Configuring Authorization and Revocation of Certificates in a PKI

This module describes the authorization and revocation of certificates in a public key infrastructure (PKI).

- Prerequisites for Authorization and Revocation of Certificates, on page 1
- Restrictions for Authorization and Revocation of Certificates, on page 2
- Information About Authorization and Revocation of Certificates, on page 2
- How to Configure Authorization and Revocation of Certificates in a PKI, on page 9
- Configuration Examples for Authorization and Revocation of Certificates in a PKI, on page 24
- Feature History for Authorization and Revocation of Certificates in a PKI, on page 38

Prerequisites for Authorization and Revocation of Certificates

Plan Your PKI Strategy

Tip It is strongly recommended that you plan your entire PKI strategy before you begin to deploy actual certificates.

Authorization and revocation can occur only after you or a network administrator have completed the following tasks:

- Configured the certificate authority (CA).
- Enrolled peer devices with the CA.
- Identified and configured the protocol (such as IPsec or secure socket layer [SSL]) that is to be used for peer-to-peer communication.

You should decide which authorization and revocation strategy you are going to configure before enrolling peer devices because the peer device certificates might have to contain authorization and revocation-specific information.

High Availability

For high availability, IPsec-secured Stream Control Transmission Protocol (SCTP) must be configured on both the active and the standby devices. For synchronization to work, the redundancy mode on the certificate servers must be set to ACTIVE/STANDBY after you configure SCTP.

Restrictions for Authorization and Revocation of Certificates

Depending on your Cisco IOS XE release, Lightweight Directory Access Protocol (LDAP) is supported.

Information About Authorization and Revocation of Certificates

PKI Authorization

PKI authentication does not provide authorization. Current solutions for authorization are specific to the router that is being configured, although a centrally managed solution is often required.

There is not a standard mechanism by which certificates are defined as authorized for some tasks and not for others. This authorization information can be captured in the certificate itself if the application is aware of the certificate-based authorization information. But this solution does not provide a simple mechanism for real-time updates to the authorization information and forces each application to be aware of the specific authorization information embedded in the certificate.

When the certificate-based access control list (ACL) mechanism is configured as part of the trustpoint authentication, the application is no longer responsible for determining this authorization information, and it is no longer possible to specify for which application the certificate is authorized. In some cases, the certificate-based ACL on the router gets so large that it cannot be managed. Additionally, it is beneficial to retrieve certificate-based ACL indications from an external server.

Current solutions to the real-time authorization problem involve specifying a new protocol and building a new server (with associated tasks, such as management and data distribution).

PKI and AAA Server Integration for Certificate Status

Integrating your PKI with an authentication, authorization, and accounting (AAA) server provides an alternative online certificate status solution that leverages the existing AAA infrastructure. Certificates can be listed in the AAA database with appropriate levels of authorization. For components that do not explicitly support PKI-AAA, a default label of “all” from the AAA server provides authorization. Likewise, a label of “none” from the AAA database indicates that the specified certificate is not valid. (The absence of any application label is equivalent, but “none” is included for completeness and clarity). If the application component does support PKI-AAA, the component may be specified directly; for example, the application component could be “ipsec,” “ssl,” or “osp.” (ipsec=IP Security, ssl=Secure Sockets Layer, and osp=Open Settlement Protocol.)

Note Currently, no application component supports specification of the application label.

- There may be a time delay when accessing the AAA server. If the AAA server is not available, the authorization fails.

RADIUS or TACACS+ Choosing a AAA Server Protocol

The AAA server can be configured to work with either the RADIUS or TACACS+ protocol. When you are configuring the AAA server for the PKI integration, you must set the RADIUS or TACACS attributes that are required for authorization.

If the RADIUS protocol is used, the password that is configured for the username in the AAA server should be set to "cisco," which is acceptable because the certificate validation provides authentication and the AAA database is only being used for authorization. When the TACACS protocol is used, the password that is configured for the username in the AAA server is irrelevant because TACACS supports authorization without requiring authentication (the password is used for authentication).

In addition, if you are using TACACS, you must add a PKI service to the AAA server. The custom attribute "cert-application=all" is added under the PKI service for the particular user or usergroup to authorize the specific username.

Attribute-Value Pairs for PKI and AAA Server Integration

The table below lists the attribute-value (AV) pairs that are to be used when setting up PKI integration with a AAA server. (Note the values shown in the table are possible values.) The AV pairs must match the client configuration. If they do not match, the peer certificate is not authorized.

Note Users can sometimes have AV pairs that are different from those of every other user. As a result, a unique username is required for each user. The **all** parameter (within the **authorization username** command) specifies that the entire subject name of the certificate will be used as the authorization username.

Table 1: AV Pairs That Must Match

AV Pair	Value
cisco-avpair=pki:cert-application=all	Valid values are "all" and "none."
cisco-avpair=pki:cert-trustpoint=msca	The value is a Cisco IOS XE command-line interface (CLI) configuration trustpoint label. **Note** The cert-trustpoint AV pair is normally optional. If it is specified, the device query must be coming from a certificate trustpoint that has a matching label, and the certificate that is authenticated must have the specified certificate serial number.
cisco-avpair=pki:cert-serial=16318DB7000100001671	The value is a certificate serial number. **Note** The cert-serial AV pair is normally optional. If it is specified, the Cisco device query must be coming from a certificate trustpoint that has a matching label, and the certificate that is authenticated must have the specified certificate serial number.

AV Pair	Value
cisco-avpair=pki:cert-lifetime-end=1:00 jan 1, 2003	The cert-lifetime-end AV pair is available to artificially extend a certificate lifetime beyond the time period that is indicated in the certificate itself. If the cert-lifetime-end AV pair is used, the cert-trustpoint and cert-serial AV pairs must also be specified. The value must match the following form: hours:minutes month day, year. **Note** Only the first three characters of a month are used: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. If more than three characters are entered for the month, the remaining characters are ignored (for example Janxxxx).

CRLs or OCSP Server Choosing a Certificate Revocation Mechanism

After a certificate is validated as a properly signed certificate, a certificate revocation method is performed to ensure that the certificate has not been revoked by the issuing CA. Cisco IOS XE software supports two revocation mechanisms--certificate revocation lists (CRLs) and Online Certificate Status Protocol (OCSP). Cisco IOS XE software also supports AAA integration for certificate checking; however, additional authorization functionality is included. For more information on PKI and AAA certificate authorization and status check, see the PKI and AAA Server Integration for Certificate Status section.

The following sections explain how each revocation mechanism works:

What Is a CRL

A certificate revocation list (CRL) is a list of revoked certificates. The CRL is created and digitally signed by the CA that originally issued the certificates. The CRL contains dates for when each certificate was issued and when it expires.

CAs publish new CRLs periodically or when a certificate for which the CA is responsible has been revoked. By default, a new CRL is downloaded after the currently cached CRL expires. An administrator may also configure the duration for which CRLs are cached in router memory or disable CRL caching completely. The CRL caching configuration applies to all CRLs associated with a trustpoint.

When the CRL expires, the router deletes it from its cache. A new CRL is downloaded when a certificate is presented for verification; however, if a newer version of the CRL that lists the certificate under examination is on the server but the router is still using the CRL in its cache, the router does not know that the certificate has been revoked. The certificate passes the revocation check even though it should have been denied.

When a CA issues a certificate, the CA can include in the certificate the CRL distribution point (CDP) for that certificate. Cisco IOS client devices use CDPs to locate and load the correct CRL. The Cisco IOS client supports multiple CDPs, but the Cisco IOS CA currently supports only one CDP; however, third-party vendor CAs may support multiple CDPs or different CDPs per certificate. If a CDP is not specified in the certificate, the client device uses the default Simple Certificate Enrollment Protocol (SCEP) method to retrieve the CRL. (The CDP location can be specified through the **cdp-url**command.)

When implementing CRLs, you should consider the following design considerations:

- CRL lifetimes and the security association (SA) and Internet Key Exchange (IKE) lifetimes.
- The CRL lifetime determines the length of time between CA-issued updates to the CRL. The default CRL lifetime value, which is 168 hours [1 week], can be changed through the **lifetime crl** command.
- The method of the CDP determines how the CRL is retrieved; some possible choices include HTTP, Lightweight Directory Access Protocol (LDAP), SCEP, or TFTP. HTTP, TFTP, and LDAP are the most commonly used methods. Although Cisco IOS software defaults to SCEP, an HTTP CDP is recommended for large installations using CRLs because HTTP can be made highly scalable.
- The location of the CDP determines from where the CRL is retrieved; for example, you can specify the server and file path from which to retrieve the CRL.

Querying All CDPs During Revocation Check

When a CDP server does not respond to a request, the Cisco IOS XE software reports an error, which may result in the peer's certificate being rejected. To prevent a possible certificate rejection and if there are multiple CDPs in a certificate, the Cisco IOS XE software will attempt to use the CDPs in the order in which they appear in the certificate. The device will attempt to retrieve a CRL using each CDP URL or directory specification. If an error occurs using a CDP, an attempt will be made using the next CDP.

Tip Although the Cisco IOS XE software will make every attempt to obtain the CRL from one of the indicated CDPs, it is recommended that you use an HTTP CDP server with high-speed redundant HTTP servers to avoid application timeouts because of slow CDP responses.

What Is OCSP

OCSP is an online mechanism that is used to determine certificate validity and provides the following flexibility as a revocation mechanism:

- OCSP can provide real-time certificate status checking.
- OCSP allows the network administrator to specify a central OCSP server, which can service all devices within a network.
- OCSP also allows the network administrator the flexibility to specify multiple OCSP servers, either per client certificate or per group of client certificates.
- OCSP server validation is usually based on the root CA certificate or a valid subordinate CA certificate, but may also be configured so that external CA certificates or self-signed certificates may be used. Using external CA certificates or self-signed certificates allows the OCSP servers certificate to be issued and validated from an alternative PKI hierarchy.

A network administrator can configure an OCSP server to collect and update CRLs from different CA servers. The devices within the network can rely on the OCSP server to check the certificate status without retrieving and caching each CRL for every peer. When peers have to check the revocation status of a certificate, they send a query to the OCSP server that includes the serial number of the certificate in question and an optional unique identifier for the OCSP request, or a nonce. The OCSP server holds a copy of the CRL to determine if the CA has listed the certificate as being revoked; the server then responds to the peer including the nonce. If the nonce in the response from the OCSP server does not match the original nonce sent by the peer, the response is considered invalid and certificate verification fails. The dialog between the OCSP server and the peer consumes less bandwidth than most CRL downloads.

If the OCSP server is using a CRL, CRL time limitations will be applicable; that is, a CRL that is still valid might be used by the OCSP server although a new CRL has been issued by the CRL containing additional certificate revocation information. Because fewer devices are downloading the CRL information on a regular basis, you can decrease the CRL lifetime value or configure the OCSP server not to cache the CRL. For more information, check your OCSP server documentation.

Note OCSP multiple response handling: Support has been enabled for handling of multiple OCSP single responses from an OCSP responder in a response packet. In addition to the debug log messages the following debug log message will be displayed:

CRYPTO_PKI: Number of single Responses in OCSP response:1(this value can change depending upon the number of responses).

When to Use an OCSP Server

OCSP may be more appropriate than CRLs if your PKI has any of the following characteristics:

- Real-time certificate revocation status is necessary. CRLs are updated only periodically and the latest CRL may not always be cached by the client device. For example, if a client does not yet have the latest CRL cached and a newly revoked certificate is being checked, that revoked certificate will successfully pass the revocation check.
- There are a large number of revoked certificates or multiple CRLs. Caching a large CRL consumes large portions of Cisco IOS memory and may reduce resources available to other processes.
- CRLs expire frequently, causing the CDP to handle a larger load of CRLs.

When to Use Certificate-Based ACLs for Authorization or Revocation

Certificates contain several fields that are used to determine whether a device or user is authorized to perform a specified action.

Because certificate-based ACLs are configured on the device, they do not scale well for large numbers of ACLs; however, certificate-based ACLs do provide very granular control of specific device behavior. Certificate-based ACLs are also leveraged by additional features to help determine when PKI components such as revocation, authorization, or a trustpoint should be used. They provide a general mechanism allowing users to select a specific certificate or a group of certificates that are being validated for either authorization or additional processing.

Certificate-based ACLs specify one or more fields within the certificate and an acceptable value for each specified field. You can specify which fields within a certificate should be checked and which values those fields may or may not have.

There are six logical tests for comparing the field with the value--equal, not equal, contains, does not contain, less than, and greater than or equal. If more than one field is specified within a single certificate-based ACL, the tests of all of the fields within the ACL must succeed to match the ACL. The same field may be specified multiple times within the same ACL. More than one ACL may be specified, and ACL will be processed in turn until a match is found or all of the ACLs have been processed.

Ignore Revocation Checks Using a Certificate-Based ACL

Certificate-based ACLs can be configured to instruct your router to ignore the revocation check and expired certificates of a valid peer. Thus, a certificate that meets the specified criteria can be accepted regardless of the validity period of the certificate, or if the certificate meets the specified criteria, revocation checking does not have to be performed. You can also use a certificate-based ACL to ignore the revocation check when the communication with a AAA server is protected with a certificate.

Ignoring Revocation Lists

To allow a trustpoint to enforce CRLs except for specific certificates, enter the **match certificate**command with the **skip revocation-check** keyword. This type of enforcement is most useful in a hub-and-spoke configuration in which you also want to allow direct spoke-to-spoke connections. In pure hub-and-spoke configurations, all spokes connect only to the hub, so CRL checking is necessary only on the hub. For one spoke to communicate directly with another spoke, the **match certificate**command with the **skip revocation-check** keyword can be used for neighboring peer certificates instead of requiring a CRL on each spoke.

Ignoring Expired Certificates

To configure your router to ignore expired certificates, enter the **match certificate** command with the **allow expired-certificate** keyword. This command has the following purposes:

- If the certificate of a peer has expired, this command may be used to "allow" the expired certificate until the peer can obtain a new certificate.
- If your router clock has not yet been set to the correct time, the certificate of a peer will appear to be not yet valid until the clock is set. This command may be used to allow the certificate of the peer even though your router clock is not set.

Note If Network Time Protocol (NTP) is available only via the IPSec connection (usually via the hub in a hub-and-spoke configuration), the router clock can never be set. The tunnel to the hub cannot be "brought up" because the certificate of the hub is not yet valid.

- "Expired" is a generic term for a certificate that is expired or that is not yet valid. The certificate has a start and end time. An expired certificate, for purposes of the ACL, is one for which the current time of the router is outside the start and end times specified in the certificate.

Skipping the AAA Check of the Certificate

If the communication with an AAA server is protected with a certificate, and you want to skip the AAA check of the certificate, use the **match certificate** command with the **skip authorization-check** keyword. For example, if a virtual private network (VPN) tunnel is configured so that all AAA traffic goes over that tunnel, and the tunnel is protected with a certificate, you can use the **match certificate** command with the **skip authorization-check** keyword to skip the certificate check so that the tunnel can be established.

The **match certificate**command and the **skip authorization-check** keyword should be configured after PKI integration with an AAA server is configured.

Note If the AAA server is available only via an IPSec connection, the AAA server cannot be contacted until after the IPSec connection is established. The IPSec connection cannot be "brought up" because the certificate of the AAA server is not yet valid.

PKI Certificate Chain Validation

A certificate chain establishes a sequence of trusted certificates --from a peer certificate to the root CA certificate. Within a PKI hierarchy, all enrolled peers can validate the certificate of one another if the peers share a trusted root CA certificate or a common subordinate CA. Each CA corresponds to a trustpoint.

When a certificate chain is received from a peer, the default processing of a certificate chain path continues until the first trusted certificate, or trustpoint, is reached. An administrator may configure the level to which a certificate chain is processed on all certificates including subordinate CA certificates.

Configuring the level to which a certificate chain is processed allows for the reauthentication of trusted certificates, the extension of a trusted certificate chain, and the completion of a certificate chain that contains a gap.

Reauthentication of Trusted Certificates

The default behavior is for the device to remove any trusted certificates from the certificate chain sent by the peer before the chain is validated. An administrator may configure certificate chain path processing so that the device does not remove CA certificates that are already trusted before chain validation, so that all certificates in the chain are re-authenticated for the current session.

Extending the Trusted Certificate Chain

The default behavior is for the device to use its trusted certificates to extend the certificate chain if there are any missing certificates in the certificate chain sent by the peer. The device will validate only certificates in the chain sent by the peer. An administrator may configure certificate chain path processing so that the certificates in the peer's certificate chain and the device's trusted certificates are validated to a specified point.

Completing Gaps in a Certificate Chain

An administrator may configure certificate chain processing so that if there is a gap in the configured trustpoint hierarchy, certificates sent by the peer can be used to complete the set of certificates to be validated.

Note If the trustpoint is configured to require parent validation and the peer does not provide the full certificate chain, the gap cannot be completed and the certificate chain is rejected and invalid.

Note It is a configuration error if the trustpoint is configured to require parent validation and there is no parent trustpoint configured. The resulting certificate chain gap cannot be completed and the subordinate CA certificate cannot be validated. The certificate chain is invalid.

How to Configure Authorization and Revocation of Certificates in a PKI

Configuring PKI Integration with a AAA Server

Perform this task to generate a AAA username from the certificate presented by the peer and specify which fields within a certificate should be used to build the AAA database username.

Note The following restrictions should be considered when using the **all** keyword as the subject name for the **authorization username** command:

- Some AAA servers limit the length of the username (for example, to 64 characters). As a result, the entire certificate subject name cannot be longer than the limitation of the server.
- Some AAA servers limit the available character set that may be used for the username (for example, a space [ ] and an equal sign [=] may not be acceptable). You cannot use the **all** keyword for a AAA server having such a character-set limitation.
- The **subject-name** command in the trustpoint configuration may not always be the final AAA subject name. If the fully qualified domain name (FQDN), serial number, or IP address of the router are included in a certificate request, the subject name field of the issued certificate will also have these components. To turn off the components, use the **fqdn**, **serial-number**, and **ip-address** commands with the **none** keyword.
- CA servers sometimes change the requested subject name field when they issue a certificate. For example, CA servers of some vendors switch the relative distinguished names (RDNs) in the requested subject names to the following order: CN, OU, O, L, ST, and C. However, another CA server might append the configured LDAP directory root (for example, O=cisco.com) to the end of the requested subject name.
- Depending on the tools you choose for displaying a certificate, the printed order of the RDNs in the subject name could be different. Cisco IOS software always displays the least significant RDN first, but other software, such as Open Source Secure Socket Layer (OpenSSL), does the opposite. Therefore, if you are configuring a AAA server with a full distinguished name (DN) (subject name) as the corresponding username, ensure that the Cisco IOS software style (that is, with the least significant RDN first) is used.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`Device# configure terminal`	
Step 3	**aaa new-model** **Example:** `Device(config)# aaa new-model`	Enables the AAA access control model.
Step 4	**aaa authorization network** *listname* [*method*] **Example:** `Device(config)# aaa authorization network maxaaa group tacacs+`	Sets the parameters that restrict user access to a network. • *method* : Can be **group radius**, **group tacacs+**, or **group group-name**.
Step 5	**crypto pki trustpoint** *name* **Example:** `Device(config)# crypto pki trustpoint msca`	Declares the trustpoint and a given name and enters ca-trustpoint configuration mode.

Step 6	**enrollment** [**mode**] [**retry period** *minutes*] [**retry count** *number*] **url** *url* [**pem**]
	Example:
	`Device(ca-trustpoint)# enrollment url http://caserver.myexample.com`
	- or-
	`Device(ca-trustpoint)# enrollment url http://[2001:DB8:1:1::1]:80`
		Specifies the following enrollment parameters of the CA:
		• (Optional) The **mode** keyword specifies the registration authority (RA) mode, if your CA system provides an RA. By default, RA mode is disabled.
		• (Optional) The **retry period** keyword and *minutes* argument specifies the period, in minutes, in which the router waits before sending the CA another certificate request. Valid values are from 1 to 60. The default is 1.
		• (Optional) The **retry count** keyword and *number* argument specifies the number of times a router will resend a certificate request when it does not receive a response from the previous request. Valid values are from 1 to 100. The default is 10.
		• The *url* argument is the URL of the CA to which your router should send certificate requests.
		Note
		An IPv6 address can be added to the **http:** enrollment method. For example: http://[ipv6-address]:80. The IPv6 address must be enclosed in brackets in the URL.

	Command or Action	Purpose
		• (Optional) The **pem** keyword adds privacy-enhanced mail (PEM) boundaries to the certificate request.
Step 7	revocation-check method **Example:** `Device(ca-trustpoint)# revocation-check crl`	(Optional) Checks the revocation status of a certificate.
Step 8	**exit** **Example:** `Device(ca-trustpoint)# exit`	Exits ca-trustpoint configuration mode and returns to global configuration mode.
Step 9	**authorization username subjectname** *subjectname* **Example:** `Device(config)# authorization username subjectname serialnumber`	Sets parameters for the different certificate fields that are used to build the AAA username. The *subjectname* argument can be any of the following: • **all**: Entire distinguished name (subject name) of the certificate. • **commonname**: Certification common name. • **country**: Certificate country. • **email**: Certificate e-mail. • **ipaddress**: Certificate IP address. • **locality**: Certificate locality. • **organization**: Certificate organization. • **organizationalunit**: Certificate organizational unit. • **postalcode**: Certificate postal code. • **serialnumber**: Certificate serial number. • **state**: Certificate state field. • **streetaddress**: Certificate street address. • **title**: Certificate title. • **unstructuredname**: Certificate unstructured name.
Step 10	**authorization list** *listname* **Example:**	Specifies the AAA authorization list.

	Command or Action	Purpose
	`Device(config)# authorization list maxaaa`	
Step 11	**tacacs server** *server-name* **Example:** `Device(config)# tacacs server yourserver`	Specifies a TACACS+ server.
Step 12	**address** {**ipv4** | **ipv6**} *ip-address* **Example:** `Device(config-server-tacacs)# address ipv4 192.0.2.2`	Configures the IP address for the TACACS server.
Step 13	**key** *string* **Example:** `Device(config-server-tacacs)# key a_secret_key`	Configures the authorization and encryption key used between the switch and the TACACS server.
Step 14	**end** **Example:** `Device(config-server-tacacs)# end` **Example:**	Returns to privileged EXEC mode.

Troubleshooting Tips

To display debug messages for the trace of interaction (message type) between the CA and the router, use the **debug crypto pki transactions**command. (See the sample output, which shows a successful PKI integration with AAA server exchange and a failed PKI integration with AAA server exchange.)

Successful Exchange

```
Device# debug crypto pki transactions

Apr 22 23:15:03.695: CRYPTO_PKI: Found a issuer match
Apr 22 23:15:03.955: CRYPTO_PKI: cert revocation status unknown.
Apr 22 23:15:03.955: CRYPTO_PKI: Certificate validated without revocation check
```

Each line that shows “CRYPTO_PKI_AAA” indicates the state of the AAA authorization checks. Each of the AAA AV pairs is indicated, and then the results of the authorization check are shown.

```
Apr 22 23:15:04.019: CRYPTO_PKI_AAA: checking AAA authorization (ipsecca_script_aaalist,
PKIAAA-L, <all>)
Apr 22 23:15:04.503: CRYPTO_PKI_AAA: reply attribute ("cert-application" = "all")
Apr 22 23:15:04.503: CRYPTO_PKI_AAA: reply attribute ("cert-trustpoint" = "CA1")
Apr 22 23:15:04.503: CRYPTO_PKI_AAA: reply attribute ("cert-serial" = "15DE")
Apr 22 23:15:04.503: CRYPTO_PKI_AAA: authorization passed
Apr 22 23:12:30.327: CRYPTO_PKI: Found a issuer match
```

Failed Exchange

```
Device# debug crypto pki transactions

Apr 22 23:11:13.703: CRYPTO_PKI_AAA: checking AAA authorization =
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: reply attribute ("cert-application" = "all")
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: reply attribute ("cert-trustpoint"= "CA1")
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: reply attribute ("cert-serial" = "233D")
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: parsed cert-lifetime-end as: 21:30:00
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: timezone specific extended
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: cert-lifetime-end is expired
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: cert-lifetime-end check failed.
Apr 22 23:11:14.203: CRYPTO_PKI_AAA: authorization failed
```

In the above failed exchange, the certificate has expired.

Configuring a Revocation Mechanism for PKI Certificate Status Checking

Perform this task to set up a CRL as the certificate revocation mechanism--CRLs or OCSP--that is used to check the status of certificates in a PKI.

The revocation-check Command

Use the **revocation-check** command to specify at least one method (OCSP, CRL, or skip the revocation check) that is to be used to ensure that the certificate of a peer has not been revoked. For multiple methods, the order in which the methods are applied is determined by the order specified via this command.

If your device does not have the applicable CRL and is unable to obtain one or if the OCSP server returns an error, your device will reject the peer's certificate--unless you include the **none** keyword in your configuration. If the **none** keyword is configured, a revocation check will not be performed and the certificate will always be accepted.

Nonces and Peer Communications with OCSP Servers

When using OCSP, nonces, unique identifiers for OCSP requests, are sent by default during peer communications with your OCSP server. The use of nonces offers a more secure and reliable communication channel between the peer and OCSP server.

If your OCSP server does not support nonces, you may disable the sending of nonces. For more information, see your OCSP server documentation.

Before you begin

- Before issuing any client certificates, the appropriate settings on the server (such as setting the CDP) should be configured.
- When configuring an OCSP server to return the revocation status for a CA server, the OCSP server must be configured with an OCSP response signing certificate that is issued by that CA server. Ensure that the signing certificate is in the correct format, or the router will not accept the OCSP response. See your OCSP manual for additional information.

Note

- OCSP transports messages over HTTP, so there may be a time delay when you access the OCSP server.
- If the OCSP server depends on normal CRL processing to check revocation status, the same time delay that affects CRLs will also apply to OCSP.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto pki trustpoint** *name* **Example:** `Device(config)# crypto pki trustpoint hazel`	Declares the trustpoint and a given name and enters ca-trustpoint configuration mode.

Step 4	**ocsp url** *url*
	Example:
	`Device(ca-trustpoint)# ocsp url http://ocsp-server`
	- or -
	`Device(ca-trustpoint)# ocsp url http://10.10.10.1:80`
	- or -
	`Device(ca-trustpoint)# ocsp url http://[2001DB8:1:1::2]:80`
		The *url* argument specifies the URL of an OCSP server so that the trustpoint can check the certificate status. This URL overrides the URL of the OCSP server (if one exists) in the Authority Info Access (AIA) extension of the certificate. All certificates associated with a configured trustpoint are checked by the OCSP server. The URL can be a hostname, IPv4 address, or an IPv6 address.

Step 5	**revocation-check** *method1* [*method2 method3*]] **Example:** `Device(ca-trustpoint)# revocation-check ocsp none`	Checks the revocation status of a certificate. • **crl** —Certificate checking is performed by a CRL. This is the default option. • **none** —Certificate checking is ignored. • **ocsp** —Certificate checking is performed by an OCSP server.

	Command or Action	Purpose
		If a second and third method are specified, each method will be used only if the previous method returns an error, such as a server being down.
Step 6	**ocsp disable-nonce** **Example:** `Device(ca-trustpoint)# ocsp disable-nonce`	(Optional) Specifies that a nonce, or an OCSP request unique identifier, will not be sent during peer communications with the OCSP server.
Step 7	**end** **Example:** `Device(ca-trustpoint)# end`	Exits ca-trustpoint configuration mode and returns to privileged EXEC mode.
Step 8	**show crypto pki certificates** **Example:** `Device# show crypto pki certificates`	(Optional) Displays information about your certificates.
Step 9	**show crypto pki trustpoints** [**status** | *label* [**status**]] **Example:** `Device# show crypto pki trustpoints`	Displays information about the trustpoint configured in router.

Configuring Certificate Authorization and Revocation Settings

Perform this task to specify a certificate-based ACL, to ignore revocation checks or expired certificates, to manually override the default CDP location, to manually override the OCSP server setting, to configure CRL caching, or to set session acceptance or rejection based on a certificate serial number, as appropriate.

Configuring Certificate-Based ACLs to Ignore Revocation Checks

To configure your router to use certificate-based ACLs to ignore revocation checks and expired certificates, perform the following steps:

- Identify an existing trustpoint or create a new trustpoint to be used when verifying the certificate of the peer. Authenticate the trustpoint if it has not already been authenticated. The router may enroll with this trustpoint if you want. Do not set optional CRLs for the trustpoint if you plan to use the **match certificate** command and **skip revocation-check** keyword.
- Determine the unique characteristics of the certificates that should not have their CRL checked and of the expired certificates that should be allowed.
- Define a certificate map to match the characteristics identified in the prior step.
- You can add the **match certificate** command and **skip revocation-check** keyword and the **match certificate command** and **allow expired-certificate** keyword to the trustpoint that was created or identified in the first step.

Note Certificate maps are checked even if the peer's public key is cached. For example, when the public key is cached by the peer, and a certificate map is added to the trustpoint to ban a certificate, the certificate map is effective. This prevents a client with the banned certificate, which was once connected in the past, from reconnecting.

Manually Overriding CDPs in a Certificate

Users can override the CDPs in a certificate with a manually configured CDP. Manually overriding the CDPs in a certificate can be advantageous when a particular server is unavailable for an extended period of time. The certificate's CDPs can be replaced with a URL or directory specification without reissuing all of the certificates that contain the original CDP.

Manually Overriding the OCSP Server Setting in a Certificate

Administrators can override the OCSP server setting specified in the Authority Information Access (AIA) field of the client certificate or set by the issuing the **ocsp url** command. One or more OCSP servers may be manually specified, either per client certificate or per group of client certificates by the **match certificate override ocsp** command. The **match certificate override ocsp**command overrides the client certificate AIA field or the **ocsp url**command setting if a client certificate is successfully matched to a certificate map during the revocation check.

Note Only one OCSP server can be specified per client certificate.

Configuring CRL Cache Control

By default, a new CRL will be downloaded after the currently cached CRL expires. Administrators can either configure the maximum amount of time in minutes a CRL remains in the cache by issuing the **crl cache delete-after** command or disable CRL caching by issuing the **crl cache none** command. Only the **crl-cache delete-after**command or the **crl-cache none** command may be specified. If both commands are entered for a trustpoint, the last command executed will take effect and a message will be displayed.

Neither the **crl-cache none** command nor the **crl-cache delete-after** command affects the currently cached CRL. If you configure the **crl-cache none** command, all CRLs downloaded after this command is issued will not be cached. If you configure the **crl-cache delete-after** command, the configured lifetime will only affect CRLs downloaded after this command is issued.

This functionality is useful is when a CA issues CRLs with no expiration date or with expiration dates days or weeks ahead.

Configuring Certificate Serial Number Session Control

A certificate serial number can be specified to allow a certificate validation request to be accepted or rejected by the trustpoint for a session. A session may be rejected, depending on certificate serial number session control, even if a certificate is still valid. Certificate serial number session control may be configured by using either a certificate map with the **serial-number** field or an AAA attribute, with the **cert-serial-not** command.

Using certificate maps for session control allows an administrator to specify a single certificate serial number. Using the AAA attribute allows an administrator to specify one or more certificate serial numbers for session control.

Before you begin

- The trustpoint should be defined and authenticated before attaching certificate maps to the trustpoint.
- The certificate map must be configured before the CDP override feature can be enabled or the **serial-number** command is issued.
- The PKI and AAA server integration must be successfully completed to use AAA attributes as described in "PKI and AAA Server Integration for Certificate Status."

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto pki certificate map** *label sequence-number* **Example:** `Device(config)# crypto pki certificate map Group 10`	Defines values in a certificate that should be matched or not matched and enters ca-certificate-map configuration mode.
Step 4	*field-name match-criteria match-value* **Example:** `Device(ca-certificate-map)# subject-name co MyExample`	Specifies one or more certificate fields together with their matching criteria and the value to match. The *field-name* is one of the following case-insensitive name strings or a date: • **alt-subject-name** • **expires-on** • **issuer-name** • **name** • **serial-number** • **subject-name**

	Command or Action	Purpose
		• **unstructured-subject-name** • **valid-start** **Note** Date field format is dd mm yyyy hh:mm:ss or mmm dd yyyy hh:mm:ss. The *match-criteria* is one of the following logical operators: • **co** —contains (valid only for name fields and serial number field) • **eq** —equal (valid for name, serial number, and date fields) • **ge** —greater than or equal (valid only for date fields) • **lt** —less than (valid only for date fields) • **nc** —does not contain (valid only for name fields and serial number field) • **ne** —not equal (valid for name, serial number, and date fields) The *match-value*is the name or date to test with the logical operator assigned by match-criteria. **Note** Use this command only when setting up a certificate-based ACL—not when setting up a certificate-based ACL to ignore revocation checks or expired certificates.
Step 5	**exit** **Example:** `Device(ca-certificate-map)# exit`	Exits ca-certificate-map configuration mode and returns to global configuration mode.
Step 6	**crypto pki trustpoint** *name* **Example:** `Device(config)# crypto pki trustpoint Access2`	Declares the trustpoint, given name and enters ca-trustpoint configuration mode.
Step 7	Do one of the following: • **crl-cache none** • **crl-cache delete-after** *time*	(Optional) Disables CRL caching completely for all CRLs associated with the trustpoint. The **crl-cache none** command does not affect any currently cached CRLs. All CRLs

	Command or Action	Purpose

	Example:
	`Device(ca-trustpoint)# crl-cache none`
	Example:
	`Device(ca-trustpoint)# crl-cache delete-after 20`
		downloaded after this command is configured will not be cached.
		(Optional) Specifies the maximum time CRLs will remain in the cache for all CRLs associated with the trustpoint.
		• *time* —The amount of time in minutes before the CRL is deleted.
		The **crl-cache delete-after** command does not affect any currently cached CRLs. The configured lifetime will only affect CRLs downloaded after this command is configured.

Step 8	**match certificate** *certificate-map-label* [**allow expired-certificate** | **skip revocation-check** | **skip authorization-check** **Example:** `Device(ca-trustpoint)# match certificate Group skip revocation-check`	(Optional) Associates the certificate-based ACL (that was defined via the **crypto pki certificate map** command) to a trustpoint. • *certificate-map-label* —Must match the *label* argument specified via the **crypto pki certificate map** command. • **allowexpired-certificate** —Ignores expired certificates. • **skip revocation-check** —Allows a trustpoint to enforce CRLs except for specific certificates. • **skip authorization-check** —Skips the AAA check of a certificate when PKI integration with an AAA server is configured.
Step 9	**match certificate** *certificate-map-label* **override cdp** {**url** | **directory**} *string* **Example:** `Device(ca-trustpoint)# match certificate Group1 override cdp url http://server.cisco.com`	(Optional) Manually overrides the existing CDP entries for a certificate with a URL or directory specification. • *certificate-map-label* —A user-specified label that must match the *label* argument specified in a previously defined **crypto pki certificate map** command. • **url** —Specifies that the certificate's CDPs will be overridden with an HTTP or LDAP URL. • **directory** —Specifies that the certificate's CDPs will be overridden with an LDAP directory specification. • *string* —The URL or directory specification.

	Command or Action	Purpose
		Note Some applications may time out before all CDPs have been tried and will report an error message. The error message will not affect the router, and the Cisco IOS software will continue attempting to retrieve a CRL until all CDPs have been tried.
Step 10	**match certificate** *certificate-map-label* **override ocsp** [**trustpoint** *trustpoint-label*] *sequence-number* **url** *ocsp-url* **Example:** `Device(ca-trustpoint)# match certificate mycertmapname override ocsp trustpoint mytp 15 url http://192.0.2.2`	(Optional) Specifies an OCSP server, either per client certificate or per group of client certificates, and may be issued more than once to specify additional OCSP servers and client certificate settings including alternative PKI hierarchies. • *certificate-map-label* —The name of an existing certificate map. • **trustpoint** —The trustpoint to be used when validating the OCSP server certificate. • *sequence-number* —The order the **match certificate override ocsp** command statements apply to the certificate being verified. Matches are performed from the lowest sequence number to the highest sequence number. If more than one command is issued with the same sequence number, it overwrites the previous OCSP server override setting. • **url** —The URL of the OCSP server. When the certificate matches a configured certificate map, the AIA field of the client certificate and any previously issued **ocsp url** command settings are overwritten with the specified OCSP server. If no map-based match occurs, one of the following two cases will continue to apply to the client certificate. • If OCSP is specified as the revocation method, the AIA field value will continue to apply to the client certificate. • If the **ocsp url** configuration exists, the **ocsp url** configuration settings will continue to apply to the client certificates.

	Command or Action	Purpose
Step 11	**exit** **Example:** `Device(ca-trustpoint)# exit`	Exits Returns to global configuration mode.
Step 12	**aaa new-model** **Example:** `Device(config)# aaa new-model`	(Optional) Enables the AAA access control model.
Step 13	**aaa attribute list** *list-name* **Example:** `Device(config)# aaa attribute list crl`	(Optional) Defines an AAA attribute list locally on a router and enters config-attr-list configuration mode.
Step 14	**attribute type** {*name*} {*value*} **Example:** `Device(config-attr-list)# attribute type cert-serial-not 6C4A`	(Optional) Defines an AAA attribute type that is to be added to an AAA attribute list locally on a router. To configure certificate serial number session control, an administrator may specify a specific certificate in the *value* field to be accepted or rejected based on its serial number where *name* is set to **cert-serial-not**. If the serial number of the certificate matches the serial number specified by the attribute type setting, the certificate will be rejected. For a full list of available AAA attribute types, execute the **show aaa attributes** command.

Step 15	**exit**
	Example:
	`Device(ca-trustpoint)# end`
	Example:
	`Device(config-attr-list)# end`
		Returns to privileged EXEC mode.

Step 16	**show crypto pki certificates** **Example:** `Device# show crypto pki certificates`	(Optional) Displays the components of the certificates installed on the router if the CA certificate has been authenticated.

Example

The following is a sample certificate. The OCSP-related extensions are shown using exclamation points.

```
Certificate:
        Data:
            Version: v3
            Serial Number:0x14
            Signature Algorithm:SHAwithRSA - 1.2.840.113549.1.1.4
            Issuer:CN=CA server,OU=PKI,O=Cisco Systems
            Validity:
                Not Before:Thursday, August 8, 2002 4:38:05 PM PST
                Not After:Tuesday, August 7, 2003 4:38:05 PM PST
            Subject:CN=OCSP server,OU=PKI,O=Cisco Systems
            Subject Public Key Info:
                Algorithm:RSA - 1.2.840.113549.1.1.1
                Public Key:
                    Exponent:65537
                    Public Key Modulus:(2048 bits) :
                        <snip>
            Extensions:
                Identifier:Subject Key Identifier - 2.5.29.14
                    Critical:no
                    Key Identifier:
                        <snip>
                Identifier:Authority Key Identifier - 2.5.29.35
                    Critical:no
                    Key Identifier:
                        <snip>
!                Identifier:OCSP NoCheck:- 1.3.6.1.5.5.7.48.1.5
                     Critical:no
                Identifier:Extended Key Usage:- 2.5.29.37
                     Critical:no
                     Extended Key Usage:
                     OCSPSigning
!
                Identifier:CRL Distribution Points - 2.5.29.31
                    Critical:no
                    Number of Points:1
                    Point 0
                        Distribution Point:
[URIName:ldap://CA-server/CN=CA server,OU=PKI,O=Cisco Systems]
        Signature:
            Algorithm:SHAwithRSA - 1.2.840.113549.1.1.4
            Signature:
            <snip>
```

The following example shows an excerpt of the running configuration output when adding a **match certificate override ocsp** command to the beginning of an existing sequence:

```
match certificate map3 override ocsp 5 url http://192.0.2.3/
show running-configuration
.
.
.
        match certificate map3 override ocsp 5 url http://192.0.2.3/
        match certificate map1 override ocsp 10 url http://192.0.2.1/
        match certificate map2 override ocsp 15 url http://192.0.2.2/
```

The following example shows an excerpt of the running configuration output when an existing **match certificate override ocsp** command is replaced and a trustpoint is specified to use an alternative PKI hierarchy:

```
match certificate map4 override ocsp trustpoint tp4 10 url http://192.0.2.4/newvalue
show running-configuration
```

```
.
.
.
        match certificate map3 override ocsp trustpoint tp3 5 url http://192.0.2.3/
        match certificate map1 override ocsp trustpoint tp1 10 url http://192.0.2.1/
        match certificate map4 override ocsp trustpoint tp4 10 url
http://192.0.2.4/newvalue
        match certificate map2 override ocsp trustpoint tp2 15 url http://192.0.2.2/
```

Troubleshooting Tips

If you ignored revocation check or expired certificates, you should carefully check your configuration. Verify that the certificate map properly matches either the certificate or certificates that should be allowed or the AAA checks that should be skipped. In a controlled environment, try modifying the certificate map and determine what is not working as expected.

Configuring Certificate Chain Validation

Perform this task to configure the processing level for the certificate chain path of your peer certificates.

Before you begin

- The device must be enrolled in your PKI hierarchy.
- The appropriate key pair must be associated with the certificate.

Note

- A trustpoint associated with the root CA cannot be configured to be validated to the next level.

The **chain-validation** command is configured with the **continue** keyword for the trustpoint associated with the root CA, an error message will be displayed and the chain validation will revert to the default **chain-validation**command setting.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto pki trustpoint***name* **Example:**	Declares the trustpoint and a given name and enters ca-trustpoint configuration mode.

	Command or Action	Purpose
	`Device(config)# crypto pki trustpoint ca-sub1`	
Step 4	**chain-validation** [{**stop** | **continue**} [*parent-trustpoint*]] **Example:** `Device(ca-trustpoint)# chain-validation continue ca-sub1`	Configures the level to which a certificate chain is processed on all certificates including subordinate CA certificates. • Use the **stop**keyword to specify that the certificate is already trusted. This is the default setting. • Use the **continue** keyword to specify that the that the subordinate CA certificate associated with the trustpoint must be validated. • The *parent-trustpoint* argument specifies the name of the parent trustpoint the certificate must be validated against.
Step 5	**exit** **Example:** `Device(ca-trustpoint)# exit`	Exits ca-trustpoint configuration mode and returns to global configuration mode

Configuration Examples for Authorization and Revocation of Certificates in a PKI

Configuration and Verification Examples fo PKI AAA Authorization

This section provides configuration examples of PKI AAA authorizations:

Example: Device Configuration

The following **show running-config**command output shows the working configuration of a device that is set up to authorize VPN connections using the PKI Integration with AAA Server feature:

```
Device#show running-config

Building configuration...
!
version 16.8
!
hostname catxxxx
!
aaa new-model
!
!
```

```
aaa authentication login default group tacacs+
aaa authentication login no_tacacs enable
aaa authentication ppp default group tacacs+
aaa authorization exec ACSLab group tacacs+
aaa authorization network ACSLab group tacacs+
aaa accounting exec ACSLab start-stop group tacacs+
aaa accounting network default start-stop group ACSLab
aaa session-id common
!
ip domain name example.com
!
crypto pki trustpoint EM-CERT-SERV
 enrollment url http://192.0.2.33:80
 serial-number
 crl optional
 rsakeypair STOREVPN 2048
 auto-enroll
 authorization list ACSLab
!
crypto pki certificate chain EM-CERT-SERV
 certificate 04
  30820214 3082017D A0030201 02020104 300D0609 2A864886 F70D0101 04050030
  17311530 13060355 0403130C 454D2D43 4552542D 53455256 301E170D 30343031
  31393232 30323535 5A170D30 35303131 38323230 3235355A 3030312E 300E0603
  55040513 07314437 45424434 301C0609 2A864886 F70D0109 02160F37 3230302D
  312E6772 696C2E63 6F6D3081 9F300D06 092A8648 86F70D01 01010500 03818D00
  30818902 818100BD F3B837AA D925F391 2B64DA14 9C2EA031 5A7203C4 92F8D6A8
  7D2357A6 BCC8596F A38A9B10 47435626 D59A8F2A 123195BB BE5A1E74 B1AA5AE0
  5CA162FF 8C3ACA4F B3EE9F27 8B031642 B618AE1B 40F2E3B4 F996BEFE 382C7283
  3792A369 236F8561 8748AA3F BC41F012 B859BD9C DB4F75EE 3CEE2829 704BD68F
  FD904043 0F555702 03010001 A3573055 30250603 551D1F04 1E301C30 1AA018A0
  16861468 7474703A 2F2F3633 2E323437 2E313037 2E393330 0B060355 1D0F0404
  030205A0 301F0603 551D2304 18301680 1420FC4B CF0B1C56 F5BD4C06 0AFD4E67
  341AE612 D1300D06 092A8648 86F70D01 01040500 03818100 79E97018 FB955108
  12F42A56 2A6384BC AC8E22FE F1D6187F DA5D6737 C0E241AC AAAEC75D 3C743F59
  08DEEFF2 0E813A73 D79E0FA9 D62DC20D 8E2798CD 2C1DC3EC 3B2505A1 3897330C
  15A60D5A 8A13F06D 51043D37 E56E45DF A65F43D7 4E836093 9689784D C45FD61D
  EC1F160C 1ABC8D03 49FB11B1 DA0BED6C 463E1090 F34C59E4
  quit
 certificate ca 01
  30820207 30820170 A0030201 02020101 300D0609 2A864886 F70D0101 04050030
  17311530 13060355 0403130C 454D2D43 4552542D 53455256 301E170D 30333132
  31363231 34373432 5A170D30 36313231 35323134 3734325A 30173115 30130603
  55040313 0C454D2D 43455254 2D534552 5630819F 300D0609 2A864886 F70D0101
  01050003 818D0030 81890281 8100C14D 833641CF D784F516 DA6B50C0 7B3CB3C9
  589223AB 99A7DC14 04F74EF2 AAEEE8F5 E3BFAE97 F2F980F7 D889E6A1 2C726C69
  54A29870 7E7363FF 3CD1F991 F5A37CFF 3FFDD3D0 9E486C44 A2E34595 C2D078BB
  E9DE981E B733B868 AA8916C0 A8048607 D34B83C0 64BDC101 161FC103 13C06500
  22D6EE75 7D6CF133 7F1B515F 32830203 010001A3 63306130 0F060355 1D130101
  FF040530 030101FF 300E0603 551D0F01 01FF0404 03020186 301D0603 551D0E04
  16041420 FC4BCF0B 1C56F5BD 4C060AFD 4E67341A E612D130 1F060355 1D230418
  30168014 20FC4BCF 0B1C56F5 BD4C060A FD4E6734 1AE612D1 300D0609 2A864886
  F70D0101 04050003 81810085 D2E386F5 4107116B AD3AC990 CBE84063 5FB2A6B5
  BD572026 528E92ED 02F3A0AE 1803F2AE AA4C0ED2 0F59F18D 7B50264F 30442C41
  0AF19C4E 70BD3CB5 0ADD8DE8 8EF636BD 24410DF4 DB62DAFC 67DA6E58 3879AA3E
  12AFB1C3 2E27CB27 EC74E1FC AEE2F5CF AA80B439 615AA8D5 6D6DEDC3 7F9C2C79
  3963E363 F2989FB9 795BA8
  quit
!
!
crypto isakmp policy 10
 encr aes
 group 14
!
```

```
!
crypto ipsec transform-set ISC_TS_1 esp-aes esp-sha-hmac
!
crypto ipsec profile ISC_IPSEC_PROFILE_2
 set security-association lifetime kilobytes 530000000
 set security-association lifetime seconds 14400
 set transform-set ISC_TS_1
!
!
controller ISA 1/1
!
!
interface Tunnel0
 description MGRE Interface provisioned by ISC
 bandwidth 10000
 ip address 192.0.2.172 255.255.255.0
 no ip redirects
 ip mtu 1408
 ip nhrp map multicast dynamic
 ip nhrp network-id 101
 ip nhrp holdtime 500
 ip nhrp server-only
 no ip split-horizon eigrp 101
 tunnel source FastEthernet2/1
 tunnel mode gre multipoint
 tunnel key 101
 tunnel protection ipsec profile ISC_IPSEC_PROFILE_2
!
interface FastEthernet2/0
 ip address 192.0.2.1 255.255.255.0
 duplex auto
 speed auto
!
interface FastEthernet2/1
 ip address 192.0.2.2 255.255.255.0
 duplex auto
 speed auto
!
!
end
```

Example: Debug of a Successful PKI AAA Authorization

The following **show debugging** command output shows a successful authorization using the PKI Integration with AAA Server feature:

```
Device#show debugging

General OS:
  TACACS access control debugging is on
  AAA Authentication debugging is on
  AAA Authorization debugging is on
Cryptographic Subsystem:
Crypto PKI Trans debugging is on
Device#
May 28 19:36:11.117: CRYPTO_PKI: Trust-Point EM-CERT-SERV picked up
May 28 19:36:12.789: CRYPTO_PKI: Found a issuer match
May 28 19:36:12.805: CRYPTO_PKI: cert revocation status unknown.
May 28 19:36:12.805: CRYPTO_PKI: Certificate validated without revocation check
May 28 19:36:12.813: CRYPTO_PKI_AAA: checking AAA authorization (ACSLab, POD5.example.com,
 <all>)
May 28 19:36:12.813: AAA/BIND(00000042): Bind i/f
May 28 19:36:12.813: AAA/AUTHOR (0x42): Pick method list 'ACSLab'
```

```
May 28 19:36:12.813: TPLUS: Queuing AAA Authorization request 66 for processing
May 28 19:36:12.813: TPLUS: processing authorization request id 66
May 28 19:36:12.813: TPLUS: Protocol set to None .....Skipping
May 28 19:36:12.813: TPLUS: Sending AV service=pki
May 28 19:36:12.813: TPLUS: Authorization request created for 66(POD5.example.com)
May 28 19:36:12.813: TPLUS: Using server 192.0.2.55
May 28 19:36:12.813: TPLUS(00000042)/0/NB_WAIT/203A4628: Started 5 sec timeout
May 28 19:36:12.813: TPLUS(00000042)/0/NB_WAIT: wrote entire 46 bytes request
May 28 19:36:12.813: TPLUS: Would block while reading pak header
May 28 19:36:12.817: TPLUS(00000042)/0/READ: read entire 12 header bytes (expect 27 bytes)
May 28 19:36:12.817: TPLUS(00000042)/0/READ: read entire 39 bytes response
May 28 19:36:12.817: TPLUS(00000042)/0/203A4628: Processing the reply packet
May 28 19:36:12.817: TPLUS: Processed AV cert-application=all
May 28 19:36:12.817: TPLUS: received authorization response for 66: PASS
May 28 19:36:12.817: CRYPTO_PKI_AAA: reply attribute ("cert-application" = "all")
May 28 19:36:12.817: CRYPTO_PKI_AAA: authorization passed
Device#
May 28 19:36:18.681: %DUAL-5-NBRCHANGE: IP-EIGRP(0) 101: Neighbor 192.0.2.171 (Tunnel0) is
 up: new adjacency
Device#
Device# show crypto isakmp sa

dst             src             state          conn-id slot
192.0.2.22     192.0.2.102   QM_IDLE             84    0
```

Example:Debug of a Failed PKI AAA Authorization

The following **show debugging** command output shows that the device is not authorized to connect using VPN. The messages are typical of those that you might see in such a situation.

In this example, the peer username was configured as not authorized, by moving the username to a Cisco Secure ACS group called VPN_Disabled in Cisco Secure ACS. The device, device9.example.com, has been configured to check with a Cisco Secure ACS AAA server prior to establishing a VPN connection to any peer.

```
Device#show debugging

General OS:
  TACACS access control debugging is on
  AAA Authentication debugging is on
  AAA Authorization debugging is on
Cryptographic Subsystem:
  Crypto PKI Trans debugging is on

Device#
May 28 19:48:29.837: CRYPTO_PKI: Trust-Point EM-CERT-SERV picked up
May 28 19:48:31.509: CRYPTO_PKI: Found a issuer match
May 28 19:48:31.525: CRYPTO_PKI: cert revocation status unknown.
May 28 19:48:31.525: CRYPTO_PKI: Certificate validated without revocation check
May 28 19:48:31.533: CRYPTO_PKI_AAA: checking AAA authorization (ACSLab, POD5.example.com,
 <all>)
May 28 19:48:31.533: AAA/BIND(00000044): Bind i/f
May 28 19:48:31.533: AAA/AUTHOR (0x44): Pick method list 'ACSLab'
May 28 19:48:31.533: TPLUS: Queuing AAA Authorization request 68 for processing
May 28 19:48:31.533: TPLUS: processing authorization request id 68
May 28 19:48:31.533: TPLUS: Protocol set to None .....Skipping
May 28 19:48:31.533: TPLUS: Sending AV service=pki
May 28 19:48:31.533: TPLUS: Authorization request created for 68(POD5.example.com)
May 28 19:48:31.533: TPLUS: Using server 192.0.2.55
May 28 19:48:31.533: TPLUS(00000044)/0/NB_WAIT/203A4C50: Started 5 sec timeout
May 28 19:48:31.533: TPLUS(00000044)/0/NB_WAIT: wrote entire 46 bytes request
```

```
May 28 19:48:31.533: TPLUS: Would block while reading pak header
May 28 19:48:31.537: TPLUS(00000044)/0/READ: read entire 12 header bytes (expect 6 bytes)
May 28 19:48:31.537: TPLUS(00000044)/0/READ: read entire 18 bytes response
May 28 19:48:31.537: TPLUS(00000044)/0/203A4C50: Processing the reply packet
May 28 19:48:31.537: TPLUS: received authorization response for 68: FAIL
May 28 19:48:31.537: CRYPTO_PKI_AAA: authorization declined by AAA, or AAA server not found.
May 28 19:48:31.537: CRYPTO_PKI_AAA: No cert-application attribute found. Failing.
May 28 19:48:31.537: CRYPTO_PKI_AAA: authorization failed
May 28 19:48:31.537: CRYPTO_PKI: AAA authorization for list 'ACSLab', and user
'POD5.example.com' failed.
May 28 19:48:31.537: %CRYPTO-5-IKMP_INVAL_CERT: Certificate received from 192.0.2.162 is
bad: certificate invalid
May 28 19:48:39.821: CRYPTO_PKI: Trust-Point EM-CERT-SERV picked up
May 28 19:48:41.481: CRYPTO_PKI: Found a issuer match
May 28 19:48:41.501: CRYPTO_PKI: cert revocation status unknown.
May 28 19:48:41.501: CRYPTO_PKI: Certificate validated without revocation check
May 28 19:48:41.505: CRYPTO_PKI_AAA: checking AAA authorization (ACSLab, POD5.example.com,
 <all>)
May 28 19:48:41.505: AAA/BIND(00000045): Bind i/f
May 28 19:48:41.505: AAA/AUTHOR (0x45): Pick method list 'ACSLab'
May 28 19:48:41.505: TPLUS: Queuing AAA Authorization request 69 for processing
May 28 19:48:41.505: TPLUS: processing authorization request id 69
May 28 19:48:41.505: TPLUS: Protocol set to None .....Skipping
May 28 19:48:41.505: TPLUS: Sending AV service=pki
May 28 19:48:41.505: TPLUS: Authorization request created for 69(POD5.example.com)
May 28 19:48:41.505: TPLUS: Using server 198.168.244.55
May 28 19:48:41.509: TPLUS(00000045)/0/IDLE/63B22834: got immediate connect on new 0
May 28 19:48:41.509: TPLUS(00000045)/0/WRITE/63B22834: Started 5 sec timeout
May 28 19:48:41.509: TPLUS(00000045)/0/WRITE: wrote entire 46 bytes request
May 28 19:48:41.509: TPLUS(00000045)/0/READ: read entire 12 header bytes (expect 6 bytes)
May 28 19:48:41.509: TPLUS(00000045)/0/READ: read entire 18 bytes response
May 28 19:48:41.509: TPLUS(00000045)/0/63B22834: Processing the reply packet
May 28 19:48:41.509: TPLUS: received authorization response for 69: FAIL
May 28 19:48:41.509: CRYPTO_PKI_AAA: authorization declined by AAA, or AAA server not found.
May 28 19:48:41.509: CRYPTO_PKI_AAA: No cert-application attribute found. Failing.
May 28 19:48:41.509: CRYPTO_PKI_AAA: authorization failed
May 28 19:48:41.509: CRYPTO_PKI: AAA authorization for list 'ACSLab', and user
'POD5.example.com' failed.
May 28 19:48:41.509: %CRYPTO-5-IKMP_INVAL_CERT: Certificate received from 192.0.2.162 is
bad: certificate invalid
Device#
Device# show crypto iskmp sa

dst             src             state          conn-id slot
192.0.2.2        192.0.2.102   MM_KEY_EXCH         95    0
```

Examples: Configuring a Revocation Mechanism

This section contains the following configuration examples that can be used when specifying a revocation mechanism for your PKI:

Example:Configuring an OCSP Server

The following example shows how to configure the router to use the OCSP server that is specified in the AIA extension of the certificate:

```
Device> enable
Device# configure terminal
Device(config)#crypto pki trustpoint mytp
Device(ca-trustpoint)# revocation-check ocsp
```

```
Device(ca-trustpoint)# end
```

Example:Specifying a CRL and Then an OCSP Server

The following example shows how to configure the router to download the CRL from the CDP. If the CRL is unavailable, the OCSP server that is specified in the AIA extension of the certificate will be used. If both options fail, certificate verification will also fail.

```
Device> enable
Device# configure terminal
Device(config)#crypto pki trustpoint mytp
Device(ca-trustpoint)#revocation-check crl ocsp
Device(ca-trustpoint)# end
```

Example: Specifying an OCSP Server

The following example shows how to configure your router to use the OCSP server at the HTTP URL "http://myocspserver:81." If the server is down, the revocation check will be ignored.

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint mytp
Device(ca-trustpoint)# ocsp url http://myocspserver:81
Device(ca-trustpoint)# revocation-check ocsp none
Device(ca-trustpoint)# end
```

Example: Disabling Nonces in Communications with the OCSP Server

The following example shows communications when a nonce, or a unique identifier for the OCSP request, is disabled for communications with the OCSP server:

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint mytp
Device(ca-trustpoint)# ocsp url http://myocspserver:81
Device(ca-trustpoint)# revocation-check ocsp none
Device(ca-trustpoint)# ocsp disable-nonce
Device(ca-trustpoint)# end
```

Example:Configuring a Hub Device at a Central Site for Certificate Revocation Checks

The following example shows a hub device at a central site that is providing connectivity for several branch offices to the central site.

The branch offices are also able to communicate directly with each other using additional IPSec tunnels between the branch offices.

The CA publishes CRLs on an HTTP server at the central site. The central site checks CRLs for each peer when setting up an IPSec tunnel with that peer.

The example does not show the IPSec configuration--only the PKI-related configuration is shown.

Home Office Hub Configuration

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint VPN-GW
Device(ca-trustpoint)# enrollment url http://ca.home-office.com:80/certsrv/mscep/mscep.dll
Device(ca-trustpoint)# serial-number none
Device(ca-trustpoint)# fqdn none
Device(ca-trustpoint)# ip-address none
Device(ca-trustpoint)# subject-name o=Home Office Inc,cn=Central VPN Gateway
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# end
```

Central Site Hub Device

```
Device# show crypto ca certificate

Certificate
  Status: Available
  Certificate Serial Number: 2F62BE14000000000CA0
  Certificate Usage: General Purpose
  Issuer:
    cn=Central Certificate Authority
    o=Home Office Inc
  Subject:
    Name: Central VPN Gateway
    cn=Central VPN Gateway
    o=Home Office Inc
  CRL Distribution Points:
    http://ca.home-office.com/CertEnroll/home-office.crl
  Validity Date:
    start date: 00:43:26 GMT Sep 26 2003
    end   date: 00:53:26 GMT Sep 26 2004
    renew date: 00:00:00 GMT Jan 1 1970
  Associated Trustpoints: VPN-GW
CA Certificate
  Status: Available
  Certificate Serial Number: 1244325DE0369880465F977A18F61CA8
  Certificate Usage: Signature
  Issuer:
    cn=Central Certificate Authority
    o=Home Office Inc
  Subject:
    cn=Central Certificate Authority
    o=Home Office Inc
  CRL Distribution Points:
    http://ca.home-office.com/CertEnroll/home-office.crl
  Validity Date:
    start date: 22:19:29 GMT Oct 31 2002
    end   date: 22:27:27 GMT Oct 31 2017
  Associated Trustpoints: VPN-GW
```

Trustpoint on the Branch Office Device

```
Device> enable
Device# configure terminal
Device(ca-trustpoint)# crypto pki trustpoint home-office
Device(ca-trustpoint)# enrollment url http://ca.home-office.com:80/certsrv/mscep/mscep.dll
Device(ca-trustpoint)# serial-number none
Device(ca-trustpoint)# fqdn none
```

```
Device(ca-trustpoint)# ip-address none
Device(ca-trustpoint)# subject-name o=Home Office Inc,cn=Branch 1
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# end
```

A certificate map is entered on the branch office device.

```
branch1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
branch1(config)# crypto pki certificate map central-site 10
branch1(ca-certificate-map)# end
```

The output from the **show certificate** command on the central site hub device shows that the certificate was issued by the following:

```
cn=Central Certificate Authority
o=Home Office Inc
```

These two lines are combined into one line using a comma (,) to separate them, and the original lines are added as the first criteria for a match.

```
Device(ca-certificate-map)# issuer-name co cn=Central Certificate Authority, ou=Home Office
 Inc
!The above line wrapped but should be shown on one line with the line above it.
```

The same combination is done for the subject name from the certificate on the central site device (note that the line that begins with “Name:” is not part of the subject name and must be ignored when creating the certificate map criteria). This is the subject name to be used in the certificate map.

cn=Central VPN Gateway

o=Home Office Inc

```
Device(ca-certificate-map)# subject-name eq cn=central vpn gateway, o=home office inc
```

Now the certificate map is added to the trustpoint that was configured earlier.

```
Device> enable
Device# configure terminal
Device(ca-certificate-map)# crypto pki trustpoint home-office
Device(ca-trustpoint)# match certificate central-site skip revocation-check
Device(ca-trustpoint)# end
```

The configuration is checked (most of configuration is not shown).

```
Device# write term

!Many lines left out
.
.
.
crypto pki trustpoint home-office
 enrollment url http://ca.home-office.com:80/certsrv/mscep/mscep.dll
 serial-number none
 fqdn none
 ip-address none
 subject-name o=Home Office Inc,cn=Branch 1
 revocation-check crl
```

```
 match certificate central-site skip revocation-check
!
!
crypto pki certificate map central-site 10
 issuer-name co cn = Central Certificate Authority, ou = Home Office Inc
 subject-name eq cn = central vpn gateway, o = home office inc
!many lines left out
```

Note that the issuer-name and subject-name lines have been reformatted to make them consistent for later matching with the certificate of the peer.

If the branch office is checking the AAA, the trustpoint will have lines similar to the following:

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint home-office
Device(ca-trustpoint)# authorization list allow_list
Device(ca-trustpoint)# authorization username subjectname commonname
Device(ca-trustpoint)# end
```

After the certificate map has been defined as was done above, the following command is added to the trustpoint to skip AAA checking for the central site hub.

```
Device(ca-trustpoint)# match certificate central-site skip authorization-check
```

In both cases, the branch site device has to establish an IPSec tunnel to the central site to check CRLs or to contact the AAA server. However, without the **match certificate**command and **central-site skip authorization-check (argument and keyword)**, the branch office cannot establish the tunnel until it has checked the CRL or the AAA server. (The tunnel will not be established unless the **match certificate**command and **central-site skip authorization-check** argument and keyword are used.)

The **match certificate** command and **allow expired-certificate** keyword would be used at the central site if the device at a branch site had an expired certificate and it had to establish a tunnel to the central site to renew its certificate.

Trustpoint on the Central Site Device

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint VPN-GW
Device(ca-trustpoint)# enrollment url http://ca.home-office.com:80/certsrv/mscep/mscep.dll
Device(ca-trustpoint)# serial-number none
Device(ca-trustpoint)# fqdn none
Device(ca-trustpoint)# ip-address none
Device(ca-trustpoint)# subject-name o=Home Office Inc,cn=Central VPN Gateway
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# end
```

Trustpoint on the Branch 1 Site Device

```
Device# show crypto ca certificate

Certificate
  Status: Available
  Certificate Serial Number: 2F62BE14000000000CA0
  Certificate Usage: General Purpose
  Issuer:
    cn=Central Certificate Authority
```

```
    o=Home Office Inc
  Subject:
    Name: Branch 1 Site
    cn=Branch 1 Site
    o=Home Office Inc
  CRL Distribution Points:
    http://ca.home-office.com/CertEnroll/home-office.crl
  Validity Date:
    start date: 00:43:26 GMT Sep 26 2003
    end   date: 00:53:26 GMT Oct 3 2003
    renew date: 00:00:00 GMT Jan 1 1970
  Associated Trustpoints: home-office
CA Certificate
  Status: Available
  Certificate Serial Number: 1244325DE0369880465F977A18F61CA8
  Certificate Usage: Signature
  Issuer:
    cn=Central Certificate Authority
    o=Home Office Inc
  Subject:
    cn=Central Certificate Authority
    o=Home Office Inc
  CRL Distribution Points:
    http://ca.home-office.com/CertEnroll/home-office.crl
  Validity Date:
    start date: 22:19:29 GMT Oct 31 2002
    end   date: 22:27:27 GMT Oct 31 2017
  Associated Trustpoints: home-office
```

A certificate map is entered on the central site device.

```
Device> enable
Device# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Device(config)# crypto pki certificate map branch1 10
Device(ca-certificate-map)# issuer-name co cn=Central Certificate Authority, ou=Home Office
 Inc
!The above line wrapped but should be part of the line above it.
Device(ca-certificate-map)# subject-name eq cn=Brahcn 1 Site,o=home office inc
Device(ca-certificate-map)# end
```

The certificate map is added to the trustpoint.

```
Device> enable
Device# configure terminal
Device(ca-certificate-map)# crypto pki trustpoint VPN-GW
Device(ca-trustpoint)# match certificate branch1 allow expired-certificate
Device(ca-trustpoint)# exit
Device (config) #exit
```

The configuration should be checked (most of the configuration is not shown).

```
Device# write term

!many lines left out
crypto pki trustpoint VPN-GW
 enrollment url http://ca.home-office.com:80/certsrv/mscep/mscep.dll
 serial-number none
 fqdn none
 ip-address none
 subject-name o=Home Office Inc,cn=Central VPN Gateway
 revocation-check crl
 match certificate branch1 allow expired-certificate
!
```

```
!
crypto pki certificate map central-site 10
 issuer-name co cn = Central Certificate Authority, ou = Home Office Inc
 subject-name eq cn = central vpn gateway, o = home office inc
! many lines left out
```

The **match certificate**command and **branch1 allow expired-certificate** (argument and keyword) and the certificate map should be removed as soon as the branch device has a new certificate.

Examples:Configuring Certificate Authorization and Revocation Settings

This section contains the following configuration examples that can be used when specifying a CRL cache control setting or certificate serial number session control:

Example: Configuring CRL Cache Control

The following example shows how to disable CRL caching for all CRLs associated with the CA1 trustpoint:

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint CA1
Device(ca-trustpoint)# enrollment url http://CA1:80
Device(ca-trustpoint)# ip-address FastEthernet0/0
Device(ca-trustpoint)# crl query ldap://ldap_CA1
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# crl cache none
Device(ca-trustpoint)# end
```

The current CRL is still cached immediately after executing the example configuration shown above:

Device# **show crypto pki crls**

```
CRL Issuer Name:
    cn=name Cert Manager,ou=pki,o=example.com,c=US
    LastUpdate: 18:57:42 GMT Nov 26 2005
    NextUpdate: 22:57:42 GMT Nov 26 2005
    Retrieved from CRL Distribution Point:
      ldap://ldap.example.com/CN=name Cert Manager,O=example.com
```

When the current CRL expires, a new CRL is then downloaded to the router at the next update. The **crl-cache none**command takes effect and all CRLs for the trustpoint are no longer cached; caching is disabled. You can verify that no CRL is cached by executing the **show crypto pki crls** command. No output will be shown because there are no CRLs cached.

The following example shows how to configure the maximum lifetime of 2 minutes for all CRLs associated with the CA1 trustpoint:

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint CA1
Device(ca-trustpoint)# enrollment url http://CA1:80
Device(ca-trustpoint)# ip-address FastEthernet 0/0
Device(ca-trustpoint)# crl query ldap://ldap_CA1
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# crl cache delete-after 2
Device(ca-trustpoint)# end
```

The current CRL is still cached immediately after executing the example configuration above for setting the maximum lifetime of a CRL:

Device# **show crypto pki crls**

```
CRL Issuer Name:
    cn=name Cert Manager,ou=pki,o=example.com,c=US
    LastUpdate: 18:57:42 GMT Nov 26 2005
    NextUpdate: 22:57:42 GMT Nov 26 2005
    Retrieved from CRL Distribution Point:
      ldap://ldap.example.com/CN=name Cert Manager,O=example.com
When the current CRL expires, a new CRL is downloaded to the router at the next update and
 the crl-cache delete-after
command takes effect. This newly cached CRL and all subsequent CRLs will be deleted after
a maximum lifetime of 2 minutes.
You can verify that the CRL will be cached for 2 minutes by executing the show crypto pki
crls
 command. Note that the NextUpdate time is 2 minutes after the LastUpdate time.
```

Device# **show crypto pki crls**

```
CRL Issuer Name:
    cn=name Cert Manager,ou=pki,o=example.com,c=US
    LastUpdate: 22:57:42 GMT Nov 26 2005

    NextUpdate: 22:59:42 GMT Nov 26 2005
    Retrieved from CRL Distribution Point:
```

ldap://ldap.example.com/CN=name Cert Manager,O=example.com

Example: Configuring Certificate Serial Number Session Control

The following example shows the configuration of certificate serial number session control using a certificate map for the CA1 trustpoint:

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint CA1
Device(ca-trustpoint)# enrollment url http://CA1
Device(ca-trustpoint)# chain-validation stop
Device(ca-trustpoint)# crl query ldap://ldap_server
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# match certificate crl
Device(ca-trustpoint)# exit
Device(config)# crypto pki certificate map crl 10
Device(ca-certificate-map)# serial-number co 279d
Device(ca-certificate-map)# end
```

Note If the *match-criteria* value is set to **eq** (equal) instead of **co** (contains), the serial number must match the certificate map serial number exactly, including any spaces.

The following example shows the configuration of certificate serial number session control using AAA attributes. In this case, all valid certificates will be accepted if the certificate does not have the serial number "4ACA."

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint CA1
Device(ca-trustpoint)# enrollment url http://CA1
Device(ca-trustpoint)# ip-address FastEthernet0/0
```

```
Device(ca-trustpoint)# crl query ldap://ldap_CA1
Device(ca-trustpoint)# revocation-check crl
Device(ca-trustpoint)# exit
Device(config)# aaa new-model
Device(config)# aaa attribute list crl
Device(config-attr-list)# attribute-type aaa-cert-serial-not 4ACA
Device(config-attr-list)# end
```

The server log shows that the certificate with the serial number "4ACA" was rejected. The certificate rejection is shown using exclamation points.

```
.
.
.
Dec 3 04:24:39.051: CRYPTO_PKI: Trust-Point CA1 picked up
Dec 3 04:24:39.051: CRYPTO_PKI: locked trustpoint CA1, refcount is 1
Dec 3 04:24:39.051: CRYPTO_PKI: unlocked trustpoint CA1, refcount is 0
Dec 3 04:24:39.051: CRYPTO_PKI: locked trustpoint CA1, refcount is 1
Dec 3 04:24:39.135: CRYPTO_PKI: validation path has 1 certs
Dec 3 04:24:39.135: CRYPTO_PKI: Found a issuer match
Dec 3 04:24:39.135: CRYPTO_PKI: Using CA1 to validate certificate
Dec 3 04:24:39.135: CRYPTO_PKI: Certificate validated without revocation check
Dec 3 04:24:39.135: CRYPTO_PKI: Selected AAA username: 'PKIAAA'
Dec 3 04:24:39.135: CRYPTO_PKI: Anticipate checking AAA list:'CRL'
Dec 3 04:24:39.135: CRYPTO_PKI_AAA: checking AAA authorization (CRL, PKIAAA-L1, <all>)
Dec 3 04:24:39.135: CRYPTO_PKI_AAA: pre-authorization chain validation status (0x4)
Dec 3 04:24:39.135: AAA/BIND(00000021): Bind i/f
Dec 3 04:24:39.135: AAA/AUTHOR (0x21): Pick method list 'CRL'
.
.
.
Dec 3 04:24:39.175: CRYPTO_PKI_AAA: reply attribute ("cert-application" = "all")
Dec 3 04:24:39.175: CRYPTO_PKI_AAA: reply attribute ("cert-trustpoint" = "CA1")
!
Dec 3 04:24:39.175: CRYPTO_PKI_AAA: reply attribute ("cert-serial-not" = "4ACA")
Dec 3 04:24:39.175: CRYPTO_PKI_AAA: cert-serial doesn't match ("4ACA" != "4ACA")
!
Dec 3 04:24:39.175: CRYPTO_PKI_AAA: post-authorization chain validation status (0x7)
!
Dec 3 04:24:39.175: CRYPTO_PKI: AAA authorization for list 'CRL', and user 'PKIAAA' failed.
Dec 3 04:24:39.175: CRYPTO_PKI: chain cert was anchored to trustpoint CA1, and chain
validation result was:
 CRYPTO_PKI_CERT_NOT_AUTHORIZED
!
Dec 3 04:24:39.175: %CRYPTO-5-IKMP_INVAL_CERT: Certificate received from 192.0.2.43 is bad:
 certificate invalid
Dec 3 04:24:39.175: %CRYPTO-6-IKMP_MODE_FAILURE: Processing of Main mode failed with peer
at 192.0.2.43
.
.
.
```

Examples: Configuring Certificate Chain Validation

This section contains the following configuration examples that can be used to specify the level of certificate chain processing for your device certificates:

Configuring Certificate Chain Validation from Peer to Root CA

In the following configuration example, all of the certificates will be validated--the peer, SubCA11, SubCA1, and RootCA certificates.

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint RootCA
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation stop
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair RootCA
Device(ca-trustpoint)# exit
Device(config)# crypto pki trustpoint SubCA1
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation continue RootCA
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair SubCA1
Device(ca-trustpoint)# exit
Device(config)# crypto pki trustpoint SubCA11
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation continue SubCA1
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair SubCA11
Device(ca-trustpoint)# end
```

Configuring Certificate Chain Validation from Peer to Subordinate CA

In the following configuration example, the following certificates will be validated--the peer and SubCA1 certificates.

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint RootCA
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation stop
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair RootCA
Device(ca-trustpoint)# exit
Device(config)# crypto pki trustpoint SubCA1
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation continue RootCA
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair SubCA1
Device(ca-trustpoint)# exit
Device(config)# crypto pki trustpoint SubCA11
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation continue SubCA1
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair SubCA11
Device(ca-trustpoint)# end
```

Configuring Certificate Chain Validation Through a Gap

In the following configuration example, SubCA1 is not in the configured Cisco IOS hierarchy but is expected to have been supplied in the certificate chain presented by the peer.

If the peer supplies the SubCA1 certificate in the presented certificate chain, the following certificates will be validated--the peer, SubCA11, and SubCA1 certificates.

If the peer does not supply the SubCA1 certificate in the presented certificate chain, the chain validation will fail.

```
Device> enable
Device# configure terminal
Device(config)# crypto pki trustpoint RootCA
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation stop
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair RootCA
Device(ca-trustpoint)# exit
Device(config)# crypto pki trustpoint SubCA11
Device(ca-trustpoint)# enrollment terminal
Device(ca-trustpoint)# chain-validation continue RootCA
Device(ca-trustpoint)# revocation-check none
Device(ca-trustpoint)# rsakeypair SubCA11
Device(ca-trustpoint)# end
```

Feature History for Authorization and Revocation of Certificates in a PKI

This table provides release and related information for the features explained in this module.

These features are available in all the releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Everest 16.6.1	Authorization and Revocation of Certificates in a PKI	Certificates contain several fields that are used to determine whether a device or user is authorized to perform a specified action. Certificate-based ACLs also help determine when PKI components such as revocation, authorization, or a trustpoint should be used.
Cisco IOS XE Cupertino 17.7.1	Authorization and Revocation of Certificates in a PKI	This feature was implemented on the supervisor modules C9400X-SUP-2 and C9400X-SUP-2XL.

Use the Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to https://cfnng.cisco.com.