Understanding Digital Certificates on z/OS

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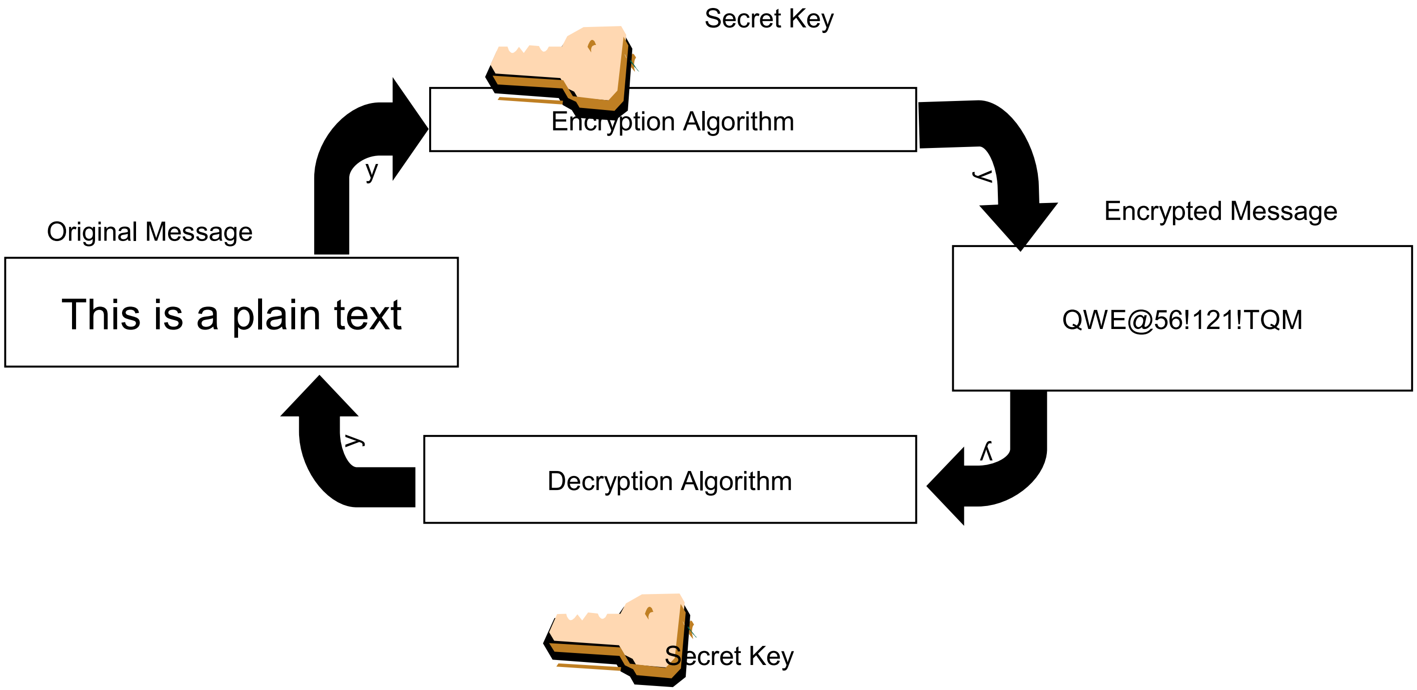
Agenda

- **Symmetric** vs. **Asymmetric Encryption**
- What are **digital certificates**
- Certificate **types** and **contents**
- Certificate **formats**
- Overview of certificate **utilities** available on z/OS
- **Summary**

Symmetric Encryption

- Defined keys
- Provide data confidentiality
- Algorithm defines strength of the encryption – DES, Triple DES, AES etc



Secret Key

Encryption Algorithm

Encrypted Message

QWE@56!121!TQM

Original Message

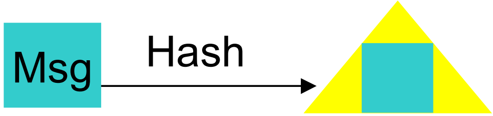
This is a plain text

Decryption Algorithm

Secret Key

Hash Algorithm

- One way function
- Arbitrary size input message produced a fixed size message digest
- No keys involved – Result determined only by the algorithm
- Any change to the input results completely unrelated message digest



Keys:

■ Plain text

▲ Message digest

Examples:

MD5	= 128 bits (16 bytes)
SHA-1	= 160 bits (20 bytes)
SHA-256	= 256 bits (32 bytes)

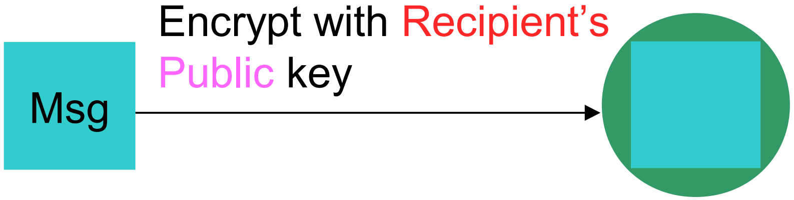
Asymmetric Encryption

- **Public/private key pairs**
- A public key and a related private key are **numerically associated** with each other.
- Provide data **confidentiality**, **integrity** and **non repudiation**
- Data **encrypted/signed using one** of the keys may only be **decrypted/verified using the other key**.
- **Public key** is intended to be **given freely**
- **Private key** needs to be treated very securely and **not distributed**

Encryption (for confidentiality)

Encrypting a message:

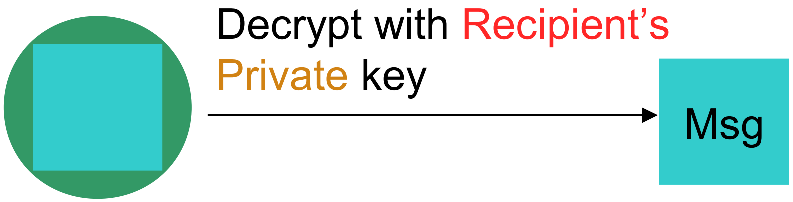
Sender:



Encrypt with Recipient's Public key

Decrypting a message:

Recipient:



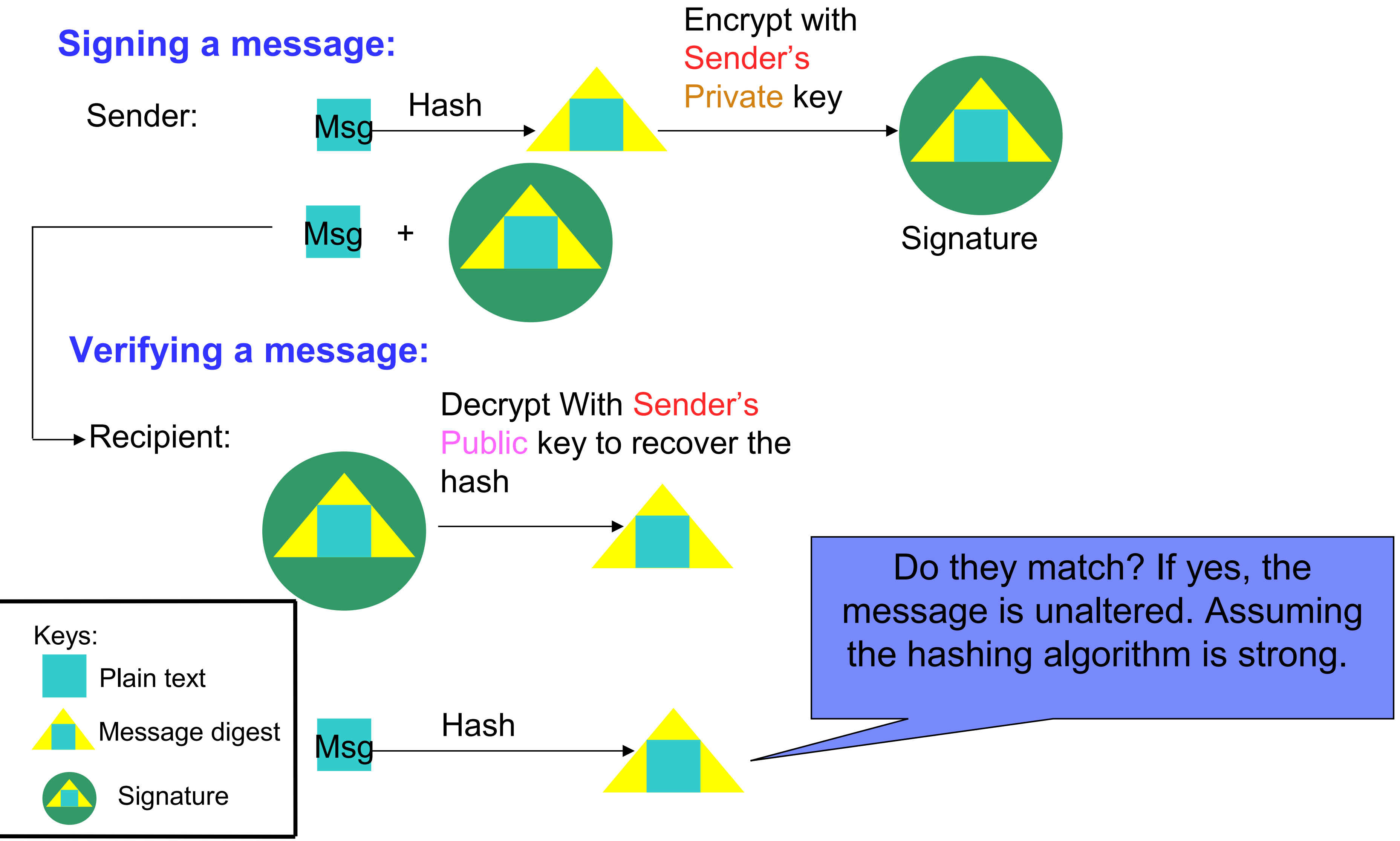
Decrypt with Recipient's Private key

Keys:

🟦 Plain text

● Encrypted text

Signing (for integrity and non repudiation)



Signing a message:

Sender:

Msg

Hash

Encrypt with Sender's Private key

Signature

Msg +

Verifying a message:

Recipient:

Decrypt With Sender's Public key to recover the hash

Msg

Hash

Do they match? If yes, the message is unaltered. Assuming the hashing algorithm is strong.

Keys:

Plain text

Message digest

Signature

What is a Digital Certificate

- A Digital Certificate is a digital document issued by a trusted third party which binds an end entity to a public key.

- **Digital document**:
  - Contents are organized according to ASN1 rules for x.509 certificates
  - Encoded in binary or base64 format

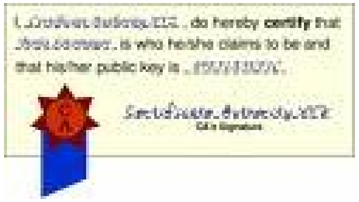
- **Trusted third party** aka **Certificate Authority** (CA):
  - The consumer of the digital certificate trusts that the CA has validated that the end entity is who they say they are before issuing the certificate.

- **Binds the end entity to a public key:**
  - **End entity** - Any person or device that needs an electronic identity. Encoded in the certificate as the Subjects Distinguished Name (SDN)
  - **Public key** - The shared half of the public / private key pair for asymmetric cryptography
  - Digitally signed by the CA

What is a Digital Certificate

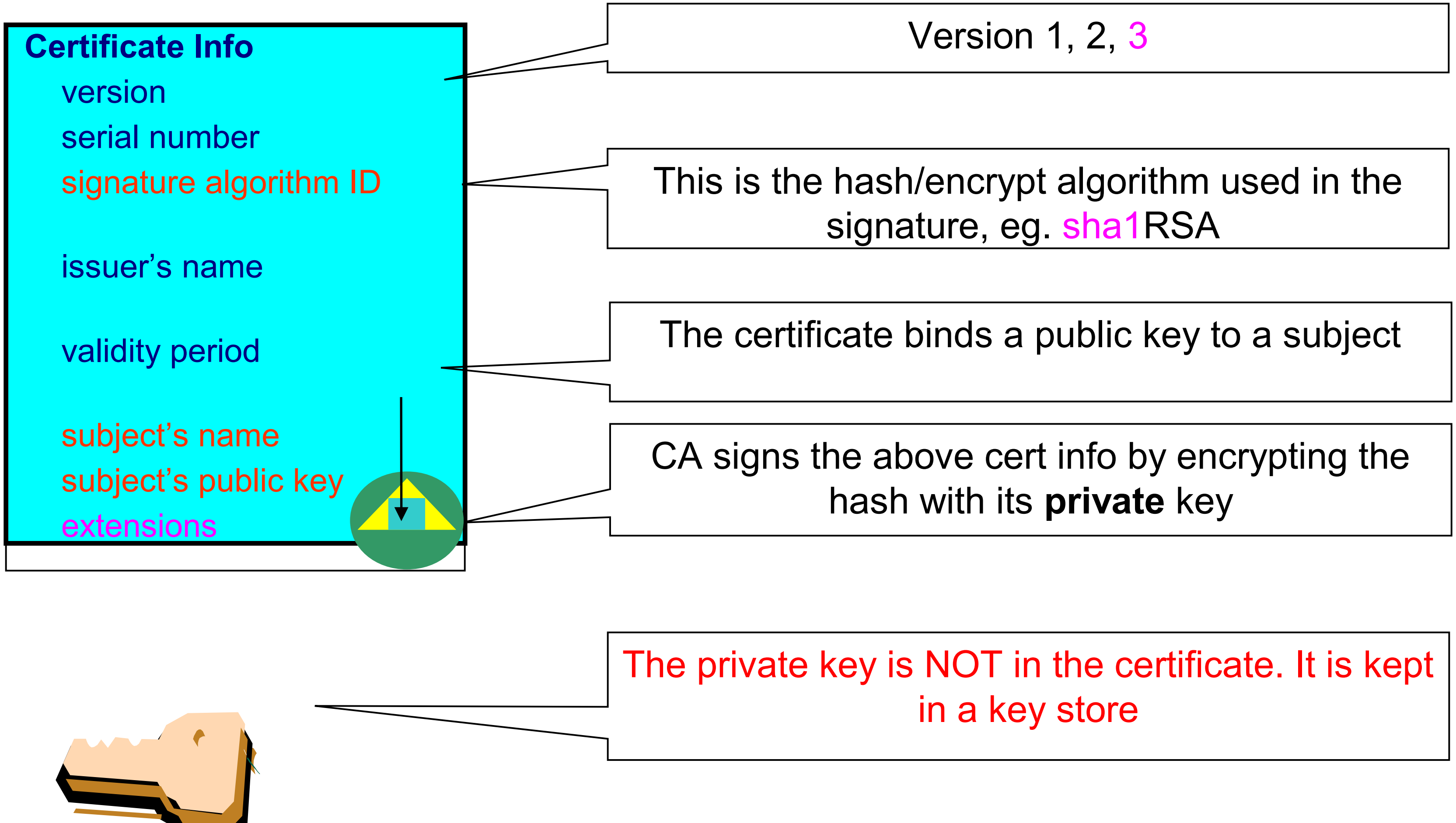
- Best way to think of it is as an ID card, like driver licenses or passport
- To establish your identity or credential to be used in electronic transactions
- Digital certificate technology has been in existence for over **20 years**
- **Packaging** of the information is commonly known as the **x.509 digital certificate**. X.509 defines the format and contents of a digital certificate.
  - **IETF RFC 5280**
- Have **evolved** over time to not only bind basic identity information to the public key but also **how public key can be used, additional identity data, revocation** etc.
- Generally a digital certificate **provides identity to a person or a server**

What's in a Digital Certificate?



I, Certificate Authority XYZ, do hereby certify that [illegible] is who he/she claims to be and that his/her public key is [illegible].

Certificate Authority XYZ
CA's Signature



Certificate Info
version
serial number
signature algorithm ID
issuer's name
validity period
subject's name
subject's public key
extensions

Version 1, 2, 3

This is the hash/encrypt algorithm used in the signature, eg. sha1RSA

The certificate binds a public key to a subject

CA signs the above cert info by encrypting the hash with its **private** key

The private key is NOT in the certificate. It is kept in a key store

You can NOT change ANY of the certificate information!

Extensions of a x.509 digital Certificate

- Adds additional definitions to a certificate and its identity information
- 15+ currently defined
- Top 6 extensions of interest
  - **Authority Key Identifier**
  - **Subject Key Identifier**
  - **Key Usage**
  - **Subject Alternate Name**
  - **BasicConstraints**
  - **CRL Distribution Point**

Extensions of a x.509 digital Certificate

- **Authority Key Identifier** – Unique identifier of the signer
- **Subject Key Identifier** – Unique identifier of the subject
- **Key Usage** – Defines how the public key can used
  - Digital Signature
  - Key Encipherment
  - Key Agreement
  - Data Encipherment
  - Certificate Signing
  - CRL signing
- **Subject Alternate Name** – Additional identity information
  - Domain name
  - E-mail
  - URI
  - IP address
- **Basic Constraints** – Certificate Authority Certificate or not
- **CRL Distribution** – Locating of Revoked certificate information

Example of a x.509 digital Certificate

Certificate issued to Server x by CA MyCompany CA to be used for SSL/TLS communication

Version	**V3**
Serial Number	**150**
Signature Algorithm	**RSA with SHA1**
Issuer	**CN=MyCompany CA,OU=Onsite CA ,O=CA Company,C=US**
Validity	
From	**Wednesday, May 31, 2008 10:41:39 AM**
To	**Wednesday, May 31, 2009 10:41:39 AM**
Subject	**CN=Server x,OU=z/OS,O=IBM,ST=New York,C=US**
Public Key	**RSA (1024)**
Extensions	
Key Usage	**Digital Signature, Key Encipherment**
Authority Key Identifier	**8014 91C1 73B0 73D5 D992 7467 CD1B F151 1434 31B6 2C5A**
Subject Key Identifier	**0414 7CA8 9E87 AA37 5D70 0301 7FDA 996C 1238 A20D 4FDE**
Basic Constraints	**Certificate issued to a certificate authority= FALSE**
Subject Alternate Name	**IP Address=9.1.2.3**

Types of digital certificates

- **Self signed**
  - Self-issued
  - Issuer and subject names identical
  - Signed by itself using associated private key
- **Signed Certificates**
  - **Signed/issued by a trusted Certificate Authority** Certificate using its private key.
  - By signing the certificate, the **CA certifies the validity of the information**. Can be a well-known commercial organization or local/internal organization.

Certificate Formats

- **X.509 certificates can exist in many different forms**
  - Single certificate
  - PKCS Package - (Public-Key Cryptographic Standards) – Developed by RSA
    - **PKCS #7** certificate package
      - Contains 1 or more certificates
    - **PKCS #12** certificate package
      - A password encrypted package containing 1 or more certificates and the private key associated with the end-entity certificate.
      - Only package type that contains a private key
- **Can be in binary or Base64 encoded format**

Base64 encoding

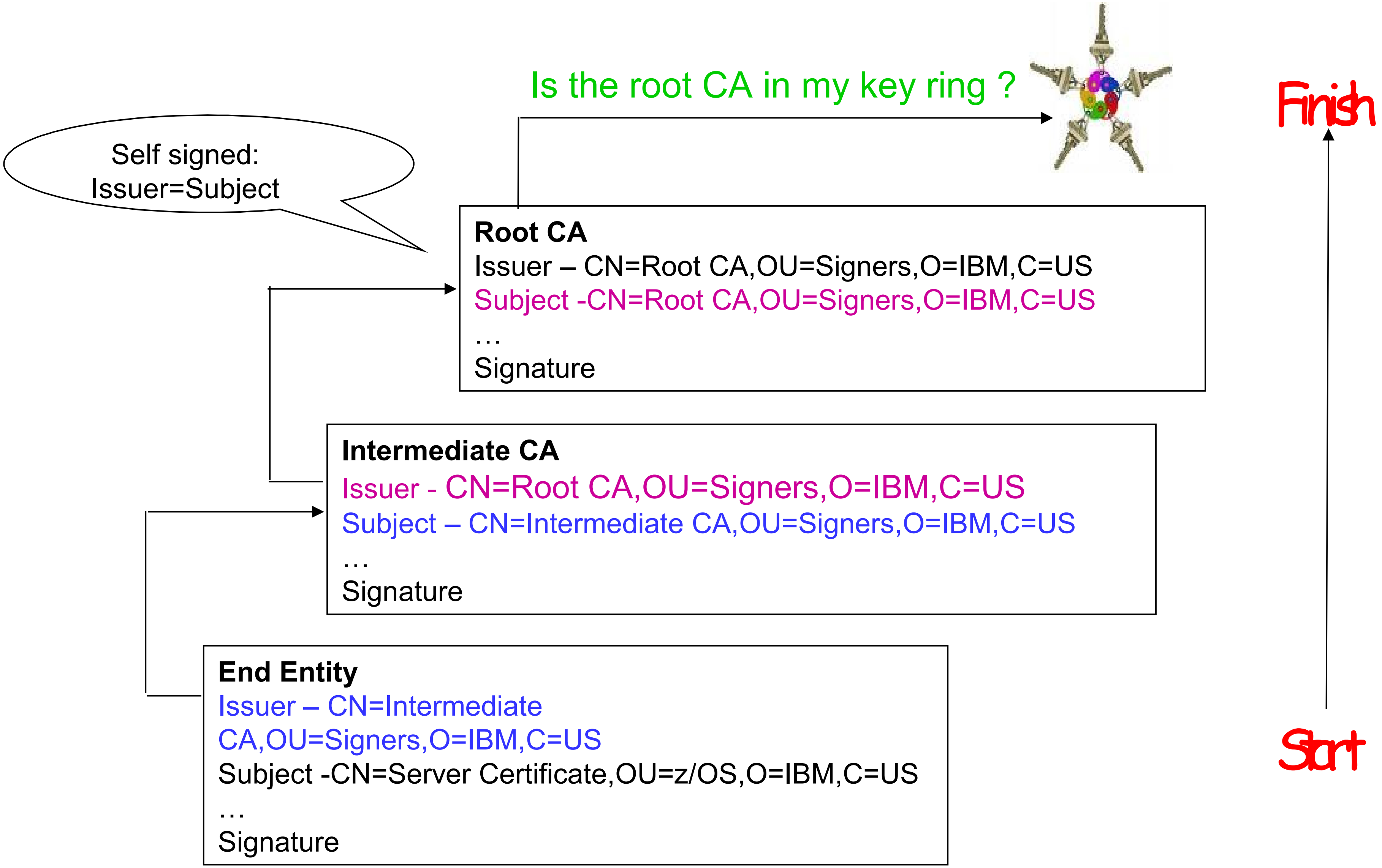
- **Converting binary data to displayable text for easy cut and paste.**

```
-----BEGIN CERTIFICATE-----
MIICPTCCAaagAwIBAgIIR49S4QANLvEwDQYJKoZIhvcNAQEFBQAwNzELMAkGA1UE
BhMCVVMxDTALBgNVBAoTBFRlc3QxGTAXBgNVBAMMEFRlc3Rfc2VsZl9zaWduZWQw
HhcNMDgwMTE3MTMwNjQxWhcNMDkwMTE2MTMwNjQxWjA3MQswCQYDVQQGEwJVUzEN
MAsGA1UEChMEVGVzdDEZMBcGA1UEAwwQVGVzdF9zZWxmX3NpZ25lZDCBnzANBgkq
hkiG9w0BAQEFAAOBjQAwgYkCgYEA9tKOv5gLaceozMfMeVd891fCjBVoR+dpzhwK
R2B/QcQYBGLfqS4YM/wGSh6YrmVygO0VxocriySbcxRuBayw3pE4/3JI2myINmLp
bFIdPCnqk/qvFK+1N+nrEnBK9yls7NmxDIuQQfFsX/o/DpoxwxzwXf+JbWDwirQR
NyLiTGMCAwEAAaNSMFAwHQYDVR0OBBYEFAwDFLjOUCRa62BVs3jVyHewuOWEMB8G
A1UdIwQYMBaAFAwDFLjOUCRa62BVs3jVyHewuOWEMA4GA1UdDwEB/wQEAwIE8DAN
BgkqhkiG9w0BAQUFAAOBgQAC5sW1f3EdE0k9zc8wKNt1sczWkQBrVy4Rdrl7ERqN
D2OfkBJQuXiNwN18pF6WPWfYG80MNwhP4oJSVePnzElh4Wzi2wl/zI8rINSW7px3
w16lz+8jEI84q/N0q0toPTAtEb6fIzwjkLtctt3oF+IjunvE5QoRsXRJbbTMD/EG
jw==
-----END CERTIFICATE-----
```

Revocation

- Normally the lifetime of certificate is the defined **validity period**
- 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
- **CRL** – Certificate Revocation List:
  - List of certificates that should no longer be trusted
  - CRL Distribution Point extension in the x.509 certificate gives information about where to locate revocation information for the certificate.
- **OCSP** – Online Certificate Status Protocol:
  - Provides a query function for the revocation status of a certificate

Certificate Chain Validation



Is the root CA in my key ring ?

Finish

Self signed:
Issuer=Subject

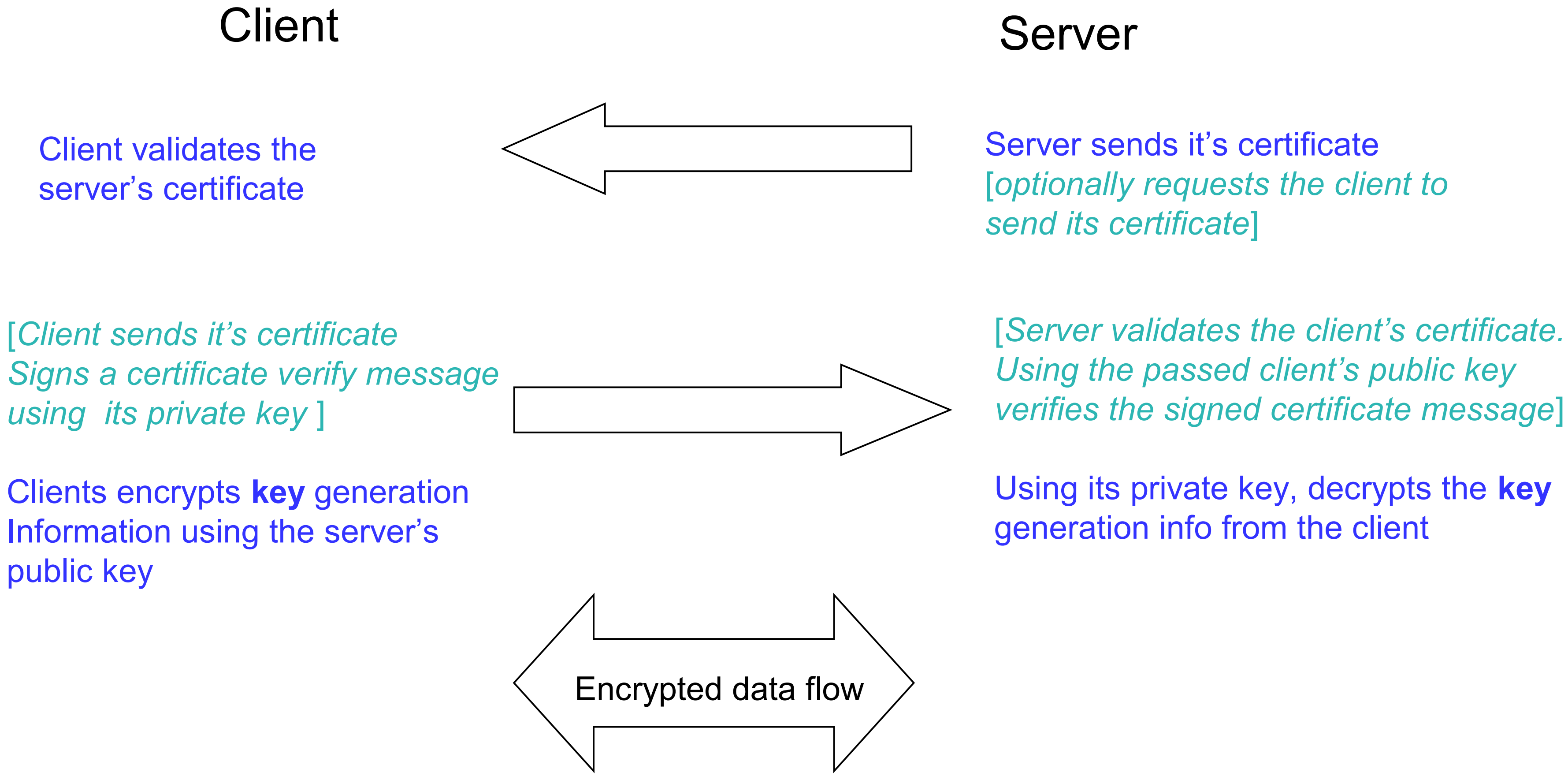
Root CA
Issuer – CN=Root CA,OU=Signers,O=IBM,C=US
Subject -CN=Root CA,OU=Signers,O=IBM,C=US
…
Signature

Intermediate CA
Issuer - CN=Root CA,OU=Signers,O=IBM,C=US
Subject – CN=Intermediate CA,OU=Signers,O=IBM,C=US
…
Signature

End Entity
Issuer – CN=Intermediate CA,OU=Signers,O=IBM,C=US
Subject -CN=Server Certificate,OU=z/OS,O=IBM,C=US
…
Signature

Start

Using Certificates for SSL handshakes



Client

Server

Client validates the server's certificate

Server sends it's certificate *[optionally requests the client to send its certificate]*

[Client sends it's certificate Signs a certificate verify message using its private key]

[Server validates the client's certificate. Using the passed client's public key verifies the signed certificate message]

Clients encrypts **key** generation Information using the server's public key

Using its private key, decrypts the **key** generation info from the client

Encrypted data flow

Using certificates to secure communication through the SSL/TLS protocol

- For example, Wilma wants to establish a secure FTP TLS connection between her workstation and FTP Server. The FTP Server is using a RACF key ring and Wilma has a key database file.
- The server certificate has been signed by **CA1**
- Wilma's certificate has been signed by **CA2**.

Wilma's Key Database File

- Wilma's Identity Certificate
- CA2 Certificate
- CA1 Certificate

FTP Server Key Ring

- FTP Server Identity Certificate
- CA1 Certificate
- CA2 Certificate

Defining a Certificate

- **How will the certificate be used**?
- What **certificate store** is to be used?
- Who will be the **certificate authority**?
- What is the identity’s **subject name**?
- What is the **size** of the public/private **keys**?
- Whether **additional identity information** is to be added to the certificate?
- What **label or nickname** will the certificate be known by?

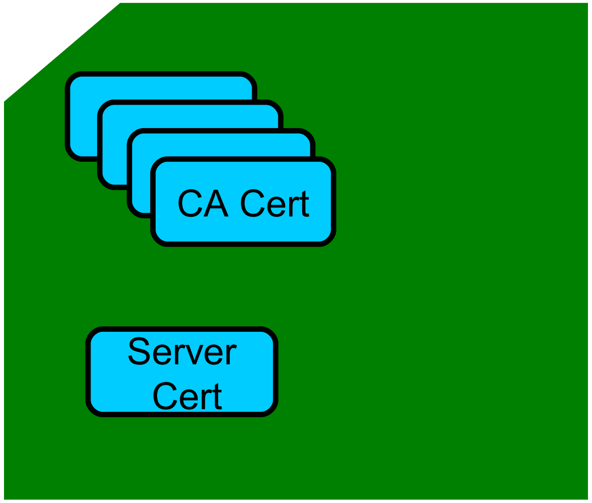
Defining a Certificate Request to be signed by a CA

- A **certificate signing request** (**CSR** or **PKCS #10**) is a message sent from the certificate requestor to a certificate authority to obtain a signed digital certificate.
- **Contains identifying information and public key** for the requestor.
- Corresponding **private key is not included** in the CSR, but is used to digitally **sign the request** to ensure the request is actually coming from the requestor.
- CSR may be accompanied by **other credentials or proofs of identity** required by the certificate authority, and the certificate authority may contact the requestor for further information.
- If the request is successful, the certificate authority will send back an **identity certificate** that has been digitally **signed** with the private key of the certificate authority.

Certificate Stores on z/OS

- gskkyman manages certificates stored in a key database file
- RACDCERT manages certificates stored in a RACF key ring.

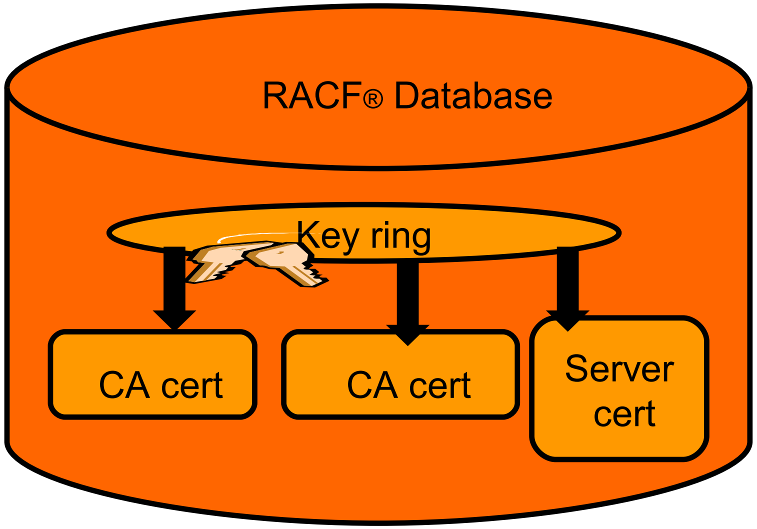
GSKKYMAN



CA Cert

Server Cert

RACDCERT



RACF® Database

Key ring

CA cert

CA cert

Server cert

Certificate utilities on z/OS

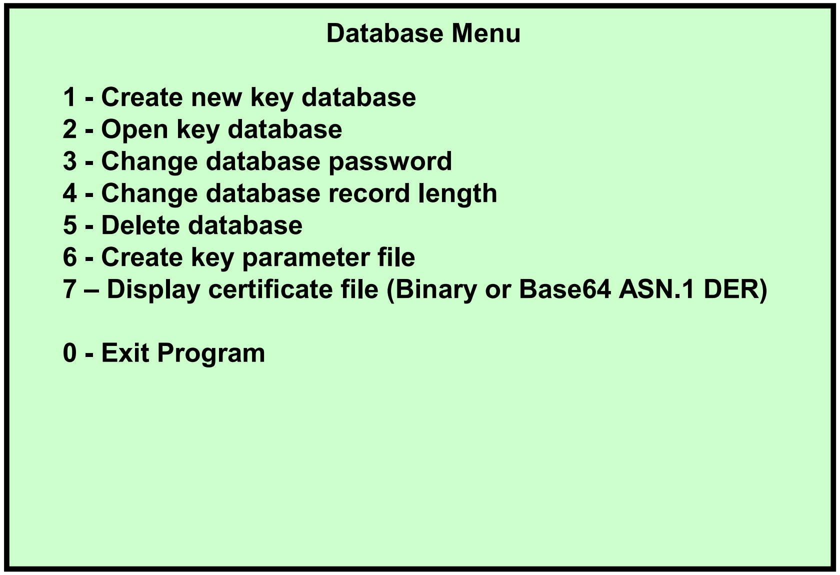
- Provide basic certificate functions:
  - **Create/delete** certificate store

    (HFS key database file / SAF key ring)
  - **Create certificate requests** (to be signed by trusted Certificate Authority)
  - **Import / Export** certificates (with and without private keys)
  - **Create** self-signed and signed certificates
- Do not have all the functions of a full featured Certificate Authority

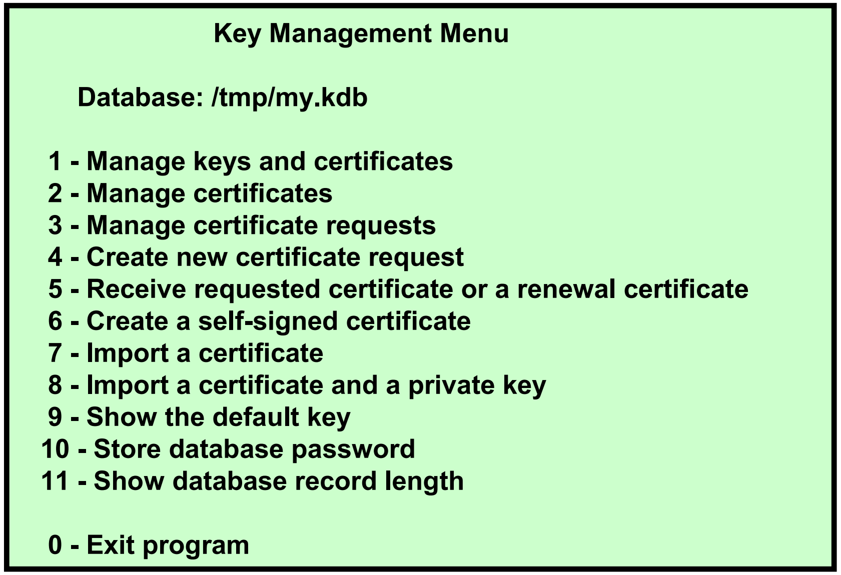
gskkyman

- **gskkyman** is a UNIX based utility shipped as part of the **System SSL** product in the z/OS Cryptographic Services Element
- **Menu** interface
- Certificates and keys are stored in a **key database file** in the HFS
- Protected by the file system's **permission bits** and **password**
- Learn more:

Cryptographic Services System Secure Sockets Layer Programming (SC24-5901)



```
                 Database Menu

  1 - Create new key database
  2 - Open key database
  3 - Change database password
  4 - Change database record length
  5 - Delete database
  6 - Create key parameter file
  7 – Display certificate file (Binary or Base64 ASN.1 DER)

  0 - Exit Program
```



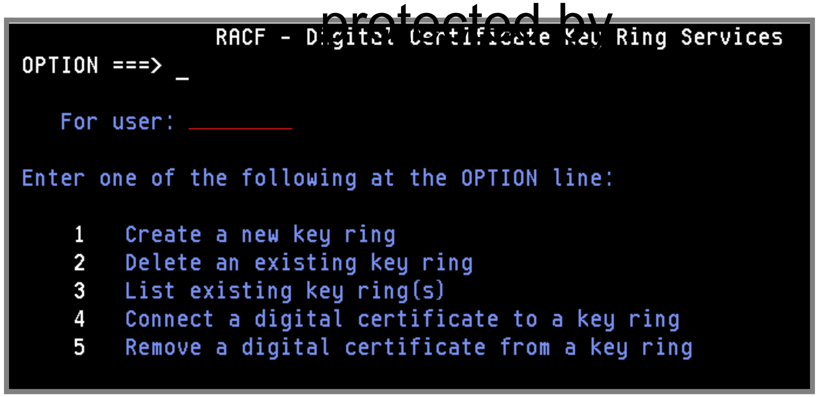
```
              Key Management Menu

     Database: /tmp/my.kdb

   1 - Manage keys and certificates
   2 - Manage certificates
   3 - Manage certificate requests
   4 - Create new certificate request
   5 - Receive requested certificate or a renewal certificate
   6 - Create a self-signed certificate
   7 - Import a certificate
   8 - Import a certificate and a private key
   9 - Show the default key
  10 - Store database password
  11 - Show database record length

   0 - Exit program
```

RACDCERT

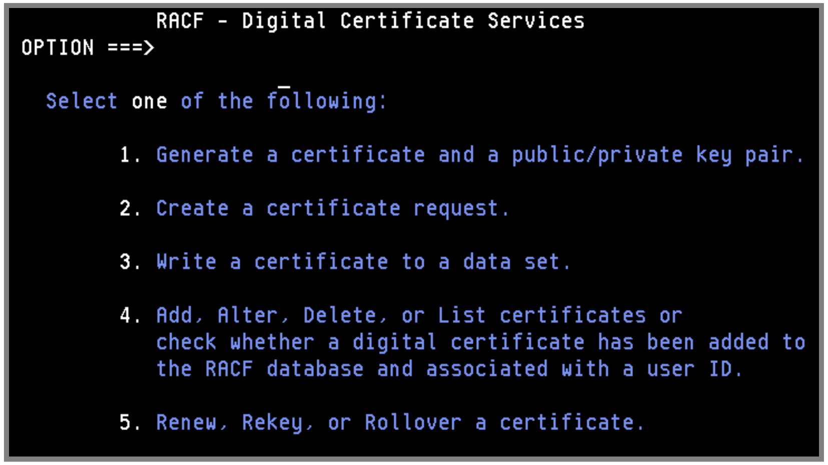
- **RACDCERT** is a **TSO command** shipped as part of **RACF**
- Command line interface with ISPF panels
- RACF certificates and rings are protected by RACF profiles
- Learn more:

  RACF Command Language Reference (SC22-7687)

```
RACDCERT ID(FTPServer) GENCERT SUBJECTSDN(CN('Server
Certificate')OU('Production')O('IBM')L('Poughkeepsie') SP('New
York')C('US')) SIZE(1024) WITHLABEL('Server Certificate')
ALTNAME(DOMAIN('mycompany.com'))

RACDCERT ID(FTPServer) ADD('user1.svrcert') WITHLABEL('Server
Certificate')

RACDCERT ID(userid) EXPORT (LABEL('label-name'))  DSN(output-
data-set-name) FORMAT(CERTDER | CERTB64 | PKCS7DER |
PKCS7B64 |   PKCS12DER | PKCS12B64 )   PASSWORD('pkcs12-
password')
```



```
               RACF - Digital Certificate Key Ring Services
OPTION ===> _

   For user: ________

Enter one of the following at the OPTION line:

    1   Create a new key ring
    2   Delete an existing key ring
    3   List existing key ring(s)
    4   Connect a digital certificate to a key ring
    5   Remove a digital certificate from a key ring
```



```
          RACF - Digital Certificate Services
OPTION ===>

  Select one of the following:

        1. Generate a certificate and a public/private key pair.

        2. Create a certificate request.

        3. Write a certificate to a data set.

        4. Add, Alter, Delete, or List certificates or
           check whether a digital certificate has been added to
           the RACF database and associated with a user ID.

        5. Renew, Rekey, or Rollover a certificate.
```

Certificate Authority on z/OS: PKI Services

- A complete PKI solution to manage the whole certificate life cycle:
  - **Request**, **create**, **renew**, **revoke** certificates
  - Provide certificate status: **CRLs** & **OCSP**
- Closely tied to **RACF:**
  - The CA cert must be **installed** in RACF's key ring
  - **Authority checking** goes through RACF's callable service
  - Most of the **auditing** work done through RACF
- CA cert private key can be stored in **ICSF**
- Generation and administration of certificates via customizable **web pages**
- Keys can be generated by requestor, or generated by PKI (**Key escrow**)
- **Smart card** support

Steps to request a CA signed Certificate

- Steps:
  - Create a key database file or SAF key ring
  - Receive CA certificate, if not already in database
  - Create a new certificate request and send to CA
  - Receive signed certificate
  - Indicate to the application that this certificate is to be used
    - Mark it as ‘default’
    - Name it with a specific required label

If you use gskkyman…

Create a key database

```
    Database Menu

 1 - Create new key database
 2 - Open key database
 3 - Change database password
 4 - Change database record length
 5 - Delete database
 6 - Create key parameter file
 7 – Display certificate file (Binary or Base64 ASN.1 DER)

 0 - Exit Program

Enter your option number: 1
Enter key database name (press ENTER to return to menu: /tmp/my.kdb
Enter database password (press ENTER to return to menu: password
Re-enter database password: password
Enter password expiration in days (press ENTER for no expiration): <enter>
Enter database record length (press ENTER to use 2500): <enter>
```

Name of key database

This will add a number of well-known trusted CA certificates to the key database.

Importing a signing Certificate Authority Certificate

```
        Key Management Menu

      Database: /tmp/my.kdb

   1 - Manage keys and certificates
   2 - Manage certificates
   3 - Manage certificate requests
   4 - Create new certificate request
   5 - Receive requested certificate or a renewal certificate
   6 - Create a self-signed certificate
   7 - Import a certificate
   8 - Import a certificate and a private key
   9 - Show the default key
  10 - Store database password
  11 - Show database record length

   0 - Exit program

Enter option number (press ENTER to return to previous menu): 7
```

Importing a signing Certificate Authority Certificate Continued

File contains the CA certificate

```
Enter import file name (press ENTER to return to menu):
cacert.b64
Enter label (press ENTER to return to menu): CA Certificate


Certificate imported.
```

Creating a new certificate request

```
        Key Management Menu

      Database: /tmp/my.kdb

   1 - Manage keys and certificates
   2 - Manage certificates
   3 - Manage certificate requests
   4 - Create new certificate request
   5 - Receive requested certificate or a renewal certificate
   6 - Create a self-signed certificate
   7 - Import a certificate
   8 - Import a certificate and a private key
   9 - Show the default key
  10 - Store database password
  11 - Show database record length

   0 - Exit program

Enter option number (press ENTER to return to previous menu): 4
```

Fill in the information about the requestor

```
    Certificate Type

   1 - Certificate with 1024-bit RSA key
   2 - Certificate with 2048-bit RSA key
   3 - Certificate with 4096-bit RSA key
   4 - Certificate with 1024-bit DSA key

Enter certificate type (press ENTER to return to menu): 1
Enter request file name (press ENTER to return to menu): certreq.arm
Enter label (press ENTER to return to menu): Server Certificate
Enter subject name for certificate
  Common name (required): Server Certificate
  Organizational unit (optional):   Production
  Organization (required): IBM
  City/Locality (optional): Endicott
  State/Province (optional): New York
  Country/Region (2 characters - required): US

Enter 1 to specify subject alternate names or 0 to continue: 1
```

File to contain certificate request

Content of the certificate request

Contents of certreq.arm file:

```
-----BEGIN NEW CERTIFICATE REQUEST-----
MIIB3jCCAUcCAQAwczELMAkGA1UEBhMCVVMxETAPBgNVBAgTCE5ldyBZb3JrMREw
DwYDVQQHEwhFbmRpY290dDEMMAoGA1UEChMDSUJNMRMwEQYDVQQLEwpQcm9kdWN0
aW9uMRswGQYDVQQDExJTZXJ2ZXIgQ2VydGlmaWNhdGUwgZ8wDQYJKoZIhvcNAQEB
BQADgY0AMIGJAoGBAMTiaO7czZdi8IU+eCL23xtrqhXBqnksHBwdW8zeCjnqxq1l
ump9GY4Jw9Wyqp9a2J85bWJD06TaHhFALru5pgOl+jMOQTbB+wZoSOlbIrwoWl6l
pLx1cqJOn53mBmv6ruP/d055jjgKTczYhOa2JdhmfpAvf+C6tUkn7qMWlRzNAgMB
AAGgKzApBgkqhkiG9w0BCQ4xHDAaMBgGA1UdEQQRMA+CDW15Y29tcGFueS5jb20w
DQYJKoZIhvcNAQEFBQADgYEAAxCvLl4Cq+YVdJuHGnVr28ySnPz8E1uMT/k9Y6qM
EE+3Hiy2aD2mUREyeljehF5VNSbHwG5VCrFVVOtuVomeJgY8bYmlE45Z4oJoyqFG
HdQVUQO5E+W3UvKYv698KQTpl668BV51F3xlBwNx6K1PLl40i0fq8gFMfB8nP0KM
LOs=
-----END NEW CERTIFICATE REQUEST-----
```

Receiving a signed certificate request

```
      Key Management Menu

    Database: /tmp/my.kdb

 1 - Manage keys and certificates
 2 - Manage certificates
 3 - Manage certificate requests
 4 - Create new certificate request
 5 - Receive requested certificate or a renewal certificate
 6 - Create a self-signed certificate
 7 - Import a certificate
 8 - Import a certificate and a private key
 9 - Show the default key
10 - Store database password
11 - Show database record length

 0 - Exit program

Enter option number (press ENTER to return to previous menu): 5
Enter certificate file name (press ENTER to return to menu): svrcert.arm
```

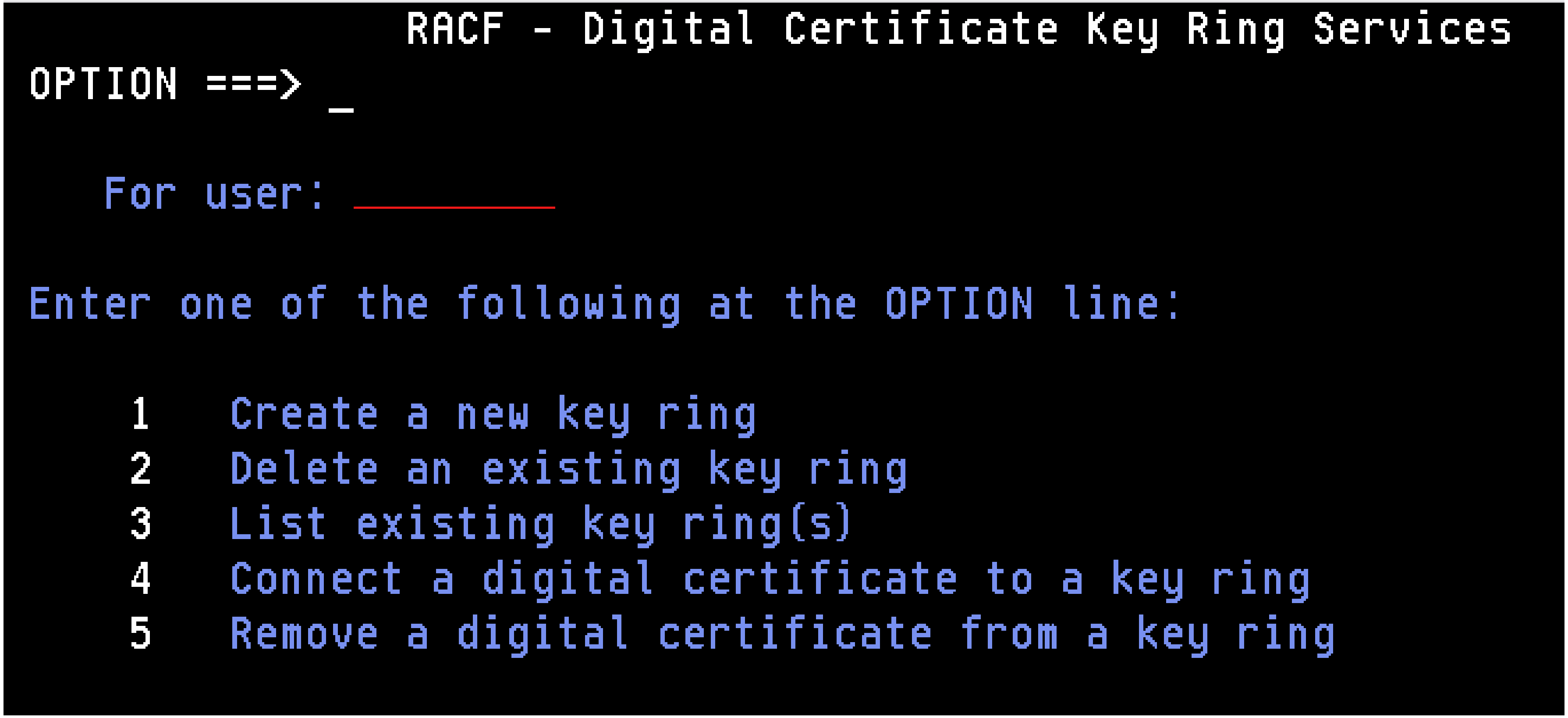
File contains cert returned from CA

Marking a certificate as the default

```
        Key and Certificate Menu

       Label:  Server Certificate

   1 - Show certificate information
   2 - Show key information
   3 - Set key as default
   4 - Set certificate trust status
   5 - Copy certificate and key to another database
   6 - Export certificate to a file
   7 - Export certificate and key to a file
   8 - Delete certificate and key
   9 - Change label
  10 - Create a signed certificate and key
  11 - Create a certificate renewal request

   0 - Exit program

Enter option number (press ENTER to return to previous menu): 3
```

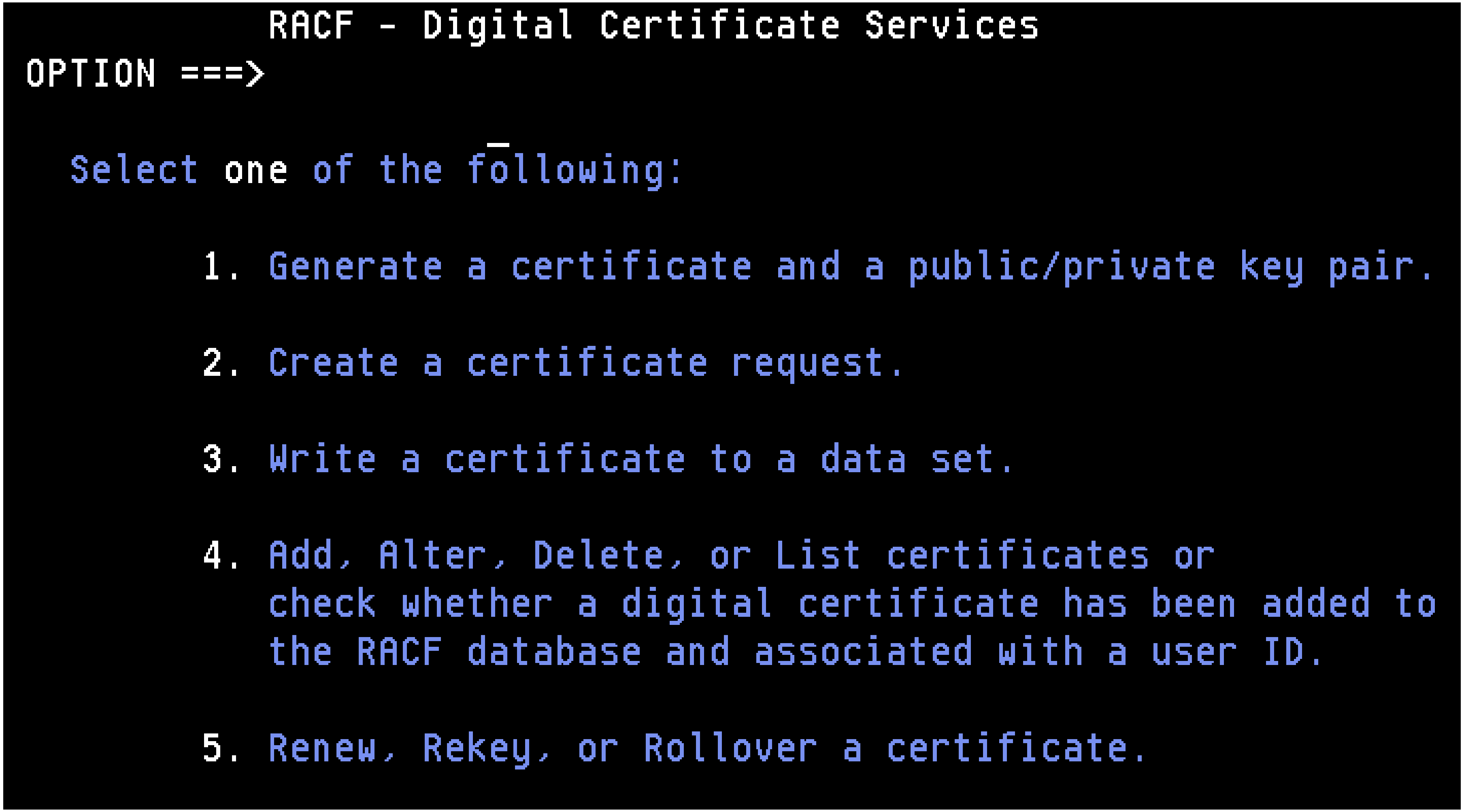
If you use RACDCERT…
(ISPF Panel or Command)

RACDCERT Panel on Key Ring



```
               RACF - Digital Certificate Key Ring Services
OPTION ===> _

   For user: ________

Enter one of the following at the OPTION line:

     1    Create a new key ring
     2    Delete an existing key ring
     3    List existing key ring(s)
     4    Connect a digital certificate to a key ring
     5    Remove a digital certificate from a key ring
```

RACDCERT Panel on Certificate



```
           RACF - Digital Certificate Services
OPTION ===>

  Select one of the following:

        1. Generate a certificate and a public/private key pair.

        2. Create a certificate request.

        3. Write a certificate to a data set.

        4. Add, Alter, Delete, or List certificates or
           check whether a digital certificate has been added to
           the RACF database and associated with a user ID.

        5. Renew, Rekey, or Rollover a certificate.
```

Create a key ring

Name of key ring

RACDCERT ID(FTPserver) ADDRING(MyRACFKeyRing)

Importing a signing Certificate Authority Certificate

Dataset contains the CA certificate

RACDCERT CERTAUTH ADD(‘user1.cacert’) TRUST WITHLABEL(‘CA Certificate’)

RACDCERT ID(FTPServer) CONNECT (CERTAUTH LABEL(‘CA Certificate’) RING(MyRACFKeyRing) USAGE(CERTAUTH))

Creating a new certificate request

```
RACDCERT ID(FTPServer) GENCERT SUBJECTSDN(CN(‘Server
Certificate’)OU(‘Production’)O(‘IBM’)L(‘Endicott’)SP(‘New
York’)C(‘US’))
SIZE(1024) WITHLABEL(‘Server Certificate’)
ALTNAME(DOMAIN(‘mycompany.com'))

RACDCERT ID(FTPServer) GENREQ(LABEL(‘Server Certificate’))
DSN(‘user1.certreq’)
```

Dataset to contain certificate request

Receiving a signed certificate request

```
RACDCERT ID(FTPServer) ADD('user1.svrcert')
WITHLABEL('Server Certificate')
```

Dataset contains cert returned from CA

```
RACDCERT ID(FTPServer) CONNECT(ID(SUIMGTF)
LABEL('Server Certificate') RING(MyRACFKeyRing)
USAGE(PERSONAL) DEFAULT)
```

Listing a RACF Key Ring

RACDCERT ID(FTPServer) LISTING(MyRACFKeyRing)

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

Note: RACF key rings allow for a certificate’s private key to be stored into ICSF’s (Integrated Cryptographic Service Facility) PKDS (Public Key Dataset) for added security.

Exporting Certificates through gskkyman

```
        Key and Certificate Menu

       Label: Server Certificate

    1 - Show certificate information
    2 - Show key information
    3 - Set key as default
    4 - Set certificate trust status
    5 - Copy certificate and key to another database
    6 - Export certificate to a file
    7 - Export certificate and key to a file
    8 - Delete certificate and key
    9 - Change label
   10 - Create a signed certificate and key
   11 - Create a certificate renewal request

    0 - Exit program

  Enter option number (press ENTER to return to previous menu):
```

Exporting Certificates through gskkyman

Option 6 – Public Certificate Information

Export File Format

1 - Binary ASN.1 DER
2 - Base64 ASN.1 DER
3 - Binary PKCS #7
4 - Base64 PKCS #7

Option 7 – Public Certificate Information and Private Key

Export File Format

1 - Binary PKCS #12 Version 1   (Few very old applications still use V1)

2 - Base64 PKCS #12 Version 1
3 - Binary PKCS #12 Version 3
4 - Base64 PKCS #12 Version 3

Exporting Certificates through RACDCERT

- **RACDCERT ID(userid) EXPORT**

  (LABEL('label-name'))

  DSN(output-data-set-name)

  FORMAT(CERTDER | CERTB64 | PKCS7DER | PKCS7B64 | PKCS12DER | PKCS12B64)

  PASSWORD('pkcs12-password')

- **Example - Export Server Certificate with its private key**
  - RACDCERT ID(FTPServer) EXPORT LABEL(‘Server Certificate’) DSN(‘USER1.SERVER.CERT’) FORMAT(PKCS12DER) PASSWORD(‘passwd’)

Summary

- Digital certificates provide **electronic identity** and **public key** information to be utilized through public key protocols (ie. SSL/TLS)
- Utilizing **trusted CAs** is key to ensure validity of the digital certificate
- **Protect the private key!!!**
- **Larger** the public/private **key** pair size, **greater security**, but **more computation intense**

Summary

- **Certificate** source **usage** is application defined.
- When **transferring** certificates, use a **format** acceptable to the receiving side.
- When **transferring** certificates, be sensitive to **binary** and **text modes** to ensure proper transfer

References

- **IBM Education Assistant web site:**

  http://publib.boulder.ibm.com/infocenter/ieduasst/stgv1r0/index.jsp
- **RACF web site:**

  http://www.ibm.com/servers/eserver/zseries/zos/racf
- **PKI Services web site:**

  http://www.ibm.com/servers/eserver/zseries/zos/pki
- **IBM Redbooks**

  z/OS V1 R8 RACF Implementation (SG24-7248)
- **Security Server Manuals:**

  RACF Command Language Reference (SC22-7687)

  RACF Security Administrator's Guide (SC28-1915)
- **Cryptographic Server Manual**

  Cryptographic Services System Secure Sockets Layer Programming (SC24-5901)
- **RFCs**

  RFC2459 - Internet X.509 Public Key Infrastructure Certificate and CRL Profile

  RFC5280 - Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile

Questions ?

See you later in
9553 / 9554
(PKI Services
overview and lab)