

Configuring AAA Services

This module describes the implementation of the administrative model of *task-based authorization* used to control user access in the Cisco IOS XR software system. The major tasks required to implement task-based authorization involve configuring user groups and task groups.

User groups and task groups are configured through the Cisco IOS XR software command set used for authentication, authorization and accounting (AAA) services. Authentication commands are used to verify the identity of a user or principal. Authorization commands are used to verify that an authenticated user (or principal) is granted permission to perform a specific task. Accounting commands are used for logging of sessions and to create an audit trail by recording certain user- or system-generated actions.

AAA is part of the Cisco IOS XR software base package and is available by default.

Note For a complete description of the AAA commands listed in this module, see the *Authentication, Authorization, and Accounting Commands* module in *System Security Command Reference for Cisco ASR 9000 Series Routers*.

Feature History for Configuring AAA Services

Release	Modification
Release 3.7.2	This feature was introduced.
Release 4.1.0	Added the support for VRF aware TACACS+.
Release 6.3.1	Added the support for Type 8 and Type 9 passwords.
Release 6.3.2	Added the support for Command Accounting.
Release 7.0.1	Added the support for Type 10 password for 64-bit IOS XR.
Release 7.4.1	Added CLI commands to configure NACM rule-lists, rules and groups in addition to existing support for YANG data models.

- Information About Configuring AAA Services, on page 2
- How to Configure AAA Services, on page 32
- TACACS+ with TLS protection, on page 96
- Command Accounting, on page 99

- Model-based AAA, on page 100
- Overview of Configuring NACM, on page 102
- Disabling NACM, on page 108
- Dynamic Retrieval of NETCONF Access Control Model Policies, on page 109
- Dynamic NACM using LDAP over TLS Authentication, on page 116
- Command Authorization Using Local User Account, on page 121
- Additional References, on page 126

Information About Configuring AAA Services

This section lists all the conceptual information that a Cisco IOS XR software user must understand before configuring user groups and task groups through AAA or configuring Remote Authentication Dial-in User Service (RADIUS) or TACACS+ servers. Conceptual information also describes what AAA is and why it is important.

User, User Groups, and Task Groups

Cisco IOS XR software user attributes form the basis of the Cisco IOS XR software administrative model. Each router user is associated with the following attributes:

- User ID (ASCII string) that identifies the user uniquely across an administrative domain
- Length limitation of 253 characters for passwords and one-way encrypted secrets
- List of user groups (at least one) of which the user is a member (thereby enabling attributes such as task IDs). (See the Task IDs, on page 18 section)

User Categories

Router users are classified into the following categories:

- Root system user (complete administrative authority)
- Root Secure Domain Router (SDR) user (specific SDR administrative authority)
- SDR user (specific SDR user access)

Root System Users

The root system user is the entity authorized to “own” the entire router chassis. The root system user functions with the highest privileges over all router components and can monitor all secure domain routers in the system. At least one root system user account must be created during router setup. Multiple root system users can exist.

The root system user can perform any configuration or monitoring task, including the following:

- Configure secure domain routers.
- Create, delete, and modify root SDR users (after logging in to the secure domain router as the root system user). (See the Root SDR Users, on page 3 section.)

- Create, delete, and modify secure domain router users and set user task permissions (after logging in to the secure domain router as the root system user). (See the Secure Domain Router (SDR) Users, on page 3 section.)
- Access fabric racks or any router resource not allocated to a secure domain router, allowing the root system user to authenticate to any router node regardless of the secure domain router configurations.

Root SDR Users

A root SDR user controls the configuration and monitoring of a particular SDR. The root SDR user can create users and configure their privileges within the SDR. Multiple root SDR users can work independently. A single SDR may have more than one root SDR user.

A root SDR user can perform the following administrative tasks for a particular SDR:

- Create, delete, and modify secure domain router users and their privileges for the SDR. (See the Secure Domain Router (SDR) Users, on page 3 section.)
- Create, delete, and modify user groups to allow access to the SDR.
- Manage nearly all aspects of the SDR.

A root SDR user cannot deny access to a root system user. (See the Root System Users, on page 2 section.)

Secure Domain Router (SDR) Users

A SDR user has restricted access to an SDR as determined by the root-system user or root SDR user. The SDR user performs the day-to-day system and network management activities. The tasks that the secure domain router user is allowed to perform are determined by the task IDs associated with the user groups to which the SDR user belongs. (See the User Groups, on page 3 section.)

User Groups

A *user group* defines a collection of users that share a set of attributes, such as access privileges. Cisco IOS XR software allows the system administrator to configure groups of users and the job characteristics that are common in groups of users. Users are not assigned to groups by default hence the assignment needs to be done explicitly. A user can be assigned to more than one group.

Each user may be associated with one or more user groups. User groups have the following attributes:

- A user group consists of the list of task groups that define the authorization for the users. All tasks, except cisco-support, are permitted by default for root system users. (See the Root System Users, on page 2 section.)
- Each user task can be assigned read, write, execute, or debug permission.

Predefined User Groups

The Cisco IOS XR software provides a collection of user groups whose attributes are already defined. The predefined groups are as follows:

- **cisco-support:** This group is used by the Cisco support team.
- **maintenance:** Has the ability to display, configure and execute commands for network, files and user-related entities.
- **netadmin:** Has the ability to control and monitor all system and network parameters.

- **operator:** A demonstration group with basic privileges.
- **provisioning:** Has the ability to display and configure network, files and user-related entities.
- **read-only-tg:** Has the ability to perform any show command, but no configuration ability.
- **retrieve:** Has the ability to display network, files and user-related information.
- **root-lr:** Has the ability to control and monitor the specific secure domain router.
- **root-system:** Has the ability to control and monitor the entire system.
- **serviceadmin:** Service administration tasks, for example, Session Border Controller (SBC).
- **sysadmin:** Has the ability to control and monitor all system parameters but cannot configure network protocols.

The user group root-system has root system users as the only members. (See the Root System Users, on page 2 section.) The root-system user group has predefined authorization; that is, it has the complete responsibility for root-system user-managed resources and certain responsibilities in other SDRs.

To verify the individual permissions of a user group, assign the group to a user and execute the **show user tasks** command.

User-Defined User Groups

Administrators can configure their own user groups to meet particular needs.

User Group Inheritance

A user group can derive attributes from another user group. (Similarly, a task group can derive attributes from another task group). For example, when user group A inherits attributes from user group B, the new set of task attributes of the user group A is a union of A and B. The inheritance relationship among user groups is dynamic in the sense that if group A inherits attributes from group B, a change in group B affects group A, even if the group is not reinherited explicitly.

Task Groups

A task group is defined by a collection of task IDs. Task groups contain task ID lists for each class of action.

Each user group is associated with a set of task groups applicable to the users in that group. A user's task permissions are derived from the task groups associated with the user groups to which that user belongs.

Predefined Task Groups

The following predefined task groups are available for administrators to use, typically for initial configuration:

- **cisco-support:** Cisco support personnel tasks
- **netadmin:** Network administrator tasks
- **operator:** Operator day-to-day tasks (for demonstration purposes)
- **root-lr:** Secure domain router administrator tasks
- **root-system:** System-wide administrator tasks
- **sysadmin:** System administrator tasks

- **serviceadmin:** Service administration tasks, for example, SBC

User-Defined Task Groups

Users can configure their own task groups to meet particular needs.

Group Inheritance

Task groups support inheritance from other task groups. (Similarly, a user group can derive attributes from another user group. See the User Groups, on page 3 section.) For example, when task group A inherits task group B, the new set of attributes of task group A is the union of A and B.

Admin Access for NETCONF and gRPC Sessions

Table 1: Feature History Table

Feature Name	Release Information	Feature Description
Admin Access for NETCONF and gRPC Sessions	Release 7.4.1	This feature allows all authorized users on XR VM to access the administration data on the router through NETCONF or gRPC interface, similar to accessing the CLI. This functionality works by internally mapping the task group of the user on XR VM to a predefined group on System Admin VM. Therefore, the NETCONF and gRPC users can access the admin-related information on the router even if their user profiles do not exist on System Admin VM. Prior to this release, only those users who were authorized on XR VM could access System Admin VM through CLI, by using the **admin** command. Users that were not configured on System Admin VM were denied access through the NETCONF or gRPC interfaces.

NETCONF is an XML-based protocol used over Secure Shell (SSH) transport to configure a network. Similarly, gRPC is an open-source remote procedure call framework. The client applications can use these protocols to request information from the router and make configuration changes to the router. Prior to Cisco IOS XR Software Release 7.4.1, users who use NETCONF, gRPC or any other configuration interface, other than CLI, to access the admin-related information on the router, had to belong to user groups that are configured on System Admin VM. Otherwise, the router would issue an UNAUTHORIZED access error message and deny access through that client interface.

By default, XR VM synchronizes only the first-configured user to System Admin VM. If you delete the first-user in XR VM, the system synchronizes the next user in the **root-lr** group (which is the highest privilege

group in XR VM for Cisco IOS XR 64-bit platforms) to System Admin VM only if there are no other users configured in System Admin VM. The system does not automatically synchronize the subsequent users to System Admin VM. Therefore, in earlier releases, users whose profiles did not exist in System Admin VM were not able to perform any NETCONF or gRPC operations on System Admin VM.

From Cisco IOS XR Software Release 7.4.1 and later, the system internally maps the users who are authorized on XR VM to System Admin VM of the router, based on the task table of the user on XR VM. With this feature, the NETCONF and gRPC users can access admin-related information on the router even if their user profiles do not exist on System Admin VM. By default, this feature is enabled.

To know more about NETCONF and gRPC operations, see the *Use NETCONF Protocol to Define Network Operations with Data Models* chapter and the *Use gRPC Protocol to Define Network Operations with Data Models* chapter in *Programmability Configuration Guide for Cisco ASR 9000 Series Routers*.

User Profile Mapping from XR VM to System Admin VM

User privileges to execute commands and access data elements on the router are usually specified using certain command rules and data rules that are created and applied on the user groups.

For details on user groups, command rules and data rules, see the *Create User Profiles and Assign Privilege* chapter in .

When the internal process for AAA starts or when you create the first user, the system creates the following set of predefined groups, command rules and data rules in System Admin VM. These configurations are prepopulated to allow users of different groups (such as **root-system**, **admin-r** and **aaa-r**) in System Admin VM.

You can use the **show running-configuration aaa** command to view the AAA configurations.

```
aaa authentication groups group aaa-r gid 100 users %%__system_user__%%
!
aaa authentication groups group admin-r gid 100 users %%__system_user__%%
!
aaa authentication groups group root-system gid 100 users "%%__system_user__%% "
!
aaa authorization cmdrules cmdrule 1 context * command * group root-system ops rx action
accept
!
aaa authorization cmdrules cmdrule 2 context * command "show running-config aaa" group aaa-r
 ops rx action accept
!
aaa authorization cmdrules cmdrule 3 context * command "show tech-support aaa" group aaa-r
 ops rx action accept
!
aaa authorization cmdrules cmdrule 4 context * command "show aaa" group   aaa-r ops rx
action accept
!
aaa authorization cmdrules cmdrule 5 context * command show group   admin-r ops rx action
accept
!
aaa authorization datarules datarule 1 namespace * context * keypath * group root-system
ops rwx action accept
!
aaa authorization datarules datarule 2 namespace * context * keypath /aaa group aaa-r ops
r action accept
!
aaa authorization datarules datarule 3 namespace * context * keypath /aaa group admin-r ops
 rwx action reject
!
aaa authorization datarules datarule 4 namespace * context * keypath / group admin-r ops r
```

```
 action accept
!
```

The administration CLI for the user works based on the above configurations. The **root-system** is the group with the highest privilege in System Admin VM. The **admin-r** group has only read and execute access to all data. The **aaa-r** group has access only to AAA data. With the introduction of the admin access feature for all users, NETCONF and gRPC applications can also access the administration data based on the above rules and groups.

User Profile Mapping Based on Task-ID

This table shows the internal mapping of XR VM users to System Admin VM. The users in XR VM belong to various user groups, such as **aaa**, **admin**, **root-lr**, and **root-system**.

XR VM User Group:Task-ID	System Admin VM User Group
aaa:rwxd	**aaa-r**
aaa:rwx	**aaa-r**
aaa:rw	**aaa-r**
aaa:wx	**aaa-r**
aaa:rx	**aaa-r**
aaa:r	**aaa-r**
aaa:w	**aaa-x**
aaa:x	**aaa-x**
root-system:rwxd	**root-system**
root-lr:rwxd	**root-system**
admin:rwxd	**admin-r**
admin:rwx	**admin-r**
admin:rw	**admin-r**
admin:r	**admin-r**

How to Allow Read Access to Administration Data for NETCONF and gRPC Clients

NETCONF and gRPC users access the administration data on the router through GET operations as defined by the respective protocols. To allow this read access to administration data for users belonging to **admin-r** group, you must configure a new command rule specifically for the NETCONF or gRPC client.

Configuration Example

```
Router#admin
sysadmin-vm:0_RP0#configure
sysadmin-vm:0_RP0(config)#aaa authorization cmdrules cmdrule 6
sysadmin-vm:0_RP0(config-cmdrule-6)#context netconf
sysadmin-vm:0_RP0(config-cmdrule-6)#command get
sysadmin-vm:0_RP0(config-cmdrule-6)#group admin-r
sysadmin-vm:0_RP0(config-cmdrule-6)#ops rx
```

```
sysadmin-vm:0_RP0(config-cmdrule-6)#action accept
sysadmin-vm:0_RP0(config)#commit
```

Running Configuration

```
aaa authorization cmdrules cmdrule 6
 context netconf
 command get
 group   admin-r
 ops     rx
 action  accept
!
```

Associated Command

- **aaa authorization (System Admin-VM)**

Cisco IOS XR Software Administrative Model

The router operates in two planes: the administration (admin) plane and secure domain router (SDR) plane. The admin (shared) plane consists of resources shared across all SDRs, while the SDR plane consists of those resources specific to the particular SDR.

The root-system user has the highest level of responsibility for the router. This user provisions secure domain routers and creates root SDR users. After being created, root SDR users take most of the responsibilities from the root-system user for the SDR. Root SDR users in turn can create secure domain router users. Root-system users and root SDR users have fixed permissions (task IDs) that cannot be changed by users.

Each SDR has its own AAA configuration including, local users, groups, and TACACS+ and RADIUS configurations. Users created in one SDR cannot access other SDRs unless those same users are configured in the other SDRs.

Administrative Access

Administrative access to the system can be lost if the following operations are not well understood and carefully planned. A lockout of all root-system users is a serious issue that requires a system reload to recover the password.

- Configuring authentication that uses remote AAA servers that are not available, particularly authentication for the console.

Note The **none** option without any other method list is not supported in Cisco IOS XR software.

- Removing the flash card from disk0:, or a disk corruption, may deny auxiliary port authentication, which can affect certain system debugging abilities. However, if the console is available, the system is still accessible.
- Configuring command authorization or EXEC mode authorization on the console should be done with extreme care, because TACACS+ servers may not be available or may deny every command, which locks the user out. This lockout can occur particularly if the authentication was done with a user not

known to the TACACS+ server, or if the TACACS+ user has most or all the commands denied for one reason or another.

To avoid a lockout, we recommend these:

- Before turning on TACACS+ command authorization or EXEC mode authorization on the console, make sure that the user who is configuring the authorization is logged in using the appropriate user permissions in the TACACS+ profile.
- If the security policy of the site permits it, use the **none** option for command authorization or EXEC mode authorization so that if the TACACS+ servers are not reachable, AAA rolls over to the **none** method, which permits the user to run the command.
- Make sure to allow local fallback when configuring AAA. See, Authorization Configuration, on page 80.
- If you prefer to commit the configuration on a trial basis for a specified time, you may do so by using the **commit confirmed** command, instead of direct **commit**.

AAA Database

The AAA database stores the users, groups, and task information that controls access to the system. The AAA database can be either local or remote. The database that is used for a specific situation depends on the AAA configuration.

Local Database

AAA data, such as users, user groups, and task groups, can be stored locally within a secure domain router. The data is stored in the in-memory database and persists in the configuration file. The stored passwords are encrypted.

Note The database is local to the specific secure domain router (SDR) in which it is stored, and the defined users or groups are not visible to other SDRs in the same system.

You can delete the last remaining user from the local database. If all users are deleted when the next user logs in, the setup dialog appears and prompts you for a new username and password.

Note The setup dialog appears only when the user logs into the console.

Remote Database

AAA data can be stored in an external security server, such as CiscoSecure ACS. Security data stored in the server can be used by any client (such as a network access server [NAS]) provided that the client knows the server IP address and shared secret.

Remote AAA Configuration

Products such as CiscoSecure ACS can be used to administer the shared or external AAA database. The router communicates with the remote AAA server using a standard IP-based security protocol (such as TACACS+ or RADIUS).

Client Configuration

The security server should be configured with the secret key shared with the router and the IP addresses of the clients.

User Groups

User groups that are created in an external server are not related to the user group concept that is used in the context of local AAA database configuration on the router. The management of external TACACS+ server or RADIUS server user groups is independent, and the router does not recognize the user group structure. The remote user or group profiles may contain attributes that specify the groups (defined on the router) to which a user or users belong, as well as individual task IDs. For more information, see the Task IDs for TACACS+ and RADIUS Authenticated Users, on page 19 section.

Configuration of user groups in external servers comes under the design of individual server products. See the appropriate server product documentation.

Task Groups

Task groups are defined by lists of permitted task IDs for each type of action (such as read, write, and so on). The task IDs are basically defined in the router system. Task ID definitions may have to be supported before task groups in external software can be configured.

Task IDs can also be configured in external TACACS+ or RADIUS servers.

AAA Configuration

This section provides information about AAA configuration.

Method Lists

AAA data may be stored in a variety of data sources. AAA configuration uses *method lists* to define an order of preference for the source of AAA data. AAA may define more than one method list and applications (such as login) can choose one of them. For example, console and auxiliary ports may use one method list and the vty ports may use another. If a method list is not specified, the application tries to use a default method list. If a default method list does not exist, AAA uses the local database as the source.

Rollover Mechanism

AAA can be configured to use a prioritized list of database options. If the system is unable to use a database, it automatically rolls over to the next database on the list. If the authentication, authorization, or accounting request is rejected by any database, the rollover does not occur and the request is rejected.

The following methods are available:

- Local: Use the locally configured database (not applicable for accounting and certain types of authorization)
- TACACS+: Use a TACACS+ server (such as CiscoSecure ACS)
- RADIUS: Use a RADIUS server

- Line: Use a line password and user group (applicable only for authentication)
- None: Allow the request (not applicable for authentication)

Note If the system rejects the authorization request and the user gets locked out, you can try to rollback the previous configuration or remove the problematic AAA configuration through auxiliary port. To log in to the auxiliary port, use the local username and password; not the tacacs+ server credentials. The **config_rollback -n 0x1** command can be used to rollback the previous configuration. If you are not able to access the auxiliary port, a router reload might be required in such scenarios.

Server Grouping

Instead of maintaining a single global list of servers, the user can form server groups for different AAA protocols (such as RADIUS and TACACS+) and associate them with AAA applications (such as PPP and EXEC mode).

Note In scenarios where multiple servers are within a TACACS AAA server group and multiple such groups exist within a remote database, the fallback behavior is when one server within a group is unreachable, and the system will default to the next server in that same group. However, when there is a mismatch in the shared secret between the router and a TACACS server, the router will not attempt to connect to the subsequent server in the group. Instead, it will bypass that group entirely and proceed to the next available method (group or local or none) based on the configuration.

Authentication

Authentication is the most important security process by which a principal (a user or an application) obtains access to the system. The principal is identified by a username (or user ID) that is unique across an administrative domain. The applications serving the user (such as or Management Agent) procure the username and the credentials from the user. AAA performs the authentication based on the username and credentials passed to it by the applications. The role of an authenticated user is determined by the group (or groups) to which the user belongs. (A user can be a member of one or more user groups.)

Authentication of Root System User

The root-system user can log in to any node in any secure domain router in the system. A user is a root-system user if he or she belongs to the root-system group. The root-system user may be defined in the local or remote AAA database.

Authentication of Non-Owner Secure Domain Router User

When logging in from a non-owner secure domain router, the root system user must add the "@admin" suffix to the username. Using the "@admin" suffix sends the authentication request to the owner secure domain router for verification. The owner secure domain router uses the methods in the list-name **remote** for choosing the authentication method. The **remote** method list is configured using the **aaa authentication login remote** *method1 method2...* command. (See the Configuring AAA Method Lists, on page 77 section.)

Authentication of Owner Secure Domain Router User

An owner secure domain router user can log in only to the nodes belonging to the specific secure domain router associated with that owner secure domain router user. If the user is member of a root-sdr group, the user is authenticated as an owner secure domain router user.

Authentication of Secure Domain Router User

Secure domain router user authentication is similar to owner secure domain router user authentication. If the user is not found to be a member of the designated owner secure domain router user group or root-system user group, the user is authenticated as a secure domain router user.

Authentication Flow of Control

AAA performs authentication according to the following process:

1. A user requests authentication by providing a username and password (or secret).
2. AAA verifies the user's password and rejects the user if the password does not match what is in the database.
3. AAA determines the role of the user (root system user, root SDR user, or SDR user).

   - If the user has been configured as a member of a root-system user group, then AAA authenticates the user as a root-system user.
   - If the user has been configured as a member of an owner secure domain router user group, then AAA authenticates the user as an owner secure domain router user.
   - If the user has not been configured as a member of a root-system user group or an owner secure domain router user group, AAA authenticates the user as a secure domain router user.

Clients can obtain a user's permitted task IDs during authentication. This information is obtained by forming a union of all task group definitions specified in the user groups to which the user belongs. Clients using such information typically create a session for the user (such as an API session) in which the task ID set remains static. Both the EXEC mode and external API clients can use this feature to optimize their operations. EXEC mode can avoid displaying the commands that are not applicable and an EMS application can, for example, disable graphical user interface (GUI) menus that are not applicable.

If the attributes of a user, such as user group membership and, consequently, task permissions, are modified, those modified attributes are not reflected in the user's current active session; they take effect in the user's next session.

Korn Shell Authentication

The korn shell (ksh) is the primary shell for the auxiliary port of the route processor (RP), standby RP, and distributed RP cards and for console and auxiliary ports of line cards (LCs) and service processors (SPs). The following are some of the characteristics of ksh authentication:

- For security reasons, ksh authentication allows only root-system users who have a secret configured. A root-system user with a normal password will not be authenticated because the normal password is two-way encrypted and poses a security risk because the password information is stored in the flash disk, which can be easily decrypted.
- Every time a root-system user with a secret is configured using the normal AAA CLI, that user is a valid ksh user and no separate configuration is required.

- Ksh does not authenticate TACACS+ or RADIUS users, even if they are root-system users.
- Ksh authentication uses a single user password database, which means when a root-system user on a dSC is configured using the normal AAA CLI, that user can log in using this username password in any card. This includes the RP, standby RP, LC, and SP.
- Ksh authentication cannot be turned off or bypassed after the card is booted. To bypass authentication, a user needs a reload of the card. (See the "Bypassing ksh Authentication" section for details).
- The ksh run from the console (using the **run** command) is not authenticated because the **run** command needs the root-system task ID. Because the user is already root-system, the user is not authenticated again.

Bypassing ksh Authentication

Although the authentication to ksh is lightweight and depends on very few processes, there are cases when ksh authentication needs to be bypassed, including the following:

- dSC (Active RP) disk0 corruption
- Loss of Qnet connectivity
- Inability to determine the node ID of the dSC (Active RP)

To bypass ksh authentication, the user has to set the ROMMON variable AUX_AUTHEN_LEVEL to 0 and then reload the image. A reboot is required only on the card that has to bypass authentication.

The ROMMON variable AUX_AUTHEN_LEVEL can have one of the following values:

- 0—Authentication will be bypassed on the card.
- 1—Loose authentication. Authentication is performed on a best-effort basis and permits the user to access ksh if the system cannot access authentication information successfully.
- 2—Strict authentication. This is the default state.

  Under no circumstances is authentication bypassed. Even if the authentication infrastructure is down, the system simply denies access.

For example, to bypass authentication on the card, enter the following:

```
rommon1> AUX_AUTHEN_LEVEL=0
rommon2> sync
rommon2> boot tftp:/ ...
```

Authentication Failure

In a system which is configured either with TACACS+ or RADIUS authentication with AAA configuration similar to the configuration below during the first login attempt or attempts, following a system reload, the login to the RP auxiliary port fails.

```
aaa authentication login default group tacacs+ group radius local
line template aux
login authentication default
```

This is because following the reload, the auxiliary port rejects login attempts with a valid TACACS+ configured *username* and *password*.

In such a scenario, the user has to first login with a valid locally configured *username* and *password*, and any login thereafter with TACACS+ configured *username* and *password*. Alternatively, if the user is connected to the auxiliary port via a terminal server, first clear the line used on the terminal server itself, and thereafter the user will be able to login to the auxiliary port with the TACACS+ configured *username* and *password*.

Password Types

In configuring a user and that user's group membership, you can specify two types of passwords: encrypted or clear text.

The router supports both two-way and one-way (secret) encrypted user passwords. Secret passwords are ideal for user login accounts because the original unencrypted password string cannot be deduced on the basis of the encrypted secret. Some applications (PPP, for example) require only two-way passwords because they must decrypt the stored password for their own function, such as sending the password in a packet. For a login user, both types of passwords may be configured, but a warning message is displayed if one type of password is configured while the other is already present.

If both secret and password are configured for a user, the secret takes precedence for all operations that do not require a password that can be decrypted, such as login. For applications such as PPP, the two-way encrypted password is used even if a secret is present.

Type 8 and Type 9 Passwords

This feature provides the options for Type 8 and Type 9 passwords in AAA security services. The Type 8 and Type 9 passwords provide more secure and robust support for saving passwords w.r.t each username. Thus, in scenarios where a lot of confidential data need to be maintained, these encryption methods ensure that the admin and other user passwords are strongly protected.

The implementation of Type 8 password uses SHA256 hashing algorithm, and the Type 9 password uses scrypt hashing algorithm.

Note The Type 8 and Type 9 passwords are supported on the IOS XR 64-bit operating system starting from Cisco IOS XR Software Release 7.0.1. Prior to this release, it was supported only on the 32-bit operating system.

Type 10 Password

The Cisco IOS XR 64 bit software introduces the support for Type 10 password that uses **SHA512** encryption algorithm. The **SHA512** encryption algorithm provides improved security to the user passwords compared to the older algorithms such as **MD5** and **SHA256**. With this feature, **SHA512** becomes the default encryption algorithm for the passwords in user name configuration, even for the first user creation scenario. Prior to the introduction of Type 10 password, **MD5** was used as the default algorithm.

To configure Type 10 password, see Configure Type 10 Password, on page 41.

Restrictions for Type 10 Password Usage

These restrictions apply to the usage of Type 10 password:

- Backward compatibility issues such as configuration loss, authentication failure, and so on, are expected when you downgrade to lower versions that still use **MD5** or **SHA256** encryption algorithms. Convert

the passwords to Type 10 before such downgrades to minimize the impact of such issues. For details, see Backward Compatibility for Password Types, on page 43.

- In a first user configuration scenario or when you reconfigure a user, the system syncs only the Type 5 and Type 10 passwords from XR VM to System Admin VM and Host VM. It doesn't sync the Type 8 and Type 9 passwords in such scenarios.

AAA Password Security for FIPS Compliance

Cisco IOS XR Software introduces advanced AAA password strengthening policy and security mechanism to store, retrieve and provide rules or policy to specify user passwords. This password policy is applicable only for local users, and not for remote users whose profile information are stored in a third party AAA server. This policy is not applicable to secrets of the user. If both secret and password are configured for a user, then secret takes precedence, and password security policy does not have any effect on authentication or change of password for such users. This AAA password security policy works as such for Cisco IOS XR platforms. Whereas, this feature is supported only on XR VM, for Cisco IOS XR 64 bit platforms.

High Availability for AAA Password Security Policy

The AAA password policy configurations and username configurations remain intact across RP failovers or process restarts in the system. The operational data such as, lifetime of the password and lockout time of the user are not stored on system database or disk. Hence, those are not restored across RP failovers or process restarts. Users start afresh on the active RP or on the new process. Hence, users who were locked out before RP failover or process restart are able to login immediately after the failover or restart.

To configure AAA password policy, see Configure AAA Password Policy, on page 43.

AAA Password Security Policies

AAA password security for FIPS compliance consists of these policies:

Password Composition Policy

Passwords can be composed by any combination of upper and lower case alphabets, numbers and special characters that include: "!", "@", "#", "$", "%", "^", "&", "*", "(", and ")". Security administrator can also set the types and number of required characters that comprise the password, thereby providing more flexibility for password composition rules. The minimum number of character change required between passwords is 4, by default. There is no restriction on the upper limit of the number of uppercase, lowercase, numeric and special characters.

Password Length Policy

The administrator can set the minimum and maximum length of the password. The minimum configurable length in password policy is 2, and the maximum length is 253.

Password Lifetime Policy

The administrator can configure a maximum lifetime for the password, the value of which can be specified in years, months, days, hours, minutes and seconds. The configured password never expires if this parameter is not configured. The configuration remains intact even after a system reload. But, the password creation time is updated to the new time whenever the system reboots. For example, if a password is configured with a life time of one month, and if the system reboots on 29th day, then the password is valid for one more month

after the system reboot. Once the configured lifetime expires, further action is taken based on the password expiry policy (see the section on Password Expiry Policy).

Password Expiry Policy

If the password credential of a user who is trying to login is already expired, then the following actions occur:

- User is prompted to set the new password after successfully entering the expired password.
- The new password is validated against the password security policy.
- If the new password matches the password security policy, then the AAA data base is updated and authentication is done with the new password.
- If the new password is not compliant with the password security policy, then the attempt is considered as an authentication failure and the user is prompted again to enter a new password. The max limit for such attempts is in the control of login clients and AAA does not have any restrictions for that.

As part of password expiry policy, if the life time is not yet configured for a user who has already logged in, and if the security administrator configures the life time for the same user, then the life time is set in the database. The system checks for password expiry on the subsequent authentication of the same user.

Password expiry is checked only during the authentication phase. If the password expires after the user is authenticated and logged in to the system, then no action is taken. The user is prompted to change the password only during the next authentication of the same user.

Debug logs and syslog are printed for the user password expiry only when the user attempts to login. This is a sample syslog in the case of password expiry:

```
RP/0/RSP1/CPU0:Jun 21 09:13:34.241 : locald_DSC[308]: %SECURITY-LOCALD-5-USER_PASSWD_EXPIRED
 :
Password for user 'user12' has expired.
```

Password Change Policy

Users cannot change passwords at will. A password change is triggered in these scenarios:

- When the security administrator needs to change the password
- When the user is trying to get authenticated using a profile and the password for the profile is expired
- When the security administrator modifies the password policy which is associated to the user, and does not immediately change the password according to the policy

You can use the **show configuration failed** command to display the error messages when the password entered does not comply with the password policy configurations.

When the security administrator changes the password security policy, and if the existing profile does not meet the password security policy rules, no action is taken if the user has already logged in to the system. In this scenario, the user is prompted to change the password when he tries to get authenticated using the profile which does not meet the password security rules.

When the user is changing the password, the lifetime of the new password remains same as that of the lifetime that was set by the security administrator for the old profile.

When password expires for non-interactive clients (such as dot1x), an appropriate error message is sent to the clients. Clients must contact the security administrator to renew the password in such scenarios.

Service Provision after Authentication

The basic AAA local authentication feature ensures that no service is performed before a user is authenticated.

User Re-authentication Policy

A user is re-authenticated when he changes the password. When a user changes his password on expiry, he is authenticated with the new password. In this case, the actual authentication happens based on the previous credential, and the new password is updated in the database.

User Authentication Lockout Policy

AAA provides a configuration option, **authen-max-attempts**, to restrict users who try to authenticate using invalid login credentials. This option sets the maximum number of permissible authentication failure attempts for a user. The user gets locked out when he exceeds this maximum limit, until the lockout timer (**lockout-time**) is expired. If the user attempts to login in spite of being locked out, the lockout expiry time keep advancing forward from the time login was last attempted.

This is a sample syslog when user is locked out:

```
RP/0/RSP1/CPU0:Jun 21 09:21:28.226 : locald_DSC[308]: %SECURITY-LOCALD-5-USER_PASSWD_LOCKED
 :
User 'user12’ is temporarily locked out for exceeding maximum unsuccessful logins.
```

This is a sample syslog when user is unlocked for authentication:

```
RP/0/RSP1/CPU0:Jun 21 09:14:24.633 : locald_DSC[308]: %SECURITY-LOCALD-5-USER_PASSWD_UNLOCKED
 :
User 'user12' is unlocked for authentications.
```

Password Policy Creation, Modification and Deletion

Security administrators having write permission for AAA tasks are allowed to create password policy. Modification is allowed at any point of time, even when the policy is associated to a user. Deletion of password policy is not allowed until the policy is un-configured from the user.

After the modification of password policy associated with a user, security administrator can decide if he wants to change passwords of associated users complying to the password policy. Based on this, there are two scenarios:

- If the administrator configures the password, then the user is not prompted to change the password on next login.
- If the administrator does not configure the password, then the user is prompted to change the password on next login.

In either of the above cases, at every password expiry interval, the user is prompted to change the password on next login.

Debug messages are printed when password policies are created, modified and deleted.

Minimum Password Length for First User Creation

To authenticate the user for the first time, Cisco router prompts you to create a username and password, in any of the following situations:

- When the Cisco Router is booted for the very first time.
- When the router is reloaded with no username configuration.
- When the already existing username configurations are deleted.

By default, the minimum length for passwords in a Cisco router is limited to two characters. Due to noise on the console, there is a possibility of the router being blocked out. Therefore, the minimum length for password has been increased to six characters for a first user created on the box, in each of the situations described above. This reduces the probability of the router being blocked out. It avoids the security risks that are caused due to very small password length. For all other users created after the first one, the default minimum length for password is still two characters.

For more information about how to configure a first user, see Configure First User on Cisco Routers, on page 36.

Task-Based Authorization

AAA employs “task permissions” for any control, configure, or monitor operation through CLI or API. The Cisco IOS software concept of privilege levels has been replaced in Cisco IOS XR software by a task-based authorization system.

Task IDs

The operational tasks that enable users to control, configure, and monitor Cisco IOS XR software are represented by task IDs. A task ID defines the permission to run an operation for a command. Users are associated with sets of task IDs that define the breadth of their authorized access to the router.

Task IDs are assigned to users through the following means:

Each user is associated with one or more user groups. Every user group is associated with one or more *task groups*; in turn, every task group is defined by a set of task IDs. Consequently, a user’s association with a particular user group links that user to a particular set of task IDs. A user that is associated with a task ID can execute any operation associated with that task ID.

General Usage Guidelines for Task IDs

Most router control, configuration, or monitoring operation (CLI or XML API) is associated with a particular set of task IDs. Typically, a given CLI command or API invocation is associated with at least one or more task IDs. Neither the **config** nor the **commit** commands require any specific task id permissions. The configuration and commit operations do not require specific task ID permissions. Aliases also don't require any task ID permissions. You cannnot perform a configuration replace unless root-lr permissions are assigned. If you want to deny getting into configuration mode you can use the TACACS+ command authorization to deny the config command. These associations are hard-coded within the router and may not be modified. Task IDs grant permission to perform certain tasks; task IDs do not deny permission to perform tasks. Task ID operations can be one, all, or a combination of classes that are listed in this table.

Table 2: Task ID Classes

Operation	Description
Read	Specifies a designation that permits only a read operation.
Write	Specifies a designation that permits a change operation and implicitly allows a read operation.

Operation	Description
Execute	Specifies a designation that permits an access operation; for example ping and Telnet.
Debug	Specifies a designation that permits a debug operation.

The system verifies that each CLI command and API invocation conforms with the task ID permission list for the user. If you are experiencing problems using a CLI command, contact your system administrator.

Multiple task ID operations separated by a slash (for example read/write) mean that both operations are applied to the specified task ID.

Multiple task ID operations separated by a comma (for example read/write, execute) mean that both operations are applied to the respective task IDs. For example, the **copy ipv4 access-list** command can have the read and write operations applied to the acl task ID, and the execute operation applied to the *filesystem* task ID.

If the task ID and operations columns have no value specified, the command is used without any previous association to a task ID and operation. In addition, users do not have to be associated to task IDs to use ROM monitor commands.

Users may need to be associated to additional task IDs to use a command if the command is used in a specific configuration submode. For example, to execute the **show redundancy** command, a user needs to be associated to the system (read) task ID and operations as shown in the following example:

```
RP/0/RSP0/CPU0:router# show redundancy
```

Whereas, in administration EXEC mode, a user needs to be associated to both admin and system (read) task IDs and operations, as shown in the following example:

```
RP/0/RSP0/CPU0:router# admin
RP/0/RSP0/CPU0:router(admin)# show redundancy
```

Task IDs for TACACS+ and RADIUS Authenticated Users

Cisco IOS XR software AAA provides the following means of assigning task permissions for users authenticated with the TACACS+ and RADIUS methods:

- Specify the text version of the task map directly in the configuration file of the external TACACS+ and RADIUS servers.

  See the "Task Maps, on page 20" section for more details.

- Specify the privilege level in the configuration file of the external TACACS+ and RADIUS servers.

  See the "Privilege Level Mapping, on page 22" section for more details.

- Create a local user with the same username as the user authenticating with the TACACS+ and RADIUS methods.

- Specify, by configuration, a default task group whose permissions are applied to any user authenticating with the TACACS+ and RADIUS methods.

Task Maps

For users who are authenticated using an external TACACS+ server and RADIUS server, Cisco IOS XR software AAA supports a method to define task IDs remotely.

Format of the Task String

The task string in the configuration file of the TACACS+ server consists of tokens delimited by a comma (,). Each token contains either a task ID name and its permissions or the user group to include for this particular user, as shown in the following example:

task = " *permissions* : *taskid name* , # *usergroup name* , ..."



Note Cisco IOS XR software allows you to specify task IDs as an attribute in the external RADIUS or TACACS+ server. If the server is also shared by non-Cisco IOS XR software systems, these attributes are marked as optional as indicated by the server documentation. For example, CiscoSecure ACS and the freeware TACACS+ server from Cisco require an asterisk (*) instead of an equal sign (=) before the attribute value for optional attributes. If you want to configure attributes as optional, refer to the TACACS+ server documentation.

For example, to give a user named user1 BGP read, write, and execute permissions and include user1 in a user group named operator, the username entry in the external server's TACACS+ configuration file would look similar to the following:

```
user = user1{
member = some-tac-server-group
opap = cleartext "lab"
service = exec {
task = "rwx:bgp,#operator"
}
}
```

The r,w,x, and d correspond to read, write, execute and debug, respectively, and the pound sign (#) indicates that a user group follows.



Note The optional keyword must be added in front of "task" to enable interoperability with systems based on Cisco IOS software.

If CiscoSecure ACS is used, perform the following procedure to specify the task ID and user groups:

SUMMARY STEPS

1. Enter your username and password.
2. Click the **Group Setup** button to display the **Group Setup** window.
3. From the Group drop-down list, select the group that you want to update.
4. Click the **Edit Settings** button.
5. Use the scroll arrow to locate the Shell (exec) check box.
6. Check the **Shell (exec)** check box to enable the custom attributes configuration.
7. Check the **Custom attributes** check box.
8. Enter the following task string without any blank spaces or quotation marks in the field:

9. Click the **Submit + Restart** button to restart the server.

DETAILED STEPS

Procedure

Step 1 Enter your username and password.

Step 2 Click the **Group Setup** button to display the **Group Setup** window.

Step 3 From the Group drop-down list, select the group that you want to update.

Step 4 Click the **Edit Settings** button.

Step 5 Use the scroll arrow to locate the Shell (exec) check box.

Step 6 Check the **Shell (exec)** check box to enable the custom attributes configuration.

Step 7 Check the **Custom attributes** check box.

Step 8 Enter the following task string without any blank spaces or quotation marks in the field:

Example:

```
task=rwx:bgp,#netadmin
```

Step 9 Click the **Submit + Restart** button to restart the server.

The following RADIUS Vendor-Specific Attribute (VSA) example shows that the user is part of the sysadmin predefined task group, can configure BGP, and can view the configuration for OSPF:

Example:

```
user Auth-Type := Local, User-Password == lab
        Service-Type = NAS-Prompt-User,
        Reply-Message = "Hello, %u",
        Login-Service = Telnet,
        Cisco-AVPair = "shell:tasks=#sysadmin,rwx:bgp,r:ospf"
```

After user1 successfully connects and logs in to the external TACACS+ server with username user1 and appropriate password, the **show user tasks** command can be used in EXEC mode to display all the tasks user1 can perform. For example:

Example:

```
Username:user1
Password:
RP/0/RSP0/CPU0:router# show user tasks

Task:      basic-services  :READ    WRITE    EXECUTEDEBUG
Task:                 bgp  :READ    WRITE    EXECUTE
Task:                 cdp  :READ
Task:                diag  :READ
Task:          ext-access  :READ             EXECUTE
Task:             logging  :READ
```

Alternatively, if a user named user2, who does not have a task string, logs in to the external server, the following information is displayed:

Example:

```
Username:user2
Password:
RP/0/RSP0/CPU0:router# show user tasks
No task ids available
```

Privilege Level Mapping

For compatibility with TACACS+ daemons that do not support the concept of task IDs, AAA supports a mapping between privilege levels defined for the user in the external TACACS+ server configuration file and local user groups. Following TACACS+ authentication, the task map of the user group that has been mapped from the privilege level returned from the external TACACS+ server is assigned to the user. For example, if a privilege level of 5 is returned from the external TACACS server, AAA attempts to get the task map of the local user group priv5. This mapping process is similar for other privilege levels from 1 to 13. For privilege level 15, the root-system user group is used; privilege level 14 maps to the user group owner-sdr.

For example, with the Cisco freeware tac plus server, the configuration file has to specify *priv_lvl* in its configuration file, as shown in the following example:

```
user = sampleuser1{
    member = bar
    service = exec-ext {
        priv_lvl = 5
    }
}
```

The number 5 in this example can be replaced with any privilege level that has to be assigned to the user *sampleuser.*

With the RADIUS server, task IDs are defined using the Cisco-AVPair, as shown in the following example:

```
user = sampleuser2{
    member = bar
    Cisco-AVPair = "shell:tasks=#root-system,#cisco-support"{
        Cisco-AVPair = "shell:priv-lvl=10"
    }
}
```

XML Schema for AAA Services

The extensible markup language (XML) interface uses requests and responses in XML document format to configure and monitor AAA. The AAA components publish the XML schema corresponding to the content and structure of the data used for configuration and monitoring. The XML tools and applications use the schema to communicate to the XML agent for performing the configuration.

The following schema are published by AAA:

- Authentication, Authorization and Accounting configuration
- User, user group, and task group configuration
- TACACS+ server and server group configuration
- RADIUS server and server group configuration

About RADIUS

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

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

Cisco supports RADIUS under its AAA security paradigm. RADIUS can be used with other AAA security protocols, such as TACACS+, Kerberos, and local username lookup.



Note RADIUS is supported on all Cisco platforms, but some RADIUS-supported features run only on specified platforms.

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

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

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

Network Security Situations in Which RADIUS is Unsuitable

RADIUS is not suitable in the following network security situations:

- Multiprotocol access environments. RADIUS does not support the following protocols:
  - AppleTalk Remote Access (ARA)
  - NetBIOS Frame Control Protocol (NBFCP)
  - NetWare Asynchronous Services Interface (NASI)
  - X.25 PAD connections
- Router-to-router situations. RADIUS does not provide two-way authentication. RADIUS can be used to authenticate from one router to a router other than a Cisco router if that router requires RADIUS authentication.
- Networks using a variety of services. RADIUS generally binds a user to one service model.

RADIUS Operation

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

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

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

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

RADIUS with TLS protection

Table 3: Feature History Table

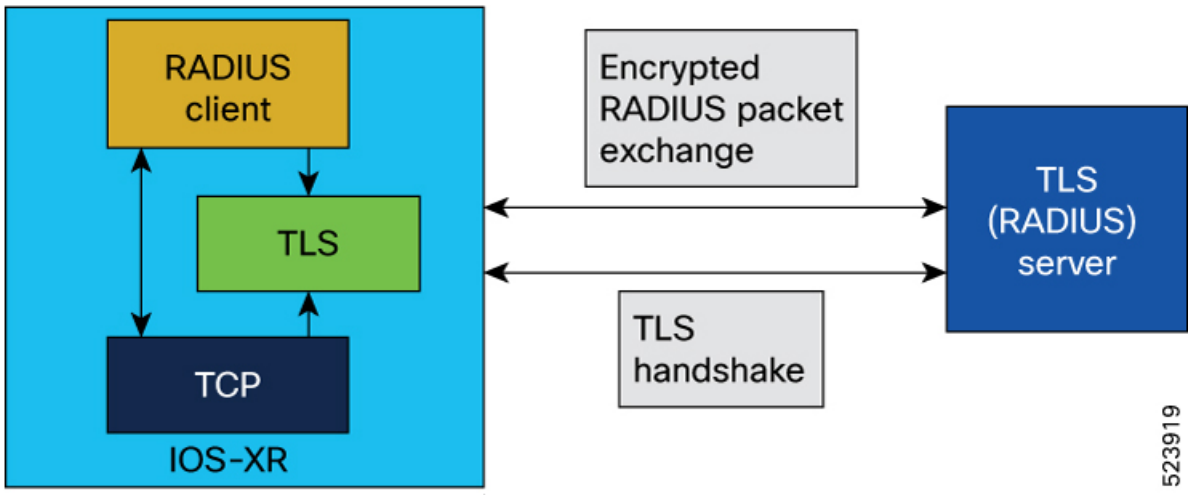
Feature Name	Release Information	Feature Description

RADIUS with TLS protection	Release 24.4.1	Remote Authentication Dial-In User Service (RADIUS) packets are now less vulnerable to security risks, including data exposure, replay attacks, weak authentication, and encryption weaknesses. This is because we have enabled support for RADIUS with TLS protection.
		
		You can configure the RADIUS protocol on the router to redirect RADIUS packets to a remote server over TLS for Authentication, Authorization, and Accounting (AAA) services.
		
		The feature introduces these changes:
		
		CLI:
		
		• The keyword **radsec-server** is introduced in the **radius-server host** command.
		
		YANG Data Models:
		
		• New Xpath for
		
		`Cisco-IOS-XR-um-aaa-cfg.yang`
		
		• New Xpath for
		
		`Cisco-IOS-XR-aaa-lib-cfg.yang`
		
		(see GitHub, YANG Data Models Navigator)

Topology for RADIUS with TLS protection

Traditionally, RADIUS has been used for Authentication, Authorization, and Accounting (AAA). However, to meet modern security demands it is important to enhance its encryption and authentication. To increase the resilience against threats and maintain a secure network environment, TLS is now utilized as the transport protocol for RADIUS.

This feature supports TLS version 1.3.



Let's understand how you can establish RADIUS communication with TLS.

Establish TLS session: The RADIUS client initiates the process to establish a secure TLS session with the RADIUS server, which acts as the TLS server. This session is built upon a TCP socket that the RADIUS client creates.

Store TLS context: Upon successful TLS connection, the TLS context is preserved within the TLS connection context. This, in turn, is stored within the RADIUS context for the specified server, ensuring a persistent secure environment for subsequent communications.

RADIUS packet handling: The format of the RADIUS packet remains consistent with that used in RADIUS over TCP. The application constructs a RADIUS packet using standard methods. Instead of sending it via a TCP socket, the packet is handed over to the TLS layer for secure encapsulation. TLS effectively becomes the transport layer for RADIUS, hence the designation "RADIUS/TLS."

Secure data transmission: The RADIUS packets are securely transmitted over the TLS layer with data encryption/decryption.

This approach ensures that the RADIUS communications are secure, especially in roaming environments where the packets may pass through various administrative domains and untrusted networks. TLS provides a robust security layer, addressing the vulnerabilities associated with traditional RADIUS over UDP.

Optimized RADIUS session control:

- To manage RADIUS sessions effectively, the RADIUS client employs Path MTU discovery before initiating traffic.
- The RADIUS client avoids using the same source socket for both RADIUS/UDP and RADIUS/TLS traffic to different servers.
- Once a TLS session is established, TLS heartbeats monitor connectivity with the server.
- Additionally, an application-layer watchdog algorithm checks server responsiveness. The client proactively closes idle sessions; sessions indicated as inactive by the TLS heartbeat, or those with only watchdog traffic for three timeouts.
- RADIUS sessions are terminated when RADIUS packets fail validation or contain invalid authenticators. When a session fails validation, the session is validated again using the next specified failover mechanism.

Restrictions for RADIUS with TLS Protection

The list provides the restrictions that apply to RADIUS with TLS protection:

- Broadband Network Gateway (BNG) applications are not supported.
- The default destination port for RADIUS over TLS is TCP 2083 for authentication and accounting. There is no support for custom ports.
- The maximum number of concurrent TLS sessions supported is 50.
- RADIUS over TLS supports IPv4 addresses only.
- A combination of TLS, UDP, and DTLS server types under one server group over RADIUS is not recommended.

Supported ciphers

TLS ciphers are encryption algorithms that secure RADIUS traffic. Here are some supported TLS ciphers:

- TLS_AES_256_CGM_SHA384
- TLS_CHACHA20_POLY1305_SHA256
- TLS_AES_128_CGM_SHA256
- TLS_ECDHE_ECDSA_WITH_AES_256_CGM_SHA384
- TLS_ECDHE_RSA_WITH_AES_256_CGM_SHA384
- TLS_DHE_RSA_WITH_AES_256_CGM_SHA384
- TLS_ECDHE_ECDSA_WITH_CHACHA20_POLY1305_SHA256
- TLS_ECDHE_RSA_WITH_CHACHA20_POLY1305_SHA256
- TLS_DHE_RSA_WITH_CHACHA20_POLY1305_SHA256
- TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256
- TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384
- TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
- TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
- TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
- TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
- TLS_DHE_RSA_WITH_AES_256_CBC_SHA
- TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA

- TLS_DHE_RSA_WITH_AES_128_CBC_SHA
- TLS_RSA_WITH_AES_256_GCM_SHA384
- TLS_RSA_WITH_AES_128_GCM_SHA256
- TLS_RSA_WITH_AES_256_CBC_SHA256
- TLS_RSA_WITH_AES_128_CBC_SHA256
- TLS_RSA_WITH_AES_256_CBC_SHA
- TLS_RSA_WITH_AES_128_CBC_SHA
- TLS_EMPTY_RENEGOTIATION_INFO_SCSV

The cipher suite negotiated between the client and the server when both support TLS 1.3 is:

- TLS_AES_256_GCM_SHA384

Configure RADIUS with TLS protection

To configure RADIUS with TLS protection, use the command **radius-server host** with keyword **radsec-server**.

Before you begin

Before configuring RADIUS with TLS protection, complete these steps on the Cisco router. See **Implementing Certification Authority Interoperability** for more information.

1. Configure a trustpoint.
2. Import the CA certificate.
3. Enroll the trustpoint and generate a client certificate on CA.
4. Import the client certificate.

Procedure

Step 1 Enter the hostname or IP address of the RADIUS server.

```
Router(Config)#radius-server host 209.165.201.1 auth-port 2083 acct-port 2083 radsec-server
```

Step 2 Enter the name of the trusted point so that the router can verify certificates issued to peers.

```
Router(config-radius-host)trustpoint test
```

Your router need not enroll with the CA that issued the certificates to the peers.

Step 3 Commit the changes.

```
Router(config-radius-host)#commit
```

Step 4 Verify that TLS is enabled by using the **show radius** command.

```
Router#show radius
Thu Jun 20 11:43:40.863 UTC
```

```
Global dead time: 0 minute(s)
Number of Servers: 3

Server: 209.165.201.1/2083/2083  is UP
  Address family: IPv4
  Total Deadtime: 0s Last Deadtime: 0s
  Timeout: 5 sec, Retransmit limit: 3
  Quarantined: No
  Authentication:
    0 requests, 0 pending, 0 retransmits
    0 accepts, 0 rejects, 0 challenges
    0 timeouts, 0 bad responses, 0 bad authenticators
    0 unknown types, 0 dropped, 0 ms latest rtt
    Throttled: 0 transactions, 0 timeout, 0 failures
    Estimated Throttled Access Transactions: 0
    Maximum Throttled Access Transactions: 0

    Automated TEST Stats:
        0 requests, 0 timeouts, 0 response, 0 pending
  Server-type: TLS
  Accounting:
    0 requests, 0 pending, 0 retransmits
    0 responses, 0 timeouts, 0 bad responses
    0 bad authenticators, 0 unknown types, 0 dropped
    0 ms latest rtt
    Throttled: 0 transactions, 0 timeout, 0 failures
    Estimated Throttled Accounting Transactions: 0
    Maximum Throttled Accounting Transactions: 0

    Automated TEST Stats:
        0 requests, 0 timeouts, 0 response, 0 pending
```

Step 5 Verify the configuration settings by using the **show running-configuration** command.

```
Router#show running-configuration radius-server
Fri Jun 21 02:59:40.238 UTC
radius-server host 209.165.201.1 auth-port 2083 acct-port 2083
radsec-server trustpoint test
!
```

Differentiated Services Code Point (DSCP) Marking support for TACACS packets

Differentiated Services is a Quality of Service (QoS) architecture that manages the data traffic in a network by using the principle of traffic classification. In this model, the traffic is divided into classes and the data packets are forwarded to the corresponding classes. Based on the priority of the network traffic, the different classes are managed.

To classify traffic, Differentiated Services uses Differentiated Services Code Point (DSCP). It is a 6-bit field in the Type of Service (ToS) byte in the IP header. Based on the DSCP value, the user is able to classify the data traffic and forward packets to the next destination.

You can set the value of DSCP. For a single connection, set the DSCP value on the socket while connecting to the server. In this way, all the outgoing packets will have the same DSCP value in their IP headers. For multiple connections, the DSCP value is set on the available open sockets. Use the **tacacs-server ipv4** command to set the DSCP value.

Hold-Down Timer for TACACS+

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
Hold-Down Timer for TACACS+	Release 7.4.1	TACACS+ servers provide AAA services to the user. When a TACACS+ server becomes unreachable, the router sends the client request to another server, leading to considerable delay in addressing requests. To prevent this delay, you can set a hold-down timer on the router. The timer gets triggered after the router marks the TACACS+ server as down. During this period, the router does not select the server that is down for processing any client requests. When the timer expires, the router starts using that TACACS+ server for client transactions. This feature improves latency in providing AAA services to the user by limiting the client requests from being sent to unresponsive servers. This feature introduces the **holddown-time** command.

The TACACS+ server is a AAA server with which the router communicates to provide authentication, authorization, and accounting services for users. When a TACACS+ server goes down, the router is not made aware. After sending a AAA request, the client waits for a response from the server for a configured timeout. If the router does not receive a response within that time frame, it sends the request to the next available server or discards the request if no other servers are available. A new request also needs to follow the same procedure in the same order of servers. The overall process results in sending multiple requests to servers that are down and therefore delays the client request from reaching an active server.

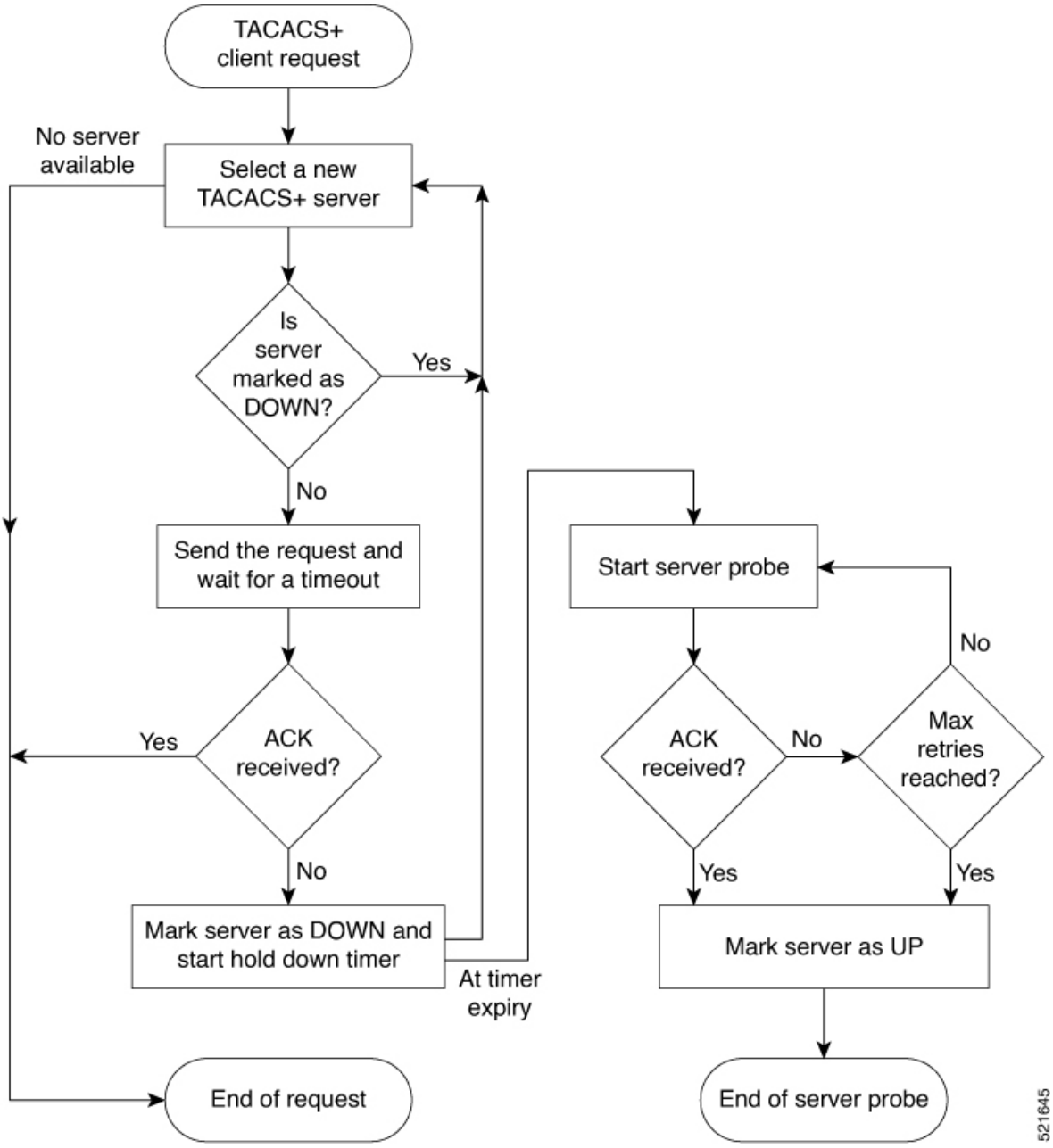
With the TACACS+ hold-down timer feature, you can mark an unresponsive TACACS+ server as down, and also set a duration for which the router does not use that server for further client transaction. After the timer expires, the router starts using that server again for processing client requests. This feature in turn allows you to control the participation of a TACACS+ server in AAA functions, without removing the TACACS+ server configuration from the router.

The hold-down timer value, in seconds, ranges from 0 to 1200. To enable hold-down timer, use the **holddown-time** command under the various configuration modes listed in the How to Configure Hold-Down Timer for TACACS+, on page 91 section.

How Does the Hold-Down Timer for TACACS+ Function?

The following image depicts the functionality of TACACS+ hold-down timer.

Figure 1: Work Flow of TACACS+ Hold-Down Timer



When a TACACS+ client request comes, the router selects a TACACS+ server and checks whether that server is marked as down. If the server is marked as down, the router selects another server until it finds an available server. If the server is not marked as down, the router sends the client request to that server. If the router does not receive an acknowledgment message from the server, it marks that server as down and initiates the hold-down timer. After the timer expires, an internal server probe begins, which checks the connectivity of the down server. The probe tries to connect to the server every 20 seconds, for a maximum of three times (these values are non-configurable). If connection is successful in any of these attempts, then the router marks that server as up, and ends the server probe. Even if the connection fails on all retries of the server probe, the

router still marks the server as up before exiting the server probe. After exiting the server probe, the router considers that server as available again to accept client requests.

If an unresponsive server is still not reachable after the hold-down timer continues, then the system continues to regard that server as being down, and does not use it for client transactions for some more time (that is, approximately, one minute). The router starts using that server again for further client transactions only after this short delay.

In case the TACACS+ server comes up while the hold-down timer is running, the router continues to consider that server as down until the timer expires.

How to Configure AAA Services

To configure AAA services, perform the tasks described in the following sections.

Prerequisites for Configuring AAA Services

The following are the prerequisites to configure AAA services:

- You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.
- Establish a root system user using the initial setup dialog. The administrator may configure a few local users without any specific AAA configuration. The external security server becomes necessary when user accounts are shared among many routers within an administrative domain. A typical configuration would include the use of an external AAA security server and database with the local database option as a backup in case the external server becomes unreachable.

Restrictions for Configuring AAA Services

This section lists the restrictions for configuring AAA services.

Compatibility

Compatibility is verified with the Cisco freeware TACACS+ server and FreeRADIUS only.

Interoperability

Router administrators can use the same AAA server software and database (for example, CiscoSecure ACS) for the router and any other Cisco equipment that does not currently run Cisco IOS XR software. To support interoperability between the router and external TACACS+ servers that do not support task IDs, see the "Task IDs for TACACS+ and RADIUS Authenticated Users, on page 19" section.

Configuring Task Groups

Task-based authorization employs the concept of a *task ID* as its basic element. A task ID defines the permission to execute an operation for a given user. Each user is associated with a set of permitted router operation tasks identified by task IDs. Users are granted authority by being assigned to user groups that are in turn associated with task groups. Each task group is associated with one or more task IDs. The first configuration task in

setting up an authorization scheme to configure the task groups, followed by user groups, followed by individual users.

Task Group Configuration

Task groups are configured with a set of task IDs per action type.

Specific task IDs can be removed from a task group by specifying the **no** prefix for the **task** command.

The task group itself can be removed. Deleting a task group that is still referred to elsewhere results in an error.

Before you begin

Before creating task groups and associating them with task IDs, you should have some familiarity with the router list of task IDs and the purpose of each task ID. Use the **show aaa task supported** command to display a complete list of task IDs.



Note Only users with write permissions for the AAA task ID can configure task groups.

SUMMARY STEPS

1. **configure**
2. **taskgroup** *taskgroup-name*
3. **description** *string*
4. **task** {**read** | **write** | **execute** | **debug**} *taskid-name*
5. Repeat Step 4 for each task ID to be associated with the task group named in Step 2.
6. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**taskgroup** *taskgroup-name* **Example:** `RP/0/RSP0/CPU0:router(config)# taskgroup beta`	Creates a name for a particular task group and enters task group configuration submode. • Specific task groups can be removed from the system by specifying the **no** form of the **taskgroup** command.
Step 3	**description** *string* **Example:**	(Optional) Creates a description of the task group named in Step 2.

	Command or Action	Purpose
	`RP/0/RSP0/CPU0:router(config-tg)# description this is a sample task group description`	
Step 4	**task** {**read** | **write** | **execute** | **debug**} *taskid-name* **Example:** `RP/0/RSP0/CPU0:router(config-tg)# task read bgp`	Specifies a task ID to be associated with the task group named in Step 2. • Assigns **read** permission for any CLI or API invocations associated with that task ID and performed by a member of the task group. • Specific task IDs can be removed from a task group by specifying the **no** prefix for the **task** command.
Step 5	Repeat Step 4 for each task ID to be associated with the task group named in Step 2.	—
Step 6	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After completing configuration of a full set of task groups, configure a full set of user groups as described in the Configuring User Groups section.

Configuring User Groups

User groups are configured with the command parameters for a set of users, such as task groups. Entering the **usergroup** command accesses the user group configuration submode. Users can remove specific user groups by using the **no** form of the **usergroup** command. Deleting a usergroup that is still referenced in the system results in a warning.

Before you begin



Note Only users associated with the WRITE:AAA task ID can configure user groups. User groups cannot inherit properties from predefined groups, such as root-system and owner-sdr.

SUMMARY STEPS

1. **configure**
2. **usergroup** *usergroup-name*
3. **description** *string*
4. **taskgroup** *taskgroup-name*
5. Repeat Step Step 4, on page 38 for each task group to be associated with the user group named in Step Step 2, on page 35.
6. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**usergroup** *usergroup-name* **Example:** `RP/0/RSP0/CPU0:router(config)# usergroup beta`	Creates a name for a particular user group and enters user group configuration submode. • Specific user groups can be removed from the system by specifying the **no** form of the **usergroup** command.
Step 3	**description** *string* **Example:** `RP/0/RSP0/CPU0:router(config-ug)# description this is a sample user group description`	(Optional) Creates a description of the user group named in Step Step 2, on page 35.
Step 4	**taskgroup** *taskgroup-name* **Example:** `RP/0/RSP0/CPU0:router(config-ug)# taskgroup beta`	Associates the user group named in Step Step 2, on page 38with the task group named in this step. • The user group takes on the configuration attributes (task ID list and permissions) already defined for the entered task group.
Step 5	Repeat Step Step 4, on page 38 for each task group to be associated with the user group named in Step Step 2, on page 35.	—
Step 6	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session.

	Command or Action	Purpose
		• **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After completing configuration of a full set of user groups, configure individual users as described in the Configuring Users, on page 37 section.

Configure First User on Cisco Routers

When a Cisco Router is booted for the very first time, and a user logs in for the first time, a root-system username and password must be created. Configure the root-system username and password, as described in the following procedure:

Step 1. Establish a connection to the Console port.

This initiates communication with the router. When you have successfully connected to the router through the Console port, the router displays the prompt:

```
Enter root-system username
```

Step 2. Type the username for the root-system login and press **Enter**.

Sets the root-system username, which is used to log in to the router.

Step 3. Type the password for the root-system login and press **Enter**.

Creates an encrypted password for the root-system username. This password must be at least six characters in length. The router displays the prompt:

```
Enter secret
```

Step 4. Retype the password for the root-system login and press **Enter**.

Allows the router to verify that you have entered the same password both times. The router displays the prompt:

```
Enter secret again
```



Note If the passwords do not match, the router prompts you to repeat the process.

Step 5. Log in to the router.

Establishes your access rights for the router management session.



Note In case of Router reload, when there is no stored username and password, you must create a new username and password.

For more information on minimum password length, see .

Example

The following example shows the root-system username and password configuration for a new router, and it shows the initial login:

```
/* Administrative User Dialog */
Enter root-system username: cisco
Enter secret:
Enter secret again:

RP/0/0/CPU0:Jan 10 12:50:53.105 : exec[65652]: %MGBL-CONFIG-6-DB_COMMIT : 'Administration
configuration committed by system'.
Use 'show configuration commit changes 2000000009' to view the changes. Use the 'admin'
mode 'configure' command to modify this configuration.

/* User Access Verification */
Username: cisco
Password:
RP/0/0/CPU0:ios#
```

The secret line in the configuration command script shows that the password is encrypted. When you type the password during configuration and login, the password is hidden.

Configuring Users

Perform this task to configure a user.

Each user is id entified by a username that is unique across the administrative domain. Each user should be made a member of at least one user group. Deleting a user group may orphan the users associated with that group. The AAA server authenticates orphaned users but most commands are not authorized.

From Cisco IOS XR Software Release 24.3.1 and later, the router synchronizes up to 100 valid Linux-compatible users to the Linux infrastructure (/etc/passwd file), and up to 20 users to the standby route processor (RP) in a dual-RP router setup.

SUMMARY STEPS

1. **configure**
2. **username** *user-name*
3. Do one of the following:
   - **password** [**0** | **7**] *password*
   - **secret** [**0** | **5**] *secret*
   - **secret** [**0** | **5** | **8** | **9**] *secret*
   - **secret 0** [**enc-type**] *secret*
   - **secret 0 enc-type** {**5** | **8** | **9**}*secret*
4. **group** *group-name*
5. Repeat Step 4, on page 38 for each user group to be associated with the user specified in Step 2, on page 38.
6. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**username** *user-name* **Example:** `RP/0/RSP0/CPU0:router(config)# username user1`	RSP0 Creates a name for a new user (or identifies a current user) and enters username configuration submode. • The *user-name* argument can be only one word. Spaces and quotation marks are not allowed.

Step 3	Do one of the following:
	• **password** [**0** | **7**] *password*
	• **secret** [**0** | **5**] *secret*
	• **secret** [**0** | **5** | **8** | **9**] *secret*
	• **secret 0** [**enc-type**] *secret*
	• **secret 0 enc-type** {**5** | **8** | **9**}*secret*
	Example:
	`RP/0/RSP0/CPU0:router(config-un)# password 0 pwd1`
	or
	`RP/0/RSP0/CPU0:router(config-un)# secret 0 sec1`
		Specifies a password for the user named in Step 2, on page 38.
		• Use the **secret** command to create a secure login password for the user names specified in Step 2, on page 38.
		• Entering **0** following the **password** command specifies that an unencrypted (clear-text) password follows. Entering **7** following the **password** command specifies that an encrypted password follows.
		• Entering **0** following the **secret** command specifies that a secure unencrypted (clear-text) password follows. Entering **5** following the **secret** command specifies that a secure encrypted password follows.
		• Entering **8** following the **secret** command specifies that a SHA256 encrypted password follows. Entering **9** following the **secret** command specifies that a scrypt encrypted password follows.
		The **enc-type** keyword under the **secret 0** command allows the user to specify the algorithm that can be used to encrypt the clear text user password.
		• Type **0** is the default for the **password** and **secret** commands.

Step 4	**group** *group-name* **Example:** `RP/0/RSP0/CPU0:router(config-un)# group sysadmin`	Assigns the user named in Step 2, on page 38 to a user group that has already been defined through the **usergroup** command.

	Command or Action	Purpose
		• The user takes on all attributes of the user group, as defined by that user group's association to various task groups. • Each user must be assigned to at least one user group. A user may belong to multiple user groups.
Step 5	Repeat Step 4, on page 38 for each user group to be associated with the user specified in Step 2, on page 38.	—
Step 6	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After completing configuration of a full set of users, configure router to use the RADIUS server communication or TACACS+ servers (See the Configuring Router to RADIUS Server Communication, on page 57 or Configuring a TACACS+ Server, on page 65 section.)

Password Masking For Type 7 Password Authentication

Table 5: Feature History Table

Feature Name	Release Information	Feature Description
Password Masking	Release 7.3.1	With this feature, when you key in a password or secret, it is not displayed on the screen. This enhances security. The feature is enabled by default. The following options are added to the **username** command: • **masked-password** • **masked-secret**

When you key in a password, to ensure that it is not displayed on the screen, use the **masked-password** option. Details:

Use the **username** command as shown below, and enter the password.

The following command contains the username us3, and 0 to specify a cleartext password.

```
Router(config)# username us3 masked-password 0

Enter password:
Re-enter password:

Router(config)#commit
```

View the encrypted password:

```
Router# show run aaa
..

username us3
 password 7 105A1D0D
```

Enable Type 7 password authentication and enter the encrypted password 105A1D0D. You can also use a password encrypted earlier.

```
Router(config)# username us3 masked-password 7

Enter password:
Re-enter password:


Router(config)#commit
```

If there is a password mismatch between the two entries, an error message is displayed.

Configure Type 8 and Type 9 Passwords

When configuring a password, user has the following two options:

- User can provide an already encrypted value, which is stored directly in the system without any further encryption.
- User can provide a cleartext password that is internally encrypted and stored in the system.

The Type 5, Type 8, and Type 9 encryption methods provide the above mentioned options for users to configure their passwords.

For more information about configuring Type 8 and Type 9 encryption methods, see Configuring Users, on page 37 section.

Configuration Example

Directly configuring a Type 8 encrypted password:

```
Router(config)# username demo8
Router(config-un)#secret 8 $8$dsYGNam3K1SIJO$7nv/35M/qr6t.dVc7UY9zrJDWRVqncHub1PE9UlMQFs
```

Configuring a clear-text password that is encrypted using Type 8 encryption method:

```
Router(config)# username demo8
Router(config-un)#secret 0 enc-type 8 PASSWORD
```

Directly configuring a Type 9 encrypted password:

```
Router(config)# username demo9
Router(config-un)# secret 9 $9$nhEmQVczB7dqsO$X.HsgL6x1il0RxkOSSvyQYwucySCt7qFm4v7pqCxkKM
```

Configuring a clear-text password that is encrypted using Type 9 encryption method:

```
Router(config)# username demo9
Router(config-un)#secret 0 enc-type 9 PASSWORD
```

Password Masking For Type 5, Type 8, Type 9 And Type 10 Password Authentication

When you key in a password, to ensure that it is not displayed on the screen, use the **masked-secret** option. Steps:

Use the **username** command as shown below, and enter the password.

The following command contains the username us6, 0 to specify a cleartext password, and the encryption type (5, 8, 9, or 10).

```
Router(config)# username us6 masked-secret 0 enc-type 8

Enter secret:
Re-enter secret:

Router(config)# commit
```

View the encrypted secret:

```
Router# show running-config aaa
..
username us6
 secret 8 $8$mlcSk/Ae5Qu/5k$RJdI3SQ8B4iP7rdxxQvVlJVeRHSubZzcgcaLYxjg36s
```

Enter the username, 8 to specify Type 8 secret authentication, and enter the Type 8 secret. You can also use a secret encrypted earlier.

```
Router(config)# username us6 masked-secret 8

Enter secret:
Re-enter secret:

Router(config)# commmit
```

If there is a password mismatch between the two entries, an error message is displayed.

Related Topics

- Type 8 and Type 9 Passwords, on page 14

Associated Commands

- secret
- username

Configure Type 10 Password

You can use these options to configure Type 10 password (that uses **SHA512** hashing algorithm) for the user:

Configuration Example

From Release 7.0.1 and later, Type 10 is applied by default for the passwords when you create a user with a clear-text password.

```
Router#configure
Router(config)#username user10 secret testpassword
Router(config-un)#commit
```

Also, a new parameter '10' is available for the **secret** option under the **username** command to configure explicitly the Type 10 passwords.

```
Router#configure
Router(config)#username root secret 10
$6$9UvJidvsTEqgkAPU$3CL1Ei/F.E4v/Hi.UaqLwX8UsSEr9ApG6c5pzhMJmZtgW4jObAQ7meAwyhu5VM/aRFJqe/jxZG17h6xPrvJWf1
Router(config-un)#commit
```

In scenarios where you have to enter the clear-text password, you can specify the encryption algorithm to be used by using the **enc-type** keyword and the clear-text password as follows:

```
Router#configure
Router(config)#username user10 secret 0 enc-type 10 testpassword
Router(config-un)#commit
```

The preceding configuration configures the user with the Type10 password.

In System Admin VM, you can specify the Type 10 encrypted password as follows:

```
Router#admin
sysadmin-vm:0_RP0# configure
sysadmin-vm:0_RP0(config)# aaa authentication users user user10 password testpassword
sysadmin-vm:0_RP0(config)# commit
Commit complete.
sysadmin-vm:0_RP0(config)# end
sysadmin-vm:0_RP0# exit
Router#
```

Running Configuration

```
Router#show running-configuration username user10
!
username user10
secret 10
$6$9UvJidvsTEqgkAPU$3CL1Ei/F.E4v/Hi.UaqLwX8UsSEr9ApG6c5pzhMJmZtgW4jObAQ7meAwyhu5VM/aRFJqe/jxZG17h6xPrvJWf1
!
```

In System Admin VM:

```
sysadmin-vm:0_RP0#show running-configuration aaa authentication users user user10
Tue Jan 14 07:32:44.363 UTC+00:00
aaa authentication users user user10
password
$6$MMvhlj1CzSd2nJfB$Bbzvxzriwx4iLFg75w4zj15YK3yeoq5UoRyc1evtSX0c4EuaMlqK.v7E3zbY1yKKxkN6rXpQuhMJOuyRHItDc1
!
sysadmin-vm:0_RP0#
```

Similarly, you can use the **admin show running-configuration aaa authentication users user user10** command in XR VM, to see the details of the password configured for the user.

Related Topics

- Type 10 Password, on page 14
- Backward Compatibility for Password Types, on page 43

Associated Commands

- **username**
- **secret**

Backward Compatibility for Password Types

When you downgrade from Cisco IOS XR Software Release 7.0.1 to lower versions, you might experience issues such as configuration loss, authentication failure, termination of downgrade process or XR VM being down. These issues occur because Type 5 (MD5) is the default encryption for older releases.

It is recommended to follow these steps to avoid such backward compatibility issues during downgrade:

- Perform all install operations for the downgrade except the **install activate** step.
- Before performing the **install activate** step, take the backup of user configurations on both the VMs. You can use the **show running-configuration username | file harddisk:***/filename* command for the same.
- Delete all users on both the VMs and initiate the **install activate** step.
- When the router boots up with the lower version, it prompts for the first root-system user creation.
- After your login with the credentials of the first user, apply the previously saved configuration to both the VMs.

For example, consider an authentication failure scenario after a downgrade. The downgrade process does not affect any existing user name configuration with Type 5 secret. Such users can log in without any issue using the clear-text password. But, the users with Type 10 configuration might experience authentication failure, and may not be able to log in. In such cases, the system treats the whole string "10<space><sha512-hashed-text>" as a clear-text password and encrypts it to Type 5 (MD5) password. Use that "10<space><sha512-hashed-text> string as the password for that Type 10 user to log in. After you log in with the preceding step, you must explicitly configure the clear-text password in XR VM and System Admin VM as described in the Configuration Example section.

Configure AAA Password Policy

To configure the AAA password policy, use the **aaa password-policy** command in the global configuration mode.

Configuration Example

This example shows how to configure a AAA password security policy, *test-policy*. This *test-policy* is applied to a user by using the **username** command along with **password-policy** option.

```
RP/0/RSP0/CPU0:router(config)#aaa password-policy test-policy
RP/0/RSP0/CPU0:router(config-aaa)#min-length 8
RP/0/RSP0/CPU0:router(config-aaa)#max-length 15
RP/0/RSP0/CPU0:router(config-aaa)#lifetime months 3
RP/0/RSP0/CPU0:router(config-aaa)#min-char-change 5
RP/0/RSP0/CPU0:router(config-aaa)#authen-max-attempts 3
RP/0/RSP0/CPU0:router(config-aaa)#lockout-time days 1
RP/0/RSP0/CPU0:router(config-aaa)#commit

RP/0/RSP0/CPU0:router(config)#username user1 password-policy test-policy password 0 pwd1
```

Running Configuration

```
aaa password-policy test-policy
 min-length 8
 max-length 15
 lifetime months 3
 min-char-change 5
 authen-max-attempts 3
 lockout-time days 1
 !
```

Verification

Use this command to get details of the AAA password policy configured in the router:

```
RP/0/RSP0/CPU0:router#show aaa password-policy

Fri Feb  3 16:50:58.086 EDT
Password Policy Name : test-policy
  Number of Users : 1
  Minimum Length : 8
  Maximum Length : 15
  Special Character Len : 0
  Uppercase Character Len : 0
  Lowercase Character Len : 1
  Numeric Character Len : 0
  Policy Life Time :
    seconds : 0
    minutes : 0
    hours : 0
    days : 0
    months : 3
    years : 0
  Lockout Time :
    seconds : 0
    minutes : 0
    hours : 0
    days : 1
    months : 0
    years : 0
  Character Change Len : 5
  Maximum Failure Attempts : 3
```

Password Masking For AAA Password Policies

When you key in a password, to ensure that it is not displayed on the screen, use the **masked-password** option. Steps:

Create a AAA password security policy and enter the cleartext password.

In this example, a policy called *security* is created, and 0 is specified for a cleartext password.

```
Router(config)# aaa password-policy security
Router(config)# username us6 password-policy security masked-password 0

Enter password:
Re-enter password:

Router(config)#commit
```

View the encrypted password:

```
Router# show run aaa
..

aaa password-policy security
..
username us6
 password-policy security password 7 0835585A
```

Enter the username, 7 to specify Type 7 password authentication, and enter the password 0835585A. You can also use a password encrypted earlier.

```
Router(config)# username us6 password-policy test-policy masked-password 7

Enter password:
Re-enter password:


Router(config)#commit
```

If there is a password mismatch between the two entries, an error message is displayed.

Related Topic

- AAA Password Security for FIPS Compliance, on page 15

Associated Commands

- **aaa password-policy**
- **show aaa password-policy**
- **username**

Display Username for Failed Authentication for Telnet Protocols

Table 6: Feature History Table

Feature Name	Release Information	Feature Description
Display Username for Failed Authentication for Telnet Protocols	Release 7.10.1	With this feature, we have enhanced the security of the routers and introduced better tracking functionality to the router. The failed authentication sys log now displays the details of users who tried to log in but failed due to authentication failure. With this feature provisioned, the router can now display the user ID of both SSH and Telnet protocols. In earlier releases, this feature was available only for SSH protocols. This feature introduces the following change: **CLI: aaa display-login-failed-users**. **YANG DATA Model**: New XPaths for `Cisco-IOS-XR-um-aaa-task-user-cfg` (see Github, YANG Data Models Navigator)

Effective Cisco IOS XR Software Release 7.10.1, you can track the username of the users who tried to login to the router and their authentication failed in the failed authentication system logs. Prior to this release, this feature was available for SSH clients only. Now, this functionality is available for both SSH and Telnet clients. By default, the feature is disabled. When this feature is disabled, failed authentication sys logs displays the username as **unknown** for both SSH and Telnet. Once the feature is enabled, the failed authentication sys logs display the username of the users who tried to login to the router, and the login attempt was unsuccessful due to failed authentication.

Use the **aaa display-login-failed-users** command in Global Configuration mode to enable this feature.

Enable Display of Username for Failed Authentication

Configuration Example

```
Router#conf
Router(config)#aaa display-login-failed-users
Router(config)#commit
```

Running configuration

```
Router#show run aaa display-login-failed-users
!
aaa display-login-failed-users
!
```

Verification

This section shows example from sys logs where the user name is displayed for failed authentication after the configuration of this feature.

System logs for Telnet client:

```
RP/0/RP0/CPU0:Jul 18 14:36:39.789 UTC: exec[65957]:
%SECURITY-LOGIN-4-AUTHEN_FAILED : Failed authentication attempt by
user lab from 'console' on 'con0_RP0_CPU0'
```

System logs for SSH client:

```
RP/0/RP0/CPU0:Jul 18 14:38:17.596 UTC: SSHD_[66072]:
 %SECURITY-SSHD-4-INFO_FAILURE : Failed authentication attempt by
 user lab from '192.168.122.1' on 'vty0
```

Password Policy to Restrict Consecutive Characters

Table 7: Feature History Table

Feature Name	Release Information	Feature Description
Password Policy to Restrict Consecutive Characters	Release 7.7.1	We have enhanced the router security by enforcing a strong password policy for all users configured on the router. You can now specify a new password policy for the user that restricts the usage of a specific number of consecutive characters for the login passwords. These characters include English alphabets, the sequence of QWERTY keyboard layout, and numbers, such as, 'abcd', 'qwer', '1234', and so on. Apart from *passwords*, the feature is also applicable for *secrets*–the one-way encrypted secure login passwords that are not easy to decrypt to retrieve the original unencrypted password text. The password policy is applicable only for the users configured on the local AAA server on the router; not those configured on the remote AAA server. The feature introduces the **restrict-consecutive-characters** command.

Most often you create passwords and secrets which are easy to remember, such as the ones that use consecutive characters from English alphabets, or numbers. Such passwords and secrets are easy to compromise, thereby making the router vulnerable to security attacks. From Cisco IOS XR Software Release 7.7.1 and later, you can enhance the security of your user passwords and secrets by defining a password policy that restricts the usage of consecutive characters from English alphabets, QWERTY layout keyboard English alphabets, and numbers (such as, 'abcd', 'qwer', 'zyxw', '1234', and so on). You can also restrict a cyclic wrapping of the alphabet and the number (such as, 'yzab', 'opqw', '9012', and so on). The feature also gives you the flexibility to specify the number of consecutive alphabets or numbers to be restricted.

Certain key aspects of this feature are:

- The feature is disabled, by default.
- The security administrator must have *write* permission for AAA tasks to create the password policies.
- All password policies are applicable only to locally-configured users; not to users who are configured on remote AAA servers.

This table depicts the examples of valid and invalid passwords and secrets when the password policy to restrict consecutive characters (say, 4 in this example) is in place.

Use Case	Examples of Invalid Password or Secret	Examples of Valid Password or Secret
4 consecutive English alphabets	AbcD, ABCD, TestPQRS, DcbA, TestZYxW123, DCBA, ihgf	AbcPqR, Xyzdef, Yzab, zabC
4 consecutive English alphabets and decimal numbers from QWERTY keyboard layout	Qwer, QWER, Mnbv, aQwerm, Test1234, TestT7890, 5678, fghj	Opas, xzLk, sapo, saqw3210, Test9012
Restrict 4 consecutive English alphabets along with cyclic wrapping	Yzab, TestYZAB, zabc	1234, Qwer, QWER, Mnbv, aQwerm, Test1234, TestT0987
Restrict 4 consecutive English alphabets and numbers from QWERTY keyboard layout along with cyclic wrapping	9012, 8901, Test3210, TestT0987, Opqw, klas, dsal, Cxzm, nmzx	AbcD, ABCD, Yzab, TestYZAB, zabc

How to Restrict Consecutive Characters for User Passwords and Secrets

To enable the feature to restrict consecutive characters for user passwords and secrets, use the **restrict-consecutive-characters** command in *aaa password policy* configuration mode. To disable the feature, use the **no** form of the command.

You can use the optional keyword, **cyclic-wrap**, to restrict the cyclic wrapping of characters and numbers.

After creating the password policies, you must explicitly apply those policies to the user profiles so that the password policies take effect in the password and secret configuration.

Configuration Example

Enabling the feature using CLI:

```
Router(config)#aaa password-policy test-policy
Router(config-pp)#restrict-consecutive-characters english-alphabet 4
Router(config-pp)#restrict-consecutive-characters qwerty-keyboard 5
```

The keyword, **cyclic-wrap**, to restrict cyclic wrapping is an optional parameter. If configured, then the feature also restricts the cyclic wrapping of characters and numbers.

```
Router(config-pp)#restrict-consecutive-characters english-alphabet 4 cyclic-wrap
Router(config-pp)#restrict-consecutive-characters qwerty-keyboard 5 cyclic-wrap
```

Applying the password policy to the user profile:

```
Router(config)#username user1
Router(config-un)#policy test-policy
Router(config-un)#commit
```

Running Configuration

This is a sample running configuration that shows that you have configured a AAA password policy that restricts six consecutive characters from the QWERTY keyboard, and cyclic wrapping of four consecutive English alphabets.

```
Router(config-pp)#show running-config aaa password-policy
Tue May 17 10:53:16.532 UTC

!
aaa password-policy test-policy
 restrict-consecutive-characters qwerty-keyboard 6
 restrict-consecutive-characters english-alphabet 4 cyclic-wrap
!
```

Verification

You can use the **show aaa password-policy** command to know if the feature to restrict consecutive characters for user passwords and secrets is applied on the password policy.

```
Router#show aaa password-policy test-policy
Tue May 17 10:54:24.064 UTC
Password Policy Name : test-policy
  Number of Users : 0
  Minimum Length : 2
  Maximum Length : 253
  Special Character Len : 0
  Uppercase Character Len : 0
  Lowercase Character Len : 0
  Numeric Character Len : 0
  Policy Life Time :
    seconds : 0
    minutes : 0
    hours : 0
    days : 0
    months : 0
    years : 0
  Warning Interval :
    seconds : 0
    minutes : 0
    hours : 0
    days : 0
    months : 0
    years : 0
  Lockout Time :
    seconds : 0
    minutes : 0
    hours : 0
    days : 0
    months : 0
    years : 0
  Restrict Old Time :
    days : 0
    months : 0
    years : 0
  Character Change Len : 2
  Maximum Failure Attempts : 0
  Reference Count : 0
  Error Count : 0
  Lockout Count Attempts : 0
  Maximum char repetition : 0
```

```
  Restrict Old count : 0
  Restrict Username : 0
  Restrict Username Reverse  : 0
  Restrict Password Reverse  : 0
  Restrict Password Advanced : 0
  Restrict Consecutive Character :
    English Alphabet characters: 4
    English Alphabet Cyclic Wrap: True
    Qwerty Keyboard characters: 6
    Qwerty Keyboard Cyclic Wrap: False
Router#
```

Password or Secret Configuration Failure Scenarios:

You notice these logs or error messages on the router console when password or secret configuration fails because of the policy violation to restrict consecutive characters or numbers:

```
Router(config)#username user1
Router(config-un)#policy test-policy
Router(config-un)#password DEFg
Router(config-un)#commit
Tue Dec  7 10:17:56.843 UTC

% Failed to commit and rollback one or more configuration items. Please issue 'show
configuration failed [inheritance]' from this session to view the errors
Router(config-un)#show  configuration failed
username user1
 password 7 03205E0D01
!!% 'LOCALD' detected the 'fatal' condition 'Password contains consecutive characters from
 qwerty keyboard or English alphabet'
!
End
```

```
Router(config)#username user1
RP/0/RP0/CPU0:ios(config-un)#masked-secret
Fri Dec  3 12:33:44.354 UTC

Enter secret:
Re-enter secret:

secret is not compliant with policy to restrict consecutive letters or numbers
RP/0/RP0/CPU0:ios(config-un)#
```

```
Router(config)#username user1
Router(config-un)#policy test-policy
Router(config-un)#secret qwerty
                             ^
% Invalid input detected at '^' marker.
Router(config-un)#
```

YANG Data Model to Restrict Consecutive Characters for User Passwords and Secrets

You can use the **Cisco-IOS-XR-aaa-locald-cfg** native YANG data model to restrict consecutive characters for user passwords and secrets. **Cisco-IOS-XR-um-aaa-locald-cfg** is the corresponding unified model (UM). You can access the data models from the Github repository.

The following is a sample format to enable the feature using the native YANG data model.

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
 <edit-config>
```

```
 <target>
<candidate/>
</target>
 <config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
 <aaa xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-lib-cfg">
<password-policies xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-locald-cfg">
<password-policy>
     <name>test-policy</name>
     <restrict-consecutive-characters>
      <qwerty-keyboard>
       <characters>4</characters>
 <cyclic-wrap></cyclic-wrap>
      </qwerty-keyboard>
      <english-alphabet>
       <characters>4</characters>
       <cyclic-wrap></cyclic-wrap>
      </english-alphabet>
</restrict-consecutive-characters>
</password-policy>
</password-policies>
</aaa>
</config>
</edit-config>
</rpc>
##
```

To learn more about the data models and to put them to use, see the *Programmability Configuration Guide for Cisco ASR 9000 Series Routers*.

Deprecation of Type 7 password and Type 5 secret

Password configuration options before Release 24.4.1

Until Release 24.4.1, there were two options for configuring a password:

- Password: Uses Type 7 encryption to store the password.
- Secret: Supports Type 5, 8, 9, or 10 hashing algorithms to store the password securely.

Deprecation Notice

Starting from the Release 24.4.1, the use of Type 7 password and Type 5 secret are deprecated due to security concerns. The deprecation process commences from the Release 24.4.1. We expect the full deprecation in a future release. We recommend using the default option, which is Type 10 secret.

Note With the deprecation of Type 7 password encryption in Cisco IOS XR Release 24.4.1, any configuration that used Type 7 passwords will be automatically converted and saved as Type 10 secrets during the upgrade to version 24.4.1.

If you have usernames that include both a password and a secret, then:

- For the first 3000 users, the router will retain the original secret and discard the password.
- For users beyond the first 3000, the router will convert the password as Type 10 secrets by overwriting the original secret.

password

The **password** options available in the router from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config-un)#password ?
LINE The type 7 password followed by '7 ' OR SHA512-based password (deprecated, use 'secret')
```

Changes:

- All the options that were present until the Release 24.4.1are removed except LINE (to accept cleartext).
- **During upgrade**: Any configuration using the Type 7 password configuration is automatically converted to Type 10 secret.

  Post-upgrade: You can still use the Type 7 password configurations option after new commits, but the password will be stored as Type 10 secret.
- New **syslog** has been added to indicate the deprecation process:

  ```
  %SECURITY-PSLIB-4-DEPRECATED_PASSWORD_TYPE : The password configuration is deprecated.

   Converting it to a Type 10 secret for user <user name>.
  ```
- **show running configuration** command output before upgrade:

  ```
  username example
  password 7 106D000A0618
  !
  ```

  show running configuration command output post-upgrade:

  ```
  username example
  Cisco Confidential
  secret 10
  $6$P53pb/FFxNIT4b/.$yVakako4fp9PZiIYYh1xS0.W6b/yPrSyC8j4gLs6xli57iClOryPXyN9y8yojRD2nhAWb9pjr/WAIhbXqq8st.
  !
  ```

masked-password

The **masked-password** options available in CLI from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config-un)#masked-password ?
0 Specifies a cleartext password will follow
clear Config deprecated. Will be removed in 7.7.1. Specify '0' instead.
<cr> The cleartext user password
```

Changes:

- The options 7 and encrypted that were present until the Release 24.4.1 are removed.
- **During upgrade**: Any configuration using the Type 7 password configuration is automatically converted to Type 10 secret.
- **Post-upgrade**: Masked-password is an alternate method of configuring the password. You can still use the masked-password keyword with a clear string after new commits, but the password will be stored as Type 10 secret.
- New **syslog** has been added to indicate the deprecation process:

  ```
  %SECURITY-PSLIB-4-DEPRECATED_PASSWORD_TYPE : The password configuration is deprecated.

   Converting it to a Type 10 secret for user <user name>.
  ```
- **show running configuration** command output before upgrade:

```
username example
password 7 106D000A0618
!
```

show running configuration command output post-upgrade:

```
username example
Cisco Confidential
secret 10
$6$P53pb/FFxNIT4b/.$yVakako4fp9PZiIYYh1xS0.W6b/yPrSyC8j4gLs6xli57iClOryPXyN9y8yojRD2nhAWb9pjr/WAIhbXqq8st.
!
```

password-policy

The **password-policy** options available in CLI from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config-un)#password-policy ?
WORD Specify the password policy name

RP/0/RP0/CPU0:ios(config-un)#password-policy abcd password ?
0 Specifies an UNENCRYPTED password will follow
7 Specifies that an encrypted password will follow
LINE The UNENCRYPTED (cleartext) user password
clear Config deprecated. Will be removed in 7.7.1. Specify '0' instead.
encrypted Config deprecated. Will be removed in 7.7.1. Specify '7' instead.
```

Changes:

- All the options that were present until 24.4.1are removed except LINE (to accept cleartext).
- **During upgrade**: Any configuration using the Type 7 password configuration is automatically converted to Type 10 secret.

  Post-upgrade: You can still use the password-policy configurations option after new commits, but the it will be stored as Type 10 secret.
- New **syslog** has been added to indicate the deprecation process:

  ```
  %SECURITY-PSLIB-4-DEPRECATED_PASSWORD_TYPE : The password configuration is deprecated.

   Converting it to a Type 10 secret for user <username>.
  ```
- **show running configuration**f command output before upgrade:

  ```
  username example
  password-policy abcd password 7 106D000A0618
  !
  ```

  show running configuration command output post-upgrade:

  ```
  username example
  secret 10
  $6$P53pb/FFxNIT4b/.$yVakako4fp9PZiIYYh1xS0.W6b/yPrSyC8j4gLs6xli57iClOryPXyN9y8yojRD2nhAWb9pjr/WAIhbXqq8st.
  !
  !
  ```

aaa password-policy

The **aaa password-policy** options available in CLI from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config)#aaa password-policy abcd
RP/0/RP0/CPU0:ios(config-pp)#?
min-char-change Number of characters change required between old and new passwords
(deprecated, will be removed in 25.3.1)
```

```
restrict-password-advanced Advanced restrictions on new password (deprecated, will be removed
 in 25.3.1)
restrict-password-reverse Restricts the password to be same as reversed old password
(deprecated, will be removed in 25.3.1)
```

Changes:

- The options min-char-change, restrict-password-advanced, and restrict-password-reverse that were present until the Release 24.4.1 are deprecated.
- **During upgrade**: These deprecated configurations do not go through any change during upgrade.

  Post-upgrade: These deprecated keywords do not take effect when configured post-upgrade.
- New **syslog** have been added to indicate the deprecation process:

  ```
  %SECURITY-LOCALD-4-DEPRECATED_PASSWORD_POLICY_OPTION : The password policy option
  'min-char-change' is deprecated.
  Password/Secret will not be checked against this option now.
  ```

  ```
  %SECURITY-LOCALD-4-DEPRECATED_PASSWORD_POLICY_OPTION : The password policy option
  'restrict-password-reverse' is deprecated.
   Password/Secret will not be checked against this option now.
  ```

  ```
  %SECURITY-LOCALD-4-DEPRECATED_PASSWORD_POLICY_OPTION : The password policy option
  'restrict-password-advanced' is deprecated.
  Password/Secret will not be checked against this option now.
  ```
- **show running configuration** command output before upgrade:

  ```
  aaa password-policy abcd
  lower-case 3
  min-char-change 1
  restrict-password-reverse
  restrict-password-advanced
  !
  ```

  show running configuration command output post-upgrade:

  ```
  aaa password-policy abcd
  lower-case 3
  min-char-change 1
  restrict-password-reverse
  restrict-password-advanced
  !
  ```

secret

The **secret** options available in CLI from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config-un)#secret ?
0 Specifies a cleartext password will follow
10 Specifies that SHA512-based password will follow
8 Specifies that SHA256-based password will follow
9 Specifies that Scrypt-based password will follow
LINE The cleartext user password
```

```
RP/0/RP0/CPU0:ios(config-un)#secret 0 enc-type ?
<8-10> Specifies which algorithm to use. Only 8,9,10 supported [Note: Option ‘5’ is not
available to use from 24.4]
```

Changes:

- The options 5 and encrypted are removed.
- **During upgrade**: Configurations using Type 5 secret will remain unchanged.

Post-upgrade: Though the keyword 5 has been deprecated, you can still apply the existing configurations using Type 5 secret.

- New **syslog** has been added to indicate the deprecation process:

```
%SECURITY-LOCALD-2-DEPRECATED_SECRET_TYPE : Type 5 secret is deprecated.
Please use the 'secret' keyword with option type 10 for user.
```

- **show running configuration** command output before upgrade:

```
username example
secret 5 $1$kACo$2RtpcwyiRuRB/DhWzabfU1
!
!
```

show running configuration command output post-upgrade:

```
username example
secret 5 $1$kACo$2RtpcwyiRuRB/DhWzabfU1
!
!
```

masked-secret

The **masked-secret** options available in CLI from the Release 24.4.1:

```
RP/0/RP0/CPU0:ios(config-un)#masked-secret ?
0 Specifies a cleartext password will follow
Cisco Confidential
10 Specifies that SHA512-based password will follow
8 Specifies that SHA256-based password will follow
9 Specifies that Scrypt-based password will follow
clear Config deprecated. Will be removed in 7.7.1. Specify '0' instead.
<cr> The cleartext user password
```

Changes:

- The options 5 and encrypted are removed.
- **During upgrade**: Configurations using masked-secret with Type 5 will remain unchanged.

  Post-upgrade: Though the keyword 5 has been deprecated, you can still apply the existing configurations using Type 5 masked secret.

- New **syslog** has been added to indicate the deprecation process:

```
%SECURITY-LOCALD-2-DEPRECATED_SECRET_TYPE : Type 5 secret is deprecated.
Please use the 'secret' keyword with option type 10 for user.
```

- **show running configuration** command output before upgrade:

```
username example
secret 5 $1$kACo$2RtpcwyiRuRB/DhWzabfU1
!
!
```

show running configuration command output post-upgrade:

```
username example
secret 5 $1$kACo$2RtpcwyiRuRB/DhWzabfU1
!
!
```

Special use cases

Use case 1: Configurations using both Type 7 password and secret with 8, 9, or 10 hashing, for the same user

- **During upgrade**:
  - For the first 3000 username configurations, the password configuration will be rejected, and the secret configuration will remain unchanged.
  - For the rest of the username configurations, the original secret configuration will be rejected, and the password will be converted to Type 10 secret.
- **Post-upgrade**:
  - For a new username configured, or the username that is already present before the upgrade, the password configuration will be rejected.
  - New **syslog** has been added to indicate the deprecation process:

    ```
    %SECURITY-PSLIB-4-SECRET_CONFIG_PRESENT : The password configuration is deprecated.

    Once secret is configured, cannot use password config for user <user name> at index
     <x> now.
    ```

    where 'x' is a number representing the index.

Use case 2: Configurations using both Type 7 password and Type 5 secret, for the same user

- **During upgrade**:
  - For any username configuration, the original Type 5 secret configuration will be rejected, and the password will be converted to Type 10 secret.
- **Post-upgrade**:
  - For a new username configured, or the username that is already present before the upgrade, the password configuration will be converted to Type 10 secret.
  - New **syslog** has been added to indicate the deprecation process:

    ```
    %SECURITY-PSLIB-4-DEPRECATED_PASSWORD_TYPE : The password configuration is
    deprecated.
     Converting it to a Type 10 secret for user <username>.
    ```

Configuring Router to RADIUS Server Communication

This task configures router to RADIUS server communication.

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

- Hostname or IP address
- Authentication destination port
- Accounting destination port

- Retransmission value
- Timeout period
- Key string

RADIUS security servers are identified on the basis of their hostname or IP address, hostname and specific User Datagram Protocol (UDP) port numbers, or IP address and specific UDP port numbers. The combination of the IP address and UDP port numbers creates a unique identifier, allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. In other words, this unique identifier enables RADIUS requests to be sent to multiple UDP ports on a server at the same IP address. If two different host entries on the same RADIUS server are configured for the same service—for example, accounting—the second host entry configured acts as an automatic switchover backup to the first one. Using this example, if the first host entry fails to provide accounting services, the network access server tries the second host entry configured on the same device for accounting services. (The RADIUS host entries are tried in the order they are configured.)

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

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

You can configure a maximum of 30 global RADIUS servers.

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

SUMMARY STEPS

1. **configure**
2. **radius-server host** {*hostname* | *ip address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*]
3. **radius-server retransmit** *retries*
4. **radius-server timeout** *seconds*
5. **radius-server key** {**0** *clear-text-key* | **7** *encrypted-key* | *clear-text-key*}
6. **radius source-interface** *type instance* [**vrf** *vrf-id*]
7. Repeat Step 2, on page 59 through Step 6, on page 60 for each external server to be configured.
8. Use the **commit** or **end** command.
9. show radius

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**radius-server host** {*hostname* | *ip address*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*] **Example:** Specifying a radius server hostname `RP/0/RSP0/CPU0:router(config)# radius-server host host1`	Specifies the hostname or IP address of the remote RADIUS server host. . • Use the **auth-port** *port-number* option to configure a specific UDP port on this RADIUS server to be used solely for authentication. • Use the **acct-port** *port-number* option to configure a specific UDP port on this RADIUS server to be used solely for accounting. • To configure the network access server to recognize more than one host entry associated with a single IP address, simply repeat this command as many times as necessary, making sure that each UDP port number is different. Set the timeout, retransmit, and encryption key values to use with the specific RADIUS host. • If no timeout is set, the global value is used; otherwise, enter a value in the range 1 to 1000. If no retransmit value is set, the global value is used; otherwise enter a value in the range 1 to 100. If no key string is specified, the global value is used. **Note** The key is a text string that must match t the key as the last item in the **radius-ser** but spaces within and at the end of the k quotation marks unless the quotation ma
Step 3	**radius-server retransmit** *retries* **Example:** `RP/0/RSP0/CPU0:router(config)# radius-server retransmit 5`	Specifies the number of times the Cisco IOS XR software searches the list of RADIUS server hosts before giving up. • In the example, the number of retransmission attempts is set to 5.
Step 4	**radius-server timeout** *seconds* **Example:**	Sets the number of seconds a router waits for a server host to reply before timing out. • In the example, the interval timer is set to 10 seconds.

	Command or Action	Purpose
	RP/0/RSP0/CPU0:router(config)# radius-server timeout 10	
Step 5	**radius-server key** {**0** *clear-text-key* | **7** *encrypted-key* | *clear-text-key*} **Example:** RP/0/RSP0/CPU0:router(config)# radius-server key 0 samplekey	Sets the authentication and encryption key for all RADIUS communications between the router and the RADIUS daemon.
Step 6	**radius source-interface** *type instance* [**vrf** *vrf-id*] **Example:** RP/0/RSP0/CPU0:router(config)# radius source-interface GigabitEthernet 0/3/0/1	(Optional) Forces RADIUS to use the IP address of a specified interface or subinterface for all outgoing RADIUS packets. • The specified interface or subinterface must have an IP address associated with it. If the specified interface or subinterface does not have an IP address or is in the down state, then RADIUS reverts to the default. To avoid this, add an IP address to the interface or subinterface or bring the interface to the up state. The **vrf** keyword enables the specification on a per-VRF basis.
Step 7	Repeat Step 2, on page 59 through Step 6, on page 60 for each external server to be configured.	—
Step 8	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 9	show radius **Example:** RP/0/RSP0/CPU0:router# show radius	(Optional) Displays information about the RADIUS servers that are configured in the system.

What to do next

After configuring router to RADIUS server communication, configure RADIUS server groups. (See the Configuring RADIUS Server Groups, on page 67 section.)

Configuring RADIUS Dead-Server Detection

This task configures the RADIUS Dead-Server Detection feature.

The RADIUS Dead-Server Detection feature lets you configure and determine the criteria that is used to mark a RADIUS server as dead. If no criteria is explicitly configured, the criteria is computed dynamically on the basis of the number of outstanding transactions. The RADIUS dead-server detection configuration results in the prompt detection of RADIUS servers that have stopped responding. The prompt detection of nonresponding RADIUS servers and the avoidance of swamped and dead-to-live-to-dead-again servers result in less deadtime and quicker packet processing.

You can configure the minimum amount of time, in seconds, that must elapse from the time that the router last received a valid packet from the RADIUS server to the time the server is marked as dead. If a packet has not been received since the router booted, and there is a timeout, the time criterion is treated as though it was met.

In addition, you can configure the number of consecutive timeouts that must occur on the router before the RADIUS server is marked as dead. If the server performs both authentication and accounting, both types of packets are included in the number. Improperly constructed packets are counted as though they are timeouts. Only retransmissions are counted, not the initial transmission. For example, each timeout causes one retransmission to be sent.



Note Both the time criterion and the tries criterion must be met for the server to be marked as dead.

The **radius-server deadtime** command specifies the time, in minutes, for which a server is marked as dead, remains dead, and, after this period, is marked alive even when no responses were received from it. When the dead criteria are configured, the servers are not monitored unless the **radius-server deadtime** command is configured

SUMMARY STEPS

1. **configure**
2. **radius-server deadtime** *minutes*
3. **radius-server dead-criteria time** *seconds*
4. **radius-server dead-criteria tries** *tries*
5. Use the **commit** or **end** command.
6. **show radius dead-criteria host** *ip address in IPv4 or IPv6 format* [**auth-port** *auth-port*] [**acct-port** *acct-port*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.

	Command or Action	Purpose
Step 2	**radius-server deadtime** *minutes* **Example:** `RP/0/RSP0/CPU0:router(config)# radius-server deadtime 5`	Improves RADIUS response times when some servers might be unavailable and causes the unavailable servers to be skipped immediately.
Step 3	**radius-server dead-criteria time** *seconds* **Example:** `RP/0/RSP0/CPU0:router(config)# radius-server dead-criteria time 5`	Establishes the time for the dead-criteria conditions for a RADIUS server to be marked as dead.
Step 4	**radius-server dead-criteria tries** *tries* **Example:** `RP/0/RSP0/CPU0:router(config)# radius-server dead-criteria tries 4`	Establishes the number of tries for the dead-criteria conditions for a RADIUS server to be marked as dead.
Step 5	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 6	**show radius dead-criteria host** *ip address in IPv4 or IPv6 format* [**auth-port** *auth-port*] [**acct-port** *acct-port*] **Example:** `RP/0/RSP0/CPU0:router# show radius dead-criteria host 172.19.192.80`	(Optional) Displays dead-server-detection information that has been requested for a RADIUS server at the specified IP address.

Configuring Per VRF AAA

The Per VRF AAA functionality enables AAA services to be based on VPN routing and forwarding (VRF) instances. The Provider Edge (PE) or Virtual Home Gateway (VHG) communicates directly with the customer's RADIUS server, which is associated with the customer's VPN, without having to go through a RADIUS proxy. Thus, ISPs can scale their VPN offerings more efficiently, because they no longer have to use RADIUS proxies and they can provide their customers with the flexibility they demand.

New Vendor-Specific Attributes (VSAs)

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific information between the network access server and the RADIUS server by using the vendor-specific attribute (attribute 26). Attribute 26 encapsulates vendor-specific attributes, thereby, allowing vendors to support their own extended attributes otherwise not suitable for general use.

The Cisco IOS XR software RADIUS implementation supports one vendor-specific option using the format recommended in the specification. Cisco's vendor-ID is 9, and the supported option has vendor-type 1, which is named “cisco-avpair ” The value is a string of the following format:

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

“Protocol” is a value of the Cisco “protocol ” attribute for a particular type of authorization. “Attribute” and “value” are an appropriate attribute-value (AV) pair defined in the Cisco RADIUS specification, and “sep” is “=” for mandatory attributes and “*” for optional attributes.

This table describes the VSAs that are now supported for Per VRF AAA.

Table 8: Supported VSAs for Per VRF AAA

VSA Name	Value Type	Description
Note The RADIUS VSAs—rad-serv, rad-serv-source-if, and rad-serv-vrf—must have the prefix “aaa:” before the VSA name.		

rad-serv	string	Indicates the IP address in IPv4 or IPv6 format, key, timeout, and retransmit number of a server and the group of the server.
		The VSA syntax follows:
		`rad-serv=a.b.c.d [key SomeKey] [auth-port X] [acct-port Y]`
		`[retransmit V] [timeout W].`
		Other than the IP address, all parameters are optional and are issued in any order. If the optional parameters are not specified, their default values are used.
		The key cannot contain any spaces; for “retransmit V,” “V” can range from 1 to 100; for “timeout W,” the “W” can range from 1 to 1000.

rad-serv-vrf	string	Specifies the name of the VRF that is used to transmit RADIUS packets. The VRF name matches the name that was specified through the **vrf** command.

This task configures RADIUS server groups per VRF. For information about configuring TACACS+ server groups per VRF, refer Configuring TACACS+ Server Groups, on page 70.

SUMMARY STEPS

1. **configure**
2. **aaa group server radius** *group-name*
3. **server-private** {*hostname* | *ip-address in IPv4 or IPv6 format*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*]

4. **vrf** *vrf-name*
5. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.

Step 2	**aaa group server radius** *group-name*
	Example:
	`RP/0/RSP0/CPU0:router(config)# aaa group server radius radgroup1`
	`RP/0/RSP0/CPU0:router(config-sg-radius)#`
		Groups different server hosts into distinct lists and enters the server group configuration mode.

Step 3	**server-private** {*hostname* | *ip-address in IPv4 or IPv6 format*} [**auth-port** *port-number*] [**acct-port** *port-number*] [**timeout** *seconds*] [**retransmit** *retries*] [**key** *string*]
	Example:
	IP address in IPv4 format
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server-private 10.1.1.1 timeout 5`
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server-private 10.2.2.2 retransmit 3`
	Example:
	IP address in IPv6 format
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server-private 2001:db8:a0b:12f0::1/64 timeout 5`
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server-private 10.2.2.2 retransmit 3`
		Configures the IP address of the private RADIUS server for the group.
		If private server parameters are not specified, global configurations are used. If global configurations are not specified, default values are used.
		Both **auth-port** and **acct-port** keywords enter RADIUS server-group private configuration mode.
		You can configure a maximum of 30 private servers per RADIUS server group.

Step 4	**vrf** *vrf-name* **Example:** `RP/0/RSP0/CPU0:router(config-sg-radius)# vrf v2.44.com`	Configures the VRF reference of an AAA RADIUS server group. **Note** Private server IP addresses can overlap with distinguish them.
Step 5	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions:

	Command or Action	Purpose
		• **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring a TACACS+ Server

This task configures a TACACS+ server.

The port, if not specified, defaults to the standard port number, 49. The **timeout** and **key** parameters can be specified globally for all TACACS+ servers. The **timeout** parameter specifies how long the AAA server waits to receive a response from the TACACS+ server. The **key** parameter specifies an authentication and encryption key shared between the AAA server and the TACACS+ server.

The **single-connection** parameter specifies to multiplex all TACACS+ requests to the TACACS+ server over a single TCP connection. The **single-connection-idle-timeout** parameter specifies the timeout value for this single connection.

You can configure a maximum of 30 global TACACS+ servers.

SUMMARY STEPS

1. **configure**
2. **tacacs-server host** *host-name* **port** *port-number*
3. **tacacs-server host** *host-name* **timeout** *seconds*
4. **tacacs-server host** *host-name* **key** [**0** | **7**] *auth-key*
5. **tacacs-server host** *host-name* **single-connection**
6. **tacacs-server host** *host-name* **single-connection-idle-timeout** *timeout-in-seconds*
7. **tacacs source-interface** *type instance* **vrf** *vrf-name*
8. Repeat step 2 through step 6 for each external server to be configured.
9. Use the **commit** or **end** command.
10. **show tacacs**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.

	Command or Action	Purpose

Step 2	**tacacs-server host** *host-name* **port** *port-number*
	Example:
	`RP/0/RSP0/CPU0:router(config)# tacacs-server host 209.165.200.226 port 51`
	`RP/0/RSP0/CPU0:router(config-tacacs-host)#`
		Specifies a TACACS+ host server and optionally specifies a server port number.
		• This option overrides the default, port 49. Valid port numbers range from 1 to 65535.

Step 3	**tacacs-server host** *host-name* **timeout** *seconds*
	Example:
	`RP/0/RSP0/CPU0:router(config-tacacs-host)# tacacs-server host 209.165.200.226 timeout 30`
	`RP/0/RSP0/CPU0:router(config)#`
		Specifies a TACACS+ host server and optionally specifies a timeout value that sets the length of time the AAA server waits to receive a response from the TACACS+ server.
		• This option overrides the global timeout value set with the **tacacs-server timeout** command for only this server. The timeout value is expressed as an integer in terms of timeout interval seconds. The range is from 1 to 1000.

Step 4	**tacacs-server host** *host-name* **key** [**0** | **7**] *auth-key* **Example:** `RP/0/RSP0/CPU0:router(config)# tacacs-server host 209.165.200.226 key 0 a_secret`	Specifies a TACACS+ host server and optionally specifies an authentication and encryption key shared between the AAA server and the TACACS+ server. • The TACACS+ packets are encrypted using this key. This key must match the key used by TACACS+ daemon. Specifying this key overrides the global key set by the **tacacs-server key** command for only this server. • (Optional) Entering **0** indicates that an unencrypted (clear-text) key follows. • (Optional) Entering **7** indicates that an encrypted key follows. • The *auth-key* argument specifies the encrypted or unencrypted key to be shared between the AAA server and the TACACS+ server.
Step 5	**tacacs-server host** *host-name* **single-connection** **Example:** `RP/0/RSP0/CPU0:router(config)# tacacs-server host 209.165.200.226 single-connection`	Prompts the router to multiplex all TACACS+ requests to this server over a single TCP connection. By default, a separate connection is used for each session.
Step 6	**tacacs-server host** *host-name* **single-connection-idle-timeout** *timeout-in-seconds* **Example:** `RP/0/0RP0RSP0/CPU0:router:hostname(config)# tacacs-server host 209.165.200.226 single-connection-idle-timeout 60`	Sets the idle timeout value, in seconds, for the single TCP connection (that is created by configuring the **single-connection** command) to the TACACS+ server. The range is: • 500 to 7200 (prior to Cisco IOS XR Software Release 6.8.1 (for 32-bit Cisco IOS XR routers) and Release 7.3.2/ Release 7.4.1 (for 64-bit Cisco IOS XR routers))

	Command or Action	Purpose
		• 5 to 7200 (starting from Cisco IOS XR Software Release 6.8.1 (for 32-bit Cisco IOS XR routers) and Release 7.3.2/ Release 7.4.1 (for 64-bit Cisco IOS XR routers))
Step 7	**tacacs source-interface** *type instance* **vrf** *vrf-name* **Example:** `RP/0/RSP0/CPU0:router(config)# tacacs source-interface GigabitEthernet 0/4/0/0 vrf abc`	(Optional) Specifies the source IP address of a selected interface for all outgoing TACACS+ packets. • The specified interface or subinterface must have an IP address associated with it. If the specified interface or subinterface does not have an IP address or is in the down state, then TACACS+ reverts to the default interface. To avoid this, add an IP address to the interface or subinterface or bring the interface to the up state. • The **vrf** option specifies the Virtual Private Network (VPN) routing and forwarding (VRF) reference of an AAA TACACS+ server group.
Step 8	Repeat step 2 through step 6 for each external server to be configured.	—
Step 9	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 10	**show tacacs** **Example:** `RP/0/RSP0/CPU0:router# show tacacs`	(Optional) Displays information about the TACACS+ servers that are configured in the system.

What to do next

After configuring TACACS+ servers, configure TACACS+ server groups. (See the Configuring TACACS+ Server Groups, on page 70 section.)

Configuring RADIUS Server Groups

This task configures RADIUS server groups.

The user can enter one or more **server** commands. The **server** command specifies the hostname or IP address of an external RADIUS server along with port numbers. When configured, this server group can be referenced from the AAA method lists (used while configuring authentication, authorization, or accounting). (See the Method Lists, on page 10 section.)

You can configure:

- Maximum 30 globally configured RADIUS server definitions.
- Maximum 30 RADIUS server groups (1global + 29 named groups) can be configured.
- Maximum 5 references to globally configured RADIUS servers in one named group.
- Maximum 30 private RADIUS servers in one named group.

Note The server and server-private limits are independent. Private servers do not consume the five-server limit for globally configured RADIUS server references.

Before you begin

For configuration to succeed, the external server should be accessible at the time of configuration.

SUMMARY STEPS

1. **configure**
2. **aaa group server radius** *group-name*
3. **server** {*hostname* | *ip address in IPv4 or IPv6 format*} [**auth-port** *port-number*] [**acct-port** *port-number*]
4. Repeat Step 4, on page 69 for every external server to be added to the server group named in Step 3, on page 69.
5. **deadtime** *minutes*
6. Use the **commit** or **end** command.
7. **show radius server-groups** [*group-name* [**detail**]]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**aaa group server radius** *group-name* **Example:** `RP/0/RSP0/CPU0:router(config)# aaa group server radius radgroup1`	Groups different server hosts into distinct lists and enters the server group configuration mode.

	Command or Action	Purpose

Step 3	**server** {*hostname* | *ip address in IPv4 or IPv6 format*} [**auth-port** *port-number*] [**acct-port** *port-number*]
	Example:
	IP address in IPv4 format
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server 192.168.20.0`
	Example:
	IP address in IPv6 format
	`RP/0/RSP0/CPU0:router(config-sg-radius)# server 2001:db8:a0b:12f0::1/64`
		Specifies the hostname or IP address of an external RADIUS server.
		• After the server group is configured, it can be referenced from the AAA method lists (used while configuring authentication, authorization, or accounting).

Step 4	Repeat Step 4, on page 69 for every external server to be added to the server group named in Step 3, on page 69.	—
Step 5	**deadtime** *minutes* **Example:** `RP/0/RSP0/CPU0:router(config-sg-radius)# deadtime 1`	Configures the deadtime value at the RADIUS server group level. • The *minutes* argument specifies the length of time, in minutes, for which a RADIUS server is skipped over by transaction requests, up to a maximum of 1440 (24 hours). The range is from 1 to 1440. The example specifies a one-minute deadtime for RADIUS server group radgroup1 when it has failed to respond to authentication requests for the **deadtime** command **Note** You can configure the group-level deadt
Step 6	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 7	**show radius server-groups** [*group-name* [**detail**]] **Example:** `RP/0/RSP0/CPU0:router# show radius server-groups`	(Optional) Displays information about each RADIUS server group that is configured in the system.

What to do next

After configuring RADIUS server groups, define method lists by configuring authentication, authorization, and accounting. (See the Configuring AAA Method Lists, on page 77 section.)

Configuring TACACS+ Server Groups

This task configures TACACS+ server groups.

You can enter one or more **server** commands. The **server** command specifies the hostname or IP address of an external TACACS+ server. Once configured, this server group can be referenced from the AAA method lists (used while configuring authentication, authorization, or accounting). (See the Method Lists, on page 10 section.)

Before you begin

For successful configuration, the external server should be accessible at the time of configuration. When configuring the same IP address for global and vrf configuration, server-private parameters are required.

SUMMARY STEPS

1. **configure**
2. **aaa group server tacacs+** *group-name*
3. **server** {*hostname* | *ip address in IPv4 or IPv6 format*}
4. Repeat Step 3, on page 70 for every external server to be added to the server group named in Step 2, on page 70.
5. **server-private** {*hostname* | *ip-address in IPv4 or IPv6 format*} [**port** *port-number*] [**timeout** *seconds*] [**key** *string*]
6. **vrf** *vrf-name*
7. Use the **commit** or **end** command.
8. **show tacacs server-groups**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**aaa group server tacacs+** *group-name* **Example:** `RP/0/RSP0/CPU0:router(config)# aaa group server tacacs+ tacgroup1`	Groups different server hosts into distinct lists and enters the server group configuration mode.
Step 3	**server** {*hostname*	*ip address in IPv4 or IPv6 format*} **Example:**	Specifies the hostname or IP address of an external TACACS+ server.

	Command or Action	Purpose
	IP address in IPv4 format `RP/0/RSP0/CPU0:router(config-sg-tacacs+)# server 192.168.100.0`	• When configured, this group can be referenced from the AAA method lists (used while configuring authentication, authorization, or accounting).
Step 4	Repeat Step 3, on page 70 for every external server to be added to the server group named in Step 2, on page 70.	—
Step 5	**server-private** {*hostname* | *ip-address in IPv4 or IPv6 format*} [**port** *port-number*] [**timeout** *seconds*] [**key** *string*] **Example:** `RP/0/RSP0/CPU0:router(config-sg-tacacs+)# server-private 10.1.1.1 key a_secret`	Configures the IP address of the private TACACS+ server for the group server. **Note** • You can configure a maximum of 1 • You can configure a maximum of 1 • If private server parameters are not are not specified, default values are
Step 6	**vrf** *vrf-name* **Example:** `RP/0/RSP0/CPU0:router(config-sg-tacacs+)# vrf abc`	Specifies the Virtual Private Network (VPN) routing and forwarding (VRF) reference of an AAA TACACS+ server group.
Step 7	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 8	**show tacacs server-groups** **Example:** `RP/0/RSP0/CPU0:router# show tacacs server-groups`	(Optional) Displays information about each TACACS+ server group that is configured in the system.

What to do next

After configuring TACACS+ server groups, define method lists used by configuring authentication, authorization, and accounting. (See the Configuring AAA Method Lists, on page 77 section.)

Configure Per VRF TACACS+ Server Groups

The Cisco IOS XR software supports per VRF AAA to be configured on TACACS+ server groups. You must use the **server-private** and **vrf** commands as listed below to configure this feature.

The global server definitions can be referred from multiple server groups, but all references use the same server instance and connect to the same server. In case of VRF, you do not need the global configuration because the server status, server statistics and the key could be different for different VRFs. Therefore, you must use the server-private configuration if you want to configure per VRF TACACS+ server groups. If you have the same server used in different groups with different VRFs, ensure that it is reachable through all those VRFs.

If you are migrating the servers to a VRF, then it is safe to remove the global server configuration with respect to that server.

Prerequisites

You must ensure these before configuring per VRF on TACACS+ server groups:

- Be familiar with configuring TACACS+, AAA, per VRF AAA, and group servers.
- Ensure that you have access to the TACACS+ server.
- Configure the VRF instance before configuring the specific VRF for a TACACS+ server and ensure that the VRF is reachable.

Configuration Example

```
Router#configure

/* Groups different server hosts into distinct lists and enters the server group configuration
 mode.
You can enter one or more server commands. The server command specifies the hostname or IP
 address of an external TACACS+ server.
Once configured, this server group can be referenced from the AAA method lists (used while
 configuring authentication, authorization, or accounting). */

Router(config)# aaa group server tacacs+ tacgroup1

/* Configures the IP address and the secret key of the private TACACS+ server that is
reachable through specific VRF.
You can have multiple such server configurations which are reachable through the same VRF.*/

Router(config-sg-tacacs+)# server-private 10.1.1.1 port 49 key a_secret

/* The vrf option specifies the VRF reference of a AAA TACACS+ server group */
Router(config-sg-tacacs+)# vrf test-vrf
Router(config-sg-tacacs+)# commit
```

Running Configuration

```
aaa group server tacacs+ tacgroup1
 vrf test-vrf
 server-private 10.1.1.1 port 49
  key 7 0822455D0A16
 !
 server-private 10.1.1.2 port 49
```

```
 key 7 05080F1C2243
!
server-private 2001:db8:1::1 port 49
 key 7 045802150C2E
!
server-private 2001:db8:1::2 port 49
 key 7 13061E010803
!
!
```

Verify Per VRF TACACS+ Server Groups

```
Router#show tacacs
Fri Sep 27 11:14:34.991 UTC

Server: 10.1.1.1/49 vrf=test-vrf [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv4

Server: 10.1.1.2/49 vrf=test-vrf [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv4

Server: 2001:db8:1::1/49 vrf=test-vrf [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv6

Server: 2001:db8:1::2/49 vrf=test-vrf [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv6
```

Associated Commands

- **server-private**
- **vrf**

View TACACS+ information in Router

Table 9: Feature History Table

Feature Name	Release Information	Feature Description
View TACACS+ information in Router	Release 7.5.4	With this feature, you can view TCP connection statistics like failures, timeout, and disconnect in connections, number of AAA packets received from an external server or sent to an external server, and so on during TACACS+ transactions. This information helps you monitor TACACS+ health in the routers. It is also helpful in identifying and debugging TACACS+ transaction failures if any. This feature introduces the following commands: • **show tacacs counters** • **show tacacs details** • **show tacacs source-interface** • **clear tacacs counters**

You can see the record of the number of requests, timeouts, failures, errors, and success for each TACACS+ server for all the AAA services using the following:

```
Router:ios# show tacacs counters

TACACS+ Server:   10.105.236.101/4010 [global]

  Authentication:
   10 requests, 4 accepts, 3 failure, 2 error, 1 timeout

  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   6 requests, 6 accepts, 0 denied, 0 error, 0 timeout

  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   6 requests, 6 accepts, 0 fail, 0 error, 0 timeout

TACACS+ Server:   10.105.236.101/2201 [private] vrf = default

  Authentication:
   0 requests, 0 accepts, 0 failure, 0 error, 0 timeout
```

```
  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout
```

You can view the complete TACACS+ statistics including server group, source-interface, individual server statistics, inpacket, outpacket, connection open and connection close counters, and TCP connection related counters using the following:

```
Router:ios# show tacacs details

TACACS+ Server                                                  : 10.105.236.101/4010
[Global]
    Family                                                      : IPv4
    Timeout(in secs)                                            : 3
    Connection Opens                                            : 8
    Connection Closes                                           : 8
    Requests sent                                               : 6
    Response received                                           : 6
    Packets Abort                                               : 2
    Server State                                                : Down
    Server On-Hold                                              : True
    Tacacs-Single-Connect                                       : False
    Tacacs-Single-Connect-Idle-Timeout(in secs)                 : 0
    Last Connection Attempted                                   : 08:32:43 UTC Tue Aug
02 2022


TACACS+ Server                                                  : 10.105.236.101/8010
[Private] vrf=default
    Family                                                      : IPv4
    Timeout(in secs)                                            : 3
    Connection Opens                                            : 8
    Connection Closes                                           : 7
    Requests sent                                               : 7
    Response received                                           : 7
    Packets Abort                                               : 0
    Server State                                                : Up
    Server On-Hold                                              : False
    Tacacs-Single-Connect                                       : False
    Tacacs-Single-Connect-Idle-Timeout(in secs)                 : 0
    Last Connection Attempted                                   : 08:32:52 UTC Tue Aug
02 2022


TACACS+ Server-groups:

Global list of servers
    Server 10.105.236.101/4010 family=IPv4

Server group 'tac1' has 1 servers
    Servers in this group are under 'default' vrf
    Server 10.105.236.101/8010 [private] family=IPv4

TACACS+ Source-Interface:

Interface                                               VRF Id
```

```
IPV4-Address

GigabitEthernet0/0/0/0                                  0x60000001
0.0.0.0
MgmtEth0/RP0/CPU0/0                                     0x60000000
192.168.122.222


Interface                                                VRF Id
IPV6-Address

GigabitEthernet0/0/0/0                                   0x60000001
 ::
MgmtEth0/RP0/CPU0/0                                      0x60000000
 ::
```

You can view the TACACS+ source interface details using the following:

```
Router:ios# show tacacs source-interfaces

Interface                                                VRF Id
IPV4-Address

MgmtEth0/RP0/CPU0/0                                     0x60000000
192.168.122.222

Interface                                                VRF Id
IPV6-Address

MgmtEth0/RP0/CPU0/0                                     0x60000000
::
```

You can clear all AAA services counters in **show tacacs counters** command for all TACACS+ servers using the command:

```
Router:ios# show tacacs counters

TACACS+ Server:   10.105.236.101/4010 [global]

  Authentication:
   10 requests, 4 accepts, 3 failure, 2 error, 1 timeout

  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   6 requests, 6 accepts, 0 denied, 0 error, 0 timeout

  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   6 requests, 6 accepts, 0 fail, 0 error, 0 timeout

TACACS+ Server:   10.105.236.101/2201 [private] vrf = default

  Authentication:
   0 requests, 0 accepts, 0 failure, 0 error, 0 timeout

  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout
```

```
  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

Router:ios# clear tacacs counters
Router:ios# show tacacs counters

TACACS+ Server:   10.105.236.101/4010 [global]

  Authentication:
   0 requests, 0 accepts, 0 failure, 0 error, 0 timeout

  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

TACACS+ Server:   10.105.236.101/2201 [private] vrf = default

  Authentication:
   0 requests, 0 accepts, 0 failure, 0 error, 0 timeout

  Exec Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Command Authorization:
   0 requests, 0 accepts, 0 denied, 0 error, 0 timeout

  Exec Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout

  Command Accounting:
   0 requests, 0 accepts, 0 fail, 0 error, 0 timeout
```

Configuring AAA Method Lists

AAA data may be stored in a variety of data sources. AAA configuration uses *method lists* to define an order of preference for the source of AAA data. AAA may define more than one method list and applications (such as login) can choose one of them. For example, console and aux ports may use one method list and the vty ports may use another. If a method list is not specified, the application tries to use a default method list.

This section contains the following procedures:

Configuring Authentication Method Lists

This task configures method lists for authentication.

Authentication Configuration

Authentication is the process by which a user (or a principal) is verified. Authentication configuration uses *method lists* to define an order of preference for the source of AAA data, which may be stored in a variety of

data sources. You can configure authentication to define more than one method list and applications (such as login) can choose one of them. For example, console and aux ports may use one method list and the vty ports may use another. If a method list is not specified, the application tries to use a default method list.

Note Applications should explicitly refer to defined method lists for the method lists to be effective.

The authentication can be applied to tty lines through use of the **login authentication** line configuration submode command.

Creation of a Series of Authentication Methods

Use the **aaa authentication** command to create a series of authentication methods, or method list. A method list is a named list describing the authentication methods to be used (such as RADIUS or TACACS+), in sequence. The method will be one of the following:

- group radius—Use a server group or RADIUS servers for authentication
- group tacacs+—Use a server group or TACACS+ servers for authentication
- local—Use the local username or password database for authentication
- line—Use the line password or user group for authentication

If the method is RADIUS or TACACS+ servers, rather than server group, the RADIUS or TACACS+ server is chosen from the global pool of configured RADIUS and TACACS+ servers, in the order of configuration. Servers from this global pool are the servers that can be selectively added to a server group.

The subsequent methods of authentication are used only if the initial method returns an error, not if the request is rejected.

Before you begin

Note The default method list is applied for all the interfaces for authentication, except when a non-default named method list is explicitly configured, in which case the named method list is applied.

The **group radius, group tacacs+**, and **group** *group-name* forms of the **aaa authentication** command refer to a set of previously defined RADIUS or TACACS+ servers. Use the **radius server-host or tacacs-server host** command to configure the host servers. Use the **aaa group server radius or aaa group server tacacs+** command to create a named group of servers.

SUMMARY STEPS

1. **configure**
2. **aaa authentication** {**login | ppp**} {**default** | *list-name* **| remote**} *method-list*
3. Use the **commit** or **end** command.
4. Repeat Step 1 through Step 3 for every authentication method list to be configured.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**aaa authentication** {**login** | **ppp**} {**default** | *list-name* | **remote**} *method-list* **Example:** `RP/0/RSP0/CPU0:router(config)# aaa authentication login default group tacacs+`	Creates a series of authentication methods, or a method list. • Using the **login** keyword sets authentication for login. Using the **ppp** keyword sets authentication for Point-to-Point Protocol. • Entering the **default** keyword causes the listed authentication methods that follow this keyword to be the default list of methods for authentication. • Entering a *list-name* character string identifies the authentication method list. • Entering the **remote** keyword causes the listed authentication methods that follow this keyword to be the default list of methods for administrative authentication on a remote non-owner SDR. **Note** The remote keyword is available only c • Entering a *method-list* argument following the method list type. Method list types are entered in the preferred sequence. The listed method types are any one of the following options: • **group tacacs+**—Use a server group or TACACS+ servers for authentication • **group radius**—Use a server group or RADIUS servers for authentication • **group** *named-group*—Use a named subset of TACACS+ or RADIUS servers for authentication • **local**—Use a local username or password database for authentication • **line**—Use line password or user group for authentication

	Command or Action	Purpose
		• The example specifies the **default** method list to be used for authentication.
Step 3	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.
Step 4	Repeat Step 1 through Step 3 for every authentication method list to be configured.	—

What to do next

After configuring authentication method lists, configure authorization method lists. (See the Configuring Authorization Method Lists, on page 80 section).

Configuring Authorization Method Lists

This task configures method lists for authorization.

Note You can configure the **radius** keyword for the **aaa authorization** command.

Authorization Configuration

Method lists for authorization define the ways authorization will be performed and the sequence in which these methods will be performed. A method list is a named list describing the authorization methods to be used (such as TACACS+), in sequence. Method lists enable you to designate one or more security protocols to be used for authorization, thus ensuring a backup system if the initial method fails. The software uses the first method listed to authorize users for specific network services; if that method fails to respond, the software selects the next method listed in the method list. This process continues until there is successful communication with a listed authorization method, or until all methods defined have been exhausted.

Note The software attempts authorization with the next listed method only when there is no response or an error response (not a failure) from the previous method. If authorization fails at any point in this cycle—meaning that the security server or local username database responds by denying the user services—the authorization process stops and no other authorization methods are attempted.

Method lists are specific to the type of authorization being requested. Four types of AAA authorization are supported:

- **Commands authorization—**Applies to the EXEC mode mode commands a user issues. Command authorization attempts authorization for all EXEC mode mode commands.

Note "Command" authorization is distinct from "task-based" authorization, which is based on the task profile established during authentication.

- **EXEC mode authorization—**Applies authorization for starting EXEC mode session.
- **Network authorization—**Applies authorization for network services, such as IKE.
- **Eventmanager authorization—**Applies an authorization method for authorizing an event manager (fault manager). RADIUS servers are not allowed to be configured for the event manager (fault manager) authorization. You are allowed to use TACACS+ or locald.

When you create a named method list, you are defining a particular list of authorization methods for the indicated authorization type. When defined, method lists must be applied to specific lines or interfaces before any of the defined methods are performed. Do not use the names of methods, such as TACACS+, when creating a new method list.

"Command" authorization, as a result of adding a command authorization method list to a line template, is separate from, and is in addition to, "task-based" authorization, which is performed automatically on the router. The default behavior for command authorization is none. Even if a default method list is configured, that method list has to be added to a line template for it to be used.

The **aaa authorization commands** command causes a request packet containing a series of attribute value (AV) pairs to be sent to the TACACS+ daemon as part of the authorization process. The daemon can do one of the following:

- Accept the request as is.
- Refuse authorization.

Note To avoid lockouts in user authorization, make sure to allow local fallback (by configuring the **local** option for **aaa authorization** command) when configuring AAA. For example, **aaa authorization commands default tacacs+ local**.

Creation of a Series of Authorization Methods

Use the **aaa authorization** command to set parameters for authorization and to create named method lists defining specific authorization methods that can be used for each line or interface.

The Cisco IOS XR software supports the following methods for authorization:

- **none—**The router does not request authorization information; authorization is not performed over this line or interface.
- **local—**Uses local database for authorization.

- **group tacacs+—**Uses the list of all configured TACACS+ servers for authorization.
- **group radius—**Uses the list of all configured RADIUS servers for authorization.
- **group** *group-name*—Uses a named subset of TACACS+ servers for authorization.



Note If you have configured AAA authorization to be subjected to TACACS+ authorization, then you must ensure that the server group is configured (use the **aaa group server tacacs+** command for this) for that TACACS+ server. Else, authorization fails.

For example,

```
aaa authorization exec default group test_tacacs+ local
aaa authorization commands default group test_tacacs+
aaa group server tacacs+ test_tacacs+ <===
```

SUMMARY STEPS

1. **configure**
2. **aaa authorization** {**commands** | **eventmanager** | **exec** | **network**} {**default** | *list-name*} {**none** | **local** | **group** {**tacacs+** | **radius** | *group-name*}}
3. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**aaa authorization** {**commands**	**eventmanager**	**exec**	**network**} {**default**	*list-name*} {**none**	**local**	**group** {**tacacs+**	**radius**	*group-name*}} **Example:** `RP/0/RSP0/CPU0:router(config)# aaa authorization commands listname1 group tacacs+`	Creates a series of authorization methods, or a method list. • The **commands** keyword configures authorization for all EXEC mode shell commands. Command authorization applies to the EXEC mode commands issued by a user. Command authorization attempts authorization for all EXEC modecommands. • The **eventmanager** keyword applies an authorization method for authorizing an event manager (fault manager). • The **exec** keyword configures authorization for an interactive (EXEC mode) session. • The **network** keyword configures authorization for network services like PPP or IKE.

	Command or Action	Purpose

		• The **default** keyword causes the listed authorization methods that follow this keyword to be the default list of methods for authorization.
		• A *list-name* character string identifies the authorization method list. The method list itself follows the method list name. Method list types are entered in the preferred sequence. The listed method list types can be any one of the following:
		  • **none**—The network access server (NAS) does not request authorization information. Authorization always succeeds. No subsequent authorization methods will be attempted. However, the task ID authorization is always required and cannot be disabled.
		  • **local**—Uses local database for authorization.
		• **group tacacs+**—Uses the list of all configured TACACS+ servers for authorization. The NAS exchanges authorization information with the TACACS+ security daemon. TACACS+ authorization defines specific rights for users by associating AV pairs, which are stored in a database on the TACACS+ security server, with the appropriate user.
		• **group radius**—Uses the list of all configured RADIUS servers for authorization.
		• **group** *group-name*—Uses a named server group, a subset of TACACS+ or RADIUS servers for authorization as defined by the **aaa group server tacacs+** or **aaa group server radius** command.

Step 3	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After configuring authorization method lists, configure accounting method lists. (See the Configuring Accounting Method Lists, on page 84 section.)

Configuring Accounting Method Lists

This task configures method lists for accounting.

Note You can configure the **radius** keyword for the **aaa accounting** command.

Accounting Configuration

Currently, Cisco IOS XR software supports both the TACACS+ and RADIUS methods for accounting. The router reports user activity to the TACACS+ or RADIUS security server in the form of accounting records. Each accounting record contains accounting AV pairs and is stored on the security server.

Method lists for accounting define the way accounting is performed, enabling you to designate a particular security protocol to be used on specific lines or interfaces for particular types of accounting services. When naming a method list, do not use the names of methods, such as TACACS+.

For minimal accounting, include the **stop-only** keyword to send a "stop accounting" notice at the end of the requested user process. For more accounting, you can include the **start-stop** keyword, so that the external AAA server sends a "start accounting" notice at the beginning of the requested process and a "stop accounting" notice at the end of the process. In addition, you can use the **aaa accounting update** command to periodically send update records with accumulated information. Accounting records are stored only on the TACACS+ or RADIUS server.

When AAA accounting is activated, the router reports these attributes as accounting records, which are then stored in an accounting log on the security server.

Creation of a Series of Accounting Methods

Use the **aaa accounting** command to create default or named method lists defining specific accounting methods that can be used for each line or interface.

The Cisco IOS XR software supports the following methods for accounting:

- none—Accounting is not performed over this line or interface.
- group tacacs+—Use the list of all configured TACACS+ servers for accounting.
- group radius—Use the list of all configured RADIUS servers for accounting.

SUMMARY STEPS

1. **configure**
2. Do one of the following:
   - **aaa accounting** {**commands** | **exec** | **network**} {**default** | *list-name*} {**start-stop** | **stop-only**}
   - {none | method}
3. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	Do one of the following: • **aaa accounting** {**commands** | **exec** | **network**} {**default** | *list-name*} {**start-stop** | **stop-only**} • {none | method} **Example:** `RP/0/RSP0/CPU0:router(config)# aaa accounting commands default stop-only group tacacs+`	**Note** Command accounting is not supported o Creates a series of accounting methods, or a method list. • The **commands** keyword enables accounting for EXEC mode shell commands. • The **exec** keyword enables accounting for an interactive (EXEC mode) session. • The **network** keyword enables accounting for all network-related service requests, such as Point-to-Point Protocol (PPP). • The **default** keyword causes the listed accounting methods that follow this keyword to be the default list of methods for accounting. • A *list-name* character string identifies the accounting method list. • The **start-stop** keyword sends a "start accounting" notice at the beginning of a process and a "stop accounting" notice at the end of a process. The requested user process begins regardless of whether the "start accounting" notice was received by the accounting server. • The **stop-only** keyword sends a "stop accounting" notice at the end of the requested user process. • The **none** keyword states that no accounting is performed. • The method list itself follows the **start-stop** keyword. Method list types are entered in the preferred sequence. The method argument lists the following types: • **group tacacs+**—Use the list of all configured TACACS+ servers for accounting.

	Command or Action	Purpose
		• **group radius—**Use the list of all configured RADIUS servers for accounting. • **group** *group-name*—Use a named server group, a subset of TACACS+ or RADIUS servers for accounting as defined by the **aaa group server tacacs+** or **aaa group server radius** command. • The example defines a **default** command accounting method list, in which accounting services are provided by a TACACS+ security server, with a stop-only restriction.
Step 3	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After configuring method lists, apply those method lists. (See the Applying Method Lists for Applications, on page 88 section.)

Generating Interim Accounting Records

This task enables periodic interim accounting records to be sent to the accounting server. When the **aaa accounting update** command is activated, Cisco IOS XR software issues interim accounting records for all users on the system.

Note Interim accounting records are generated only for network sessions, such as Internet Key Exchange (IKE) accounting, which is controlled by the **aaa accounting** command with the **network** keyword. System, command, or EXEC accounting sessions cannot have interim records generated.

SUMMARY STEPS

1. **configure**
2. **aaa accounting update** {**newinfo** | **periodic** *minutes*}
3. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**aaa accounting update** {**newinfo** | **periodic** *minutes*} **Example:** `RP/0/RSP0/CPU0:router(config)# aaa accounting update periodic 30`	Enables periodic interim accounting records to be sent to the accounting server. • If the **newinfo** keyword is used, interim accounting records are sent to the accounting server every time there is new accounting information to report. An example of this report would be when IPCP completes IP address negotiation with the remote peer. The interim accounting record includes the negotiated IP address used by the remote peer. • When used with the **periodic** keyword, interim accounting records are sent periodically as defined by the argument number. The interim accounting record contains all the accounting information recorded for that user up to the time the interim accounting record is sent. **Caution** The **periodic** keyword causes heavy con
Step 3	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

Applying Method Lists for Applications

After you configure method lists for authorization and accounting services, you can apply those method lists for applications that use those services (console, vty, auxiliary, and so on). Applying method lists is accomplished by enabling AAA authorization and accounting.

This section contains the following procedures:

Enabling AAA Authorization

This task enables AAA authorization for a specific line or group of lines.

Method List Application

After you use the **aaa authorization** command to define a named authorization method list (or use the default method list) for a particular type of authorization, you must apply the defined lists to the appropriate lines in order for authorization to take place. Use the **authorization** command to apply the specified method lists (or, if none is specified, the default method list) to the selected line or group of lines.

SUMMARY STEPS

1. **configure**
2. **line** {**aux** | **console** | **default** | **template** *template-name*}
3. **authorization** {**commands** | **exec**} {**default** | *list-name*}
4. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**line** {**aux**	**console**	**default**	**template** *template-name*} **Example:** `RP/0/RSP0/CPU0:router(config)# line console`	Enters line template configuration mode.
Step 3	**authorization** {**commands**	**exec**} {**default**	*list-name*} **Example:** `RP/0/RSP0/CPU0:router(config-line)# authorization commands listname5`	Enables AAA authorization for a specific line or group of lines. • The **commands** keyword enables authorization on the selected lines for all commands. • The **exec** keyword enables authorization for an interactive (EXEC mode) session.

	Command or Action	Purpose
		• Enter the **default** keyword to apply the name of the default method list, as defined with the **aaa authorization** command. • Enter the name of a list of authorization methods to use. If no list name is specified, the system uses the default. The list is created with the **aaa authorization** command. • The example enables command authorization using the method list named listname5.
Step 4	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After applying authorization method lists by enabling AAA authorization, apply accounting method lists by enabling AAA accounting. (See the Enabling Accounting Services, on page 89 section.)

Enabling Accounting Services

This task enables accounting services for a specific line of group of lines.

SUMMARY STEPS

1. **configure**
2. **line { aux | console | default | template template-name}**
3. **accounting** {**commands** | **exec**} {**default** | *list-name*}
4. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`RP/0/RSP0/CPU0:router# configure`	
Step 2	**line { aux | console | default | template template-name}** **Example:** `RP/0/RSP0/CPU0:router(config)# line console`	Enters line template configuration mode.
Step 3	**accounting** {**commands** | **exec**} {**default** | *list-name*} **Example:** `RP/0/RSP0/CPU0:router(config-line)# accounting commands listname7`	Enables AAA accounting for a specific line or group of lines. • The **commands** keyword enables accounting on the selected lines for all EXEC mode shell commands. • The **exec** keyword enables accounting for an interactive (EXEC mode) session. • Enter the **default** keyword to apply the name of the default method list, as defined with the **aaa accounting** command. • Enter the name of a list of accounting methods to use. If no list name is specified, the system uses the default. The list is created with the **aaa accounting** command. • The example enables command accounting using the method list named listname7.
Step 4	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

What to do next

After applying accounting method lists by enabling AAA accounting services, configure login parameters. (See the Configuring Login Parameters, on page 90 section.)

Configuring Login Parameters

This task sets the interval that the server waits for reply to a login.

SUMMARY STEPS

1. **configure**
2. **line template** *template-name*
3. **timeout login response** *seconds*
4. Use the **commit** or **end** command.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RSP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**line template** *template-name* **Example:** `RP/0/RSP0/CPU0:router(config)# line template alpha`	Specifies a line to configure and enters line template configuration mode.
Step 3	**timeout login response** *seconds* **Example:** `RP/0/RSP0/CPU0:router(config-line)# timeout login response 20`	Sets the interval that the server waits for reply to a login. • The *seconds* argument specifies the timeout interval (in seconds) from 0 to 300. The default is 30 seconds. • The example shows how to change the interval timer to 20 seconds.
Step 4	Use the **commit** or **end** command.	**commit** —Saves the configuration changes and remains within the configuration session. **end** —Prompts user to take one of these actions: • **Yes** — Saves configuration changes and exits the configuration session. • **No** —Exits the configuration session without committing the configuration changes. • **Cancel** —Remains in the configuration session, without committing the configuration changes.

How to Configure Hold-Down Timer for TACACS+

By default, the hold-down timer for TACACS+ is disabled. To enable the hold-down timer, use the **holddown-time** command under respective configuration modes as per the following hierarchy levels:

- **Global Level**: Applicable to all TACACS+ servers that are configured on the router.

- **Server Group Level**: Applicable only to TACACS+ servers that are configured in a particular server group. This configuration overrides the global hold-down timer configuration.
- **Server Level**: Applicable only to a particular TACACS+ server (that also includes the private server). This configuration overrides the timer value at all other levels.
- **Private Server Level**: Applicable only to a particular private TACACS+ server.

While selecting the timer at various configuration levels, the router gives preference to the one which is more specific to the server. That is, the server-level timer has the highest precedence, followed by server group-level and finally, the global-level timer.

Guidelines for Configuring Hold-Down Timer for TACACS+

- You must configure the TACACS+ servers for this feature to take effect.
- A timer value of zero indicates that the feature is disabled.
- The timer value is decided by the configuration that is closest to the server regardless of its value. That is, if the server-level timer is configured as 0, the system disables the feature for that particular server, even if a positive value exists at other levels. So, if you need to disable the feature for some servers or server-groups, and not for others, you can configure a zero value for those specific servers or server-groups, and configure a positive value at the global level.
- The system assigns priority to the servers based on the order in which they are configured in the router. The server that is configured first is used first. If the first server becomes unavailable or unreachable, the second server is used, and so on.
- Avoid configuring a large timer value, as it marks the server as being down for a longer period. Also, the router does not use that server for further client requests during the hold-down time, even if the server becomes available in between. As a result, we recommend that you configure an optimal timer value of say, one or two minutes.
- If there is a process restart or router reload while the timer is running, the timer immediately expires, and the router considers the unresponsive server as being up.

Syslog for Hold-Down Timer

The TACACS+ hold-down timer feature introduces a new syslog to notify that the server is marked as being down, and that the hold-down timer has started. This syslog replaces the old syslog which was invoked during earlier scenarios when server was down. If the feature is not enabled, the router continues to display the old syslog.

The syslog without enabling hold-down timer:

```
RP/0/RP0/CPU0:Aug 21 17:42:49.664 UTC: tacacsd[1226]: %SECURITY-TACACSD-6-SERVER_DOWN :
TACACS+ server 10.10.10.2/2020 is DOWN [vrf: 0x60000000, server-private: No]- Socket 116:
No route to host
```

The syslog with hold-down timer enabled:

```
RP/0/RP0/CPU0:ios#RP/0/RP0/CPU0:Aug 21 16:00:25.200 UTC: tacacsd[1227]:
%SECURITY-TACACSD-6-HOLDDOWN_TIME_START :
TACACS+ server 10.105.236.103/2020 is DOWN [vrf: 0x60000000, server-private: Yes]. Server
will be marked as DOWN for 20 seconds: Success
```

Configuration Example

- **Global Level**:

```
Router#configure
Router(config)#tacacs-server holddown-time 30
```

- **Server Level**:

```
Router(config)#tacacs-server host 10.105.236.102 port 2020
Router(config-tacacs-host)#holddown-time 35
```

- **Server-Group Level**:

```
Router#configure
Router(config)#aaa group server tacacs+ test-group
Router(config-sg-tacacs)#holddown-time 40
```

- **Private Server Level**:

```
Router(config)#aaa group server tacacs+ test-group
Router(config-sg-tacacs)#server-private 10.105.236.109 port 2020
Router(config-sg-tacacs-private)#holddown-time 55
```

Running Configuration

```
Router#show running-config
!
tacacs-server holddown-time 30
!
tacacs-server host 10.105.236.102 port 2020
 holddown-time 35
!
aaa group server tacacs+ test-group
 holddown-time 40
 server-private 10.105.236.109 port 2020
  holddown-time 55
 !
!
```

How to Disable Hold-Down Timer for TACACS+

You can disable the hold-down timer for TACACS+ at respective levels either by using the **no** form of the **holddown-time** command, or by configuring a timer value of zero.

For example,

```
Router(config)#no tacacs-server holddown-time 30
OR
Router(config)#tacacs-server holddown-time 0
```

Verification

A new field, **on-hold**, is introduced in the output field of the **show tacacs** command to indicate whether a server is on hold due to the hold-down timer or the server probe is in progress. A value of *true* indicates that the server is marked as being down. The router does not use that server for addressing any client request.

```
Router#show tacacs
Wed Oct 21 06:45:38.341 UTC
Server: 10.105.236.102/2020 opens=1 closes=1 aborts=1 errors=0
       packets in=0 packets out=0
       status=down single-connect=false family=IPv4
       idle-timeout=0 on-hold=true

Server: 10.105.236.103/2020 vrf=default [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv4
        on-hold=true
```

The following is a sample output with **on-hold** value as *false*, which indicates that the server is not marked as being down. The router considers that server as being available for addressing client requests.

```
Router#show tacacs
Fri Aug 21 15:57:02.139 UTC

Server: 10.105.236.102/2020 opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv4
        idle-timeout=0 on-hold=false

Server: 10.105.236.103/2020 vrf=default [private]
        opens=0 closes=0 aborts=0 errors=0
        packets in=0 packets out=0
        status=up single-connect=false family=IPv4
        on-hold=false
```

Related Topics

- Hold-Down Timer for TACACS+, on page 30

Associated Commands

- **holddown-time**

Configuration Examples for Configuring AAA Services

This section provides the following configuration example:

Configuring AAA Services: Example

The following examples show how to configure AAA services.

An authentication method list vty-authen is configured. This example specifies a method list that uses the list of all configured TACACS+ servers for authentication. If that method fails, the local username database method is used for authentication.

```
configure
aaa authentication login vty-authen group tacacs+ local
```

The default method list for PPP is configured to use local method.

```
aaa authentication ppp default local
```

A username user1 is created for login purposes, a secure login password is assigned, and user1 is made a root-lr user. Configure similar settings for username user2.

```
username user1
secret lab
group root-lr
exit

username user2
secret lab
exit
```

A task group named tga is created, tasks are added to tga, a user group named uga is created, and uga is configured to inherit permissions from task group tga. A description is added to task group uga.

```
taskgroup tga
task read bgp
task write ospf
exit

usergroup uga
taskgroup tga
description usergroup uga
exit
```

Username user2 is configured to inherit from user group uga.

```
username user2
group uga
exit
```

Three TACACS servers are configured.

```
tacacs-server host 10.1.1.1 port 1 key abc
tacacs-server host 10.2.2.2 port 2 key def
tacacs-server host 10.3.3.3 port 3 key ghi
```

A user group named priv5 is created, which will be used for users authenticated using the TACACS+ method and whose entry in the external TACACS+ daemon configuration file has a privilege level of 5.

```
usergroup priv5
taskgroup operator
exit
```

An authorization method list, vty-author, is configured. This example specifies that command authorization be done using the list of all configured TACACS+ servers.

```
aaa authorization commands vty-author group tacacs+
```

An accounting method list, vty-acct, is configured. This example specifies that start-stop command accounting be done using the list of all configured TACACS+ servers.

```
aaa accounting commands vty-acct start-stop group tacacs+
```

For TACACS+ authentication, if, for example, a privilege level 8 is returned, and no local usergroup priv8 exists and no local user with the same name exists, the **aaa default-taskgroup** command with tga specified as the *taskgroup-name* argument ensures that such users are given the taskmap of the task group tga.

```
aaa default-taskgroup tga
```

For line template vty, a line password is assigned that is used with line authentication and makes usergroup uga the group that is assigned for line authentication (if used), and makes vty-authen, vty-author, and vty-acct, respectively, the method lists that are used for authentication, authorization, and accounting.

```
line template vty
password lab
users group uga
login authentication vty-authen
authorization commands vty-author
accounting commands vty-acct
exit
```

A TACACS+ server group named abc is created and an already configured TACACS+ server is added to it.

```
aaa group server tacacs+ abc
server 10.3.3.3
exit
```

TACACS+ with TLS protection

The TACACS+ with TLS protection is a security enhancement to the TACACS+ protocol that

- uses Transport Layer Security (TLS) to encrypt authentication, authorization, and accounting (AAA) communication between network devices and TACACS+ servers,
- provides confidentiality and integrity for sensitive data transmitted over potentially insecure networks, and
- supports mutual authentication to safeguard against unauthorized access.

Table 10: Feature History Table

Feature Name	Release Information	Feature Description
TACACS+ with TLS protection	Release 25.3.1	You can significantly enhance security and reduce the risk of attacks on weak encryption by using TACACS+ over TLS. This method ensures the secure transmission of all Authentication, Authorization, and Accounting (AAA) data between the client and server. It provides robust protection for sensitive environments by supporting mutual authentication through a TLS X.509 certificate-based infrastructure. This feature is compatible with both TLS versions 1.3 and 1.2.

Benefits of TACACS+ with TLS protection

- Enhances security by encrypting TACACS+ communications.

- Protects AAA data with robust encryption.
- Supports mutual authentication between client and server.
- Complies with TLS 1.3 and 1.2 standards.

TACACS+ with TLS protection improves the security of AAA services by using TLS for encrypted communication. It addresses vulnerabilities associated with weak encryption and is designed for sensitive environments that require strong protection for AAA data.

How TACACS+ with TLS protection work

Summary

TACACS+ with TLS protection secures AAA communications between a network device and a TACACS+ server by carrying TACACS+ packets within an encrypted TLS session that is established when a user initiates SSH access.

The key components involved in the process are:

- End user: Initiates an SSH session to access the network device.
- Router as TACACS+ TLS client: The router receives the AAA service request and initiates a TLS session to the TACACS+ server.
- TACACS+ server: The server uses valid TLS configuration, terminates the TLS session, and processes AAA requests and responses.
- TLS session: Encrypts the TACACS+ traffic between the client and server.
- TACACS+ packets: Carry authentication, authorization, and accounting information over the TLS tunnel.

Workflow

These are the stages of how TACACS+ with TLS protection works:

1. Session initiation: The end user initiates an SSH session to the network device.
2. AAA request: The router receives the user's AAA service request for TACACS+ with TLS protection.
3. TLS establishment: If the TACACS+ server is configured with valid TLS settings, the TACACS+ TLS client and server establish a TLS session.
4. Secure exchange: The client and server exchange TACACS+ packets over the TLS-encrypted session.

Result

The process establishes an encrypted channel for TACACS+ traffic, securing AAA communications during SSH access.

Guidelines for TACACS+ with TLS protection

Follow these guidelines when configuring TACACS+ with TLS protection:

- Configure the destination port for TACACS+ with TLS protection. There are no dedicated ports for authentication, accounting, or authorization changes.
- Use TLS X.509 certificate-based mutual authentication between client and server.
- Ensure you use either TLS 1.3 (as mandated by RFC 8446) or TLS 1.2, which is also supported.
- Use either multi-connect or single connect without TLS resumption as needed.
- Ensure your implementation supports the cipher suites mandated by TLS 1.3 and TLS 1.2.
- Use IPv4 or IPv6 for TACACS+ transactions as appropriate.
- Use the source interface and non-default Virtual Routing and Forwarding (VRF) as required.
- Configure the connection timer and single-connect idle timeout as appropriate—these settings work the same as for TACACS+ over TCP.

Restrictions for TACACS+ with TLS protection

These restrictions apply when configuring TACACS+ with TLS protection:

- The TACACS+ encryption method supported in Cisco IOS-XR software releases before 25.3.1 is no longer supported.
- The router does not support using both non-TLS and TLS servers in the same server group.
- The router does not support TLS session resumption or TLS sessions with PSK cipher suites.

Configure TACACS+ with TLS protection

Configure TACACS+ to use Transport Layer Security (TLS) for secure communication, enhancing the confidentiality and integrity of authentication, authorization, and accounting traffic.

This task describes how to enable TLS for TACACS+ server communication. You can enable TLS directly for a TACACS+ host or within an AAA server group. With TLS enabled, data exchanged between the network device and the TACACS+ server is encrypted.

Procedure

Step 1 Use the **tls** to enable TACACS+ with TLS protection.

a) Tacacs-server host configuration:

Example:

```
Router(config)# tacacs-server host 10.105.236.101 port 4950
Router(config-tacacs-host)# tls
Router(config-tacacs-host-tls)# server-name-indicator aaa.cisco.com
Router(config-tacacs-host-tls)# trustpoint test
Router(config-tacacs-host-tls)# commit
```

b) Server-group configuration:

Example:

```
Router(config)# configure
Router(config)# aaa group server tacacs+ tac1
Router(config-sg-tacacs)# server-private 10.105.236.101 port 2345
Router(config-sg-tacacs-private)# tls
Router(config-sg-tacacs-private-tls)# server-name-indicator aaa.cisco.com
Router(config-sg-tacacs-private-tls)# trustpoint abc
Router(config-sg-tacacs-private-tls)# commit
```

Step 2 Run the **show tacacs** command to display the TACACS information.

Example:

```
Router# show tacacs
Info: Verify that TACACS+ with TLS protection is configured.

Server: 10.105.236.101/2084
.....
FIPS mode : TRUE/FALSE.
TLS:
   Version: TLS 1.3/1.2      // only for active connection
   Cipher: TLS_AES_128_GCM_SHA256  // only for active connection
Statistics:
   Successfull connections: 0
   Failed connections         : 0
   SSL  errors :
    Connect error:
    Read error:
    Write error:
    Handshake Failure:
    Protocol Mismatch :
  Certificate Validation Error:
  Cipher Suite Mismatch:
  Session Timeout:
  Revoked Certificate:
  Unsupported TLS Version:
  Untrusted CA:
```

TACACS+ communication with the specified server is now secured using TLS, encrypting authentication, authorization, and accounting traffic.

Command Accounting

Command accounting with a method as local, enables the logging of commands executed by all users as syslog messages. This feature can be enabled or disabled only by users who have AAA write permissions. Once enabled, all the commands that are executed by all users can be viewed from the output of the **show logging** command.

Command accounting is not supported for commands that are executed using Netconf, XML or GRPC. Command accounting is not used as a failover accounting method but as an additional method of accounting. So this feature will be active even when other accounting methods are configured and functional.

Configuring Command Accounting

Command Accounting can either be configured alone or along with other accounting methods as shown below:

1. Configuring command accounting alone

```
RP/0/RSP0/CPU0:router(config)# aaa accounting commands default start-stop local none
RP/0/RSP0/CPU0:router(config)# commit
```

2. Configuring command accounting along with other accounting methods

```
RP/0/RSP0/CPU0:router(config)# aaa accounting commands default start-stop group tacacs+
 local none
RP/0/RSP0/CPU0:router(config)# commit
```

Model-based AAA

Table 11: Feature History Table

Feature Name	Release Information	Description
NETCONF Access Control Model (NACM) for Protocol Operations and Authorization	Release 7.4.1	NACM is defined in AAA subsystem to manage access control for NETCONF Remote Procedure Calls (RPCs). NACM addresses the need to authenticate the user or user groups, authorize whether the user has the required permission to perform the operation. With this feature, you can configure the authorization rules, groups and rule lists containing multiple groups and rules using CLI commands in addition to existing support for YANG data models. This feature also introduces `Cisco-IOS-XR-um-aaa-nacm-cfg.yang` unified data model to configure user access and privileges. You can access this data model from the Github repository.

The Network Configuration Protocol (NETCONF) protocol does not provide any standard mechanisms to restrict the protocol operations and content that each user is authorized to access. The NETCONF Access Control Model (NACM) is defined in AAA subsystem to manage access-control for NETCONF/YANG RPC requests.

The NACM module provides the ability to control the manageability activities of NETCONF users on the router. You can manage access privileges, the kind of operations that users can perform, and a history of the operations that were performed on the router. The NACM functionality accounts for all the operations that are performed on the box over the NETCONF interface. This functionality authenticates the user or user groups and authorizes permissions for users to perform the operation.

Prerequisites for Model Based AAA

Working with the model based AAA feature requires prior understanding of the following :

- NETCONF-YANG
- RFC 6536: Network Configuration Protocol (NETCONF) Access Control Model

Initial Operation

These are the NACM default values. By default a user is denied write permission, hence you'll not be able to edit the NACM configurations after enabling NACM authorization using AAA command.

```
<enable-nacm>false</enable-nacm>
<read-default>permit</read-default>
<write-default>deny</write-default>
<exec-default>permit</exec-default>
<enable-external-groups>true</enable-external-groups>
```

Therefore we recommend to enable NACM after configuring the required NACM configurations, or after changing the default NACM configurations. Here are few sample configurations:



Note If `access-denied` message is returned while writing NACM configurations, then NACM authorization can be disabled to edit the NACM configurations.

```
<aaa xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-lib-cfg">
<usernames xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-locald-cfg">
<username>
<ordering-index>3</ordering-index>
<name>username</name>
<password>password</password>
     <usergroup-under-usernames>
      <usergroup-under-username>
       <name>root-lr</name>
      </usergroup-under-username>
      <usergroup-under-username>
       <name>cisco-support</name>
      </usergroup-under-username>
     </usergroup-under-usernames>
</username>
</usernames>
</aaa>

<nacm xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-nacm-cfg">
<read-default>permit</read-default>
<write-default>permit</write-default>
<exec-default>permit</exec-default>
<enable-external-groups>true</enable-external-groups>
<groups>
    <group>
    <name>nacm_group</name>
    <user-name>lab</user-name>
    </group>
</groups>
<rule-list>
<name>Rule-list-1</name>
<group>Group_nacm_0_test</group>
```

```
<rule>
    <name>Rule-1</name>
    <access-operations>read</access-operations>
    <action>permit</action>
    <module-name>ietf-netconf-acm</module-name>
    <rpc-name>edit-config</rpc-name>
                <access-operations>*</access-operations>
                <path>/</path>
                <action>permit</action>
            </rule>
       </rule-list>
</nacm>
```

The NACM configuration allows to choose the precedence of external groups over the local groups.

NACM Configuration Management and Persistence

The NACM configuration can be modified using NETCONF or RESTCONF. In order for a user to be able to acccess the NACM configuration, they must have explicit permission to do so, that is, through a NACM rule. Configuration under the /nacm subtree persists when the **copy running-config startup-config** EXEC command is issued, or the **cisco-ia:save-config** RPC is issued.

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
<save-config xmlns="http://cisco.com/yang/cisco-ia"/>
</rpc>
```

Overview of Configuring NACM

Here are the steps involved in configuring NACM:

1. Configure all NACM rules
2. Enable NACM
3. Disconnect all active NETCONF sessions
4. Launch new NETCONF session



Note Enabling or disabling NACM does not affect any existing NETCONF sessions.

NACM Rules

As per the RFC 6536, NACM defines two categories of rules:

- Global Rules—It includes the following:
  - Enable/Disable NACM
  - Read-Default
  - Write-Default
  - Exec-Default

- Enable External Groups

- Access Control Rules—It includes the following:
  - Module (used along with protocol rule / data node rule)
  - Protocol
  - Data Node

The following table lists the rules and access operations:

Operation	Description
all	Rule is applied to all types of protocol operations
create	Rule is applied to all protocol operations, which create a new data node such as edit-config operation
read	Rule is applied to all protocol operations, which reads the data node such as get, get-config or notification
update	Rule is applied to all protocol operations, which alters a data node such as edit-config operation
exec	Rule is applied to all exec protocol access operations such as action RPC
delete	Rule is applied to all protocol operations that removes a data node



Note Before enabling NACM using NETCONF RPC, any user with access to the system can create NACM groups and rules. However, after NACM is enabled, only authorised users can change the NACM configurations.



Note Only users who belong to `root-lr` group or with write access in `aaa task` group can enable or disable NACM using CLI commands.

Example: Configure Global Rules

YANG Data Model: You must configure NACM groups and NACM rulelist before configuring NACM rules. The following sample configuration shows a NACM group configuration:

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" >
<edit-config>
  <target><candidate/></target>
<config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <nacm xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-acm">
    <groups>
      <group>
        <name>group1</name>
        <user-name>user1</user-name>
```

```
        <user-name>user2</user-name>
        <user-name>user3</user-name>
      </group>
    </groups>
  </nacm>
</config>
</edit-config>
</rpc>
```

The following sample configuration shows a NACM rule list configuration:

```
<rpc
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"message-id="101">
<edit-config>
  <target>
    <candidate/>
  </target>
 <config>
  <nacm xmlns="http://cisco.com/ns/yang/Cisco-IOS-XR-aaa-nacm-cfg">
  <rulelist-classes>
  <rulelist-class>
  <ordering-index>1</ordering-index>
 <rulelist-name>GlobalRule</rulelist-name>
 <group-names>
  <group-name>root-system</group-name>
   <group-name>AdminUser</group-name>
 </group-names>
 </rulelist-class>
 </rulelist-classes>
</nacm>
</config>
</edit-config>
</rpc>
```

You can configure the NACM rule list using CLI commands in addition to configuring using YANG data models. The following commands are supported:

```
Router(config)#nacm rule-list 1 GlobalRule
Router(config-rlst)#groupnames root-system AdminUser
```

Example: Configure NACM Global Rules

YANG Data Model:

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" >
<edit-config>
  <target><candidate/></target>
<config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <nacm xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-acm">
    <read-default>permit</read-default>
    <write-default>permit</write-default>
    <exec-default>permit</exec-default>
    <enable-external-groups>false</enable-external-groups>
  </nacm>
</config>
</edit-config>
</rpc>
```

CLI Command: You can configure the NACM global rules using CLI commands in addition to configuring using YANG data models. The following commands are supported:

```
Router(config)#nacm read-default [ permit | deny ]
Router(config)#nacm write-default [ permit | deny ]
```

```
Router(config)#nacm exec-default [ permit | deny ]
Router(config)#nacm enable-external-groups [ true | false ]
```

Note You must have NACM task permissions to make changes.

Example: Configure Access Control Rules

YANG Data Model:

```
<rpc message-id="101"
xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" >
<edit-config>
<target><candidate/></target>
<config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <nacm xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-acm">
    <rule-list>
     <name>GlobalRule</name>
     <rule>
       <name>rule1</name>
       <module-name>ietf-netconf-acm</module-name>
       <rpc-name>edit-config</rpc-name>
       <access-operations>*</access-operations>
       <action>permit</action>
     </rule>
    <rule>
      <name>rule2</name>
      <module-name>ietf-netconf-acm</module-name>
      <rpc-name>get-config</rpc-name>
      <access-operations>create read update exec</accessoperations>
      <action>permit</action>
    </rule>
   </rule-list>
  </nacm>
 </config>
 </edit-config>
</rpc>
```

Note '*' refers to all operations.

CLI Command: You can onfigure the NACM protocol rules using CLI commands in addition to configuring using YANG data models:

```
Router(config)#nacm rule-list 1 GlobalRule
Router(nacm-rlst)#groupnames AdminUser
Router(nacm-rlst)#rule 1 rule1
Router(nacm-rule)#action permit
Router(nacm-rule)#module-name ietf-netconf-acm
Router(nacm-rule)#rule-type rpc edit-config
Router(nacm-rule)#access-operations create read update exec
Router(nacm-rlst)#rule 2 rule2
Router(nacm-rule)#action deny
Router(nacm-rule)#module-name ietf-netconf-acm
Router(nacm-rule)#rule-type rpc get-config
Router(nacm-rule)#access-operations create read update exec
```

Example: Configure NACM Data Node Rules

```
<rpc message-id="101"xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" >
<edit-config>
<target><candidate/></target>
  <config xmlns:xc="urn:ietf:params:xml:ns:netconf:base:1.0">
    <nacm xmlns="urn:ietf:params:xml:ns:yang:ietf-netconf-acm">
     <rule-list>
        <name>GlobalRule</name>
      <rule>
       <name>rule4</name>
       <module-name>*</module-name>
       <path>/nacm/groups/group</path>
       <access-operations>*</access-operations>
       <action>permit</action>
      </rule>
      <rule>
       <name>rule5</name>
       <module-name>ietf-netconf-acm</module-name>
       <path>/nacm/rule-list</path>
       <access-operations>read</access-operations>
       <action>deny</action>
      </rule>
     </rule-list>
   </nacm>
  </config>
 </edit-config>
</rpc>
```

Note '*' refers to all modules, and all operations.

CLI Command: You can configure the NACM data rules using CLI commands in addition to configuring using YANG data models. The following commands are supported:

```
nacm rule-list 1 GlobalRule
 groupnames AdminUser
  rule 4 rule4
   action permit
   module-name *
   rule-type data-node /nacm/groups/group
   access-operations all
  rule 5 rule5
   action deny
   module-name ietf-netconf-acm
   rule-type data-node /nacm/rule-list
   access-operations all
```

Enabling NACM

NACM is disabled on the router by default. Users with root-lr or 'aaa' write task privilege users can enable/disable the NACM via CLI.

To enable NACM, use the following command in the Global configuration mode:

```
Router(config)#aaa authorization nacm default local
```

Cisco IOS XR Software Release 7.4.1 introduces support for external group names.

The external group names are added to the list of local group names to determine the access control rules. External group names are preferred from the list:

```
Router(config)#aaa authorization nacm default prefer-external group tacacs+ local
```

The `local` keyword refers to the locald (AAA local database) and not the NACM database.

Only external group names will be used to determine the access control rules:

```
Router(config)#aaa authorization nacm default only-external local
```

Verification

Use the **show nacm summary** command to verify the default values after enabling NACM:

```
Router# show nacm summary
Mon Jan 15 16:47:43.549 UTC
 NACM SUMMARY
 ------------------------------------------------------------------------------
 Enable Nacm : True
 Enable External Groups : True
 Number of Groups : 0
 Number of Users : 0
 Number of Rules : 0
 Number of Rulelist : 0
 Default Read : permit
 Default Write : deny
 Default Exec : permit
 Denied Operations : 0
 Denied Data Writes : 0
 Denied Notifications : 0
```

Associated Commands

- Router#**show nacm summary**
- Router#**show nacm users [user-name]**
- Router#**show nacm rule-list [rule-list-name] [rule [rule-name]]**
- Router#**show nacm groups [group-name]secret**

Verify the NACM Configurations

Use the **show nacm summary** command to verify the NACM configurations:

```
Router# show nacm summary
Mon Jan 15 17:02:46.696 UTC
 NACM SUMMARY
 ------------------------------------------------------------------------------
 Enable Nacm : True
 Enable External Groups : True
 Number of Groups : 3
 Number of Users : 3
 Number of Rules : 4
 Number of Rulelist : 2
 Default Read : permit
 Default Write : permit
 Default Exec : permit
 Denied Operations : 1
```

```
 Denied Data Writes : 0
 Denied Notifications : 0
----------------------------------------------------------------------------------
```

Associated Commands

- Router#**show nacm summary**
- Router#**show nacm users [user-name]**
- Router#**show nacm rule-list [rule-list-name] [rule [rule-name]]**
- Router#**show nacm groups [group-name]secret**

Disabling NACM

There are two ways you can disable NACM. Use one of the following commands:

Configuring NACM authorization as none:

```
Router(config)# aaa authorization nacm default none
```

or

Using no form of AAA authorization command:

```
Router(config)# no aaa authorization nacm default
```

Verification

Use the **show nacm summary** command to verify the default values after disabling NACM:

```
Router# show nacm summary

Mon Jan 15 17:02:46.696 UTC
 NACM SUMMARY
 ------------------------------------------------------------------------------
 Enable Nacm : False
 Enable External Groups : True
 Number of Groups : 0
 Number of Users : 0
 Number of Rules : 0
 Number of Rulelist : 0
 Default Read : permit
 Default Write : deny
 Default Exec : permit
 Denied Operations : 0
 Denied Data Writes : 0
 Denied Notifications : 0
```

Dynamic Retrieval of NETCONF Access Control Model Policies

Table 12: Feature History Table

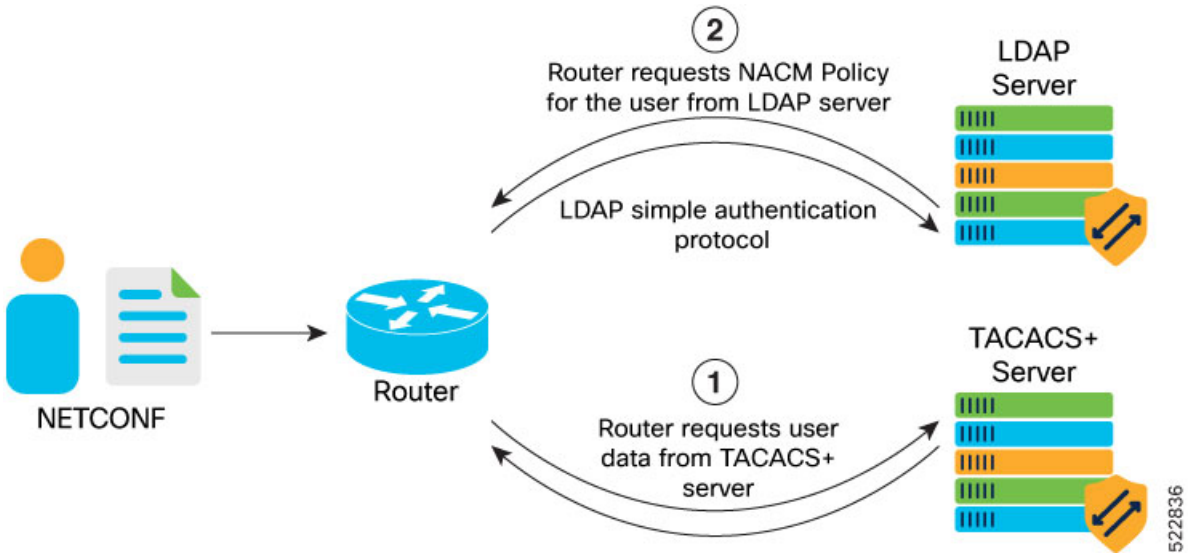
Feature Name	Release Information	Description
Dynamic Retrieval of NETCONF Access Control Model Policies	Release 7.8.1	Your router now retrieves the NETCONF Access Control Model (NACM) policies or rules on-demand for an authorized user from a remote Lightweight Directory Access Protocol (LDAP) server to validate each NETCONF operation. As the policies are stored in an external server and retrieved dynamically, this feature eliminates the need to manually update policies on a per-router basis. Before this release, your router supported static NACM, where the NACM policies or rules were stored locally, requiring manual policy updates on each router. This feature introduces the **nacm enable-external-policies** command.

When you log in to the router using a NETCONF interface, the router authenticates the user credentials, and the authorization check is done for exec service and NETCONF service. After a successful NETCONF service authorization, the user is authorized to perform NETCONF operations or access data nodes within a given RPC based on the rules obtained from the external LDAP server. Unlike in static NACM, where the authorization policies are stored locally, in dynamic NACM, the router retrieves and stores these authorization policies for the authenticated user from the external server dynamically in a secure transfer manner. These policies are used to authorize the NETCONF operations.

LDAP server stores NACM policies. You must configure the LDAP server with the policies (NACM rule-list and rules) for the user or the user group.

The TACACS+ servers contain the netconf service configuration that contains group-mapping, and information to query LDAP server for retrieving the NACM policies.

Figure 2: Workflow of Dynamic NACM



The work flow of the Dynamic NACM is as follows:

1. Router requests the following information from the TACACS+ server:
   - User and user groups
   - LDAP server contact
   - Home directory, and so on

   For a successful authorization, the TACACS+ server responds with `nacm-groups`, `basedn`, `filter`, `map`, and `timestamp` as attribute-value pairs.

   If TACACS+ server becomes unreachable, authorizations of the NETCONF operations use locally defined NACM policies.

2. Router requests the following information from the LDAP server:
   - User's NACM policy

   LDAP server responds with user NCAM policies.

   The authorization policies obtained for a given authenticated user are internally committed to running configuration on the router. If the retrieved policies not required, such policies have to be deleted from the running configuration.

When the router receives a NETCONF service authorization response having a new timestamp attribute-value pair as compared to the timestamp of the policy that is existing on the router, a dynamic policy is downloaded from the LDAP server. The dynamic policies are stored (cached) in the static NACM database.

Configure Dynamic NACM

Configuring dynamic NACM involves the following tasks.

- Router Configuration

- Configure Router-to-LDAP Server Communication, on page 111
- Configure TACACS+ Server Profile, on page 111
- Configure LDAP Server Profile, on page 112
- Enable Dynamic NACM, on page 112

- TACACS+ Server Configuration
- LDAP Server Configuration

Router Configuration

This section provides router configuration for dynamic NACM, which includes establishing a communication between router and LDAP server, LDAP and TACACS+ server profile configurations on router.

Configuring a router for dynamic NACM involves the following tasks:

- Configure Router-to-LDAP Server Communication
- Configure TACACS+ Server Profile
- Configure LDAP Server Profile
- Enable Dynamic NACM

Configure Router-to-LDAP Server Communication

LDAP communication is established between LDAP client running on router and LDAP server, using simple authentication protocol. Use LDAP server host configuration on router to communicate with LDAP server.

For configuration procedure, see Configure LDAP Server Profile, on page 112.

You can use `Cisco-IOS-XR-aaa-ldapd-cfg.yang` file to configure LDAP parameters such as `connect-timeout`, `bind-distinguished-name`, and `bind-password` values for the LDAP and router connectivity.

Configure TACACS+ Server Profile

The TACACS+ client sends the NETCONF authorization request to LDAP server to retrieve nacm_group and LDAP url attributes.

Configuration Example

```
Router# configure
Router(config)# tacacs-server host 10.105.236.101 port 7010
Routers(config-tacacs-host)# key 7 00071A150754
Routers(config-tacacs-host)# commit
```

Running Configuration

```
Router# show run
 tacacs-server host 10.105.236.101 port 7010
  key 7 00071A150754
 !
```

Configure LDAP Server Profile

LDAP communication is established between LDAP client running on router and LDAP server located externally using a simple authentication protocol. Use **ldap-server host** command to configure the LDAP server host (ldap-server) to communicate with LDAP server through CLI.

Note You can configure only one LDAP server host.

Table 13: LDAP Server Host Configuration Parameters

Attribute	Description
ip-address	LDAP server IP address. This is mandatory.
port-number	The port number to connect to the LDAP server. The default value is 389 (LDAP) or 636 (LDAPS). The port value ranges between 1- 65,535.
bind-dn	The Distinguished Name (DN) to bind to the LDAP server. This is mandatory for Authentication.
bind-password	The password to use to bind to the LDAP server. This is mandatory for authentication.
Connect-timeout	Connection establishment time-out between LDAP client and LDAP server. The value ranges between 1–1000 seconds. Default time is five seconds. You can perform three attempts upon bind timeout. If the bind does not respond within three attempts, the server is marked as Dead and router connects to the next available server which is marked as UP.

Configuration Example

```
Router# configure
Router(config)# ldap-server host 10.105.236.10
Router(config-ldap-host)# bind-dn cn=admin,dc=cisco,dc=com
Router(config-ldap-host)# bind-password lablab
Router(config-ldap-host)# connect-timeout 10
Router(config-ldap-host)# commit
```

Running Configuration

```
Router# sh run ldap-server host
 ldap-server host 10.105.236.10 port 389
 bind-dn cn=admin,dc=cisco,dc=com
 bind-password 7 04570A0403204E
 connect-timeout 10
!
```

Enable Dynamic NACM

You can configure NACM either through NETCONF client or CLI.

Note The dynamic policies once configured are not removed. To remove these policies, unconfigure those policies from the running configuration

Configuration Example

To enable dynamic NACM, use the following command in the global configuration mode:

```
Router(config)# nacm enable-external-policies
```

TACACS+ Server Configuration

This section provides TACACS+ server configuration for dynamic NACM, with a set of newly introduced attribute-value pairs.

Cisco IOS XR software Release 7.8.1 introduces **BaseDN**, **filter**, **map**, and **timestamp** attribute-value pairs with which TACACS+ server is configured in the user profile.

Table 14: Attribute-value pair of TACACS+ Server

Attribute-value pair	Description
BaseDN	LDAP client (aaa_ldapd) uses base distinguished name (baseDN) to search for the NACM policy in the LDAP server.
filter	The LDAP filter in the search operation to determine the existence of a specific attribute or an object.
map	Customized name for nacmRuleList.
timestamp	The time at which the NACM policy for the group has changed at the LDAP server.

Configuration Example

The following configuration shows the TACAC+ configuration with LDAP attributes.

```
user = netconf_user1 {
default service = permit
global = cleartext lab
opap = cleartext "lab"
member = aaa-india

service = exec {
   task = "#root-lr,#cisco-support"
   idletime = 2
}
service = netconf {
   nacm-group = “FULL-ACCESSGROUP”
   basedn = “nacmRuleList=FULL-ACCESS,gtacdomain=IPNSG,dc=domain,dc=gtac,dc=cisco,dc=net”
     filter = “(|(objectclass=nacmRuleList)(objectclass=nacmRule))”
     map nacmRuleList profile
  timestamp = 1638169449
 }
}
```

LDAP Server Configuration

This section provides the schema and rule-lists configuration on the LDAP server for dynamic NACM.

LDAP schema rules and rule-lists must be defined in similar way as defined in the `NACM RFC 8341` YANG model.

Schema

A sample LDAP schema for dynamic NACM is as followed:

```
olcAttributeTypes: {0}( 1.3.6.1.4.1.1234.101 NAME 'nacmRuleName' DESC ' Name of the rule'
EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15{32} SINGLE-VALUE )
olcAttributeTypes: {1}( 1.3.6.1.4.1.1234.102 NAME 'nacmRuleIndex' DESC  'Order of the rule'
 SYNTAX 1.3.6.1.4.1.1466.115.121.1.27 SINGLE-VALUE )
olcAttributeTypes: {2}( 1.3.6.1.4.1.1234.105 NAME 'nacmModuleName' DESC  'Name of the YANG
 module associated with this rule' EQUALITY caseIgnoreMatch SYNTAX
1.3.6.1.4.1.1466.115.121.1.15{32} SINGLE-VALUE )
olcAttributeTypes: {3}( 1.3.6.1.4.1.1234.106 NAME 'nacmRuleType' DESC 'Choice between 1=
rpc, 2=data-node or 3=notification' SYNTAX 1.3.6.1.4.1.1466.115.121.1.27 SINGLE-VALUE )
olcAttributeTypes: {4}( 1.3.6.1.4.1.1234.107 NAME 'nacmRuleData' DESC 'XPath
instance-identifier associated with the data node controlled by this rule or rpc-name or
notification-name' EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15{32}
SINGLE-VALUE )
olcAttributeTypes: {5}( 1.3.6.1.4.1.1234.109 NAME 'nacmAccessOperations ' DESC 'Access
operations associated with this rule. CRUDX bits (Create-Read-Update-Delete-eXecute-ALL)
value' SYNTAX 1.3.6.1.4.1.1466.115.121.1.6 SIN GLE-VALUE )
olcAttributeTypes: {6}( 1.3.6.1.4.1.1234.110 NAME 'nacmAction' DESC 'Action taken by the
server when a particular rule matches' SYNTAX 1.3.6.1.4.1.1466.115.121.1.7 SINGLE-VALUE )
olcAttributeTypes: {7}( 1.3.6.1.4.1.1234.113 NAME 'nacmRule' DESC 'NACM Rule' EQUALITY
caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15 SINGLE -VALUE )
olcAttributeTypes: {8}( 1.3.6.1.4.1.1234.103 NAME 'nacmRuleListName' DESC 'Name of the
rulelist' EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466. 115.121.1.15{32} SINGLE-VALUE
)
olcAttributeTypes: {9}( 1.3.6.1.4.1.1234.104 NAME 'nacmRuleListIndex' D ESC 'Order of the
rulelist' SYNTAX 1.3.6.1.4.1.1466.115.121.1.27 SINGLE-VAL UE )
olcAttributeTypes: {10}( 1.3.6.1.4.1.1234.135 NAME 'nacmRuleListGroup' DESC 'NACM Group
that will be assigned the associated access defined by the  nacmRuleList' EQUALITY
caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.1 5{32} SINGLE-VALUE )
olcAttributeTypes: {11}( 1.3.6.1.4.1.1234.111 NAME 'nacmLastModifiedTim e' DESC 'date/time
 the ruleList was last modified' EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15
 SINGLE-VALUE )
olcAttributeTypes: {12}( 1.3.6.1.4.1.1234.112 NAME 'nacmRuleList' DESC 'NACM set of Rules'
 EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15 SINGLE-VALUE )
olcAttributeTypes: {13}( 1.3.6.1.4.1.1234.114 NAME 'nacmNACMGlobal' DESC 'Global NACM
settings' EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.1 15.121.1.15 SINGLE-VALUE )
olcAttributeTypes: {14}( 1.3.6.1.4.1.1234.120 NAME 'nacmEnableNACM' DESC 'Boolean enable
or disable NACM on device' SYNTAX 1.3.6.1.4.1.1466.115.12 1.1.7 SINGLE-VALUE )
olcAttributeTypes: {15}( 1.3.6.1.4.1.1234.121 NAME 'nacmReadDefault' DE SC 'Read Access
default' SYNTAX 1.3.6.1.4.1.1466.115.121.1.7 SINGLE-VALUE )
olcAttributeTypes: {16}( 1.3.6.1.4.1.1234.122 NAME 'nacmWriteDefault' DESC 'Write Access
default' SYNTAX 1.3.6.1.4.1.1466.115.121.1.7 SINGLE-VALUE )
olcAttributeTypes: {17}( 1.3.6.1.4.1.1234.123 NAME 'nacmExecDefault' DESC 'Exec Access
default' SYNTAX 1.3.6.1.4.1.1466.115.121.1.7 SINGLE-VALUE )
olcAttributeTypes: {18}( 1.3.6.1.4.1.1234.124 NAME 'nacmEnableExternalG roups' DESC 'Use
external groups' SYNTAX 1.3.6.1.4.1.1466.115.121.1.7 SINGL E-VALUE )
olcAttributeTypes: {19}( 1.3.6.1.4.1.1234.115 NAME 'nacmNACMGroup' DESC 'NACM Group' EQUALITY
 caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15  SINGLE-VALUE )
olcAttributeTypes: {20}( 1.3.6.1.4.1.1234.130 NAME 'nacmGroupName' DESC 'NACM Group Name'
EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121 .1.15{32} )
olcAttributeTypes: {21}( 1.3.6.1.4.1.1234.131 NAME 'nacmUsersNACM' DESC  'List of users'
EQUALITY caseIgnoreMatch SYNTAX 1.3.6.1.4.1.1466.115.121.1.15{32} )
olcObjectClasses: {0}( 1.3.6.1.4.1.1235.100 NAME 'nacmRuleList' DESC 'NACM set of Rules OC'
```

```
 SUP top STRUCTURAL MUST ( nacmRuleList $ nacmRuleListName $ nacmRuleListGroup ) MAY (
nacmRuleListIndex $ nacmLastModifiedTime $ description ) )
olcObjectClasses: {1}( 1.3.6.1.4.1.1235.110 NAME 'nacmRule' DESC 'NACM Rule OC' SUP top
STRUCTURAL MUST ( nacmRule $ nacmRuleName $ nacmModuleName $ nacmAccessOperations $ nacmAction
 $ nacmRuleList ) MAY ( nacmRuleIndex $ description $ nacmRuleType $ nacmRuleData ) )
olcObjectClasses: {2}( 1.3.6.1.4.1.1235.120 NAME 'nacmNACMGlobal' DESC 'Global NACM settings
 OC' SUP top STRUCTURAL MAY ( nacmNACMGlobal $ nacmEna bleNACM $ nacmReadDefault $
nacmWriteDefault $ nacmExecDefault $ nacmEnable ExternalGroups $ nacmLastModifiedTime ) )
olcObjectClasses: {3}( 1.3.6.1.4.1.1235.130 NAME 'nacmNACMGroup' DESC ' NACM Group OC' SUP
 top STRUCTURAL MUST ( nacmGroupName $ nacmUsersNACM ) MAY nacmNACMGroup )
```

Note You can use `olcAttributeTypes` and `olcObjectClasses` as per your setup and requirement.

Rule-lists

The LDAP database must be updated with the user NACM policies.

Configuration

Use `show running-config` command to view the LDAP server configuration on the router.

```
Router# show running-config
 nacm rule-list 202 Netconf-READONLY
  rule 1 rule1
   action permit
   module-name *
   access-operations read
  !
  groupnames READONLYGROUP
 !
 nacm rule-list 201 Netconf-FULL-ACCESS
  rule 1 rule1
   action permit
   module-name *
   access-operations all
  !
  groupnames FULL-ACCESSGROUP
 !
```

Note Dynamically downloaded rule-lists are indexed from 201.

Configure an LDAP source interface

Starting with Cisco IOS XR Release 26.3.1, specify the source interface for LDAP packets.

You can optionally specify the VRF for the source-interface configuration.

Procedure

Configure the source interface for LDAP packets.

Example:

```
RP/0/RP0/CPU0:ios(config)# ldap-server source-interface <interface> [vrf <vrf-name>]
```

Use this command syntax:

- Specify an interface that the platform supports. For example, `MgmtEth`.
- Use the interface name in Rack/Slot/Instance/Port (`R/S/I/P`) format when applicable. For example, `MgmtEth 0/RP0/CPU0/0`.
- The `vrf` keyword is optional. Omit it to configure only the source interface.

LDAP traffic is bound to the specified interface and, when configured, the specified VRF.

Dynamic NACM using LDAP over TLS Authentication

Table 15: Feature History Table

Feature Name	Release Information	Description
Securely retrieve NACM policies using LDAP over TLS connection	Release 7.9.1	You can now securely retrieve the NETCONF Access Control Model (NACM) policies or rules from a remote Lightweight Directory Access Protocol (LDAP) server using Transport Layer Security (TLS) authentication. With TLS authentication, the communication between the router and the LDAP server is encrypted for security. Before this release, the communication between the LDAP server and the router was not secured.

You can use the LDAP over TLS (LDAPS) communication to request and retrieve information from remote LDAP server in a secure manner. A maximum of 11 LDAP servers are supported.

The following procedure shows the steps involved in generating the Certification Authority (CA) certificate, adding the CA certificate to the trustpoint and configuring the LDAP server and router to download the NACM policies.

Before you begin

Setup TACACS server. For more information, see Configuring TACACS+ Server Groups, on page 70.

Procedure

Step 1 Add or update the configuration file on the TACACS server as shown in the following example:

Example:

```
user = nacm_user4 {
     default service = permit
     global = cleartext lab
     opap = cleartext "lab"
     member = aaa-member
     service = exec {
```

```
            task = "#serviceadmin"
            idletime = 2
        }
        service = netconf {
           nacm-groups = "READONLY-ACCESSGROUP"
           basedn = "nacmRuleList=Netconf-READONLY-ACCESS,cn=LEAF-XR,ou=users,dc=cisco,dc=com"
           filter = "(|(objectclass=nacmRule)(objectclass=nacmRuleList))"
           map = "nacmRuleList profile"
           timestamp = 1638169449
        }
}
```

Step 2 Enable NACM authorization.

Example:

```
Router(config)#aaa authorization nacm default group tacacs+ local
```

Step 3 Configure the LDAP server.

Example:

```
Router(config)#ldap-server host 172.27.74.235 port 636
Router(config-ldap-host)#bind-dn “”
Router(config-ldap-host)#bind-password “”
```

The bind-dn and bind-password commands accept input values. If certificate authentication is used, the value is null ("").

Step 4 Configure the parameters for TLS communication.

a) Generate RSA key pair for the router. The RSA keys are generated in pairs—a public RSA key and a private RSA key. If the router already has RSA keys when you issue this command, a message is displayed to replace the existing keys with new keys. The keys are generated and saved in the secure NVRAM.

Example:

```
Router#crypto key generate rsa crl
Wed Mar 29 14:13:19.368 UTC
The name for the keys will be: crl
  Choose the size of the key modulus in the range of 512 to 4096 for your General Purpose Keypair.

  Choosing a key modulus greater than 512 may take a few minutes.

How many bits in the modulus [2048]:
Generating RSA keys ...
Done w/ crypto generate keypair
[OK]
```

b) Check that the key pair is generated successfully.

Example:

```
Router#show crypto key mypubkey rsa
Wed Mar 29 14:13:44.592 UTC
Key label: crl
Type     : RSA General purpose
Size     : 2048
Created  : 14:13:25 UTC Wed Mar 29 2023
Data     :
 30820122 300D0609 2A864886 F70D0101 01050003 82010F00 3082010A 02820101
 00A6490A D2184AE0 78F0D4C7 3491886D 6ED679DE 31833CBF B1D0CFA9 33112169
 FDC3443B 79C478D3 B8CC05FB 9810D2E4 E3782733 BFCA7CDD EE56CE5B C98ADF57
 C0D9DE72 D4915A2A 298313D8 A17ABA48 6FA199CE F661F26B 608130B0 F08363DE
 0BC2DDCE 2B79ADA2 D23C9905 96380FEA 60DA6AE8 A38DDEA4 F2233532 2B0788BF
 80BC734B 6CD585D1 60519EFF C65363D2 C98CA384 878F7078 6AE68C81 BE59C09B
 EAC211A9 49D4C04A 3187EF8E 8AA357F7 754F1B9E 80276462 7DC249BF 2649BCD3
```

```
B6C2F6F0 A41926A5 7297F7D9 F3403928 194102F7 601E4CE4 A7190F8F CE8DBE24
082C3D7A 24CA8C1C 2323C7F7 499C1BD6 21DD218C F1F72740 978AB9F4 801FB38B
09020301 0001
```

c) Configure a trustpoint with the server so that the router can verify the certificates issued to peers.

Example:

```
Router#configure
Router(config)#crypto ca trustpoint ldaps
Router(config-trustp)#subject-name
C=IN,ST=Karnataka,L=Bengaluru,O=cisco,OU=department,CN=client.cisco.com
Router(config-trustp)#enrollment url terminal
Router(config-trustp)#enrollment retry count 99
Router(config-trustp)#enrollment retry period 1
Router(config-trustp)#rsakeypair crl
Router(config-trustp)#domain name cisco.com
```

The retry count is the number of times the router resends a certificate request when the router does not receive a certificate from the previous request. The range is from 1 to 100. If no retry count is specified, the default value is 10. The retry period is the time between certificate requests issued to a certification authority (CA) from the router. The range is from 1 to 60 minutes. The default is 1 minute.

d) Authenticate the CA. Configure the security public key infrastructure (PKI) trace options.

Example:

Router:

```
Router#crypto ca authenticate ldaps
Mon Mar 20 02:20:18.044 UTC

Enter the base 64 encoded certificate.
End with a blank line or the word "quit" on a line by itself

-----BEGIN CERTIFICATE-----
MIIF6TCCA9GgAwIBAgIJAK7Auq53lyF3MA0GCSqGSIb3DQEBCwUAMIGKMQswCQYD
VQQGEwJJTjEMMAoGA1UECAwDS2FyMQ4wDAYDVQQHDAVCbG9yZTEOMAwGA1UECgwF
------------ Certificate details truncated for brevity ------------
hUFUx56f158KIiDx4SgwLZL4+UXLM+wxbpSgB9sQVz3f1yLhMuf9KgHZjE6O2Rr3
5te9emSo64ros6M01sQ5rWsPdqYC/jlN3M7eBIw=
-----END CERTIFICATE-----

  Serial Number  : AE:00:BA:AE:77:77:21:97
  Subject:

emailAddress=user@cisco.com,CN=server.example.com,OU=Test,O=Cisco,L=Bengaluru,ST=Karnataka,C=India

  Issued By      :

emailAddress=user@cisco.com,CN=server.example.com,OU=Test,O=Cisco,L=Bengaluru,ST=Karnataka,C=India

  Validity Start : 17:07:28 UTC Mon Mar 20 2023
  Validity End   : 17:07:28 UTC Tue Mar 19 2024
  SHA1 Fingerprint:
            C500X79A7A7FBBB668D009554BDA80698DABC6A4
Do you accept this certificate? [yes/no]: yes
```

The router authenticates the CA by obtaining the self-signed certificate that contains the public key.

e) Enroll the device certificate with CA.

Example:

Router:

```
Router#crypto ca enroll ldaps
Mon Mar 20 02:24:05.270 UTC
% Start certificate enrollment ...
% Create a challenge password. You will need to verbally provide this
  password to the CA Administrator in order to revoke your certificate.
% For security reasons your password will not be saved in the configuration.
% Please make a note of it.

Password:
Re-enter Password:

% The subject name in the certificate will include:
C=India,ST=Karnataka,L=Bengaluru,O=Cisco,OU=test,CN=client.cisco.com
% The subject name in the certificate will include: R2.cisco.co
% Include the router serial number in the subject name? [yes/no]: no
% Include an IP address in the subject name? [yes/no]: no
    Fingerprint:  44443744 33377244 45563033 44334668
Display Certificate Request to terminal? [yes/no]: yes
Certificate Request follows:

MIIDJjCCAg4CAQAwgYExCzAJBgNVBAYTAklOMQwwCgYDVQQIDANLYXIxDjAMBgNV
BAcMBUJsb3JlMQ4wDAYDVQQKDAVDaXNjbzENMAsGA1UECwwEdGVzdDEZMBcGA1UE
------------ Certificate details truncated for brevity ------------
ugcy9fUHnV+YoKD3pg3p8Cutg2Tudm1DYj4U8BBbp+YZNMc8BhHX3F8Cx4JOvioR
BKo4IfxPi0HspcQDDDdivNtl6JRJA+8scGHajsVgI8eXE+5PxY7ejsbS

---End - This line not part of the certificate request---
Redisplay enrollment request? [yes/no]:
```

Step 5 Copy the generated CA request certificate to `/etc/openldap/cacerts/ca-req.pem` file with the start and end tags.

Example:

LDAP server terminal:

```
-----BEGIN CERTIFICATE----- <.data from router.> -----END CERTIFICATE-----
```

Step 6 Generate `sys-cert.pem` router certificate.

Example:

```
Serevr>openssl ca -md sha256 -config /etc/pki/tls/openssl.cnf -keyfile /etc/pki/CA/ca.key -cert
/etc/pki/CA/ca.cert.pem -in /etc/openldap/cacerts/ca-req.pem -out /etc/openldap/cacerts/sys-cert.pem
```

The `ca-req.pem` certificate is configured during router configuration. The `ca.cert.pem` key is created during server setup.

Step 7 Import the generated `sys-cert.pem` certificate to the router.

Example:

```
Router#crypto ca import ldaps certificate
```

Step 8 Check that the certificate is imported successfully.

Example:

```
Router#show crypto ca certificates
Mon Mar 20 02:23:35.438 UTC

Trustpoint       : ldaps
================================================
CA certificate
  Serial Number  : AE:00:BA:AE:77:77:21:97
```

```
  Subject:

emailAddress=user@cisco.com,CN=server.example.com,OU=Test,O=Cisco,L=Bengaluru,ST=Karnataka,C=India
  Issued By      :

emailAddress=user@cisco.com,CN=server.example.com,OU=Test,O=Cisco,L=Bengaluru,ST=Karnataka,C=India
  Validity Start : 17:07:28 UTC Mon Mar 20 2023
  Validity End   : 17:07:28 UTC Tue Mar 19 2024
  SHA1 Fingerprint:
            C500X79A7A7FBBB668D009554BDA80698DABC6A4
```

The certificate details enrolled in trustpoint is displayed.

With this configuration, the LDAPS server is ready for the NETCONF operations to download the NACM rules using TLS communication.

The following example shows the NACM rules added to the LDAP server.

```
# Netconf-READONLY, MTLAB-X-LEAF-PEERING-XR_TL, users, cisco.com
dn: nacmRuleList=Netconf-READONLY,cn=MTLAB-X-LEAF-PEERING-XR_TL,ou=users,dc=example,dc=com
nacmLastModifiedTime: 20220215003
nacmRuleListIndex: 1
nacmRuleListGroup: READONLYGROUP
nacmRuleList: Netconf-READONLY
nacmRuleListName: Netconf-READONLY
objectClass: top
objectClass: nacmRuleList
```

Command Authorization Using Local User Account

Table 16: Feature History Table

Feature Name	Release Information	Feature Description
Command Authorization Using Local User Account	Release 7.5.1	This feature allows locally authenticated users—authenticated by the AAA server internal to the router—to run all XR VM commands even if a remote TACACS+ AAA server is not reachable for authorization. It prevents a complete router lockdown. The feature also prevents remotely authenticated users—authenticated using a remote AAA server (say, TACACS+ server)—from running any non-permitted commands on the router, and thus prevents misuse of user privileges. This feature modifies the **aaa authorization commands default** command to include the **local** option for XR VM command authorization.

Currently, when a user tries to execute a command on XR VM, the router checks to see whether the user has required permissions to execute it. The router does this authorization process in two steps. First, the system compares the task-IDs of the user with the required task-IDs for the command. If the user has all required task-IDs, and if AAA authorization is configured, then the system sends an authorization request to the local or remote AAA server, based on that configuration. Based on the response from the AAA server, the system allows or rejects the command execution. If authorization is not configured or if it configured with option *none*, then the system bypasses authorization check and allows user to execute the command.

Similarly, the existing remote authorization process using TACACS+ server has two options—remote authorization using *tacacs+* and *none*. The authorization process using *TACACS+* option uses an external TACACS+ server for authorization. The authorization using *none* option allows the user to execute the command without any authorization check. TACACS+ authorization has the advantage of fine-tuning authorization rules and providing more control on system access that cannot be otherwise done locally. However, if the remote server is not reachable, a user who leverages TACACS+ authorization might get into an unpredictable state of router, as mentioned in these scenarios:

- Remote authorization using *TACACS+* with failover option as *none* (that is, with the **aaa authorization commands default group tacacs+ none** configuration)

  If TACACS+ server is not reachable, then the system bypasses the authorization check and allows user to execute the command. A user who does not have permission to execute certain commands due to additional authorization rules on the TACACS+ server, then gets permission to execute those commands in this scenario. This action introduces a privilege escalation.

- Remote authorization using *TACACS+* without any failover option (that is, with the **aaa authorization commands default group tacacs+** configuration)

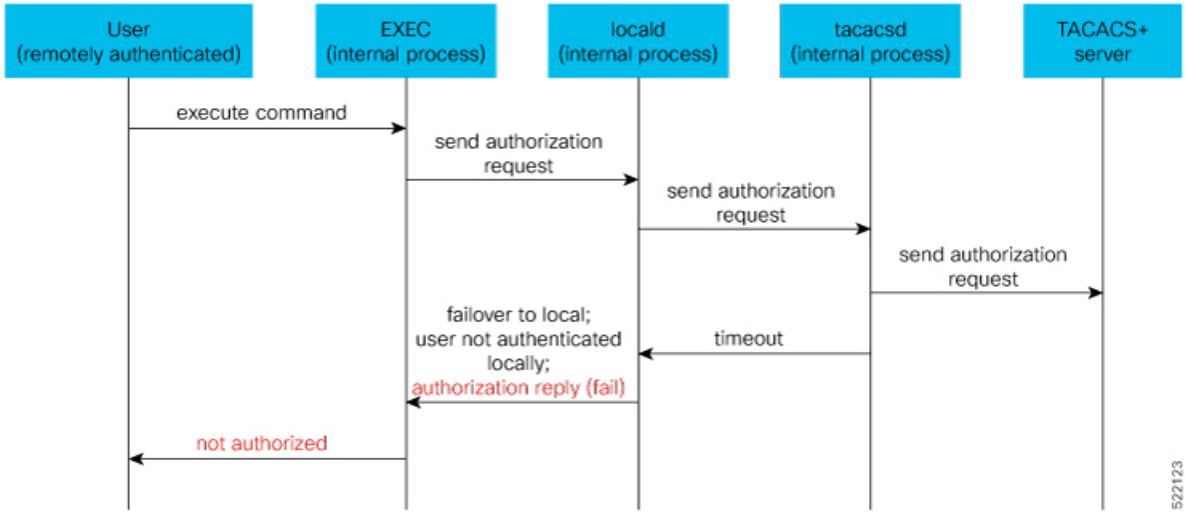
  If TACACS+ server is not reachable, then the system does not authorize the command at all. Because the user then cannot execute any command, the router gets locked out.

With the introduction of command authorization using local user account feature in Cisco IOS XR Software Release 7.5.1, locally authenticated users can execute commands even if a TACACS+ server is not reachable. This behavior is similar to the behavior with the failover option *none*, with the only difference that only locally authenticated users can execute commands in this case. This functionality thereby prevents a complete lockdown of the router as mentioned in one of the previously existing scenarios mentioned earlier. At the same time, the feature also prevents users who are authenticated remotely (that is, TACACS+ authenticated users) from executing any non-permitted command on the router. This behavior in turn helps to prevent any sort of misuse of user privileges on the router.

Call Flow of Command Authorization

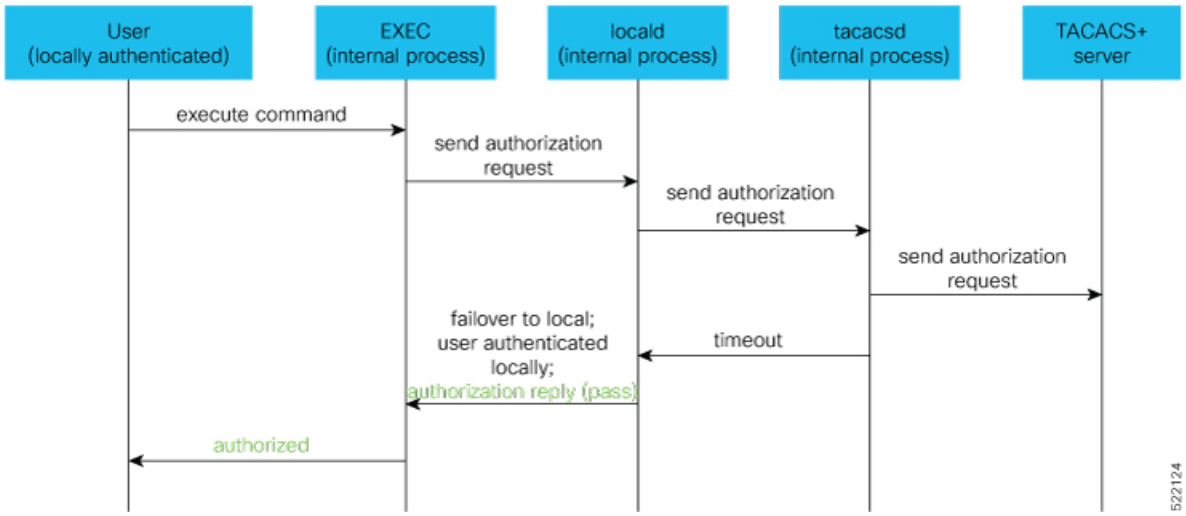
Consider a scenario where the user is remotely authenticated. In the event of timeout from the TACACS+ server, the command authorization fails. The user cannot execute any command until the TACACS+ server is reachable again, thereby preventing misuse of user privileges on the router.

Figure 3: Call Flow of Command Authorization for Remotely Authenticated Users



Consider a scenario where the user is locally authenticated. The command authorization still succeeds even if the authorization request to the TACACS+ server times out. There is no additional check done by the local AAA component in the router. As a result, the user can execute the command irrespective of the fact that the TACACS+ server is not reachable. This functionality prevents a complete lockdown of the router.

Figure 4: Call Flow of Command Authorization for Locally Authenticated Users



Configure Command Authorization Using Local User Account

Guidelines

Although there is no restriction in configuring local command authorization, you must be cautious to prevent any potential lockout due to misconfiguration. For instance, if *local* is the only method of authorization specified for the commands, a remotely authenticated user configuring command authorization using local user account feature cannot execute further commands.

Configuration Example

To configure command authorization using local user account, use the **local** option in the **aaa authorization** command in any of these formats:

```
Router#configure
Router(config)#aaa authorization commands default group tacacs+ local
```

Or

```
Router(config)#aaa authorization commands default local
```

Running Configuration

```
Router#show run aaa
!
aaa authorization commands default group tacacs+ local
!
```

```
Router#show run aaa
!
aaa authorization commands default local
!
```

Verification

```
Router#show user authentication method
local
```

Feature Behavior and Use Case Scenarios

Feature Behavior With Various Local Command Authorization Options

This table lists the feature behavior scenarios with various local command authorization options.

Table 17: Feature Behavior with Various Local Command Authorization Options

AAA Configuration	Expected Behavior
aaa authorization commands default group tacacs+ local	If TACACS+ server is not reachable, system allows locally authenticated users to execute the command. If TACACS+ server is reachable and if it returns an authorization failure, then the system does not perform any failover to local authentication with this configuration.
aaa authorization commands default local	This configuration allows only locally authenticated users to execute commands. System completely blocks remote users from executing any command.
aaa authorization commands default local group tacacs+	In this scenario, system chooses local authorization first and grants access if the user is locally authenticated. If not, the request fails over to TACACS+ server. This combination of command options is useful when both local and remote authenticated users want to execute commands when TACACS+ server is reachable.
aaa authorization commands default local none	Although configurable, this combination of command options does not provide any additional security with respect to user access. It is equivalent to having no authorization.

Use Case Scenarios of Command Authorization

In the following scenarios, local user refers to user whose is authenticated locally and whose profile is available locally, but not available on the remote server (TACACS+ server). Similarly, remote user refers to user whose is authenticated remotely and whose profile is available on the remote server, but not available locally. And, both local user and remote user are considered to have *root-lr* permission to execute the commands, in these scenarios.

Table 18: Use Case Scenarios of Command Authorization

Type of User (local or remote)	AAA Configuration Summary	Use Case Scenario	Expected Behavior
Local and remote user	No command authorization configured	Execute a command	Command authorization succeeds if the required task-IDs are available
Local user	Only *tacacs+ command authorization* configured.	Execute a command when TACACS+ server is reachable	Command authorization fails
		Execute a command when TACACS+ server is not reachable	Command authorization fails

Remote user	Only *tacacs+ command authorization* configured	Execute a command when TACACS+ server is reachable	Command authorization succeeds
			`Router#show run aaa authorization`
			`aaa authorization commands default group tacacs+`

		Execute a command when TACACS+ server is not reachable	Command authorization fails
Local user	Only *tacacs+ command authorization* configured with failover option as *none*.	Execute a command when TACACS+ server is reachable	Command authorization fails

		Execute a command when TACACS+ server is not reachable	Command authorization succeeds
			`Router#show user authentication method`
			`local`

Remote user	Only *tacacs+ command authorization* configured with failover option as *none*.	Execute a command that is restricted only to that user when TACACS+ server is reachable	Command authorization fails
		Execute a command that is restricted only to that user when TACACS+ server is not reachable	Command authorization succeeds

Type of User (local or remote)	AAA Configuration Summary	Use Case Scenario	Expected Behavior

Local user	Only *local command authorization* configured.	Execute a command	Command authorization succeeds
			`Router#show run aaa authentication`
			`aaa authentication login default group tacacs+ local`

Remote user	Only *local command authorization* configured.	Execute a command	Command authorization fails
Local user	Only *tacacs+ command authorization* configured with failover option as *local*.	Execute a command when TACACS+ server is reachable	Command authorization fails

		Execute a command when TACACS+ server is not reachable	Command authorization succeeds
			`Router#show run aaa authorization`
			`aaa authorization commands default group tacacs+ local`

Remote user	Only *tacacs+ command authorization* configured with failover option as *local*.	Execute a command when TACACS+ server is reachable	Command authorization succeeds
			`Router#show run aaa authorization`
			`aaa authorization commands default group tacacs+ local`

		Execute a command when TACACS+ server is not reachable	Command authorization fails

Additional References

The following sections provide references related to configuring AAA services.

Related Documents

Related Topic	Document Title
AAA services commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Authentication, Authorization, and Accounting Commands on* the Cisco ASR 9000 Series Router in the

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport