a RemoteServer. See Configuring an ODBC RemoteServer, page 19-3 for more information.

```
[ //localhost/Radius/RemoteServers/mysql-a ]
    Name = mysql
    Description =
    Protocol = odbc
    ReactivateTimerInterval = 300000
    Timeout = 15
    DataSourceConnections = 8
    ODBCDataSource = mysql
    KeepAliveTimerInterval = 0
    SQLDefinition/
    UserPasswordAttribute = asdfjkl
    SQLStatements/
        SQL1/
           Name = SQL1
           Type = query (mandatory, no default; must be query)
           SQL = SQL statement (mandatory, no default)
           ExecutionSequenceNumber = Sequence number for SQLStatement
           execution.(mandatory, no default and must be greater than zero).
           MarkerList = UserName/SQL_DATA_TYPE …… (mandatory, UserName must be defined)
        SQL2/
        SQL3/
    ODBCToRadiusMappings/
    ODBCToEnvironmentMappings/
    ODBCToCheckItemMappings/
```

The following shows an example configuration for an ODBC service. See Configuring an ODBC Service, page 19-2 for more information.

```
[ //localhost/Radius/Services/ODBC ]
    Name = ODBC
    Description =
    Type = ODBC
    IncomingScript~ =
    OutgoingScript~ =
    OutagePolicy~ = RejectAll
    OutageScript~ =
    MultipleServersPolicy = Failover
        RemoteServers/
           1.  mysql-a
```

The following shows an example configuration where the DefaultAuthenticationService and DefaultAuthorizationService properties have been set to the ODBC service.

```
[ //localhost/Radius ]
    Name = Radius
    Description =
    Version = 4.1.2
    IncomingScript~ =
    OutgoingScript~ =
    DefaultAuthenticationService~ = ODBC
    DefaultAuthorizationService~ = ODBC
```

CHAPTER 20

Using SNMP

This chapter provides information about Cisco Access Registrar support for SNMP.

Overview

Cisco AR provides SNMP MIB and trap support for users of network management systems. The supported MIBs enable the network management station to collect state and statistic information from an Cisco AR server. The traps enable Cisco AR to notify interested network management stations of failure or impending failure conditions.

Cisco AR supports the MIBs defined in the following RFCs:

- RADIUS Authentication Client MIB, RFC 2618
- RADIUS Authentication Server MIB, RFC 2619
- RADIUS Accounting Client MIB, RFC 2620
- RADIUS Accounting Server MIB, RFC 2621

Cisco AR MIB support enables a standard SNMP management station to check the current state of the server as well as the statistics on each client or each proxied remote server.

Cisco AR Trap support enables a standard SNMP management station to receive trap messages from an Cisco AR server. These messages contain information indicating that either the server was brought up or down, or that the proxied remote server is down or has come back online.

Supported MIBs

The MIBs supported by Cisco AR enable a standard SNMP management station to check the current state of the server and statistics for each client or proxied remote server.

RADIUS-AUTH-CLIENT-MIB

The RADIUS-AUTH-CLIENT-MIB describes the client side of the RADIUS authentication protocol. The information contained in this MIB is useful when an Cisco AR server is used as a proxy server.

RADIUS-AUTH-SERVER-MIB

The RADIUS-AUTH-SERVER-MIB describes the server side of the RADIUS authentication protocol. The information contained in this MIB describes managed objects used for managing a RADIUS authentication server.

RADIUS-ACC-CLIENT-MIB

The RADIUS-ACC-CLIENT-MIB describes the client side of the RADIUS accounting protocol. The information contained in this MIB is useful when an Cisco AR server is used for accounting.

RADIUS-ACC-SERVER-MIB

The RADIUS-ACC-CLIENT-MIB describes the server side of the RADIUS accounting protocol. The information contained in this MIB is useful when an Cisco AR server is used for accounting.

SNMP Traps

The traps supported by Cisco AR enable a standard SNMP management station to receive trap messages from an Cisco AR server. These messages contain information indicating whether a server was brought up or down, or that the proxied remote server is down or has come back online.

A trap is a network message of a specific format issued by an SNMP entity on behalf of a network management agent application. A trap is used to provide the management station with an asynchronous notification of an event.

When a trap is generated, a single copy of the trap is transmitted as a trap PDU to each destination contained within a list of trap recipients.

The list of trap recipients is shared by all events and is determined at server initialization time along with other trap configuration information. The list of trap recipients dictates where Cisco AR traps are directed.

The configuration of any other SNMP agent on the host is ignored. By default, all traps are enabled but no trap recipients are defined. By default, no trap is sent until trap recipients are defined.

Traps are configured using the command line interface (CLI). After configuring traps, the configuration information is re initialized when a server reload or restart occurs.

When you configure traps, you must provide the following information:

- List of trap recipients (community string for each)
- Suppressing traps for any type of message
- Frequency of traps for any type of message

Supported Traps

The traps supported by Cisco AR enable the Cisco AR server to notify interested management stations of events, failure, or impending failure conditions. Traps are a network message of a specific format issued by an SNMP entity on behalf of a network management agent application. Traps are used to provide the management station with an asynchronous notification of an event.

carServerStart

carServerStart signifies that the server has started on the host from which this notification was sent. This trap has one object, *carNotifStartType,* which indicates the start type. A *firstStart* indicates this is the server process' first start. *reload* indicates this server process has an internal reload. This typically occurs after rereading some configuration changes, but *reload* indicates this server process did not quit during the reload process.

carServerStop

carServerStop signifies that the server has stopped normally on the host from which this notification was sent.

carInputQueueFull

carInputQueueFull indicates that the percentage of use of the packet input queue has reached its high threshold. This trap has two objects:

- *carNotifInputQueueHighThreshold*—indicates the high limit percentage of input queue usage
- *carNotifInputQueueLowThreshold*—indicates the low limit percentage of input queue usage

By default, *carNotifInputQueueHighThreshold* is set to 90% and *carNotifInputQueueLowThreshold* is set to 60%.

Note The values for these objects cannot be changed at this time. You will be able to modify them in a future release of Cisco AR.

After this notification has been sent, another notification of this type will not be sent again until the percentage usage of the input queue goes below the low threshold.

If the percentage usage reaches 100%, successive requests might be dropped, and the server might stop responding to client requests until the queue drops down again.

carInputQueueNotVeryFull

carInputQueueNotVeryFull indicates that the percentage usage of the packet input queue has dropped below the low threshold defined in *carNotifInputQueueLowThreshold*. This trap has two objects:

- *carNotifInputQueueHighThreshold*—indicates the high limit percentage of input queue usage
- *carNotifInputQueueLowThreshold*—indicates the low limit percentage of input queue usage

After this type of notification has been sent, it will not be sent again until the percentage usage goes back up above the high threshold defined in *carNotifInputQueueHighThreshold*.

carOtherAuthServerNotResponding

carOtherAuthServerNotResponding indicates that an authentication server is not responding to a request sent from this server. This trap has three objects:

- *radiusAuthServerAddress*—indicates the identity of the concerned server
- *radiusAuthClientServerPortNumber*—indicates the port number of the concerned server
- *carAuthServerType*—indicates the type of the concerned server

The index of these three objects identifies the entry in *radiusAuthServerTable* and *carAccServerExtTable* which maintains the characteristics of the concerned server.

Note One should not rely solely on **carOtherAuthServerNotResponding** for server state. Several conditions, including a restart of the Cisco AR server, could result in either multiple *carOtherAuthServerNotResponding* notifications being sent or in a *carOtherAuthServerResponding* notification *not* being sent. NMS can query the *carAuthServerRunningState* in *carAuthServerExtTable* for the current running state of this server.

carOtherAuthServerResponding

carOtherAuthServerResponding signifies that an authentication server which had formerly been in a *down* state is now responding to requests from the Cisco AR server. This trap has three objects:

- *radiusAuthServerAddress*—indicates the identity of the concerned server
- *radiusAuthClientServerPortNumber*—indicates the port number of the concerned server
- *carAuthServerType*—indicates the type of the concerned server

The index of these three objects identifies the entry in *radiusAuthServerTable* and *carAccServerExtTable* which maintains the characteristics of the concerned server.

One should not rely on receiving this notification as an indication that all is well with the network. Several conditions, including a restart of the Cisco AR server, could result in either multiple *carOtherAuthServerNotResponding* notifications being sent or in a *carOtherAuthServerResponding* notification *not* being sent. The NMS can query the *carAuthServerRunningState* in *carAuthServerExtTable* for the current running state of this server.

carOtherAccServerNotResponding

carOtherAuthServerNotResponding signifies that an accounting server is not responding to the requests sent from this server. This trap has three objects:

- *radiusAccServerAddress*—indicates the identity of the concerned server
- *radiusAccClientServerPortNumber*—indicates the port number of the concerned server
- *carAcchServerType*—indicates the type of the concerned server

The index of these three objects identifies the entry in *radiusAuthServerTable* and *arAccServerExtTable* which maintains the characteristics of the concerned server.

One should not solely rely on this for server state. Several conditions, including the restart of the Cisco AR server, could result in either multiple *carOtherAccServerNotResponding* notifications being sent or in a *carOtherAccServerResponding* notification *not* being sent. The NMS can query the *carAccServerRunningState* in *carAccServerExtTable* for current running state of this server.

carOtherAccServerResponding

carOtherAccServerResponding signifies that an accounting server that had previously sent a *not responding* message is now responding to requests from the Cisco AR server. This trap has three objects:

- *radiusAccServerAddress*—indicates the identity of the concerned server
- *radiusAccClientServerPortNumber*—indicates the port number of the concerned server
- *carAccServerType*—indicates the type of the concerned server

The index of these three objects identifies the entry in *radiusAuthServerTable* and *arAccServerExtTable* which maintains the characteristics of the concerned server.

One should not rely on the reception of this notification as an indication that all is well with the network. Several conditions, including the restart of the Cisco AR server, could result in either multiple *carOtherAccServerNotResponding* notifications being sent or in a **carOtherAccServerResponding** notification *not* being sent. The NMS can query the *carAccServerRunningState* in *carAccServerExtTable* for the current running state of this server.

carAccountingLoggingFailure

carAccountingLoggingFailure signifies that this Cisco AR server cannot record accounting packets locally. This trap has two objects:

- *carNotifAcctLogErrorReason*—indicates the reason packets cannot be recorded locally
- *carNotifAcctLogErrorInterval*—indicates how long to wait until another notification of this type might be sent. A value of 0 (zero) indicates no time interval checking, meaning that no new notification can be sent until the error condition is corrected.

Configuring Traps

The Cisco AR SNMP implementation uses various configuration files to configure its applications.

Directories Searched

Configuration files can be found and read from numerous places. By default, SNMP applications look for configuration files in the following three directories (in the order listed):

1. **/usr/local/share/snmp/snmp.conf**

   This directory contains common configuration for the agent and the application. Refer to man page **snmp.conf(5)** for details.

2. **/usr/local/share/snmp/snmpd.conf**
3. **/usr/local/share/snmp/snmp.local.conf**

   This directory configures the agent. Refer to man page **snmp.conf(5)** for details.

In each of these directories, an SNMP application looks for files with the extension ***.conf***. The application also looks for configuration files in default locations where a configuration file can exist for any given configuration file type.

These files are optional and are only used to configure the extensible portions of the agent, the values of the community strings, and the optional trap destinations. By default, the first community string (“public” by default) is allowed read-only access and the second (“private” by default) is allowed write access, as well. The third to fifth community strings are also read-only.

Additionally, the above default search path can be over-ridden by setting the environmental variable SNMPCONFPATH to a colon-separated list of directories to search.

Finally, applications that store persistent data will also look for configuration files in the **/var/snmp** directory.

Configuration File Types

Each application can use multiple configuration files, which will configure various different aspects of the application. For instance, the SNMP agent (**snmpd**) knows how to understand configuration directives in both the **snmpd.conf** and the **snmp.conf** files. In fact, most applications understand how to read the contents of the **snmp.conf** files. Note, however, that configuration directives understood in one file might not be understood in another file. For further information, read the associated manual page with each configuration file type. Also, most of the applications support a '-H' switch on the command line that will list the configuration files it will look for and the directives in each one that it understands.

The **snmp.conf** configuration file is intended to be a application suite-wide configuration file that supports directives that are useful for controlling the fundamental nature of all of the SNMP applications, such as how they all manipulate and parse the textual SNMP MIB files.

Switching Configuration Files in Mid-File

It's possible to switch in mid-file the configuration type that the parser is supposed to be reading. Since that output for the agent by default, but you didn't want to do that for the rest of the applications (for example, **snmpget** and **snmpwalk**, you would need to put a line like the following into the **snmp.conf** file.

```
dumpPacket true
```

But, this would turn it on for all of the applications. So, instead, you can put the same line in the snmpd.conf file so that it only applies to the snmpd demon. However, you need to tell the parser to expect this line. You do this by putting a special type specification token inside a square bracket ([ ]) set. In other words, inside your **snmpd.conf** file you could put the above **snmp.conf** directive by adding a line like the following:

```
[snmp] dumpPacket true
```

This tells the parser to parse the above line as if it were inside a **snmp.conf** file instead of an snmpd.conf file. If you want to parse a bunch of lines rather than just one then you can make the context switch apply to the remainder of the file or until the next context switch directive by putting the special token on a line by itself:

```
# make this file handle snmp.conf tokens:
[snmp]
dumpPacket true
logTimestamp true
# return to our original snmpd.conf tokens:
[snmpd]
rocommunity mypublic
```

Community String

A community string is used to authenticate the trap message sender (SNMP agent) to the trap recipient (SNMP management station). A community string is required in the list of trap receivers.

CHAPTER 21

Backing Up the Database

This chapter describes the Cisco Access Registrar shadow backup facility, which ensures a consistent snapshot of Cisco AR's database for backup purposes.

Because the Cisco AR's database (called MCD) does a variety of memory caching, and might be active at any time, you cannot simply rely on doing system backups to protect the data in the database. At the time you run a system backup, there could be Cisco AR operations in progress that cause the data copied to the system backup tape to be inconsistent and unusable as a replacement database.

To ensure a consistent backup, Cisco AR uses a shadow backup facility. Once a day, at a configurable time, Cisco AR suspends all activity to the database and takes a snapshot of the critical files. This snapshot is guaranteed to be a consistent view of the database, and it is preserved correctly on a system backup tape.

Configuration

The only configuration for this facility is through a single entry in the system Registry at **$INSTALL/conf/car.conf** is the registry path to this item.

This entry is a string that represents the time-of-day at which the shadow backup is scheduled to occur (in 24 hour HH:MM format). The default is 23:45.

When you remove this entry or set it to an illegal value (for example, anything that does not begin with a digit), backups are suppressed. The server is otherwise unaffected.

Command Line Utility

In addition to being available at a scheduled time of day, you can also force a shadow backup by using the **mcdshadow** utility located in the **$INSTALL/bin** directory. There are no command-line arguments.

This might take a few minutes to complete as a full copy of the database is created.

Recovery

When it is necessary to use the shadow backup to recover data, either because the regular working database has been corrupted by a system crash, or because the disk on which it resides has become corrupted, perform the following:

Step 1 Stop all Cisco AR servers.

Step 2 Make sure three files (**mcddb.d01**, **mcddb.d02**, and **mcddb.d03**) exist in the **$INSTALL/data/db.bak** directory.

Step 3 Copy the files into the **$INSTALL/data/db** directory. Do not move them because they might be needed again.

Step 4 Change directory to the **$INSTALL/data/db** directory.

```
cd $INSTALL/data/db
```

Step 5 Rebuild the key files by typing the command:

```
$INSTALL/bin/keybuild mcddb
```

This might take several minutes.

Step 6 As a safety check, run **$INSTALL/bin/dbcheck mcddb** (UNIX) to verify the integrity of the database. Note, you must be user **root** to run **dbcheck**.

No errors should be detected.

mcdshadow Command Files

The **mcdshadow** command uses the files listed in Table 21-1.

Table 21-1 mcdshadow Files

File	Description
mcddb.dbd	Template file that describes the low-level data schema for the Raima run-time library.
mcddb.k01 **mcddb.k02** **mcddb.k03**	Key files that contain the data that is redundant with the data files. Cisco AR does not back up these files because they can be completely rebuilt with the **keybuild** command.
mcdcd.d01 **mcdcd.d02** **mcdcd.d03**	Data files that contain the backup.
mcdConfig.txt	Text file from which Cisco AR configures the initial at-install-time database.
mcdschema.txt	Text file that contains a version number denoting the level of the schema contained in the dbd file. Cisco AR will not attempt to open the database unless the number in this file matches a constant that is hard-coded in the libraries. If the result of the mcdshadow command (which uses copies of the data files) is divorced from its original mcdschema.txt, you will not be able to run Cisco AR.
vista.taf **vista.tcf** **vista.tjf**	Working files used by the Raima run-time library to ensure transactional integrity.

CHAPTER 22

Using the REX Accounting Script

This chapter describes how to use the REX Accounting script. The REX Accounting Script (RAS) writes RADIUS Accounting requests to a local, flat file and is included as an option for Cisco Access Registrar. Is is designed to be attached to a Cisco AR IncomingScript or OutgoingScript point. When used in conjunction with the Cisco AR built-in proxy support, the server will concurrently store a local copy of an Accounting request and proxy another copy to another RADIUS server.

Note Unless you require log rotation at an exact time or when the accounting log reaches a specific file size, Cisco recommends that you use service grouping to log and proxy accounting packets.

RAS can be attached to more than one Cisco AR extension point. For example, in a dial-up resale scenario, you might configure Cisco AR to proxy Accounting requests to many different Remote Servers (by realm). For some subset of those, you might want to keep a local copy of the Accounting requests. In this case, RAS could be installed as the IncomingScript on just the Services for which a local copy is desired.

Note Also included is the **DropAcctOnOff** Script. This script causes Cisco AR to drop all Accounting-Requests with an **Acct-Status-Type** of **Accounting-On** or **Accounting-Off**.

Building and Installing the REX Accounting Script

To build and install RAS you must do the following:

Step 1 Change directory to **$INSTALL/examples/rexacctscript**.

Step 2 Modify the **Makefile** to ensure the **AR_INSTALL_DIR** variable points to the directory where the Cisco AR software was installed, and then choose a compiler (**gcc** or SUNPro **CC**).

Step 3 From the command line prompt, type:

host% **make**

Step 4 Login as user **root**.

Step 5 From the command line prompt, type:

host# **make install**

Configuring the Rex Accounting Script

To configure RAS, do the following:

Step 1 Start the Cisco AR **aregcmd** configuration utility and login:

> $INSTALL/usrbin/aregcmd -C localhost -N admin -P aicuser

```
Access Registrar Configuration Utility Version 1.3

Copyright (C) 1995-1998 by American Internet Corporation, and 1998-1999 by Cisco Systems,
Inc. All rights reserved.

Logging in to localhost

[ //localhost ]

      LicenseKey = xxxx-xxxx-xxxx-xxxx
      Radius/
      Administrators/

Server 'Radius' is Running, its health is 10 out of 10

-->
```

Step 2 Using **aregcmd**, create a new Cisco AR Script object:

--> cd /Radius/Scripts

```
[ //localhost/Radius/Scripts ]
      Entries 1 to 20 from 39 total entries
      Current filter: <all>
      ACMEOutgoingScript/
      AscendIncomingScript/
```

<... other output deleted...>

--> add LocalAccounting

```
Added LocalAccounting
```

Step 3 Using **aregcmd**, fill in the details of the new Cisco AR Script object. See Chapter 4, "Access Registrar Server Objects," for more details.

--> cd LocalAccounting

```
[ //localhost/Radius/Scripts/LocalAccounting ]
      Name = LocalAccounting
      Description =
      Language =
      Filename =
      EntryPoint =
      InitEntryPoint =
      InitEntryPointArgs =
```

--> set Desc "Log Accounting requests to local file"

```
Set Description "Log Accounting requests to local file"
```

--> set lang REX

```
Set Language REX
```

--> set filename libRexAcctScript.so

```
Set Filename libRexAcctScript.so
```

--> set entry RexAccountingScript

```
Set EntryPoint RexAccountingScript
```

--> set initentrypoint InitRexAccountingScript

```
Set InitEntryPoint InitRexAccountingScript
```

--> set initentrypointargs "-f Accounting -t 1:15"

```
Set InitEntryPointArgs "-f Accounting -t 1:15"
```

--> ls

```
[ //localhost/Radius/Scripts/LocalAccounting ]
      Name = LocalAccounting
      Description = "Log Accounting requests to local file"
      Language = REX
      Filename = libRexAcctScript.so
      EntryPoint = RexAccountingScript
      InitEntryPoint = InitRexAccountingScript
      InitEntryPointArgs = "-f Accounting -t 1:15"

-->
```

Step 4 Using **aregcmd**, attach the new Cisco AR Script object to the appropriate Cisco AR Scripting point. See Chapter 4, "Access Registrar Server Objects," for more details.

--> set /radius/IncomingScript LocalAccounting

```
Set /Radius/IncomingScript LocalAccounting
```

Step 5 Using **aregcmd**, save the configuration modifications:

--> save

```
Validating //localhost...
Saving //localhost...
```

Step 6 Using **aregcmd**, reload the server:

--> reload

```
Reloading Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10
```

Specifying REX Accounting Script Options

The REX Accounting Script supports the options shown in Table 22-1.

Table 22-1 REX Accounting Script Supported Options

Option	Description
-f <*filename*>	Required. Specify the name of the output file.
-t <HH:MM[:SS]>	Specify a time of day to roll the output file. Note, this is time on the 24-hour clock, for example, 00:05 = 12:05am, 13:30 = 1:30pm. This option can not be used with the **-i** option.
-i <*seconds*>	Specify the number of seconds between rolling the output file, beginning at start-up. This option can not be used with the **-t** option.

Table 22-1 REX Accounting Script Supported Options (continued)

Option	Description
-s <*size*>[k|m|g]	Specify the maximum size for an output file. When the file reaches this size, it will be rolled. When specifying the <*size*> option, a <*unit*> can be included. When a <*unit*> is not included, the <*size*> is in bytes. Note, do not use a space character between the <*size*> and <*unit*> options. <*unit*> can be either: k = 1K, m = 1Meg, g = 1Gig.
-g	Use GMT whenwriting the date/time in the Accounting output file for each record (default is local time).
-G	Use GMT when naming rolled output files (default is local time).
-A	Process all packets, not just Accounting-Requests.
-I	Ignore errors when processing packets, always return successfully.
-a <*buffer-count*>	Pre-allocate this many Accounting buffers to improve performance.
-T <*trace-level*>	Set the trace level. This trace info appears in the output file (as its written by the background thread which no longer has a packet to use for logging or tracing.)
-O <*script-description*>	Call another REX extension before calling the **RexAcctScript**.
-o <*script-description*>	Call another REX extension after calling the **RexAcctScript**.

Example Script Object

This is an example of what a Cisco AR Script object using RAS might look like when viewed in the Cisco AR configuration utility, **aregcmd**:

```
[ //localhost/Radius/Scripts/REX-Accounting-Script ]
      Name = REX-Accounting-Script
      Description =
      Language = REX
      Filename = librexacctscript.so
      EntryPoint = RexAccountingScript
      InitEntryPoint = InitRexAccountingScript
      InitEntryPointArgs = "-f Accounting -t 16:20 -s 100k -o
         libRexAcctScript.so:DropAcctOnOff"
```

This example causes RAS to write to a file called **Accounting.log** (in the **logs** directory of the installation tree). The file rolls every day at 4:20pm (local time), as well as whenever it grows larger than 100k in size. RAS also runs the **DropAcctOnOff** script against every packet, after it has processed the packet.

CHAPTER 23

Logging Syslog Messages

Logging messages via syslog provides centralized error reporting for Cisco Access Registrar. Local logging and syslog logging can be turned on or off at any time by modifying the control flags in the **$INSTALLPATH/conf/car.conf** file.

Logging syslog messages requires a UNIX host running a ***syslog daemon*** as a receiver for Cisco AR messages. Cisco AR and the syslog daemon can be running on the same host or different hosts.

This chapter has the following sections:

syslog Messages

Messages sent to the following logs will be forwarded to **syslog** server in a slightly different format. The logs are:

- aregcmd_log
- config_mcd_[1..n]_log
- name_radius_[1..n]_log
- agent_server_[1..n]_log

Messages less than 1024 bytes in length display in the following format:

```
MMM DD hh:mm:ss hostname %CAR-[severity]-[mnemonic]: [#n], [System|Server]:
message_description
```

Where:

MMM DD is the month and date that the message is received by the syslog server.

hh:mm:ss is the arrival time of the message.

hostname is the name of the syslog server.

severity is one of the following levels:

0 - emergency

1 - alert

2 - critical

3 - error

4 - warning

5 - notification

6 - informational

7 - debugging

mnemonic can be ***aregcmd***, ***name_radius***, ***agent_server*** and ***config_mcd*** for the identification of AR-relative subsystems.

#n is the id for the components: ***name_radius***, ***agent_server***, and ***config_mcd***

message_description provides detailed information of the message.

Messages greater than 1024 bytes in length display in multiple lines. At the end of each 1024 bytes line, three dots indicate a continuation of the message as follows:

```
MMM DD hh:mm:ss hostname %CAR-[severity]-[mnemonic]: [#n], [System|Server]:
message_description: Configuration: text and more message text and more message text
and more message text and more message text and more message text and more message
text and more message text and more message text and more message text and more
message text and more message text and more message text and more message text and
more message text and more message text and more message text and more message text
and more message text and more message text and more message text and more message
text and more message text and more message text and more message text ...
```

The continuation of a message begins with three dots as follows:

```
MMM DD hh:mm:ss hostname %CAR-[severity]-[mnemonic]: [#n], [System|Server]:
message_description: Configuration: ... text and more message text and more message
text and more message text and more message text and more message text and more
message text and more message text and more message text and more message text and
more message text and more message text and more message text
```

Example 1

```
May 19 14:28:44 dwlau-ultra2.cisco.com
%CAR-3-name_radius: #1, System: Remote LDAP Server.Unable to bind.
```

Example 2

```
May 19 14:28:45 dwlau-ultra2.cisco.com
%CAR-6-name_radius: #1, Server: Stopping server
```

Configuring Message Logging (Solaris)

Message logging is on by default, and all logs are stored in the **$INSTALL/logs** directory. To turn logging off, or to change the location where logs are stored, you must modify the **$INSTALLPATH/conf/car.conf** file.

In **$INSTALLPATH/conf/car.conf** file, the following lines control logging.

```
LOCAL_LOGGING [ON|OFF]
LOGDIR full_path
DATADIR full_path
SYSLOG_LOGGING [ON|OFF]
SERVER_IP_ADDRESS [ip_address]
FACILITY_LOCAL_NUMBER [0..7]
```

Where:

LOCAL_LOGGING enables (ON) or disables (OFF) the local logging function. (Local logging is on by default.)

LOGDIR specifies a full pathname to a different local log directory.

DATADIR specifies a full pathname to a different data directory.

SYSLOG_LOGGING enables (ON) or disables (OFF) the syslog logging function. (syslog logging is on by default.)

SERVER_IP_ADDRESS specifies the IP address of the host to which AR will send syslog messages.

FACILITY_LOCAL_NUMBER specifies the facility being used by the syslogd.

The following is an example

```
LOCAL_LOGGING OFF
SYSLOG_LOGGING ON
SERVER_IP_ADDRESS 209.165.200.224
FACILITY_LOCAL_NUMBER 7
```

Note You must first stop the Cisco AR server prior to changing the **car.conf** file, then restart the server. If you change the directory location where logs or database data are stored, you should also copy all log files or data files to that same directory before restarting the Cisco AR server.

Configuring Message Logging (Linux)

To enable **syslog** logging in Linux, you must modify the **syslog** file in the **/etc/sysconfig** directory. The following is the default syslog file.

```
# Options to syslogd
# -m 0 disables 'MARK' messages.
# -r enables logging from remote machines
# -x disables DNS lookups on messages recieved with -r
# See syslogd(8) for more details
```

```
SYSLOGD_OPTIONS="-m 0"
# Options to klogd
# -2 prints all kernel oops messages twice; once for klogd to decode, and
#    once for processing with 'ksymoops'
# -x disables all klogd processing of oops messages entirely
# See klogd(8) for more details
KLOGD_OPTIONS="-x"
```

To enable logging of **syslog** messages, you must enable the **syslog** daemon to listen on port 514 by adding the -r flag to the SYSLOGD_OPTIONS line as follows:

```
SYSLOGD_OPTIONS=”-m 0 -r”
```

Changing Log Directory

You can change the directory where local log messages are stored by adding the following line in the **$INSTALLPATH/conf/car.conf** file.

```
LOGDIR full_path
```

Where *full_path* is a full path to the directory where you want to store the log messages. For example, to store all system logs in **/var/log/AICar1**, add the following line in the **$INSTALLPATH/conf/car.conf** file:

```
LOGDIR /var/log/AICar1
```

You must first stop the Cisco AR server prior to changing the **car.conf** file. After changing the **car.conf** file, copy all existing log files to the new directory, then restart the server.

Note Specifying a path for local logging does not affect the storage location of syslog messages.

Configuring syslog Daemon (syslogd)

You must specify the facility from which *syslogd* will receive messages and the file into which the messages will be deposited.

In the syslog server's **/etc/syslog.conf** file, the following line might be needed.

```
local<n>.info <tab> <tab> <tab> /var/log/filename.log
```

Note Use at least one <tab> as a field separator.

Where:

local*n*—is the facility being used for syslogd; ***n*** must be a value from 0-7 and match the FACILITY_LOCAL_NUMBER used in AR's **car.conf** file.

/var/log/—is the path to the file that stores **syslogd** messages.

filename.log—is the file that stores **syslogd** messages. You can give this file a name of your choice.

Creating a Log File

To create a syslog log file, complete the following steps:

Step 1 Log in as user ***root***.

Step 2 Enter the following command, where ***filename.log*** is a name you choose.

touch *filename.log*

Step 3 Change permissions on the syslog log file by entering the following:

chmod 664 *filename.log*

Restarting syslogd

To restart the **syslog** daemon, log in as user ***root*** and enter the following commands:

/etc/init.d/syslog stop

/etc/init.d/syslog start

Managing the Syslog File

Left unmanaged, the **syslog** file will grow in size over time and eventually fill all available disk space in its partition. Cisco AR writes log files and session data (to persist user sessions) in the same disk partition where Cisco AR is installed.

In normal operation, log files consume a large amount of disk space. If log files are not managed regularly, Cisco AR might not have sufficient disk space to write session data. To avoid this, you should move the Cisco AR log files directory to a different disk partition than the one where Cisco AR writes session data, as described in Changing Log Directory.

Using a cron Program to Manage the syslog Files

Cisco recommends that you use the **cron** program to manage the **syslog** files.

The following example **crontab** file performs a weekly archival of the existing **syslog** file (named **ar_syslog.log** in this example). This scheme keeps the previous two week's worth of **syslog** files.

```
#
#  At 02:01am on Sundays:
#  Move a weeks worth of 'ar_syslog.log' log messages to 'ar_syslog.log.1'.
#  If there was a 'ar_syslog.log.1' move it to 'ar_syslog.log.2'.
#  If there was a 'ar_syslog.log.2' then it is lost.
01 02 * * 0 cd /var/log;
if [ -f ar_syslog.log ];
then if [ -f ar_syslog.log.1 ];
then /bin/mv ar_syslog.log.1 ar_syslog.log.2;
fi;
```

```
/usr/bin/cp ar_syslog.log ar_syslog.log.1;
>ar_syslog.log;
fi
```

Note Consider using move (**mv**) or copy (**cp**) commands to store the previous week's syslog files in a different disk partition to reserve space for the current syslog file.

To add this **crontab** segment to the existing **cron** facility in **/usr/spool/cron/crontabs** directory, complete the following steps at the syslog server console.

Step 1 Log in as user ***root***.

Step 2 Enter the following command:

crontab -e

Server Up/Down Status Change Logging

Cisco AR supports RADIUS server up/down detection and logging. The information messages are saved in the **$INSTALL/logs/name_radius_1_log** file where **$INSTALL** is the Cisco AR installation directory. Each message consists of a header and a message description.

Header Formats

The format of a header entry is:

mm/*dd*/*yyyy HH*:*MM*:*SS* name/radius/*n* Error Server 0

Example Log Messages

Following are the descriptions and types of messages that can be found within the *<AR_install_dir>***/logs/name_radius_1_log** file.

1. Cisco AR detects a Remote Server when it responds for the first time or after it is reentered into Cisco AR's server pool for retry. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) is UP!

   The following is an example header and message:

   ```
   09/14/1999 17:56:32 name/radius/1 Error Server 0
   Remote Server dave-ultra (171.69.237.99:1645) is UP!
   ```

   Cisco AR detects the Remote Server is not responding to its request. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) is DOWN!

   The following is an example header and message:

   ```
   09/14/1999 17:57:12 name/radius/1 Error Server 0 Remote
   server dave-ultra (171.69.237.99:1645) is DOWN!
   ```

2. Cisco AR receives no response from theRemote Server after the server is reentered into Cisco AR's server pool for retry. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) remains DOWN!

   The following is an example header and message:

   ```
   09/14/1999 17:56:32 name/radius/1 Error Server 0 Remote
   server dave-ultra (171.69.237.99:1645) remains DOWN!
   ```

3. The Remote Server is responding to the first retry but not the initial request. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) is UP but slow!

   The following is an example header and message:

   ```
   09/14/1999 17:56:32 name/radius/1 Error Server 0 Remote
   server dave-ultra (171.69.237.99:1645) is UP but slow!
   ```

4. The Remote Server is responding to the second retry request but not the initial request or the first retry request. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) is UP but very slow!

   The following is an example header and message:

   ```
   09/14/1999 17:56:32 name/radius/1 Error Server 0 Remote
   server dave-ultra (171.69.237.99:1645) is UP but very slow!
   ```

5. The Remote Server has been marked inactive and is being put back into Cisco AR's server pool for later use. The format of the message is:

   Remote Server <*hostname*> (<*ipaddress*>:<*port*>) is being reactivated for later use.

   The following is an example header and message:

   ```
   09/14/1999 17:56:32 name/radius/1 Error Server 0 Remote
   server dave-ultra (209.165.200.224:1645) is being reactivated for later use.
   ```

CHAPTER 24

Troubleshooting Cisco Access Registrar

This chapter provides information about techniques used when troubleshooting Cisco Access Registrar and highlights common problems.

Gathering Basic Information

Table 24-1 lists UNIX commands that provide basic and essential information to help you understand the Cisco AR installation environment.

Table 24-1 UNIX Commands to Gather Information

UNIX Command	Information Returned
/usr/bin/uname -r	Solaris release level
/usr/bin/uname -i	Machine hardware name
/usr/bin/uname -v	Solaris version
/usr/bin/uname -a	All system information including hostname, operating system type and release, machine model and type
/usr/sbin/prtconf	System configuration information including memory capacity, machine type, and peripheral equipment
/usr/sbin/df -k	File system disk space usage including partitions, capacity, and space used
/usr/bin/ps -ef	Currently running processes
/usr/sbin/psinfo -v	Information about processors
/usr/bin/pkginfo -l CSCOar	Software package information about Cisco AR version number and installation directory

Note More information about these commands and their options is available using the **man** command in a terminal window on the Sun workstation.

Troubleshooting Quick Checks

Many of the most common problems can be diagnosed by doing the following:

- Check disk space
- Check for resource conflicts
- Check the Cisco AR log files

Disk Space

Running out of disk space can cause a number of problems including:

- Failure to process RADIUS requests
- Parts of the Cisco AR configuration *disappearing* in **aregcmd**
- Failure to log into **aregcmd**

Check that the Cisco AR installation partition (**$INSTALL**) and **/tmp** are not at capacity.

Resource Conflicts

Resource conflicts are a common reason for the Cisco Access Registrar server failing to start. The most common resource conflicts are the following:

- Cisco Network Registrar is running on the Cisco AR server
- Another application is also using ports 1645 and 1646
- A network management application is using the Sun SNMP Agent

No Co-Existence With Cisco Network Registrar

Cisco Network Registrar cannot coexist on a machine running Cisco AR for this reason. You can determine if CNR is running by entering the following command line in a terminal window:

pkginfo | grep -i “network registrar”

Port Conflicts

The default ports used by the Cisco AR server are ports 1645 and 1646. You should check to determine that no other applications are listening on the same ports as Cisco AR.

You can check to see which TCP ports are in use by entering the following command line:

netstat -aP tcp

You can check to see which UDP ports are in use by entering the following command line:

netstat -aP udp

Note If you configure the Cisco AR server to use ports other than the default, you will have to specifically add ports 1645 and 1646 if you want to also use those ports.

Server Running Sun SNMP Agent

If you plan to use the Cisco AR server's SNMP agent, you cannot use the Sun Microsystems SNMP agent that comes with the Solaris operating system.

Cisco AR Log Files

Examining the Cisco AR log files can help you diagnose most CAR issues. By default, the Cisco AR log files are located in **/opt/CSCOar/logs**. Table 24-2 lists the Cisco AR logfiles and the information stored in each log.

Table 24-2 Cisco AR Log Files

Log File	Information Recorded
agent_server_1_log	Log of the server agent process
ar-status	Log of Cisco AR stop and start using the **arserver** utility
aregcmd_log	Log of commands executed in aregcmd (very useful for tracing the steps that took place before a problem occurred)
config_mcd_1_log	Log of the mcd internal database
name_radius_1_log	Log of the radius server process
name_radius_1_trace	Debugging output of RADIUS request processing (only generated when the trace level, set in **aregcmd**, is greater than zero)

Modifying File Sizes for Agent Server and MCD Server Logs

Two new parameters have been added to the **car.conf** file under **$BASEDIR/conf** in Cisco AR 4.1.3. These parameters affect the **agent_server_logs** and **config_mcd_server_logs logs** files:

- AGENT_SERVER_LOG_SIZE (10 MB by default)
- AGENT_SERVER_LOG_FILES (2 by default)

You will find these new parameters at the beginning of the **car.conf** file. When the log file size reaches the value set in AGENT_SERVER_LOG_SIZE, a rollover of the **agent_server_log_file** occurs. The value set in AGENT_SERVER_LOG_FILES specifies the number of log files to be created.

Using xtail to Monitor Log File Activity

A useful way of monitoring all of the log files is to run **xtail**, a utility provided with Cisco AR. The **xtail** program monitors one or more files and displays all data written to a file since command invocation.

Run **xtail** in a dedicated terminal window. It is very useful for monitoring multiple logfiles simultaneously, such as with a command line like the following:

```
xtail $INSTALL/logs/*
```

Note Cisco AR 4.1.5 and later include the millisecond field in the logs' timestamp.

Modifying the Trace Level

By modifying the trace level, you can gather more detailed information in the log files about what is happening in the Cisco AR server. There are five different trace levels. Each higher trace level also includes the information logged using lower trace levels. The different trace levels provide the following information:

- Level 0—No tracing occurs
- Level 1—Indicates when a packet is sent or received and when a status change occurs in a remote server (RADIUS Proxy and LDAP)
- Level 2—Information includes the following:
  - Which services and session managers are used to process
  - Which client and vendor objects are being used to process a packet
  - More details about remote servers (RADIUS Proxy and LDAP), packet transmission, and timeouts
  - Details about poorly-formed packets.
- Level 3—Information includes the following:
  - Tracing of errors in Tcl scripts when referencing invalid RADIUS attributes
  - Which scripts have been run
  - Details about local userlist processing
- Level 4—Information includes the following:
  - Advanced duplication detection processing
  - Details about creating, updating, and deleting sessions
  - Tracing of all APIs called during the running of a script
- Level 5—Provides information about policy engine operations

Installation and Server Process Start-up

The installation process installs the Cisco AR software to the specified installation directory and then starts the server processes. This process rarely fails but the following checks should always be performed:

- Ensure that there is an **installation success message** at the end of the **pkgadd** dialog, otherwise check the dialog for the problem
- Follow the installation instructions carefully especially when performing an upgrade. For example, when upgrading to 1.6R1, 1.6R2, or 1.6R3, a post-installation upgrade script needs to be run

- Pay attention to the information included in README files

At the end of a successful installation, **arstatus** should show the following four server processes:

> $INSTALL/usrbin/arstatus

```
AR RADIUS server running    (pid: 6285)
AR MCD lock manager running (pid: 6284)
AR MCD server running       (pid: 6283)
AR Server Agent running     (pid: 6277)
```

If any of the above processes are not displayed, check the log file of the failed process to determine the reason. The MCD processes might fail to start if Cisco Network Registrar is installed on the same machine.

The manual method of starting and stopping the Cisco AR processes is using the **arserver** utility.

To start Cisco AR processes: **arserver start**

To stop Cisco AR processes: **arserver stop**

To restart Cisco AR processes: **arserver restart**

aregcmd and Cisco AR Configuration

While troubleshooting, you should always use the **aregcmd** command **trace** to turn on tracing. With tracing active, Cisco AR generates debugging output to the log file **name_radius_1_trace**.The syntax is:

trace [<server>] [<level>]

When you do not specify a server, Cisco AR sets the trace level for all servers in the current cluster. When you do not specify a trace level, the currently set level is used. The default trace level is 0.

Running and Stopped States

Cisco AR can be in two states, running or stopped. In either state, all four Cisco AR processes remain running. The state of Cisco AR will be displayed when logging into **aregcmd** or by using the **aregcmd status** command:

status

```
Server 'Radius' is Running, its health is 10 out of 10\
```

The **start** and **stop** commands allow Cisco AR to move between states. **Reload** is equivalent to a **stop** followed by a **start** if Cisco AR is already running, and just a **start** if it is already stopped.

stop

```
Stopping Server 'Radius'...
Server 'Radius' is Stopped
```

start

```
Starting Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10
```

reload

```
Reloading Server 'Radius'...
Server 'Radius' is Running, its health is 10 out of 10
```

During the transition from running to stopped, Cisco AR stops processing new RADIUS requests and releases resources such memory, network and database connections and open files.

During the transition from stopped to running, Cisco AR reverses this process by opening a connection with its internal database, reading configuration data, claiming memory, establishing network connections, opening files, and initializing scripts. During this transition, problems can occur. Cisco AR might fail to start and display the following:

reload

```
Reloading Server 'Radius'...
310 Command failed
```

Cisco AR failed to move from stopped state to running:

status

```
Server 'Radius' is Stopped
```

This might occur for a number of reasons including the following:

- An invalid configuration
- Insufficient memory
- Listening ports already in use by another application
- Unable to open files
- Unable to initialize scripts

Check the **name_radius_1_log** file for the one of these indications.

RADIUS Request Processing

The main technique for troubleshooting RADIUS request processing in Cisco AR is to examine the **name_radius_1_trace** log file with the trace level set to 5. Most issues are fairly self-explanatory. Some issues that can arise are:

- Cisco AR has marked a remote server as ***down***
- A resource manager has run out of resources (for example, user or group session limit has been reached or no more IP addresses are available)
- A configuration error (such as an accounting service not being set)
- A run time error in a script

Some issues are not immediately evident from the log files though, such as the following:

- Failure to save or reload Cisco AR after a configuration change
- Cisco AR is not listening on the correct UDP ports for RADIUS requests

Other Troubleshooting Techniques and Resources

aregcmd Stats Command

The **aregcmd** command **stats** provides statistics on request processing.

--> **stats**

```
Global Statistics for Radius:
serverStartTime = Tue Oct  2 10:28:02 2001
serverResetTime = Tue Oct  2 20:25:12 2001
serverState = Running
totalPacketsInPool = 1024
totalPacketsReceived = 0
totalPacketsSent = 0
totalRequests = 0
totalResponses = 0
totalAccessRequests = 0
totalAccessAccepts = 0
totalAccessChallenges = 0
totalAccessRejects = 0
totalAccessResponses = 0
totalAccountingRequests = 0
totalAccountingResponses = 0
totalStatusServerRequests = 0
totalAscendIPAAllocateRequests = 0
totalAscendIPAAllocateResponses = 0
totalAscendIPAReleaseRequests = 0
totalAscendIPAReleaseResponses = 0
totalUSRNASRebootRequests = 0
totalUSRNASRebootResponses = 0
totalUSRResourceFreeRequests = 0
totalUSRResourceFreeResponses = 0
totalUSRQueryResourceRequests = 0
totalUSRQueryResourceResponses = 0
totalUSRQueryReclaimRequests = 0
totalUSRQueryReclaimResponses = 0
totalPacketsInUse = 0
totalPacketsDrained = 0
totalPacketsDropped = 0
totalPayloadDecryptionFailures = 0
```

Core Files

A core file in the Cisco AR installation directory is an indication that Cisco AR has crashed and restarted. Check that the radius server process generated the core file using the UNIX **file** command:

> **file core**

```
core:           ELF 32-bit MSB core file SPARC Version 1, from 'radius'
```

Check the timestamp on the core file and look for corresponding log messages in the **name_radius_1_log** file in **$INSTALL/logs**. The word *assertion* commonly appears in core messages. Try to establish what caused the problem and contact Cisco TAC.

radclient

The Cisco AR package provides a utility called **radclient** that allows RADIUS requests to be generated. Use **radclient** to test configurations and troubleshoot problems.

Cisco AR Replication

For more information about using Cisco AR replication, refer to Chapter 10, "Using Replication."

APPENDIX A

Cisco Access Registrar Tcl and REX Dictionaries

This appendix describes the Tcl and REX dictionaries that are used when writing Incoming or Outgoing scripts.

A dictionary is a data structure that contains key/value pairs. Two types of dictionaries exist: the Attribute dictionaries (used by the Request and Response dictionaries), and the Environment dictionary.

This section contains the dictionaries you reference when writing a Tcl script and the dictionaries you reference when you write a script using the shared libraries (REX—RADIUS EXtension).

Tcl Attribute Dictionaries

An *Attribute dictionary* is a dictionary in which the keys are constrained to be the names of attributes as defined in the Cisco AR server configuration, and the values are the string representation of the legal values for that particular attribute. For example, IP addresses are specified by the dotted-decimal string representation of the address, and enumerated values are specified by the name of the enumeration. This means numbers are specified by the string representation of the number.

Attribute dictionaries have the unusual feature that there can be more than one instance of a particular key in the dictionary. These instances are ordered, with the first instance at index zero. Some of the methods of an Attribute dictionary allow an index to be specified to indicate a particular instance or position in the list of instances to be referenced.

Attribute Dictionary Methods

Attribute dictionaries use active commands, called *methods*, that allow you to change and access the values in the dictionaries. Table A-1 lists of all of the methods you can use with the Request and Response dictionaries.

Table A-1 Tcl Attribute Dictionary Methods

Name	Syntax	Description
addProfile	**$dict addProfile** <*profile*> [<*mode*>]	Copies all of the attributes in the profile <*profile*> into the dictionary. Note, <*profile*> must be the name of one of the profiles listed in the server configuration. When <*mode*> is not provided or when <*mode*> equals the special value **REPLACE**, any duplicate instances of the attributes in the dictionary are replaced with the attribute from <*profile*>. When <*mode*> is provided and equals the special value **APPEND**, new instances of the attributes are appended to the attributes already in the dictionary. When <*mode*> is provided and equals the special value **AUGMENT**, only add the attribute when it does not already exist.
clear	**$dict clear**	Removes all entries from the dictionary.
containsKey	**$dict containsKey** <*attribute*>	Returns 1 when the dictionary contains the attribute <*attribute*>, otherwise returns 0.
firstKey	**$dict firstKey**	Returns the name of the first attribute in the dictionary. Note, the attributes are not stored sorted by name.
get	**$dict get** <*attribute*> [<*index*> [**bMore**]]	Returns the value of the <*attribute*> attribute from the dictionary, represented as a string. When the dictionary does not contain the <*attribute*>, an empty string is returned. When <*index*> is provided, return the <*index*>'th instance of the attribute. Some attributes can appear more than once in the request (or response) packet. The <*index*> argument is used to select which instance to return. When **bMore** is provided, the **get** method sets **bMore** to 1 when more attributes exist after the one returned, and to 0 otherwise. You can use this to determine whether another call to **get** should be made to retrieve other instances of the attribute.
isEmpty	**$dict isEmpty**	Returns 1 when the dictionary has no entries, otherwise returns 0.
log	**$dict log** <*level*> <*message*> …	Outputs a message into the RADIUS server's logging system. The <*level*> should be either **LOG_ERROR**, **LOG_WARNING**, or **LOG_INFO**. The remaining arguments are concatenated together and sent to the logging system at the specified level.

Table A-1 Tcl Attribute Dictionary Methods (continued)

Name	Syntax	Description
nextKey	**$dict nextKey**	Returns the name of the next attribute in the dictionary that follows the attribute returned in the last call to **firstKey** or **nextKey**.
put	**$dict put** <*attribute*> <*value*> [<*index*>]	Associates <*value*> with the attribute <*attribute*> in the dictionary. When <*index*> is not provided or when <*index*> equals the special value **REPLACE**, any existing instances of <*attribute*> are replaced with the single value. When <*index*> is provided and equals the special value **APPEND**, a new instance of <*attribute*> is appended to the end of the list of instances of the <*attribute*>. When <*index*> is provided and is a number, a new instance of <*attribute*> is inserted at the position indicated. When <*index*> is provided and equals the special value **AUGMENT**, only put the attribute when it does not already exist.
remove	**$dict remove** <*attribute*> [<*index*>]	Removes the <*attribute*> attribute from the dictionary. When <*index*> is not provided or when <*index*> equals the special value **REMOVE_ALL**, remove any existing instances of <*attribute*>. When <*index*> is provided and is a number, remove the instance of <*attribute*> at the position indicated. Always returns 1, even when the dictionary did not contain the <*attribute*> at that <*index*>.
size	**$dict size**	Returns the number of entries in the dictionary.
trace	**$dict trace** <*level*> <*message*> ...	Outputs a message into the packet tracing system used by the RADIUS server. At level 0, no tracing occurs. At level 1, only an indication the server received the packet and sent a reply is output. As the number gets higher, the amount of information output increases, until at level 4, where everything is traced as output. The remaining arguments are concatenated and sent to the tracing system at the specified level.

Tcl Environment Dictionary

A dictionary is a data structure that contains key/value pairs. An Environment dictionary is a dictionary in which the keys and values are constrained to be strings. The Tcl Environment dictionary is used to communicate information from the script to the server and from script to script within the processing of a particular request. Note, there can be only one instance of a key in the Environment dictionary.

Table A-2 lists of all the methods you can use with the Request and Response dictionaries.

Table A-2 Tcl Environment Dictionary Methods

Name	Syntax	Description
clear	**$dict clear**	Removes all entries from the dictionary.
containsKey	**$dict containsKey** <*key*>	Returns 1 when the dictionary contains the <*key*> key, otherwise returns 0.
firstKey	**$dict firstKey**	Returns the name of the first key in the dictionary. Note, the keys are not stored sorted by name.
get	**$dict get** <*key*>	Returns the value of <*key*> from the dictionary. When the dictionary does not contain the <*key*>, an empty string is returned.
isEmpty	**$dict isEmpty**	Returns 1 when the dictionary has no entries, otherwise returns 0.
log	**$dict log** <*level*> <*message*> …	Outputs a message into the logging system used by the RADIUS server. <*level*> should be one of **LOG_ERROR**, **LOG_WARNING**, or **LOG_INFO**. The remaining arguments are concatenated together and sent to the logging system at the specified level.
nextKey	**$dict nextKey**	Returns the name of the next key in the dictionary that follows the key returned in the last call to **firstKey** or **nextKey**.
put	**$dict put** <*key*> <*value*>	Associates <*value*> with the <*key*> key in the dictionary, replacing an existing instance of <*key*> with the new value.
remove	**$dict remove** <*key*>	Removes the <*key*> key from the dictionary. Always returns 1, even when the dictionary did not contain the <*key*>.
size	**$dict size**	Returns the number of entries in the dictionary.
trace	**$dict trace** <*level*> <*message*> …	Outputs a message into the packet tracing system used by the RADIUS server. At level 0, no tracing occurs. At level 1, only an indication the server received the packet and sent a reply is output. As the number gets higher, the amount of information output is greater, until at level 4, where everything the server traces is output. The remaining arguments are concatenated together and sent to the tracing system at the specified level.

REX Attribute Dictionary

A dictionary is a data structure that contains key/value pairs. An Attribute dictionary is a dictionary in which the keys are constrained to be the attributes as defined in the RADIUS server configuration and the values are constrained to be legal values for that particular attribute. Attribute dictionaries have the unusual feature that there can be more than one instance of a particular key in the dictionary. These instances are ordered, with the first instance at index 0. Some of the methods of an Attribute dictionary allow an index to be specified to indicate a particular instance or position in the list of instances to be referenced.

When writing REX scripts, you can specify keys as the string representation of the name of the attribute or by type, which is a byte sequence defining the attribute. The values can also be specified as the string representation of the value or as the byte sequence, which is the attribute. These options mean some of these access methods have four different variations that are the combinations of string or type for the key, and string or bytes for the value.

Attribute Dictionary Methods

Attribute dictionaries use active commands, called *methods*, that allow you to change and access the values in the dictionaries.

Table A-3 lists all of the methods you can use with the Request and Response dictionaries.

Table A-3 REX Attribute Dictionary Methods

Name	Syntax	Description
addProfile	**abool_t pDict->addProfile(rex_AttributeDictionary_t* pDict, const char*** *<pszProfile>***, int** *<iMode>***)**	Copies all of the attributes in the *<pszProfile>* profile into the dictionary. Note, *<pszProfile>* must be the name of one of the profiles listed in the server configuration. When *<iMode>* equals the special value **REX_REPLACE**, it replaces any duplicate instances of the attributes in the dictionary with the attribute from the profile. When *<iMode>* equals the special value **REX_APPEND**, it appends a new instance of the attributes to any attributes already in the dictionary. When *<iMode>* equals the special value **REX_AUGMENT**, it only puts the attribute when does not already exist.
allocateMemory	**void* pDict->allocateMemory(rex_AttributeDictionary_t* pDict, unsigned int** *<iSize>***)**	Allocates memory for use in scripts that persist only for the lifetime of this request. This memory is released when processing for this request is complete.
clear	**void pDict->clear(rex_AttributeDictionary_t* pDict)**	Removes all entries from the dictionary.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
containsKey	**abool_t pDict->containsKey(rex_AttributeDictionary_t* pDict, const char*** *<pszAttribute>***)**	Returns TRUE when the dictionary contains *<pszAttribute>*, otherwise returns FALSE.
containsKeyByType	**abool_t pDict->containsKeyByType(rex_AttributeDictionary_t* pDict, const abytes_t*** *<pAttribute>***)**	Returns TRUE when the dictionary contains *<pAttribute>*, otherwise returns FALSE.
firstKey	**const char* pDict->firstKey(rex_AttributeDictionary_t* pDict)**	Returns the name of the first attribute in the dictionary. Note, the attributes are not stored sorted by name.
firstKeyByType	**const abytes_t* pDict->firstKeyByType (rex_AttributeDictionary_t* pDict)**	Returns a pointer to the byte sequence defining the first attribute in the dictionary. Note, attributes are not stored sorted by name.
get	**const char* pDict->get(rex_AttributeDictionary_t* pDict, const char* pszAttribute, int** *<iIndex>***, abool_t*** *<pbMore>***)**	Returns the value of the *<iIndex>*'d instance of the attribute from the dictionary, represented as a string. When the dictionary does not contain the attribute (or that many instances of the attribute), an empty string is returned. When *<pbMore>* is non-zero, the **get** method sets *<pbMore>* to TRUE when more instances of the attribute exist after the one returned, and to FALSE otherwise. This can be used to determine whether another call to **get** should be made to retrieve other instances of the attribute.
getBytes	**const abytes_t* pDict->getBytes(rex_AttributeDictionary_t* pDict, const char* pszAttribute, int** *<iIndex>***, abool_t*** *<pbMore>***)**	Returns the value of the *<iIndex>*'d instance of the attribute from the dictionary, as a sequence of bytes. When the dictionary does not contain the attribute (or that many instances of the attribute), 0 is returned. When *<pbMore>* is non-zero, the **getBytes** method sets *<pbMore>* to TRUE when more instances of the attribute exist after the one returned, and to FALSE otherwise. This can be used to determine whether another call to **getBytes** should be made to retrieve other instances of the attribute.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
getBytesByType	**const abytes_t* pDict->getBytesByType (rex_AttributeDictionary_t* pDict, const abytes_t* pAttribute, int** <*iIndex*>**, abool_t*** <*pbMore*>**)**	Returns the value of the <*iIndex*>'d instance of the attribute from the dictionary, as a sequence of bytes. When the dictionary does not contain the attribute (or that many instances of the attribute), 0 is returned instead. When <*pbMore*> is non-zero, sets the variable pointed to TRUE when more instances of the attribute exist after the one returned, and to FALSE otherwise. This can be used to determine whether another call to **get** should be made to retrieve other instances of the attribute.
getByType	**const char* pDict->get(rex_AttributeDictionary_t* pDict,** const abytes_t* <*pszAttribute*>, int <*iIndex*>, abool_t* <*pbMore*>)	Returns the value of the <*iIndex*>'d instance of the attribute from the dictionary, as represented as a string. When the dictionary does not contain the attribute (or that many instances of the attribute), returns an empty string. When <*pbMore*> is non-zero, the **getByType** method sets <*pbMore*> to TRUE when more instances of the attribute exist after the one returned, and to FALSE otherwise. This can be used to determine whether another call to **getByType** should be made to retrieve other instances of the attribute.
getType	**const char* pDict->getByType(rex_AttributeDictionary_t* pDict, const abytes_t*** <*pAttribute*>**)**	Returns a pointer to the byte sequence defining the attribute, when the attribute name matches a configured attribute, zero otherwise.
isEmpty	**abool_t pDict->isEmpty(rex_AttributeDictionary_t* pDict)**	Returns TRUE when the dictionary has 0 entries, FALSE otherwise.
log	**abool_t pDict->log(rex_AttributeDictionary_t* pDict, int** <*iLevel*>**, const char*** <*pszFormat*>**, ...)**	Outputs a message into the logging system used by the RADIUS server. <*iLevel*> should be one of **REX_LOG_ERROR**, **REX_LOG_WARNING**, or **REX_LOG_INFO**. The **pszFormat** argument is treated as a **printf**-style format string, and it, along with the remaining arguments, are formatted and sent to the logging system at the specified level.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
nextKey	**const char* pDict->nextKey(rex_AttributeDictionary_t* pDict)**	Returns the name of the *next* attribute in the dictionary that follows the attribute returned in the last call to **firstKey** or **nextKey**.
nextKeyByType	**const abytes_t* pDict->nextKeyByType(rex_AttributeDictionary_t* pDict)**	Returns a pointer to the byte sequence defining the next attribute in the dictionary that follows the attribute returned in the last call to **firstKeyByType** or **nextKeyByType**.
put	**abool_t pDict->put(rex_AttributeDictionary_t* pDict, const char*** <*pszAttribute*>**, const char*** <*pszValue*>**, int** <*iIndex*>**)**	Converts <*pszValue*> to a sequence of bytes, according to the definition of <*pszAttribute*> in the server configuration. Associates that sequence of bytes with <*pszAttribute*> in the dictionary. When <*iIndex*> equals the special value **REX_REPLACE**, it replaces any existing instances of <*pszAttribute*> with a single value. When <*iIndex*> equals the special value **REX_APPEND**, it appends a new instance of <*pszAttribute*> to the end of the list of existing instances of <*pszAttribute*>. Otherwise, a new instance of <*pszAttribute*> is inserted at the position indicated. This method returns TRUE unless <*pszAttribute*> does not match any configured attributes or the value could not be converted to a legal value. When <*iIndex*> equals the special value **REX_AUGMENT**, only **put** <*pszAttribute*> when it does not already exist.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
putBytes	**abool_t pDict->putBytes(rex_AttributeDictionary_t* pDict, const char*** *<pszAttribute>***, const abytes_t*** *<pValue>***, int** *<iIndex>***)**	Associates *<pValue>* with the attribute *<pszAttribute>* in the dictionary. When *<iIndex>* equals the special value **REX_REPLACE**, it replaces any existing instances of the *<pszAttribute>* with a single new value. When *<iIndex>* equals the special value **REX_APPEND**, it appends a new instance of *<pszAttribute>* to the end of the list of existing instances of *<pszAttribute>*. When *<iIndex>* equals the special value **REX_AUGMENT**, only put the *<pszAttribute>* when it does not already exist. Otherwise, a new instance of *<pszAttribute>* is inserted at the position indicated. This method returns TRUE unless the attribute name does not match any configured attributes.
putBytesByType	**abool_t pDict->putBytesByType(rex_AttributeDictionary_t* pDict, const abytes_t*** *<pAttribute>***, const abytes_t*** *<pValue>***, int** *<iIndex>***)**	Associates *<pValue>* with the attribute *<pAttribute>* in the dictionary. When *<iIndex>* equals the special value **REX_REPLACE**, it replaces any existing instances of *<pAttribute>* with the new value. When *<iIndex>* equals the special value **REX_APPEND**, it appends a new instance of *<pAttribute>* to the end of the list of existing instances of *<pAttribute>*. When *<iIndex>* equals the special value **REX_AUGMENT**, only **put** *<pAttribute>* when it does not already exist. Otherwise, insert a new instance of *<pAttribute>* at the position indicated. This method returns TRUE unless the attribute name does not match any configured attributes.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
putByType	**abool_t pDict->putByType(rex_AttributeDictionary_t* pDict, const abytes_t*** *<pszAttribute>***, const char*** *<pszValue>***, int** *<iIndex>***)**	Converts *<pszValue>* to a sequence of bytes, according to the definition of *<pszAttribute>* in the server configuration. Associates that sequence of bytes with *<pszAttribute>* in the dictionary. When *<iIndex>* equals the special value **REX_REPLACE**, it replaces any existing instances of *<pszAttribute>* with a single new value. When *<iIndex>* equals the special value **REX_APPEND**, it appends a new instance of *<pszAttribute>* to the end of the list of existing instances of *<pszAttribute>*. Otherwise, it inserts a new instance of *<pszAttribute>* at the position indicated. This method returns TRUE unless *<pszAttribute>* does not match any configured attributes, or the value could not be converted to a legal value.
remove	**abool_t pDict->remove(rex_AttributeDictionary_t* pDict, const char*** *<pszAttribute>***, int** *<iIndex>***)**	Removes the *<pszAttribute>* from the dictionary. When *<iIndex>* equals the special value **REX_REMOVE_ALL**, removes any existing instances of *<pszAttribute>*. Otherwise, it removes the instance of *<pszAttribute>* at the position indicated. Returns TRUE, even when the dictionary did not contain *<pszAttribute>* at the *<iIndex>*, unless *<pszAttribute>* does not match any configured attribute.
removeByType	**abool_t pDict->removeByType(rex_AttributeDictionary_t* pDict, const abytes_t*** *<pAttribute>***, int** *<iIndex>***)**	Removes the *<pAttribute>* from the dictionary. When *<iIndex>* equals the special value **REX_REMOVE_ALL**, it removes any existing instances of *<pszAttribute>*. Otherwise, the instance of *<pAttribute>* at the position indicated is removed. Always returns TRUE, even when the dictionary did not contain *<pAttribute>* at the *<iIndex>*.
reschedule	**abool_t pDict->reschedule(rex_AttributeDictionary_t* pDict)**	Enables control over asynchronous activities. It enables you to collect similar activities and mark them as pending. You can then process them and reschedule them. You can only use this attribute with multithreaded services. Use caution when employing this method.

Table A-3 REX Attribute Dictionary Methods (continued)

Name	Syntax	Description
size	**int pDict->size(rex_AttributeDictionary_t* pDict)**	Returns the number of entries in the dictionary.
trace	**abool_t pDict->trace(rex_AttributeDictionary_t* pDict, int** *<iLevel>***, const char*** *<pszFormat>***, ...)**	Outputs a message into the packet tracing system used by the RADIUS server. At level 0, no tracing occurs. At level 1, only an indication the packet was received and a reply was sent is output. As the number gets higher, the amount of information output is greater, until at level 4, where everything traceable is output. The remaining arguments are formatted and sent to the tracing system at the specified level.

REX Environment Dictionary

A dictionary is a data structure that contains key/value pairs. An Environment dictionary is a dictionary in which the keys and values are constrained to be strings. The REX Environment dictionary is used to communicate information from the script to the server and from script to script within the processing of a particular request. Note, there can be only one instance of a key in the Environment dictionary.

REX Environment Dictionary Methods

The Environment dictionary uses active commands, called *methods*, to allow you to change and access the values in the dictionary. Table A-4 lists all of the methods you can use with the REX Environment dictionary.

Table A-4 REX Environment Dictionary Methods

Name	Syntax	Description
allocateMemory	**void* pDict->allocateMemory(rex_EnvironmentDictionary_t* pDict, unsigned int** *<iSize>***)**	Allocate memory for use in scripts that persist only for the lifetime of this request. This memory is released when processing for this request is complete.
clear	**void pDict->clear(rex_EnvironmentDictionary_t* pDict)**	Removes all entries from the dictionary.
containsKey	**abool_t pDict->containsKey(rex_EnvironmentDictionary_t* pDict, const char*** *<pszKey>*)	Returns TRUE when the dictionary contains *<pszKey>*, otherwise returns FALSE.
firstKey	**const char* pDict->firstKey(rex_EnvironmentDictionary_t* pDict)**	Returns the name of the first key in the dictionary. Note, the keys are not stored sorted by name.

Table A-4 REX Environment Dictionary Methods (continued)

Name	Syntax	Description
get	**const char* pDict->get(rex_EnvironmentDictionary_t* pDict, const char*** *<pszKey>***)**	Returns the value associated with *<pszKey>* from the dictionary. When the dictionary does not contain *<pszKey>*, an empty string is returned.
isEmpty	**abool_t pDict->isEmpty(rex_EnvironmentDictionary_t* pDict)**	Returns TRUE when the dictionary has 0 entries, FALSE otherwise.
log	**abool_t pDict->log(rex_EnvironmentDictionary_t* pDict, int** *<iLevel>***, const char*** *<pszFormat>***, ...)**	Outputs a message into the logging system used by the RADIUS server. *<iLevel>* should be one of **REX_LOG_ERROR**, **REX_LOG_WARNING**, or **REX_LOG_INFO**. The *<pszFormat>* argument is treated as a **printf**-style format string, and it, along with the remaining arguments, are formatted and sent to the logging system at the specified level.
nextKey	**const char* pDict->nextKey(rex_EnvironmentDictionary_t* pDict)**	Returns the name of the next key in the dictionary that follows the key returned in the last call to **firstKey** or **nextKey**.
put	**abool_t pDict->put(rex_EnvironmentDictionary_t* pDict, const char*** *<pszValue>***, const char*** *<pszKey>***)**	Associates the value with *<pszKey>* in the dictionary, replacing any existing instance of *<pszKey>* with the new *<pszValue>*.
remove	**abool_t pDict->remove(rex_EnvironmentDictionary_t* pDict, const char*** *<pszKey>***)**	Removes *<pszKey>* and the associated value from the dictionary. Always returns TRUE, even when the dictionary did not contain *<pszKey>*
reschedule	**abool_t pDict->reschedule(rex_AttributeDictionary_t* pDict)**	Enables control over asynchronous activities. It enables you to collect similar activities and mark them as pending. You can then process them and reschedule them. You can only use this attribute with multithreaded services. Use caution whenemploying this method.

Table A-4 REX Environment Dictionary Methods (continued)

Name	Syntax	Description
size	**int pDict->size(rex_EnvironmentDictionary_t* pDict)**	Returns the number of entries in the dictionary.
trace	**abool_t pDict->trace(rex_EnvironmentDictionary_t* pDict, int** <*iLevel*>**, const char*** <*pszFormat*>**, ...)**	Outputs a message into the packet tracing system used by the RADIUS server. At level 0, no tracing occurs. At level 1, only an indication the packet was received and a reply was sent is output. As the number gets higher, the amount of information output is greater, until at level 4, where everything traceable is output. The remaining arguments are formatted and sent to the tracing system at the specified level.

APPENDIX B

Environment Dictionary

This appendix describes the environment variables the scripts use to communicate with Cisco Access Registrar or to communicate with other scripts.

Cisco AR sets the **arguments** variable in the Environment dictionary, before calling the **InitEntryPoint** of each script. The **arguments** variable is set to the value of the **InitEntryPointArgs** property corresponding to that script, and it allows the administrator to pass (possibly unique) information to each script initialization function.

Environment variables that are set and read for resource management override provide scripts further control over session management. These environment variables, including the following **Acquire-User-Session-Limit**, **Acquire-Group-Session-Limit**, **Acquire-IP-Dynamic**, **Acquire-IP-Per-NAS-Port**, **Acquire-IPX-Dynamic**, and **Acquire-USR-VPN**, can be set at any point before session management is invoked. These environment variables are read as the packet flows through each Resource Manager that the chosen Session Manager calls. The default setting for these environment variables is TRUE. See the "Resource Managers" section on page 4-29 for additional information about Resource Managers.

This appendix has the following major sections:

- Cisco AR Environment Dictionary Variables

  This section lists environment variables you can use in scripts to communicate with Cisco AR or to communicate with other scripts.

- Internal Variables

  This section lists environment variables used by the Cisco AR server for internal operations. The environment variables listed in this section must not be modified by scripts.

Cisco AR Environment Dictionary Variables

The following variables are text strings stored in the Environment dictionary passed to each scripting point.

Accepted-Profiles

Accepted-Profiles is read during authorization after calling server and client incoming scripts (not set by Cisco AR code). If set, the authorization done by local user lists checks to see if the given user's profile as specified in the user record is one of those in the separated list of profiles. If it is not in the separated list of profiles, the request is rejected.

Accounting-Service

Accounting-Service is set after calling server and client incoming scripts and is used to determine which accounting service is used for this request. If set, the server directs the request to be processed by the specified accounting service.

When **Accounting-Service** is not set, the **DefaultAccountingService** (as defined in the server configuration) is used instead.

Acquire-Dynamic-DNS

Acquire-Dynamic-DNS is set and read for resource management override. **Acquire-Dynamic-DNS** is set to FALSE to skip DNS updating during resource management processing.

Acquire-Group-Session-Limit

Acquire-Group-Session-Limit is set and read for resource management override.
Acquire-Group-Session-Limit is set to FALSE to override the use of group session limit resource management.

Acquire-Home-Agent

Acquire-Home-Agent is set and read for resource management override. **Acquire-Home-Agent** is set to FALSE to override the allocation of the home agent IP address during resource management processing.

Acquire-IP-Dynamic

Acquire-IP-Dynamic is set and read for resource management override. **Acquire-IP-Dynamic** is set to FALSE to override the use of a managed pool of IP addresses resource management.

Acquire-IPX-Dynamic

Acquire-IPX-Dynamic is set and read for resource management override. **Acquire-IPX-Dynamic** is set to FALSE to override the use of a managed pool of IPX addresses resource management.

Acquire-IP-Per-NAS-Port

Acquire-IP-Per-NAS-Port is set and read for resource management override.
Acquire-IP-Per-NAS-Port is set to FALSE to override the use of ports associated with specific IP addresses resource management.

Acquire-Subnet-Dynamic

Acquire-Subnet-Dynamic is not always used. If set to FALSE, subnet-dynamic resource managers are skipped.

Acquire-User-Session-Limit

Acquire-User-Session-Limit set and read for resource management override.
Acquire-User-Session-Limit is set to FALSE to override the use of user session limit resource management.

Acquire-USR-VPN

Acquire-USR-VPN is set and read for resource management override. **Acquire-USR-VPN** is set to FALSE to override the use of Virtual Private Networks (VPNs) that use USR NAS Clients resource management.

Allow-Null-Password

Allow-Null-Password is read during password matching and set in local userlist password matching if not set prior. If **Allow-Null-Password** is set to TRUE, the Cisco AR server accepts requests with null passwords.

Authentication-Service

Authentication-Service is set and read for authentication service selection and is used to determine which service is used to authenticate the user. If set, the server directs the request to be processed by the specified authentication service. When **Authentication-Service** is not set, the **DefaultAuthenticationService** is used instead.

Authorization-Service

Authorization-Service is set and read for authorization service selection and is used to determine which service to use to authorize the user. If set, the server directs the request to be processed by the specified authorization service. When **Authorization-Service** is not set, the **DefaultAuthorizationService** is used instead.

BackingStore-Env-Vars

BackingStore-Env-Vars overrides the BackingStoreEnvironmentVariables property of remote servers of type *odbc-accounting* only when the property BufferAccountingPackets is set to TRUE. The value is a comma separated list of environment variables to be stored along with the packet contents in the local disk.

Broadcast-Accounting-Packet

If set to TRUE, **Broadcast-Accounting-Packet** enables broadcasting of Accounting-on or Accounting-off packets to all remote servers of type *radius*.

Cache-Attributes-In-Session

Cache-Attributes-In-Session is set and read for resource management override. **Cache-Attributes-In-Session** is set to FALSE to override the caching of attributes by the *session-cache* type of resource manager.

Current-Group-Count

Current-Group-Count is set and read for group session management. If set, the group-session-limit resource manager sets **Current-Group-Count** to be the new value of the group-session-limit counter.

Destination-IP-Address

Destination-IP-Address is a read only value which is set to the receiver IP address. **Destination-IP-Address** contains the IP address of the request packet receiver.

Destination-Port

Destination-port is a read only value which is set to the receiving port number. **Destination-port** contains the port number of the receiver of the request.

Disable-Accounting-On-Off-Broadcast

If set to TRUE, **Disable-Accounting-On-Off-Broadcast** disables broadcasting of Accounting-On and Accounting-Off packets to all remote servers of type 'radius'

Dynamic-DNS-HostName

Dynamic-DNS-HostName is read while constructing the forward hostname during resource management processing to update DNS entries. If set, the name will be used as forward hostname instead of constructing one.

Dynamic-Search-Filter

Dynamic-Search-Filter overrides the Filter property in remote servers of type *ldap*. The format of the value set for **Dynamic-Search-Filter** should be similar to that of the Filter property.

Dynamic-Search-Path

Dynamic-Search-Path is read for LDAP searching. If set, the server uses it as its LDAP search path rather than the value set in the remote server configuration.

Dynamic-Search-Scope

Dynamic-Search-Scope is used to dynamically set the SearchScope property of an LDAP remote server configuration on a per-packet basis.

Note Dynamic-Search-Scope is supported in Cisco AR 4.1.3 and later versions.

Dynamic-User-Password-Attribute

Dynamic-User-Password-Attribute is read for LDAP authentication and overrides the UserPasswordAttribute. If set, the server uses it toretrieve the password field as its LDAP UserPassword attribute instead of the value set in the remote server configuration.

EAP-Actual-Identity

EAP-Actual-Identity is a read-only variable that contains the International Mobile Subscriber Identity (IMSI) of the user after a successful EAP-SIM authentication.

EAP-Authentication-Mode

EAP-Authentication-Mode is a read-only variable, set after a successful EAP-SIM authentication, that indicates whether the EAP-SIM authentication was a reauthentication or a full authentication.

Group-Session-Limit

Group-Session-Limit is set and read for group session management. The group-session-limit resource manager sets this environment variable to be the limit of the group-session-limit counter as set by the configuration.

Ignore-Accounting-Signature

Ignore-Accounting-Signature is set after calling server and client incoming scripts and is used to ignore missing or incorrect accounting signatures from NASs. If set, Cisco AR does not check whether the account request packet has been signed with the same shared secret as the NAS.

Ignore-Accounting-Signature is used to work with RADIUS implementations that did not sign Accounting-Requests. A script was provided in the distribution (for USR NASs) that could be set in the IncomingScript extension point for the USR Vendor that simply set this environment variable.

Incoming-Translation-Groups

Incoming-Translation-Groups is read for authentication while processing responses from a remote RADIUS server. If set, **Incoming-Translation-Groups** specifies the translation groups to be used to filter attributes on requests.

Master-URL-Fragment

Used with the Windows Provisioning Service feature, **Master-URL-Fragment** specifies the fragment within the Master URL to be sent back to the provisioning server. **Master-URL-Fragment** can be set to any of the following four values: *signup*, *renewal*, *passwordchange*, and *forceupdate*. If **Master-URL-Fragment** is not set and is required to send the URL, *signup* will be sent by default.

The environmental variable **Send-PEAP-URL-TLV** indicates whether or not to send the URL.

Misc-Log-Message-Info

Misc-Log-Message-Info is read for packet event logging. If a log message is generated, the value of **Misc-Log-Message-Info** is inserted into the middle of the log message.

Outgoing-Translation-Groups

Outgoing-Translation-Groups is read while proxying to a remote radius server. If set, **Outgoing-Translation-Groups** specifies the translation groups to be used to filter attributes.

Pager

The **aregcmd** command supports the **Pager** environment variable. When the **aregcmd** command **stats** is used and the **Pager** environment variable is set, the output of the **stats** command is displayed using the program specified by the **Pager** environment variable.

Query-Service

The Query-Service variable is set and read for the *radius-query* service selection type. The Query-Service variable must be set before authentication phase begins at the server, vendor, or client incoming scripting point or using the policy engine. If set, the server directs requests to be processed by the specified *radius-query* service. Once the Query-Service variable is set, no AAA processing will be done.

Realm

The **Realm** variable is set for *domain-auth* type of service and is used as the domain name for windows authentication.

Reject-Reason

Reject-Reason is set when a request is being rejected and contains the **Reject-Reason**. Cisco AR uses the value of **Reject-Reason** to look up the reject reason in the reply message table.

If **Reject-Reason** is set to one of: UnknownUser, UserNotEnabled, UserPasswordInvalid, UnableToAcquireResource, ServiceUnavailable, InternalError, MalformedRequest, ConfigurationError, IncomingScriptFailed, OutgoingScriptFailed, IncomingScriptRejectedRequest, OutgoingScriptRejectedRequest, or TerminationAction, then the value set in the configuration under **/Radius/Advanced/ReplyMessages** will be returned.

Remote-Server

Remote-Server is set and read for logging a rejected packet from a remote server. **Remote-Server** records the name and IP address of the remote server to which the request has been forwarded.

Remove-Session-On-Acct-Stop

When set to TRUE, server removes the session on receiving an accounting stop packet.

Remote-Servers-Tried

Remote-Servers-Tried contains a list of remote servers that were tried before a request was accepted or rejected (in the case of a Failover multiple remoteserver policy). The list of servers is a comma-separated list of remote server names.

Request-Authenticator

Request-Authenticator is set for every packet upon reception. Getting the **Request-Authenticator** from a script returns the value of the request authenticator.

Request-Type

Request-Type is set when a request is first received to the type of request, such as one of Access-Request, Access-Accept, Access-Reject, Accounting-Request, Accounting-Response, or Access-Challenge before calling any extension points.

The request contains a string representation of the RADIUS packet type (code). When Cisco AR does not recognize the packet type, it is represented as "Unknown-Packet-Type-<*N*>, where <*N*> is the numeric value of the packet type (for example "Unknown-Packet-Type-9). The known packet types are listed in Table 0-1.

Table 0-1 Request-Type Packets

String	Packet Code
Access-Request	(1)
Access-Accept	(2)

Table 0-1 Request-Type Packets (continued)

String	Packet Code
Access-Reject	(3)
Accounting-Request	(4)
Accounting-Response	(5)
Access-Challenge	(11)
Status-Server	(12)
Status-Client	(13)
USR-Resource-Free-Request	(21)
USR-Resource-Free-Response	(22)
USR-Resource-Query-Request	(23)
USR-Resource-Query-Response	(24)
USR-NAS-Reboot-Request	(26)
USR-NAS-Reboot-Response	(27)
Ascend-IPA-Allocate	(50)
Ascend-IPA-Release	(51)
USR-Enhanced-Radius	(254)

Note **Request-Type** is to be used as a read-only variable by scripts.

Require-User-To-Be-In-Authorization-List

Require-User-To-Be-In-Authorization-List is read for authorization. If we are authorizing with a different service than we authenticated with (not usually done) and the user is not known by the authorization service, the default is to continue on unless this environment variable is set, in which case we reject the request with a cause of Unknown-user.

Response-Type

Response-Type is set and read throughout processing and used to determine whether the request should be accepted, rejected, or challenged. When **Response-Type** is set to "Access-Reject at any time during the processing of a request, no more processing of the request is done, and an Access-Reject response is sent. For other valid values for **Response-Type**, see Table 0-1.

Retrace-Packet

If set, **Retrace-Packet**, causes a trace the packet to be displayed during the incoming and outgoing scripts. If set, will cause a second trace of the request packet's contents after running all the incoming scripts and/or a second trace of the response packet's contents before running the outgoing scripts.

Send-PEAP-URI-TLV

When set to TRUE, the URI PEAP-TLV is included along with the Result PEAP-TLV in the access-challenge packet. The authenticating user service (of type userlist, LDAP, or WDA) can set this to TRUE using an extension point script or attribute mapping so that the PEAP-v0 service can send the URI PEAP-TLV. The default value for this is FALSE.

Note This variable is used with the Windows Provisioning Service (WPS) feature.

Session-Key

Session-Key is read for session management. If set, the server uses it as the key to look up the session associated with the current request, if any. If not set, the server uses the NAS IP Address and NAS Port to create a session key.

Session-Manager

Session-Manager is read after user authorization and determines which dynamic resources to allocate for this user, when one is needed. If set, the server directs the request to be processed by the specified session manager. When not set, the SessionManager (as defined in **DefaultSessionManager**) is used when needed.

Session-Notes

Session-Notes is a comma-separated list set to make session information available to scripts. **Session-Notes** contains the names of other environment variables. If set, these variables are stored on a Session as notes.

Session-Service

Session-Service is set and read during session management. If set, the server will direct the request to be processed by the specified session service.

Set-Session-Mgr-And-Key-Upon-Lookup

When **Set-Session-Mgr-And-Key-Upon-Lookup** is set to TRUE, a session-cache resource manager sets the session-manager and session-key environment variable during a query-lookup, and the Cisco AR server does not cache the response dictionary attributes. **Set-Session-Mgr-And-Key-Upon-Lookup** is set to TRUE by a query-service IncomingScript.

Skip-Session-Management

When set to TRUE in a request, **Skip-Session-Management** causes session management to be skipped for the request, even if session management might normally occur.

Skip-Overriding-Username-With-LDAP-UID

Skip-Overriding-Username-With-LDAP-UID is used to decide if the username should be replaced with the UID from the LDAP server. When Skip-Overriding-Username-With-LDAP-UID is set to TRUE, the username is not replaced with the UID from the LDAP server.

Note Skip-Overriding-Username-With-LDAP-UID is supported in Cisco AR 4.1.3 and later versions.

You can use Skip-Overriding-Username-With-LDAP-UID to retain case sensitivity in usernames when the username given logging in to the network is in a different case that the UID in the LDAP server database, such as *User1* and *user1*.

Source-IP-Address

Source-IP-Address is set when a request is first received to the IP address from which the IP request was received before calling any extension points. **Source-IP-Address** contains the IP address of the NAS or proxy server that sent the request to this server.

Note **Source-IP-Address** is to be used as a read-only variable by scripts.

Source-Port

Source-Port is set when a request is first received to the port from which the request was received. Source-Port is set for each request before calling any extension points and contains the port on the NAS or proxy server that was used to send the request to this server.

Note **Source-Port** is to be used as a read-only variable by scripts.

Subnet-Size-If-No-Match

Subnet-Size-If-No-Match is set to one of BIGGER, SMALLER or EXACT, determines the behavior of the subnet-dynamic resource manager if a pool of the requested size is not available.

Trace-Level

Trace-Level is set for each request before calling any extension points. **Trace-Level** is set to the current trace level as specified through **aregcmd**. If set by a script, Trace-Level changes the trace level used to determine what level of information is traced.

Unavailable-Resource

Unavailable-Resource is set during session management. If the request is being rejected because one of the resource managers failed to allocate a resource, **Unavailable-Resource** is set to the name of the resource manager that failed.

Unavailable-Resource-Type

Unavailable-Resource-Type is set during session management. If the request is being rejected because one of the resource managers failed to allocate a resource, **Unavailable-Resource-Type** is set to the type of the resource manager that failed.

UserDefined1

UserDefined1 is set to the value of the UserDefined1 property of the user from a local user list during password matching of local users.

User-Authorization-Script

User-Authorization-Script is read in local services during authorization. If set, the server calls the specified script to do additional user authorization after authentication succeeds.

User-Group

User-Group is read in local services during authorization. If set, species the UserGroup to which the current user belongs.

User-Group-Session-Limit

User-Group-Session-Limit is read during session management. If set, **User-Group-Session-Limit** overrides the limit specified for the group-session-limit resource manager.

User-Name

User-Name is read by a local service during authentication. When **User-Name** is set, it is the name used to authenticate or authorize the request and overrides the **User-Name** in the Request dictionary.

User-Profile

User-Profile is read in local services during authorization. If set, **User-Profile** specifies the Profile from which the current user should receive attributes.

User-Session-Limit

User-Session-Limit is read during session management. If set, **User-Session-Limit** overrides the limit specified for the user-session-limit resource manager.

Windows-Domain-Groups

The Windows-Domain-Groups variable is a read-only variable that contains a comma separated list of group names to which the user belongs in the Active Directory. The Windows-Domain-Groups variable is set after a successful authentication using a *domain-auth* type of service.

Internal Variables

The following environment variables are used by the server for internal operation. The values for these environment variables must not be modified.

- Add-Message-Authenticator
- Calling-Service-Name
- Current-Service-Name
- Dynamic-Search-UID
- Group-Service
- Group-Service-State-ID
- Hidden-Attrib
- IMSI
- Local-Port-type
- Message-Authenticator-Present
- MS-ChapV2-Message
- NAS-Name-And-IPAddress
- Notify-Service-Session-Key
- Notify-Service-State-ID
- Number-Requested-Triplets
- Proxied-Dynamic-Auth (named Proxied-POD in earlier releases)
- Provider-Identifier
- Rcd-NT-Password-Hash-Hash (named Rcd-NT-Password-Hash in earlier releases)
- Remote-Session
- Script-Level
- Session-ID
- Session-Generation-Tag
- Session-Start-Time
- Session-Last-Accessed-Time

- Session-Accounting-Counter
- Session-NAS-Identifier
- Session-NAS-Port
- Session-User-Name
- Session-Manager-Key
- Session-Resource-Count
- Session-Resource-%d
- Session-Survives-NAS-Reboot
- User-Name-Used-For-Lookup

APPENDIX C

RADIUS Attributes

This appendix lists the attributes Cisco Access Registrar 4.1 supports with their names and values. RADIUS attributes carry the specific authentication, authorization information, and configuration details for requests and replies. For more detailed information about specific attributes, refer to the appropriate RFC as listed Table 0-1.

Table 0-1 RFCs for RADIUS Attributes

RFC Subject	RFC Number
Standard RADIUS Attributes	2865
RADIUS Accounting Attributes	2866
Accounting Modifications for Tunnel Protocol Support	2867
Attributes for Tunnel Protocol Support	2868
RADIUS Extensions	2869
RADIUS for IPv6	3162

This appendix has two sections:

RADIUS Attributes—This section provides an alphabetic list of all RADIUS attributes Cisco AR 4.1 supports and a list of all RADIUS attributes in numeric order.

Vendor-Specific Attributes—This section provides lists of RADIUS vendor-specific attributes (VSAs).

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RADIUS Attributes

This section lists the RADIUS attributes supported in Cisco AR 4.1. RADIUS attributes carry specific authentication, authorization, information, and configuration details in the Access-Request and the RADIUS server response.

Cisco AR 4.1 Attributes

This section provides an alphabetical list of all attributes used in Cisco AR 4.1 and the attribute number.

Table 0-2 RADIUS Attributes Alphabetical List

Attribute Name	Attribute Number
Acct-Authentic	45
Acct-Delay-Time	41
Acct-Input-Gigawords	52
Acct-Input-Octets	42
Acct-Input-Packets	47
Acct-Interim-Interval	85
Acct-Link-Count	51
Acct-Multi-Session-Id	50
Acct-Output-Gigawords	53
Acct-Output-Octets	43
Acct-Output-Packets	48
Acct-Session-Id	44
Acct-Session-Time	46
Acct-Status-Type	40
Acct-Terminate-Cause	49
Acct-Tunnel-Connection	68
Acct-Tunnel-Packets-Lost	86
Acquire-Group-Session-Limit	280
ARAP-Challenge-Response	84
ARAP-Features	71
ARAP-Password	70
ARAP-Security	73
ARAP-Security-Data	74
ARAP-Zone-Access	72
Callback-Id	20
Callback-Number	19
Called-Station-Id	30
Calling-Station-Id	31
Change-Password	17
CHAP-Challenge	60
CHAP-Password	3
Class	25
Configuration-Token	78

Table 0-2 RADIUS Attributes Alphabetical List (continued)

Attribute Name	Attribute Number
Connect-Info	77
Digest-Attributes	207
Digest-Response	206
EAP-Message	79
Error-Cause	101
Event-Timestamp	55
Filter-Id	11
Framed-AppleTalk-Link	37
Framed-AppleTalk-Network	38
Framed-AppleTalk-Zone	39
Framed-Compression	13
Framed-Interface-Id	96
Framed-IP-Address	8
Framed-IP-Netmask	9
Framed-IPv6-Pool	100
Framed-IPv6-Prefix	97
Framed-IPv6-Route	99
Framed-IPX-Network	23
Framed-MTU	12
Framed-Pool	88
Framed-Protocol	7
Framed-Route	22
Framed-Routing	10
Idle-Timeout	28
Login-IP-Host	14
Login-IPv6-Host	98
Login-LAT-Group	36
Login-LAT-Node	35
Login-LAT-Port	63
Login-LAT-Service	34
Login-Service	15
Login-TCP-Port	16
Message-Authenticator	80
NAS-Identifier	32
NAS-IP-Address	4
NAS-IPv6-Address	95

Table 0-2 RADIUS Attributes Alphabetical List (continued)

Attribute Name	Attribute Number
NAS-Port	5
NAS-Port-ID	87
NAS-Port-Type	61
Originating-Line-Info	94
Password-Expiration	21
Password-Retry	75
Port-Limit	62
Prompt	76
Proxy-State	33
Reply-Message	18
Service-Type	6
Session-Timeout	27
State	24
Termination-Action	29
Text-Ascend-Data-Filter	225
Tunnel-Assignment-ID	82
Tunnel-Client-Auth-ID	90
Tunnel-Client-Endpoint	66
Tunnel-Medium-Type	65
Tunnel-Password	69
Tunnel-Preference	83
Tunnel-Private-Group-ID	81
Tunnel-Server-Auth-ID	91
Tunnel-Server-Endpoint	67
Tunnel-Type	64
User-Name	1
User-Password	2
Vendor-Specific Attributes	26

RADIUS Attributes Numeric List

Table 0-3 lists all RFC-defined RADIUS attributes in numeric order.

Table 0-3 RADIUS Attributes Numeric List

Number	Attribute Name
1	User-Name
2	User-Password
3	CHAP-Password
4	NAS-IP-Address
5	NAS-Port
6	Service-Type
7	Framed-Protocol
8	Framed-IP-Address
9	Framed-IP-Netmask
10	Framed-Routing
11	Filter-Id
12	Framed-MTU
13	Framed-Compression
14	Login-IP-Host
15	Login-Service
16	Login-TCP-Port
17	Change-Password
18	Reply-Message
19	Callback-Number
20	Callback-Id
21	Password-Expiration
22	Framed-Route
23	Framed-IPX-Network
24	State
25	Class

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
26	Vendor-Specific Attributes (VSAs) Refer to "Vendor-Specific Attributes" section on page C-13 or the specific vendor's VSA list: • 3GPP VSAs • 3GPP2 VSAs • ACC VSAs • Altiga VSAs • Ascend VSAs • Bay Networks VSAs • Cabletron VSAs • Cisco AR Internal VSAs • Cisco VSAs • Compatible VSAs • Microsoft VSAs • Nomadix VSAs • RedBack VSAs • RedCreek VSAs • Telebit VSAs • Unisphere VSAs • USR VSAs • WiMax • WISPr • XML
27	Session-Timeout
28	Idle-Timeout
29	Termination-Action
30	Called-Station-ID (DNIS)
31	Calling-Station-ID (CLID)
32	NAS-Identifier
33	Proxy-State
34	Login-LAT-Service
35	Login-LAT-Node
36	Login-LAT-Group
37	Framed-AppleTalk-Link
38	Framed-AppleTalk-Network

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
39	Framed-AppleTalk-Zone
40	Acct-Status-Type
41	Acct-Delay-Time
42	Acct-Input-Octets
43	Acct-Output-Octets
44	Acct-Session-Id
45	Acct-Authentic
46	Acct-Session-Time
47	Acct-Input-packets
48	Acct-Output-packets
49	Acct-Terminate-Cause
50	Acct-Multi-Session-Id
51	Acct-Link-Count
52	Acct-Input-Gigawords
53	Acct-Output-Gigawords
54	unassigned
55	Event-Timestamp
56	unassigned
57	unassigned
58	unassigned
59	unassigned
60	CHAP-Challenge
61	NAS-Port-Type
62	Port-Limit
63	Login-LAT-PortNo
64	Tunnel-Type
65	Tunnel-Medium-Type
66	Tunnel-Client-Endpoint
67	Tunnel-Server-Endpoint
68	Acct-Tunnel-Connection
68	Tunnel-ID
69	Tunnel-Password
70	ARAP-Password
71	ARAP-Features
72	ARAP-Zone-Access
73	ARAP-Security

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
74	ARAP-Security-Data
75	Password-Retry
76	Prompt
77	Connect-Info
78	Configuration-Token
79	EAP-Message
80	Message-Authenticator
81	Tunnel-Private-Group-ID
81	Ascend-Auth-Type
82	Tunnel-Assignment-ID
83	Tunnel-Preference
84	ARAP-Challenge-Response
85	Acct-Interim-Interval
85	Ascend-IP-Pool-Chaining
86	Acct-Tunnel-Packets-Lost
87	NAS-Port-ID
88	Framed-Pool
88	Ascend-IP-TOS
89	Ascend-IP-TOS-Precedence
90	Tunnel-Client-Auth-ID
90	Ascend-IP-TOS-Apply-To
91	Tunnel-Server-Auth-ID
91	Ascend-Filter
92	Ascend-Dsl-Rate-Type
93	Ascend-Redirect-Number
94	Originating-Line-Info
95	Ascend-ATM-Vci
96	Ascend-Source-IP-Check
97	Ascend-Dsl-Rate-Mode
98	Ascend-Dsl-Upstream-Limit
99	Ascend-Dsl-Downstream-Limit
100	Ascend-Dsl-CIR-Recv-Limit
101	Error-Cause
102	EAP-Key-Name
103	Ascend-Source-Auth
104	Ascend-Private-Route

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
105	unassigned
106	Ascend-FR-Link-Status-DLCI
107	unassigned
108	Ascend-Callback-Delay
109	unassigned
110	unassigned
111	Ascend-Multicast-GLeave-Delay
112	Ascend-CBCP-Enable
113	Ascend-CBCP-Mode
114	unassigned
115	Ascend-CBCP-Trunk-Group
116	Ascend-Appletalk-Route
117	Ascend-Appletalk-Peer-Mode
118	Ascend-Route-Appletalk
119	unassigned
120	Ascend-Modem-PortNo
121	Ascend-Modem-SlotNo
122	unassigned
123	unassigned
124	unassigned
125	Ascend-Maximum-Call-Duration
126	Ascend-Preference
127	Tunneling-Protocol
128	Ascend-Shared-Profile-Enable
129	Ascend-Primary-Home-Agent
130	Ascend-Secondary-Home-Agent
131	Ascend-Dialout-Allowed
132	Ascend-Client-Gateway
133	Ascend-BACP-Enable
134	Ascend-DHCP-Maximum-Leases
135	Ascend-Client-Primary-DNS
136	Ascend-Client-Secondary-DNS
137	Ascend-Client-Assign-DNS
138	Ascend-User-Acct-Type
139	Ascend-User-Acct-Host
140	Ascend-User-Acct-Port

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
141	Ascend-User-Acct-Key
142	Ascend-User-Acct-Base
143	Ascend-User-Acct-Time
144	Ascend-Assign-IP-Client
145	Ascend-Assign-IP-Server
146	Ascend-Assign-IP-Global-Pool
147	Ascend-DHCP-Reply
148	Ascend-DHCP-Pool-Number
149	Ascend-Expect-Callback
150	Ascend-Event-Type
151	Ascend-Session-Svr-Key
152	Ascend-Multicast-Rate-Limit
153	Ascend-IF-Netmask
154	Ascend-Remote-Addr
155	Ascend-Multicast-Client
156	Ascend-FR-Circuit-Name
157	Ascend-FR-LinkUp
158	Ascend-FR-Nailed-Grp
159	Ascend-FR-Type
160	Ascend-FR-Link-Mgt
161	Ascend-FR-N391
162	Ascend-FR-DCE-N392
163	Ascend-FR-DTE-N392
164	Ascend-FR-DCE-N393
165	Ascend-FR-DTE-N393
166	Ascend-FR-T391
167	Ascend-FR-T392
168	Ascend-Bridge-Address
169	Ascend-TS-Idle-Limit
170	Ascend-TS-Idle-Mode
171	Ascend-DBA-Monitor
172	Ascend-Base-Channel-Count
173	Ascend-Minimum-Channels
174	Ascend-IPX-Route
175	Ascend-FT1-Caller
176	Ascend-backup

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
177	Ascend-Call-Type
178	Ascend-Group
179	Ascend-FR-DLCI
180	Ascend-FR-Profile-Name
181	Ascend-Ara-PW
182	Ascend-IPX-Node-Addr
183	Ascend-Home-Agent-IP-Addr
184	Ascend-Home-Agent-Password
185	Ascend-Home-Network-Name
186	Ascend-Home-Agent-UDP-Port
187	Ascend-Multilink-ID supported
188	Ascend-Num-In-Multilink
189	Ascend-First-Dest (Not supported)
190	Ascend-Pre-Input-Octets
191	Ascend-Pre-Output-Octets
192	Ascend-Pre-Input-packets
193	Ascend-Pre-Output-packets
194	Ascend-Maximum-Time
195	Ascend-Disconnect-Cause
196	Ascend-Connect-Progress
197	Ascend-Data-Rate
198	Ascend-PreSession-Time
199	Ascend-Token-Idle
200	Ascend-Token-Immediate
201	Ascend-Require-Auth
202	Ascend-Number-Sessions
203	Ascend-Authen-Alias
204	Ascend-Token-Expiry
205	Ascend-Menu-Selector
206	Digest-Response
207	Digest-Attributes
208	Ascend-PW-Lifetime
209	Ascend-IP-Direct
210	Ascend-PPP-VJ-Slot-Comp
211	Ascend-PPP-VJ-1172
212	Ascend-PPP-Async-Map

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
213	Ascend-Third-Prompt
214	Ascend-Send-Secret
215	Ascend-Receive-Secret
216	Ascend-IPX-Peer-Mode
217	Ascend-IP-Pool-Definition
218	Ascend-Assign-IP-Pool
219	Ascend-FR-Direct
220	Ascend-FR-Direct-Profile
221	Ascend-FR-Direct-DLCI
222	Ascend-Handle-IPX
223	Ascend-Netware-timeout
224	Ascend-IPX-Alias
225	Ascend-Metric
226	Ascend-PRI-Number-Type
227	Ascend-Dial-Number
228	Ascend-Route-IP
229	Ascend-Route-IPX
230	Ascend-Bridge
231	Ascend-Send-Auth
232	Ascend-Send-Passwd
233	Ascend-Link-Compression
234	Ascend-Target-Util
235	Ascend-Maximum-Channels
236	Ascend-Inc-Channel-Count
237	Ascend-Dec-Channel-Count
238	Ascend-Seconds-Of-History
239	Ascend-History-Weigh-Type
240	Ascend-Add-Seconds
241	Ascend-Remove-Seconds
242	Ascend-Data-Filter
243	Ascend-Call-Filter
244	Ascend-Idle-Limit
245	Ascend-Preempt-Limit
246	Ascend-Callback
247	Ascend-Data-Svc
248	Ascend-Force-56

Table 0-3 RADIUS Attributes Numeric List (continued)

Number	Attribute Name
249	Ascend-Billing-Number
250	Ascend-Call-By-Call
251	Ascend-Transit-Number
252	Ascend-Host-Info
253	Ascend-PPP-Address
254	Ascend-MPP-Idle-Percent
255	Ascend-Xmit-Rate

Vendor-Specific Attributes

This section lists all vendor-specific attributes (VSAs) supported by Cisco AR 4.1.

3GPP VSAs

Table 0-4 lists the 3GPP VSAs. The vendor ID for 3GPP VSAs is 10415.

Table 0-4 3GPP VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	3GPP-IMSI	String	0-15
2	3GPP-Charging-Id	UINT	0-65535
3	3GPP-PDPType	ENUM	0-2 0 = IPv4 1 = PPP 2 = IPv6
4	3GPP-OG-Address	IP Address	
5	3GPP-GPRS-QoS-Profile	String	0-31
6	3GPP-SGSN-Address	IP Address	
7	3GPP-GGSN-Address	IP Address	
8	3GPP-IMSI-MCC-MNC	String	6-6
9	3GPP-GGSN-MCC-MNC	String	6-6
10	3GPP-NSAPI	String	1-1
11	3GPP-Session-Stop-Indicator	String	2-2

Table 0-4 3GPP VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
12	3GPP-Selection-Mode	String	1-1
13	3GPP-Charging-Characteristics	String	4-4
14	3GPP-CG-IPv6-Address	String	16-16
15	3GPP-SGSN-IPv6-Address	String	16-16
16	3GPP-GGSN-IPv6-Address	String	6-6
17	3GPP-IPv6-DNS-Servers	String	16-253
18	3GPP-SGSN-MCC-MNC	String	0-1
19	3GPP-Teardown-Indicator	UINT32	0-1
20	3GPP-IMEISV	String	16-16
21	3GPP-RAT-Type	String	1-1
22	3GPP-User-Location-Info	String	0-253
23	3GPP-MS-Timezone	String	2-2
24	3GPP-Camel-Charging-Info	String	0-253
25	3GPP-Packet-Filter	String	0-253
26	3GPP-Negotiated-DSCP	String	1-1

3GPP2 VSAs

Table 0-5 lists the 3GPP2 VSAs. The vendor ID for 3GPP2 VSAs is 5535 with 8-bit VendorTypeSize.

Table 0-5 3GPP2 VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	CDMA-IKE-Pre-Shared-Secret-Request	ENUM	1-2; 1 = The PDSN requests a pre-shared secret for IKE 2 = The PDSN does not request a pre-shared secret for IKE
2	CDMA-Security-Level	ENUM	1-4; 1 = IPSec for registration messages 2 = IPSec for tunnels 3= IPSec for tunnels and registration messages 4 = No IPSec security
3	CDMA-Pre-Shared-Secret	String	0-24
4	CDMA-Reverse-Tunnel-Spec	ENUM	0-1; 0 = Reverse tunneling is not required 1 = Reverse tunneling is required
5	CDMA-Diff-Svc-Class-Opt	ENUM	0-46; 0 = Best Effort 10 = AF11 12 = AF12 14 = AF13 18 = AF21 20 = AF22 22 = AF23 26 = AF31 28 = AF32 30 = AF33 34 = AF41 36 = AF42 38 = AF43 46 = EF
6	CDMA-Container	String	0-253
7	CDMA-HA-IP-Addr	IPADDR	
8	CDMA-KeyID-Attribute	String	0-28
9	CDMA-PCF-IP-Addr	IP Address	
10	CDMA-BS-MSC-Addr	String	0-253

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
11	CDMA-User-ID	UINT32	0-0
12	CDMA-Forward-MUX	UINT32	0-0
13	CDMA-Reverse-MUX	UINT32	0-0
14	CDMA-Forward-Rate	UINT32	0-0
15	CDMA-Reverse-Rate	UINT32	0-0
16	CDMA-Service-Option	UINT32	0-0
17	CDMA-Forward-Type	ENUM	0-1; 0 = Primary 1 = Secondary
18	CDMA-Reverse-Type	ENUM	0-1; 0 = Primary 1 = Secondary
19	CDMA-Frame-Size	ENUM	0-2; 0 = No Fundamental 1 = 5 ms Frame and 20ms Mixed Frame 2 = 20 ms Frame
20	CDMA-Forward-RC	UINT32	0-0
21	CDMA-Reverse-RC	UINT32	0-0
22	CDMA-IP-Technology	ENUM	1-3; 1 = Simple-IP 2 = Mobile-IP 3 = Proxy-Mobile-IP
23	CDMA-Comp-Flag	ENUM	0-2; 0 = None 1 = Non-secure 2 = Secure

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
24	CDMA-Release-Ind	ENUM	0-14; 0 = Unknown 1 = PPP/Service timeout 2 = Handoff 3 = PPP termination 4 = Mobile IP registration failure 5 = Abnormal Terminations 6 = Termination due to Resource management 7 = Service instance released 8 = Volume Quota reached, service instance released 9 = Duration Quota reached, Service instance released 10 = Incompatible PrePaid accounting information 11 = Airlink Parameter Change 12 = Time of Day Timer expiration 13 = Dormant by Accounting-Stop-triggered-by-Active-Stop 14 = Hot-Line status changed
25	CDMA-Dropped-Octets	UINT32	0-0
26	CDMA-Start-Date	String	0-253
27	CDMA-Start-Time	String	0-253
28	CDMA-Stop-Date	String	0-253
29	CDMA-Stop-Time	String	0-253
30	CDMA-Num-Active	UINT32	0-0
31	CDMA-SDB-Input-Octets	UINT32	0-0
32	CDMA-SDB-Output-Octets	UINT32	0-0
33	CDMA-NumSDB-Input	UINT32	0-0
34	CDMA-NumSDB-Output	UINT32	0-0

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
35	CDMA-Alt-Billing	UINT32	0-0
36	CDMA-IP-QoS	UINT32	0-0
37	CDMA-Interconnect-IP	UINT32	0-0
38	CDMA-Interconnect-QoS	UINT32	0-0
39	CDMA-Air-QoS	UINT32	0-0
40	CDMA-Airlink-Record-Type	ENUM	1-4; 1 = Connection Setup 2 = Active Start 3 = Active Stop 4 = SDB Record
41	CDMA-R-P-Link-ID	UINT32	0-0
42	CDMA-Airlink-Record-Type	UINT32	0-0
43	CDMA-PPP-Bytes-Received	UINT32	0-0
44	CDMA-Correlation-ID	String	0-253
45	CDMA-Mobile-Terminate-Originated-Ind	UINT32	0-0
46	CDMA-Inbound-Mobile-IP-Signalling-Octets	UINT32	0-0
47	CDMA-Outbound-Mobile-IP-Signalling-Octets	UINT32	0-0
48	CDMA-Session-Continue	ENUM	0-1; 0 = False 1 = True
49	CDMA-Active-Time	UINT32	0-0
50	CDMA-DCCH-Frame-Format	UINT32	0-3
51	CDMA-Beginning-Session	ENUM	0-1; 0 = False 1 = True
52	CDMA-ESN	String	0-253
54	CDMA-S-Attribute	String	0-253

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
55	CDMA-S-Request-Attribute	ENUM	0-1; 0 = The HA does not request a S secret for IKE 1 = The HA requests a S secret for IKE
56	CDMA-S-Lifetime-Attribute	UINT32	0-0
57	CDMA-MN-HA-SPI	String	0-4
58	CDMA-MN-HA-Shared-Key	String	0-253
59	CDMA-Remote-IPv4-Address	String	12-253
60	CDMA-HRPD-Access-Authentication	ENUM	1-1; 1 = HRPD Access Authentication
70	CDMA-Remote-IPv6-Address	String	68-253
71	CDMA-Remote-Address-Table-Index	UINT32	0-253
72	CDMA-Remote-IPv4-Address-Octet-Count	String	24-253
73	CDMA-Allowed-Differentiated-Service-Marking	String	12-253
74	CDMA-Service-Option-Profile	String	8-253
75	CDMA-DNS-Update-Required	ENUM	0-1; 0 = HA does not need to send DNS Update 1 = HA does need to send DNS Update
78	CDMA-Always-On	ENUM	0-1; 0 = Inactive 1 = Active
79	CDMA-Foreign-Agent-Address	IP Address	
80	CDMA-Last-User-Activity	UINT32	0-0
81	CDMA-MN-AAA-Removal-Indication	ENUM	1-1; 1 = MN-AAA not required
82	CDMA-RN-Packet-Data-Inactivity-Timer	UINT32	0-0
83	CDMA-Forward-PDCH-RC	UINT32	0-0
84	CDMA-Forward-DCCH-Mux-Option	UINT32	0-0

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
85	CDMA-Reverse-DCCH-Mux-Option	UINT32	0-0
86	CDMA-Forward-DCCH-RC	UINT32	0-0
87	CDMA-Reverse-DCCH-RC	UINT32	0-0
88	CDMA-Session-Termination-Capability	UINT32	0-0
89	CDMA-Allowed-Persistent-TFTs	UINT32	0-0
90	CDMA-PrePaid-Accounting-Quota	String	0-253
91	CDMA-PrePaid-Accounting-Capability	String	0-253
92	CDMA-MIP-Lifetime	String	0-253
93	CDMA-Accounting-Stop-Triggered-By-Active-Stop-Indication	ENUM	1-1; 1 = Accounting report at active/dormant transitions
94	CDMA-Service-Reference-ID	String	0-253
95	CDMA-DNS-Update-Capability	ENUM	1-1: 1 = HA is capable of dynamic DNS Update
96	CDMA-Disconnect-Reason	ENUM	1-1: 1 = MS Mobility Detection
97	CDMA-Remote-IPv6-Address-Octet-Count	String	36-253
98	CDMA-PrePaid-Tariff-Switching	String	0-253
99	CDMA-Authorization-Parameters	String	0-253
100	CDMA-BCMCS-Flow-ID	String	0-253
101	CDMA-BCMCS-Capability	String	0-253
102	CDMA-Common-Session-Info	String	0-253
103	CDMA-BSN-Session-Info	String	0-253
104	CDMA-RN-Session-Info	String	0-253
105	CDMA-Reason-Code	String	0-253
106	CDMA-Physical-Channel	String	0-253
107	CDMA-BCMCS-Flow-Transmission-Time	String	0-253
108	CDMA-Subnet	String	0-253
109	CDMA-Multicast-IP-Address	String	0-253
110	CDMA-Port	String	0-253
111	CDMA-Auth-Key	String	0-253

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
112	CDMA-TK-Info	String	0-253
113	CDMA-BAK-ID	String	0-253
114	CDMA-Reverse-PDCH-RC	UINT32	0-0
115	CDMA-Acq-Info-Timestamp	UINT32	0-0
116	CDMA-MEID	String	0-16
117	CDMA-DNS-Server-IP-Address	String	0-22
118	CDMA-MIP6-Home-Agent-from-BU	String	0-18
119	CDMA-MIP6-CoA	String	0-22
120	CDMA-MIP6-HoA-Not-Authorized	ENUM	1-1; 1 = The HoA is not authorized
121	CDMA-MIP6-Session-Key	String	0-253
122	CDMA-Hot-Line-Accounting-Indication	String	0-253
123	CDMA-Hot-Line-Profile-ID	String	0-253
124	CDMA-Filter-Rule	String	0-253
125	CDMA-HTTP-Redirection-Rule	String	0-253
126	CDMA-IP-Redirection-Rule	String	0-253
127	CDMA-Hot-Line-Capability	UINT32	0-0
128	CDMA-MIP6-Home-Link-Prefix	String	0-253
129	CDMA-MIP6-Home-Address	String	0-253
130	CDMA-Maximum-Authorized-Aggregate-Bandwidth-for-Best-Effort-Traffic	UINT32	0-0
131	CDMA-Authorized-QoS-Profile-IDs-for-the-User	String	0-253
132	CDMA-Granted-QoS-Parameters	String	0-253
133	CDMA-Maximum-Per-Flow-Priority-for-the-User	UINT32	0-15
134	CDMA-MIP6-Authenticator	String	0-253
135	CDMA-Source-IPv6-Address	String	0-253
136	CDMA-Program-ID	String	0-253
137	CDMA-Program-Name	String	0-253
138	CDMA-MIP6-MAC-Mobility-Data	String	0-253
139	CDMA-Inter-User-Priority	UINT32	0-3
140	CDMA-MIP6-Home-Agent-Attribute-B	String	0-253
141	CDMA-MIP6-HoA	String	0-253

Table 0-5 3GPP2 VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
142	CDMA-Carrier-ID	String	0-8
143	CDMA-GMT-Time-Zone-Offset	String	0-253

ACC VSAs

Table C-6 lists the ACC VSAs. The vendor ID for ACC VSAs is 5.

Table C-6 ACC VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Acc-Reason-Code	ENUM: no reason given/no failure resource shortage protocol error invalid attribute invalid service type invalid framed protocol invalid attribute value invalid user information invalid IP address invalid integer syntax invalid NAS port	0-56
1	Acc-Reason-Code *(Continued)*	ENUM: requested by user session already open network disconnect service interruption physical port error idle timeout session timeout administrative reset NAS reload or reset NAS error NAS request	0-56
1	Acc-Reason-Code *(Continued)*	ENUM: undefined reason given too many RADIUS users conflicting attributes port limit exceeded facility not available internal configuration error bad route specification	0-56

Table C-6 ACC VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
1	Acc-Reason-Code *(Continued)*	Access Partition bind failure security violation request type conflict configuration disallowed missing attribute no authentication server invalid request missing parameter invalid parameter call cleared with cause inopportune config request invalid config parameter missing config parameter incompatible service profile administrative reset	0-56
1	Acc-Reason-Code *(Continued)*	administrative reload no authentication response port unneeded port preempted port suspended service unavailable callback user error host request no accounting server no accounting response access denied temporary buffer shortage	0-56
2	Acc-Ccp-Option	ENUM: Disabled Enabled	1-2
3	Acc-Input-Errors	UINT32	0-253
4	Acc-Output-Errors	UINT32	0-253
5	Acc-Access-Partition	String	0-253
6	Acc-Customer-Id	String	0-253
7	Acc-Ip-Gateway-Pri	IPADDR	0-253
8	Acc-Ip-Gateway-Sec	IPADDR	0-253
9	Acc-Route-Policy	ENUM : Funnel Direct	1-2
10	Acc-ML-MLX-Admin-State	ENUM: Enabled Disabled	1-2
11	Acc-ML-Call-Threshold	UINT32	0-253

Table C-6 ACC VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
12	Acc-ML-Clear-Threshold	UINT32	0-253
13	Acc-ML-Damping-Factor	UINT32	0-253
14	Acc-Tunnel-Secret	String	0-253
15	Acc-Clearing-Cause	ENUM: cause unspecified unassigned number invalid information element c message incompatible with sta recovery on timer expiration mandatory information element protocol error interworking normal clearing user busy no user responding user alerted no answer	0-127
15	Acc-Clearing-Cause *(Continued)*	ENUM: no route to transit network call rejected number changed non selected user clearing destination out of order invalid or incomplete number facility rejected no route to destination response to status inquiry normal unspecified cause no circuit or channel availab network out of order	0-127
15	Acc-Clearing-Cause *(Continued)*	ENUM: temporary failure switching equipment congestio access information discarded circuit or channel unavailabl circuit or channel preempted resources unavailable quality of service unavailabl facility not subscribed outgoing calls barred incoming calls barred bearer capability unauthorize bearer capability not availab	0-127

Table C-6 ACC VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
15	Acc-Clearing-Cause *(Continued)*	ENUM: channel unacceptable service not available bearer capability not impleme channel type not implemented facility not implemented call awarded being delivered restricted digital informatio service not implemented invalid call reference identified channel does not e call identity does not exist call identity in use no call suspended	0-127
15	Acc-Clearing-Cause *(Continued)*	ENUM: suspended call cleared incompatible destination invalid transit network selec invalid message mandatory information element message not implemented inopportune message information element not imple	0-127
16	Acc-Clearing-Location	ENUM: local or remote user private network serving local beyond interworking point public network serving local transit network private network serving remot public network serving remote international network	0-10
17	Acc-Service-Profile	String	0-253
18	Acc-Request-Type	ENUM: Ring Indication Dial Request User Authentication Tunnel Authentication User Accounting Tunnel Accounting	1-6
19	Acc-Framed-Bridge	ENUM : Disabled Enabled	0-1
20	Acc-Vpsm-Oversubscribed	ENUM : False True	1-2

Table C-6 ACC VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
21	Acc-Acct-On-Off-Reason	ENUM : NAS Reset NAS Reload Configuration Reset Configuration Reload Enabled Disabled	0-5
22	Acc-Tunnel-Port	UINT32	0-253
23	Acc-Dns-Server-Pri	IPADDR	0-253
24	Acc-Dns-Server-Sec	IPADDR	0-253
26	Acc-Nbns-Server-Sec	IPADDR	0-253
27	Acc-Dial-Port-Index		
28	Acc-Ip-Compression	ENUM: Disabled Enabled	0-1
29	Acc-Ipx-Compression	ENUM: Disabled Enabled	0-1
30	Acc-Connect-Tx-Speed	UINT32	0-253
31	Acc-Connect-Rx-Speed	UINT32	0-253
32	Acc-Modem-Modulation-Type	String	0-253
33	Acc-Modem-Error-Protocol	String	0-253
34	Acc-Callback-Delay	UINT32	0-253
35	Acc-Callback-Num-Valid	String	0-253
36	Acc-Callback-Mode	ENUM: User-Auth User-Specified-E-164 CBCP-Callback CLI-Callback	0-7
37	Acc-Callback-CBCP-Type	ENUM: CBCP-None CBCP-User-Specified CBCP-Pre-Specified	1-3
38	Acc-Dialout-Auth-Mode	ENUM: PAP CHAP CHAP-PAP NONE	1-4
39	Acc-Dialout-Auth-Password	String	0-253
40	Acc-Dialout-Auth-UserName	String	0-253

Table C-6 ACC VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
42	Acc-Access-Community	ENUM: PUBLIC NETMAN	1-2
43	Acc-Vpsm-Reject-Cause	ENUM: No-Access-Partition Access-Partition-Disabled Partition-Portlimit-Exceeded License-Portlimit-Exceeded Home-Server-Down Rejected-By-Home-Server NAS-Administratively-Disabled	1-7
44	Acc-Ace-Token	String	0-253
45	Acc-Ace-Token-Ttl	UINT	0-253
46	Acc-Ip-Pool-Name	String	0-253
47	Acc-Igmp-Admin-State	ENUM : Enabled Disabled	1-2
48	Acc-Igmp-Version	ENUM : V1 V2	1-2

Altiga VSAs

Table C-7 lists the Altiga VSAs. The vendor ID for Altiga VSAs is 3076.

Table C-7 Altiga VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Altiga-General-Acces-Hours	String	0-253
2	Altiga-General-Simultaneous-Logic	UINT32	0-253
3	Altiga-General-Minimum-Password-Length	UINT32	0-253
4	Altiga-General-All-Alphabetic-Only-Passwords	ENUM	0-1
5	Altiga-General-Primary-DNS	IP Address	0-253
6	Altiga-General-Secondary-DNS	IP Address	0-253
8	Altiga-General-Secondary-WINS	IP Address	0-253
9	Altiga-General-SEP-Card-Assignment	UINT32	0-253
10	Altiga-General-Priority-On-SEP	UINT32	0-253
11	Altiga-General-Tunneling-Protoco	UNIT32	0-253
12	Altiga-IPSec-Security-Associatio	String	0-253

Table C-7 Altiga VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
13	Altiga-IPSec-Authentication	ENUM: None RADIUS LDAP NT Domain SDI Internal	0-5
15	Altiga-IPSec-Banner	String	0-253
16	Altiga-IPSec-Allow-Password-Storage-On-Client	ENUM: False True	0-1
17	Altiga-PPTP-L2TP-Use-Client-Specified-Address	ENUM: False True	0-1
18	Altiga-PPTP-Minimal-Authentication-Protocol	UINT32	0-253
19	Altiga-L2TP-Minimal-Authentication	UINT32	0-253
20	Altiga-PPTP-Encryption	UINT32	0-253
21	Altiga-L2TP-Encryption	UINT32	0-253
22	Altiga-Argument-Authentication-Server-Type	ENUM: First Active Server RADIUS LDAP NT SDI Internal	0-5
23	Altiga-Argument-Authentication-Server-Password	String	0-253
24	Altiga-Argument-Request-Authenticatior-Vector	String	0-253
25	Altiga-IPSec-LTL-Keepalives	ENUM: False True	0-1
26	Altiga-Argument-IPSec-Group-Name	String	0-253
27	Altiga-IPSec-Split-Tunneling	String	0-253
28	Altiga-IPSec-Default-Domain	String	0-253
28	Altiga-IPSec-Secondary-Domain-List	String	0-253
30	Altiga-IPSec-Tunnel-Type	ENUM: LAN to LAN Remote Access	1-2

Table C-7 Altiga VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
31	Altiga-IPSec-Mode-Configuration	ENUM: False True	0-1
32	Altiga-Argument-Authentication-Server-Priority	UINT32	0-253
33	Altiga-IPSec-Group-Lock-Of-User	ENUM: False True	0-1
34	Altiga-IPSec-IPSec-Over-UDP	ENUM: False True	0-1
35	Altiga-IPSec-UDP-Port-For-IPSec	UINT32	0-253
128	Altiga-Partitioning-Primary-DHCP		
129	Altiga-Partitioning-Secondary-DHCP	IP Address	0-253
131	Altiga-Partitioning-Premise-Rout	IP Address	0-253
132	Altiga-Partitioning-Partition-Max-Sessions	String	0-253
133	Altiga-Partitioning-Mobile-IP-Key	String	0-253
134	Altiga-Partitioning-Mobile-IP-Address	IP Address	0-253
135	Altiga-Partitioning-Mobile-IP-SPI	IP Address	0-253
136	Altiga-Partitioning-Strip-Realm	ENUM: False True	0-1
137	Altiga-Partitioning-Group-ID	UINT32	0-253
250	Altiga-Group-Name	String	0-253

Ascend VSAs

Table C-8 lists the Ascend VSAs. The vendor ID for Ascend VSAs is 529.

Table C-8 Ascend VSAs

SubAttr	VSA Name	Type	Min-Max Value
17	Ascend-Change-Password	String	0 - 253
18	Ascend-Session-Type	ENUM: Unused Unknown G711-Ulaw G711-Alaw G723 G729 G723-64KPS G728 RT24	0 - 8
19	Ascend-H323-Gatekeeper	IP Address	0 - 253
21	Ascend-H323-Conference-ID	String	0-253
22	Ascend-H323-Destination-NAS-ID	IP Address	0-65535
23	Ascend-H323-Dialed-Time	UINT32	0-253
24	Ascend-H323-Dialed-Number	String	0-253
25	Ascend-Inter-Arrival-Jitter	UINT32	0-253
26	Ascend-Dropped-Octets	UINT32	0-253
27	Ascend-Dropped-Packets	UINT32	0-253
48	Ascend-Call-Direction	ENUM: Incoming Outgoing	0-1

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
49	Ascend-Service-Type	ENUM	0 - 23; NotUsed None EuUi Telnet TelnetBin RawTcp TermServer MP VirtualConn X25DChan PseuTun PPP IpFax Other ATM HdlcNrm VoIp Visa2 PPP Slip MPP X25 Combinet FR EuRaw
68	Ascend-Tunnel-ID	String	0 - 253
126	Ascend-Route-Preference	ENUM: Interface, OSPF-Internal, RIP, Down-WAN, OSPF-ASE, Infinite, ICMP	0-225
132	Ascend-Client-Gateway	IP Address	0 - 253
144	Ascend-Assign-IP-Client	IP Address	0-0
145	Ascend-Assign-IP-Server	IP Address	0-0
152	Ascend-Multicast-Rate-Limit	UINT32	0-65535
162	Ascend-FR-DCE-N392	UINT32	0-65535

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
163	Ascend-FR-DTE-N392	UINT32	0-65535
164	Ascend-FR-DCE-N393	UINT32	0-65535
165	Ascend-FR-DTE-N393	UINT32	0-65535
166	Ascend-FR-T391	UINT32	0-65535
167	Ascend-FR-T392	UINT32	0-65535
168	Ascend-Bridge-Address	UINT32	1-253
169	Ascend-TS-Idle-Limit	UINT32	0-65535
170	Ascend-TS-Idle-Mode	ENUM; TS-Idle-None TS-Idle-Input TS-Idle-Input-Output	0-2
171	Ascend-DBA-Monitor	ENUM; Transmit Transmit-Receive None	0-2
172	Ascend-Base-Channel-Count	UINT32	0-65535
173	Ascend-Minimum-Channels	UINT32	0-65535
174	Ascend-IPX-Route	String	1-253
175	Ascend-FT1-Caller	ENUM; FT1-No FT1-Yes	0-1
176	Ascend-Backup	String	1-253
177	Ascend-Call-Type	ENUM; Nailed Nailed/MPP Perm/Switched	0-2
178	Ascend-Group	String	1-253
179	Ascend-FR-DLCI	UINT32	0-65535
180	Ascend-FR-Profile-Name	String	1-253
181	Ascend-Ara-PW	String	1-253
182	Ascend-IPX-Node-Address	String	1-253
183	Ascend-Home-Agent-IP-Addr	IP Address	0-0
184	Ascend-Home-Agent-Password	String	1-253
185	Ascend-Home-Network-Name	String	1-253
186	Ascend-Home-Agent-UDP-Port	UINT32	0-65535
187	Ascend-Multilink-ID	UINT32	0-65535

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
188	Ascend-Num-In-Multilink	UINT32	0-65535
189	Ascend-First-Dest	IP Address	0-0
190	Ascend-Pre-Input-Octets	UINT32	0-65535
191	Ascend-Pre-Output-Octets	UINT32	0-65535
192	Ascend-Pre-Input-Packets	UINT32	0-65535
193	Ascend-Pre-Output-Packets	UINT32	0-65535
194	Ascend-Maximum-Time	UINT32	0-65535

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
195	vAscend-Pre-Output-Packets (continued)	ENUM: No-Reason, Not-Applicable, Modem-No-DCD, Session-Timeout, Invalid-Incoming-User, Disconnect-Due-To-Callback, DCD-Detected-Then-Inactive, Modem-Invalid-Result-Codes, Protocol-Disabled-Or-Unsuppor, Disconnect-Req-By-RADIUS, Disconnect-Req-By-Local-Admin, V110-Timeout-Or-Sync-Retry-Ex, PPP-Auth-Timeout-Exceeded, User-Executed-Do-Hangup, Remote-End-Hung-Up, Resource-Has-Been-Quiesced, Max-Call-Duration-Reached, Unknown, (continued)	0-195

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
195	vAscend-Pre-Output-Packets	ENUM: TermSrv-User-Quit, TermSrv-Idle-Timeout, TermSrv-Exit-Telnet, TermSrv-No-IPaddr, TermSrv-Exit-Raw-TCP, TermSrv-Exit-Login-Failed, TermSrv-Exit-Raw-TCP-Disabled, TermSrv-CTRL-C-In-Login, TermSrv-Destroyed, TermSrv-User-Closed-VCon, Call-Disconnected, TermSrv-VCon-Destroyed, TermSrv-Exit-Rlogin, TermSrv-Bad-Rlogin-Option, TermSrv-Not-Enough-Resources, MPP-No-NULL-Msg-Timeout, CLID-Authentication-Failed, (continued)	0-195

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
195	vAscend-Pre-Output-Packets	ENUM: PPP-LCP-Timeout, PPP-LCP-Negotion-Failed, PPP-PAP-Auth-Failed, PPP-CHAP-Auth-Failed, PPP-Rmt-Auth-Failed, PPP-Rcv-Terminate-Req, PPP-Rcv-Close-Event, PPP-No-NCPs-Open, PPP-MP-Bundle-Unknown,. PPP-LCP-Close-MP-Add-Fail, CLID-RADIUS-Timeout (continued)	0-195

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
195	vAscend-Pre-Output-Packets (*continued*)	Out-Of-Resources, Invalid-IP-Address, Hostname-Resolution-Failed, Bad-Or-Missing-Port-Number, Host-Reset, Connection-Refused, Connection-Timeout, Connection-Closed, Network-Unreachable, Host-Unreachable, Network-Unreachable-Admin, Host-Unreachable-Admin, Port-Unreachable,	

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
196	Ascend-Connect-Progress	ENUM: No-Progress, unknown1, Call-Up, unknown2, Modem-Up, Modem-Awaiting-DCD, Modem-Awaiting-Codes, TermSrv-Started, TermSrv-Raw-TCP-Started, TermSrv-Telnet-Started, TermSrv-Raw-TCP-Connected, TermSrv-Telnet-Connected, TermSrv-Rlogin-Started, TermSrv-Rlogin-Connected, TermSrv-Authentication-Begin, Modem-Outdial-Call-Up	0-94

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
196	Ascend-Connect-Progress	ENUM: LAN-Session-Up, LCP-Opening, CCP-Opening, IPNCP-Opening, NCP-Opening, LCP-Opened, CCP-Opened, IPNCP-Opened, BNCP-Opened, LCP-State-Initial, LCP-State-Starting, LCP-State-Closed, LCP-State-Stopped, BACP-Opened, LCP-State-Stopping, LCP-State-Request-Sent, LCP-State-Ack-Received, LCP-State-Ack-Sent, IPXNCP-Opened, ATNCP-Opened, BACP-Opening, V110-Up, V110-State-Opened, V110-State-Carrier, V110-State-Reset, V110-State-Closed	0-94
197	Ascend-Data-Rate	UINT32	0-65535

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
198	Ascend-PreSession-Time	UINT32	0-65535
199	Ascend-Token-Idle	UINT32	0-65535
200		ENUM: Tok-Imm-No, Tok-Imm-Yes	0-1
201	Ascend-Require-Auth	ENUM: Not-Require-Auth Require-Auth Pap-Only Pap-Only Pap-Login-Only Pap-Framed-Only Pap-Outbound-Only CHAP-Only CHAP-Only CHAP-Login-Only CHAP-Framed-Only CHAP-Outbound-Only MS-CHAP-Only MS-CHAP-Only MS-CHAP-Login-Only MS-CHAP-Framed-Only MS-CHAP-Outbound-Only	0-55
210	Ascend-PPP-VJ-Slot-Comp	ENUM: VJ-Slot-Comp-No	1-1
211	Ascend-PPP-VJ-1172	ENUM: PPP-VJ-1172	1-1
212	Ascend-PPP-Async-Map	UINT32	0-65535
213	Ascend-Third-Prompt	String	1-253
214	Ascend-Send-Secret	String	1-253
215	Ascend-Receive-Secret	String	1-253

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
216	Ascend-IPX-Peer-Mode	ENUM: IPX-Peer-Router, IPX-Peer-Dialin	1-1
217	Ascend-IP-Pool-Definition	String	1-253
218	Ascend-Assign-IP-Pool	UINT32	0-65535
219	Ascend-FR-Direct	ENUM: FR-Direct-No, FR-Direct-Yes	1-1
220	Ascend-FR-Direct-Profile	String	1-253
221	Ascend-FR-Direct-DLCI	UINT32	0-65535
222	Ascend-Handle-IPX	ENUM: Handle-IPX-None, Handle-IPX-Client, Handle-IPX-Server	0-2
223	Ascend-Netware-timeout	UINT32	0-65535
224	Ascend-IPX-Alias	UINT32	0-65535
225	Ascend-Metric	UINT32	0-65535
226	Ascend-PRI-Number-Type	ENUM: Unknown-Number, Intl-Number, National-Number, Local-Number Abbrev-Number	0-5
227	Ascend-Dial-Number	String	1-253
228	Ascend-Route-IP	ENUM: Unknown-Number, Intl-Number, National-Number, Local-Number, Abbrev-Number	0-5

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
229	Ascend-Route-IPX	ENUM: Route-IPX-No Route-IPX-Yes	0-1
230	Ascend-Bridge	ENUM: Bridge-No, Bridge-Yes	0-1
231	Ascend-Send-Auth	ENUM: Send-Auth-None, end-Auth-PAP, Send-Auth-CHAP	0-2
232	Ascend-Send-Passwd	String	1-253
233	Ascend-Link-Compression	ENUM: Link-Comp-None, Link-Comp-Stac, Link-Comp-Stac-Draft-9, Link-Comp-MS-Stac	0-3
234	Ascend-Target-Util	UINT32	0-65535
235	Ascend-Maximum-Channels	UINT32	0-65535
236	Ascend-Inc-Channel-Count	UINT32	0-65535
237	Ascend-Dec-Channel-Count	UINT32	0-65535
238	Ascend-Seconds-Of-History	UINT32	0-65535
239	Ascend-History-Weigh-Type	ENUM: History-Constant, History-Linear, History-Quadratic	0-2
240	Ascend-Add-Seconds	UINT32	0-65535
241	Ascend-Remove-Seconds	UINT32	0-65535
242	Ascend-Data-Filter	String	1-253
243	Ascend-Call-Filter	String	1-253
244	Ascend-Idle-Limit	UINT32	0-65535
245	Ascend-Idle-Limit	UINT32	0-65535

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
246	Ascend-Callback	ENUM: Callback-No, Callback-Yes	0-1

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
247	Ascend-Data-Svc	ENUM: Switched-Voice-Bearer, Switched-56KR, Switched-192K, Switched-256K, Switched-320K, Switched-384K-MR, Switched-448K, Switched-512K, Switched-566K, Switched-640K, Switched-704K, Switched-768K, Switched-64K, Switched-832K, Switched-896K, Switched-960K, Switched-1024K, Switched-1088K, Switched-1152K, Switched-1216K,. Switched-1280K, Switched-1344K, Switched-1408K, Switched-64KR, Switched-1472K, Switched-1600K, Switched-1664K, Switched-1728	0-43

Table C-8 Ascend VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
248	Ascend-Force-56	ENUM: Force-56-No, Force-56-Yes	0-1
249	Ascend-Billing-Number	String	1-253
250	Ascend-Call-By-Call	UINT32	0-65535
251	Ascend-Transit-Number	String	1-253
252	Ascend-Host-Info	String	1-253
253	Ascend-PPP-Address	IP Address	0-0
254	Ascend-MPP-Idle-Percent	UINT32	0-65535

Bay Networks VSAs

Table C-9 Lists the Bay Networks VSAs. The vendor ID for Bay Networks VSAs is 1584.

Table C-9 Bay Networks VSAs

SubAttr	VSA Name	Type	Min-Max Value
28	Annex-Filter	String	1-253
29	Annex-CLI-Command	String	1-253
30	Annex-CLI-Filter	String	1-253
31	Annex-Host-Restrict	String	1-253
32	Annex-Host-Allow	String	1-253
33	Annex-Product-Name	String	1-253
34	Annex-SW-Version	String	1-253
35	Annex-Local-IP-Address	IPADDR	1-253
36	Annex-Callback-Portlist	UINT32	0-0
44	Annex-System-Disc-Reason	UINT32	0-0
45	Annex-Modem-Disc-Reason	UINT32	0-0
46	Annex-Disconnect-Reason	UINT32	0-0
50	Annex-Transmit-Speed	UINT32	0-0
51	Annex-Receive-Speed	UINT32	0-0

Cabletron VSAs

Table C-10 lists the Cabletron VSAs. The vendor ID for Cabletron VSAs is 52.

Table C-10 Cabletron VSAs

SubAttr	VSA Name	Type	Min-Max Value
192	Cabletron-Framed-Data-Rate	ENUM: Rate-56KB Rate-64KB Rate-112KB Rate-128KB	0-4
193	Cabletron-Phone-Number	String	0-253
194	Cabletron-Caller-Id	String	0-253
196	Cabletron-Connection-Reference	UINT32	0-253
198	Cabletron-Initial-Rate	UINT32	0-253
199	Cabletron-Maximum-Rate	UINT32	0-253
192	Cabletron-Framed-Data-Rate	Enum: Rate-56KB Rate-64KB Rate-112KB Rate-128KB	192

Cisco AR Internal VSAs

Table C-12 lists the Cisco AR Internal VSAs. The vendor ID for Cisco AR internal VSAs is 1760.

Table C-11 Cisco AR Internal VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Realm	String	1-253
2	Incoming-Translation-Groups	String	1-253
3	Client-IP-Address	IP Address	1-253
4	Subnet-Mask	IP Address	1-253
5	Outgoing-Translation-Groups	String	1-253
6	Authentication-Service	String	1-253
7	Authorization-Service	String	1-253
8	DNIS	String	1-253
9	CLID	String	1-253
10	UserFilterMask	String	1-253
11	Session-Manager	String	1-253

Table C-11 Cisco AR Internal VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
12	Accounting-Service	String	1-253
13	TimeRange	String	1-253
14	AcceptedProfiles	String	1-253
15	Policy	String	1-253
16	Prefix	String	1-253
17	Delimiters	String	1-253
18	StripPrefix	String	1-253
19	ODBC-Reply-Attribs	String	1-253
20	ODBC-Check-Attribs	String	1-253
21	Session-Service	String	1-253
22	Prepaid	ENUM: 0 = False 1 = True	1-2
23	Suffix	String	0-253
23	Implicit-Auth-Enabled	ENUM: 0 = False 1 = True	0-1
24	StripSuffix	ENUM: 0 = False 1 = True	0-1
24	Query-Service	String	0-253
92	RepSourceIP	String	1-253
93	RepTargetIP	String	1-253
94	RepTxnNum	String	1-253
95	RepTxnCRC	String	1-253
96	RepTxnElementCount	String	1-253
97	RepNeedsFullSync	UINT32	0-253
98	RepNeedsReSync	UINT32	0-253
99	RepLastRxTxnNum	UINT32	0-253
100	RepLastRxTxnCRC	UINT32	0-253
101	RepNeedsMember	UINT32	0-253
102	RepMemberName	String	1-253
103	RepMemberIP	IP Address	0-253
104	RepMemberPort	UINT32	0-253
105	RepMemberOrdinal	UINT32	0-253
106	RepWorkLoad	UINT32	0-253

Table C-11 Cisco AR Internal VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
107	RepTxTime	UINT32	0-253
108	RepElementPath	String	1-253
109	RepElementValue	String	1-253
110	RepElementOrdinal	UINT32	0-253
111	RepElementCRC	UINT32	0-253
112	RepElementType	UINT32	0-253
113	RepElementMode	UINT32	0-253
114	RepPartialElement	Undefined	0-253

Cisco VSAs

Table C-12 lists the Cisco VSAs. The vendor ID for Cisco VSAs is 9.

Table C-12 Cisco VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Cisco-AVPair	String	0-253
2	Cisco-NAS-Port	String	0-253
3	Cisco-Fax-Account-ID-Origin	String	0-253
4	Cisco-Fax-Message-ID	String	0-253
5	Cisco-Fax-Pages	String	0-253
6	Cisco-FAX Cover Page Flag	String	0-253
7	Cisco-Fax-Modem-Time	String	0-253
8	Cisco-Fax-Connect-Speed	String	0-253
9	Cisco-Fax-Recipient-Count	String	0-253
10	Cisco-Fax-Process-Abort-Flag	String	0-253
11	Cisco-Fax-DSN-Address	String	0-253
12	Cisco-Fax-DSN-Flag	String	0-253
13	Cisco-Fax-MDN-Address	String	0-253
14	Cisco-Fax-MDN-Flag	String	0-253
15	Cisco-Fax-Auth-Status	String	0-253
16	Cisco-Email-Server-Address	IP Address	

Table C-12 Cisco VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
17	Cisco-Email-Server-ACK Flag	String	0-253
18	Cisco-Gateway-ID	String	0-253
19	Cisco-Call-Type	String	0-253
20	Cisco-Port-Used	String	0-253
21	Cisco-Abort-Cause	String	0-253
22	Cisco-CRS-Info	String	0-253
23	Cisco-h323-Remote-Address	String	0-253
24	Cisco-h323-Conf-ID	String	0-253
25	Cisco-h323-Setup-Time	String	0-253
26	Cisco-h323-Call-Origin	String	0-253
27	Cisco-h323-Call-Type	String	0-253
28	Cisco-h323-Connect-Time	String	0-253
29	Cisco-h323-Disconnect-Time	String	0-253
30	Cisco-h323-Disconnect-Cause	String	0-253
31	Cisco-h323-Voice-Quality	String	0-253
32	Cisco-h323-Generic-IVR-Out	String	0-253
33	Cisco-h323-Gateway-ID	String	0-253
34	Cisco-3GPP2-AVPair	String	0-253
35	Cisco Connection ID-h323-incoming-connection -ID	String	0-253
100	Cisco-h323-Generic-IVR-In	String	0-253
101	Cisco-h323-Amount-Balance		
102	Cisco-h323-Time-Balance	String	0-253
103	Cisco-h323-Return-Code	String	0-253
104	Cisco-h323-Prompt-ID	String	0-253
105	Cisco-h323-Time-of-Day	String	0-253
106	Cisco-h323-Redirect-Number	String	0-253
107	Cisco-h323-Preferred-Langua ge	String	0-253
108	Cisco-h323-Redirect-IP-Addr ess	String	0-253
109	Cisco-h323-Billing-Model	ENUM: postpai d prepaid	0-1
110	Cisco-h323-Currency	String	0-253

Table C-12 Cisco VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
128	Cisco-UCP-IP-Pool-ID	String	0-253
129	Cisco-UCP-User-Max-Sessions	String	0-253
130	Cisco-UCP-User-Session-Count	String	0-253
131	Cisco-UCP-Next-Session-ID	String	0-253
132	Cisco-UCP-VPDN-Max-Sessions	String	0-253
133	Cisco-UCP-VPDN-Session-Count	String	0-253
134	Cisco-UCP-B-Channel-Max-Sessions	String	0-253
135	Cisco-UCP-B-Channel-Session-Coun	String	0-253
136	Cisco-UCP-Status	String	0-253
137	Cisco-UCP-BLOB-Attribute-Length	String	0-253
138	Cisco-UCP-Disable-Statu	String	0-253
139	Cisco-UCP-Block-Access-Range	String	0-253
140	Cisco-UCP-Home-POP-ID	String	0-253
175	Cisco-UCP-IP-Addresses	IP Address	0-253
176	Cisco-UCP-Session-Info	String	0-253
211	Cisco-Ascend AV pairs	String	0-253
250	Cisco-SSG-Account-Info	String	0-253
251	Cisco-SSG-Service-Info	String	0-253
252	Cisco-SSG-Command-Code	String	0-253
253	Cisco-SSG-Control-Info	String	0-253

Compatible VSAs

Table C-13 lists the Compatible VSAs. The vendor ID for Compatible VSAs is 255.

Table C-13 Compatible VSAs

SubAttr	VSA Name	Type	Min-Max Value
0	Compatible-Tunnel-Delay	UNIT32	0-253
1	Compatible-Tunnel-Throughput	UNIT32	0-253
3	Compatible-Tunnel-Server-Endpoint	IP Address	0-253
4	Compatible-Tunnel-Group-Info	String	0-253
5	Compatible-Tunnel-Password	String	0-253
6	Compatible-Echo	UNIT32	0-253
7	Compatible-Tunnel-Client-IPX	UNIT32	0-253

Microsoft VSAs

Table C-14 lists the Microsoft VSAs. The vendor ID for Microsoft VSAs is 311.

Table C-14 Microsoft VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	MS-CHAP-Response	String	50-50
2	MS-CHAP-Error	String	0-253
3	MS-CHAP-CPW1	String	70-70
4	MS-CHAP-CPW2	String	84-84
5	MS-CHAP-LM-Enc-PW	String	4-253
6	MS-CHAP-NT-Enc-PW	String	4-253
7	MS-MPPE-Encryption-Policy	ENUM: Encryption-Allowed Encryption-Required	1-2
8	MS-MPPE-Encryption-Types	String	0-4
9	MS-RAS-Vendor	UINT32	0-253
10	MS-CHAP-Domain	String	0-253
11	MS-CHAP-Challenge	String	0-253
12	MS-CHAP-MPPE-Keys	String	32-32
13	MS-BAP-Usage	ENUM: Not allowed Allowed Required	0-2
14	MS-Link-Utilization-Threshold	UINT32	0-253
15	MS-Link-Drop-Time-Limit	String	0-253

Table C-14 Microsoft VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
16	MS-MPPE-Send-Key	String	0-253
17	MS-MPPE-Recv-Key	String	0-253
18	MS-RAS-Version	String	0-253
19	MS-Old-ARAP-Password	String	0-253
20	MS-New-ARAP-Password	String	0-253
21	MS-ARAP-Password-Change-Reason	ENUM: Just-Change-Password Expired-Password Admin-Requires-Password-Chang Password-Too-Short	1-4
22	MS-Filter	String	0-253
23	MS-Acct-Auth-Type	ENUM: PAP CHAP MS-CHAP-1 MS-CHAP-2 EAP	1-5
26	MS-CHAP2-Success	String	43-43
27	MS-CHAP2-CPW8	String	68-68
29	MS-Secondary-DNS-Server	IP Address	68-68
31	MS-Secondary-NBNS-Server	IP Address	70-70
33	MS-ARAP-Challenge	String	8-8

Nomadix VSAs

Table C-15 lists the Nomadix VSAs. The vendor ID for Nomadix VSAs is 3309.

Table C-15 Nomadix VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Nomadix-Bw-Up 0 253	UINT32	0-253
2	Nomadix-Dw-Down	UINT32	0-253

RedBack VSAs

Table C-16 lists the RedBack VSAs. The vendor ID for RedBack VSAs is 2352.

Table C-16 RedBack VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	RedBack-Client-DNS-Pri	String	0-253
2	RedBack-Client-DNS-Sec	String	0-253
3	RedBack-DHCP-Max-Leases	String	0-253
4	RedBack-Context-Name	String	0-253
5	RedBack-Bridge-Group	String	0-253
6	RedBack-BG-Aging-Time	String	0-253
7	RedBack-BG-Path-Cost	String	0-253
8	RedBack-BG-Span-Dis	String	0-253
9	RedBack-BG-Trans-BPDU	String	0-253
10	RedBack-Rate-Limit-Rate	String	0-253
11	RedBack-Rate-Limit-Burst	String	0-253
12	RedBack-Police-Rate	String	0-253
13	RedBack-Police-Burst	String	0-253
14	RedBack-Source-Validation	String	0-253
15	RedBack-Tunnel-Domain	String	0-253
16	RedBack-Tunnel-Local-Name	String	0-253
17	RedBack-Tunnel-Remote-Name	String	0-253
18	RedBack-Tunnel-Function	String	0-253
21	RedBack-Tunnel-Max-Sessions	String	0-253
22	RedBack-Tunnel-Max-Tunnels	String	0-253
23	RedBack-Tunnel-Session-Auth	String	0-253
24	RedBack-Tunnel-Window	String	0-253
25	RedBack-Tunnel-Retransmit	String	0-253
26	RedBack-Tunnel-Cmd-Timeout	String	0-253
27	RedBack-PPPOE-URL	String	0-253
28	RedBack-PPPOE-MOTM	String	0-253
29	RedBack-Tunnel-Group	String	0-253
30	RedBack-Tunnel-Context	String	0-253
31	RedBack-Tunnel-Algorithm	String	0-253
32	RedBack-Tunnel-Deadtime	String	0-253
33	RedBack-Mcast-Send	String	0-253
34	RedBack-Mcast-Receive	String	0-253

Table C-16 RedBack VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
35	RedBack-Mcast-MaxGroups	String	0-253
36	RedBack-Ip-Address-Pool-Name	String	0-253
37	RedBack-Tunnel-DNIS	String	0-253
38	RedBack-Medium-Type	String	0-253
39	RedBack-PVC-Encapsulation-Type	String	0-253
40	RedBack-PVC-Profile-Name	String	0-253
41	RedBack-PVC-Circuit-Padding	String	0-253
42	RedBack-Bind-Type	String	0-253
43	RedBack-Bind-Auth-Protocol	String	0-253
44	RedBack-Bind-Auth-Max-Sessions	String	0-253
45	RedBack-Bind-Bypass-Bypass	String	0-253
46	RedBack-Bind-Auth-Context	String	0-253
47	RedBack-Bind-Auth-Service-Grp	String	0-253
48	RedBack-Bind-Bypass-Context	String	0-253
49	RedBack-Bind-Int-Context	String	0-253
50	RedBack-Bind-Tun-Context	String	0-253
51	RedBack-Bind-Ses-Context	String	0-253
52	RedBack-Bind-Dot1q-Slot	String	0-253
53	RedBack-Bind-Dot1q-Port	String	0-253
54	RedBack-Bind-Dot1q-Vlan-Tag-Id	String	0-253
55	RedBack-Bind-Int-Interface-Name	String	0-253
56	RedBack-Bind-L2TP-Tunnel-Name	String	0-253
57	RedBack-Bind-L2TP-Flow-Control	String	0-253
58	RedBack-Bind-Sub-User-At-Context	String	0-253
59	RedBack-Bind-Sub-Password	String	0-253
60	RedBack-Ip-Host-Addr	String	0-253
61	RedBack-IP-TOS-Field	String	0-253
62	RedBack-NAS-Real-Port	String	0-253
63	RedBack-Tunnel-Session-Auth-Ctx	String	0-253

Table C-16 RedBack VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
64	RedBack-Tunnel-Session-Auth-Service-Grp	String	0-253
65	RedBack-Tunnel-Rate-Limit-Rate	String	0-253
66	RedBack-Tunnel-Rate-Limit-Burst	String	0-253
67	RedBack-Tunnel-Police-Rate	String	0-253
68	RedBack-Tunnel-Police-Burst	String	0-253
69	RedBack-Tunnel-L2F-Second-Password	String	0-253
128	RedBack-Acct-Input-Octets-64	String	0-253
129	RedBack-Acct-Output-Octets-64	String	0-253
130	RedBack-Acct-Input-Packets-64	String	0-253
131	RedBack-Acct-Output-Packets-64	String	0-253
132	RedBack-Assigned-IP-Address	String	0-253
133	RedBack-Acct-Mcast-In-Octets	String	0-253
134	RedBack-Acct-Mcast-Out-Octets	String	0-253
135	RedBack-Acct-Mcast-In-Packets	String	0-253
136	RedBack-Acct-Mcast-Out-Packets	String	0-253
137	RedBack-LAC-Port	String	0-253
138	RedBack-LAC-Real-Port	String	0-253
139	RedBack-LAC-Port-Type	String	0-253
140	RedBack-LAC-Real-Port-Type	String	0-253

RedCreek VSAs

Table C-17 lists the RedCreek VSAs. The vendor ID for RedCreek VSAs is 1958.

Table C-17 RedCreek VSAs

SubAttr	VSA Name	Type	Min-Max Value
6	RedCreek-Tunneled-IP-Netmask	IP Address	0-253
7	RedCreek-Tunneled-Gateway	IP Address	0-253
9	RedCreek-Tunneled-WINS-Server1	String	0-253
10	RedCreek-Tunneled-WINS-Server2	String	0-253
11	RedCreek-Tunneled-HostName	String	0-253

Table C-17 RedCreek VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
12	RedCreek-Tunneled-DomainName	String	0-253
13	RedCreek-Tunneled-Search-List	String	0-253

TACACS+ VSAs

Table C-18 lists the TACACS+ VSAs. The vendor ID for TACACS+ VSAs is 268435456.

Table C-18 TACACS+ VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Tacacs-Version	ENUM: 192 = 12.0 193 = 12.1	0-255
2	Tacacs-Type	ENUM: 1 = Authentication 2 = Authorization 3 = Accounting	1-3
3	Tacacs-Sequence-Number	UINT32	0-1
4	Tacacs-Session-Id	UINT32	0-2147483647
5	Tacacs-Action	ENUM: 1 = Login 2 = ChPass 3 = SendPass 4 = SendAuth	0-253
6	Tacacs-Privilege-Level	UINT32	0-15
7	Tacacs-Authentication-Type	ENUM: 1 = ASCII 2 = PAP 3 = CHAP 4 = ARAP 5 = MSCHAP	1-5
8	Tacacs-Service	ENUM: 1 = Login 2 = Enable 3 = PPP 4 = ARAP 5 = PT 6 = RCMD 7 = X25 8 = NASI 9 = FWPROXY	1-9

Table C-18 TACACS+ VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
9	Tacacs-User-Name	String	0-253
10	Tacacs-Port	String	0-253
11	Tacacs-Remote-Address	String	0-253
12	Tacacs-Data	String	0-253
13	Tacacs-User-Message	String	0-253
14	Tacacs-User-Data	String	0-253
15	Tacacs-Authentication-Continue-Flag	ENUM: 0 = Continue 1 = Abort	0-1
16	Tacacs-Authentication-Reply-Flag‘	ENUM: 0 = Echo 1 = NoEcho	0-1
17	Tacacs-Authentication-Reply-Status	ENUM: 1 = Pass 2= Fail 3 = GetData 4 = GetUser 5 = GetPass 6 = Restart 7 = Error 33 = Follow	0-33
18	Tacacs-Authorization-Reply-Status	ENUM: 1 = PassAdd 2 = PassRepl 16 = Fail 17 = Error 33 = Follow	0-33
19	Tacacs-Server-Message	String	0-253
20	Tacacs-Authentication-Method	ENUM: 0 = NotSet 1 = None 2 = KRB5 3 = Line 4 = Enable 5 = Local 6 = TacacsPlus 7 = Guest 16 = Radius 17 = KRB4 32 = RCMD	0-32
21	Tacacs-AVPair	String	0-253

Table C-18 TACACS+ VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
22	Tacacs-Accounting-Reply-Status	ENUM: 1 = Success 2 = Fail 33 = Follow	0-33
23	Tacacs-Header-Flag	ENUM: 0 = Encrypted 1 = Unencrypted 4 = Encrypted + ReuseConnection 5 = Unencrypted + ReuseConnection	0-5
24	Tacacs-User-Password	String	0-253
25	Tacacs-Accounting-Request-Flag	ENUM: 1 = More 2 = Start 3 = Start 4 = Stop 5 = Stop 6 = Start 7 = Start 8 = Update 9 = More 10 = Start 11 = Start 12 = Stop 13 = Stop 14 = Start 15 = Start	0-33
26	Tacacs-CHAP-Password	CHAP_PASSWORD	17-17
27	Tacacs-CHAP-Challenge	String	0-253
28	Tacacs-MSCHAP-Response	String	50-50
29	Tacacs-MSCHAP-Challenge	String	0-253

Telebit VSAs

Table C-19 lists the Telebit VSAs. The vendor ID for Telebit VSAs is 117.

Table C-19 Telebit VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Telebit-Login-Command	String	0-253
2	Telebit-Port-Name	String	0-253

Table C-19 Telebit VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
3	Telebit-Activate-Command	String	0-253
4	Telebit-Accounting-Info	String	0-253
5	Telebit-Login-Option	String	0-253

Unisphere VSAs

Table C-20 lists the Unisphere VSAs. The vendor ID for RedBack VSAs is 4874.

Table C-20 Unisphere VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	Unisphere-Virtual-Router	String	0-253
2	Unisphere-Local-Address-Pool	String	0-253
3	Unisphere-Local-Interface	String	0-253
4	Unisphere-Primary-DNS	String	0-253
5	Unisphere-Secondary-DNS	String	0-253
6	Unisphere-Primary-WINS	String	0-253
7	Unisphere-Secondary-WINS	String	0-253
8	Unisphere-Tunnel-Virtual-Router	String	0-253
9	Unisphere-Tunnel-Password	String	0-253
10	Unisphere-Ingress-Policy-Name	String	0-253
11	Unisphere-Egress-Policy-Name	String	0-253
12	Unisphere-Ingress-Statistics	String	0-253
13	Unisphere-Egress-Statistics	String	0-253
14	Unisphere-Service-Category	String	0-253
15	Unisphere-PCR	String	0-253
16	Unisphere-SCR	String	0-253
17	Unisphere-MBS	String	0-253
18	Unisphere-Init-CLI-Access-Level	String	0-253
19	Unisphere-Allow-All-VR-Access	String	0-253
20	Unisphere-Alt-CLI-Access-Level	String	0-253

Table C-20 Unisphere VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
21	Unisphere-Alt-CLI-VRouter-Name	String	0-253
22	Unisphere-SA-Validate	String	0-253
23	Unisphere-IGMP-enable	String	0-253
24	Unisphere-PPPoE-Description	String	0-253
25	Unisphere-Redirect-VRouter-Name	String	0-253

USR VSAs

Table C-21 lists the USR VSAs. The vendor ID for USR VSAs is 429.

Table C-21 USR VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	USR-DTE-Data-Idle-Timeout	UINT32	0-0
2	USR-Default-DTE-Data-Rate	ENUM: 110_BPS 300_BPS 600_BPS 1200_BPS 2400_BPS 4800_BPS 7200_BPS 9600_BPS 12K_BPS 14.4K_BPS 16.8_BPS 19.2K_BPS 38.4K_BPS 75_BPS 450_BPS UNKNOWN_BPS 57.6K_BPS 21.6K_BPS 24K_BPS 26K_BPS 28K_BPS 115K_BPS 31K_BPS 33K_BPS 25333_BPS 110_BPS 300_BPS 600_BPS 1200_BPS 2400_BPS 26666_BPS 28000_BPS 29333_BPS 30666_BPS 32000_BPS	1-54

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
2	USR-Default-DTE-Data-Rate	33333_BPS 34666_BPS 36000_BPS 37333_BPS 38666_BPS 40000_BPS 41333_BPS 42666_BPS 44000_BPS 45333_BPS 46666_BPS 48000_BPS 49333_BPS 50666_BPS 52000_BPS 53333_BPS 54666_BPS 56000_BPS 57333_BPS 58666_BPS 60000_BPS 61333_BPS 62666_BPS 64000_BPS	
3	USR-Last-Number-Dialed-Out	String	1-253
4	USR-Sync-Async-Mode	ENUM: Asynchronous Synchronous	1-2
5	USR-Originate-Answer-Mode	ENUM: Originate_in_Originate_Mode Originate_in_Answer_Mode Answer_in_Originate_Mode Answer_in_Answer_Mode	1-4
6	USR-Failure-to-Connect-Reason	ENUM:	1-67

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
7	USR-Initial-Tx-Link-Data-Rate	ENUM: 110_BPS 14.4K_BPS 16.8_BPS 19.2K_BPS 38.4K_BPS 75_BPS 450_BPS UNKNOWN_BPS 57.6K_BPS 21.6K_BPS 24K_BPS 300_BPS 26K_BPS 28K_BPS 115K_BPS 31K_BPS 33K_BPS 25333_BPS 26666_BPS 28000_BPS 29333_BPS 30666_BPS 600_BPS 32000_BPS 33333_BPS 34666_BPS 36000_BPS 37333_BPS 38666_BPS 40000_BPS 41333_BPS 42666_BPS 44000_BPS 1200_BPS 45333_BPS 46666_BPS 48000_BPS 49333_BPS 50666_BPS 52000_BPS 53333_BPS 54666_BPS 56000_BPS 57333_BPS 2400_BPS 58666_BPS 60000_BPS	1-54

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
7	USR-Initial-Tx-Link-Data-Rate (*continued*)	61333_BPS 62666_BPS 64000_BPS 4800_BPS 7200_BPS 9600_BPS 12K_BPS	
8	USR-Final-Tx-Link-Data-Rate	ENUM: 110_BPS 14.4K_BPS 16.8_BPS 19.2K_BPS 38.4K_BPS 75_BPS 450_BPS UNKNOWN_BPS 57.6K_BPS 21.6K_BPS 24K_BPS 300_BPS 26K_BPS 28K_BPS 115K_BPS 31K_BPS 33K_BPS 25333_BPS 26666_BPS 28000_BPS 29333_BPS 30666_BPS 600_BPS	1-54

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
8	USR-Final-Tx-Link-Data-Rate	32000_BPS 33333_BPS 34666_BPS 36000_BPS 37333_BPS 38666_BPS 40000_BPS 41333_BPS 42666_BPS 44000_BPS 1200_BPS 45333_BPS 46666_BPS 48000_BPS 49333_BPS 50666_BPS 52000_BPS 53333_BPS	1-54
8	USR-Final-Tx-Link-Data-Rate	54666_BPS 56000_BPS 57333_BPS 2400_BPS 58666_BPS 60000_BPS 61333_BPS 62666_BPS 64000_BPS 4800_BPS 7200_BPS 9600_BPS	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
9	USR-Modulation-Type	ENUM: usRoboticsHST bell208b v21FaxClass1 v27FaxClass1 v29FaxClass1 v17FaxClass1 v21FaxClass2 v27FaxClass2 v29FaxClass2 v17FaxClass2 v32Terbo ccittV32 v34 vFC v34plus x2 v110 v120 x75 ayncSyncPPP clearChannel ccittV22bis bell103 ccittV21 bell212 ccittV32bis ccittV23 negotiationFailed	1-28
9	USR-Modulation-Type	ENUM:	
10	USR-Equalization-Type	ENUM: Long Short	1-2
112	USR-Characters-Sent	UINT32	0-0
13	USR-Characters-Received	UINT32	0-0
14	USR-Blocks-Sent	UINT32	0-0
15	USR-Blocks-Received 0	UINT32	0-0
16	USR-Blocks-Resent	UINT32	0-0
17	USR-Retrains-Requested	UINT32	0-0
18	USR-Retrains-Granted	UINT32	
19	USR-Line-Reversals	UINT32	
20	USR-Number-Of-Characters-Lost0	UINT32	0-0

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
21	USR-Back-Channel-Data-Rate	ENUM : 450BPS 300BPS None	1-3
22	USR-Number-of-Blers	UINT32	0-0
23	USR-Number-of-Link-Timeouts	UINT32	0-0
24	USR-Number-of-Fallbacks	UINT32	0-0
25	USR-Number-of-Upshifts	UINT32	0-0
26	USR-Number-of-Link-NAKs	UINT32	0-0
27	USR-Simplified-MNP-Levels	ENUM: Unknown NON_ARQ MNP10ec LAPMAC V42ETC2 V42SREJ PIAFS V120 X75 MNP3 MNP4 V42 HST synchronous MNP2 MNP10(Cellular) V42ETC	0-16

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
28	USR-Connect-Term-Reason	ENUM: dtrDrop retransmitLimit linkDisconnectMsg Received noLoopCurrent invalidSpeed unableToRetrain managementComm and noDialTone keyAbort lineBusy noAnswer escapeSequence voice noAnswerTone noCarrier undetermined v42SabmeTimeout v42BreakTimeout v42DisconnectCmd v42IdExchangeFail v42BadSetup v42InvalidCodeWo rd athCommand v42StringToLong v42InvalidComman d none v32Cleardown dialSecurity	1-67

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
28	USR-Connect-Term-Reason	remoteAccessDenied loopLoss ds0Teardown promptNotEnabled noPromptingInSync carrierLoss nonArqMode modeIncompatible noPromptInNonARQ dialBackLink linkAbort autopassFailed pbGenericError pbLinkErrTxPreAck pbLinkErrTxTardyACK pbTransmitBusTimeout inactivityTimout pbReceiveBusTimeout pbLinkErrTxTAL pbLinkErrRxTAL pbTransmitMasterTimeout pbClockMissing pbReceivedLsWhileLinkUp pbOutOfSequenceFrame pbBadFrame pbAckWaitTimeout pbReceivedAckSeqErr mnpIncompatible pbReceiveOvrflwRNRFail pbReceiveMsgBufOvrflw rcvdGatewayDiscCmd tokenPassingTimeout dspInterruptTimeout mnpProtocolViolation	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
28	USR-Connect-Term-Reason	class2FaxHangupCmd hstSpeedSwitchTimeout undefined remotePassword linkPassword	
29	USR-DTR-False-Timeout	UINT32	0-0
30	USR-Fallback-Limit	UINT32	0-0
31	USR-Block-Error-Count-Limit	UINT32	0-0
32	USR-Simplified-V42bis-Usage	ENUM: None ccittV42bis mnpLevel5	1-3
33	USR-DTR-True-Timeou	UINT32	0-0
34	USR-Last-Number-Dialed-In-DNIS	String	1-253
35	USR-Last-Callers-Number-ANI	String	1-253
36	USR-Mbi-Ct-PRI-Card-Slot	UINT32	0-0
37	USR-Mbi-Ct-TDM-Time-Slot	UINT32	0-0
38	USR-Mbi-Ct-PRI-Card-Span-Line	UINT32	0-0
39	USR-Mbi-Ct-BChannel-Used	UINT32	0-0
40	USR-IP-Input-Filter	String	1-253
41	USR-IPX-Input-Filter	String	1-253
42	USR-IP-Output-Filter	String	1-253
43	USR-IPX-Output-Filter	String	1-253
44	USR-SAP-Output-Filter	String	1-253
45	USR-VPN-ID	UINT32	0-0
46	USR-VPN-Name	String	1-253
47	USR-VPN-Neighbor	String	1-253
48	USR-Framed-Routing-V2	ENUM: RIP-V2-Off RIP-V2-On	1-2
49	USR-VPN-Gateway	String	1-253
50	USR-Tunnel-Authenticato	String	1-253
51	USR-Packet-Index	String	1-253
52	USR-Cutoff	String	1-253

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
53	USR-Access-Accept-Packet	String	1-253
54	USR-Primary-DNS-Server	String	1-253
55	USR-Secondary-DNS-Server	String	1-253
56	USR-Primary-NBNS-Server	String	1-253
57	USR-Secondary-NBNS-Server	String	1-253
58	USR-Syslog-Tap	UINT32	0-0
59	USR-Chassis-Call-Slot	UINT32	0-0
60	USR-Chassis-Call-Span	UINT32	0-0
61	-Chassis-Call-Channel	UINT32	0-0
62	USR-Keypress-Timeout	UINT32	0-0
63	USR-Unauthenticated-Time	UINT32	0-0
64	USR-Bearer-Capabilities	UINT32	0-0
65	USR-Speed-Of-Connection	UINT32	0-0
66	USR-Max-Channels	UINT32	0-0
67	USR-Channel-Expansion	UINT32	0-0
68	USR-Channel-Decrement	UINT32	0-0
69	USR-Expansion-Algorithm	UINT32	0-0
70	USR-Compression-Algorithm	UINT32	0-0
71	USR-Receive-Acc-Map	UINT32	0-0
72	USR-Transmit-Acc-Map	UINT32	0-0
73	USR-Compression-Reset-Mode	UINT32	0-0
74	USR-Min-Compression-Size	UINT32	0-0
75	USR-IP	UINT32	0-0
76	USR-IPX	UINT32	0-0
77	USR-Filter-Zones	UINT32	0-0
78	USR-Appletalk	UINT32	0-0
79	USR-Bridging	UINT32	0-0
80	USR-Spoofing	UINT32	0-0
81	USR-Host-Type	String	1-253
82	USR-Send-Name	UINT32	0-0
83	USR-Send-Password	String	1-253
84	USR-Start-Time	UINT32	0-0
85	USR-End-Time	UINT32	0-0
86	USR-Send-Script1	String	1-253
87	USR-Reply-Script1	String	1-253

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
88	USR-Send-Script2	String	1-253
89	USR-Reply-Script2	String	1-253
90	USR-Send-Script3	String	1-253
91	USR-Send-Script3 USR-Reply-Script3	String	1-253
92	USR-Send-Script4	String	1-253
93	USR-Reply-Script4	String	1-253
94	USR-Send-Script5	String	1-253
95	USR-Reply-Script5	String	1-253
96	USR-Send-Script6	String	1-253
97	USR-Reply-Script6	String	1-253
98	USR-Terminal-Type	String	1-253
99	USR-Appletalk-Network-Range	UINT32	0-0
100	USR-Local-IP-Address	String	1-253
101	USR-Routing-Protocol	UINT32	0-0
102	USR-Modem-Group	UINT32	0-0
103	USR-IPX-Routing	UINT32	0-0
104	USR-IPX-Wan	UINT32	0-0
105	USR-IP-RIP-Policies	UINT32	0-0
106	USR-IP-RIP-Simple-Auth-Password	String	0-253
107	USR-IDS0-Call-Type	UINT32	0-0
108	USR-Call-Terminate-in-GMT	UINT32	0-0
109	USR-Call-Connect-in-GMT	UINT32	0-0
110	USR-Call-Arrival-in-GMT	UINT32	0-0
111	USR-Channel-Connected-To	UINT32	0-0
112	USR-Slot-Connected-To	UINT32	0-0
113	USR-Device-Connected-To	ENUM: None isdnGateway quadModem	1-3
114	USR-NFAS-ID	UINT32	0-0
115	USR-Q931-Call-Reference-Value	UINT32	0-0

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
116	USR-Call-Event-Code	ENUM: notSupported noFreeIGW igwRejectCall igwSetupTimeout noFreeTdmts bcReject ieReject chidReject progReject callingPartyReject calledPartyReject setup blocked analogBlocked digitalBlocked outOfService busy congestion protocolError noFreeBchannel inOutCallCollision usrSetup telcoDisconnect usrDisconnect noFreeModem modemsNotAllowed modemsRejectCall modemSetupTimeout	1-28
117	USR-DS0	UINT32	0-0
118	USR-DS0s	String	1-253
119	USR-Gateway-IP-Address	IP Address	0-0
120	USR-Physical-State	UINT32	0-0
121	USR-Chassis-Temp-Threshold	UINT32	0-0

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
122	USR-Card-Type	ENUM: SlotEmpty QuadV32DigitalModemNAC DualT1NIC DualAlogMdmNIC QuadDgtlMdmNIC QuadAlogDgtlMdmNIC TokenRingNIC SingleT1NIC EthernetNIC ShortHaulDualT1NIC DualAlogMgdIntlMdmNIC X25NIC	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
122	USR-Card-Type (continued)	ENUM: QuadAlogNonMgd MdmNIC QuadAlogMgdIntl MdmNIC QuadAlogNonMgd IntlMdmNIC QuadLsdLiMgdMd mNIC QuadLsdLiNonMg dMdmNIC QuadLsdLiMgdIntl MdmNIC QuadLsdLiNonMg dIntlMdmNIC EthernetWithV35N IC HSEthernetWithout V35NIC DualHighSpeedV3 5NIC QuadV35RS232Lo wSpeedNIC DualE1NIC ShortHaulDualE1N IC BellcoreLongHaul DualT1NIC BellcoreShrtHaulD ualT1NIC SCSIEdgeServerNI C QuadV32AnalogM odemNAC QuadV32DigAnlM odemNAC QuadV34DigMode mNAC QuadV34AnlMode mNAC QuadV34DigAnlM odemNAC SingleT1NAC EthernetGatewayN AC AccessServer 486TrGatewayNAC SlotUnknown	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
122	USR-Card-Type *(continued)*	ENUM: 486EthernetGatewayNAC DualRS232NAC 486X25GatewayNAC ApplicationServerNAC ISDNGatewayNAC ISDNpriT1NAC ClkedNetMgtCard ModemPoolManagementNAC NetwMgtCard ModemPoolNetserverNAC (continued)	1-1027
122	USR-Card-Type *(continued)*	ModemPoolV34ModemNAC ModemPoolISDNNAC NTServerNAC QuadV34DigitalG2NAC QuadV34AnalogG2NAC QuadV34DigAnlgG2NAC NETServerFrameRelayNAC NETServerTokenRingNAC X2524ChannelNAC DualT1NAC WirelessGatewayNac EnhancedAccessServer EnhancedISDNGatewayNAC DualModemNAC QuadModemNAC TrGatewayNAC X25GatewayNAC DualV34ModemNAC	
123	USR-Security-Login-Limit	UINT32	0-0

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
124	USR-Security-Resp-Limit	UINT32	0-0
125	USR-Packet-Bus-Session	UINT32	0-0
126	USR-DTE-Ring-No-Answer-Limit	UINT32	0-0
127	USR-Final-Rx-Link-Data-Rate	ENUM: 110_BPS 14.4K_BPS 16.8_BPS 19.2K_BPS 38.4K_BPS 75_BPS 450_BPS UNKNOWN_BPS 57.6K_BPS 21.6K_BPS 24K_BPS 300_BPS 6K_BPS 28K_BPS 115K_BPS 31K_BPS 33K_BPS 25333_BPS 26666_BPS 28000_BPS 62666_BPS 9333_BPS 30666_BPS 600_BPS (continued)	1-54

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
127	USR-Final-Rx-Link-Data-Rate (continued)	32000_BPS 33333_BPS 34666_BPS 36000_BPS 37333_BPS 38666_BPS 40000_BPS 41333_BPS 42666_BPS 44000_BPS 1200_BPS 45333_BPS 46666_BPS 48000_BPS 49333_BPS 50666_BPS 52000_BPS 53333_BPS 54666_BPS 56000_BPS 57333_BPS 2400_BPS 58666_BPS 60000_BPS 61333_BPS 64000_BPS 800_BPS 7200_BPS 9600_BPS 12K_BPS	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
128	USR-Initial-Rx-Link-Data-Rate	ENUM: 110_BPS 14.4K_BPS 16.8_BPS 19.2K_BPS 38.4K_BPS 75_BPS 450_BPS UNKNOWN_BPS 57.6K_BPS 21.6K_BPS 24K_BPS 300_BPS 26K_BPS 28K_BPS 115K_BPS 31K_BPS 33K_BPS 25333_BPS 26666_BPS	1-54
128	USR-Initial-Rx-Link-Data-Rate	28000_BPS 29333_BPS 30666_BPS 600_BPS 32000_BPS 33333_BPS 34666_BPS 36000_BPS 37333_BPS 38666_BPS 40000_BPS 41333_BPS 42666_BPS 44000_BPS 1200_BPS 45333_BPS 46666_BPS 48000_BPS 49333_BPS 50666_BPS 52000_BPS 53333_BPS	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
128	USR-Initial-Rx-Link-Data-Rate	54666_BPS 56000_BPS 57333_BPS 2400_XBPS 58666_BPS 60000_BPS 61333_BPS 62666_BPS 64000_BPS 4800_BPS 7200_BPS 9600_BPS 12K_BPS	
129	USR-Event-Date-Time	UINT32	0-0
130	USR-Chassis-Temperature	UINT32	0-0
131	USR-Actual-Voltage	UINT32	0-0
132	USR-Expected-Voltage	UINT32	0-0
133	USR-Power-Supply-Number	UINT32	0-0
134	USR-Channel	UINT32	0-0
135	USR-Chassis-Slot	UINT32	0-0

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
136	USR-Event-Id	ENUM: HUB_Temp_Out_of_Range Fan_Failed Watchdog_Timeout Mgmt_Bus_Failure In_Connection_Est Out_Connection_Est In_Connection_Term Out_Connection_Term Connection_Failed Connection_Timeout DTE_Transmit_Idle DTR_True DTR_False Block_Error_at_Threshold Fallbacks_at_Threshold No_Dial_Tone_Detected No_Loop_Current_Detected Yellow_Alarm Red_Alarm Loss_Of_Signal Rcv_Alrm_Ind_Signal Timing_Source_Switch Modem_Reset_by_DTE Modem_Ring_No_Answer DTE_Ring_No_Answer Pkt_Bus_Session_Active Pkt_Bus_Session_Congestion Pkt_Bus_Session_Lost Pkt_Bus_Session_Inactive User_Interface_Reset Gateway_Port_Out_of_Service Gateway_Port_Link_Active	

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
136	USR-Event-Id (*Continued*)	Rcv_Alrm_Ind_Signal_Clear Incoming_Connection_Establish Module_Inserted Outgoing_Connection_Establish Incoming_Connection_Terminate Outgoing_Connection_Terminate Connection_Attempt_Failure Continuous_CRC_Alarm Continuous_CRC_Alarm_Clear Physical_State_Change Module_Removed Gateway_Network_Failed Gateway_Network_Restored Packet_Bus_Clock_Lost Packet_Bus_Clock_Restored D_Channel_In_Service D_Channel_Out_of_Service DS0s_In_Service DS0s_Out_of_Service T1/T1PRI/E1PRI_Call_Event PSU_Voltage_Alarm Psu_Incompatible T1,T1-E1/PRI-Call-Arrive-Even T1,T1-E1/PRI-Call-Connect-Eve T1,T1-E1/PRI-Call-Termina-Eve T1,T1-E1/PRI-Call-Failed-Even	6-84

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
137	USR-Number-of-Rings-Limit	UINT32	0-0
138	USR-Connect-Time-Limit	UINT32	0-0
139	USR-Call-End-Date-Time	UINT32	0-0
140	USR-Call-Start-Date-Time	UINT32	0-0
141	USR-Server-Time	UINT32	0-0
142	USR-Request-Type	ENUM: Access-Request Access-Challenge Status-Server Status-Client Access-Accept Reserved Access-Reject Accounting-Request Accounting-Response Access-Password-Change Access-Password-Ack Access-Password-Reject	1-255
143	USR-Old-Password	String	0-253
144	USR-Expiration	UINT32	0-0
145	USR-Prompt	UINT32	0-1
146	USR-Char-Noecho	UINT32	0-0
147	USR-User-Group-Name	String	0-253
148	148 USR-Call-Reference-Number	UINT32	0-253
149	USR-Dial-In-Sec-Mode	UNIT32	0-0
150	USR-Req-Db-Mdm-Sel	UINT32	0-0
151	USR-Req-Db-Login-Valid	UINT32	0-0
152	USR-Dialback-Group-Names	String	0-253
153	USR-Dial-In-Call-Rest	String	0-253
154	USR-Dial-Out-Call-Rest	String	0-253
155	USR-Logins-Before-Blacklist	UINT32	0-0
156	USR-Failed-Logins	UINT32	0-0
157	USR-Allowed-DB-Modems	String	0-253
158	USR-VPN-Encrypter	String	0-253

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
159	USR-Acct-VPN-Gateway	String	0-253
160	USR-Re-CHAP-Timeout	UINT32	0-0
161	USR-RMMIE-Manufacutere-ID	String	0-253
162	USR-RMMIE-Product-Code	String	0-253
163	USR-RMMIE-Serial-Number	String	0-253
164	USR-RMMIE-Firmware-Version	String	0-253
165	USR-RMMIE-Firmware-Build-Date	String	0-253
166	USR-RMMIE-Status	ENUM: notEnabledInLocalModem notDetectedInRemoteModem ok	1-3
170	USR-RMMIE-Last-Update-Time	UINT32	0-253
171	USR-RMMIE-Last-Update-Event	ENUM: None initialConnection retrain speedShift plannedDisconnect	1-5
172	USR-RMMIE-Rcv-Tot-PwrLvl	UNIT32	0-253
173	USR-RMMIE-Rcv-PwrLvl-3300Hz	UNIT32	0-253
174	USR-RMMIE-Rcv-PwrLvl-3750Hz	UNIT32	0-253
175	USR-RMMIE-PwrLvl-NearEcho-Canc	UNIT32	0-253
176	USR-RMMIE-PwrLvl-FarEcho-Canc	UNIT32	0-253
177	USR-RMMIE-PwrLvl-Noise-Lvl	UNIT32	0-253
178	USR-RMMIE-PwrLvl-Xmit-Lvl	UNIT32	0-253
179	USR-IPX-SAP	String	0-253
180	USR-MIC	UNIT32	0-253
181	USR-Call-Tracking-ID	UNIT32	0-253
182	USR-Log-Filter-Packet	UNIT32	0-253
183	USR-CCP-Algorithm	UNIT32	0-253

Table C-21 USR VSAs (continued)

SubAttr	VSA Name	Type	Min-Max Value
184	USR-ACCM-Type	UNIT32	0-253
185	USR-Connect-Speed	UNIT32	0-253
186	USR-Framed-IP-Address-Pool-Name	UNIT32	0-253
187	USR-MP-EDO	String	0-253
188	USR-Local-Framed-IP-Addr	UNIT32	0-253
189	USR-IP-RIP-Input-Filter	String	0-253
190	USR-IP-Call-Input-Filter	String	0-253
191	USR-IPX-Call-Input-Filter	String	0-253
192	USR-AT-Input-Filter	String	0-253
193	USR-AT-RTMP-Input-Filter	String	0-253
194	USR-AT-Zip-Input-Filter	String	0-253
195	USR-AT-Call-Input-Filter	String	0-253
196	USR-ET-Bridge-Input-Filter	String	0-253
197	USR-IP-RIP-Output-Filter	String	0-253
198	USR-IP-Call-Output-Filter	String	0-253
199	USR-IPX-RIP-Output-Filter	String	0-253
200	USR-IPX-Call-Output-Filter	String	0-253
201	USR-AT-Output-Filter	String	0-253
202	USR-ET-RTMP-Output-Filter	String	0-253
203	USR-AT-Zip-Output-Filter	String	0-253
204	USR-AT-Call-Output-Filter	String	0-253
205	USR-ET-Bridge-Output-Filter	String	0-253
206	USR-ET-Bridge-Call-Output-Filter	String	0-253
207	USR-IP-Default-Route-Option	UINT32	0-253
208	USR-MP-EDO-HIPER	String	0-253
209	USR-MP-MRRU	UINT32	0-253

WiMax

Table C-22 lists the WiMax VSAs. The vendor ID for WiMax VSAs is 24757.

Table C-22 WiMax VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	HA-IP-MIP4	IPAddress	0-253
2	HA-IP-MIP6	IPAddress	0-253
3	GMT-Time-Zone-Offet	String	0-253
4	NAP-ID	String	0-253
5	NSP-ID	String	0-253
6	Hotline-Indicator	String	0-253
7	BS-ID	String	0-253

WISPr

Table C-23 lists the WISPr VSAs. The vendor ID for WISPr VSAs is 14122.

Table C-23 WISPr VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	WISPr-Location-ID	String	0-65535
2	WISPr-Location-Name	String	0-253
3	WISPr-Logoff-URL	String	0-253
4	WISPr-Redirection-URL	String	0-253
5	WISPr-Bandwidth-Min-Up	UINT32	0-65535
6	WISPr-Bandwidth-Min-Down	UINT32	0-65535
7	WISPr-Bandwidth-Max-Up	UINT32	0-65535
8	WISPr-Bandwidth-Max-Down	UINT32	0-65535
9	WISPr-Session-Terminate-Time	UINT32	0-65535
10	WISPr-Session-Terminate-End-Of-Day	UINT32	0-65535
11	WISPr-Billing-Class-Of-Service	String	0-253

XML

Table C-24 lists the XML VSAs, attributes for XML tags. The vendor ID for XML VSAs is 5842.

Table C-24 XML VSAs

SubAttr	VSA Name	Type	Min-Max Value
1	XML-Address-format-IPv4	IPADDR	0-253
2	XML-Association	String	0-253
3	XML-Request	String	0-253
4	XML-Response	String	0-253
5	XML-UserId-id_type-subscriber_id	String	0-253
6	XML-UserIdRequest	String	0-253

GLOSSARY

A

Access point — A device that bridges the wireless link on one side to the wired network on the other.

Analog Channel — A circuit-switched communication path intended to carry 3.1 KHz audio in each direction.

ARP — Address Resolution Protocol is the TCP/IP protocol that translates an Internet address into the hardware address of a network interface card.

ATM — Asynchronous Transfer Mode is a virtual circuit, fast packet technology. Traffic of all kinds (data, voice, video) is divided into 53-byte cells and conducted over very high speed media.

ATO — Adaptive TimeOut is the time that must elapse before an acknowledgment is considered lost. After a timeout, the sliding window is partially closed and the ATO is backed off.

C

Call — A connection or attempted connection between two terminal end points on a PSTN or ISDN; for example, a telephone call between two modems.

CHAP — Challenge Authentication Protocol is a PPP cryptographic challenge/response authentication protocol in which the clear text password is not passed in the clear over the line.

CLID — Calling Line ID indicates to the receiver of a call, the phone number of the caller.

CM — Cable Modem is usually a modem with an RF (cable) interface on one side and an Ethernet interface on the other. A cable modem might also have a telephone interface for "telco return," which is used when only downstream capability exists in the cable plant.

CNR — Cisco Network Registrar—A network management application which includes a DHCP server and a DNS server.

Community String — A string used to authenticate the trap message sender (SNMP agent) to the trap recipient (SNMP management station).

Control Messages — Control messages are exchanged between LAC, LNS pairs, and operate in-band within the tunnel protocol. Control messages govern aspects of the tunnel and sessions within the tunnel.

CSG — Cable Systems Group is a billing systems company.

CSR — Customer Service Representative—the person you call to activate or obtain service for your account.

C

CSU/DSU Channel Service Unit/Data Service Unit isolates your network from your exchange carrier's network. It also receives the timing, low-level framing information, and data passed from the termination point. CSU/DSUs are specific to the general circuit type.

Customer A user of an ISP or an enterprise. The provider offers the customer MPLS VPN service. The enterprise provides the customer remote user access to various sites. In the case of ISPs, MPLS BPN provides a scalable wholesale access/open access solution.

D

DAP Directory Access Protocol is a heavyweight protocol that runs over a full OSI stack and requires a significant amount of computing resources to run.

Data Source Sets of data and their associated environments which include operating system, DBMS, and network platforms used to access the DBMS that an application wants to access.

DHCP Dynamic Host Configuration Protocol—a protocol that describes the service of providing and managing IP addresses to clients on a network.

DHCP Client The IOS DHCP client used to generate requests for host addresses and subnets for non-PPP clients.

DHCP Proxy Client The IOS DHCP client used to request an address for a PPP user from a DHCP server.

Dial Use Dial Use is an end-system or router attached to an on-demand PSTN or ISDN, which is either the initiator or recipient of a call.

Digital Channel Digital Channel is a circuit-switched communication path that is intended to carry digital information in each direction.

DNIS Dialed Number Information String is an indication to the receiver of a call as to what phone number the caller used to reach it.

Driver Manager A special library that manages communication between applications and drivers. Applications call ODBC API functions in the driver managers which load and call one or more drivers on behalf of the applications.

E

EAP Extensible Authentication Protocol is a framework for a family of PPP authentication protocols, including cleartext, challenge/response, and arbitrary dialog sequences.

F

FT Field Technician is someone who installs your cable modem in your house.

Frame Relay Frame Relay is a cost-effective, lightweight, many-to-many, medium-speed, virtual network, link-layer technology.

G

GGSN GPRS Gateway Support Node, a network node that acts as a gateway between a GPRS wireless data network and other networks such as the Internet or a private network.

GPRS General Packet Radio Service, a mobile data service available to users of GSM and IS-136 mobile phones.

I

ISDN Integrated Services Digital Network enables synchronous PPP access.

ISP Internet Service Provider is a company that provides Internet connectivity.

H

HDLC High-level Data Link Control is both a point-to-point and multiparty link-layer technology. HDLC provides reliable, acknowledged transfer across dedicated links.

L

L2TP Access Concentrator (LAC) LAC is a device attached to one or more PSTN or ISDN lines capable of PPP operation and of handling the L2TP protocol. The LAC needs only to implement the media over which L2TP is to operate to pass traffic to one or more LNSs. It might tunnel any protocol carried within PPP.

LAN Local Area Network consists of all of the components that create a system up to a router. These components include cables, repeaters, bridges, and software up to the network layer.

LDAP Lightweight Directory Access Protocol provides a standard way for Internet clients, applications, and WWW servers to access directory information across the Internet such as user names, e-mail addresses, security certificates, and other contact information.

LEAP Light Extensible Authentication Protocol—

L

LLC Logical Link Control is an interface that defines several common interfaces between higher-level protocols (for example, IP) and the networks they ride upon (for example, Ethernet, Token Ring, and others).

L2TP Network Server (LNS) An LNS operates on any platform capable of PPP termination. The LNS handles the server side of the L2TP protocol. Since L2TP relies only on the single media over which L2TP tunnels arrive, the LNS can have only a single LAN or WAN interface, yet still be able to terminate calls arriving at any LAC's full range of PPP interfaces (async, synchronous ISDN, V.120, etc.).

M

MIB Management Information Base—Database of network management information used and maintained by a network management protocol such as SNMP. The value of a MIB object can be changed or retrieved using SNMP commands. MIB objects are organized in a tree structure that includes public and private branches.

MPLS Multi-Protocol Label Switching—

MPLS VPN MPLS-based Virtual Private Networks

MSO Multiple System Operators are typically cable companies that provide Internet access for regional independent operators.

N

NAS Network Access Server is a device providing temporary, on-demand network access to users. This access is point-to-point using PSTN or ISDN lines. A NAS operates as a client of RADIUS. The client is responsible for passing user information to designated RADIUS servers.

In PPTP terminology, this is referred toas the PPTP Access Concentrator (PAC). In L2TP terminology, the NAS is referred to as the L2TP Access Concentrator (LAC).

NCP Network Control Protocol is responsible for negotiating the protocol-specific particulars of the point-to-point protocol (PPP) link.

Network Access Identifier In order to provide for the routing of RADIUS authentication and accounting requests, the UserID field used in PPP and in the subsequent RADIUS authentication and accounting requests, known as the Network Access Identifier (NAI), might contain structure. This structure provides a means by which the RADIUS proxy locates the RADIUS server that is to receive the request. This same structure can also be used to locate the tunnel end point when domain-based tunneling is used.

O

ODBC Open Database Connectivity—a standard set of application programming interface (API) function calls (supported by Microsoft and in general use) that can be used to access data store in both relational and non-relational database management systems (DBMSs).

ODBC Driver Processes ODBC function calls, submits SQL requests to specific data source, and returns results to applications. ODBC drivers for specific types of data files, including database files, spreadsheet files, and text fields, are available from Microsoft Corporation.

P

packet A block of data in a standard format for transmission.

PAP Password Authentication Protocol is a simple PPP authentication mechanism in which a cleartext username and password are transmitted to prove identity.

Payload The contents of a request packet.

PDU Protocol Data Unit—An SNMP compliant request, response, or trap message.

PE Router Provider Edge router—a router located at the edge of the provider's MPLS core network.

POP Point of Presence is the dial-in point or connection point for users connecting to an ISP.

PPD Packet Processing Delay is the amount of time required for each peer to process the maximum amount of data buffered in their offered receive packet window. The PPD is the value exchanged between the LAC and LNS when a call is established. For the LNS, this number should be small. For an LAC supporting modem connections, this number could be significant.

PPP Point-to-Point Protocol—a multiprotocol and includes UDP, Frame Relay PVC, and X.25 VC.

Profile A collection of one or more attributes that describe how a user should be configured; for example, a profile can contain an attribute whose value specifies the type of connection service to provide the user, such as PPP, SLIP, or Telnet. Profiles can be set up for a specific user or can be shared amongst users.

Provider Service Provider—A provider who operates the access networks and MPLS backbone and provides MPLS VPN service on the backbone.

PSTN Public Switched Telephone Network enables async PPP through modems.

Q

Quality of Service (QOS) A given Quality of Service level is sometimes required for a given user being tunneled between an LNS-LAC pair. For this scenario, a unique L2TP tunnel is created (generally on top of a new SVC) and encapsulated directly on top of the media providing the indicated QOS.

R

RAC Client The IOS DHCP client used to generate requests for host addresses and subnets for non-PPP clients.

RADIUS Remote Authentication Dial-In User Service. The RADIUS protocol provides a method that allows multiple dial-in Network Access Server (NAS) devices to share a common authentication database.

RADIUS Client A Network Access Server (NAS) operates as a client of RADIUS. The client is responsible for passing user information to designated RADIUS servers, and then acting on the response that is returned. A RADIUS server can act as a proxy client to other RADIUS servers.

RADIUS Dictionary The RADIUS dictionary passes information between a script and the RADIUS server, or between scripts running on a single packet.

RADIUS Proxy In order to provide for the routing of RADIUS authentication and accounting requests, a RADIUS proxy might be employed. To the NAS, the RADIUS proxy appears to act as a RADIUS server, whereas to the RADIUS server the proxy appears to act as a RADIUS client.

RADIUS Server A server that is responsible for receiving user connection requests, authenticating the user, and then returning all of the configuration information necessary for the client to deliver the service to the user.

RAS Remote Access Services. See RADIUS Client.

Remote DHCP Server Usually a DHCP server in the service provider's networks, however it might also be a DHCP server in the customer's VPN.

Remote Server A server that has been registered with the user interface, which can later be referenced as a proxy client or as the method to perform a service; for example, a remote RADIUS server can be specified to act as a proxy client.

REX RADIUS EXtension allows you to write C and C++ programs to affect the behavior of Cisco Access Registrar.

Roaming The ability to connect to a NAS that is not your normal POP (Point of Presence) and have the Access-Request redirected to your normal RADIUS server. The ability to use any one of multiple Internet server providers, while maintaining a formal, customer-vendor relationship with only one.

Router A network device that connects multiple network segments and forwards packets from one network to another. The router must determine how to forward a packet based on addresses, network traffic, and cost.

Routing Tables A table that lists all of the possible paths data can take to get from a source to a destination. Depending on how routers are configured, they can build their tables dynamically by trading information with other routers, or they can be statically configured in advance.

RTT Round-Trip Time is the estimated round-trip time for an Acknowledgment to be received for a given transmitted packet. When the network link is a local network, this delay will be minimal (if not zero). When the network link is the Internet, this delay could be substantial and vary widely. RTT is adaptive; it adjusts to include the PPD (Packet Processing Delay) and whatever shifting network delays contribute to the time between a packet being transmitted and receiving its acknowledgment.

S

SAP Service Access Points (source and destination) identify protocols from which a packet has come and to which a packet must be delivered.

Script Instructions that are run in the context of a RADIUS client/server session. Scripts can be specified for servers, clients, vendors, and services. A script can be used as an incoming script, an outgoing script, or both. Incoming scripts are executed during the Access-Request portion of a dial-in session. Outgoing scripts are executed during the Access-Accept portion of a dial-in session. Scripts are referenced within the User Interface by name. Scripts can be source code for a scripting language or a binary file.

Service A means of specifying the method to use to perform a function. A service can be specified for the following functions: authentication, authorization, accounting, and authentication-authorization. For example, a service can specify that authentication be performed using the local database, or a service can specify that accounting be supported by logging information to a file.

Services Three default services are referenced by the server configuration and when processing scripts. They are Default Authentication Service, Default Authorization Service, and Default Accounting Service. Each service has a type and (if it is using remote servers) an ordered list of servers to use.

Session Each service provided by the NAS to a dial-in user constitutes a session, with the beginning of the session defined as the point where service is first provided and the end of the session defined as the point where service is ended. Depending on NAS support capabilities, a user can have multiple sessions in parallel or in series.

SHA-1 Secure Hash Algorithm; a hashing algorithm that produces a 160-bit digest based upon the input. The algorithm produces SHA passwords that are irreversible or prohibitively expensive to reverse.

Shared Secret Used to authenticate transactions between the client and the RADIUS server. The shared secret is never sent over the network.

Shared Use Network An IP dial-up network whose use is shared by two or more organizations. Shared use networks typically implement distributed authentication and accounting in order to facilitate the relationship amongst the sharing parties.

Silently Discard RADIUS discards the packet without further processing. The server logs an error, including the contents of the silently discarded packet, and records the event in a statistics counter.

SLIP Serial Line Internet Protocol is TCP/IP over direct connections and modems, which allows one computer to connect to another or to a whole network.

SMDS Switched Multi-megabit Data Service is a high-speed Metropolitan-Area Networking technology that behaves like a LAN.

SSHA Netscape's (iPlanet) enhancement of the SHA-1 algorithm which includes *salted* password data.

SNAP SubNetwork Access Protocol is used when a SAP definition does not exist for the encapsulated user data protocol.

S

SSL Secure Socket Layer is the protocol defined by Netscape that is used for encryption and authentication between two Internet entities. It uses public/private key certificates instead of shared secrets.

SVC Switched Virtual Circuit is an L2TP-compatible media on top of which L2TP is directly encapsulated. SVCs are dynamically created, permitting tunnel media to be created dynamically in response to desired LNS-LAC connectivity requirements.

T

TACACS Terminal Access Controller Access Control System, a an authentication server that validates user IDs and passwords, thus controlling entry into systems.

Telnet A service that lets you log in to a system over a network just as though you were logging in from a remote character terminal attached to the system. It is commonly used to provide an Internet service that is exactly the same as the one you would get if you dialed into the system directly with a modem.

Trap A network message of a specific format issued by an SNMP entity on behalf of a network management agent application. A trap is used to provide the management station with an asynchronous notification of an event.

Tunnel A tunnel is defined by an LNS-LAC pair. The tunnel carries PPP datagrams between the LAC and the LNS; many sessions can be multiplexed over a single tunnel. A control connection operating in band over the same tunnel controls the establishment, release, and maintenance of sessions and of the tunnel itself.

Tunnel Network Server A server that terminates a tunnel. In PPTP terminology, this is known as the PPTP Network Server (PNS). In L2TP terminology, this is known as the L2TP Network Server (LNS).

U

UDP User Datagram Protocol, a data packet protocol.

User List The list of users registered for dial-in access.

User Record The UserRecord contains all the information that needs to be accessed at runtime about a particular user. This enables it to be read in one database operation in order to minimize the cost of authenticating the user. The UserRecord is stored as an encrypted string in the MCD database, because it contains the user's password, amongst other things.

Users Users are represented by entities in specific UserLists. See User Record.

V

Vendor Each NAS has a vendor associated with it. A vendor can specify attributes for the NAS that are not part of the standard specification.

VHG Virtual Home Gateway—a Cisco IOS component that terminates PPP sessions. It is owned and managed by the service provider on behalf of its customer to provide access to remote users of that customer's network. A single service provider device (router) can host multiple VHGs of different customers. A VHG can be dynamically brought up and down based on the access pattern of the remote users. Note that there is no single IOS feature called the VHG; it is a collection of function and features (PPP, virtual profiles, VRFs, etc.).

VPN Virtual Private Network is a way for companies to use the Internet to securely transport private data.

VRF Virtual routing and forwarding. A per VPM routing table on the PE router. Each VPN instantiated on that PE router has its own VRF.

W

WAP Wireless Application Protocol; an application environment and set of communication protocols for wireless devices designed to enable manufacturer-, vendor-, and technology-independent access to the Internet and advanced telephony services.

WPS Wireless Provisioning Service; provides a standards-based and integrated platform to simply provision and manage their Wi-Fi hot spots. WPS allows users of Windows XP to connect to Wi-Fi hot spots with a seamless sign-up process and enables a more secure wireless network access.

X

X.25 A reliable public data network technology consisting of private virtual circuits, virtual calling, and per-packet charging.

X.500 Defines the Directory Access Protocol (DAP) for clients to use when contacting directory servers. DAP is a heavyweight protocol that runs over a full OSI stack and requires a significant amount of computing resources to run.

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