An Overview of X.509 Certificates

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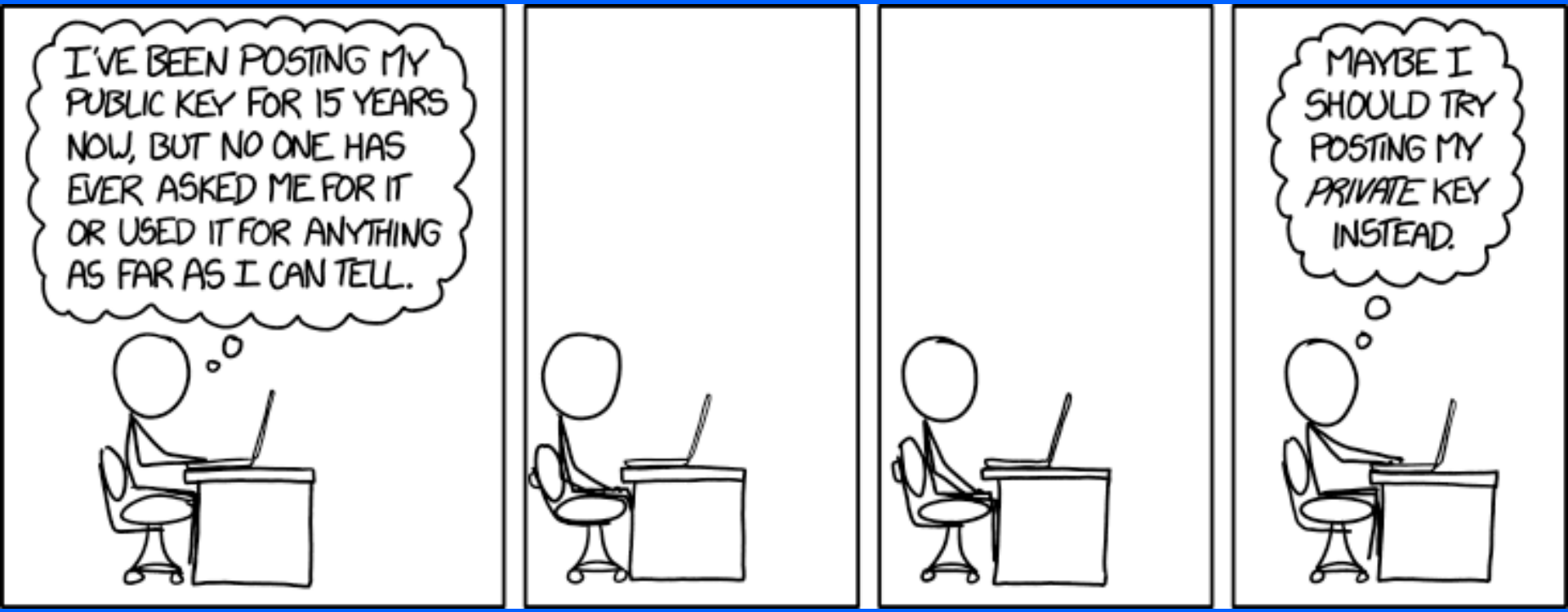
Background


I'VE BEEN POSTING MY PUBLIC KEY FOR 15 YEARS NOW, BUT NO ONE HAS EVER ASKED ME FOR IT OR USED IT FOR ANYTHING AS FAR AS I CAN TELL.
MAYBE I SHOULD TRY POSTING MY PRIVATE KEY INSTEAD.

What is Public-key Cryptography?

Uses two keys - a *public* key potentially known to everyone and a *private* key that is known only to one party in an exchange of information

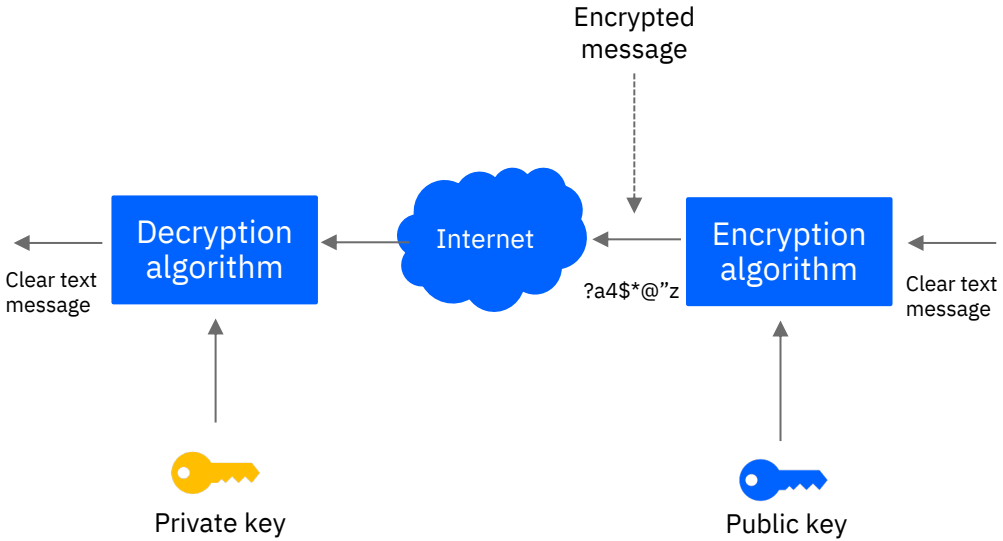
- Early 70s - First discovered by British government cryptographers
- Mid-70s - Three famous researchers, Ron Rivest, Adi Shamir, and Leonard Adleman, created the popular RSA asymmetric key algorithm using public-key cryptography.

Benefit:

- Used to encrypt data sent between two parties and authenticates sender identity

Cons:

- Uses complex calculations and are relatively slow. They are not used for encryption of bulk data.

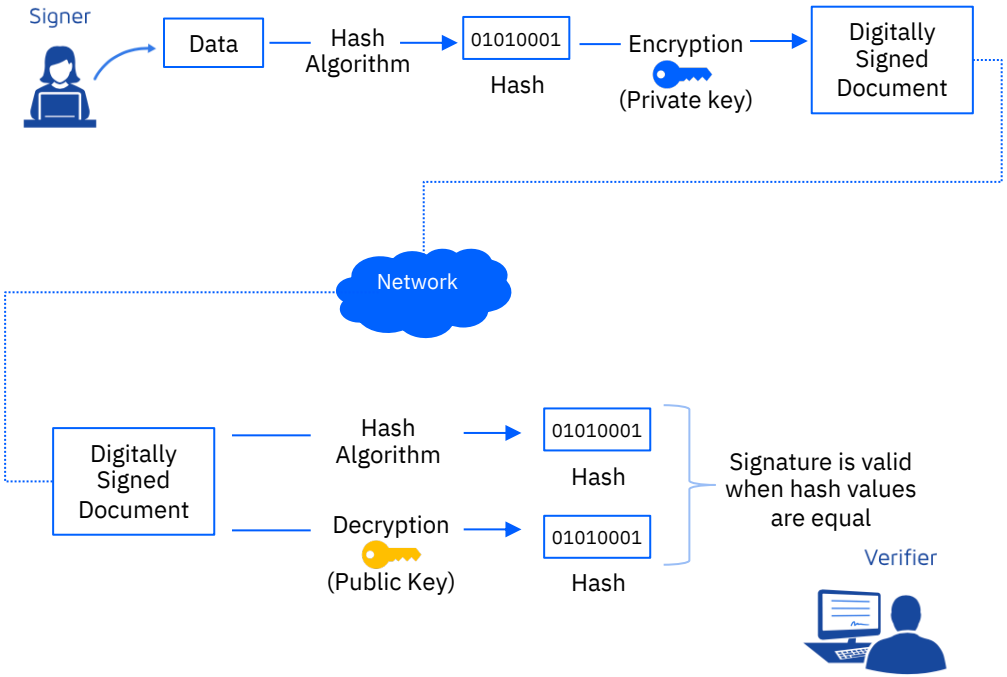


What is a Digital Signature?

An electronic signature created by using a digital certificate's private key. Provides a unique electronic binding of the identity of the signer to the origin of the object.

To verify the digital signature, we need the signing authority's public key:

1. A secure hashing algorithm is used to create a digest of the message or certificate's content
2. The digest is encrypted with the CA's private key
3. The signature is decrypted with the CA's public key
4. A new digest of the certificate's contents is made and compared with the decrypted signature

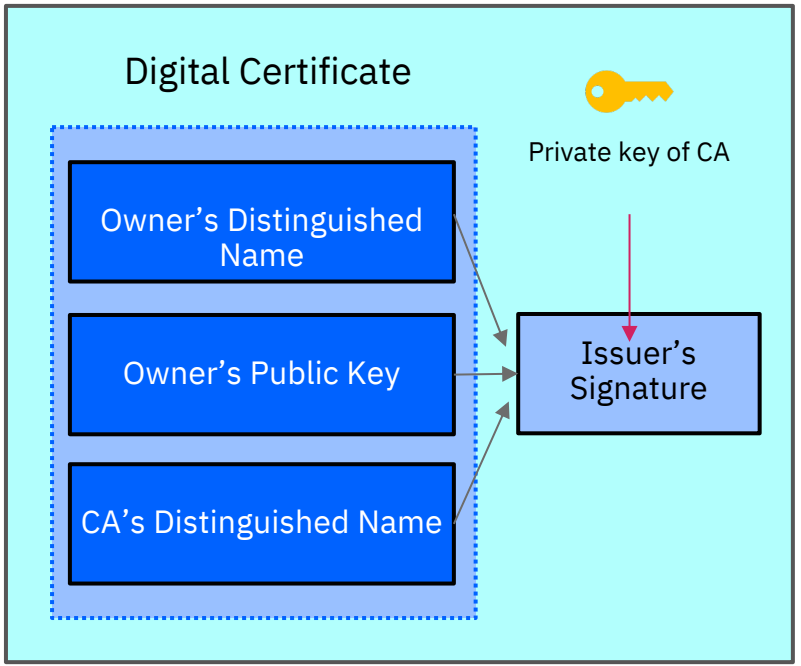


Digital Certificates

An electronic document used to identify an individual, server, company or some other entity. It contains the public key and is signed with the private key to verify that it belongs to the sender.

- Two purposes:
  - Establishes the owner's identity
  - Makes the owner's public key available

- Contains specific pieces of information about the identify of the certificate owner and, if applicable, the Certificate Authority:
  - Owner's distinguished name of the owner of the public key, *aka subject's name*
  - Issuer's distinguished name, *aka issuer's name*
  - Owner's public key itself
  - The time period during which the certificate is valid, *aka the validity period*
  - Certificate's serial number as designated by the issuer
  - Issuer's digital signature



Types of Certificates

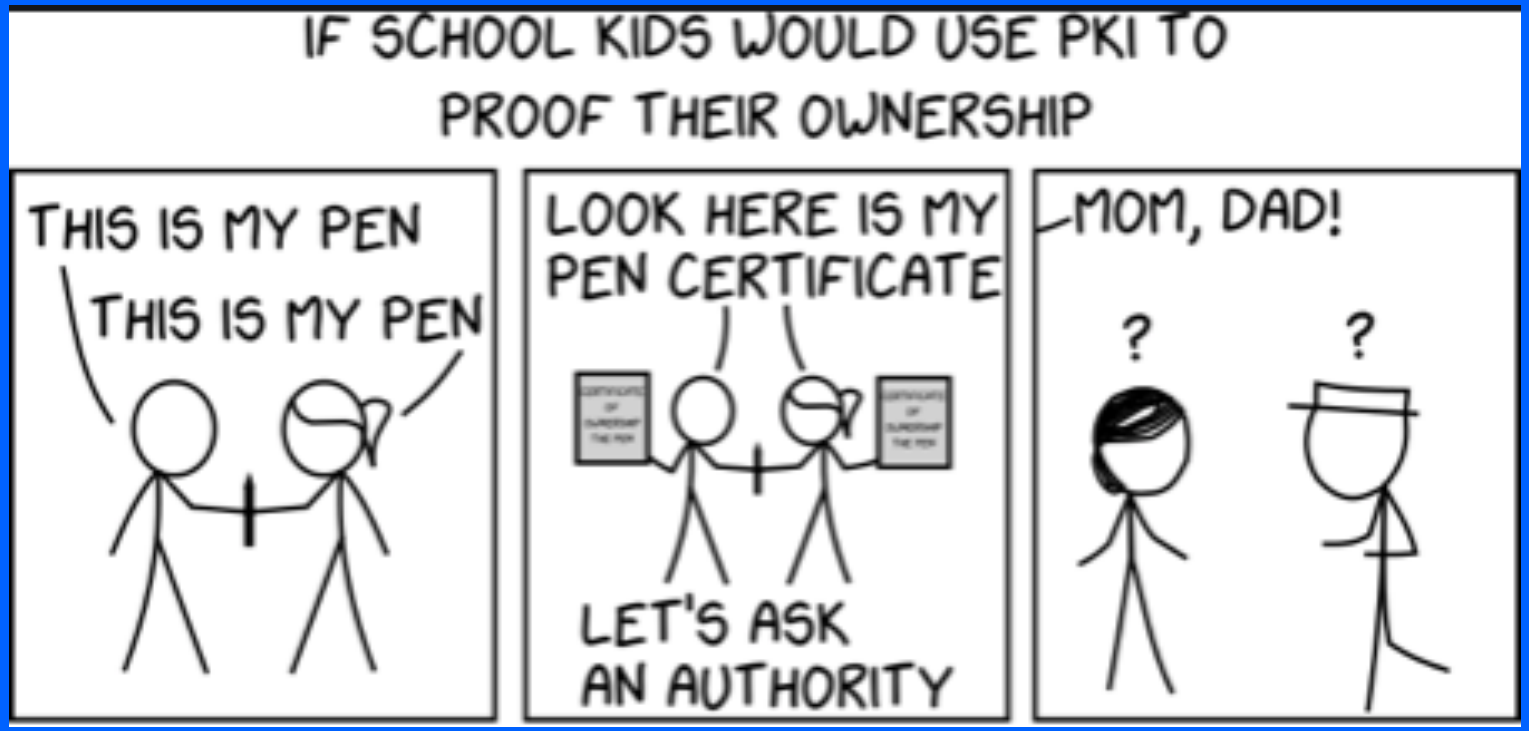
Only three types of certificates can be stored in RACF keyrings:

1. A *user certificate* is associated with a RACF user ID and is used to authenticate the user's identity
   - An organization can issue its own certificate with itself as subject and issuer, signing with its own private key. This is called a *self-signed certificate*.
   - A certificate issued by a well-known Certificate Authority (CA) corporation (Verisign, Thawte, etc.) is known as a *CA-signed certificate*.
     - A certificate can be issued by a local CA.

2. A *shared site certificate* is a certificate shared among two or more servers (user IDs).

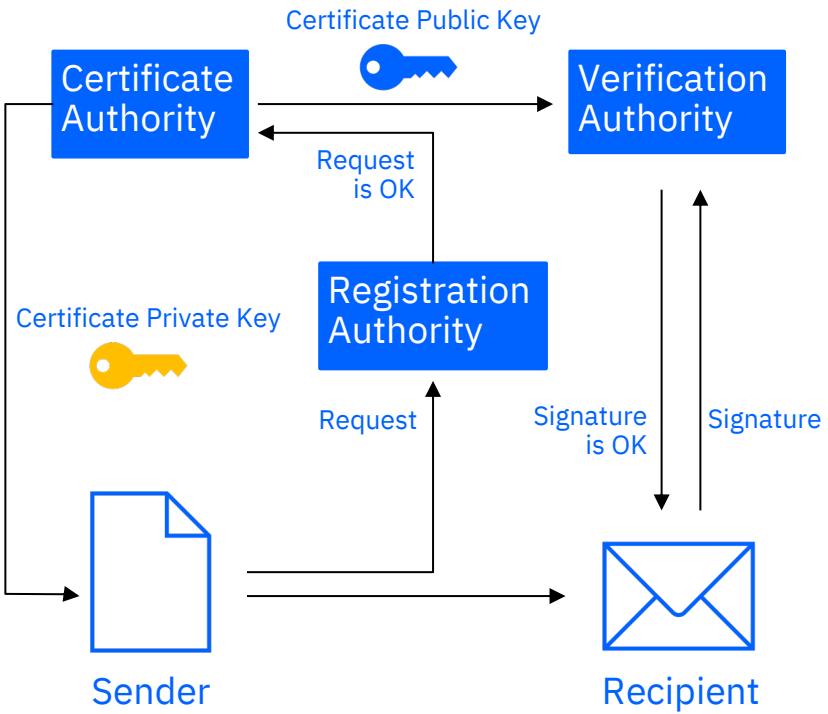
3. A *Certificate Authority* certificate is associated with a certificate authority and is used to verify signatures in other certificates.

Public-Key Infrastructure



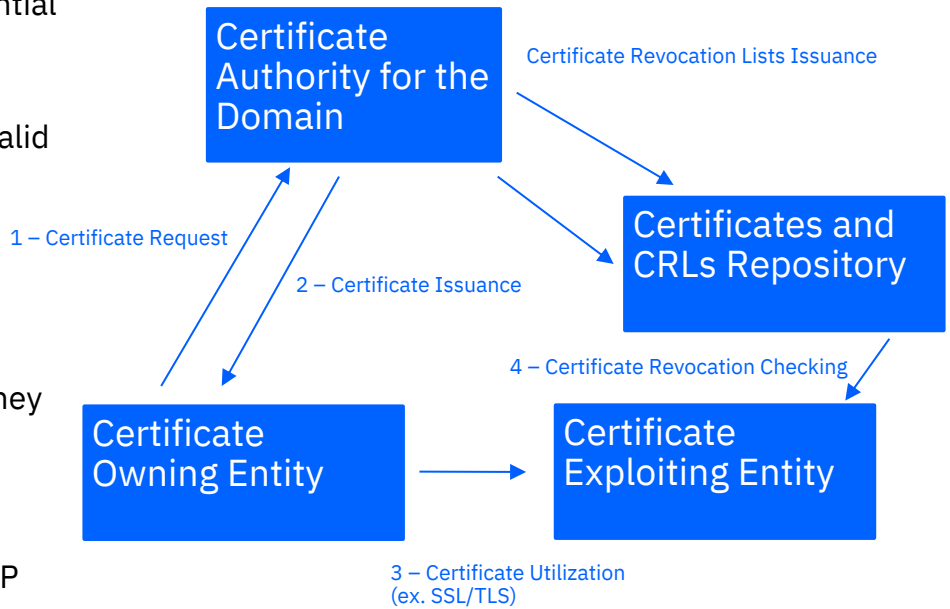
Public-Key Infrastructure

- In order to ensure that a public key you have was really created by that specific person, you need some sort of trusted third party.
- 1990s – Public-key infrastructure (PKI) surfaced commercially. This is a set of technologies and standards to manage the creation, storage, and distribution of certificates bound to Certificate Authorities (CAs). This was helped by x.509 certificates.



Certificate Revocation

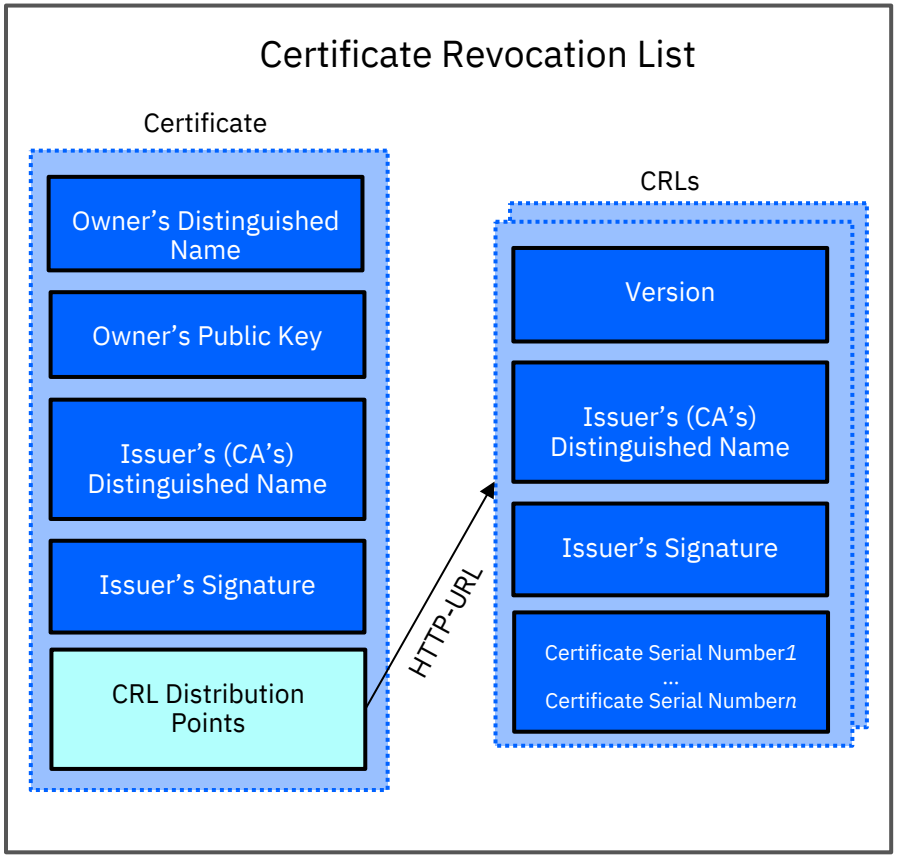
- Certificate renewal interval is based on risk analysis of potential losses. X.509 renewal interval is usually one year.
- Revocation provides a means for a certificate to become invalid prior to its validity end date
- **Reasons for revocation:**
  - Private key associated with the certificate has been compromised
  - Certificates are being used for purpose other than what they are defined
- Revocation information is made available either via
  - Publishing of a Certificate Revocation List (CRL) in an LDAP directory
  - Real-time interrogation of the Certificate Authority via the Online Certificate Status Protocol (OCSP)



Certificate Revocation

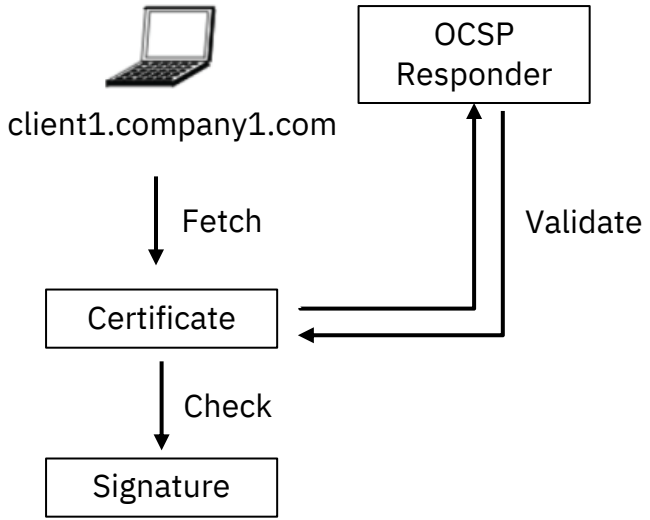
- Certificate Revocation List (**CRL**)
  - A time-stamped list of revoked certificates that is signed by a certificate authority
  - Equivalent to 1970s-era credit card blacklist booklets that were based on earlier cheque blacklists

- **How it works:**
  - Fetch certificate
  - Fetch certificate revocation list (CRL)
  - Check certificate against CRL
  - Check signature using certificate



Certificate Revocation

- Online Certificate Status Protocol (**OCSP**) inquires of the issuing CA whether a given certificate is still valid.
  - Returned status values are “good”, “revoked”, or “unknown”
  - Instead of obtaining a CRL of everything, the process with OCSP sends a CRL/OCSP response for specific certificates

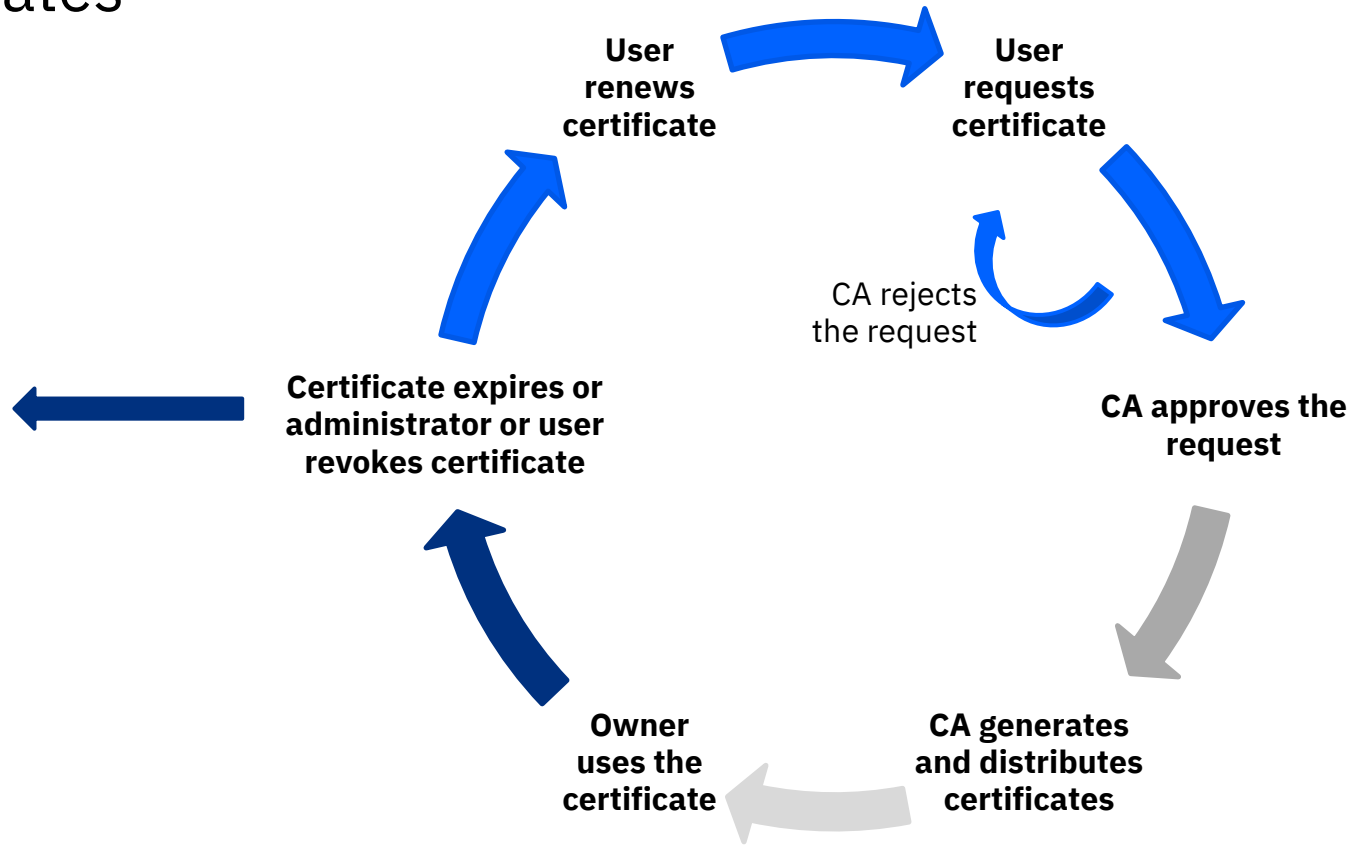


Certificate Request

- A certificate request that is sent to a certificate authority to be signed contains the owner's distinguished name, the owners' public key, and the owner's own signature over these fields.

- The Certificate Authority verifies the signature with the public key in the digital certificate to ensure that:
  - The certificate request was not modified in transit between the requester and the CA
  - The requester is in possession of the private key that belongs to the public key in the certificate request

Managing Keys and Certificates



Uses for Certificates in Internet Applications

SSL/TLS
- Used by servers for security for connections between servers and clients
- SSL/TLS uses digital certificates for key exchange, server authentication, and client authentication

Secure electronic mail
- Privacy Enhanced Mail (PEM) or Secure/Multipurpose Internet Mail Extensions (S/MIME)
- Uses digital certificates for digital signatures and for exchange of keys to encrypt and decrypt messages

Virtual Private Networks (VPNs)
- aka secure tunnels that can be set up between firewalls to enable protected connections between secure networks over insecure communication links. The protocols used in tunneling follow the IP Security (IPSec) standard.

Secure Electronic Transaction
- Standard for secure credit card payments in insecure networks
- Digital certificates are used for cardholders to allow for secure private connections between cardholders, merchants, and banks

This is only a subset of certificate usage and not meant to be a comprehensive list.

Authentication using digital certificates

Client authentication

- An option in SSL that requires a server to authenticate a client's digital certificate prior to login
- Server requests and authenticates client's digital certificate during the SSL handshake
- The identification of a client by a server, or the identification of the person assumed to be using the client

Server authentication

- The identification of a server by a client, or the identification of the organization assumed to be responsible for the server at a network address

X.509 Certificates

”X.509 certificates…recognizes that information within a digital certificate are all placed in the same location and in the same order, which makes it possible for all kinds of certificates to be shared across organizations.”

All Types of Digital Certificates Are Also A X509 Certificate
Digi-Sign

What Are X.509 Certificates?

- 1998– the first X.509 digital certificate was issued as part of the International Telecommunications Union's (ITU) Telecommunication Standardization Sector and the X.500 Directory Services Standard.

- X.509 uses the widely accepted international X.509 public key infrastructure standard to verify that a public key belongs to the user, computer or service identify contained within the certificate.

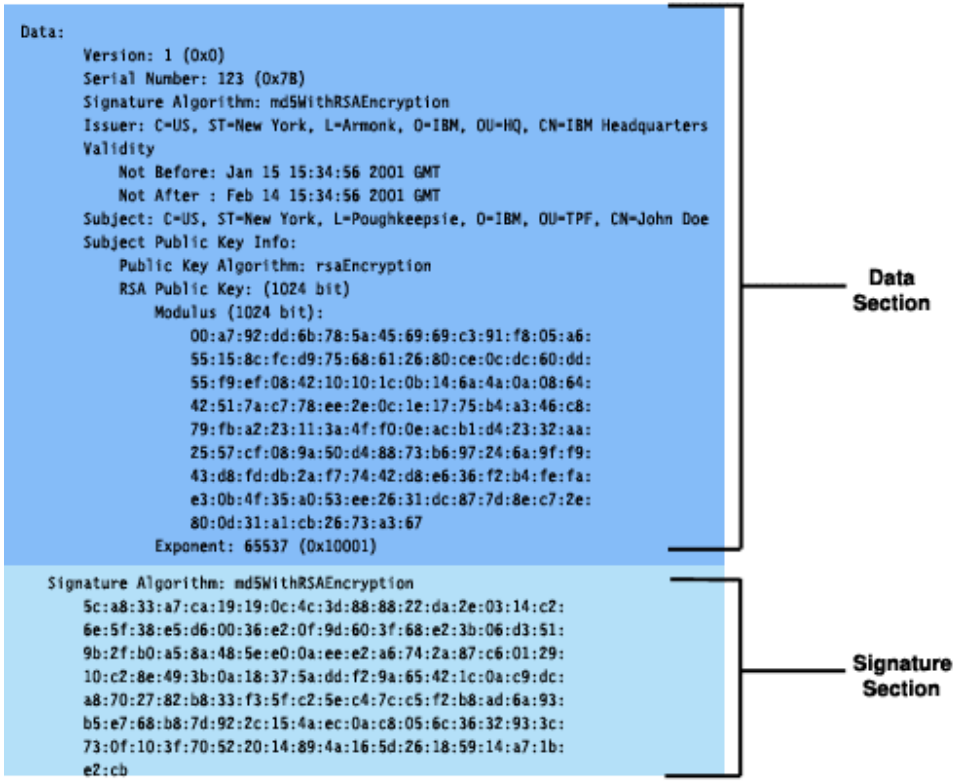
- When a certificate is generated, a private key is also produced, but this private key is not stored inside the x.509 certificate. Only the public key resides in the x.509 certificate.
  - The private key resides in the repository of the end-entity that is represented with the certificate.
  - The private key is used for signing certificates and decrypt data that has been encrypted with the public key. The private key may also be used to encrypt data.

- Every x.509 certificate contains a data section and a signature section.

What Are X.509 Certificates?

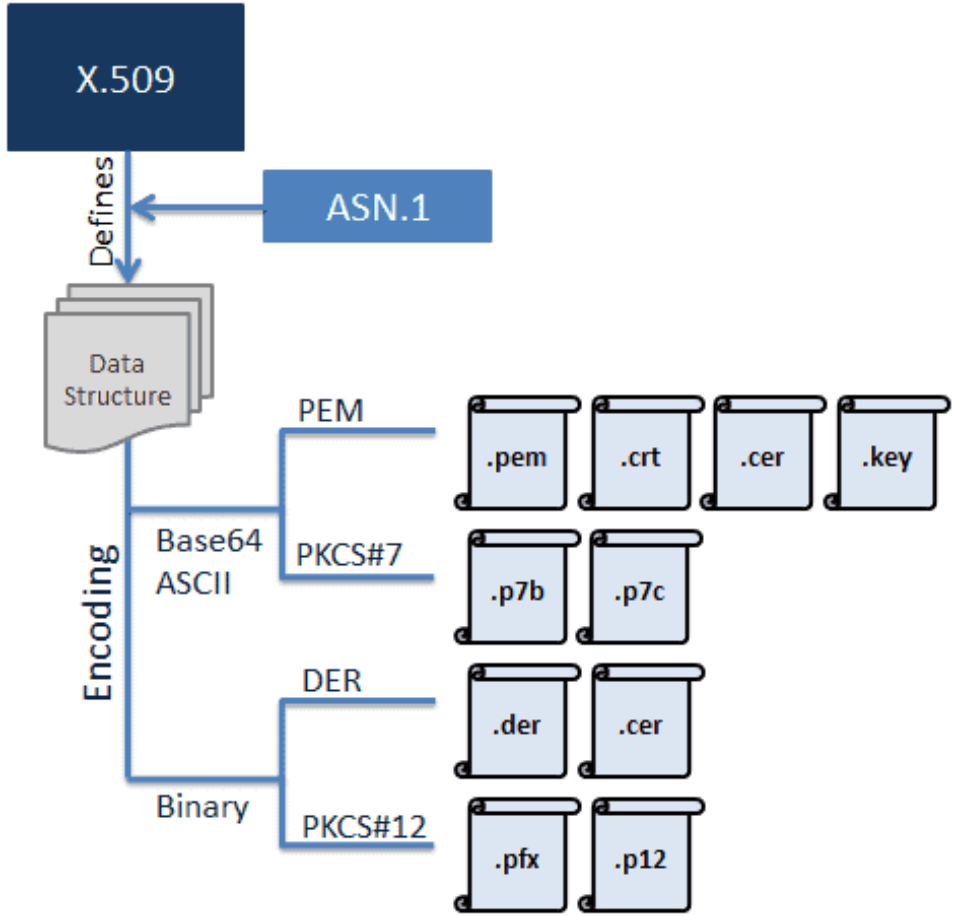
- Certificates include:
  - Which **X.509 version** applies to the certificate
  - **Serial number** – the identity creating the certificate must assign it a serial number that distinguishes it from other certificates
  - **Algorithm information** – the algorithm used by the issuer to sign the certificate
  - **Issuer distinguished name** – name of the entity issuing the certificate (Usually a CA)
  - **Validity period** of the certificate – start/end date and time
  - **Subject distinguished name** – the identity the certificate is issued to
  - **Subject public key information** – the public key associated

- The signature section includes:
  - The cipher algorithm – the algorithm used by the issuer to create a digital signature
  - The digital signature for the CA – a hash of all the information in the certificate encrypted with the CA private key



Certificate Formats

Certificate are packaged into “formats”.



Certificate Formats

Binary

- **.DER** (Distinguished Encoding Rules)
  - A single binary certificate, platform-independent format, the default format for most browsers
  - **Use**: Used for Certificate Requests, which are always DER-encoded and then base64-encoded
- **PKCS#12** (Public-Key Cryptographic Standards)
  - One or more certificates packed together, password-encrypted
  - **Use**: When the CA wants to ship a package confidentially that contains the private key

Base64 (ASCII)

- **.PEM**
  - Default format for OpenSSL. Suitable for sending files as text between systems
  - Prefixed with a “--BEGIN…” line
  - **Use**: When making a Certificate Request in an email
- **PKCS#7**
  - One or more certificate packaged together but not signed or encrypted
  - **Use**: When the CA wants to deliver multiple certificates to a destination

Certificate Formats

Here are some UNIX commands that will let you output the contents of PEM and DER-encoded certificate formats in a human readable form:

View

Use the command that has the extension of your certificate replacing cert.xx with the name of your certificate

View a PEM encoded certificate

```
openssl x509 –in cert.pem –text –noout
```

View a DER encoded certificate

```
openssl x509 –in certificate.der –inform der –text –noout
```

Transform

Take one type of encoded certificate to another (i.e. PEM to DER)

Transform a PEM encoded certificate to DER encoded certificate

```
openssl x509 –in cert.crt –outform der –out cert.der
```

Transform a DER encoded certificate to PEM encoded certificate

```
openssl x509 –in cert.crt -inform der –outform pem –out cert.pem
```

Protocols Supporting X.509 Certificates

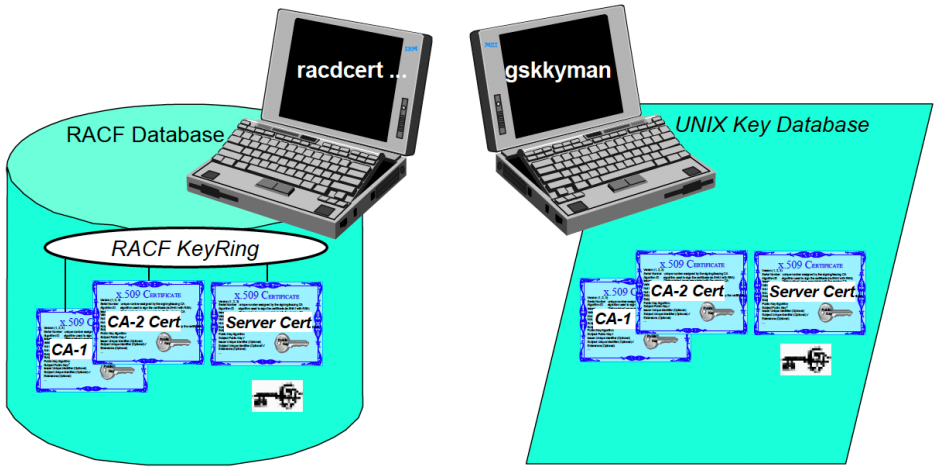
- Transport Layer Security (SSL/TLS)
- IPSec
- Secure Multipurpose Internet Mail Extensions (S/MIME)
- Smartcard
- SSH
- HTTPS
- LDAPv3

Certificate Usage on z/OS

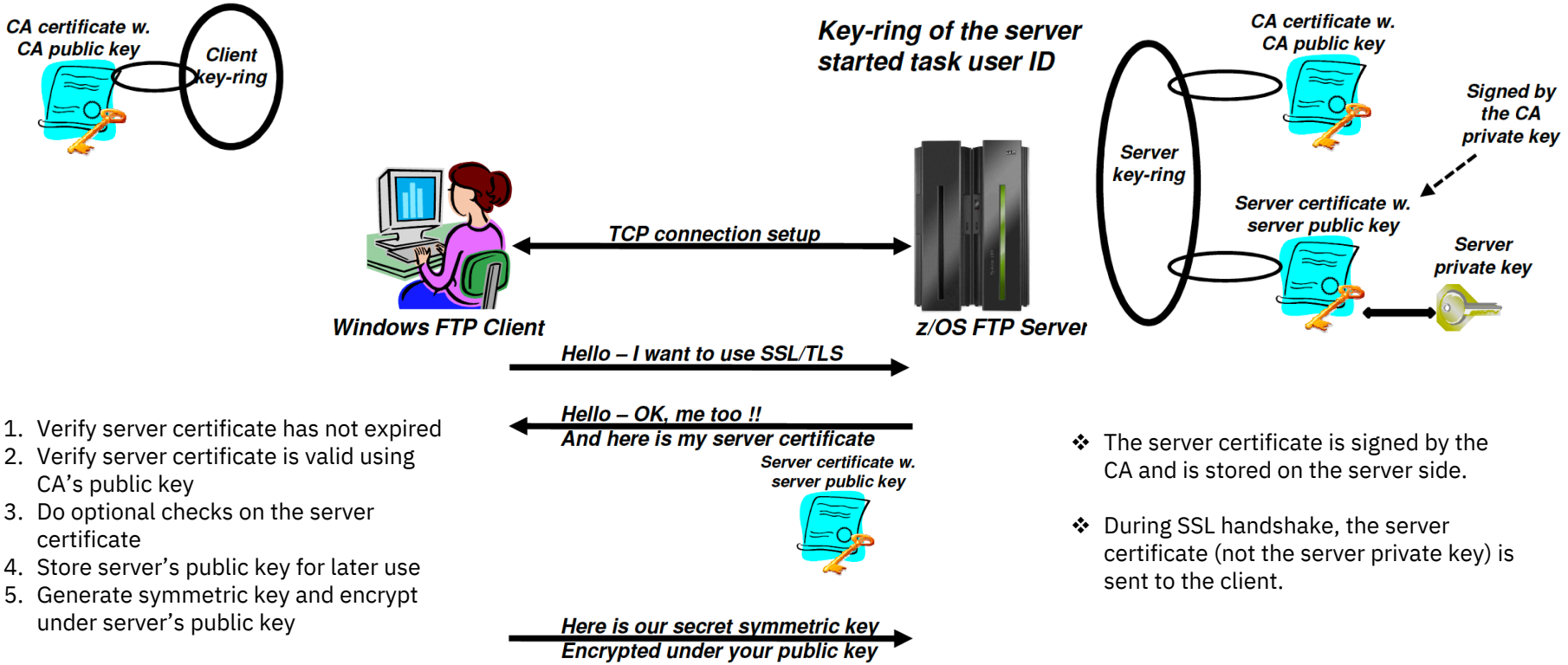
Creating and Storing Certificates

- Create certificates and certificate requests with:
  - RACDCERT in z/OS RACF
  - gskkyman in z/OS UNIX

- Certificates are stored and managed
  - in a RACF keyring
  - in a key database file in z/OS UNIX.



z/OS Server Authentication only



1. Verify server certificate has not expired
2. Verify server certificate is valid using CA's public key
3. Do optional checks on the server certificate
4. Store server's public key for later use
5. Generate symmetric key and encrypt under server's public key

- The server certificate is signed by the CA and is stored on the server side.
- During SSL handshake, the server certificate (not the server private key) is sent to the client.

Common Exploiters of x.509 Certificates

Exploiter	Connecting a Server Certificate to a Keyring	Where to Specify the Keyring Name
TN3270 Server (native SSL/TLS)	Connect server certificate as the DEFAULT on the keyring	Telnet Profile “KEYRING SAF ABCRING” (RACF)
TN3270 Server (AT-TLS)	Connect as the DEFAULT if the AT-TLS policy does not exploit the Certificate Label Name. If it does, certificate does not need to be the DEFAULT.	AT-TLS Policy
FTP Server (native SSL/TLS)	Connect server certificate as the DEFAULT on the keyring	FTP.DATA file “KEYRING ABCRING”
FTP Server (AT-TLS)	Connect as the DEFAULT if the AT-TLS policy does not exploit the Certificate Label Name. If it does, certificate does not need to be the DEFAULT.	AT-TLS Policy
IP Security (IPSEC) Dynamic VPN in z/OS Comm Server	Connect as the DEFAULT if the AT-TLS policy does not exploit the Certificate Label Name. If it does, certificate does not need to be the DEFAULT.	Iked.conf file “KEYRING ABCRING”
HTTP Server (native SSL/TLS)	Connect server certificate as the DEFAULT on the keyring	httpd.conf file “KEYRING ABCRING”
WebSphereMQ (native SSL/TLS)	NOTE: Label of the certifiate must start with “ibmWebSphereMQ”	Issue MQ command: “ALTER QMGR SSLKEYR(ABCRING)”

Considerations

Considerations

- A digital certificate alone can never be proof of anyone’s identity. It simply verifies the identity of the digital certificate owner by providing the public key that is needed to check the digital certificate owner’s digital signature. Therefore the digital certificate owner must protect the private key that belongs to the public key in the digital certificate.
- An application that authenticates the owner of a certificate cannot accept just the certificate. A message signed by the certificate owner should accompany the certificate. This allows the application to verify that the message is a “fresh” signature from the certificate owner and not a replayed message from an imposter.
- The larger the public/private key pair size, the greater the security but more computationally intensive.
- When transferring certificates, use a format acceptable to the receiving side. Be sensitive to binary and text modes to ensure proper transfer!

Certificate Errors

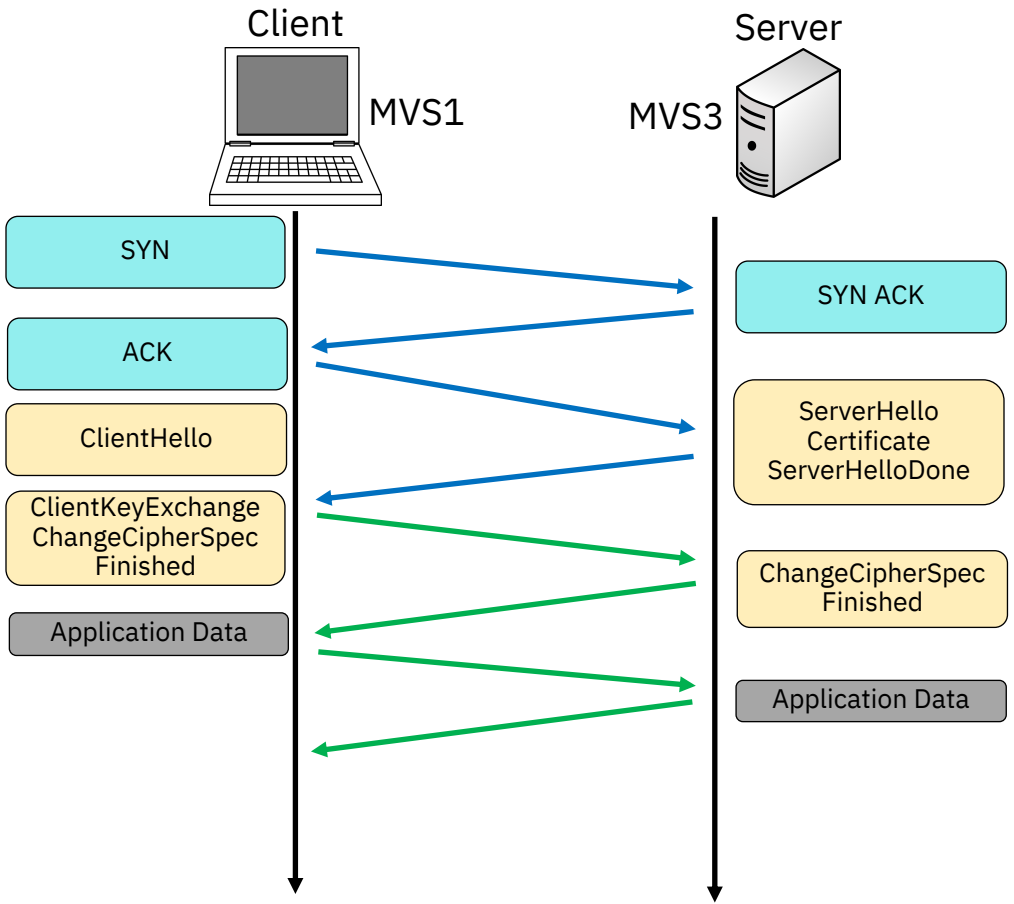
Certificate Errors

- For z/OS Communications Server, it is rarely necessary to take an SSL trace for diagnosing problems with SSL/TLS or AT-TLS. A simple look in SYSLOGD or the MVS console can reveal what has gone wrong with the secured connection you are testing.

- **Common Problems:**
  - Wrong Owner of Key Ring that Certificates reside on
  - Wrong Owner of Personal Certificate
  - Expired Certificate
  - Signing authority certificate not available to validate a certificate received during negotiation of secured session
  - Exporting certificates without understanding certificate formats

Error Example #1: Server Cannot Find its Certificate

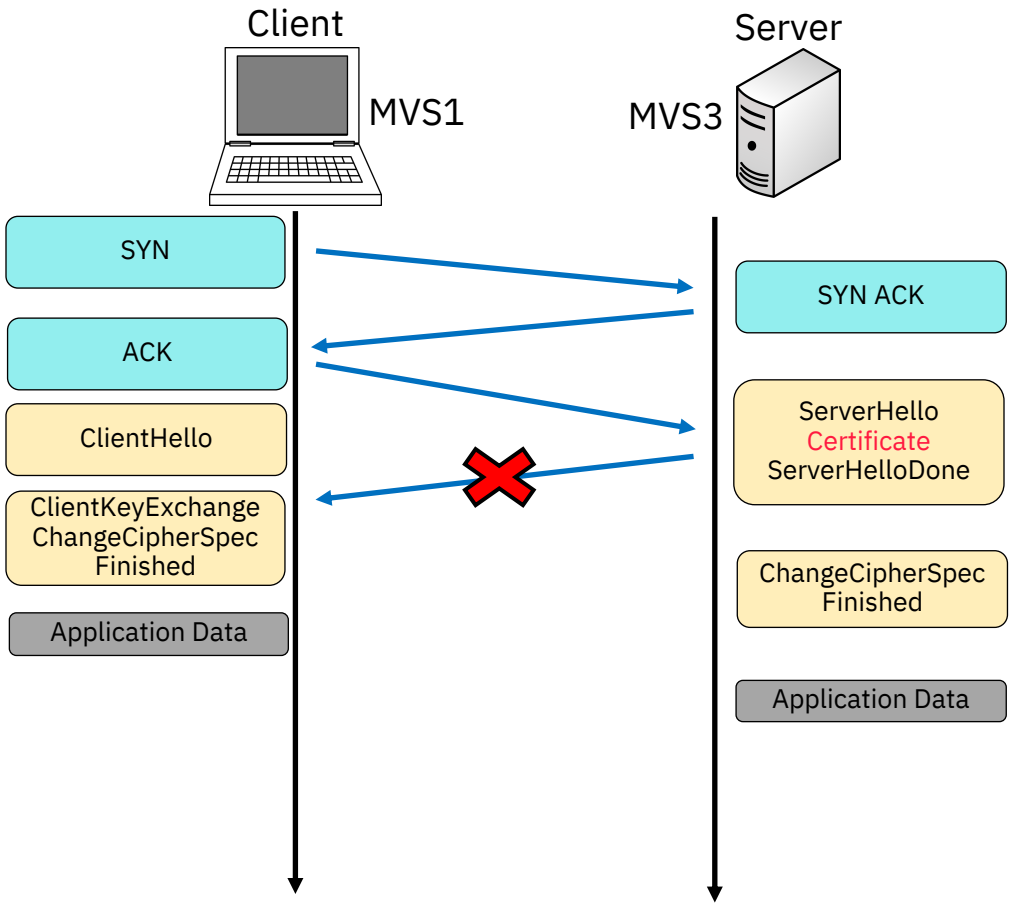
The following flow is seen when a client connects to an AT-TLS secured port.



Error Example #1: Server Cannot Find its Certificate

The following flow is seen when a client connects to an AT-TLS secured port.

In this case, the FTP server fails to provide a certificate.



Error Example #1: Server Cannot Find its Certificate

The following shows the error messages. The server reset the connection, not the client.

```
234 Security environment established - ready for negotiation

FC2838 authServerAttls: Start Handshake

FC2847 authServerAttls: ioctl() failed on SIOCTTLSCTL - EDC8121I Connection re
set. (errno2=0x77A9733D)  <<<<<<<<<<<<  Different errno2 from previous example

EZA2897I  Authentication negotiation failed

EZA1534I *** Control connection with 192.168.20.93 dies.
```

AT MVS3 (SERVER) :	EZD1287I TTLS Error RC: 6	Initial Handshake
AT MVS1 (CLIENT) :	EZD1287I TTLS Error RC: 438	Initial Handshake

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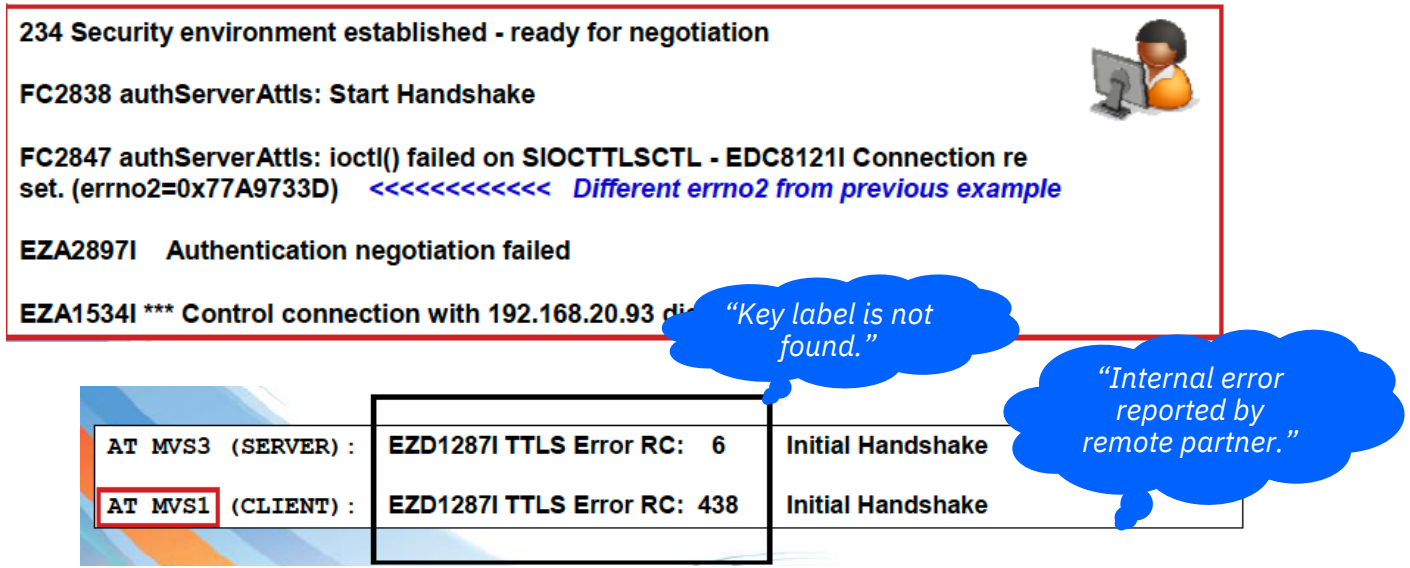

Error Example #1: Server Cannot Find its Certificate

MVS (server) indicates a problem with finding the correct key label in the key database or ring.

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```
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set. (errno2=0x77A9733D)  <<<<<<<<<<<<  Different errno2 from previous example

EZA2897I  Authentication negotiation failed

EZA1534I *** Control connection with 192.168.20.93 di
```

"Key label is not found."

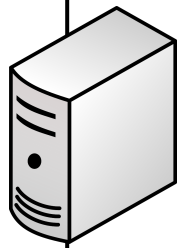
"Internal error reported by remote partner."

AT MVS3 (SERVER) :	EZD1287I TTLS Error RC: 6	Initial Handshake
AT MVS1 (CLIENT) :	EZD1287I TTLS Error RC: 438	Initial Handshake

Error Example #1: Server Cannot Find its Certificate

The following shows a display of the key ring at MVS3 (server).

```
racdcert id(FTPD) listring(Server_RING)
Digital ring information for user FTPD:
        Ring:
                >Server_RING<
        Certificate Label Name                  Cert Owner      USAGE       DEFAULT
        ------------------------------          ------------ -  -------     -------
        MVS1 LABS Certificate Authority         CERTAUTH        CERTAUTH    NO
```



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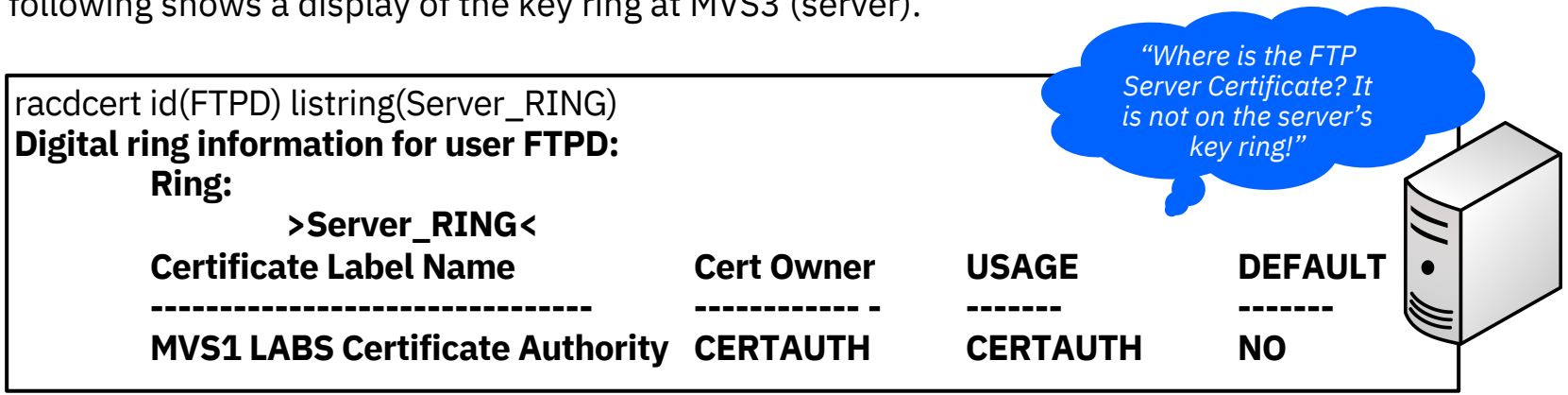
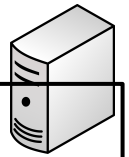


Error Example #1: Server Cannot Find its Certificate

Solution:

1. Connect FTP Server Certificate to Key Ring.
2. Change Policy Instance number and UPDATE PAGENTT to reinstall changes to the Key ring for FTP Server.
3. Recycle FTP Server to reinstall changes to Key Ring.

```
RACDCERT ID(FTPD) CONNECT(ID(FTPD)                -
         LABEL('FTP Server on MVS1-MVS7')         -
         RING(Server_RING) USAGE(PERSONAL) DEFAULT)
setropts generic(DIGTCERT) refresh
setropts raclist(DIGTCERT) refresh
racdcert ID(FTPD) listring(Server_RING)
```



```
Digital ring information for user FTPD:

Ring:
>Server_RING<
Certificate Label Name                Cert Owner    USAGE      DEFAULT
--------------------------------      ------------  --------   -------
MVS1 LABS Certificate Authority       CERTAUTH      CERTAUTH   NO
FTP Server on MVS1-MVS7               ID(FTPD)      PERSONAL   YES
```

Error Example #2: Expired x.509 Certificate and Keys

This visual shows the SSL Return code that you would see if your certificate cannot be found due to an invalid status of one type or another.

MVS Console Log at FTP Server LPAR

```
EZD1287I TTLS Error RC:  401 Initial Handshake 036
  LOCAL: 192.168.20.113..21
  REMOTE: 192.168.20.111..1038
  JOBNAME: FTPT1 RULE: FTPT@192.168.20.113 2
  USERID: TCPIP GRPID: 00000002 ENVID: 00000009 CONNID: 000000AD
```

RC 401

SYSLOGD Output with AT-TLS Policy Trace Level of 255 at Client LPAR

```
EZD1284I TTLS Flow  GRPID: 00000001 ENVID: 00000006 CONNID: 000000CA
RC:  401 Call GSK_SECURE_SOCKET_INIT - 7EB3C318

EZD1283I TTLS Event GRPID: 00000001 ENVID: 00000006 CONNID: 000000CA
RC:  401 Initial Handshake 00000000 7EB9C798

EZD1286I TTLS Error GRPID: 00000001 ENVID: 00000006 CONNID: 000000CA
LOCAL: 192.168.20.111..1038 REMOTE: 192.168.20.113..21 JOBNAME:
USER201 USERID: USER301 RULE: FTPTClient@192.168.20.11n~5
RC:  401 Initial Handshake 00000000 7EB9C798
```

Error Example #2: Expired x.509 Certificate and Keys

This visual shows the SSL Return code that you would see if your certificate cannot be found due to an invalid status of one type or another.

"Cryptographic Services SYSTEM SECURE SOCKETS LAYER Programming (SC24-5901-10)

At MVS1 and MVS3 … RC 401:
401 Certificate is expired or is not valid yet.

Explanation: The current time is either before the Certificate start time or after the Certificate end time.

User response: Obtain a new Certificate if the Certificate is expired or wait until the Certificate becomes valid is not valid yet.

Digital certificate information for user TCPIP:
Label: FTPServer31 EXP
Certificate ID: 2QXjw9fJ18bj1+KFmaWFmfLyQMXn10BA
Status: TRUST
Start Date: 2017/06/07 00:00:00
End Date: 2020/06/07 23:59:59

Error Example #2: Solution

To renew the expiration dates of a Certificate, follow these steps:

1. Generate a Certificate Request for the Certificate with the invalid dates *(“RACDCERT GENREQ” command)*
2. Generate a new Certificate, keeping the original old date, but extending the new data by one year. *(“RACDCERT GENCERT” command)*
3. Mark the Certificate as TRUSTED – since the old date will cause it to default to UNTRUSTED. *(“RACDCERT ALTER” command)*

How-to Guides

Certificate Services with RACDCERT

One method of creating and managing certificates and asymmetric keys it to use the RACF command RACDCERT.

RACDCERT can be used to create public and private keys and store them in the RACF database along with X.509 certificates containing the public keys.

Function	Description
ADD	Add certificate into the RACF data base
ADDRING	Create a RACF keyring
ALTER	Change the trust status of a certificate
CHECKCERT	Check whether a certificate has already been added to the RACF database
CONNECT	Connect a certificate to a keyring
DELETE	Delete a certificate from the RACF database
DELRING	Delete a keyring
EXPORT	Export a certificate as a PKCS#7 package or as a binary DER certificate
GENCERT	Generate a key pair and certificate
GENREQ	Generate a PKCS# 10 certificate request
LIST	List the contents of a certificate
LISTRING	List the contents of a keyring
REMOVE	Remove a certificate from a keyring

Generate a certificate

```
RACDCERT ID(certificate-owner) GENCERT + a
            SUBJECTSDN( +
                        CN('common-name') +
                        OU('organization-unit-name') +
                        O('organization-name') +
                        L('locality') +
                        SP('state-or-province') +
                        C('country') ) +
            SIZE(key-size) +
            NOTBEFORE(DATE(yyyy-mm-dd)) +
            NOTAFTER(DATE(yyyy-mm-dd)) +
            WITHLABEL('label-name') +
            ALTNAME( +
                        DOMAIN('internet-domain-name') )

RACDCERT ID(certificate-owner) GENREQ (LABEL('label-name')) + b
            DSN(output-data-set-name)
---
RACDCERT ID(certificate-owner) + c
            ADD(data-set-name) +
            TRUST +
            WITHLABEL('label-name')
```

a. Create a server certificate and a private/public key pair:
   - ID(USERID) – the started task user ID of your server

b. Generate a request to have the certificate signed by an external CA
   - Send the request to the CA
   - Receive from the CA

c. Add the signed certificate into RACF

Generate a certificate *(with JCL)*

```
//CERT01 JOB MSGCLASS=X,NOTIFY=&SYSUID
//CERT01 EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*************************************************************
//* Create Individual Personal Certificate for server *
//*************************************************************
//SYSTSPRT DD SYSOUT=*
//SYSTSIN DD *
RACDCERT ID(certificate-owner) GENCERT a                    -
          SUBJECTSDN (CN('Common Name') b   -
                    OU('organization-unit-name1')           -
                    C('country'))                           -
                    NOTBEFORE(DATE(yyyy-mm-dd)) c           -
                    NOTAFTER(DATE(yyyy-mm-dd)) c            -
                    WITHLABEL('label-name') d
setropts raclist(DIGTCERT) refresh e
racdcert ID(certificate-owner) list(label('label-name')) f
/*
```

a. The ID parameter identifies this certificate is being generated as a server certificate

b. SUBJECTSDN identifies several components of the x.509 Distinguished Name (DN)

c. Timeframe for certificate's validity

d. A label for organizing the certificate within a RACF database

e. Refreshes the DIGTCERT class so that the changes are known immediately

f. Displays the certificate with its attributes. Verifies that certificate has been properly created.

Create a RACF key ring

```
RACDCERT ID(ring-owner) ADDRING(ring-name) a

RACDCERT ID(certificate-owner) +
         CONNECT(CERTAUTH LABEL('label-name') +
         RING(ring-name) )                    b

RACDCERT ID(certificate owner) +
         CONNECT(LABEL('label-name') +
         RING(ring-name) +
         DEFAULT)                             c

RACDCERT ID(ring-owner) LISTRING(ring-name) d

         Ring:
                          >MyRACFKeyRing<
         Certificate Label Name   Cert Owner     Usage      Default
         ------------------------ -------------- ---------- ---------
         CA Certificate           CERTAUTH       CERTAUTH   NO
         Server Certificate       ID(FTPServer)  PERSONAL   YES
```

a. Create a keyring:
   - ADDRING(KeyRing) – the name of the key ring

b. Connect the Certificate Authority certificate to the keyring
   - ADD(data-set-name) – the dataset contains the CA certificate

c. Connect the server certificate to the keyring

d. Show the contents of the keyring

Create a RACF key ring *(with JCL)*

```
//KEYRNG01 JOB MSGCLASS=X,NOTIFY=&SYSUID
//KEYRNG01 EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*******************************************************************
//*          Add a separate keyring for ring-owner for server *
//*******************************************************************
//SYSTSPRT DD SYSOUT=*
//SYSTSIN DD *
racdcert ID(ring-owner) addring(ring-name) a
racdcert ID(ring-owner) CONNECT(ID(certificate-owner) -    b
             LABEL('label-name') -
             RING(ring-name) -
             DEFAULT) c
racdcert ID(ring-owner) CONNECT(CERTAUTH - d
             LABEL('CA-label-name') -
             RING(ring-name) -
             USAGE(CERTAUTH)) e
PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ID(USER) ACCESS(READ) f
PERMIT IRR.DIGTCERT.GENCERT CLASS(FACILITY) ID(USER) ACCESS(READ) g
setropts raclist(DIGTRING) refresh
setropts raclist(DIGTCERT) refresh h
setropts raclist(FACILITY) refresh
racdcert listring(ring-name) id(ring-owner) i
```

a. Adds a key ring to the RACF database
b. Connects a certificate to the created keyring
c. Indicates this certificate may be used as a single entity (server) only
d. Connects the CA certificate to the key ring
e. Indicates that this is a CA certificate
f. Protects the key ring with RACF control commands
g. Protects the private key and permits the user ID of the server to access it
h. This refreshed classes in MVS storage.
i. This command lists the contents of the keyring with the label identified

Create a SITE certificate

```
RACDCERT SITE GENCERT SUBJECTSDN(cn('common-name') a
        o('organization-name')
        ou('organizational—unit-name')
        C('country'))
        withlabel('label-name')
        signwith(certauth label('label-name')

RACDCERT SITE LIST

RACDCERT ID(ring-owner) CONNECT(SITE - c
LABEL('label-name') -
        RING(ring-owner) –
        DEFAULT              -
        USAGE(PERSONAL))
```

a. Create a SITE certificate

b. Lists names of all site certificates in the RACF database

c. Connect the site certificate to the new keyring using the RACDCERT CONNECT command

Create a SITE certificate *(with JCL)*

```
//CERTSITE JOB MSGCLASS=X,NOTIFY=&SYSUID
//CERTSITE EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*************************************************************
//* CREATE SITE AUTHORITY CERTIFICATE FOR ALL SERVERS (SHARED) *
//*************************************************************
//SYSTSPRT DD SYSOUT=*
//SYSTSIN DD *
RACDCERT SITE GENCERT SUBJECTSDN(CN('common-name') - a
             O('organization-name')                  -
                       OU('organizational-unit-name')        -
                       C('country'))                                 -
                       WITHLABEL('label-name') b
RACDCERT SITE LIST c
/*
```

a. The SITE ID is used to indicate that this certificate is to be used as a site certificate

b. The label name implies that the certificate is a shared site certificate

c. The command lists the names of all known site certificates in the RACF database

Create a new key ring for a shared SITE Certificate *(with JCL)*

```
//KEYRNGS JOB MSGCLASS=X,NOTIFY=&SYSUID
//KEYRNGS EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*******************************************************************
//*          Add a new keyring to the various clients' RACF ID, then ...    *
//*          Add the SITE certificate to the servers' keyring.
//*******************************************************************
//SYSTSPRT DD SYSOUT=*
//SYSTSIN DD *
racdcert ID(ring-owner) ADDRING(ring-name) a
racdcert ID(certificate-owner) CONNECT(CERTAUTH) -        b
                        LABEL('label-name') -
                        RING(ring-name) -
                        USAGE(CERTAUTH)
racdcert ID(ring-owner) CONNECT(SITE - c
LABEL('label-name') -
             RING(ring-owner) –
             DEFAULT                -
             USAGE(PERSONAL))
setropts raclist(DIGTRING) refresh
setropts raclist(DIGTCERT) refresh
racdcert listring(*) id(ring-owner)
```

a. Create a new RACF shared keyring using the RACDCERT ADDRING command

b. Connects the internal CA to the new keyring using the RACDCERT CONNECT command

c. Connect the site certificate to the new keyring using the RACDCERT CONNECT command

Appendix

Certificate Authorities

- A company that is considered trustworthy and produces digital certificates for other individuals and companies (i.e. subjects) bearing that subject's public key
- A Certificate Authority (CA) can be either a:
  - well-known corporation (Verisign, Thawte, etc.) or
  - local CA that is established within a corporation to sign server or client certificates
- They are only issued for a limited time.