Digital Certificates – From Concept to Implementation

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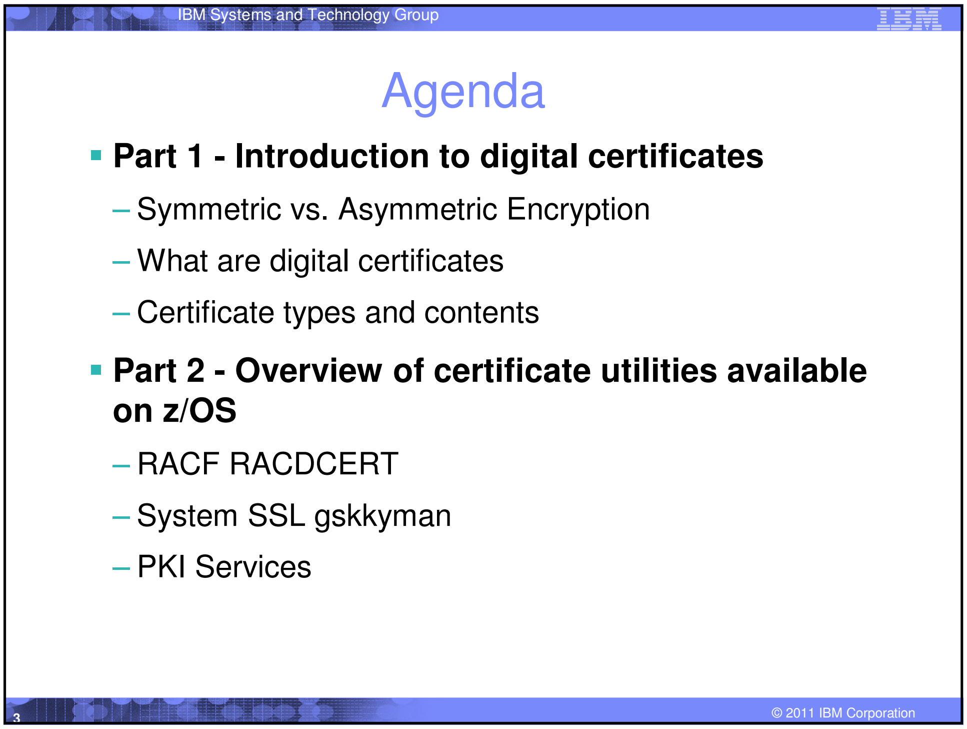
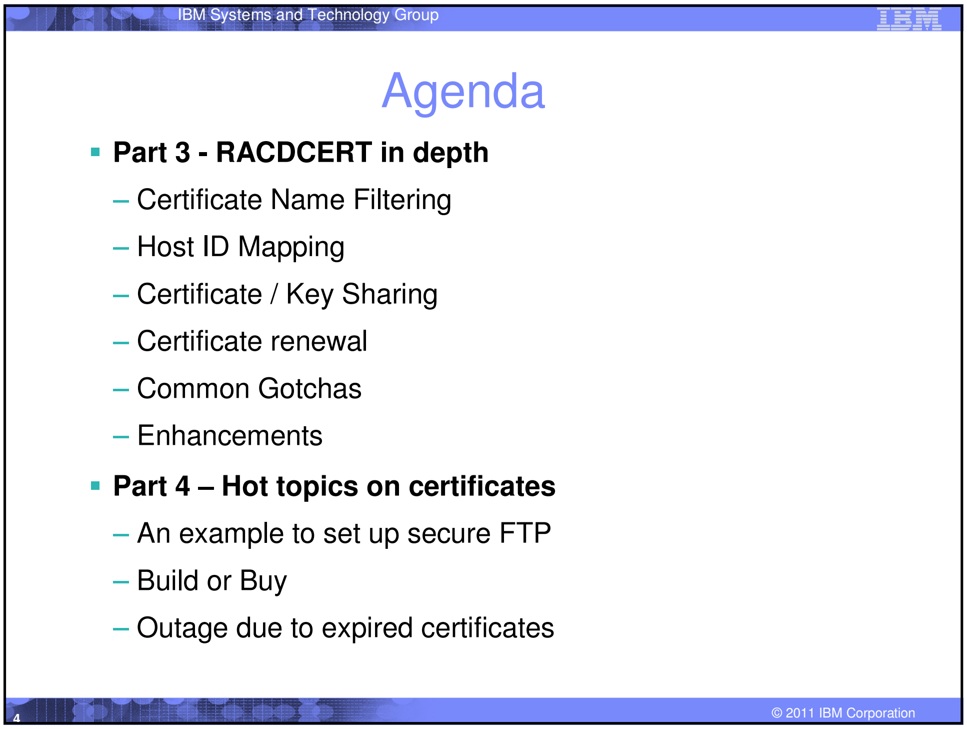


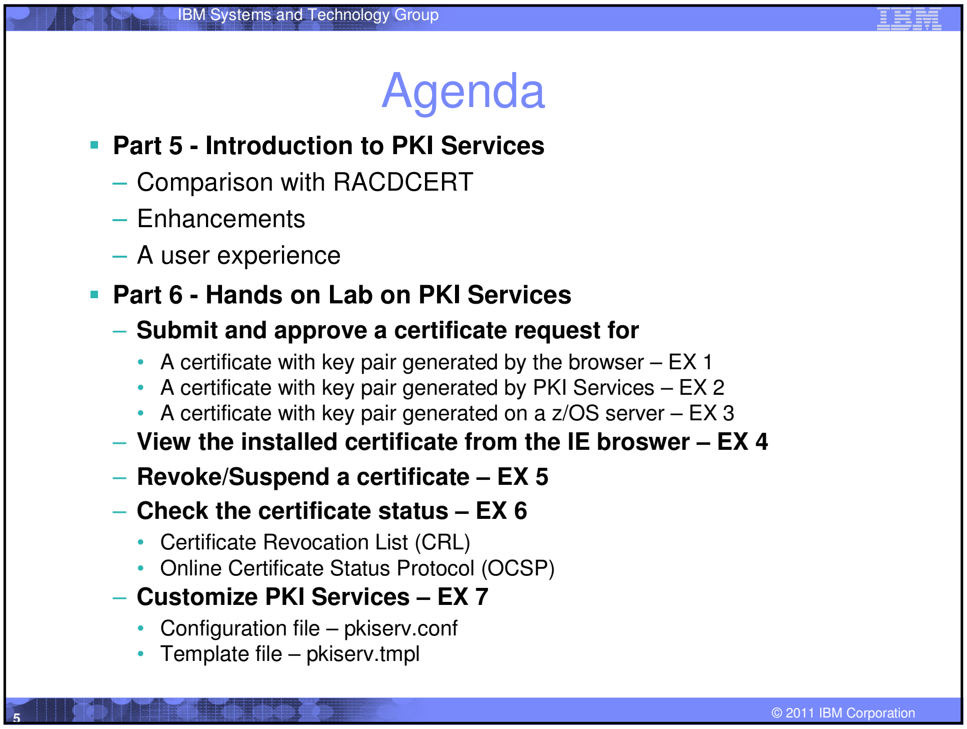
Agenda

- **Part 1 - Introduction to digital certificates**
  - Symmetric vs. Asymmetric Encryption
  - What are digital certificates
  - Certificate types and contents
- **Part 2 - Overview of certificate utilities available on z/OS**
  - RACF RACDCERT
  - System SSL gskkyman
  - PKI Services



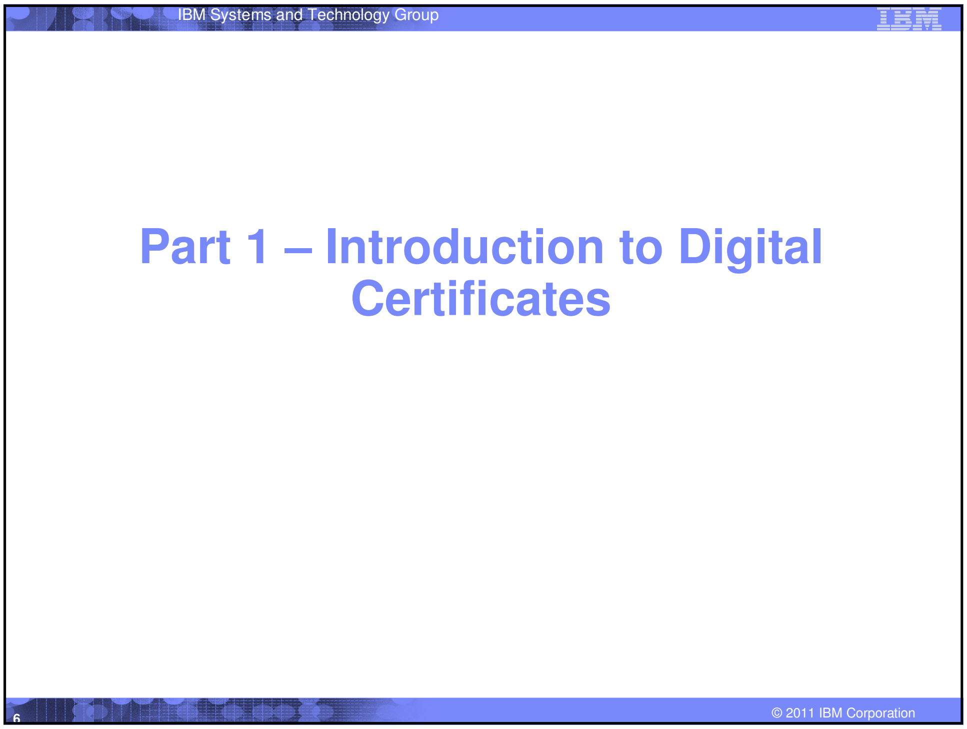
Agenda

- **Part 3 - RACDCERT in depth**
  - Certificate Name Filtering
  - Host ID Mapping
  - Certificate / Key Sharing
  - Certificate renewal
  - Common Gotchas
  - Enhancements
- **Part 4 – Hot topics on certificates**
  - An example to set up secure FTP
  - Build or Buy
  - Outage due to expired certificates

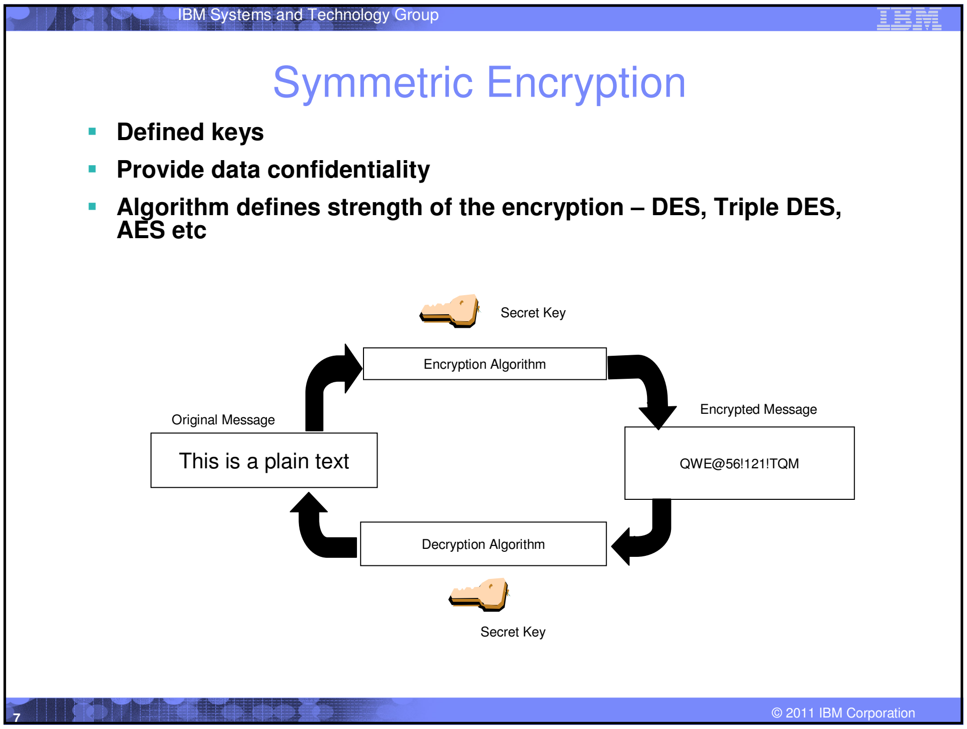


Agenda

- **Part 5 - Introduction to PKI Services**
  - Comparison with RACDCERT
  - Enhancements
  - A user experience
- **Part 6 - Hands on Lab on PKI Services**
  - **Submit and approve a certificate request for**
    - A certificate with key pair generated by the browser – EX 1
    - A certificate with key pair generated by PKI Services – EX 2
    - A certificate with key pair generated on a z/OS server – EX 3
  - **View the installed certificate from the IE broswer – EX 4**
  - **Revoke/Suspend a certificate – EX 5**
  - **Check the certificate status – EX 6**
    - Certificate Revocation List (CRL)
    - Online Certificate Status Protocol (OCSP)
  - **Customize PKI Services – EX 7**
    - Configuration file – pkiserv.conf
    - Template file – pkiserv.tmpl



Part 1 – Introduction to Digital Certificates



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Symmetric Encryption

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

Secret Key

Encryption Algorithm

Original Message

This is a plain text

Encrypted Message

QWE@56!121!TQM

Decryption Algorithm

Secret Key

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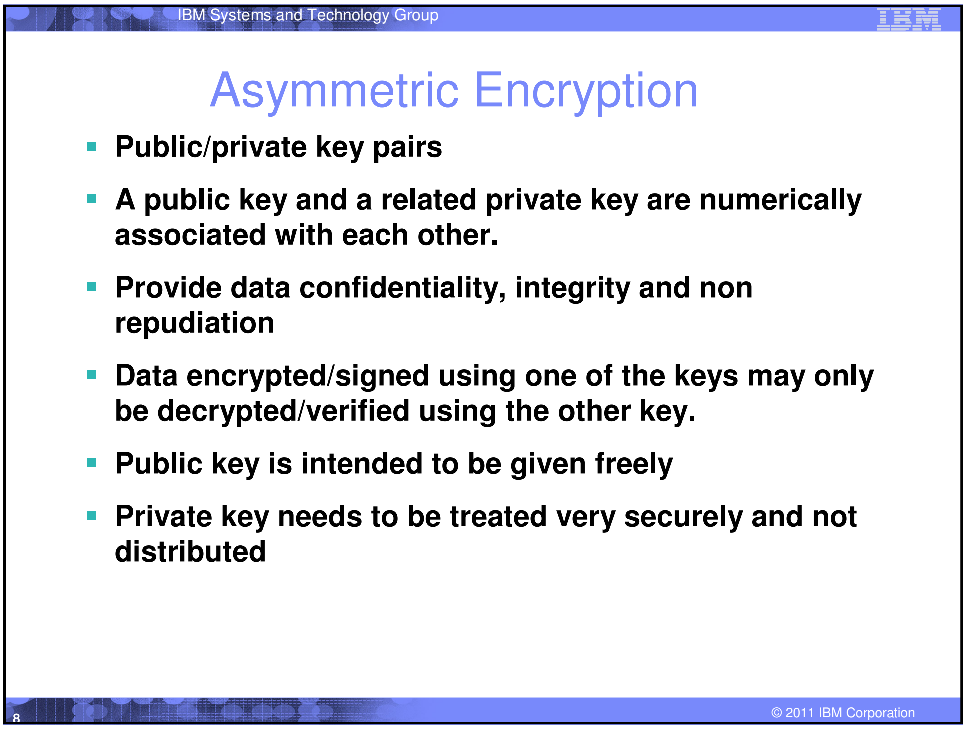

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Asymmetric Encryption

- 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

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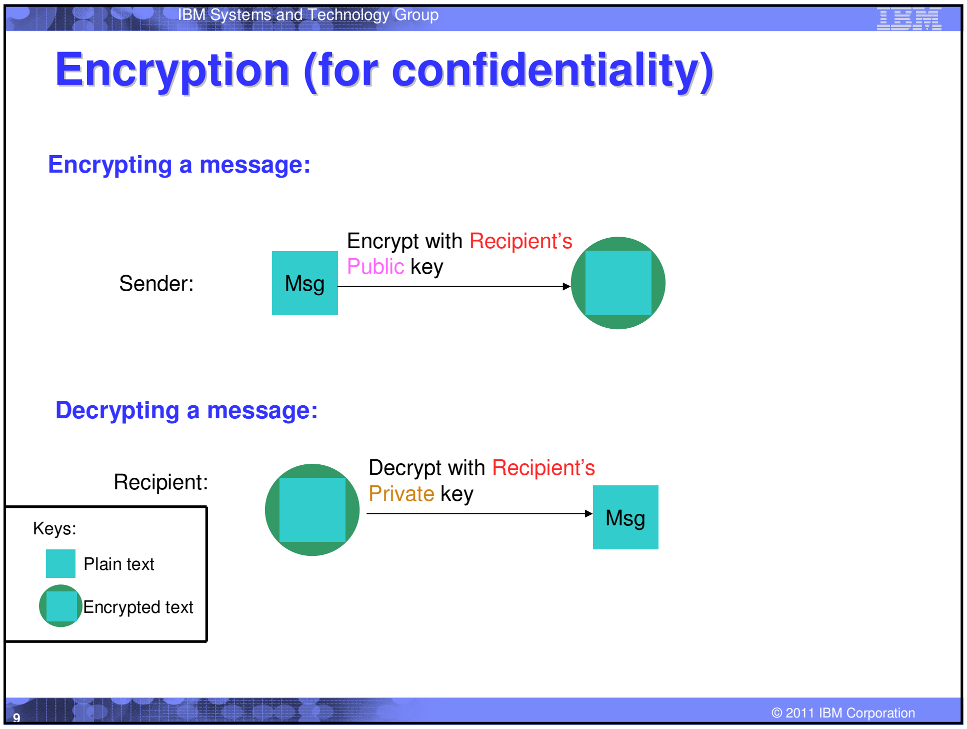


Encryption (for confidentiality)

Encrypting a message:

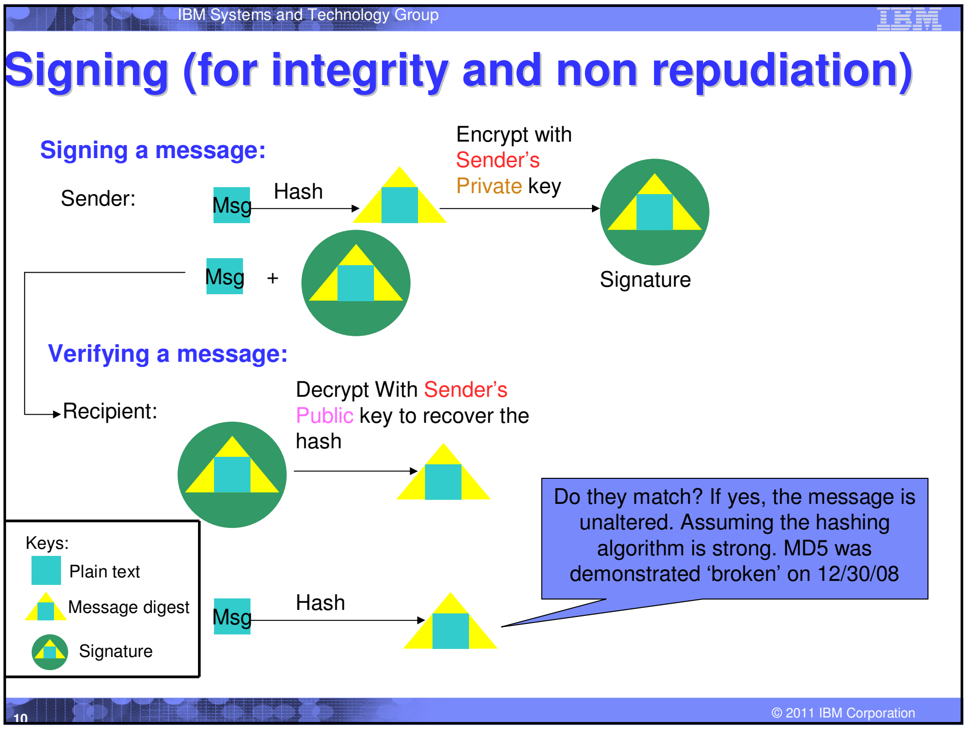
Sender: Msg — Encrypt with Recipient's Public key →

Decrypting a message:

Recipient: — Decrypt with Recipient's Private key → Msg

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 →

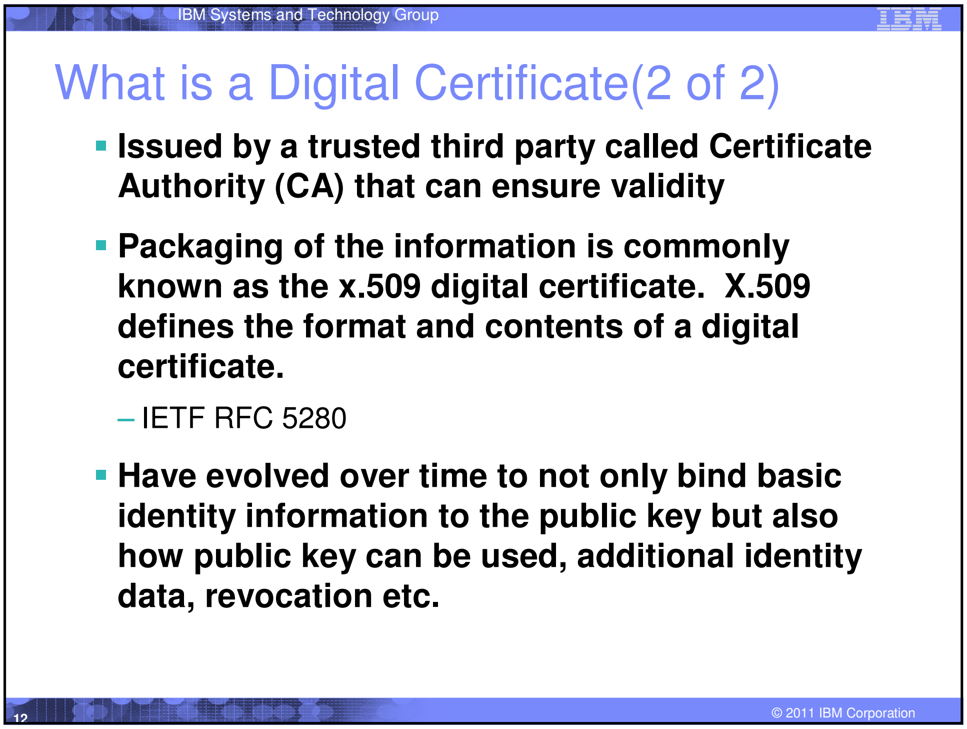
Do they match? If yes, the message is unaltered. Assuming the hashing algorithm is strong. MD5 was demonstrated 'broken' on 12/30/08

Keys:

■	Plain text
▲	Message digest
●	Signature

What is a Digital Certificate (1 of 2)

- Best way to think of it is as an ID card, like driver licenses, passports
- To establish your identity or credential to be used in electronic transactions
- Digital certificates been in existence for over 20 years
- It binds public key information to your identity to be used by applications that are based on public key protocols. (e.g. SSL/TLS)
- Generally digital certificates provide identity to a person or a server



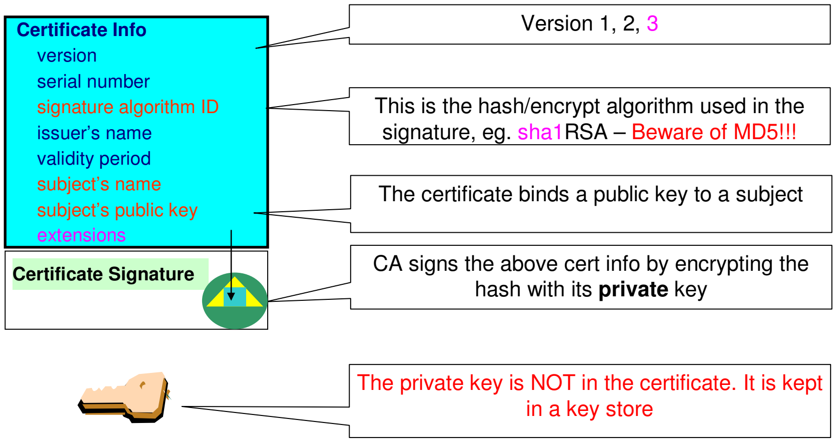
What is a Digital Certificate(2 of 2)

- Issued by a trusted third party called Certificate Authority (CA) that can ensure validity
- 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.

What's inside a Certificate?

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

[illegible]
CA's Signature



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

Certificate Signature

Version 1, 2, 3

This is the hash/encrypt algorithm used in the signature, eg. sha1RSA – Beware of MD5!!!

The certificate binds a public key to a subject

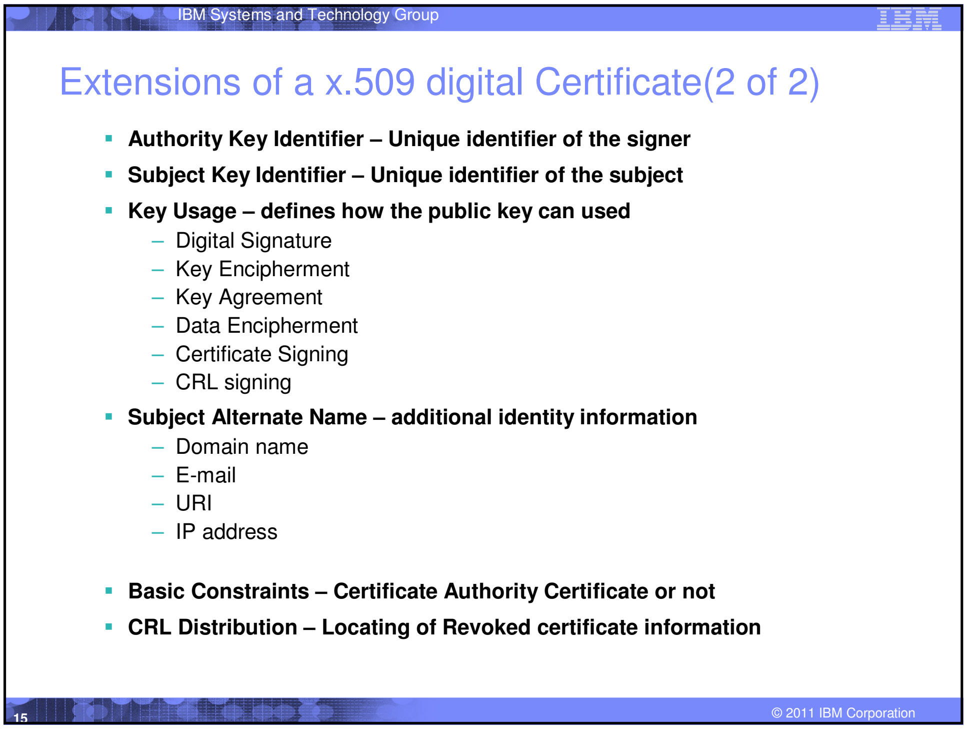
CA signs the above cert info by encrypting the hash with its **private** key

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

You can NOT change ANY of the certificate information!

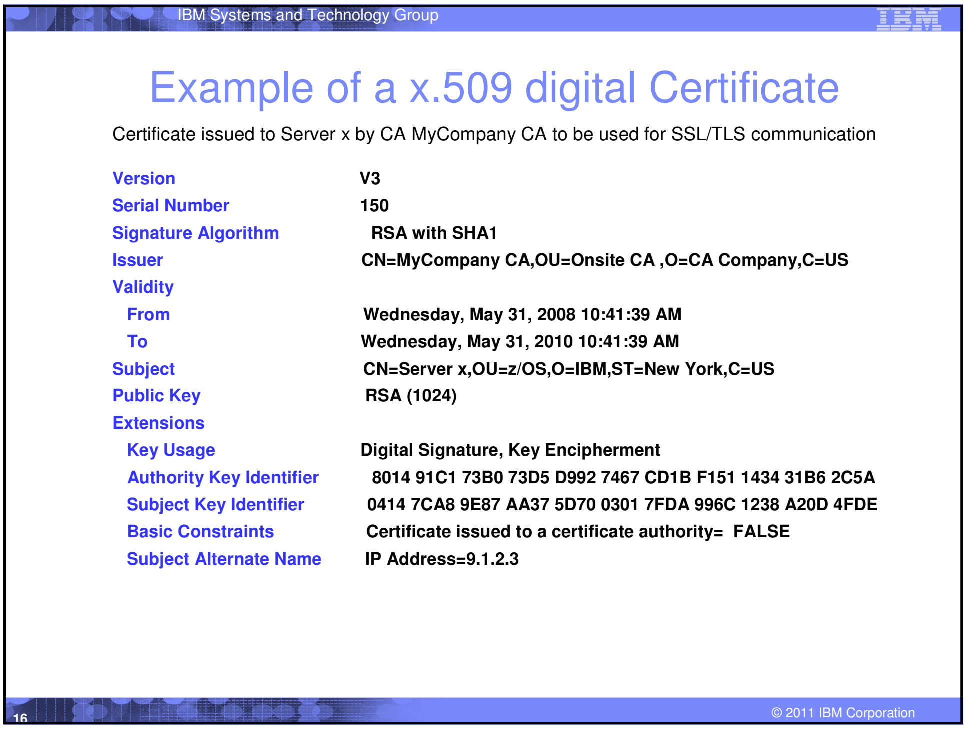
Extensions of a x.509 digital Certificate(1 of 2)

- 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(2 of 2)

- **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

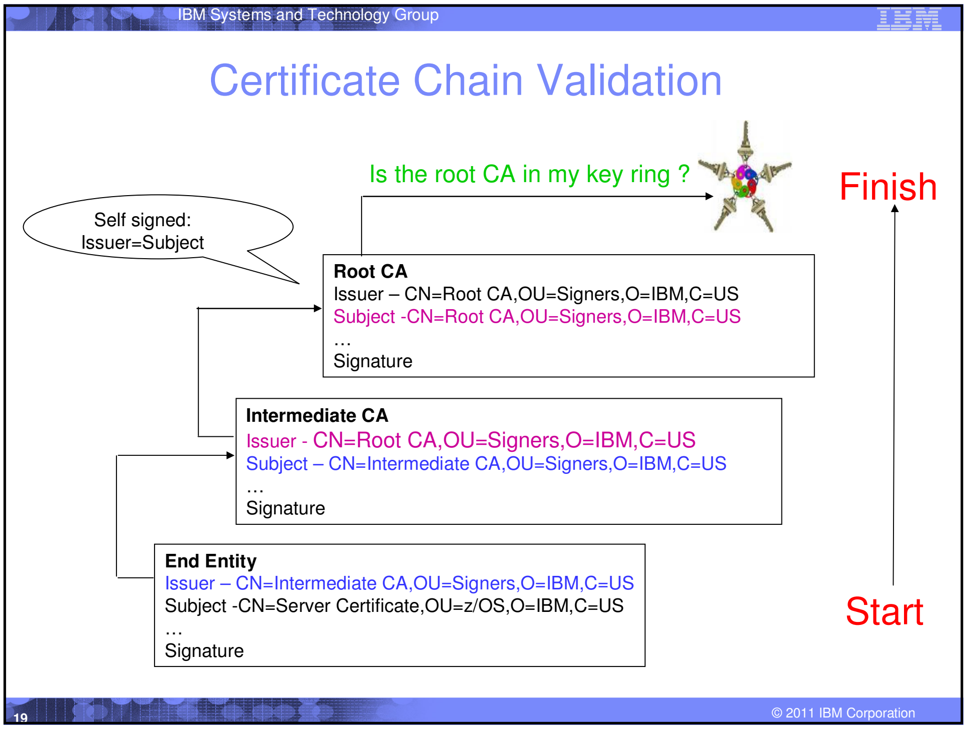
Version	**V3**
Serial Number	**150**
Signature Algorithm	**RSA with SHA1**
Issuer	**CN=MyCompany CA,OU=Onsite CA ,O=CA Company,C=US**
Validity	
From	**Wednesday, May 31, 2008 10:41:39 AM**
To	**Wednesday, May 31, 2010 10:41:39 AM**
Subject	**CN=Server x,OU=z/OS,O=IBM,ST=New York,C=US**
Public Key	**RSA (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**

Relationship between Certificate and certificate store

- Certificate must be placed in a certificate store before it can be used by an application to perform validation
- The application needs to retrieve the certificate and/or its corresponding private key from the store
- On z/OS, many components like Communication Server, HTTP Server call System SSL APIs to access the store
- Certificate store = key ring = key file

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.



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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

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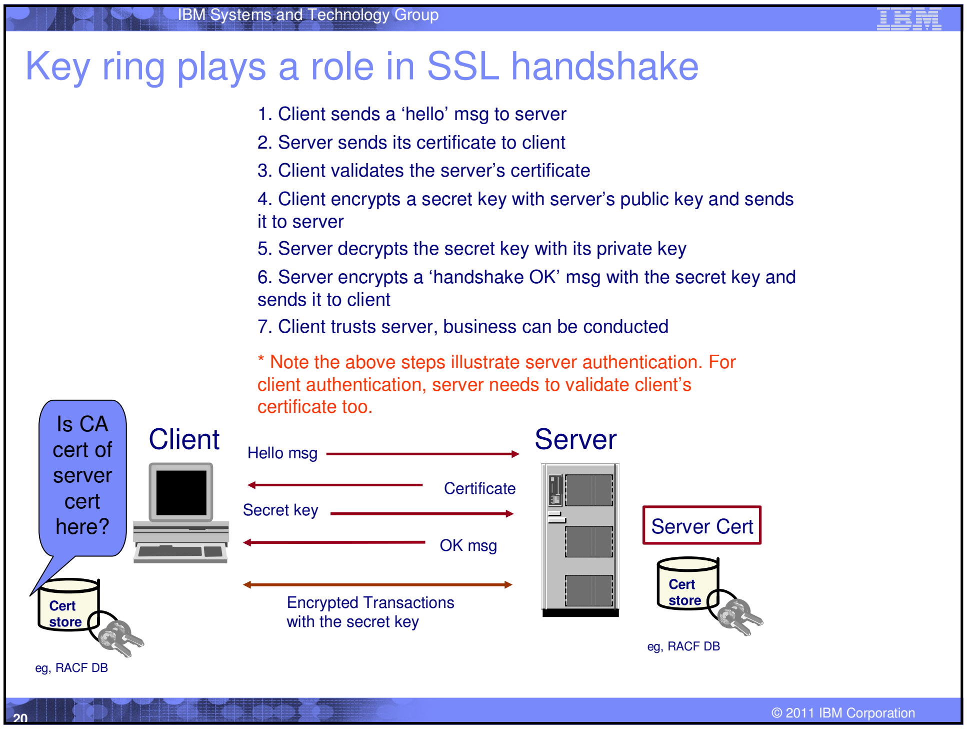

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Key ring plays a role in SSL handshake

1. Client sends a ‘hello’ msg to server
2. Server sends its certificate to client
3. Client validates the server’s certificate
4. Client encrypts a secret key with server’s public key and sends it to server
5. Server decrypts the secret key with its private key
6. Server encrypts a ‘handshake OK’ msg with the secret key and sends it to client
7. Client trusts server, business can be conducted

* Note the above steps illustrate server authentication. For client authentication, server needs to validate client’s certificate too.

Is CA cert of server cert here?

Client

Server

Hello msg

Certificate

Secret key

OK msg

Encrypted Transactions
with the secret key

Server Cert

Cert store

eg, RACF DB

Cert store

eg, RACF DB

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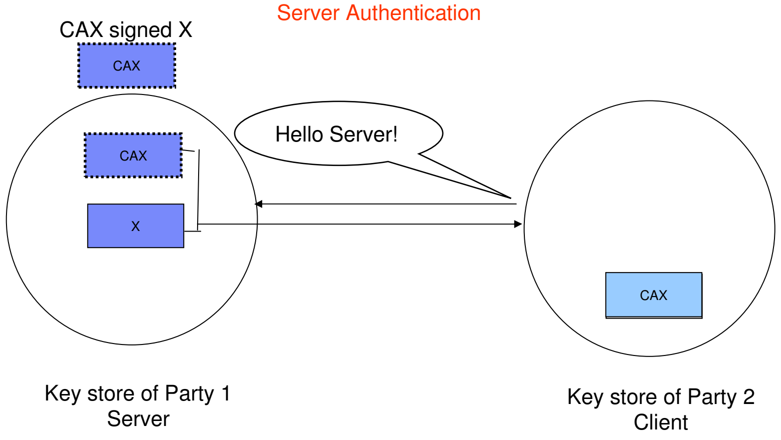
Remember the simple rule – PVC(1 of 3)

- **PVC - Parent Validates Child**
  - Child<-Parent<-Grandparent<-Great Grandparent<-…. <-Great Great….<-Root Grandparent
    - Ensure the content of the whole certificate chain has not been altered
      - Signature on the child verified by parent’s public key
      - Signature on the root verified by its own public key
    - Trusting the Root Grandparent
      - Putting the root in the key store is the indication of trusting all its descendents

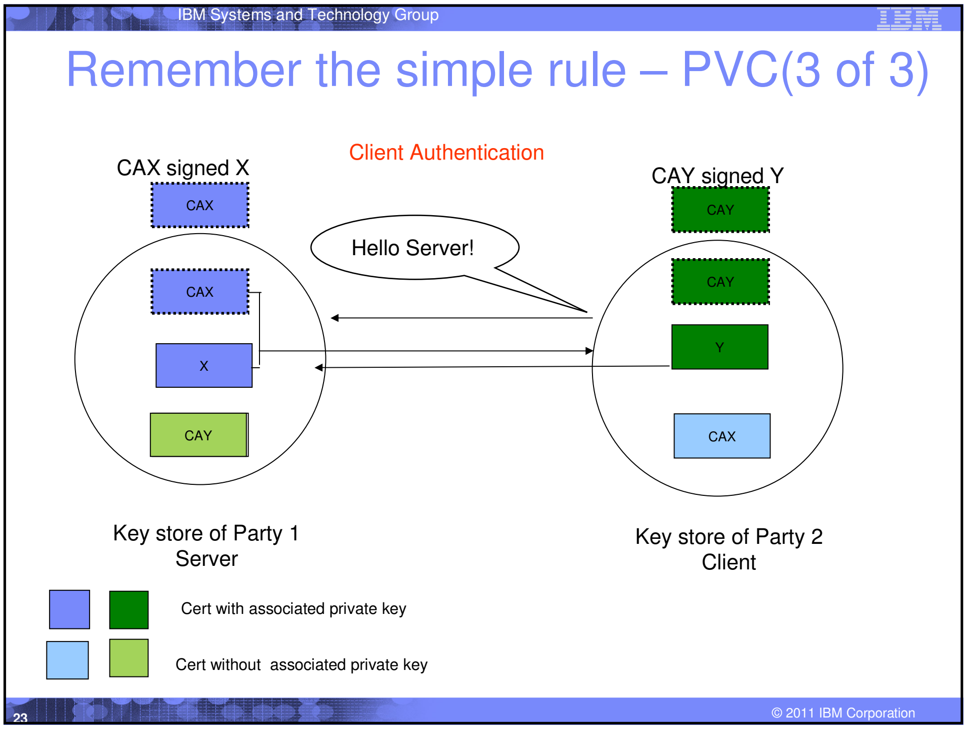
Remember the simple rule – PVC(2 of 3)

Server Authentication



🟦 Cert with associated private key

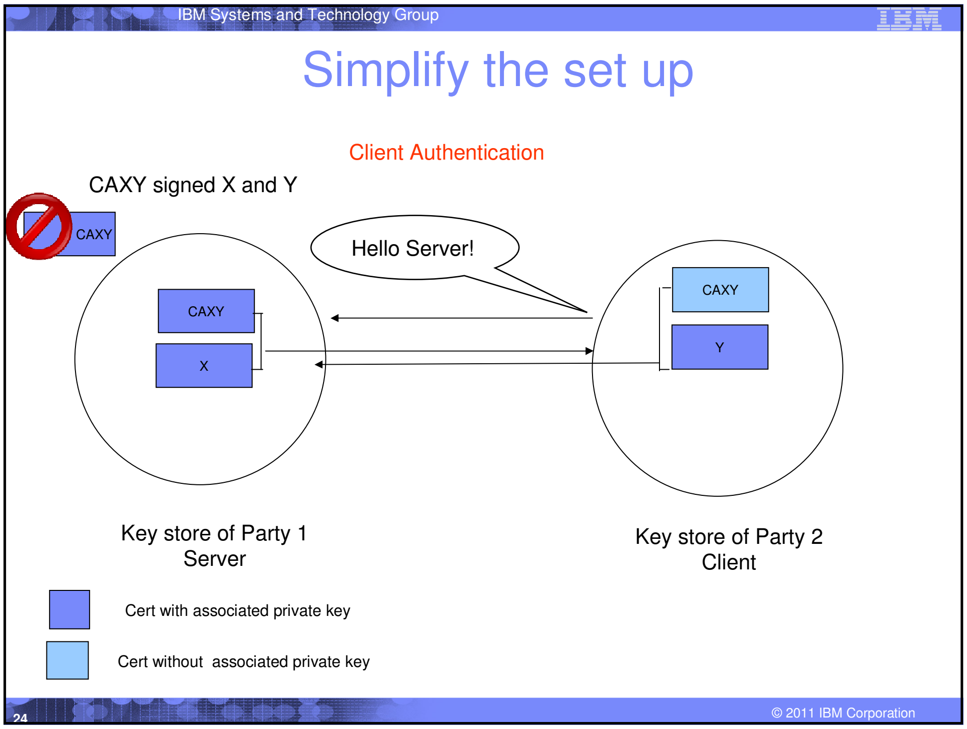
▢ Cert without associated private key



Remember the simple rule – PVC(3 of 3)

🟦 🟩 Cert with associated private key

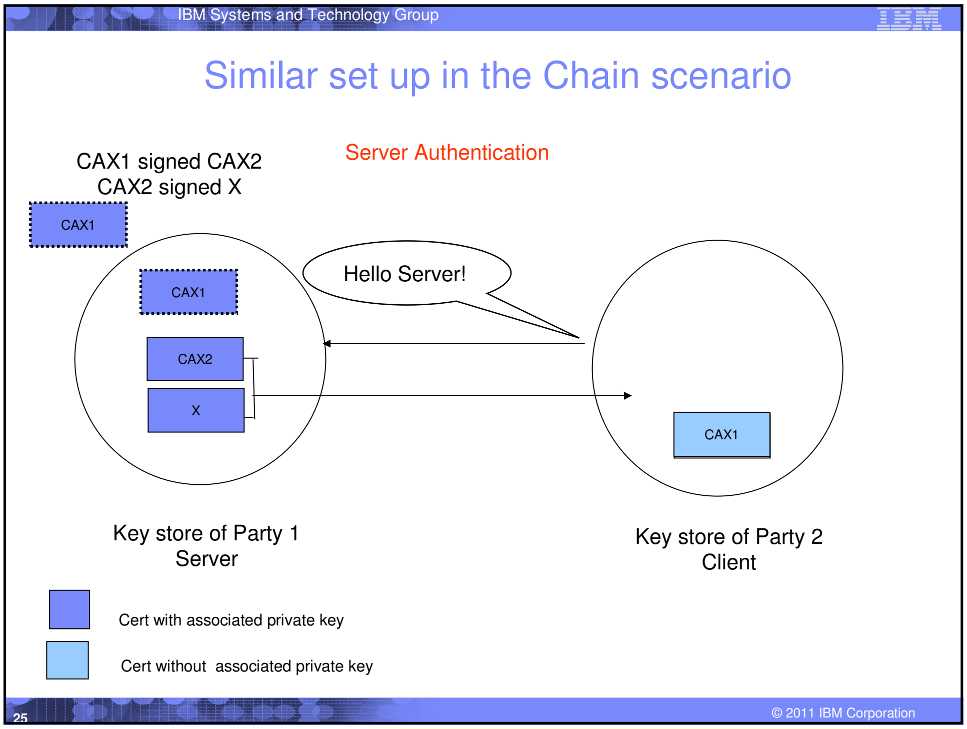
🟦 🟩 Cert without associated private key



Simplify the set up

🟦 Cert with associated private key

🟦 Cert without associated private key



Similar set up in the Chain scenario

Server Authentication

CAX1 signed CAX2
CAX2 signed X

CAX1

CAX1

CAX2

X

Hello Server!

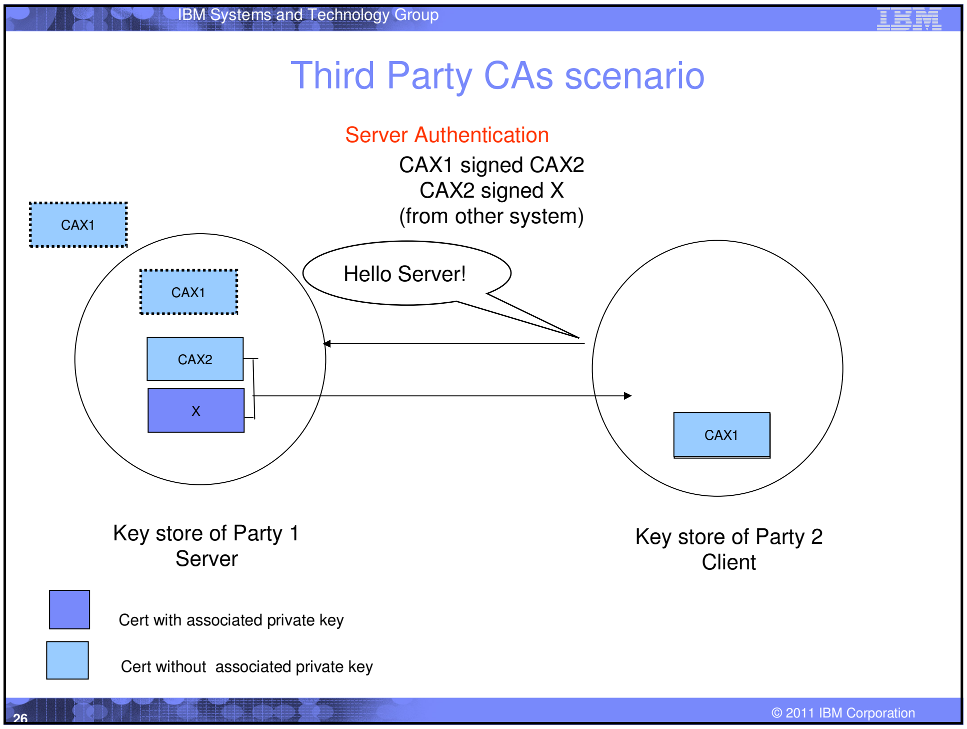
CAX1

Key store of Party 1
Server

Key store of Party 2
Client

■ Cert with associated private key

□ Cert without associated private key



Third Party CAs scenario

Server Authentication

CAX1 signed CAX2
CAX2 signed X
(from other system)

CAX1

CAX1

CAX2

X

Hello Server!

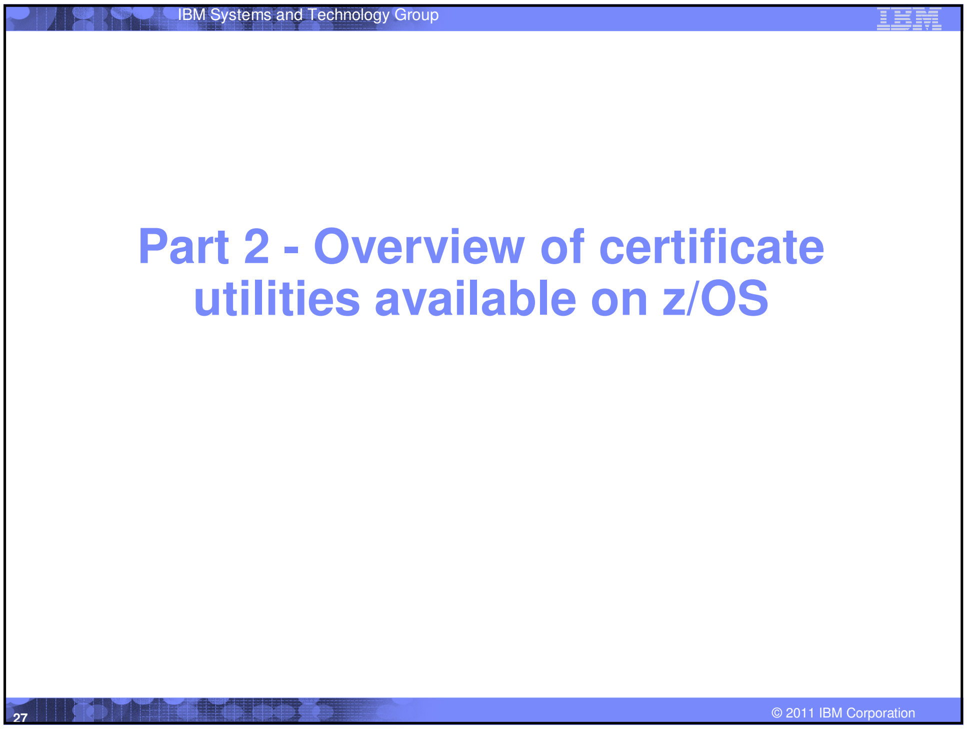
CAX1

Key store of Party 1
Server

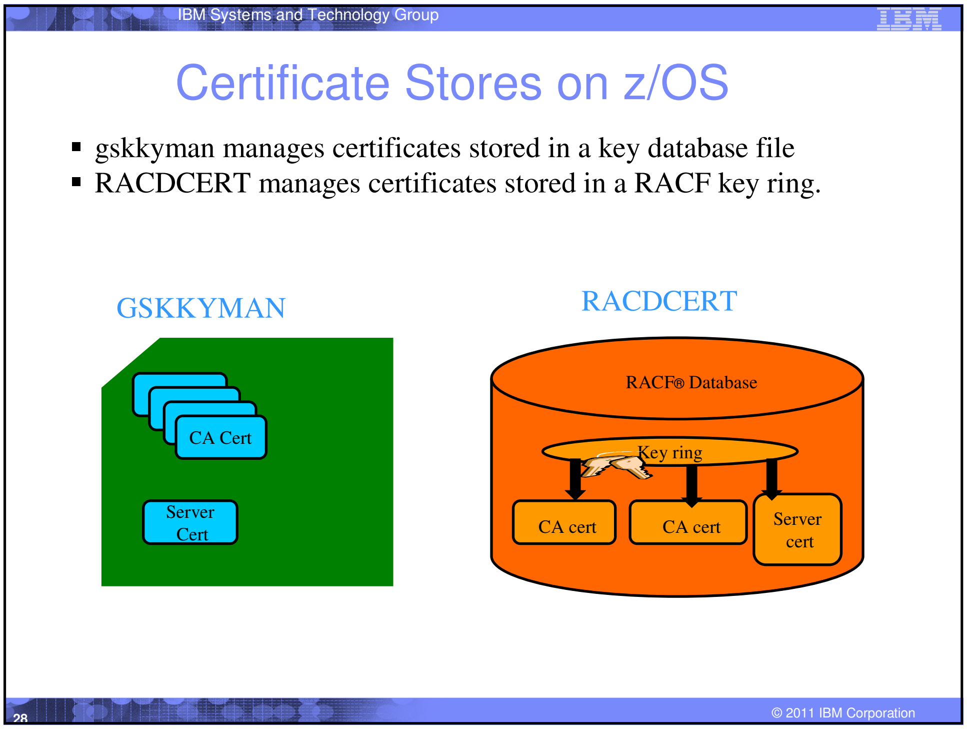
Key store of Party 2
Client

■ Cert with associated private key

□ Cert without associated private key



Part 2 - Overview of certificate utilities available on z/OS



Certificate Stores on z/OS

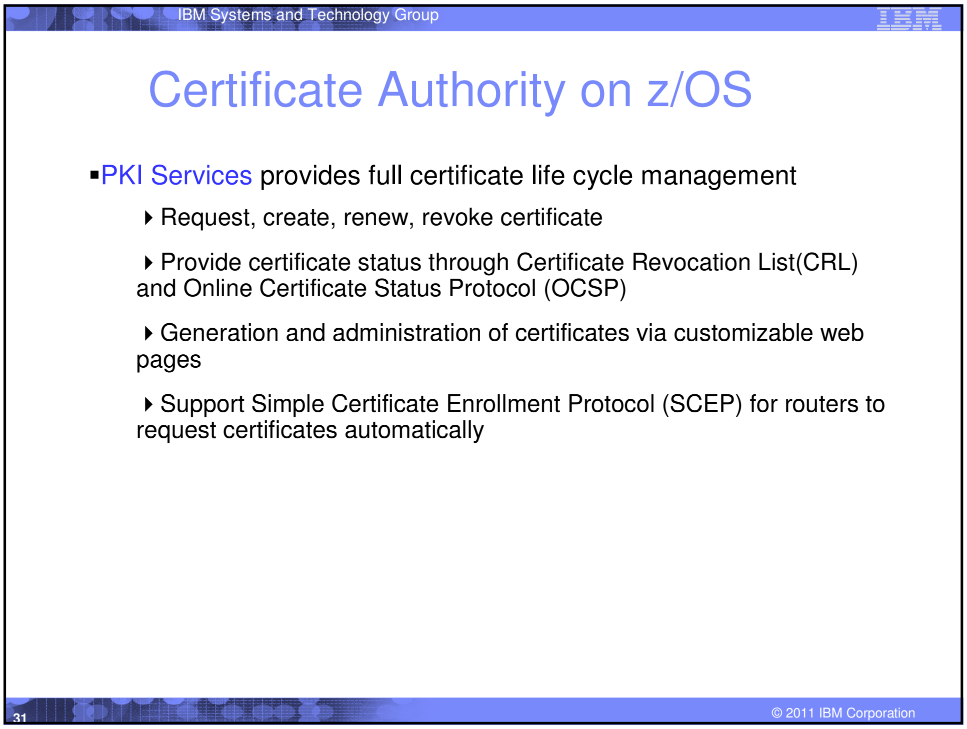
- gskkyman manages certificates stored in a key database file
- RACDCERT manages certificates stored in a RACF key ring.

Certificate Store Protection

- gskkyman key database files
  - Protected by the file system’s permission bits and password
  - Upon creation, permission bits are 700 giving the issuer of gskkyman read and write to the file only.
  - Applications using these files need at least read to the file
- RACF Key Rings
  - RACF key rings are protected by resource profiles.
  - Users rings need read access to IRR.DIGTCERT.LISTRING or <ring owner>.<ring name>.LST to be able to read the contents of their key ring.

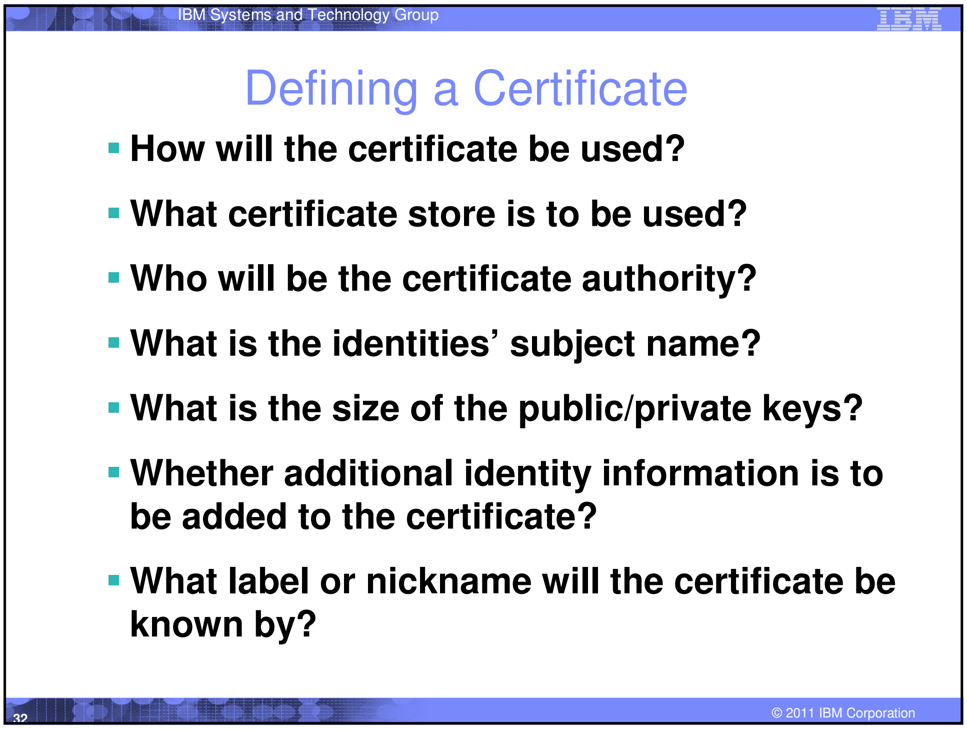
Certificate Utilities

- gskkyman is a Unix based utility shipped as part of the System SSL product in the z/OS Cryptographic Services Element
- RACDCERT is a TSO command shipped as part of RACF
- 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 certificates
- Do not have all the functions of a real Certificate Authority



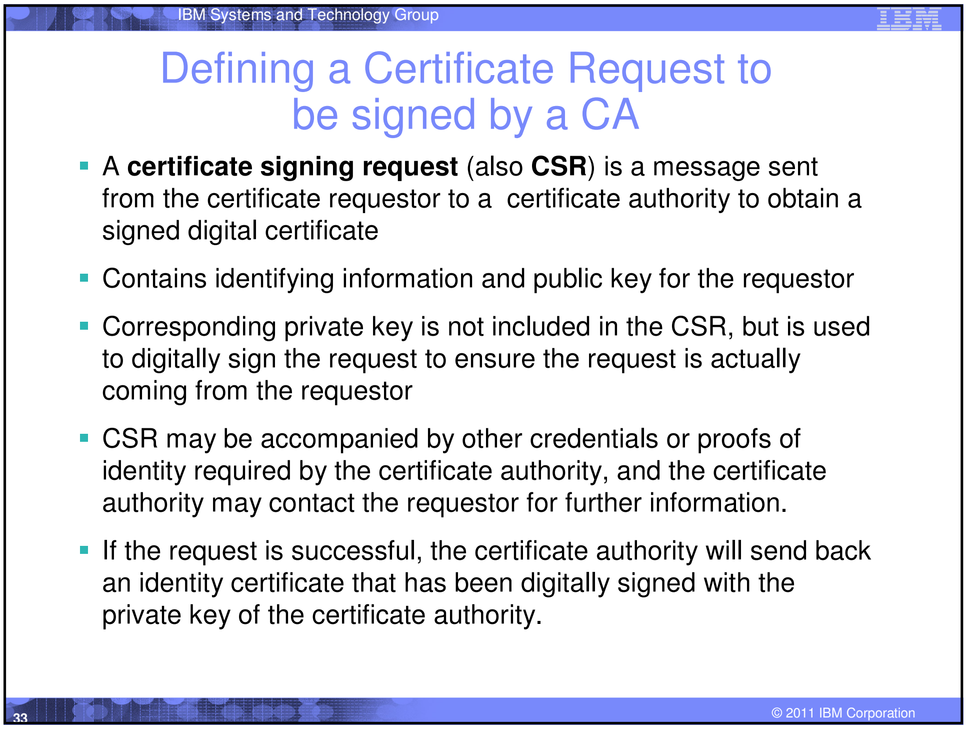
Certificate Authority on z/OS

- PKI Services provides full certificate life cycle management
  - Request, create, renew, revoke certificate
  - Provide certificate status through Certificate Revocation List(CRL) and Online Certificate Status Protocol (OCSP)
  - Generation and administration of certificates via customizable web pages
  - Support Simple Certificate Enrollment Protocol (SCEP) for routers to request certificates automatically



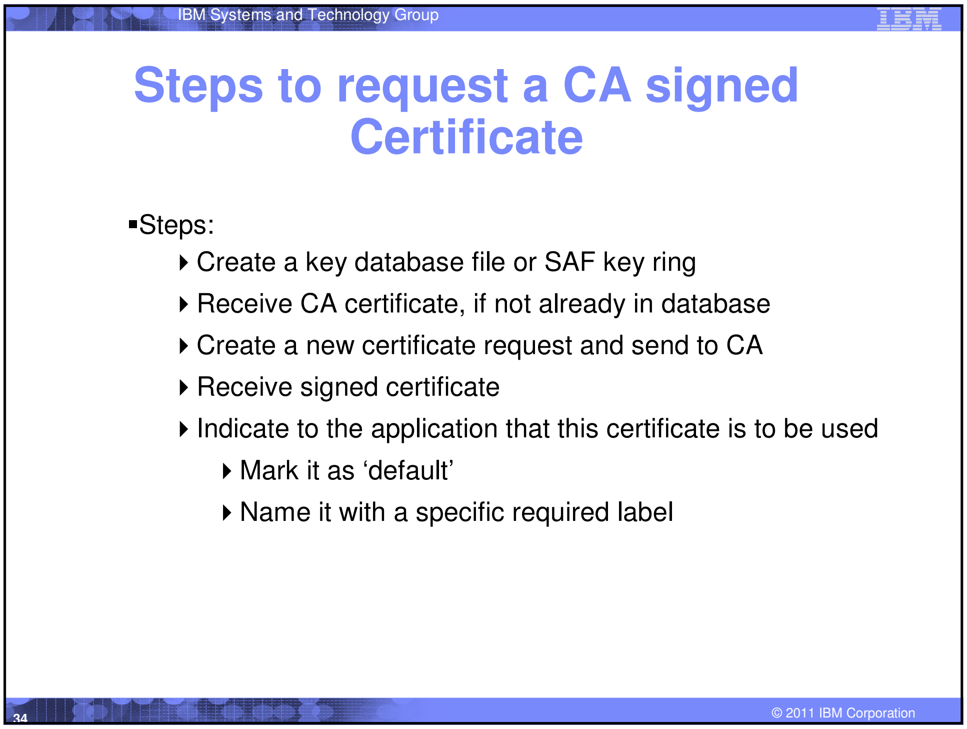
Defining a Certificate

- **How will the certificate be used?**
- **What certificate store is to be used?**
- **Who will be the certificate authority?**
- **What is the identities’ 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?**



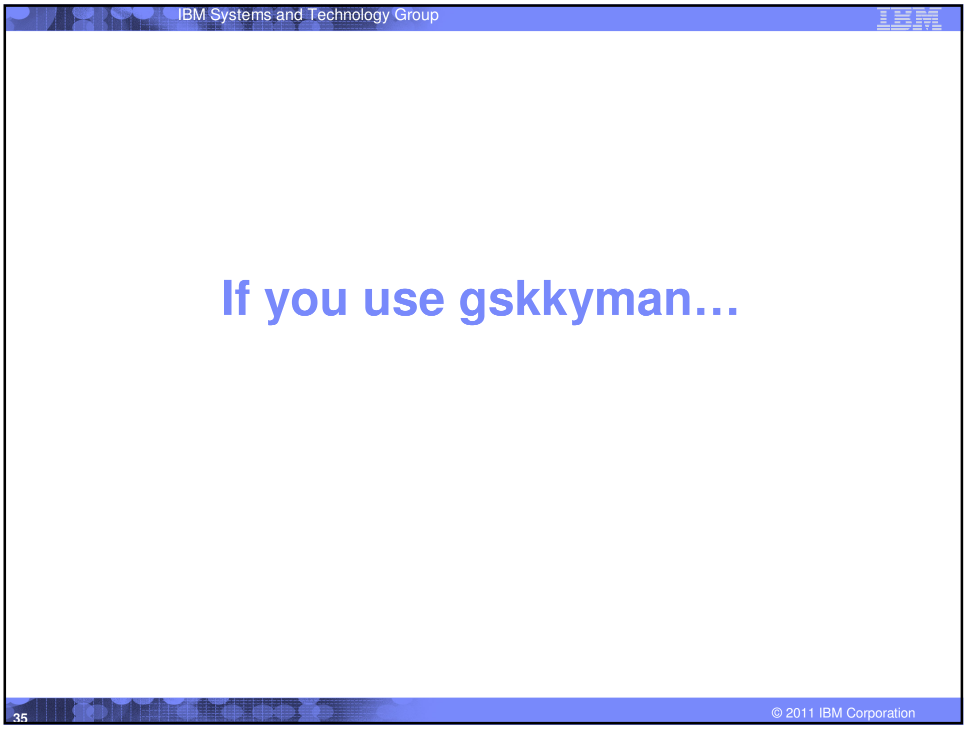
Defining a Certificate Request to be signed by a CA

- A **certificate signing request** (also **CSR**) 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.

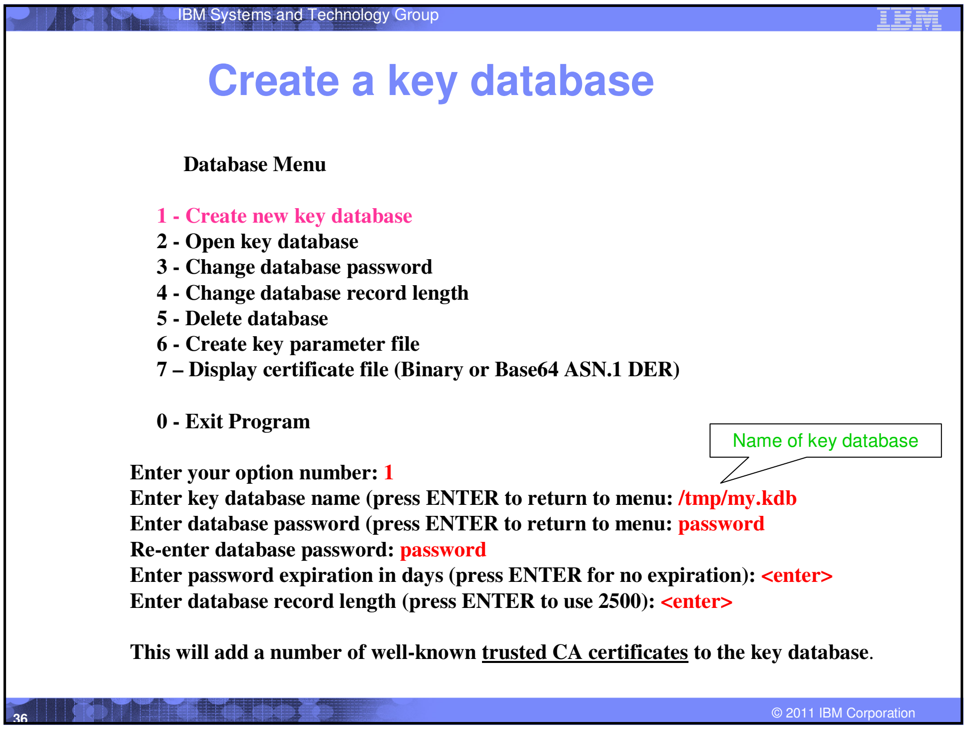


Steps to request a CA signed Certificate

- 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…

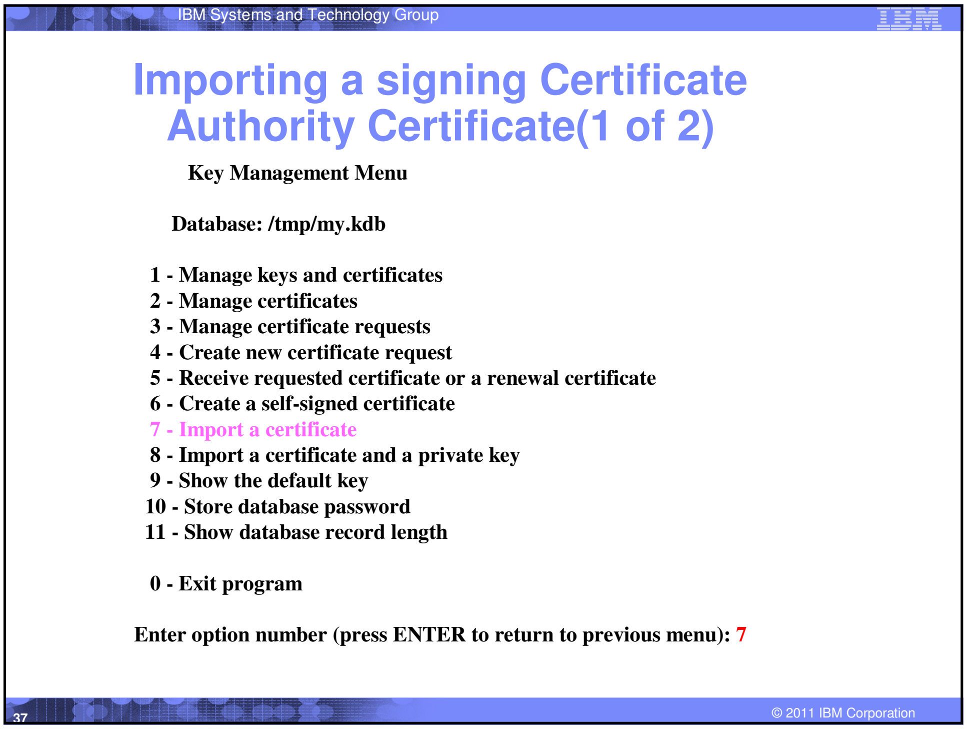


Create a key database

```
        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>
```

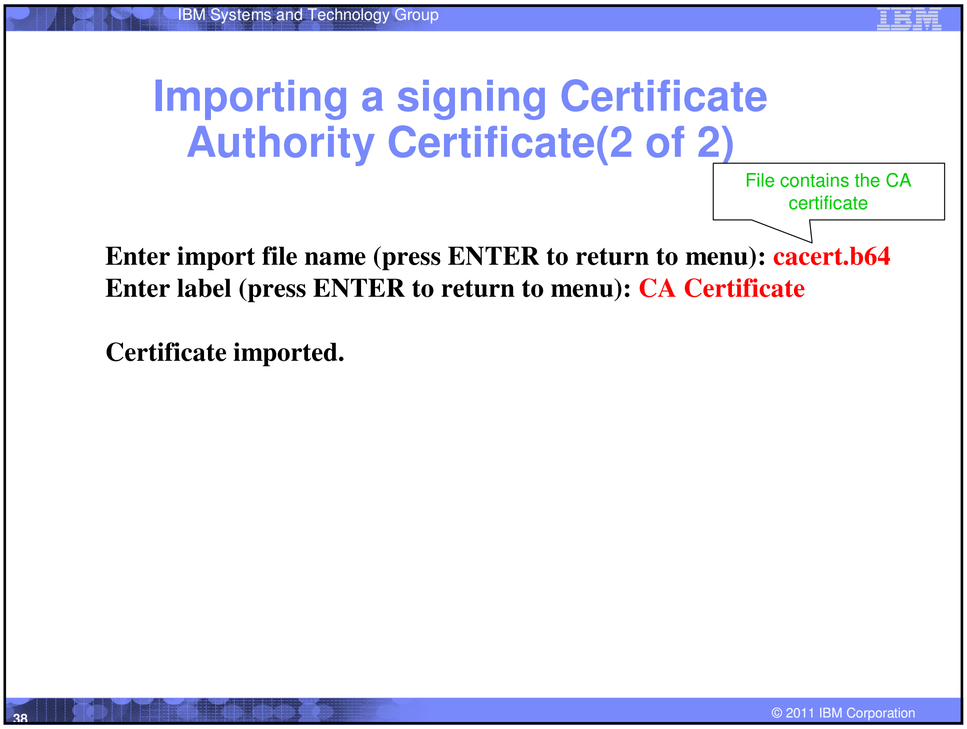
Name of key database

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



Importing a signing Certificate Authority Certificate(1 of 2)

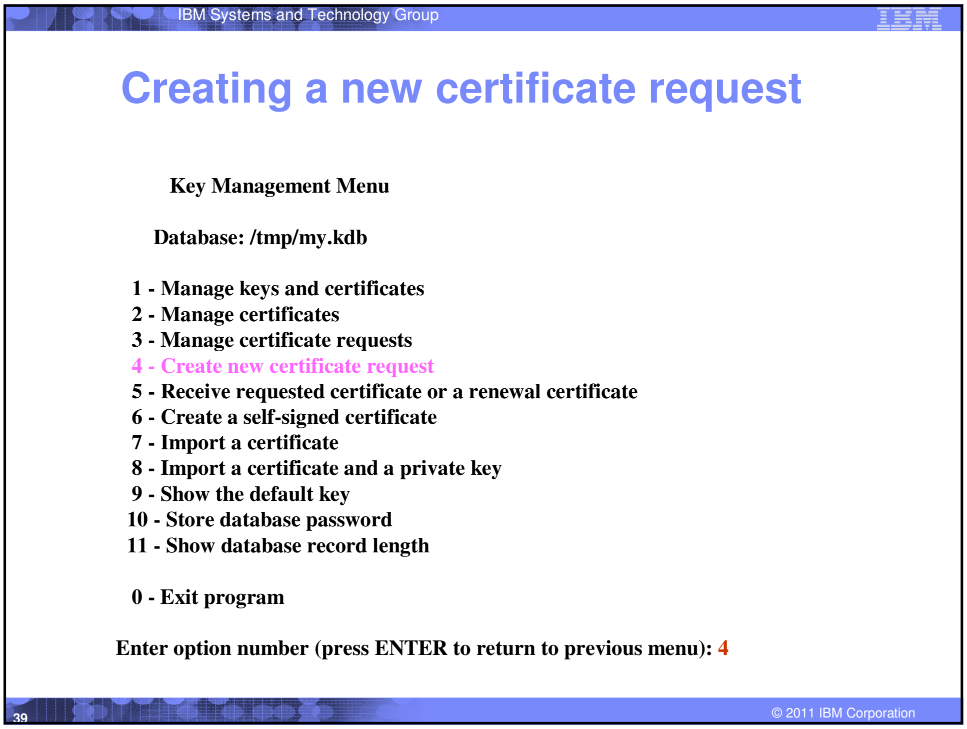
```
      Key Management Menu

    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(2 of 2)

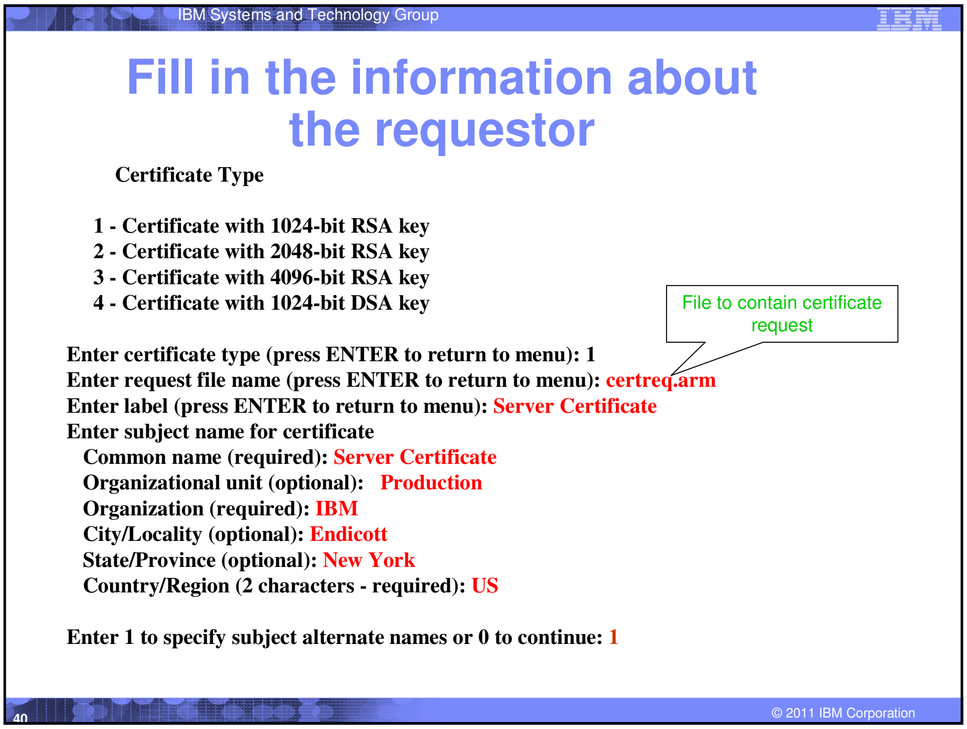
File contains the CA certificate

```
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

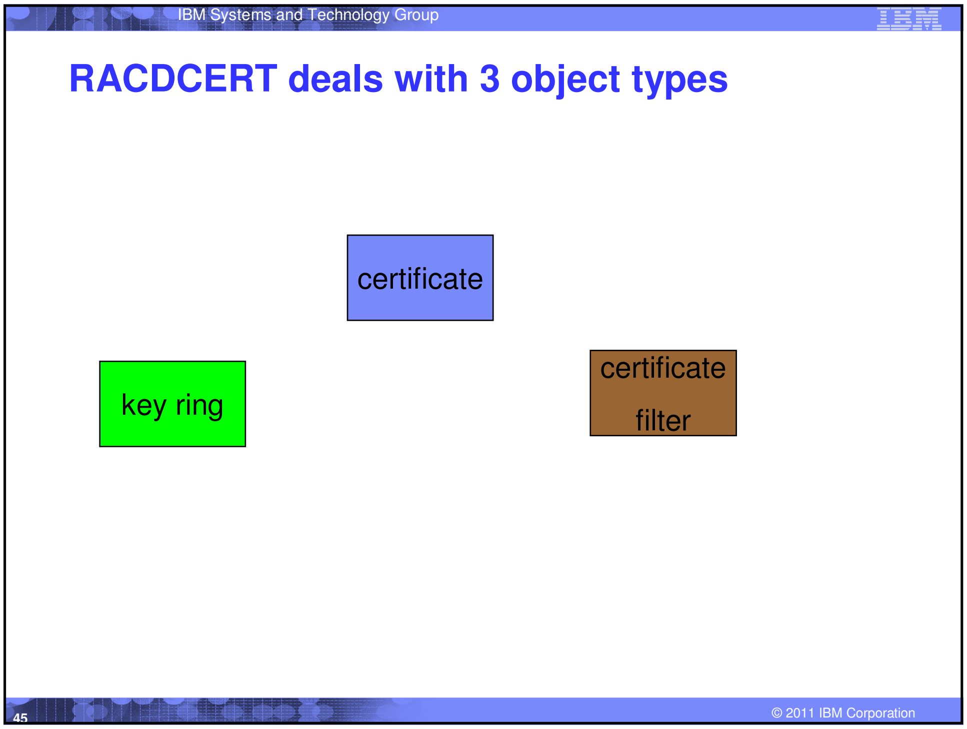
```
   Key Management Menu

  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

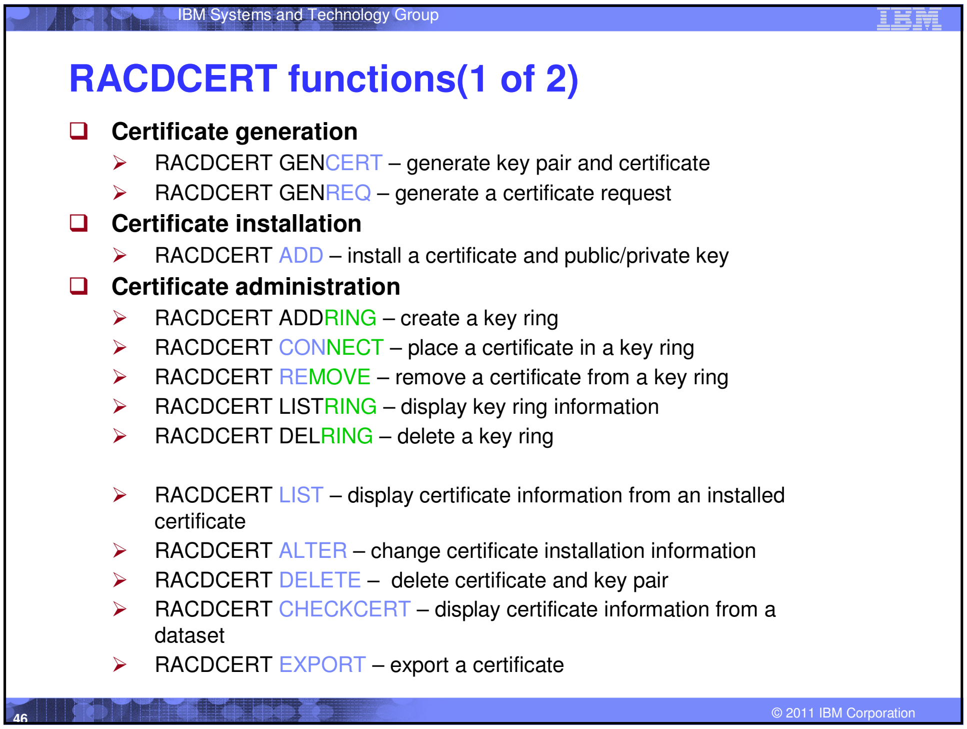
Marking a certificate as the default

```
     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 deals with 3 object types



RACDCERT functions(1 of 2)

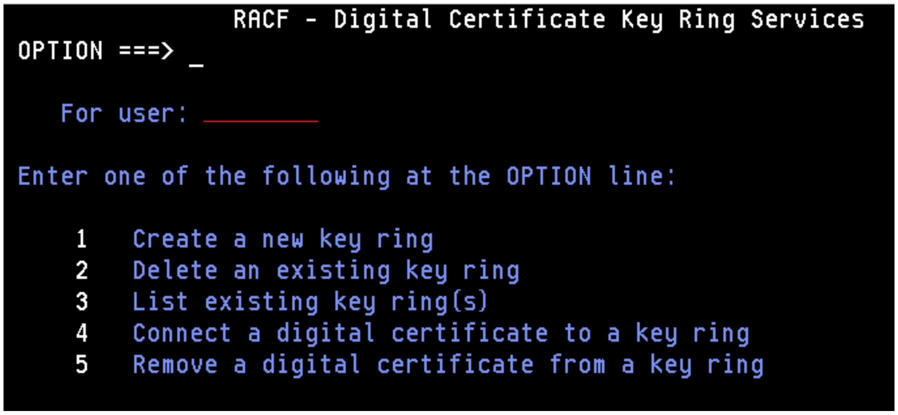
- **Certificate generation**
  - RACDCERT GENCERT – generate key pair and certificate
  - RACDCERT GENREQ – generate a certificate request
- **Certificate installation**
  - RACDCERT ADD – install a certificate and public/private key
- **Certificate administration**
  - RACDCERT ADDRING – create a key ring
  - RACDCERT CONNECT – place a certificate in a key ring
  - RACDCERT REMOVE – remove a certificate from a key ring
  - RACDCERT LISTRING – display key ring information
  - RACDCERT DELRING – delete a key ring

  - RACDCERT LIST – display certificate information from an installed certificate
  - RACDCERT ALTER – change certificate installation information
  - RACDCERT DELETE – delete certificate and key pair
  - RACDCERT CHECKCERT – display certificate information from a dataset
  - RACDCERT EXPORT – export a certificate

RACDCERT functions(2 of 2)

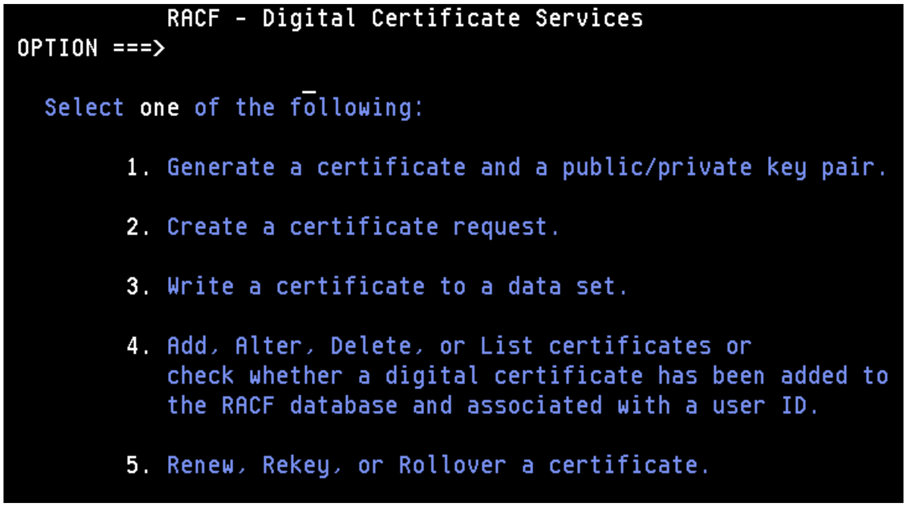
- **Certificate administration…**
  - RACDCERT MAP – create a certificate filter
  - RACDCERT ALTMAP – change the certificate filter
  - RACDCERT DELMAP – delete a certificate filter
  - RACDCERT LISTMAP – display certificate filter information
  - RACDCERT REKEY – renew certificate with new key pair
  - RACDCERT ROLLOVER – finalize the REKEY process
- **… more**

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

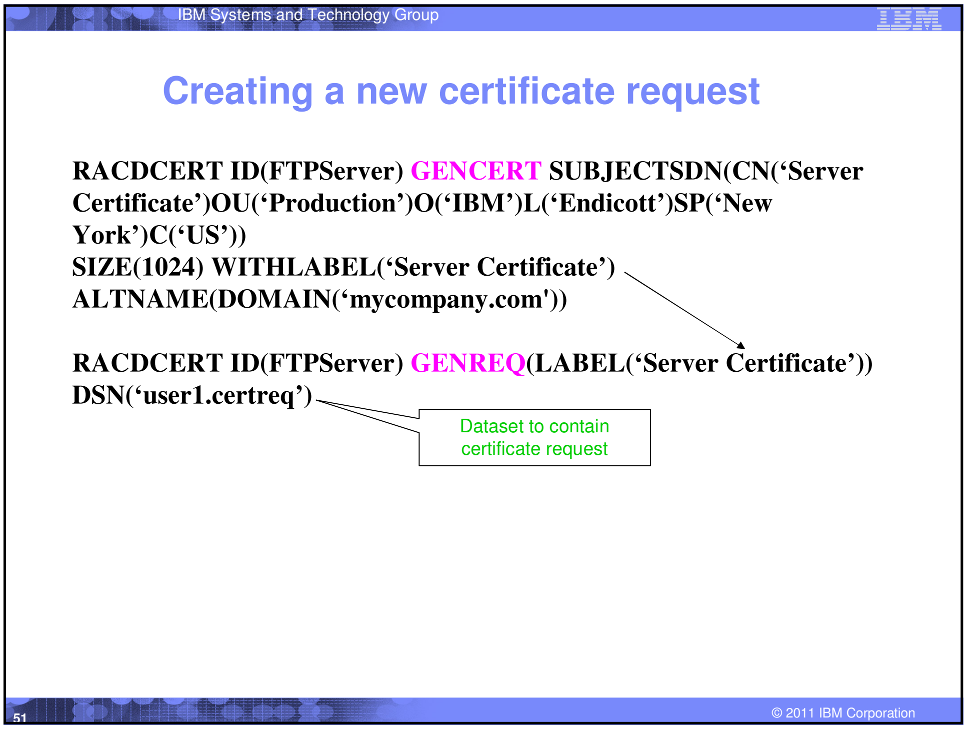
RACDCERT ID(FTPserver) ADDRING(MyRACFKeyRing)

Importing a signing Certificate Authority Certificate

Dataset contains the CA certificate

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

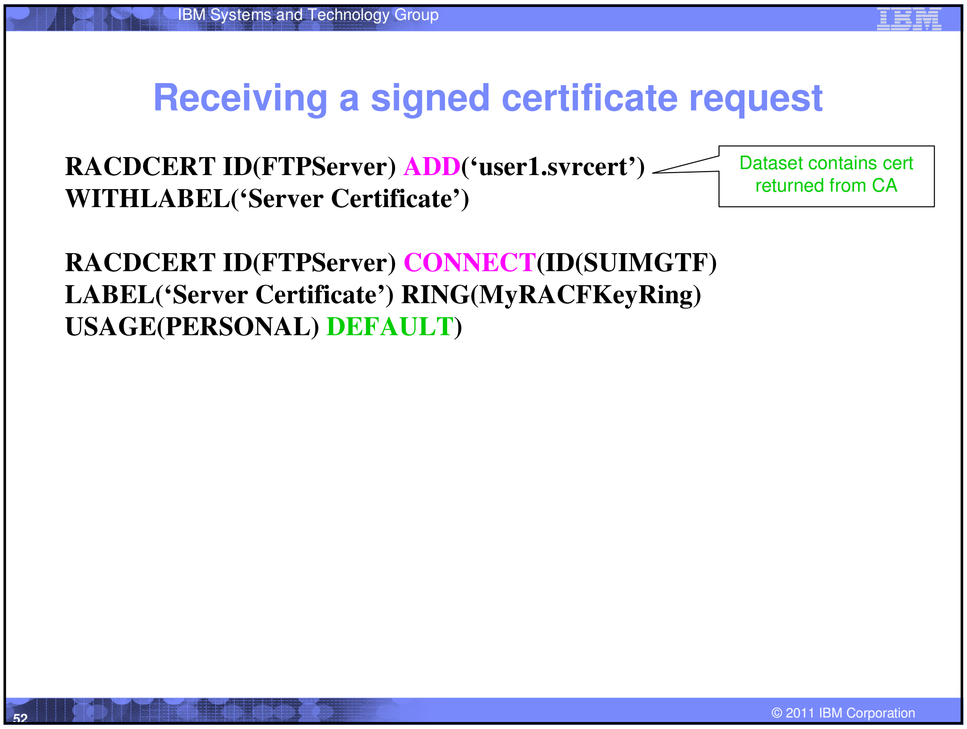
RACDCERT ID(FTPServer) CONNECT (CERTAUTH LABEL(‘CA Certificate’) RING(MyRACFKeyRing) USAGE(CERTAUTH))



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’)
```

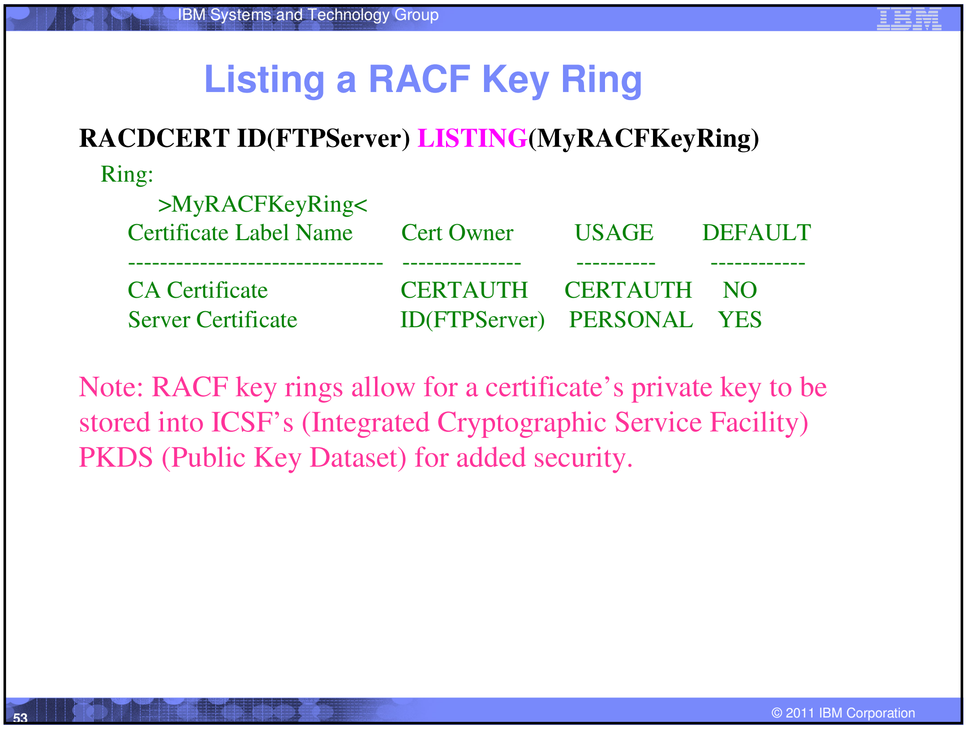
Dataset to contain certificate request



Receiving a signed certificate request

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

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

Dataset contains cert returned from CA

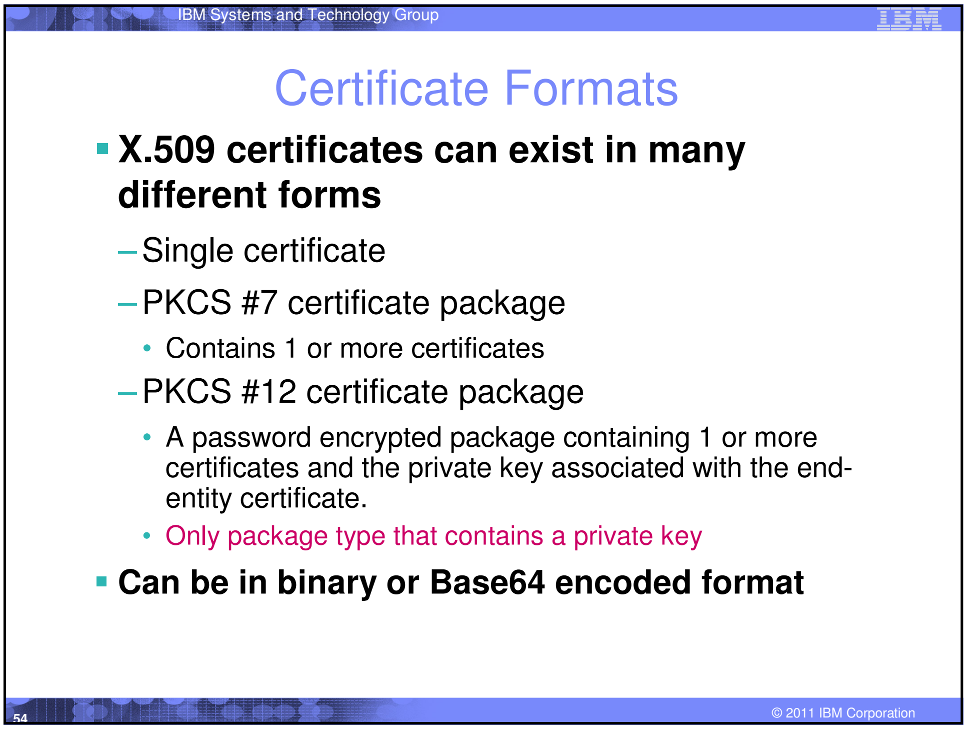


Listing a RACF Key Ring

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.



Certificate Formats

- **X.509 certificates can exist in many different forms**
  - Single certificate
  - 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**

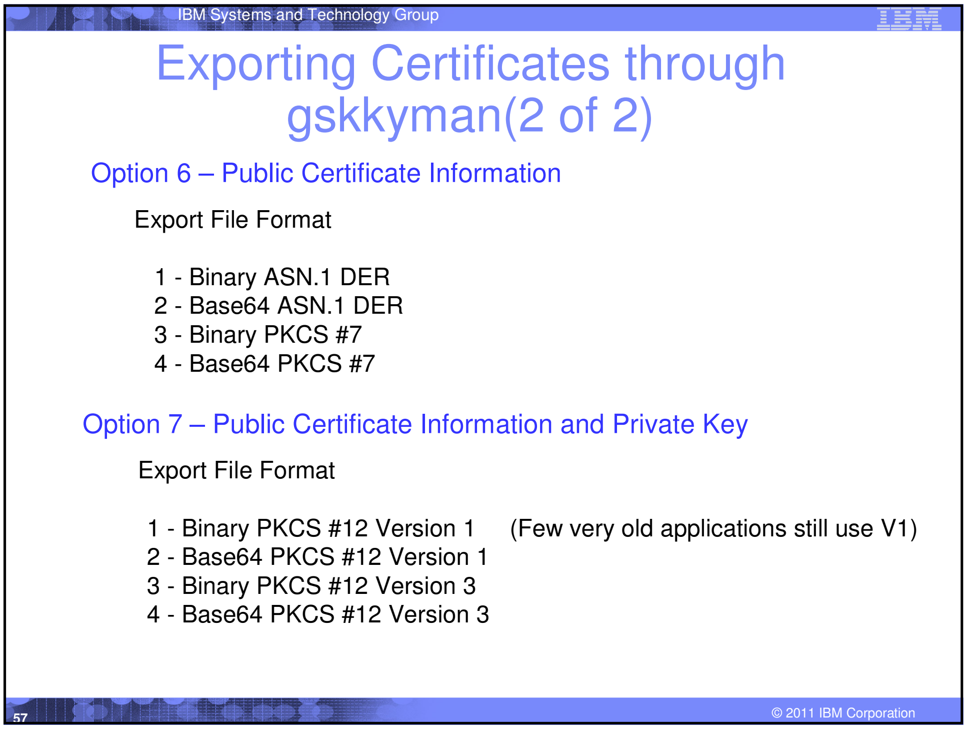
Base64 encoding

- **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-----
```

Exporting Certificates through gskkyman(1 of 2)

```
    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(2 of 2)

Option 6 – Public Certificate Information

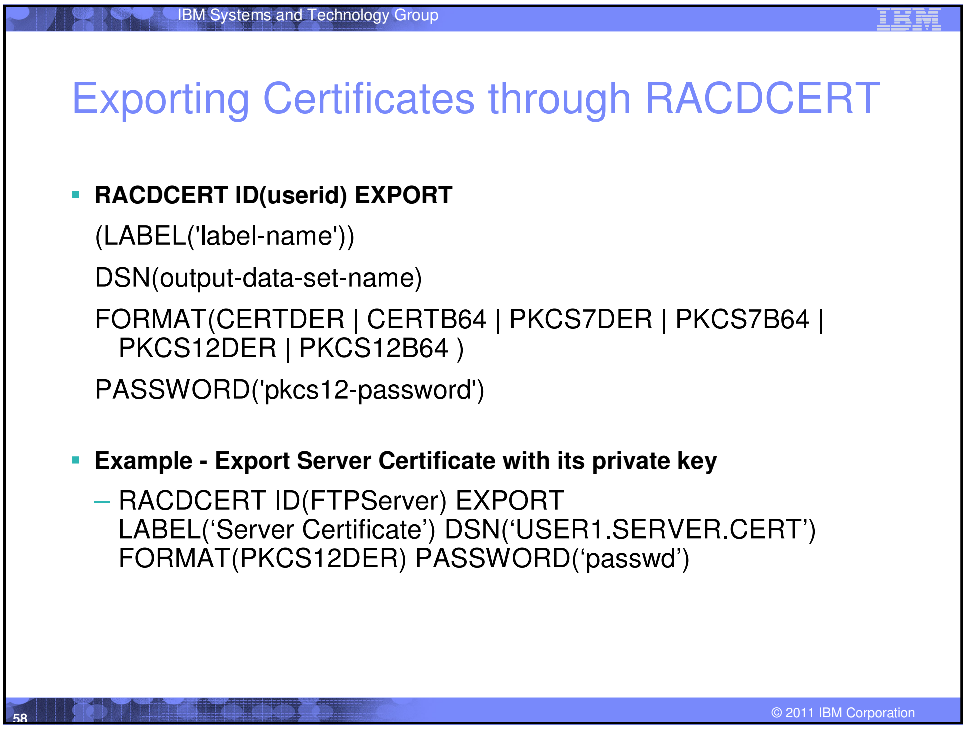
Export File Format

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**

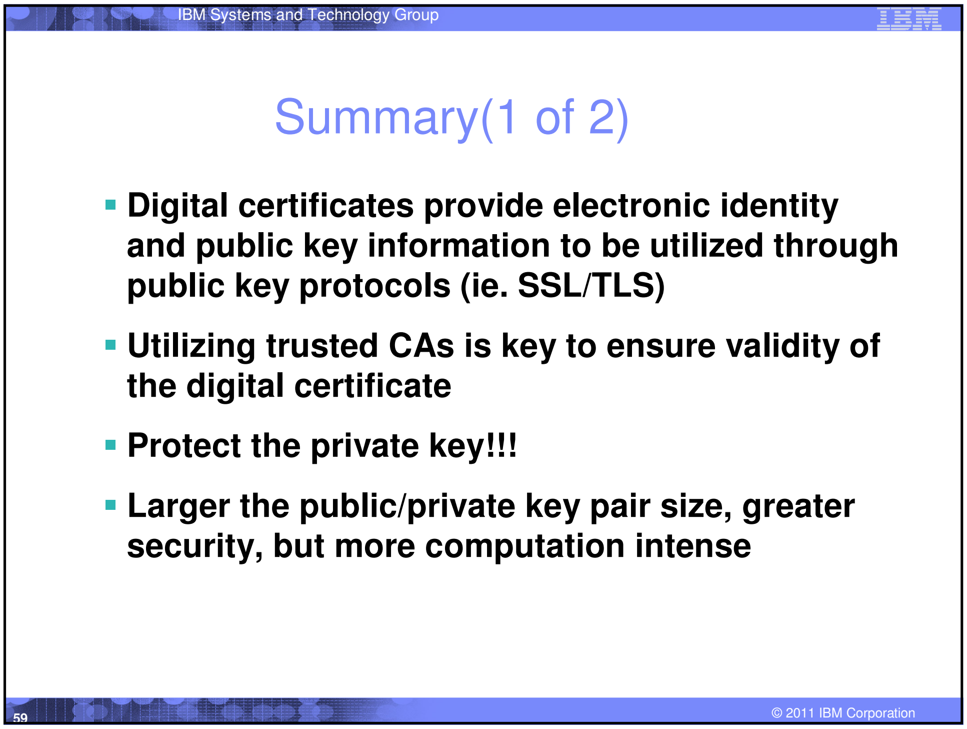
  (LABEL('label-name'))

  DSN(output-data-set-name)

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

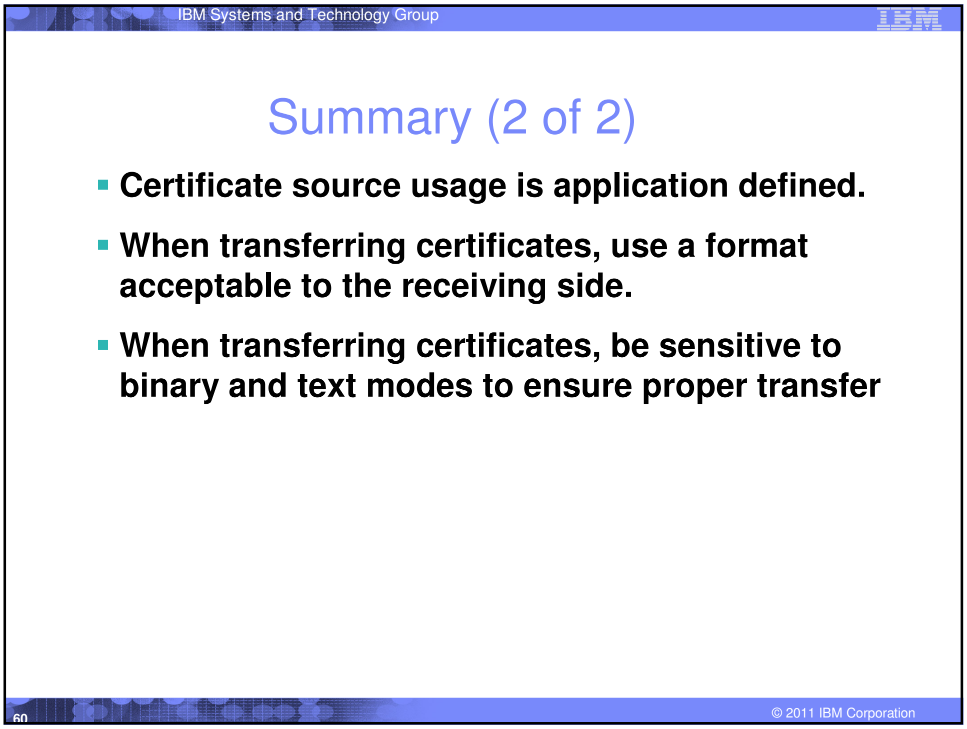
  PASSWORD('pkcs12-password')

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



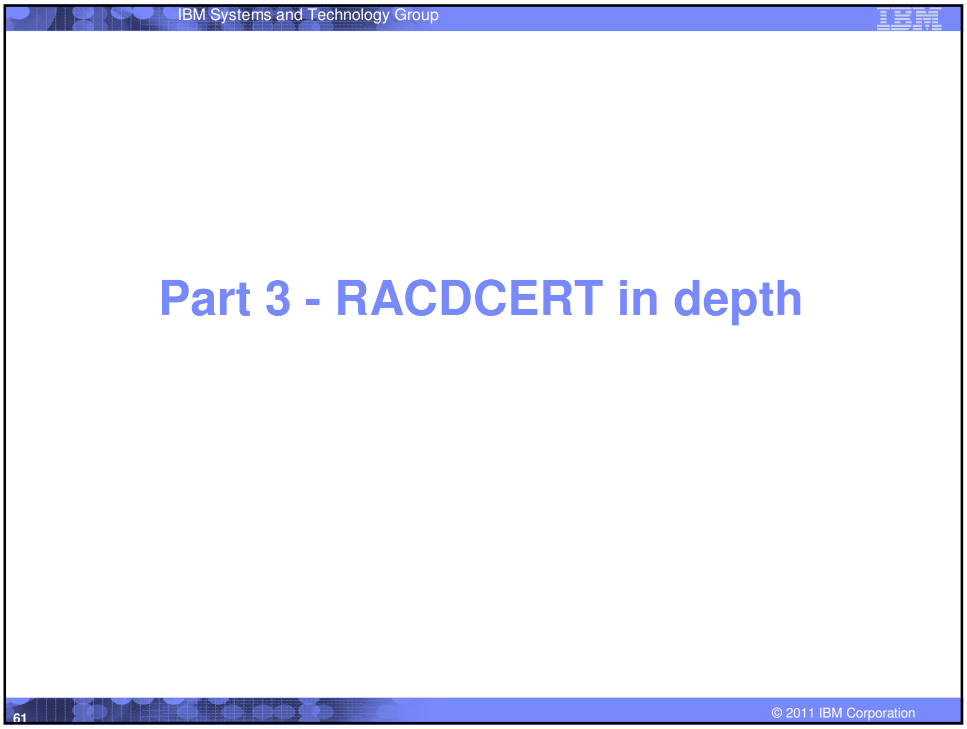
Summary(1 of 2)

- 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

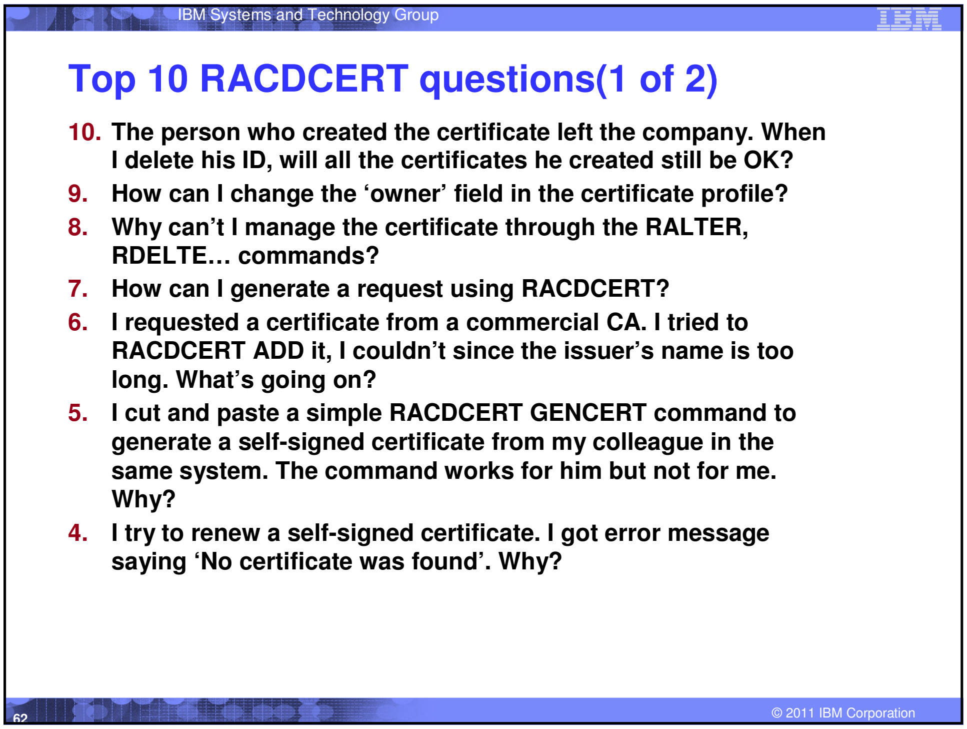


Summary (2 of 2)

- 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



Part 3 - RACDCERT in depth



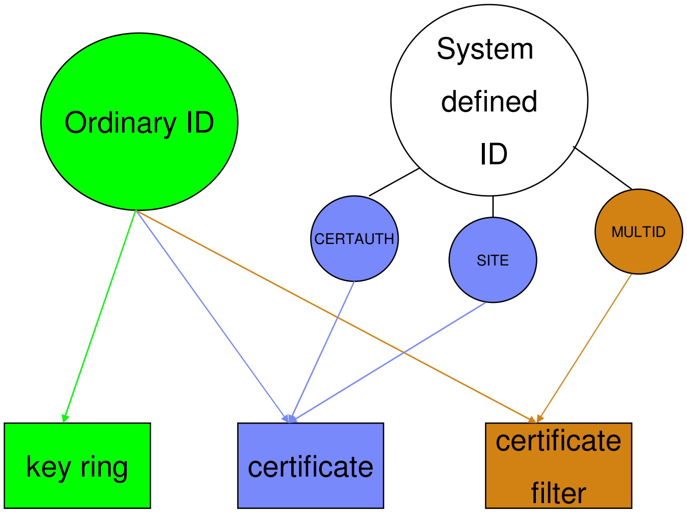
Top 10 RACDCERT questions(1 of 2)

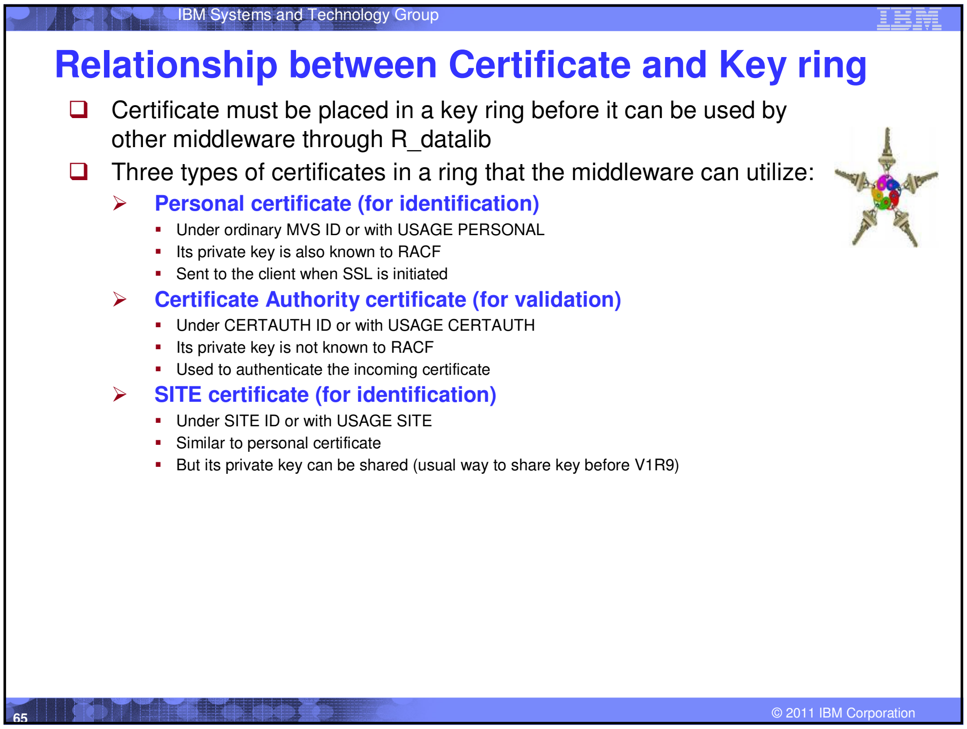
10. The person who created the certificate left the company. When I delete his ID, will all the certificates he created still be OK?
9. How can I change the ‘owner’ field in the certificate profile?
8. Why can’t I manage the certificate through the RALTER, RDELTE… commands?
7. How can I generate a request using RACDCERT?
6. I requested a certificate from a commercial CA. I tried to RACDCERT ADD it, I couldn’t since the issuer’s name is too long. What’s going on?
5. I cut and paste a simple RACDCERT GENCERT command to generate a self-signed certificate from my colleague in the same system. The command works for him but not for me. Why?
4. I try to renew a self-signed certificate. I got error message saying ‘No certificate was found’. Why?

Top 10 RACDCERT questions(2 of 2)

3. I connect a certificate to a key ring. I am sure the certificate and the ring are there. But I got message ‘No certificate was found’. Why?
2. I used RACDCERT to generate a request and submit it to the external CA. When I get back the certificate from CA and install it, the FTP server program does not work, complaining about no private key found. Why?
1. Whose certificates need to be installed in whose key ring for FTP to work?

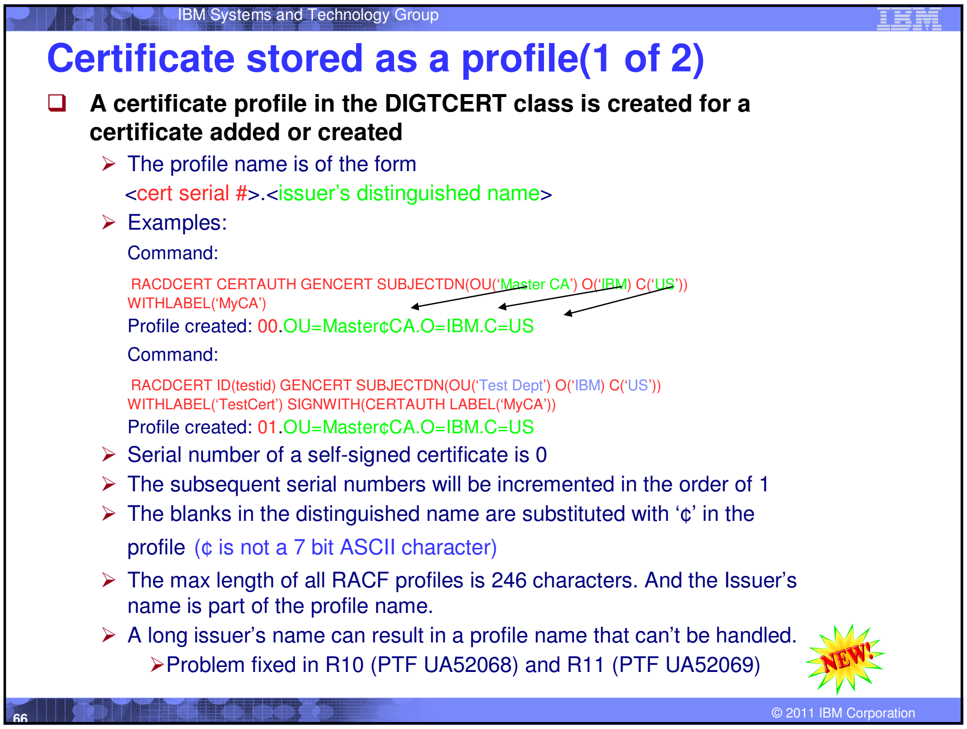
Relationship between entities and owner IDs





Relationship between Certificate and Key ring

- ❑ Certificate must be placed in a key ring before it can be used by other middleware through R_datalib
- ❑ Three types of certificates in a ring that the middleware can utilize:
  - ➢ **Personal certificate (for identification)**
    - Under ordinary MVS ID or with USAGE PERSONAL
    - Its private key is also known to RACF
    - Sent to the client when SSL is initiated
  - ➢ **Certificate Authority certificate (for validation)**
    - Under CERTAUTH ID or with USAGE CERTAUTH
    - Its private key is not known to RACF
    - Used to authenticate the incoming certificate
  - ➢ **SITE certificate (for identification)**
    - Under SITE ID or with USAGE SITE
    - Similar to personal certificate
    - But its private key can be shared (usual way to share key before V1R9)



Certificate stored as a profile(1 of 2)

- ❑ **A certificate profile in the DIGTCERT class is created for a certificate added or created**
  - ➢ The profile name is of the form
    <cert serial #>.<issuer's distinguished name>
  - ➢ Examples:

    Command:

    ```
    RACDCERT CERTAUTH GENCERT SUBJECTDN(OU('Master CA') O('IBM) C('US'))
    WITHLABEL('MyCA')
    ```

    Profile created: 00.OU=Master¢CA.O=IBM.C=US

    Command:

    ```
    RACDCERT ID(testid) GENCERT SUBJECTDN(OU('Test Dept') O('IBM) C('US'))
    WITHLABEL('TestCert') SIGNWITH(CERTAUTH LABEL('MyCA'))
    ```

    Profile created: 01.OU=Master¢CA.O=IBM.C=US
  - ➢ Serial number of a self-signed certificate is 0
  - ➢ The subsequent serial numbers will be incremented in the order of 1
  - ➢ The blanks in the distinguished name are substituted with '¢' in the profile (¢ is not a 7 bit ASCII character)
  - ➢ The max length of all RACF profiles is 246 characters. And the Issuer's name is part of the profile name.
  - ➢ A long issuer's name can result in a profile name that can't be handled.
    - ➢Problem fixed in R10 (PTF UA52068) and R11 (PTF UA52069)

Now you should be able to answer …

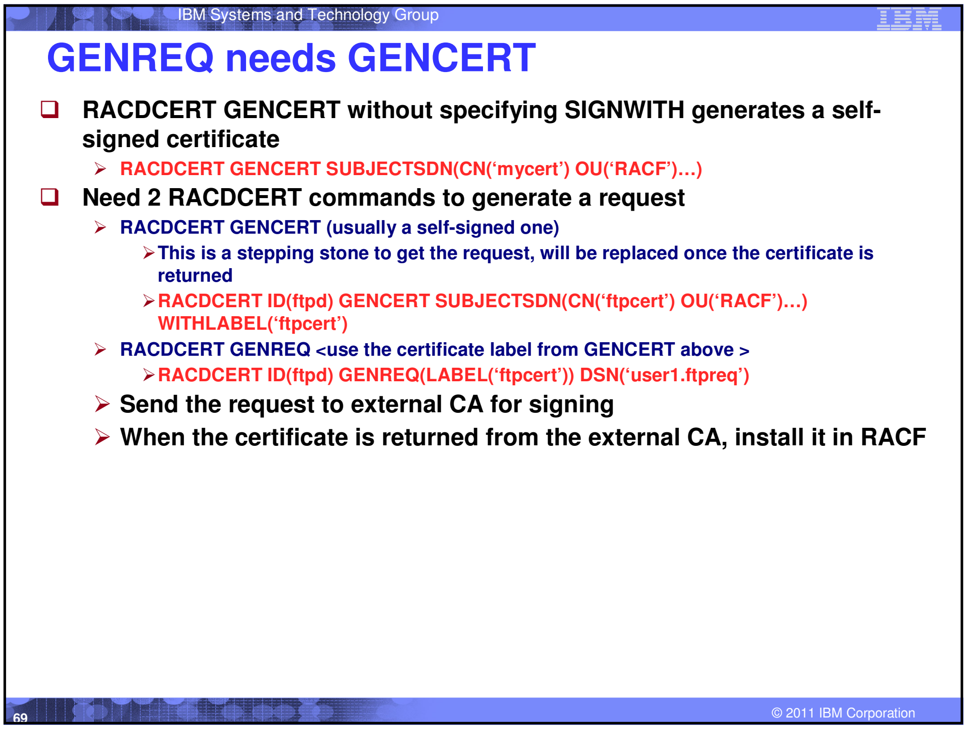
John cut and pasted a simple RACDCERT GENCERT command to generate a self-signed certificate from his colleague, Mary, in the same system. The command works for Mary but not for John. Why?

- **1st, , Mary issued: RACDCERT ID(Mary) GENCERT SUBJECT(CN(‘XYZ’)) WITHLABEL(‘Marycert’) - OK**
- **2nd, John issued: RACDCERT ID(John) GENCERT SUBJECT(CN(’XYZ’)) WITHLABEL(‘Johncert’) – Error**

Certificate stored as a profile (2 of 2)

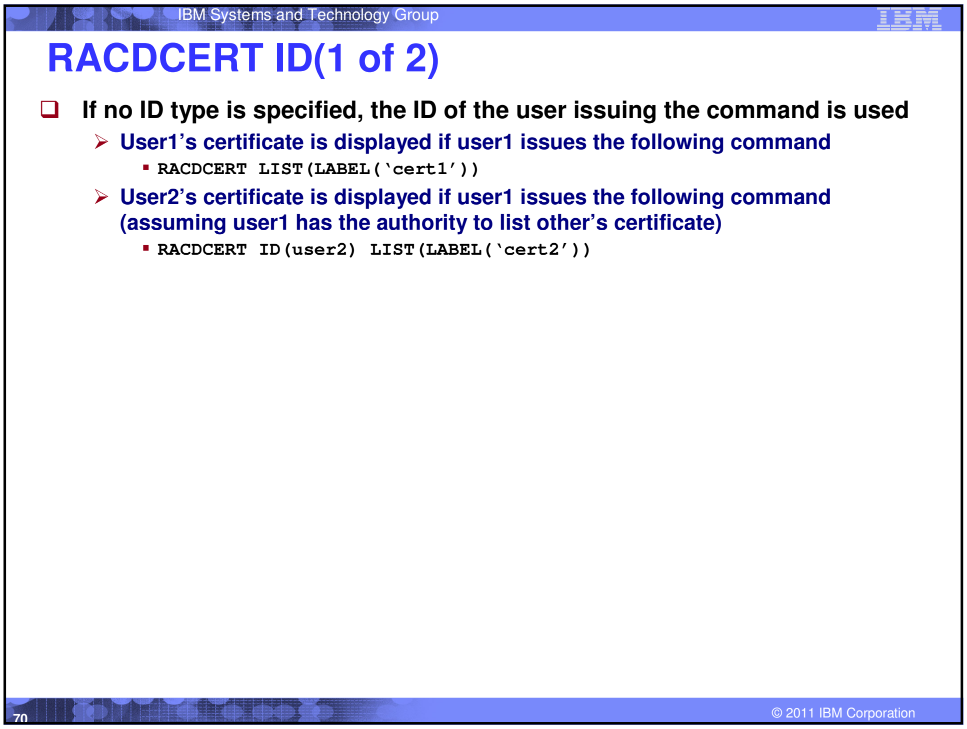
- **This profile represents the certificate. NOT a protection profile!**
  - The owner field in this profile indicates the issuer of the RACDCERT command, NOT the certificate owner
  - The certificate profile can NOT be managed through the resources management commands, like RALTER, RDELETE…
  - Managed through RACDCERT commands

- **There are function specific profiles in the facility class for authority checking**
  - Read, Update or Control on IRR.DIGTCERT.<function>
    - `Eg. IRR.DIGTCERT.GENCERT, IRR.DIGTCERT.ADD`



GENREQ needs GENCERT

- RACDCERT GENCERT without specifying SIGNWITH generates a self-signed certificate
  - RACDCERT GENCERT SUBJECTSDN(CN('mycert') OU('RACF')...)
- Need 2 RACDCERT commands to generate a request
  - RACDCERT GENCERT (usually a self-signed one)
    - This is a stepping stone to get the request, will be replaced once the certificate is returned
    - RACDCERT ID(ftpd) GENCERT SUBJECTSDN(CN('ftpcert') OU('RACF')...) WITHLABEL('ftpcert')
  - RACDCERT GENREQ <use the certificate label from GENCERT above >
    - RACDCERT ID(ftpd) GENREQ(LABEL('ftpcert')) DSN('user1.ftpreq')
  - Send the request to external CA for signing
  - When the certificate is returned from the external CA, install it in RACF



RACDCERT ID(1 of 2)

- If no ID type is specified, the ID of the user issuing the command is used
  - User1's certificate is displayed if user1 issues the following command
    - `RACDCERT LIST(LABEL('cert1'))`
  - User2's certificate is displayed if user1 issues the following command (assuming user1 has the authority to list other's certificate)
    - `RACDCERT ID(user2) LIST(LABEL('cert2'))`

Now you should be able to answer …

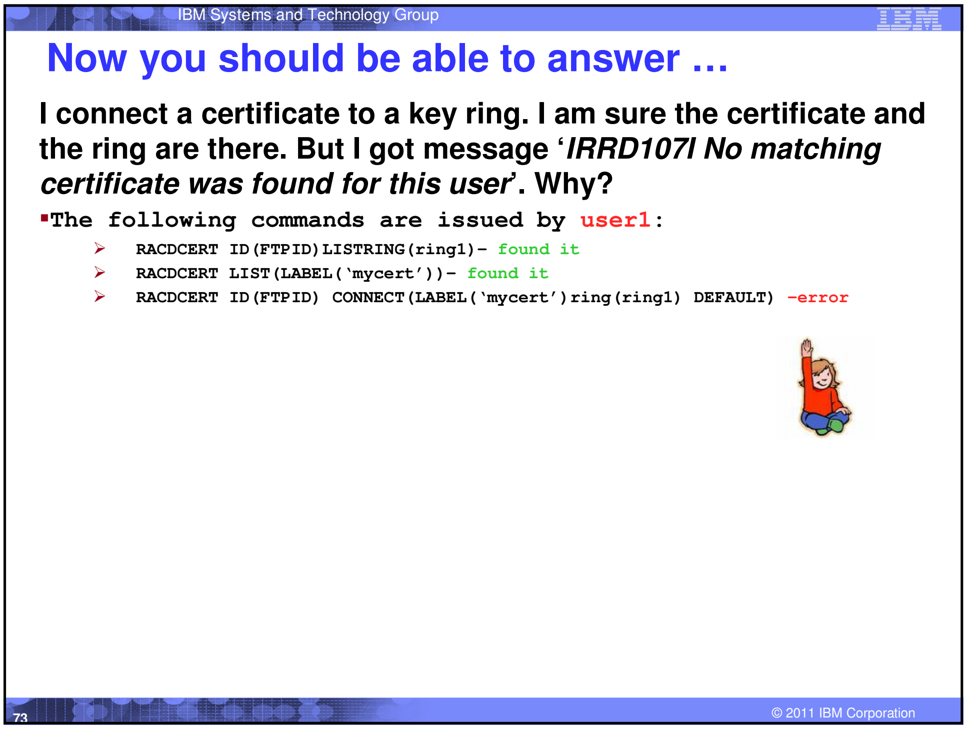
I try to renew a self-signed certificate. I got error message saying '*IRRD107I No matching certificate was found for this user*'. Why?

- **User1 issues the following command to renew a self-signed certificate** 'FTPCert' owned by **FTPID:**

  -
    ```
    RACDCERT ID(FTPID) GENCERT(<request based on the original
    self-signed FTPCert> SIGNWITH(LABEL('FTPCert'))
    ```

RACDCERT ID (2 of 2)

- ❑ **There is an exception in the CONNECT command which involves 2 entities, ring and cert.**
- ❑ **Syntax: RACDCERT <ring owner id> CONNECT(<cert owner id> <cert label>…)**
- ❑ **Which case has the exception?**
  - `RACDCERT ID(Mary) CONNECT(ID(John) LABEL…)`
    - Ring owner: Mary, Cert owner: John
  - `RACDCERT ID(Mary) CONNECT(LABEL…)`
    - Ring owner: Mary, Cert owner: Mary ⚠
  - `RACDCERT CONNECT(ID(John) LABEL…)`
    - Ring owner: Issuer of command, Cert owner: John
  - `RACDCERT CONNECT(LABEL…)`
    - Ring owner: Issuer of command, Cert owner: Issuer of command



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Now you should be able to answer …

I connect a certificate to a key ring. I am sure the certificate and the ring are there. But I got message '*IRRD107I No matching certificate was found for this user*'. Why?

- The following commands are issued by user1:
  - ➢ `RACDCERT ID(FTPID)LISTRING(ring1)- found it`
  - ➢ `RACDCERT LIST(LABEL('mycert'))- found it`
  - ➢ `RACDCERT ID(FTPID) CONNECT(LABEL('mycert')ring(ring1) DEFAULT) -error`

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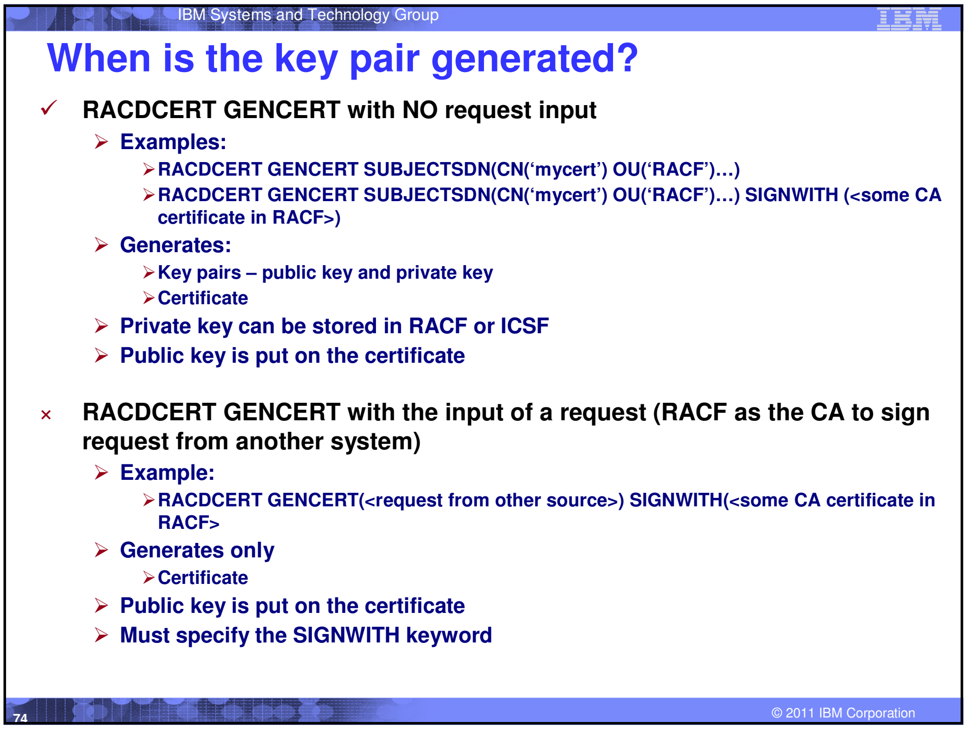

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When is the key pair generated?

✓ **RACDCERT GENCERT with NO request input**

- ➢ Examples:
  - ➢ RACDCERT GENCERT SUBJECTSDN(CN('mycert') OU('RACF')…)
  - ➢ RACDCERT GENCERT SUBJECTSDN(CN('mycert') OU('RACF')…) SIGNWITH (<some CA certificate in RACF>)
- ➢ Generates:
  - ➢ Key pairs – public key and private key
  - ➢ Certificate
- ➢ Private key can be stored in RACF or ICSF
- ➢ Public key is put on the certificate

× **RACDCERT GENCERT with the input of a request (RACF as the CA to sign request from another system)**

- ➢ Example:
  - ➢ RACDCERT GENCERT(<request from other source>) SIGNWITH(<some CA certificate in RACF>
- ➢ Generates only
  - ➢ Certificate
- ➢ Public key is put on the certificate
- ➢ Must specify the SIGNWITH keyword

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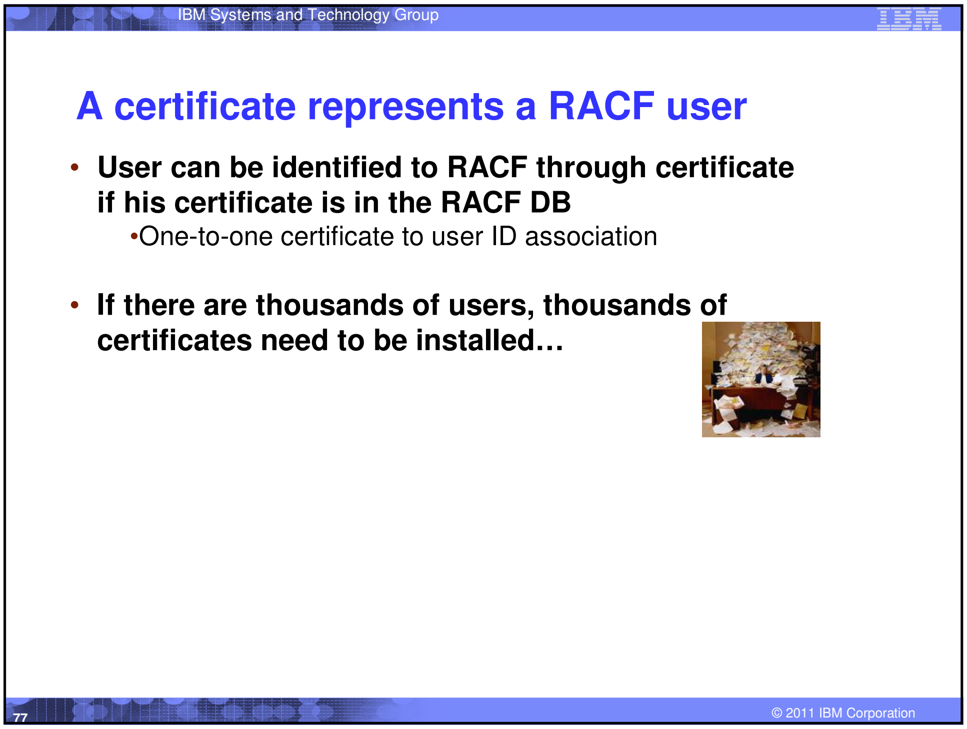
Now you should be able to answer …

I used RACDCERT to generate a request and submit it to the external CA. When I get back the certificate from CA and install it, the FTP server program does not work, complaining about no private key found. Why?

- **Here are the steps:**
  - RACDCERT ID(ftpid) GENCERT …WITHLABEL(‘temp cert’)
  - RACDCERT ID(ftpid) GENREQ(LABEL(‘temp cert’)) DSN(<output request_dsn>)
  - RACDCERT ID(ftpid) DELETE(LABEL(‘temp cert’))
  - Send the request to external CA
  - Get back the certificate
  - RACDCERT ID(ftpid) ADD (<dataset contains the returned cert>) WITHLABEL(‘real cert’)
  - RACDCERT ID(ftpid) CONNECT (LABEL(‘real cert’) RING(<ftpring>)…DEFAULT)

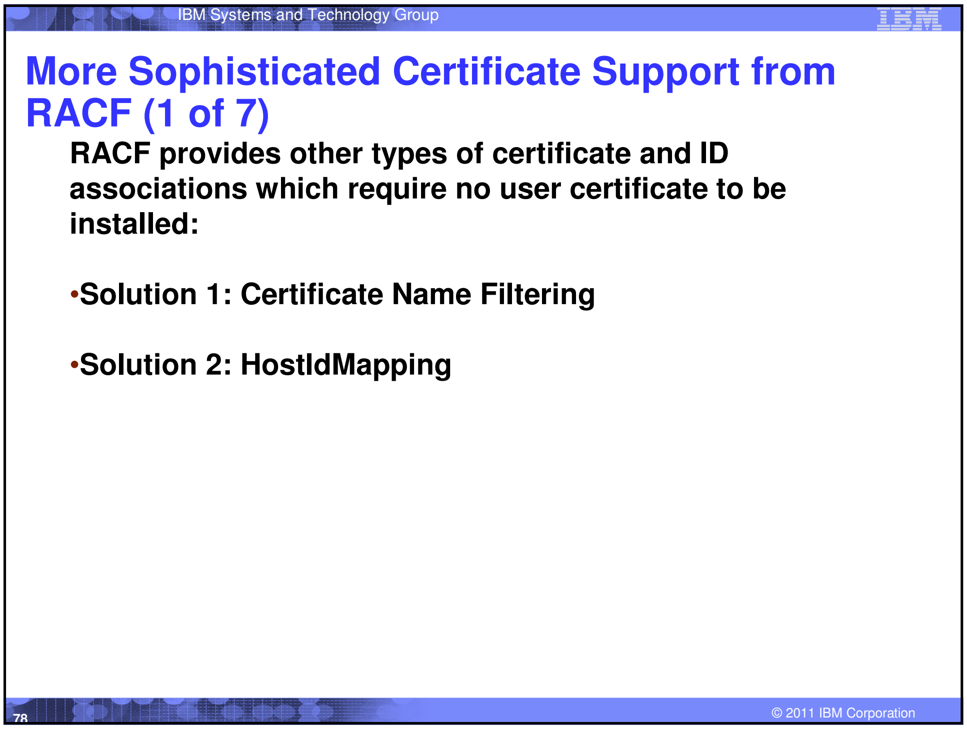
Certificate Name Filtering and Host ID Mapping



A certificate represents a RACF user

- **User can be identified to RACF through certificate if his certificate is in the RACF DB**
  - One-to-one certificate to user ID association

- **If there are thousands of users, thousands of certificates need to be installed…**

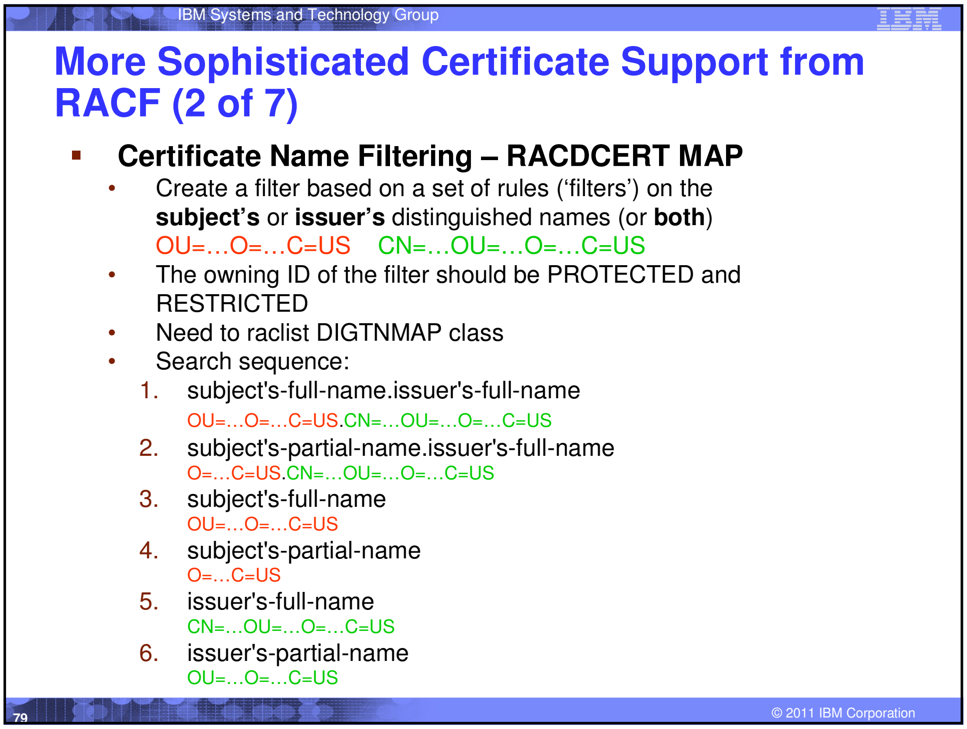


More Sophisticated Certificate Support from RACF (1 of 7)

RACF provides other types of certificate and ID associations which require no user certificate to be installed:

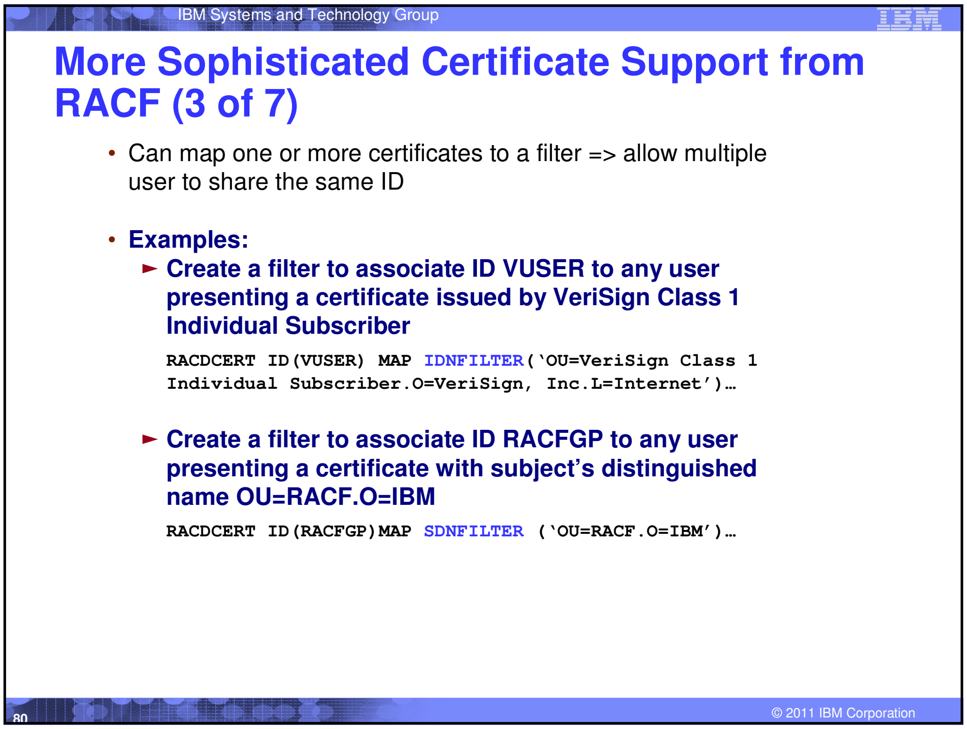
- **Solution 1: Certificate Name Filtering**

- **Solution 2: HostIdMapping**



More Sophisticated Certificate Support from RACF (2 of 7)

- **Certificate Name Filtering – RACDCERT MAP**
  - Create a filter based on a set of rules (‘filters’) on the **subject’s** or **issuer’s** distinguished names (or **both**)
    OU=…O=…C=US   CN=…OU=…O=…C=US
  - The owning ID of the filter should be PROTECTED and RESTRICTED
  - Need to raclist DIGTNMAP class
  - Search sequence:
    1. subject's-full-name.issuer's-full-name
       OU=…O=…C=US.CN=…OU=…O=…C=US
    2. subject's-partial-name.issuer's-full-name
       O=…C=US.CN=…OU=…O=…C=US
    3. subject's-full-name
       OU=…O=…C=US
    4. subject's-partial-name
       O=…C=US
    5. issuer's-full-name
       CN=…OU=…O=…C=US
    6. issuer's-partial-name
       OU=…O=…C=US



More Sophisticated Certificate Support from RACF (3 of 7)

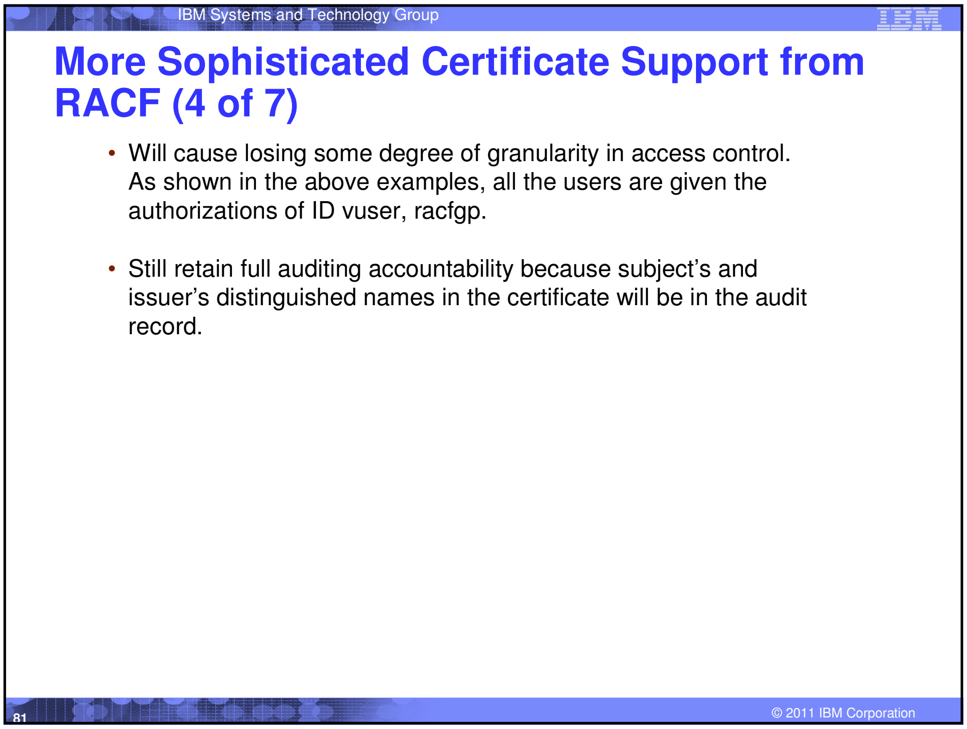
- Can map one or more certificates to a filter => allow multiple user to share the same ID

- **Examples:**
  - **Create a filter to associate ID VUSER to any user presenting a certificate issued by VeriSign Class 1 Individual Subscriber**

```
RACDCERT ID(VUSER) MAP IDNFILTER(‘OU=VeriSign Class 1
Individual Subscriber.O=VeriSign, Inc.L=Internet’)…
```

  - **Create a filter to associate ID RACFGP to any user presenting a certificate with subject’s distinguished name OU=RACF.O=IBM**

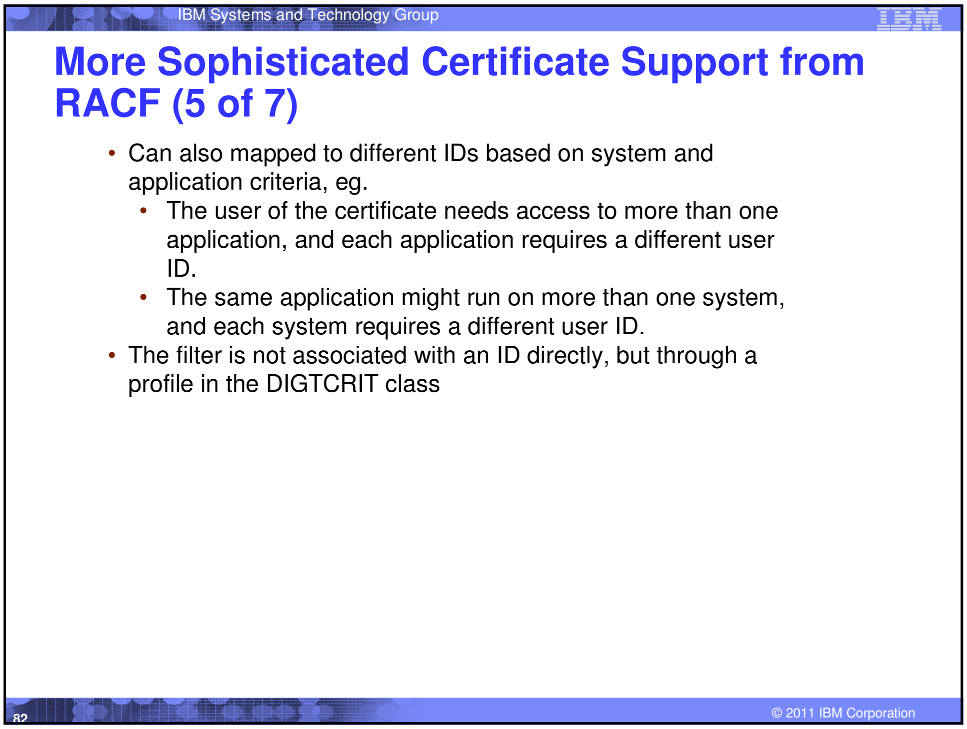
```
RACDCERT ID(RACFGP)MAP SDNFILTER (‘OU=RACF.O=IBM’)…
```



More Sophisticated Certificate Support from RACF (4 of 7)

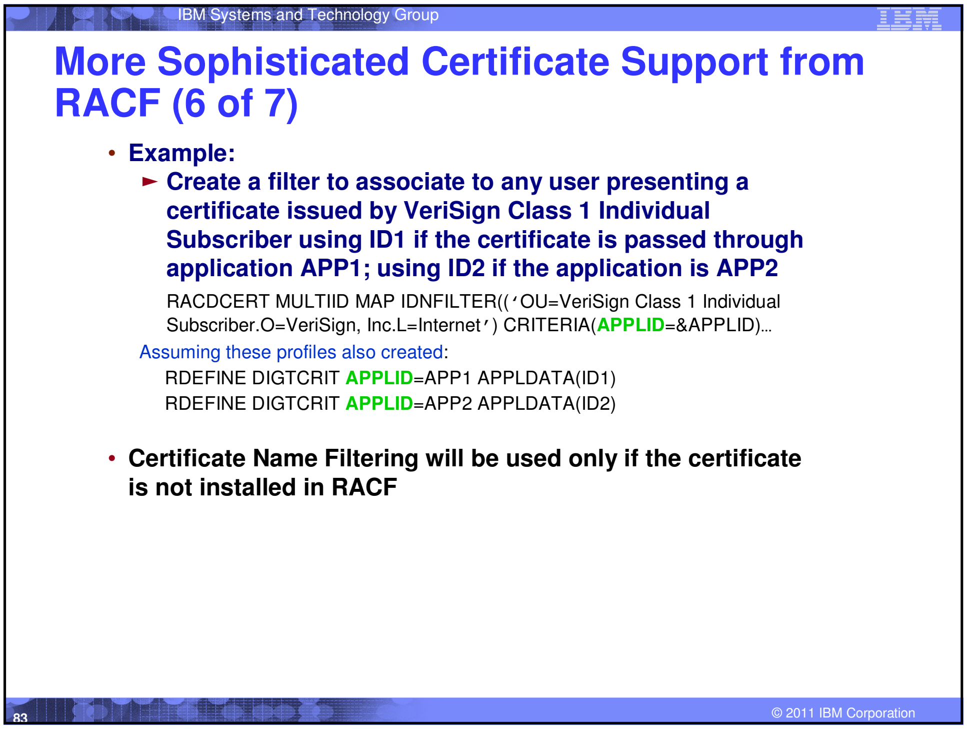
- Will cause losing some degree of granularity in access control. As shown in the above examples, all the users are given the authorizations of ID vuser, racfgp.

- Still retain full auditing accountability because subject's and issuer's distinguished names in the certificate will be in the audit record.



More Sophisticated Certificate Support from RACF (5 of 7)

- Can also mapped to different IDs based on system and application criteria, eg.
  - The user of the certificate needs access to more than one application, and each application requires a different user ID.
  - The same application might run on more than one system, and each system requires a different user ID.
- The filter is not associated with an ID directly, but through a profile in the DIGTCRIT class



More Sophisticated Certificate Support from RACF (6 of 7)

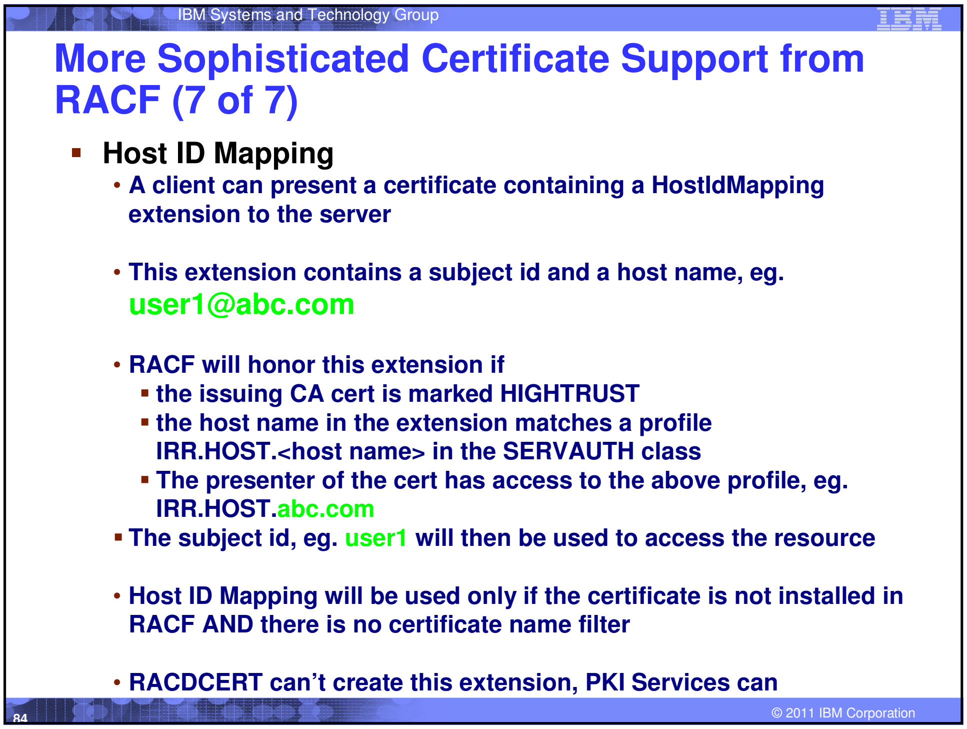
- **Example:**
  - ► **Create a filter to associate to any user presenting a certificate issued by VeriSign Class 1 Individual Subscriber using ID1 if the certificate is passed through application APP1; using ID2 if the application is APP2**

```
RACDCERT MULTIID MAP IDNFILTER((‘OU=VeriSign Class 1 Individual
Subscriber.O=VeriSign, Inc.L=Internet’) CRITERIA(APPLID=&APPLID)…
```

Assuming these profiles also created:

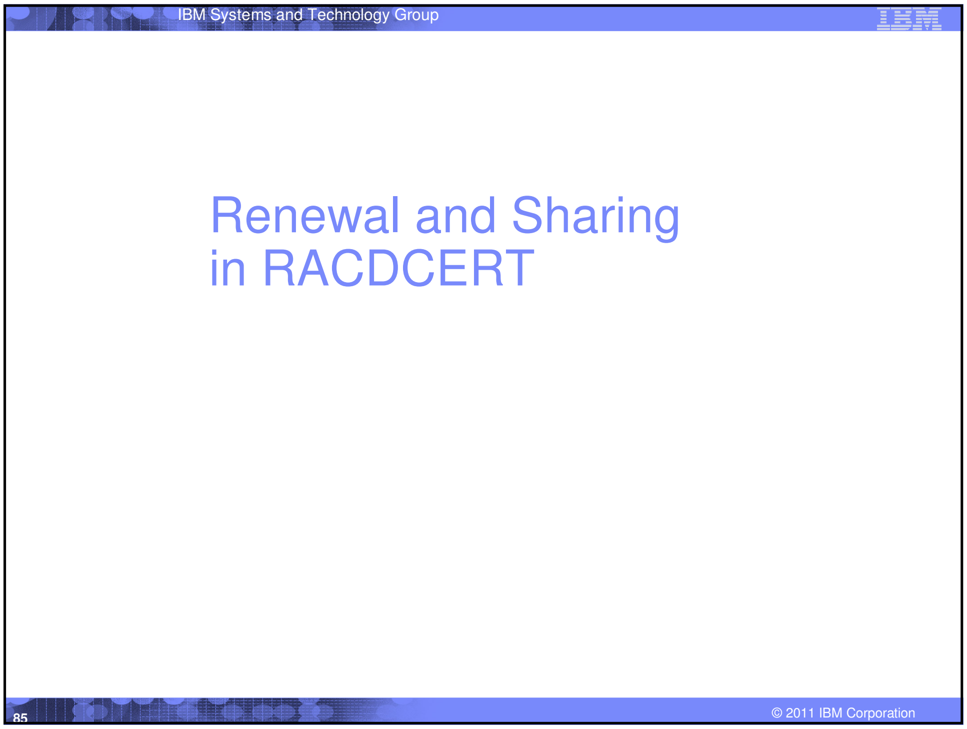
```
RDEFINE DIGTCRIT APPLID=APP1 APPLDATA(ID1)
RDEFINE DIGTCRIT APPLID=APP2 APPLDATA(ID2)
```

- **Certificate Name Filtering will be used only if the certificate is not installed in RACF**

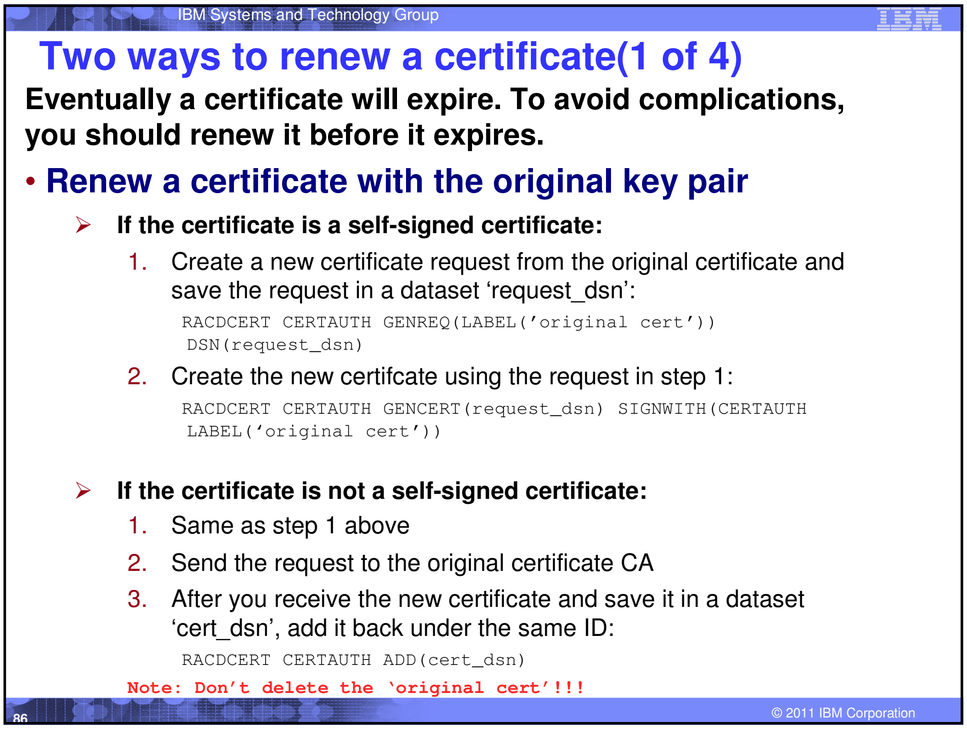


More Sophisticated Certificate Support from RACF (7 of 7)

- **Host ID Mapping**
  - **A client can present a certificate containing a HostIdMapping extension to the server**
  - **This extension contains a subject id and a host name, eg. user1@abc.com**
  - **RACF will honor this extension if**
    - **the issuing CA cert is marked HIGHTRUST**
    - **the host name in the extension matches a profile IRR.HOST.<host name> in the SERVAUTH class**
    - **The presenter of the cert has access to the above profile, eg. IRR.HOST.abc.com**
  - **The subject id, eg. user1 will then be used to access the resource**
  - **Host ID Mapping will be used only if the certificate is not installed in RACF AND there is no certificate name filter**
  - **RACDCERT can’t create this extension, PKI Services can**



Renewal and Sharing in RACDCERT



Two ways to renew a certificate(1 of 4)

Eventually a certificate will expire. To avoid complications, you should renew it before it expires.

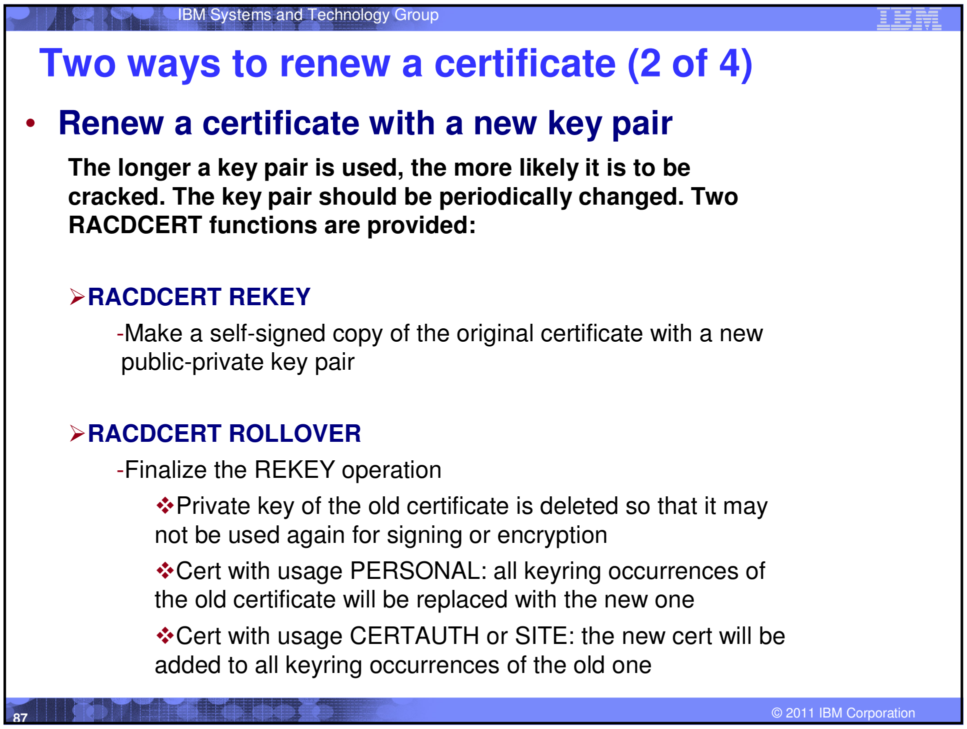
- **Renew a certificate with the original key pair**
  - **If the certificate is a self-signed certificate:**
    1. Create a new certificate request from the original certificate and save the request in a dataset ‘request_dsn’:

       ```
       RACDCERT CERTAUTH GENREQ(LABEL(’original cert’))
        DSN(request_dsn)
       ```
    2. Create the new certifcate using the request in step 1:

       ```
       RACDCERT CERTAUTH GENCERT(request_dsn) SIGNWITH(CERTAUTH
        LABEL(‘original cert’))
       ```
  - **If the certificate is not a self-signed certificate:**
    1. Same as step 1 above
    2. Send the request to the original certificate CA
    3. After you receive the new certificate and save it in a dataset ‘cert_dsn’, add it back under the same ID:

       ```
       RACDCERT CERTAUTH ADD(cert_dsn)
       ```

Note: Don’t delete the `original cert’!!!



Two ways to renew a certificate (2 of 4)

- **Renew a certificate with a new key pair**

  The longer a key pair is used, the more likely it is to be cracked. The key pair should be periodically changed. Two RACDCERT functions are provided:

  ➢**RACDCERT REKEY**

  -Make a self-signed copy of the original certificate with a new public-private key pair

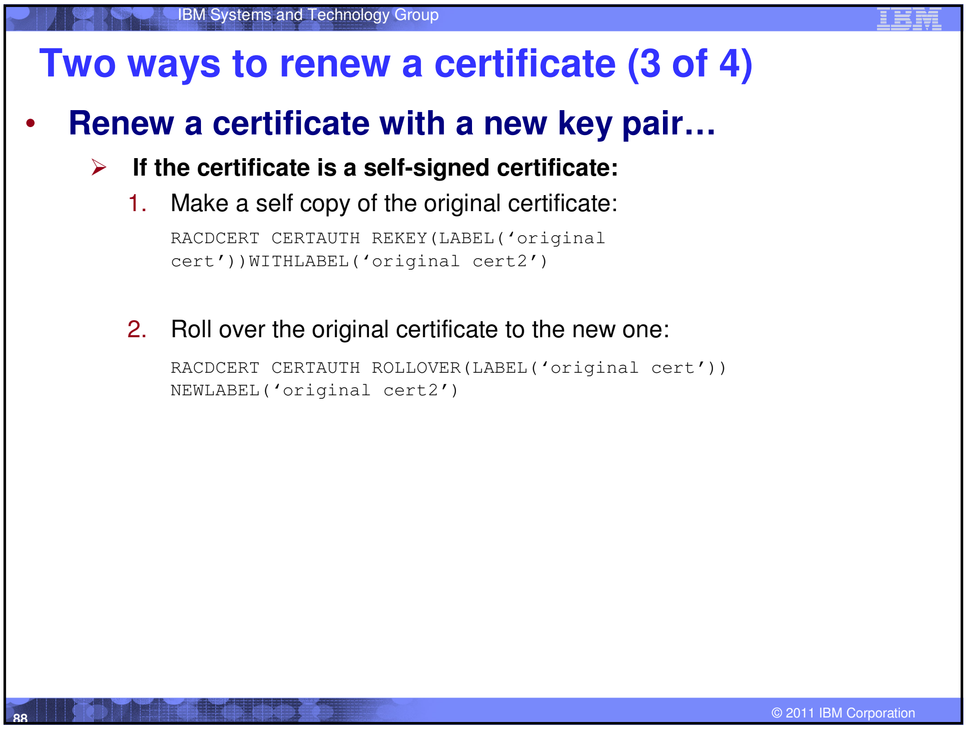
  ➢**RACDCERT ROLLOVER**

  -Finalize the REKEY operation

  ❖Private key of the old certificate is deleted so that it may not be used again for signing or encryption

  ❖Cert with usage PERSONAL: all keyring occurrences of the old certificate will be replaced with the new one

  ❖Cert with usage CERTAUTH or SITE: the new cert will be added to all keyring occurrences of the old one



Two ways to renew a certificate (3 of 4)

- **Renew a certificate with a new key pair…**

  ➢ **If the certificate is a self-signed certificate:**

  1. Make a self copy of the original certificate:

     ```
     RACDCERT CERTAUTH REKEY(LABEL(‘original
     cert’))WITHLABEL(‘original cert2’)
     ```

  2. Roll over the original certificate to the new one:

     ```
     RACDCERT CERTAUTH ROLLOVER(LABEL(‘original cert’))
     NEWLABEL(‘original cert2’)
     ```

Two ways to renew a certificate (4 of 4)

- **Renew a certificate with a new key pair…**
  - **If the certificate is not a self-signed certificate:**
    1. Make a self copy of the original certificate

       ```
       RACDCERT ID(myid) REKEY(LABEL(‘original cert’))
       WITHLABEL(‘original cert2’)
       ```
    2. Create a certificate request from the copied certificate in step 1:

       ```
       RACDCERT ID(myid) GENREQ(LABEL(’original
       cert2’)) DSN(request_dsn)
       ```
    3. Send the request to the original certificate CA
    4. After you receive the new certificate and save it in a dataset ‘cert_dsn’, add it back under the same ID:

       ```
       RACDCERT ID(myid) ADD(cert_dsn)
       ```
    5. Roll over the original certificate to the new one:

       ```
       RACDCERT ID(myid) ROLLOVER(LABEL(‘original
       cert’)) NEWLABEL(‘original cert2’)
       ```

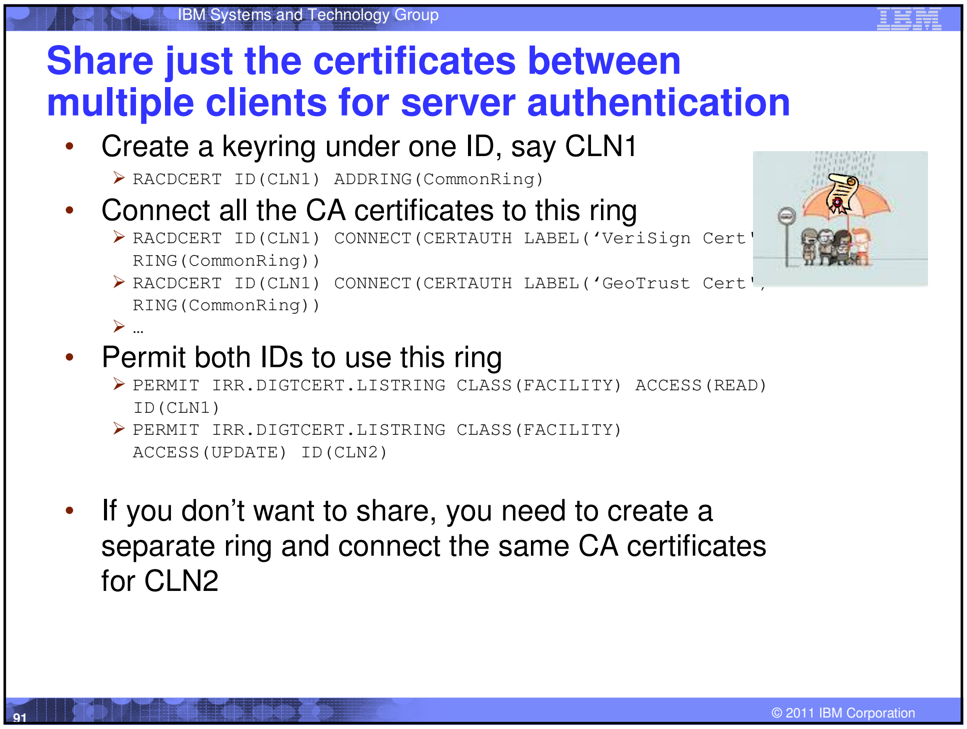
Share keyring, certificate, private key?

✓ ✗

Share keyring ===>Share certificate===>Share private key

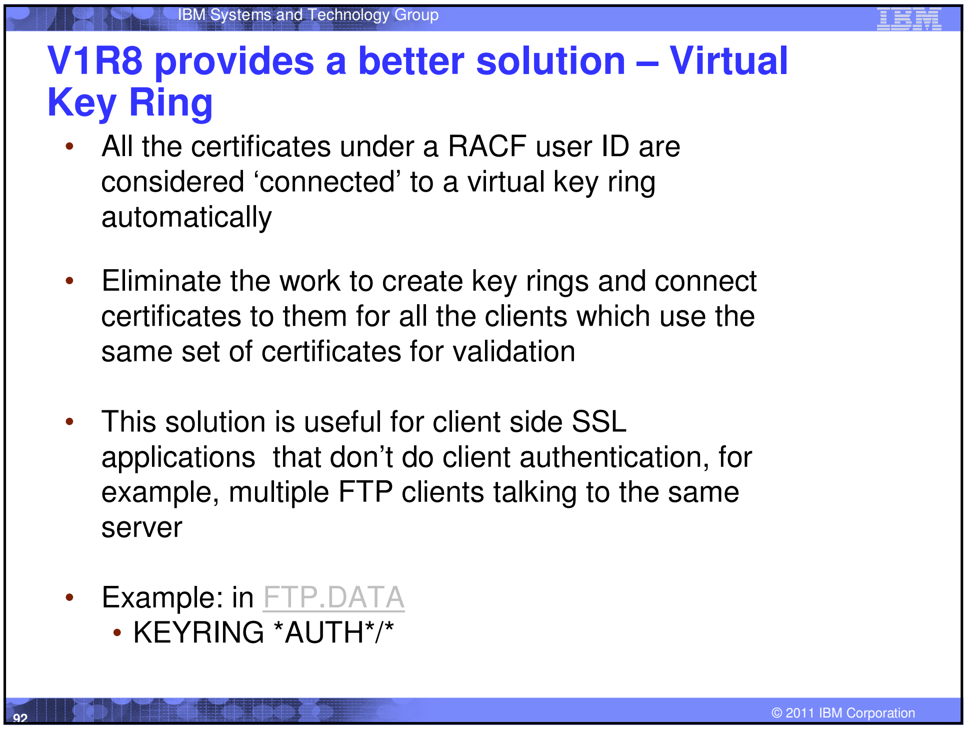
- You may share a keyring and hence its content (certificates) amongst different IDs by giving permission to IRR.DIGTCERT.LISTRING
  - eg. Set up client A, B, C…for server authentication *(remember the quiz: no private key is involved in the client side)*

- Sharing private key is not recommended, but in case you really want to …eg. Avoid buying a separate certificate for another server or client, there is a way



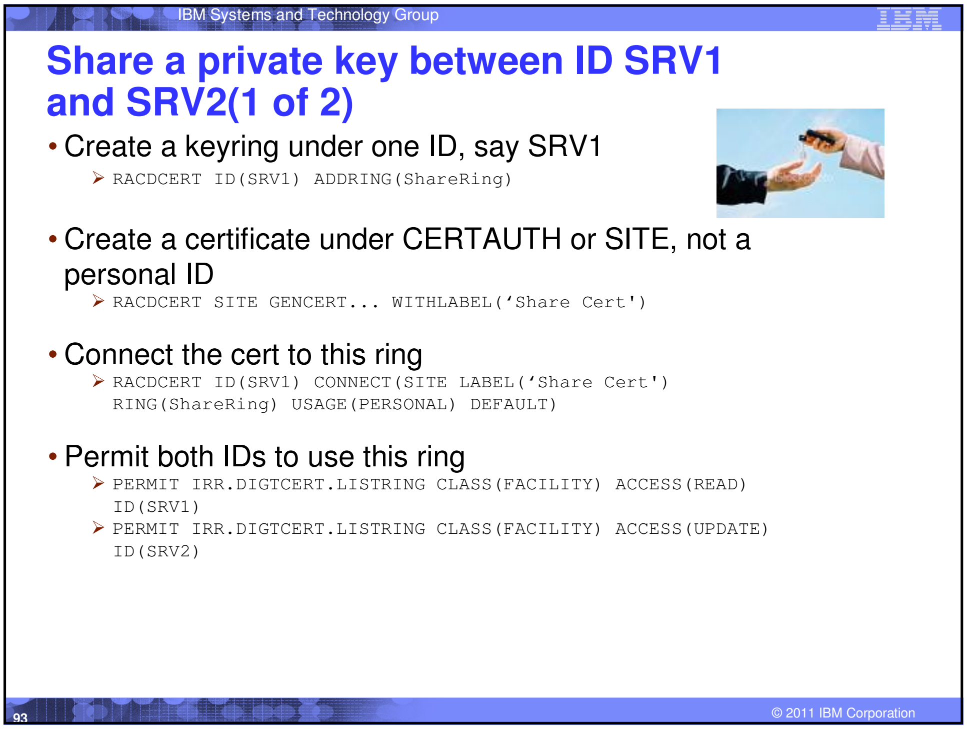
Share just the certificates between multiple clients for server authentication

- Create a keyring under one ID, say CLN1
  - ➢ `RACDCERT ID(CLN1) ADDRING(CommonRing)`
- Connect all the CA certificates to this ring
  - ➢ `RACDCERT ID(CLN1) CONNECT(CERTAUTH LABEL('VeriSign Cert' RING(CommonRing))`
  - ➢ `RACDCERT ID(CLN1) CONNECT(CERTAUTH LABEL('GeoTrust Cert', RING(CommonRing))`
  - ➢ …
- Permit both IDs to use this ring
  - ➢ `PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ACCESS(READ) ID(CLN1)`
  - ➢ `PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ACCESS(UPDATE) ID(CLN2)`
- If you don't want to share, you need to create a separate ring and connect the same CA certificates for CLN2



V1R8 provides a better solution – Virtual Key Ring

- All the certificates under a RACF user ID are considered 'connected' to a virtual key ring automatically
- Eliminate the work to create key rings and connect certificates to them for all the clients which use the same set of certificates for validation
- This solution is useful for client side SSL applications that don't do client authentication, for example, multiple FTP clients talking to the same server
- Example: in FTP.DATA
  - KEYRING *AUTH*/*



Share a private key between ID SRV1 and SRV2(1 of 2)

- Create a keyring under one ID, say SRV1

```
➢ RACDCERT ID(SRV1) ADDRING(ShareRing)
```

- Create a certificate under CERTAUTH or SITE, not a personal ID

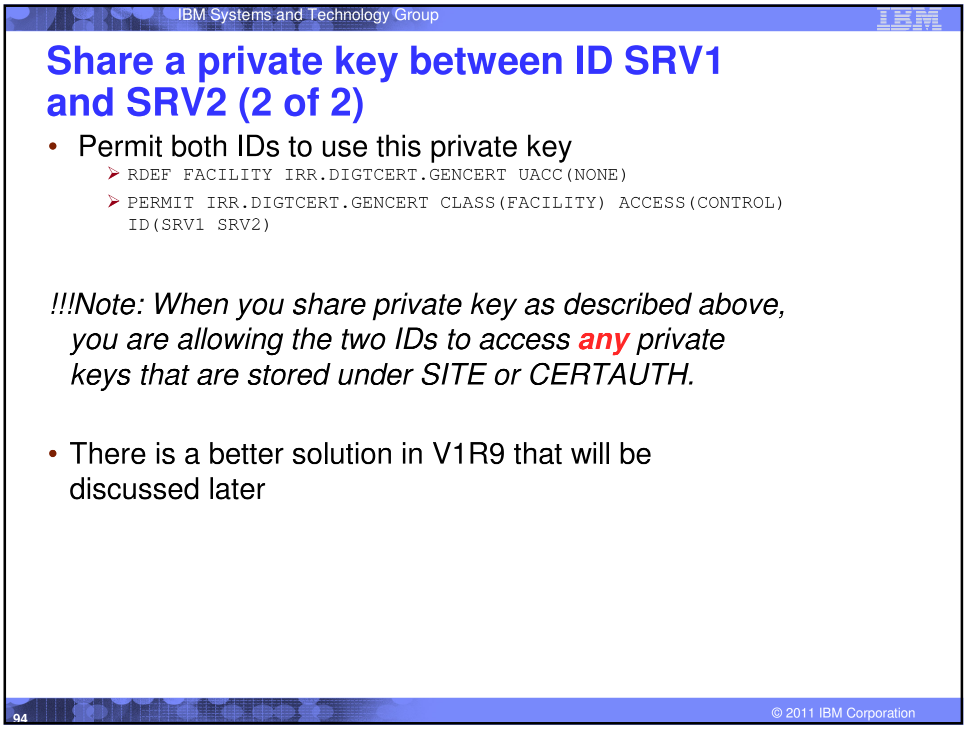
```
➢ RACDCERT SITE GENCERT... WITHLABEL(‘Share Cert')
```

- Connect the cert to this ring

```
➢ RACDCERT ID(SRV1) CONNECT(SITE LABEL(‘Share Cert')
  RING(ShareRing) USAGE(PERSONAL) DEFAULT)
```

- Permit both IDs to use this ring

```
➢ PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ACCESS(READ)
  ID(SRV1)
➢ PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ACCESS(UPDATE)
  ID(SRV2)
```



Share a private key between ID SRV1 and SRV2 (2 of 2)

- Permit both IDs to use this private key

```
➢ RDEF FACILITY IRR.DIGTCERT.GENCERT UACC(NONE)
➢ PERMIT IRR.DIGTCERT.GENCERT CLASS(FACILITY) ACCESS(CONTROL)
  ID(SRV1 SRV2)
```

*!!!Note: When you share private key as described above, you are allowing the two IDs to access **any** private keys that are stored under SITE or CERTAUTH.*

- There is a better solution in V1R9 that will be discussed later

V1R9 provides another solution – Granular access control on Key Ring

- Access is based on a profile of a specific key ring in a new class called RDATALIB
- The class RDATALIB must be RACLISTed
- A resource with the format <ringOwner>.<ringName>.LST is used to provide access control to a specific key ring on R_datalib READ functions
- This new support also allows the retrieval of another person's private key
- So instead of giving access to all the rings
  - PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ACCESS(UPDATE) ID(CLN2)
- Just give access to that particular ring
  - PERMIT CLN1.COMMONRING.LST CLASS(RDATALIB) ACCESS(READ) ID(CLN2)
- If you want to share the private key, then
  - PERMIT CLN1.COMMONRING.LST CLASS(RDATALIB) ACCESS(UPDATE) ID(CLN2)

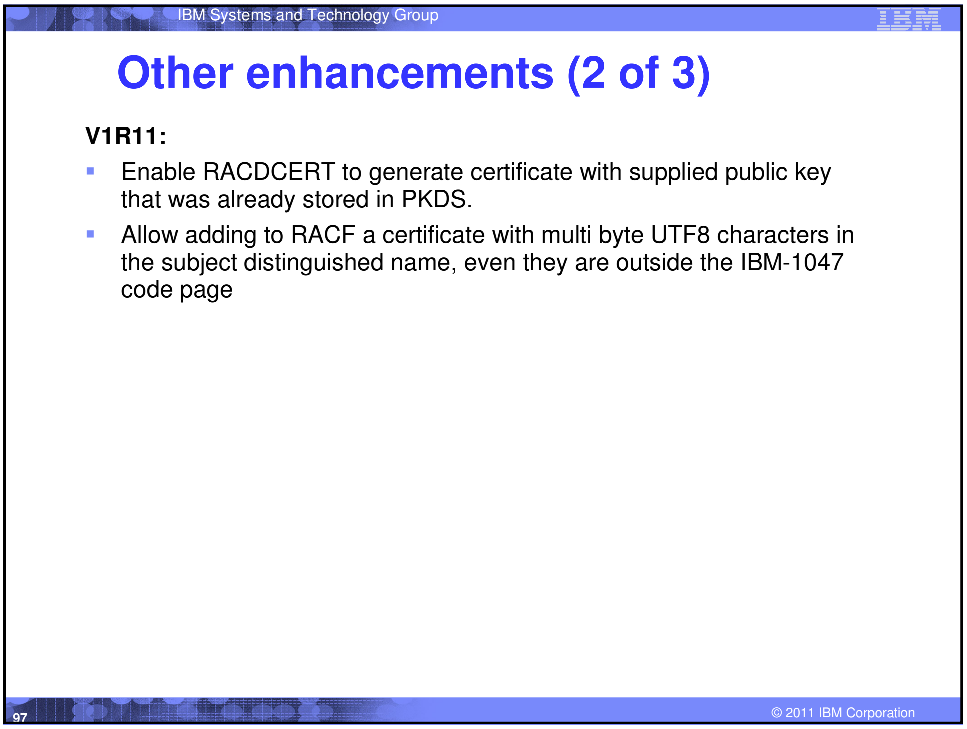
Other enhancements(1 of 3)

V1R9:

- Provide new R_datalib functions to create/delete key ring, add/delete certificate to/from RACF and connect/remove certificate from key ring
- Allow adding to RACF a certificate with multi byte UTF8 characters in the subject distinguished name, as long as they can be converted to characters in the IBM-1047 code page

V1R10:

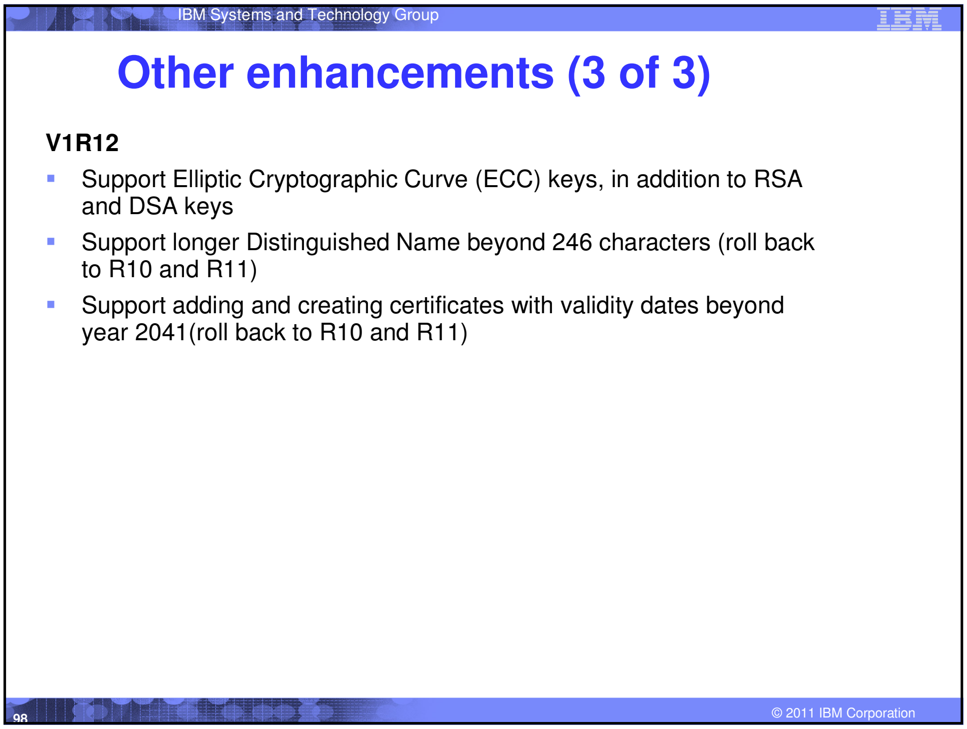
- Enable RACDCERT to generate, install certificates with 4096 bits RSA key
- Support Alternate Name extension with IPv6 format



Other enhancements (2 of 3)

V1R11:

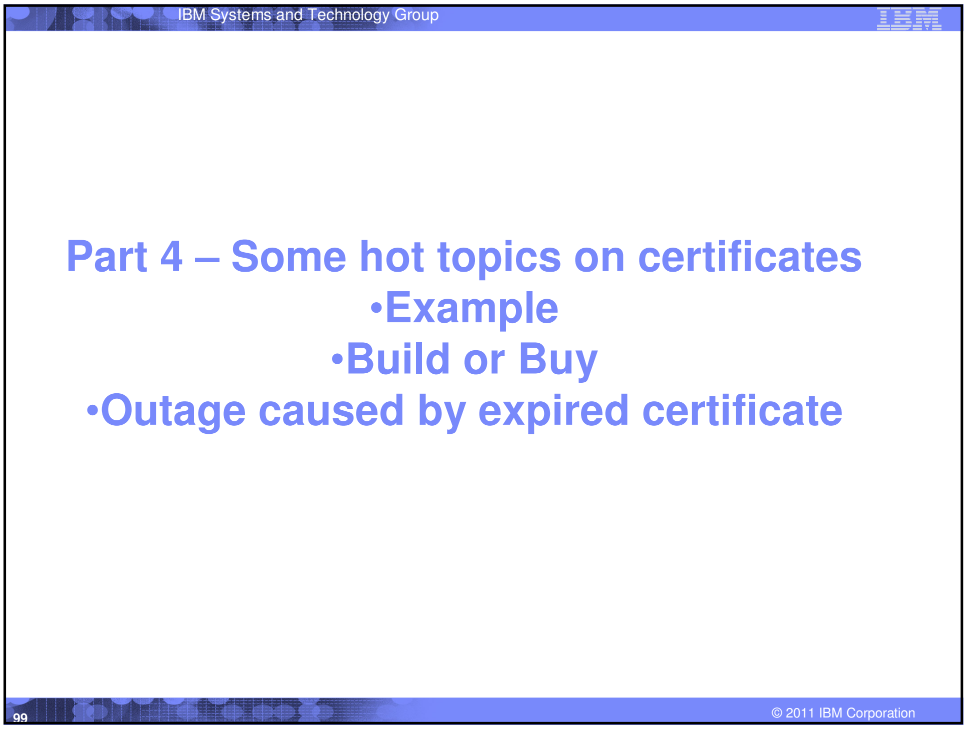
- Enable RACDCERT to generate certificate with supplied public key that was already stored in PKDS.
- Allow adding to RACF a certificate with multi byte UTF8 characters in the subject distinguished name, even they are outside the IBM-1047 code page



Other enhancements (3 of 3)

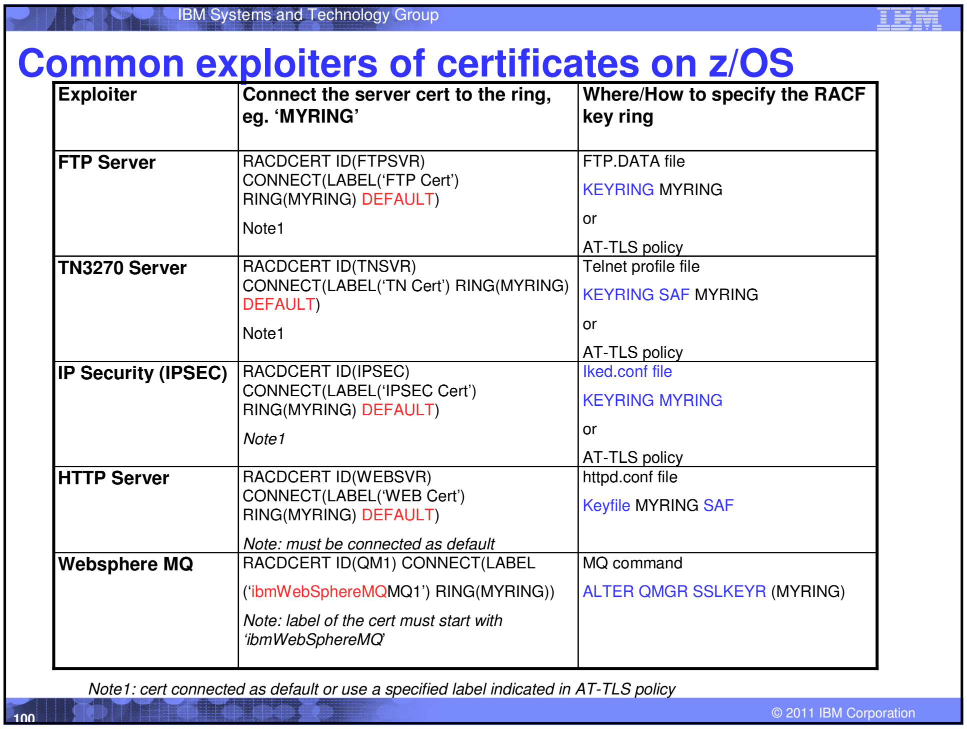
V1R12

- Support Elliptic Cryptographic Curve (ECC) keys, in addition to RSA and DSA keys
- Support longer Distinguished Name beyond 246 characters (roll back to R10 and R11)
- Support adding and creating certificates with validity dates beyond year 2041(roll back to R10 and R11)



Part 4 – Some hot topics on certificates

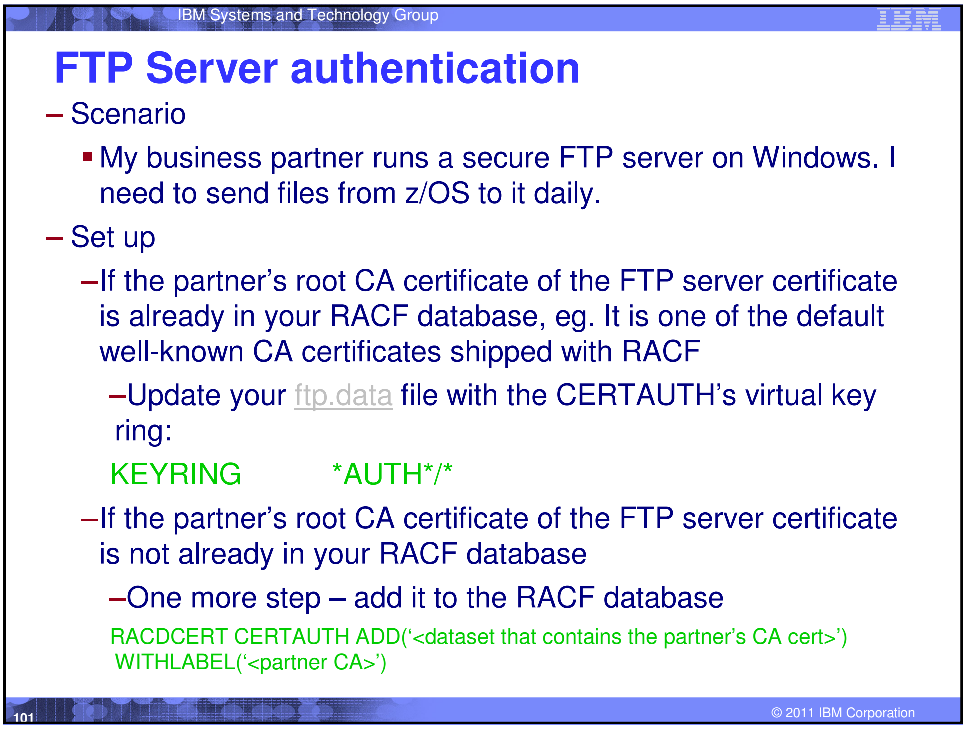
- •Example
- •Build or Buy
- •Outage caused by expired certificate



Common exploiters of certificates on z/OS

Exploiter	Connect the server cert to the ring, eg. 'MYRING'	Where/How to specify the RACF key ring
FTP Server	RACDCERT ID(FTPSVR) CONNECT(LABEL('FTP Cert') RING(MYRING) DEFAULT) Note1	FTP.DATA file KEYRING MYRING or AT-TLS policy
TN3270 Server	RACDCERT ID(TNSVR) CONNECT(LABEL('TN Cert') RING(MYRING) DEFAULT) Note1	Telnet profile file KEYRING SAF MYRING or AT-TLS policy
IP Security (IPSEC)	RACDCERT ID(IPSEC) CONNECT(LABEL('IPSEC Cert') RING(MYRING) DEFAULT) *Note1*	Iked.conf file KEYRING MYRING or AT-TLS policy
HTTP Server	RACDCERT ID(WEBSVR) CONNECT(LABEL('WEB Cert') RING(MYRING) DEFAULT) *Note: must be connected as default*	httpd.conf file Keyfile MYRING SAF
Websphere MQ	RACDCERT ID(QM1) CONNECT(LABEL ('ibmWebSphereMQMQ1') RING(MYRING)) *Note: label of the cert must start with 'ibmWebSphereMQ'*	MQ command ALTER QMGR SSLKEYR (MYRING)

Note1: cert connected as default or use a specified label indicated in AT-TLS policy



FTP Server authentication

– Scenario

- My business partner runs a secure FTP server on Windows. I need to send files from z/OS to it daily.

– Set up

–If the partner's root CA certificate of the FTP server certificate is already in your RACF database, eg. It is one of the default well-known CA certificates shipped with RACF

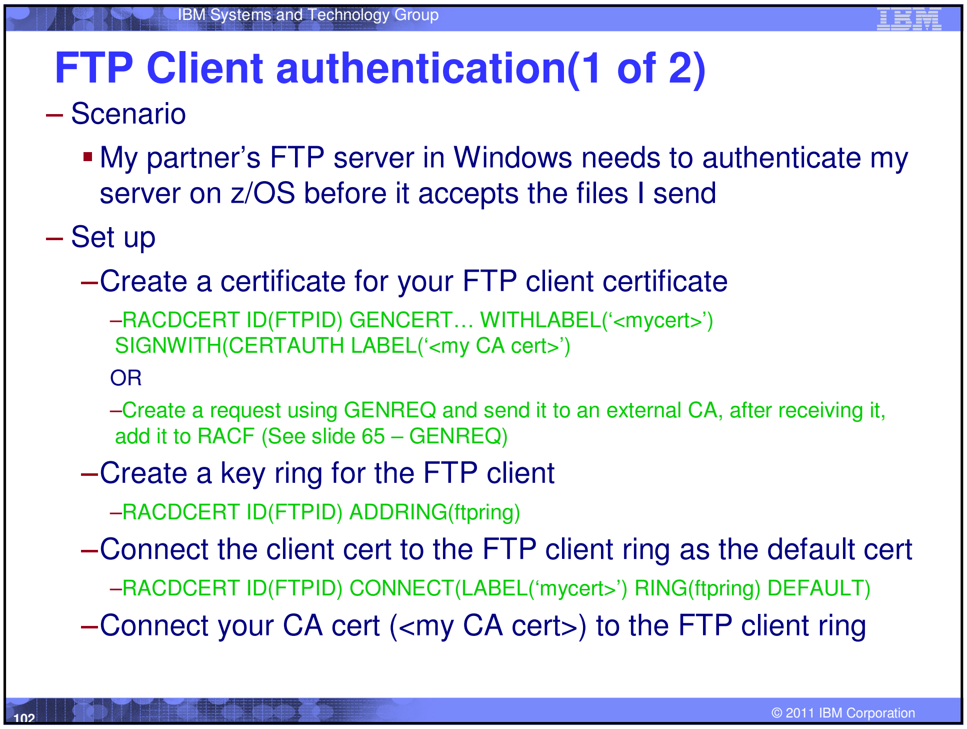
–Update your ftp.data file with the CERTAUTH's virtual key ring:

```
KEYRING          *AUTH*/*
```

–If the partner's root CA certificate of the FTP server certificate is not already in your RACF database

–One more step – add it to the RACF database

```
RACDCERT CERTAUTH ADD('<dataset that contains the partner's CA cert>')
 WITHLABEL('<partner CA>')
```



FTP Client authentication(1 of 2)

– Scenario

- My partner's FTP server in Windows needs to authenticate my server on z/OS before it accepts the files I send

– Set up

–Create a certificate for your FTP client certificate

–RACDCERT ID(FTPID) GENCERT… WITHLABEL('<mycert>') SIGNWITH(CERTAUTH LABEL('<my CA cert>')

OR

–Create a request using GENREQ and send it to an external CA, after receiving it, add it to RACF (See slide 65 – GENREQ)

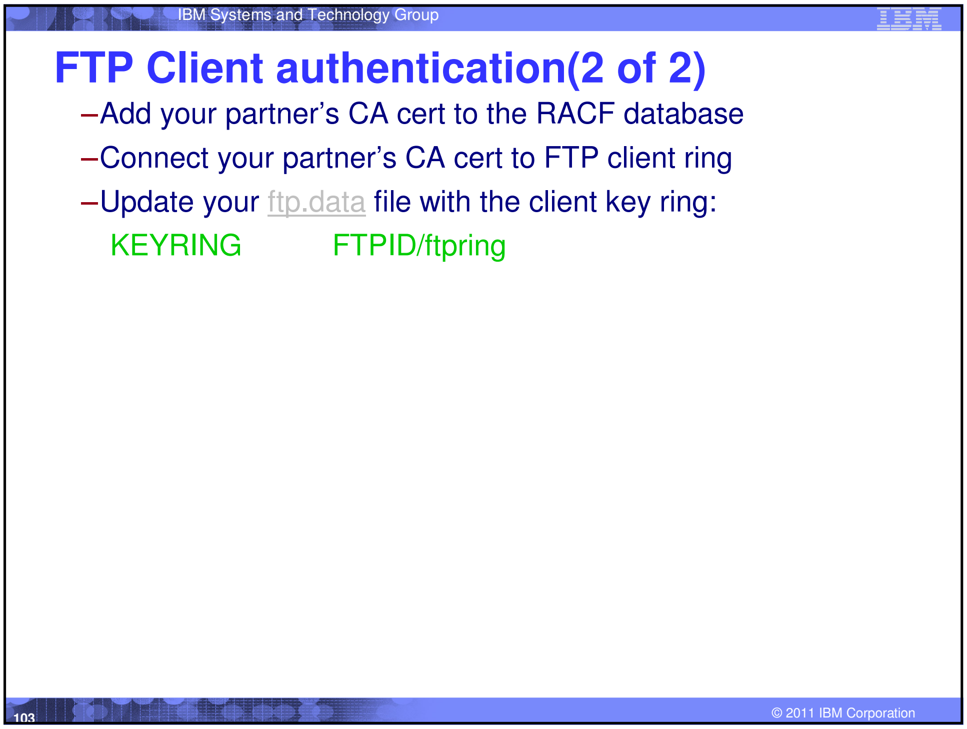
–Create a key ring for the FTP client

–RACDCERT ID(FTPID) ADDRING(ftpring)

–Connect the client cert to the FTP client ring as the default cert

–RACDCERT ID(FTPID) CONNECT(LABEL('mycert>') RING(ftpring) DEFAULT)

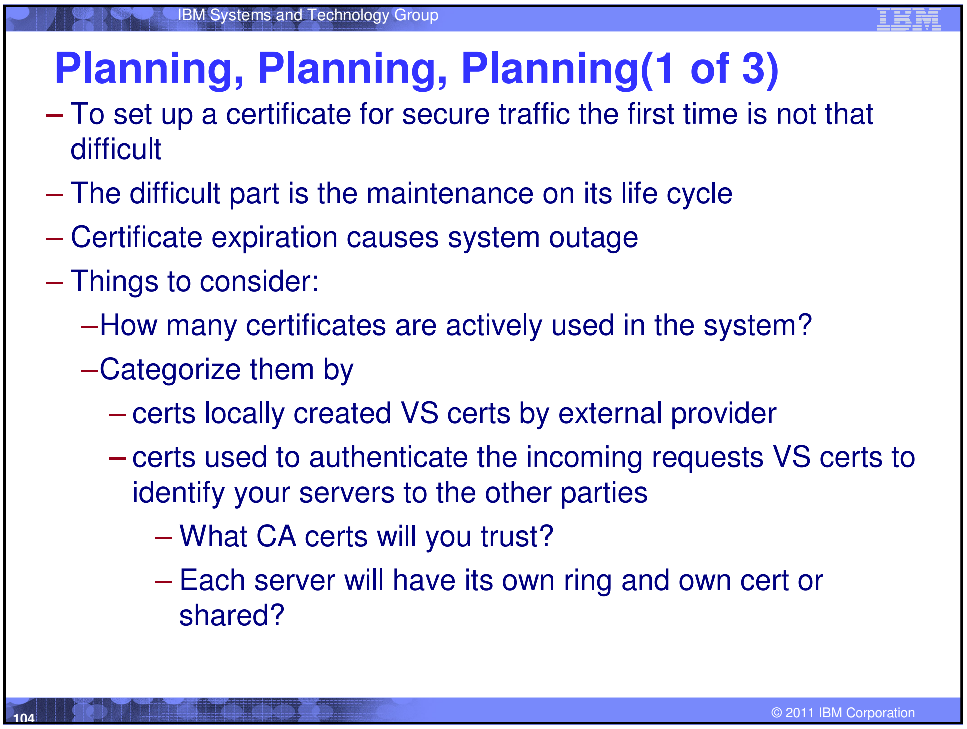
–Connect your CA cert (<my CA cert>) to the FTP client ring



FTP Client authentication(2 of 2)

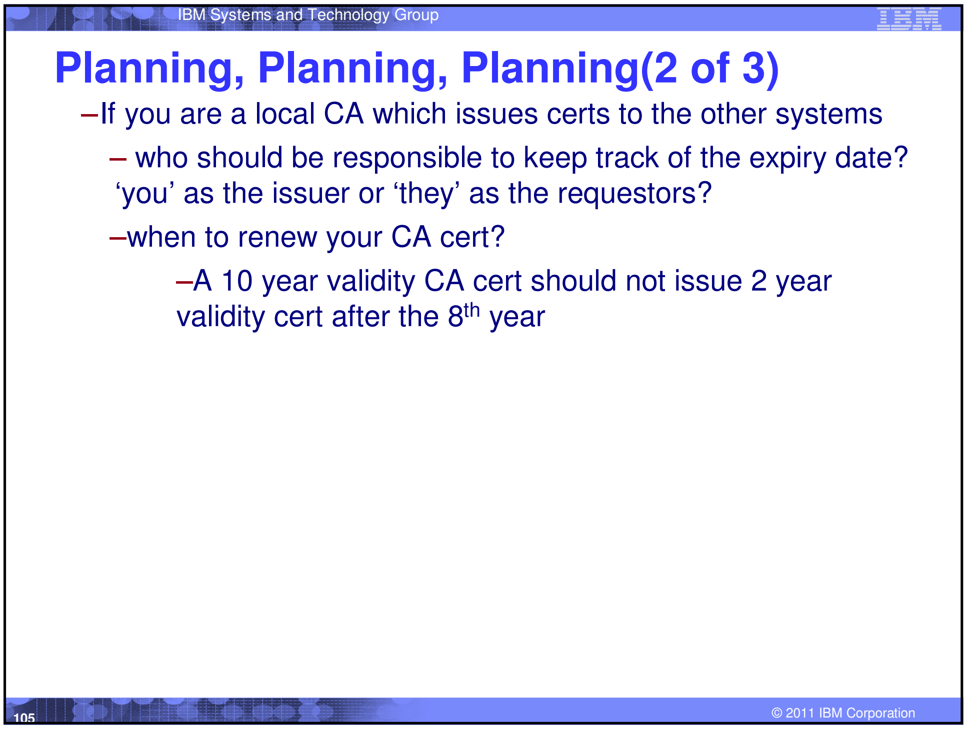
- Add your partner’s CA cert to the RACF database
- Connect your partner’s CA cert to FTP client ring
- Update your ftp.data file with the client key ring:

```
KEYRING          FTPID/ftpring
```



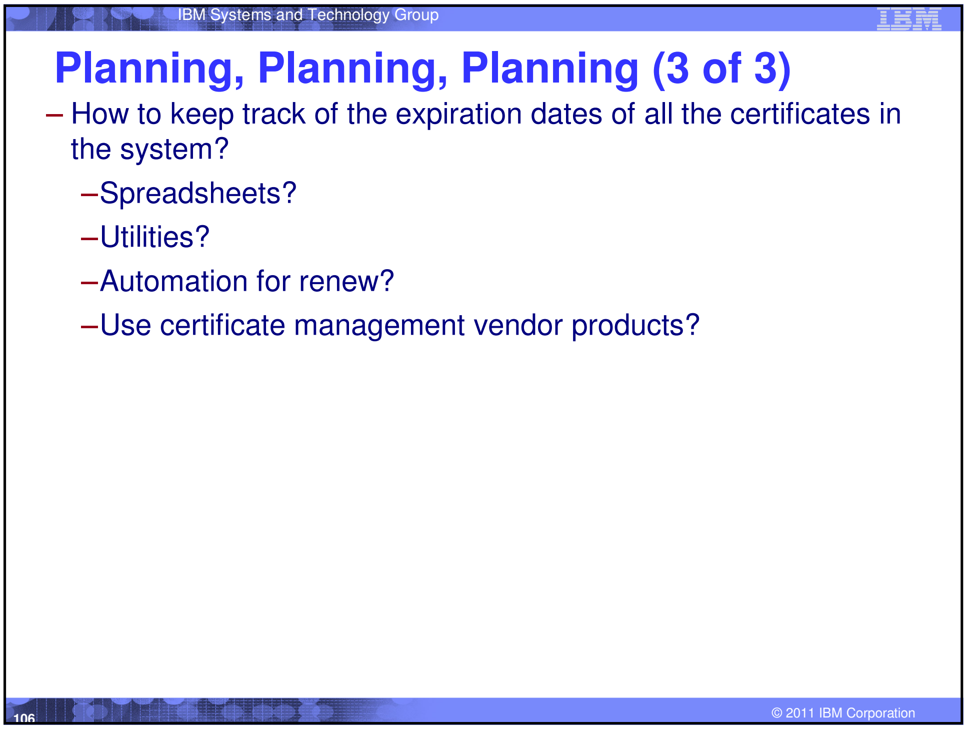
Planning, Planning, Planning(1 of 3)

- To set up a certificate for secure traffic the first time is not that difficult
- The difficult part is the maintenance on its life cycle
- Certificate expiration causes system outage
- Things to consider:
  - How many certificates are actively used in the system?
  - Categorize them by
    - certs locally created VS certs by external provider
    - certs used to authenticate the incoming requests VS certs to identify your servers to the other parties
      - What CA certs will you trust?
      - Each server will have its own ring and own cert or shared?



Planning, Planning, Planning(2 of 3)

- If you are a local CA which issues certs to the other systems
  - who should be responsible to keep track of the expiry date? ‘you’ as the issuer or ‘they’ as the requestors?
  - when to renew your CA cert?
    - A 10 year validity CA cert should not issue 2 year validity cert after the 8th year

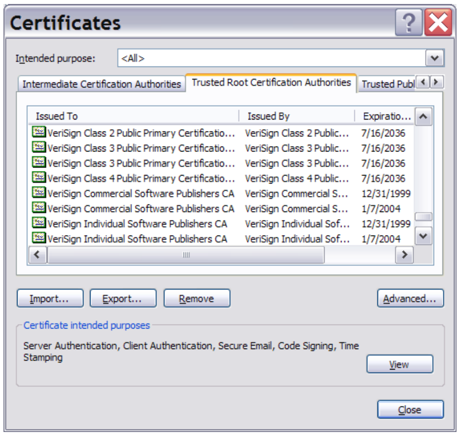


Planning, Planning, Planning (3 of 3)

- How to keep track of the expiration dates of all the certificates in the system?
  - Spreadsheets?
  - Utilities?
  - Automation for renew?
  - Use certificate management vendor products?

Build or Buy? (1 of 2)

- Who will be validating your certificate?
  - Global internet customers
    - Easier to buy from a well known CA since it is already installed in the browsers’ certificate store



Certificates

Intended purpose: <All>

Intermediate Certification Authorities | Trusted Root Certification Authorities | Trusted Publ

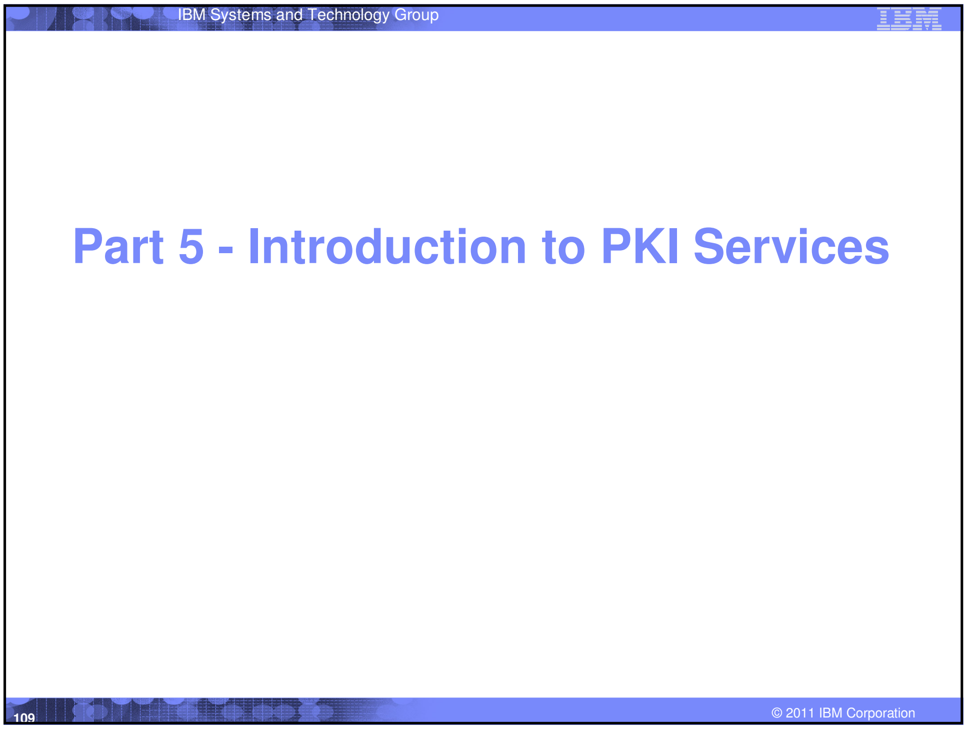
Issued To	Issued By	Expiratio...
VeriSign Class 2 Public Primary Certificatio...	VeriSign Class 2 Public...	7/16/2036
VeriSign Class 3 Public Primary Certificatio...	VeriSign Class 3 Public...	7/16/2036
VeriSign Class 3 Public Primary Certificatio...	VeriSign Class 3 Public...	7/16/2036
VeriSign Class 4 Public Primary Certificatio...	VeriSign Class 4 Public...	7/16/2036
VeriSign Commercial Software Publishers CA	VeriSign Commercial S...	12/31/1999
VeriSign Commercial Software Publishers CA	VeriSign Commercial S...	1/7/2004
VeriSign Individual Software Publishers CA	VeriSign Individual Sof...	12/31/1999
VeriSign Individual Software Publishers CA	VeriSign Individual Sof...	1/7/2004

Certificate intended purposes

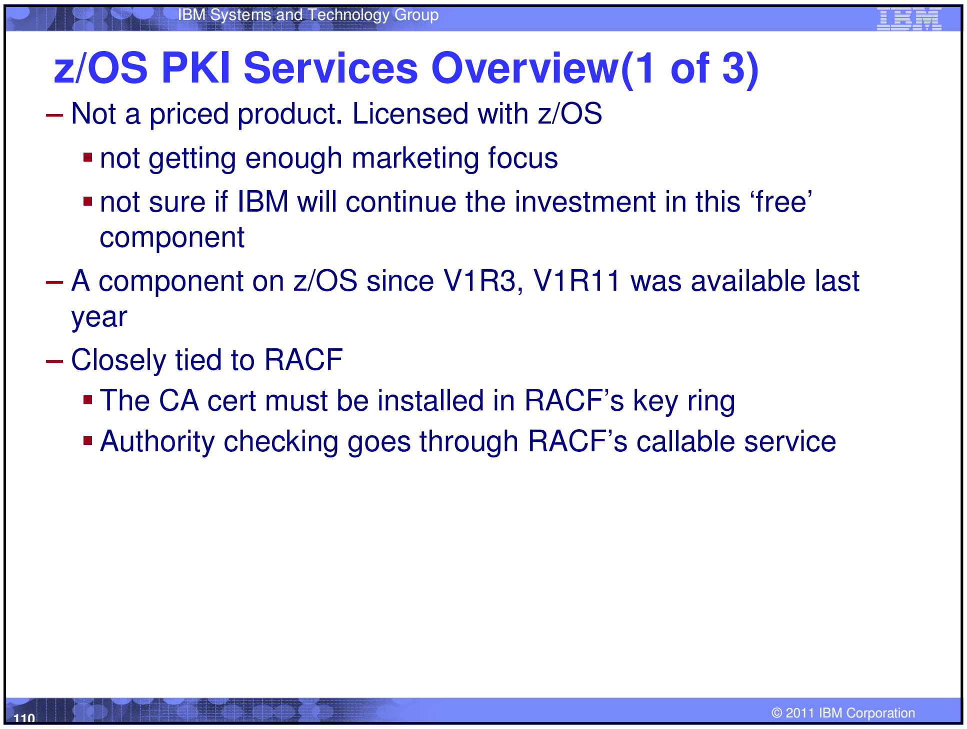
Server Authentication, Client Authentication, Secure Email, Code Signing, Time Stamping

Build or Buy? (2 of 2)

- Internal servers, employees
  - Build your own since you can have the internal CA certs distributed easily
- Business partners
  - Either way
  - If you already built a trust relationship with the partners, there should be no problem for them to install your CA cert

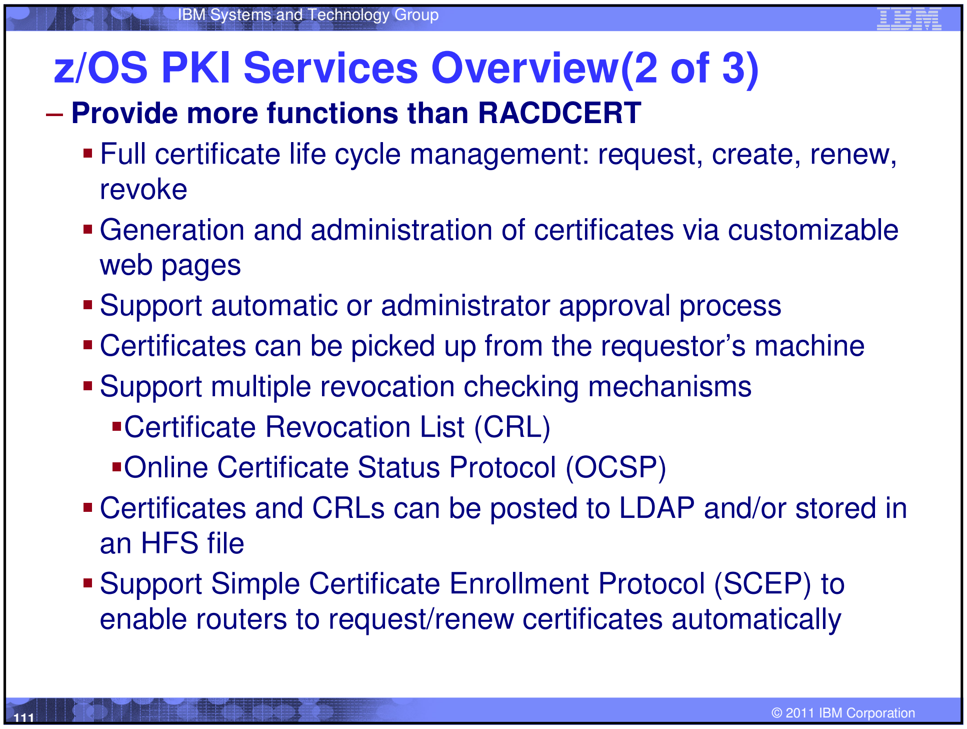


Part 5 - Introduction to PKI Services



z/OS PKI Services Overview(1 of 3)

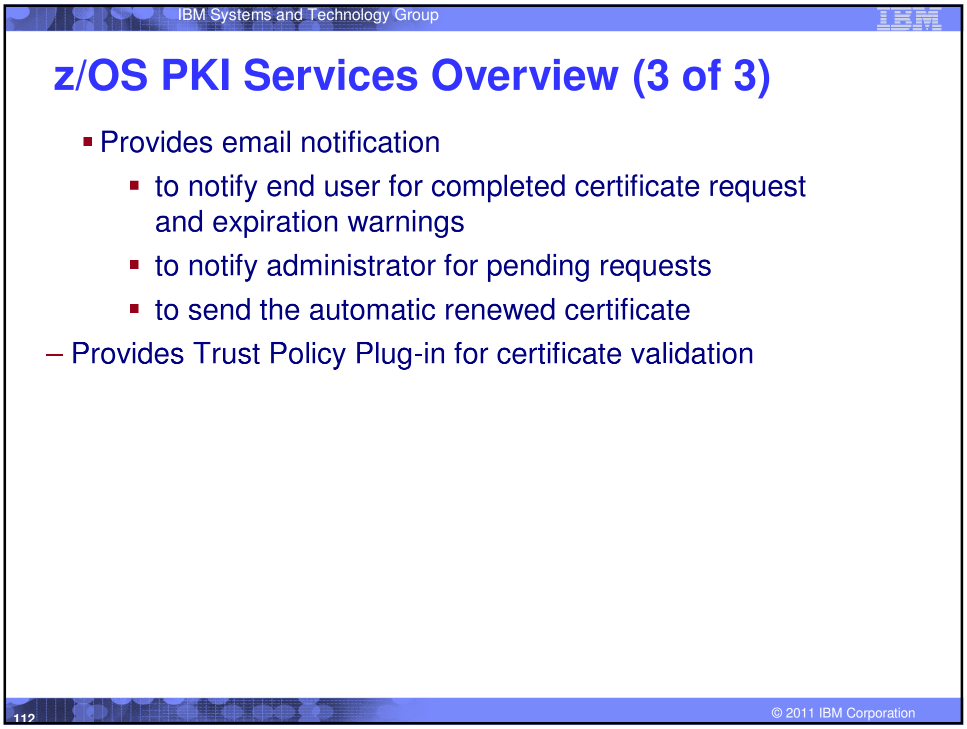
- Not a priced product. Licensed with z/OS
  - not getting enough marketing focus
  - not sure if IBM will continue the investment in this ‘free’ component
- A component on z/OS since V1R3, V1R11 was available last year
- Closely tied to RACF
  - The CA cert must be installed in RACF’s key ring
  - Authority checking goes through RACF’s callable service



z/OS PKI Services Overview(2 of 3)

– **Provide more functions than RACDCERT**

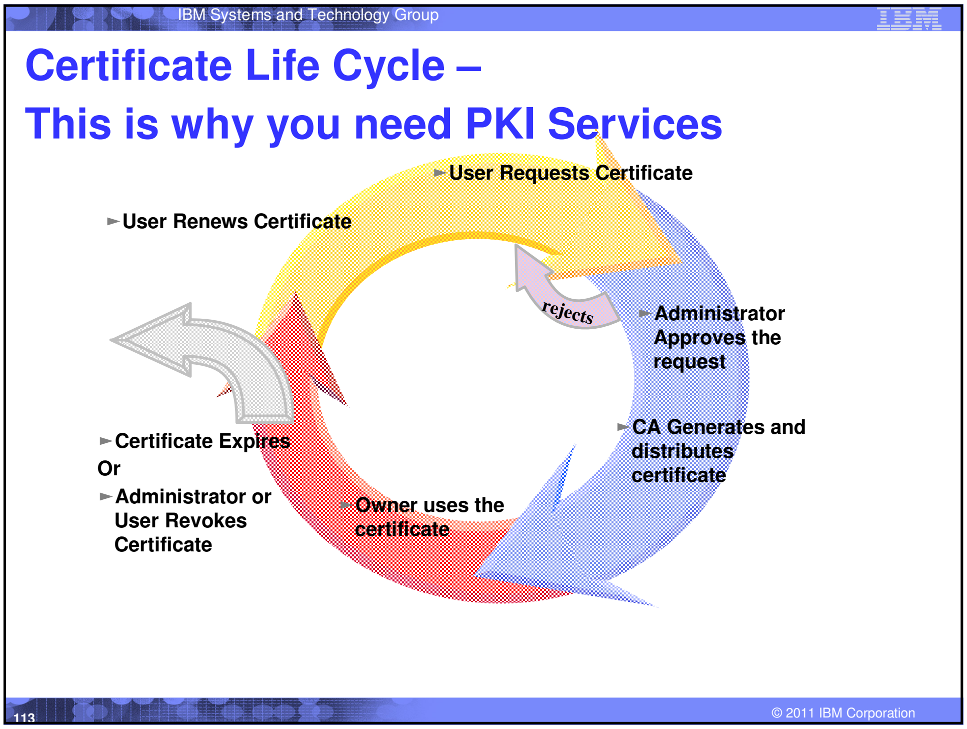
- Full certificate life cycle management: request, create, renew, revoke
- Generation and administration of certificates via customizable web pages
- Support automatic or administrator approval process
- Certificates can be picked up from the requestor’s machine
- Support multiple revocation checking mechanisms
  - Certificate Revocation List (CRL)
  - Online Certificate Status Protocol (OCSP)
- Certificates and CRLs can be posted to LDAP and/or stored in an HFS file
- Support Simple Certificate Enrollment Protocol (SCEP) to enable routers to request/renew certificates automatically



z/OS PKI Services Overview (3 of 3)

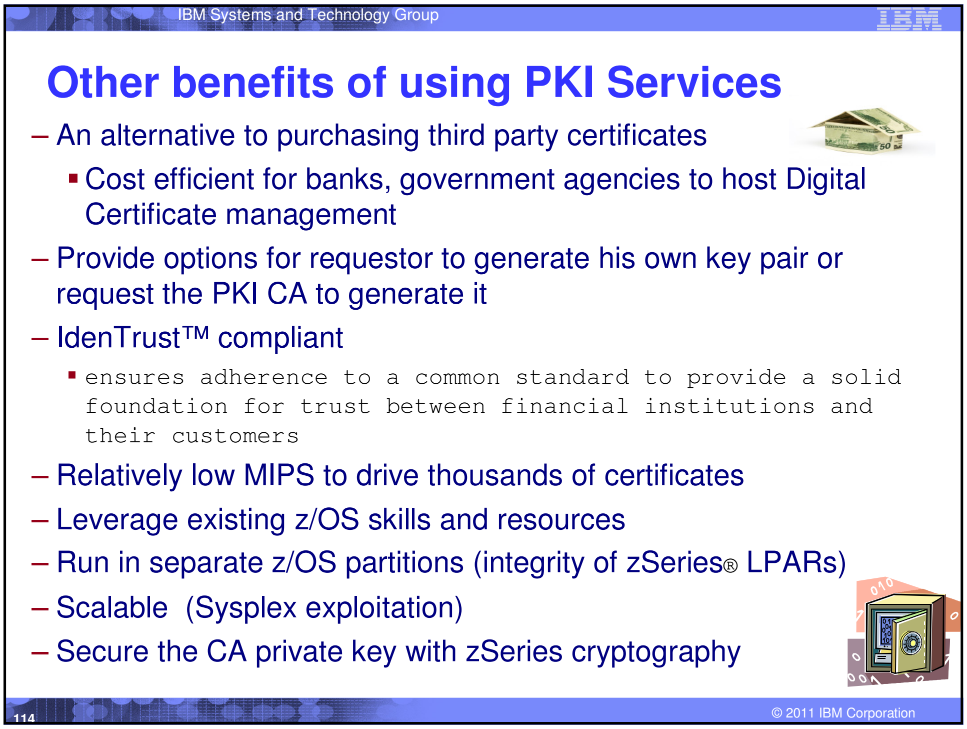
- Provides email notification
  - to notify end user for completed certificate request and expiration warnings
  - to notify administrator for pending requests
  - to send the automatic renewed certificate

– Provides Trust Policy Plug-in for certificate validation



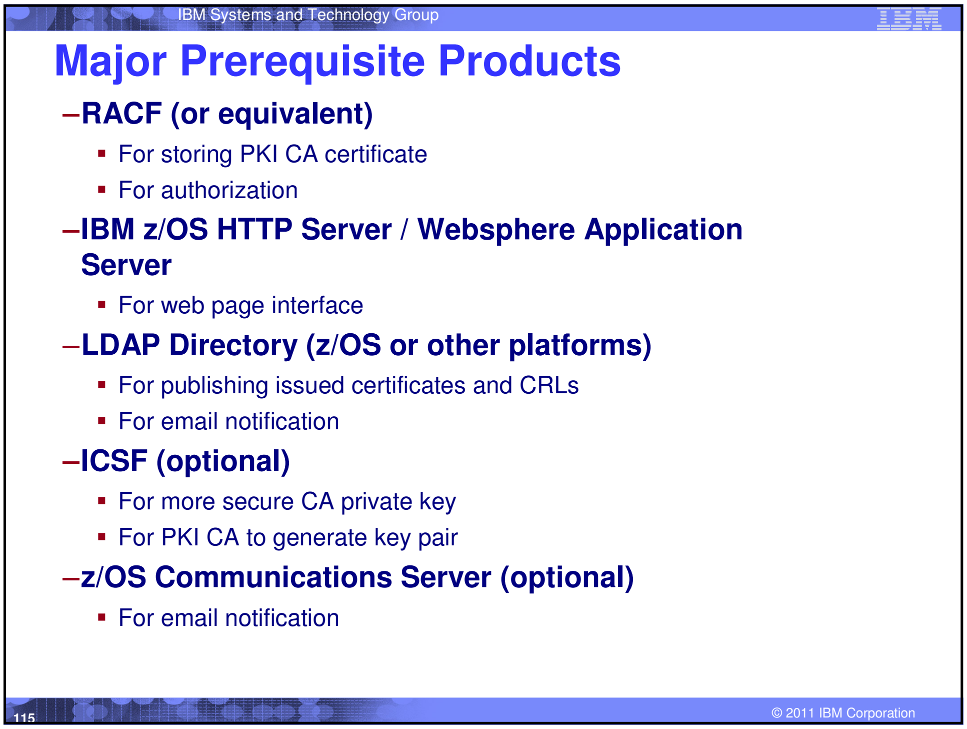
Certificate Life Cycle – This is why you need PKI Services

►User Requests Certificate
►User Renews Certificate
rejects
►Administrator Approves the request
►CA Generates and distributes certificate
►Owner uses the certificate
►Certificate Expires
Or
►Administrator or User Revokes Certificate



Other benefits of using PKI Services

- An alternative to purchasing third party certificates
  - Cost efficient for banks, government agencies to host Digital Certificate management
- Provide options for requestor to generate his own key pair or request the PKI CA to generate it
- IdenTrust™ compliant
  - ensures adherence to a common standard to provide a solid foundation for trust between financial institutions and their customers
- Relatively low MIPS to drive thousands of certificates
- Leverage existing z/OS skills and resources
- Run in separate z/OS partitions (integrity of zSeries® LPARs)
- Scalable (Sysplex exploitation)
- Secure the CA private key with zSeries cryptography



Major Prerequisite Products

–RACF (or equivalent)

- For storing PKI CA certificate
- For authorization

–IBM z/OS HTTP Server / Websphere Application Server

- For web page interface

–LDAP Directory (z/OS or other platforms)

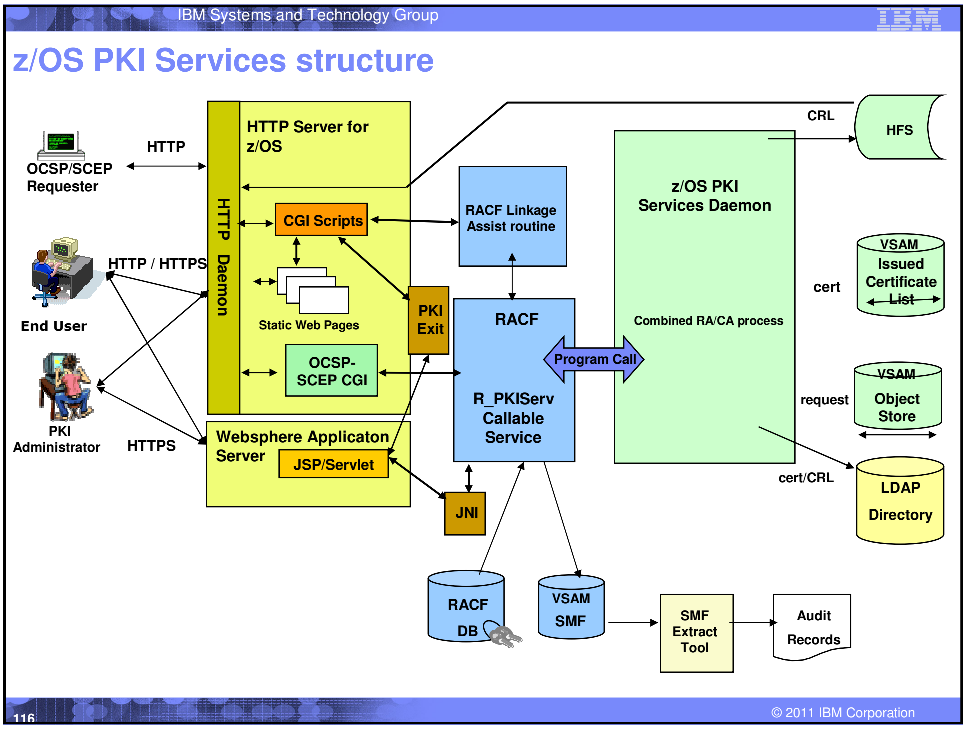
- For publishing issued certificates and CRLs
- For email notification

–ICSF (optional)

- For more secure CA private key
- For PKI CA to generate key pair

–z/OS Communications Server (optional)

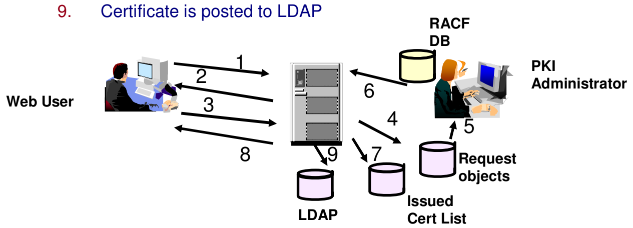
- For email notification



z/OS PKI Services structure

z/OS PKI Services Process Flow – a simplified sample view

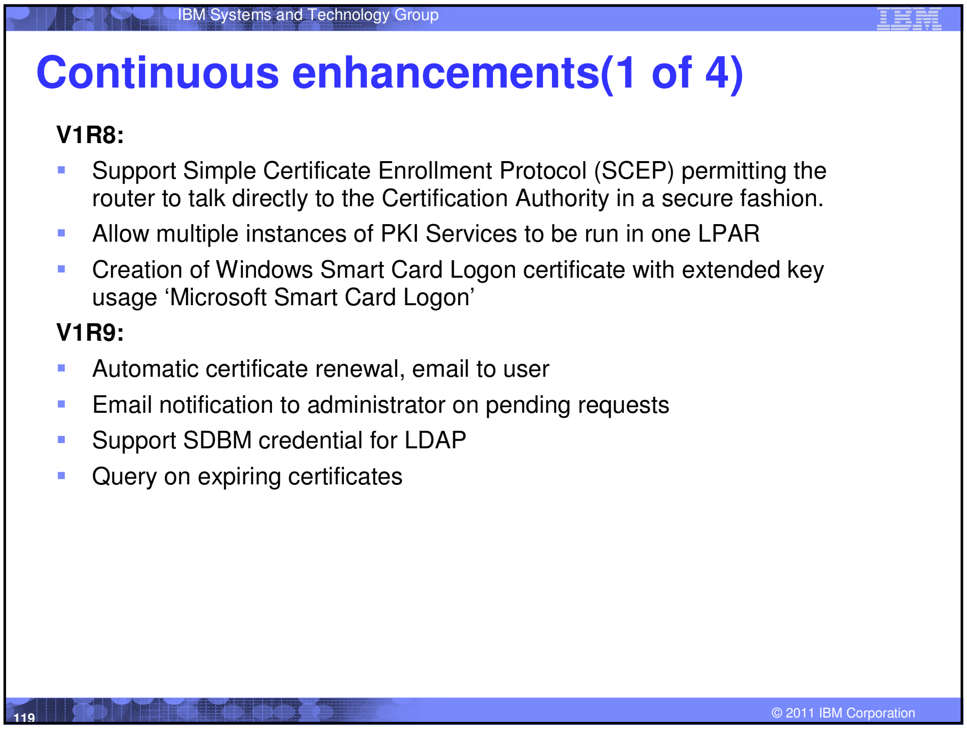
1. User contacts PKI Services to request for certificate
2. CGI/JSP constructs a web page for user to input information
3. CGI/JSP packages all the info and send to the callable service
4. Callable service calls the daemon to generate the request object and put it in the Request objects DB
5. Administrator approves the request through the administrator web page
6. CGI/JSP calls callable service which in turn calls the daemon to create the certificate, sign with the CA key in the RACF DB
7. Certificate is placed in the Issued Cert List DB
8. Certificate is sent to the user
9. Certificate is posted to LDAP



Customization

- **Configuaration file** - pkiserv.conf (used by the PKI Services daemon)
  - Contains mainly setup information for PKI Services
  - May contain certificate information applies to all types of certificates that PKI Services creates
- **Template file** - pkiserv.tmpl (used by the PKI Services CGIs)

  - pkitmpl.xml (used by PKI Services JSPs)
  - Provides different types of certificate template
    - Browser certificate – key generated by browser
    - Server certificate – key generated by server
    - Key certificate – key generated by PKI CA
  - Each template contains certificate information that is specific to a certain type of certificate
    - S/MIME, IPSEC, SSL, CA, Windows Logon…



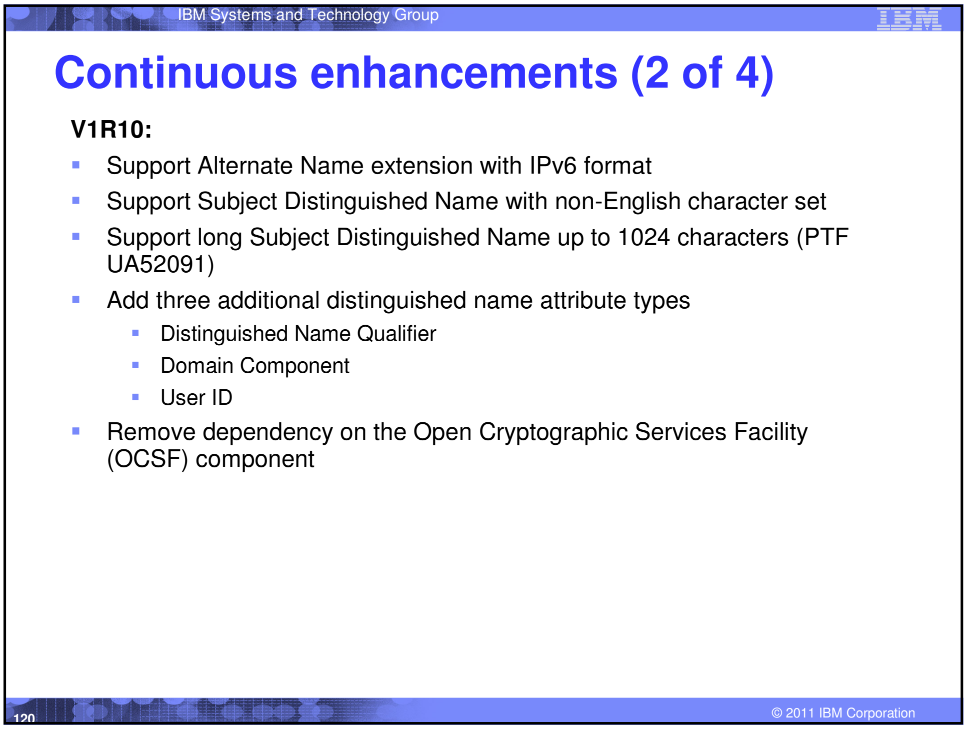
Continuous enhancements(1 of 4)

V1R8:

- Support Simple Certificate Enrollment Protocol (SCEP) permitting the router to talk directly to the Certification Authority in a secure fashion.
- Allow multiple instances of PKI Services to be run in one LPAR
- Creation of Windows Smart Card Logon certificate with extended key usage ‘Microsoft Smart Card Logon’

V1R9:

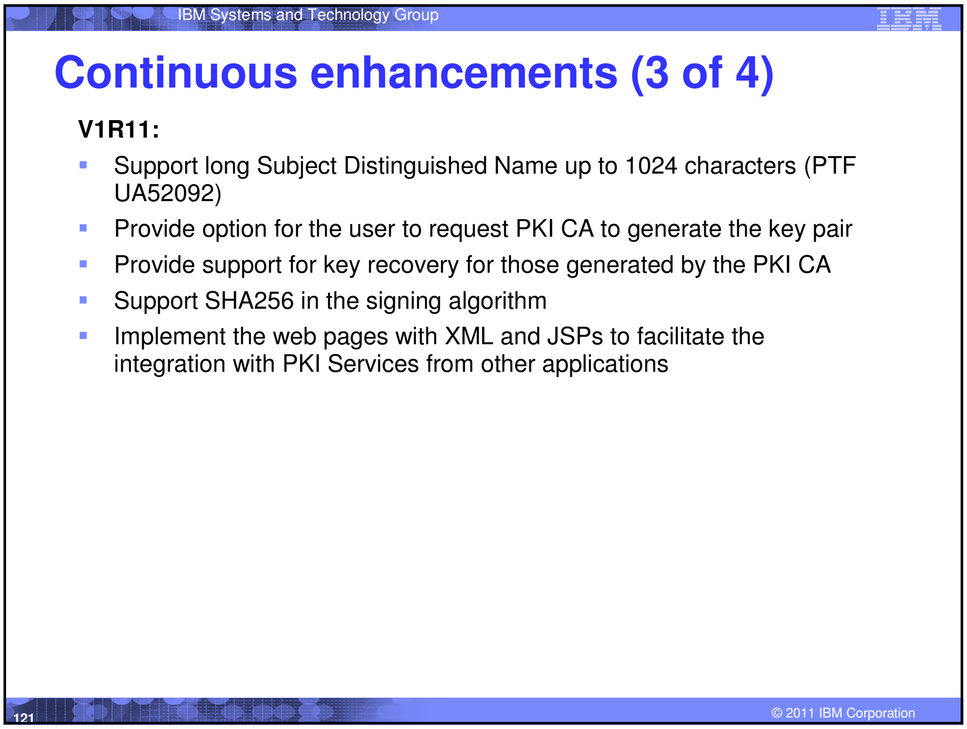
- Automatic certificate renewal, email to user
- Email notification to administrator on pending requests
- Support SDBM credential for LDAP
- Query on expiring certificates



Continuous enhancements (2 of 4)

V1R10:

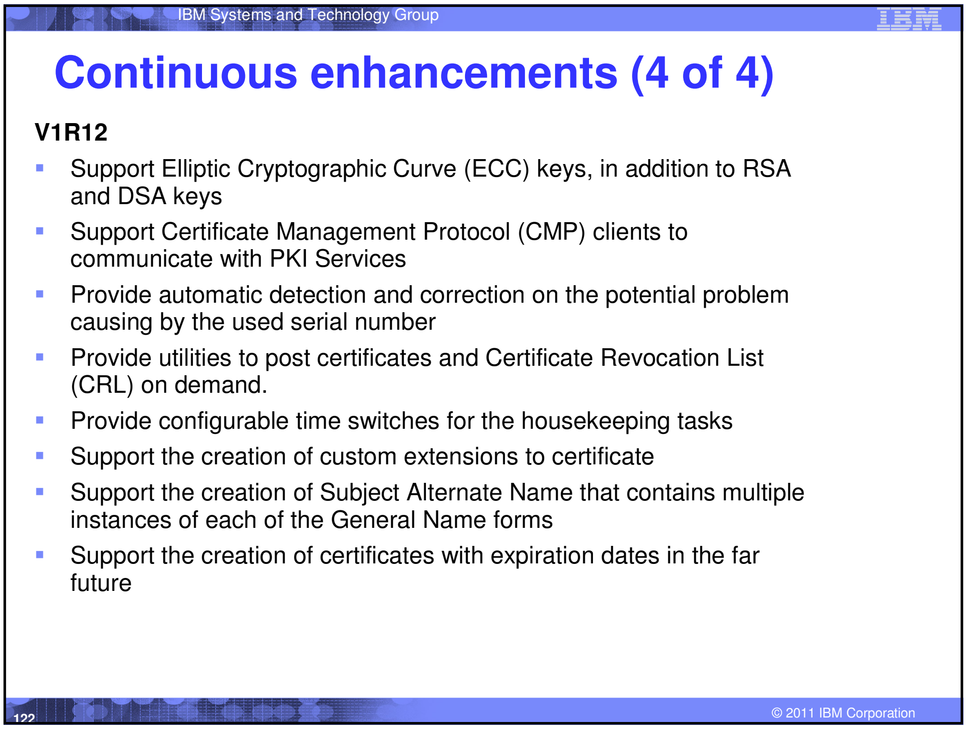
- Support Alternate Name extension with IPv6 format
- Support Subject Distinguished Name with non-English character set
- Support long Subject Distinguished Name up to 1024 characters (PTF UA52091)
- Add three additional distinguished name attribute types
  - Distinguished Name Qualifier
  - Domain Component
  - User ID
- Remove dependency on the Open Cryptographic Services Facility (OCSF) component



Continuous enhancements (3 of 4)

V1R11:

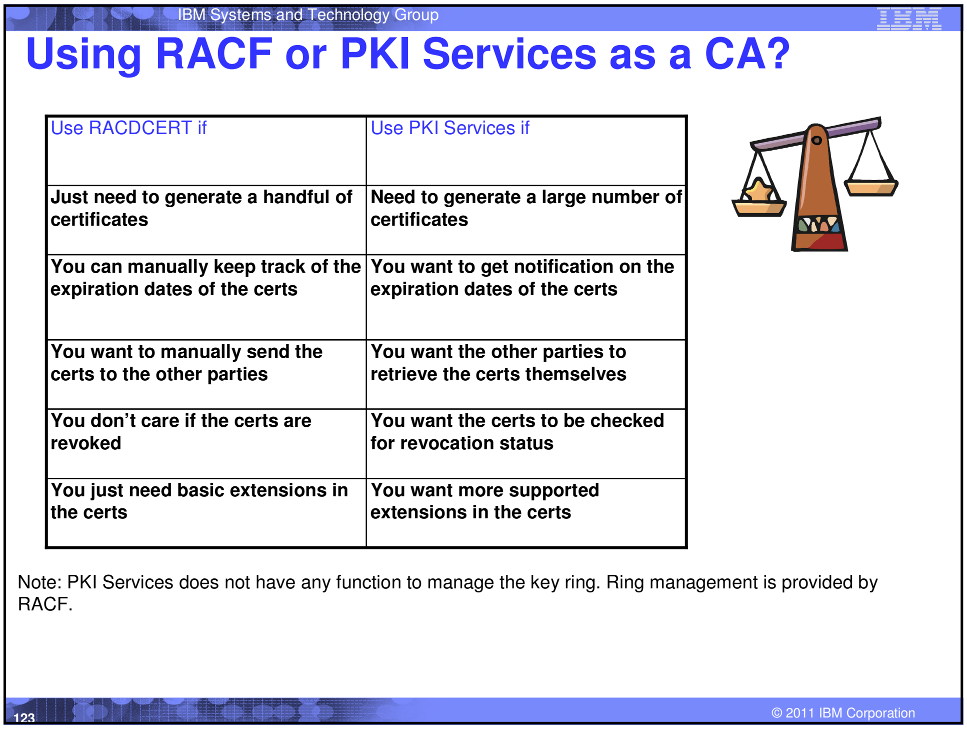
- Support long Subject Distinguished Name up to 1024 characters (PTF UA52092)
- Provide option for the user to request PKI CA to generate the key pair
- Provide support for key recovery for those generated by the PKI CA
- Support SHA256 in the signing algorithm
- Implement the web pages with XML and JSPs to facilitate the integration with PKI Services from other applications



Continuous enhancements (4 of 4)

V1R12

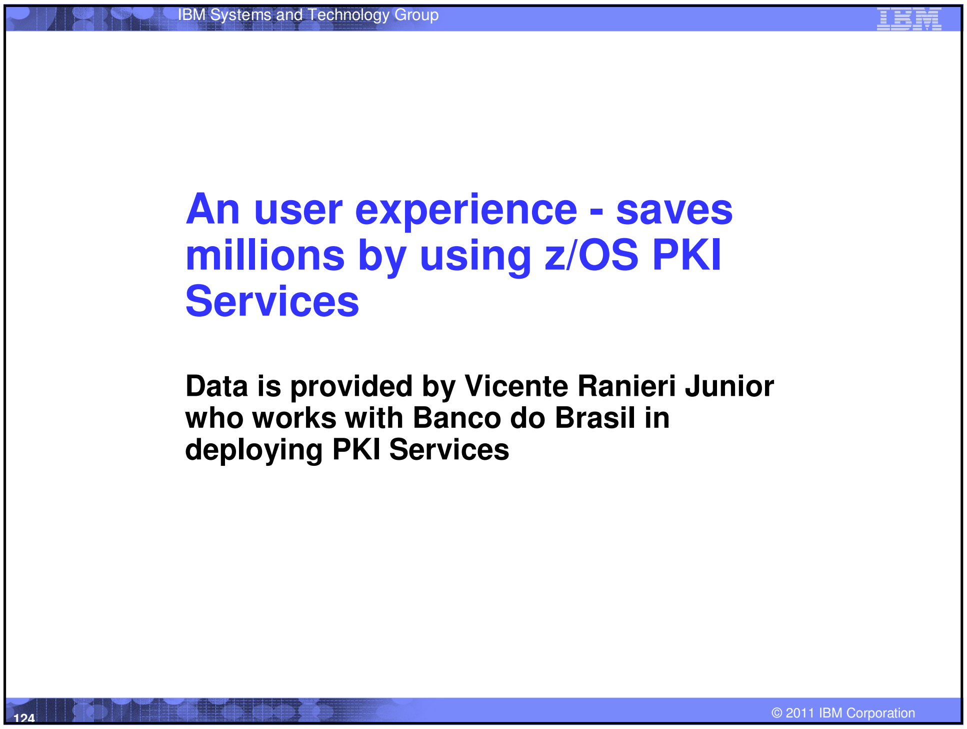
- Support Elliptic Cryptographic Curve (ECC) keys, in addition to RSA and DSA keys
- Support Certificate Management Protocol (CMP) clients to communicate with PKI Services
- Provide automatic detection and correction on the potential problem causing by the used serial number
- Provide utilities to post certificates and Certificate Revocation List (CRL) on demand.
- Provide configurable time switches for the housekeeping tasks
- Support the creation of custom extensions to certificate
- Support the creation of Subject Alternate Name that contains multiple instances of each of the General Name forms
- Support the creation of certificates with expiration dates in the far future



Using RACF or PKI Services as a CA?

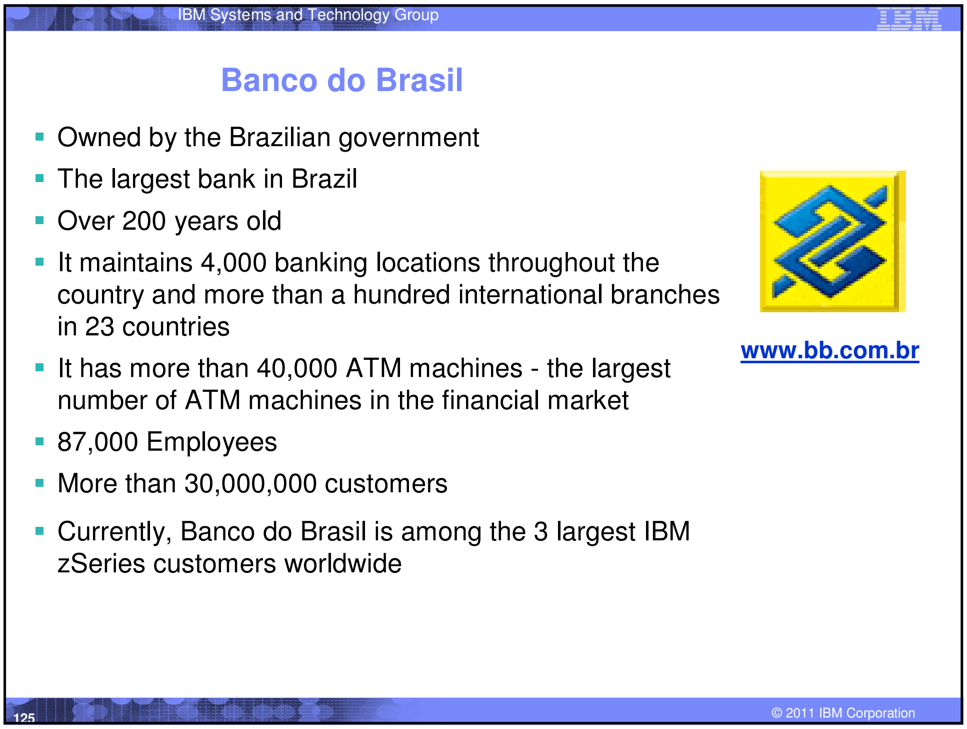
Use RACDCERT if	Use PKI Services if
Just need to generate a handful of certificates	**Need to generate a large number of certificates**
You can manually keep track of the expiration dates of the certs	**You want to get notification on the expiration dates of the certs**
You want to manually send the certs to the other parties	**You want the other parties to retrieve the certs themselves**
You don't care if the certs are revoked	**You want the certs to be checked for revocation status**
You just need basic extensions in the certs	**You want more supported extensions in the certs**

Note: PKI Services does not have any function to manage the key ring. Ring management is provided by RACF.



An user experience - saves millions by using z/OS PKI Services

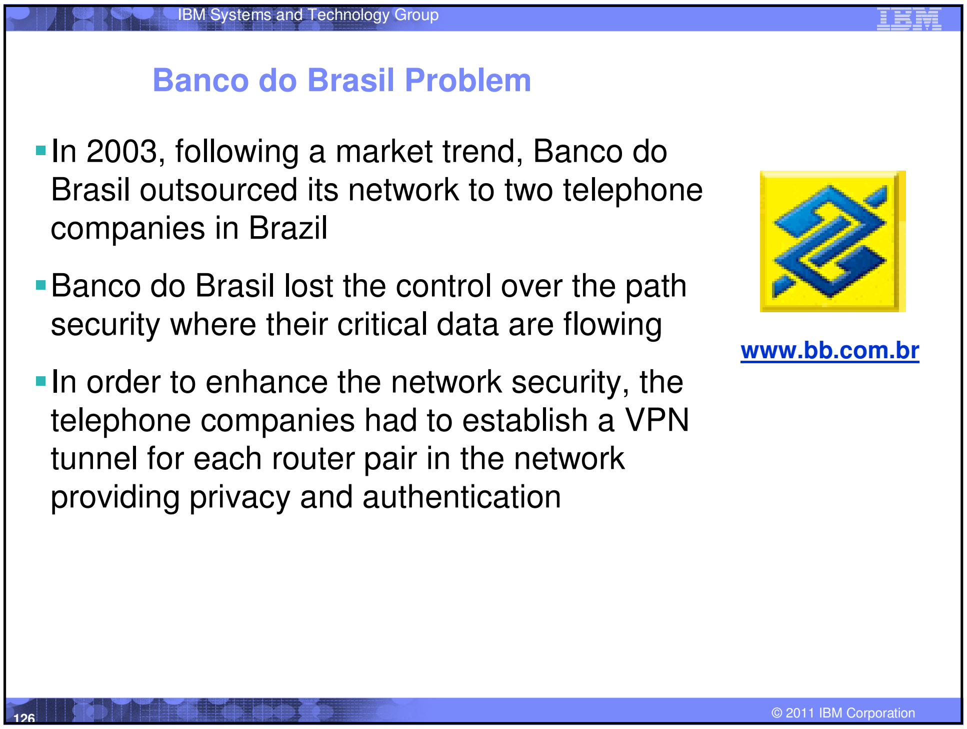
Data is provided by Vicente Ranieri Junior who works with Banco do Brasil in deploying PKI Services



Banco do Brasil

- Owned by the Brazilian government
- The largest bank in Brazil
- Over 200 years old
- It maintains 4,000 banking locations throughout the country and more than a hundred international branches in 23 countries
- It has more than 40,000 ATM machines - the largest number of ATM machines in the financial market
- 87,000 Employees
- More than 30,000,000 customers
- Currently, Banco do Brasil is among the 3 largest IBM zSeries customers worldwide

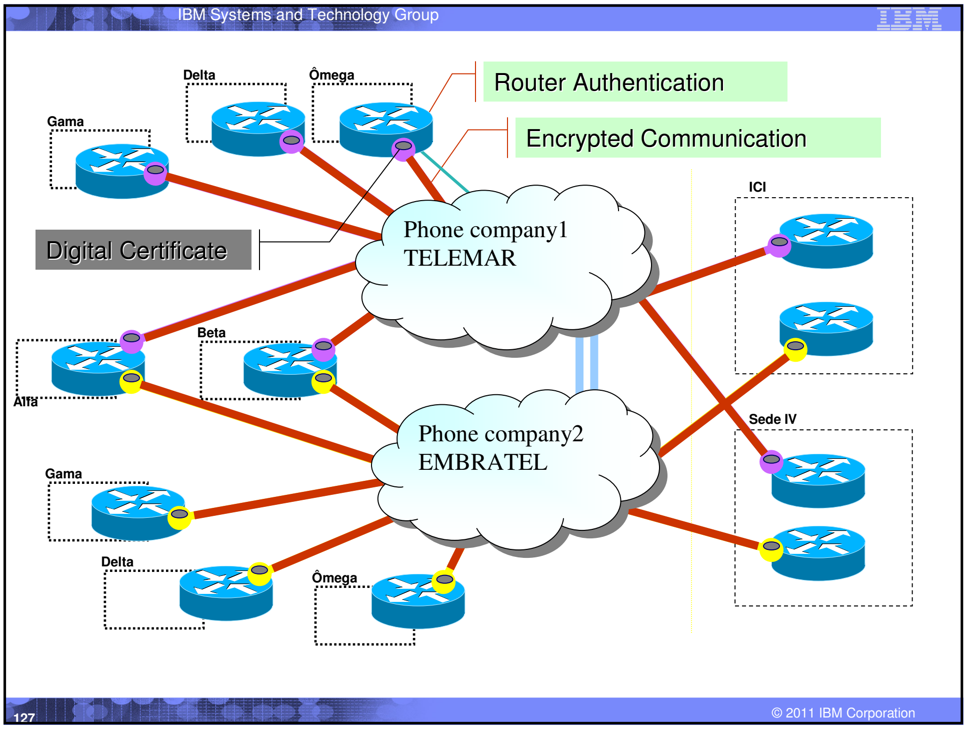
www.bb.com.br



Banco do Brasil Problem

- In 2003, following a market trend, Banco do Brasil outsourced its network to two telephone companies in Brazil
- Banco do Brasil lost the control over the path security where their critical data are flowing
- In order to enhance the network security, the telephone companies had to establish a VPN tunnel for each router pair in the network providing privacy and authentication

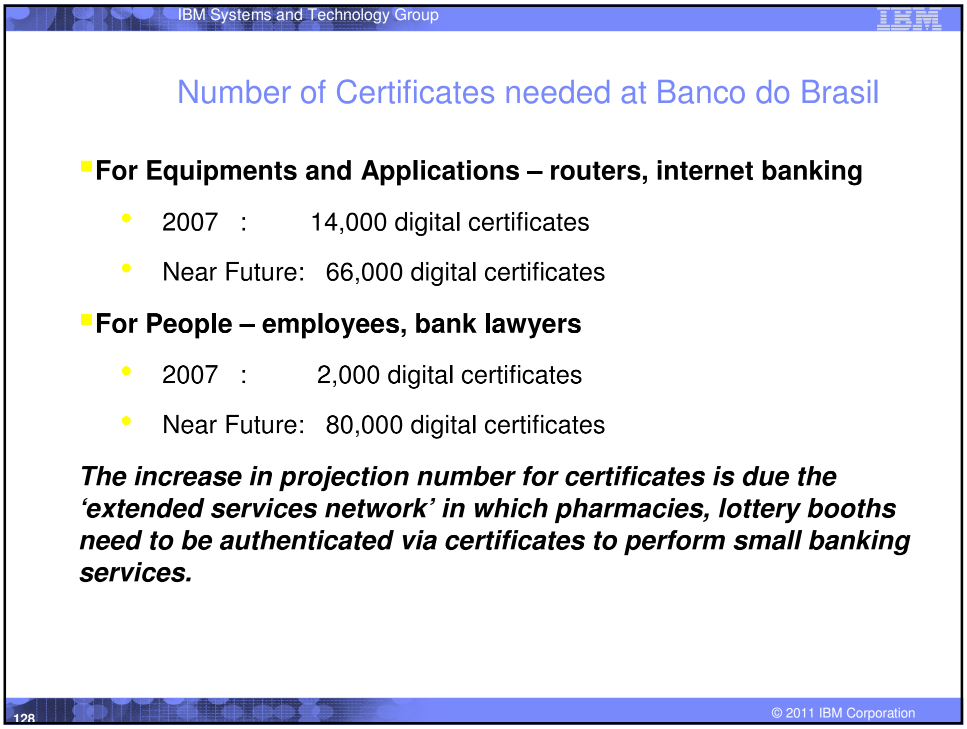
www.bb.com.br



Router Authentication

Encrypted Communication

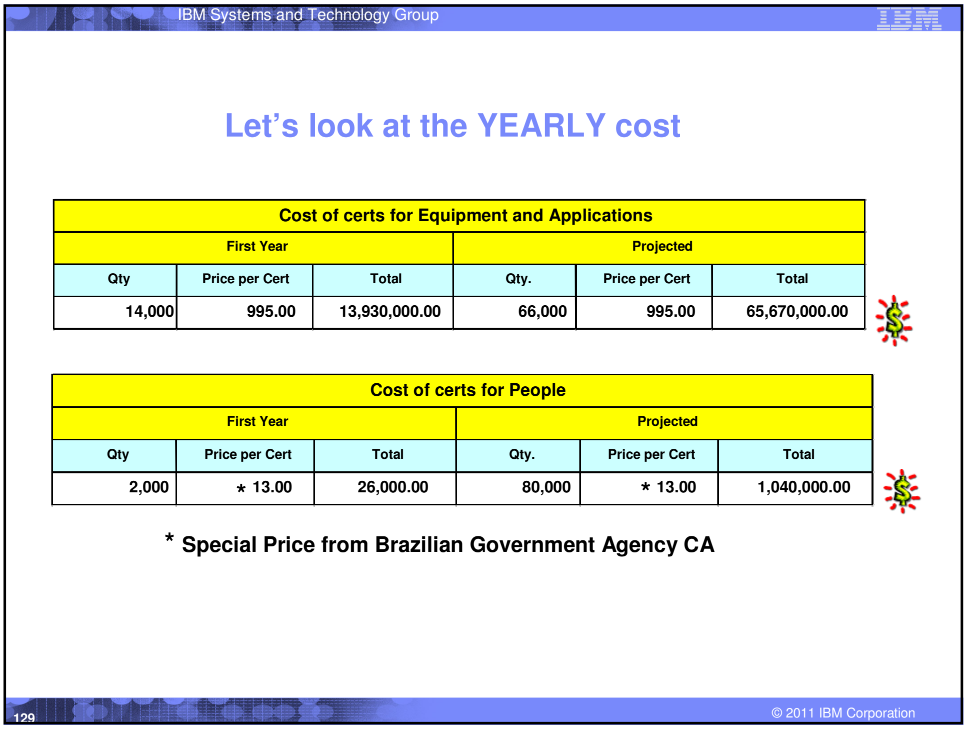
Digital Certificate



Number of Certificates needed at Banco do Brasil

- **For Equipments and Applications – routers, internet banking**
  - 2007 : 14,000 digital certificates
  - Near Future: 66,000 digital certificates
- **For People – employees, bank lawyers**
  - 2007 : 2,000 digital certificates
  - Near Future: 80,000 digital certificates

The increase in projection number for certificates is due the ‘extended services network’ in which pharmacies, lottery booths need to be authenticated via certificates to perform small banking services.

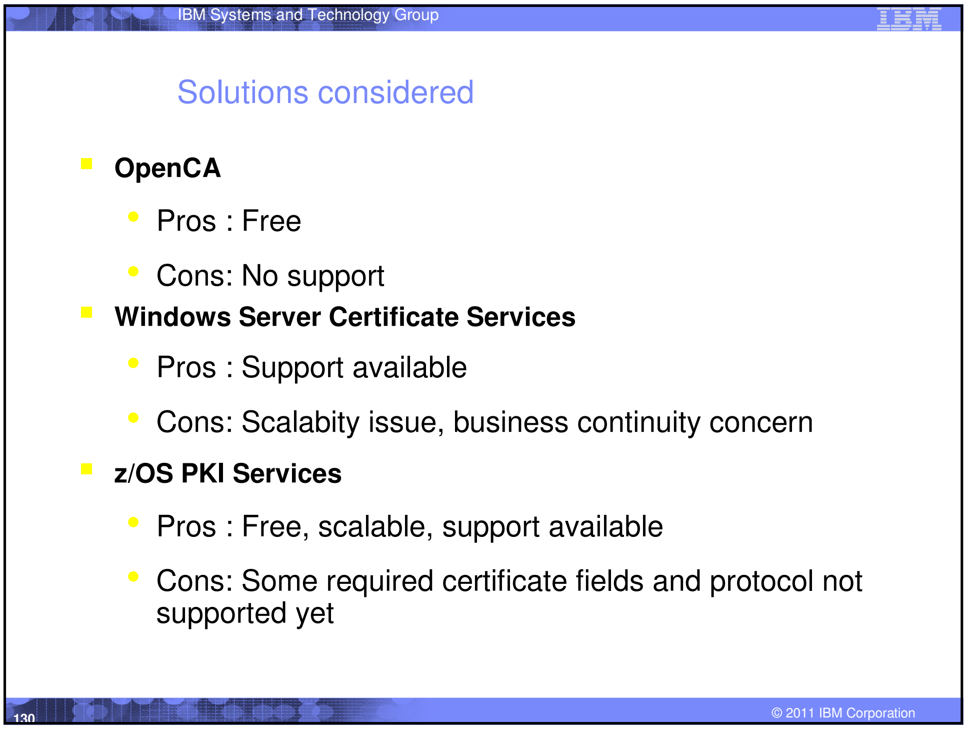


Let’s look at the YEARLY cost

Cost of certs for Equipment and Applications					
First Year			Projected		
Qty	Price per Cert	Total	Qty.	Price per Cert	Total
14,000	995.00	13,930,000.00	66,000	995.00	65,670,000.00

Cost of certs for People					
First Year			Projected		
Qty	Price per Cert	Total	Qty.	Price per Cert	Total
2,000	* 13.00	26,000.00	80,000	* 13.00	1,040,000.00

* Special Price from Brazilian Government Agency CA



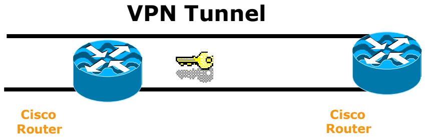
Solutions considered

- **OpenCA**
  - Pros : Free
  - Cons: No support
- **Windows Server Certificate Services**
  - Pros : Support available
  - Cons: Scalabity issue, business continuity concern
- **z/OS PKI Services**
  - Pros : Free, scalable, support available
  - Cons: Some required certificate fields and protocol not supported yet

Banco do Brasil Solution(1 of 4)

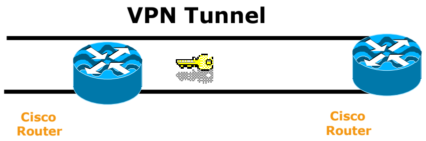
- Banco do Brasil submitted requirements to IBM to enhance PKI Services
- After knowing that the requirements were in plan, Banco do Brasil decided to start exploiting z/OS PKI Services to issue its VPN digital certificates

Banco do Brasil Solution(2 of 4)

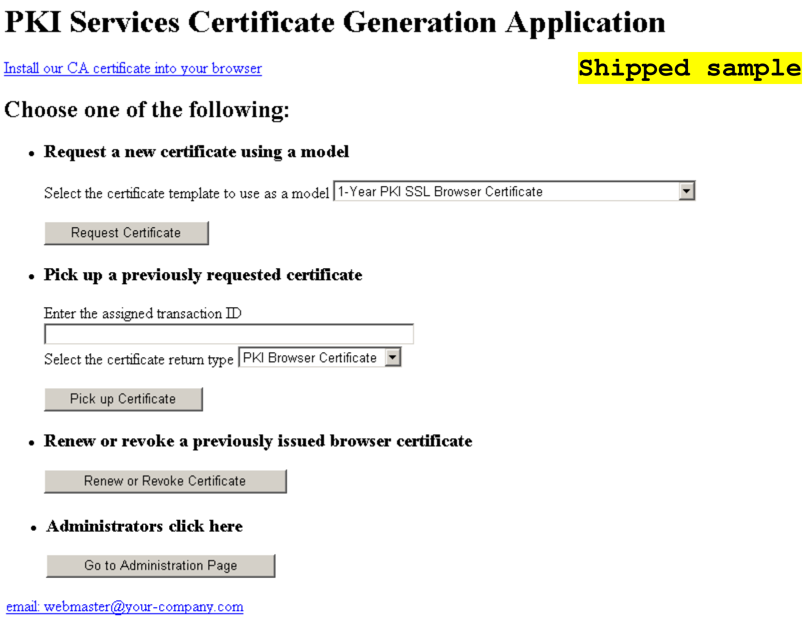


- In Brazil, there are 2 ways to be a certified CA
  - get a certification from the PKI Brazil government department which requires the PKI application runs alone on a separate machine (the bank is working on getting the acceptance that LPAR isolation is as good as a stand alone machine)
  - the issuer and the requester sign an agreement
- Banco do Brasil signed an agreement with the telephone companies

Banco do Brasil Solution(3 of 4)



- Banco do Brasil network had its security dramatically improved with almost no additional cost (z/OS is their prime operating system and RACF was already deployed)
- In a week’s time, PKI Services was set up and running in the test system
- Low consumption of MIPS to run PKI Services
- There are no extra head counts to run PKI Services
- The customer cost was only related to customize z/OS PKI Services pages to meet their requirements



PKI Services Certificate Generation Application

Install our CA certificate into your browser

Shipped sample

Choose one of the following:

- **Request a new certificate using a model**

  Select the certificate template to use as a model 1-Year PKI SSL Browser Certificate

  Request Certificate

- **Pick up a previously requested certificate**

  Enter the assigned transaction ID

  Select the certificate return type PKI Browser Certificate

  Pick up Certificate

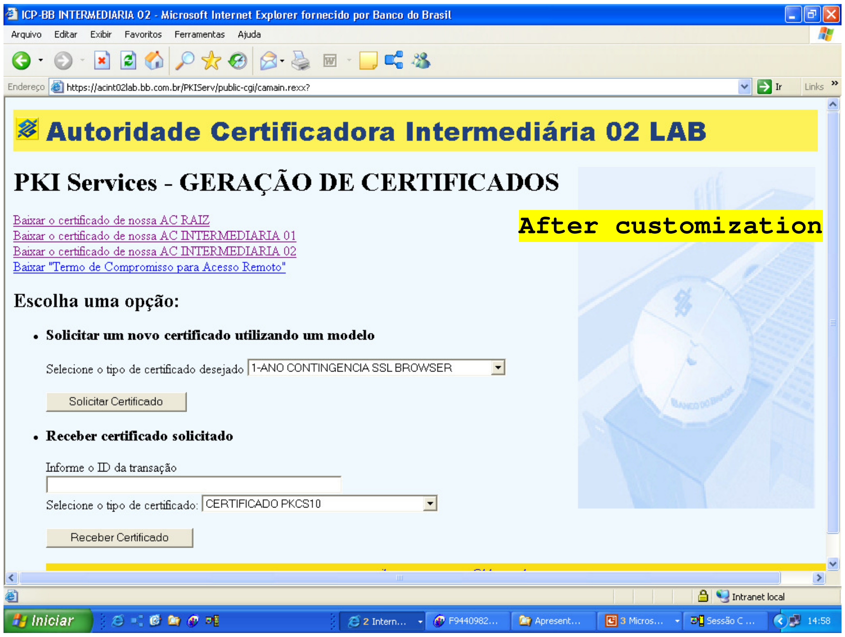
- **Renew or revoke a previously issued browser certificate**

  Renew or Revoke Certificate

- **Administrators click here**

  Go to Administration Page

email: webmaster@your-company.com


ICP-BB INTERMEDIARIA 02 - Microsoft Internet Explorer fornecido por Banco do Brasil
Arquivo Editar Exibir Favoritos Ferramentas Ajuda
Endereço https://acint02lab.bb.com.br/PKIServ/public-cgi/camain.rexx?
Ir Links
Iniciar
Intranet local
14:58

Autoridade Certificadora Intermediária 02 LAB

PKI Services - GERAÇÃO DE CERTIFICADOS

After customization

Baixar o certificado de nossa AC RAIZ
Baixar o certificado de nossa AC INTERMEDIARIA 01
Baixar o certificado de nossa AC INTERMEDIARIA 02
Baixar "Termo de Compromisso para Acesso Remoto"

Escolha uma opção:

- **Solicitar um novo certificado utilizando um modelo**

  Selecione o tipo de certificado desejado: 1-ANO CONTINGENCIA SSL BROWSER

  Solicitar Certificado

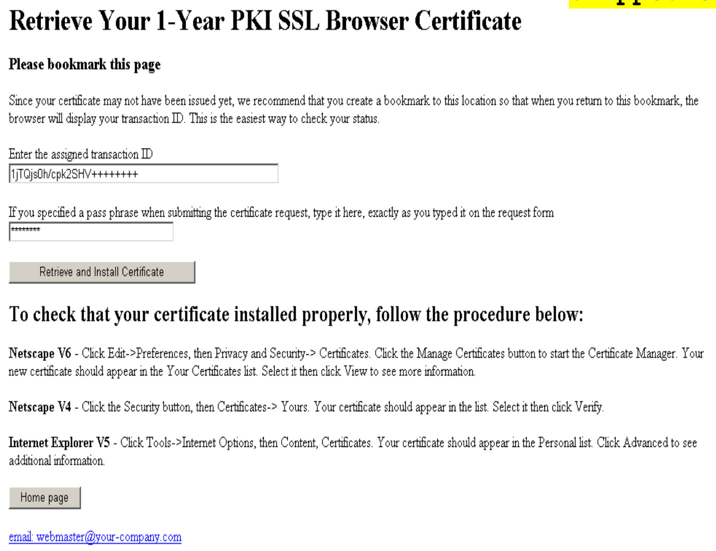
- **Receber certificado solicitado**

  Informe o ID da transação

  Selecione o tipo de certificado: CERTIFICADO PKCS10

  Receber Certificado

Shipped sample



Retrieve Your 1-Year PKI SSL Browser Certificate

Please bookmark this page

Since your certificate may not have been issued yet, we recommend that you create a bookmark to this location so that when you return to this bookmark, the browser will display your transaction ID. This is the easiest way to check your status.

Enter the assigned transaction ID
1jTQjs0h/cpk2SHV++++++++

If you specified a pass phrase when submitting the certificate request, type it here, exactly as you typed it on the request form
****

Retrieve and Install Certificate

To check that your certificate installed properly, follow the procedure below:

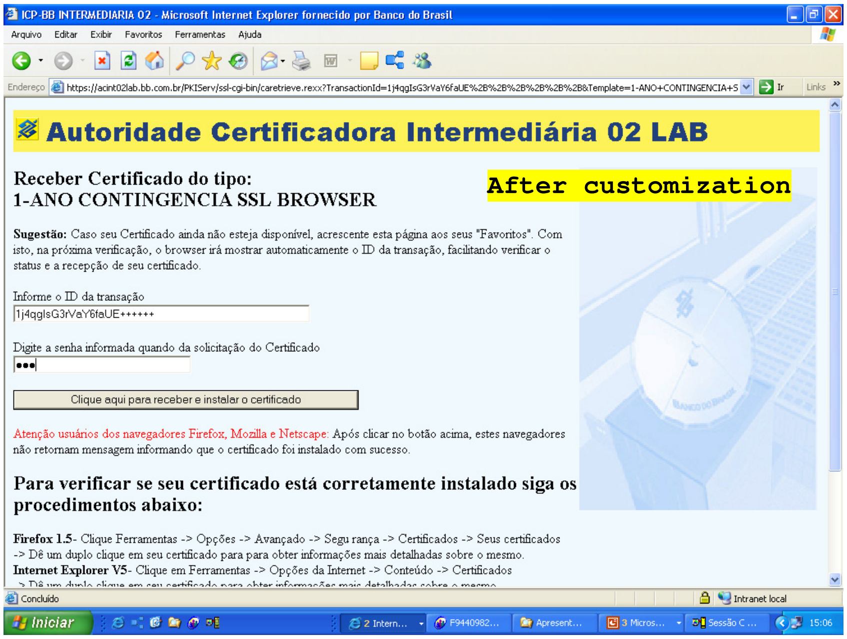
Netscape V6 - Click Edit->Preferences, then Privacy and Security-> Certificates. Click the Manage Certificates button to start the Certificate Manager. Your new certificate should appear in the Your Certificates list. Select it then click View to see more information.

Netscape V4 - Click the Security button, then Certificates-> Yours. Your certificate should appear in the list. Select it then click Verify.

Internet Explorer V5 - Click Tools->Internet Options, then Content, Certificates. Your certificate should appear in the Personal list. Click Advanced to see additional information.

Home page

email: webmaster@your-company.com


ICP-BB INTERMEDIARIA 02 - Microsoft Internet Explorer fornecido por Banco do Brasil
Arquivo Editar Exibir Favoritos Ferramentas Ajuda
Endereço
Ir
Links
Concluído
Intranet local
Iniciar
2 Intern...
F9440982...
Apresent...
3 Micros...
Sessão C ...
15:06

https://acint02lab.bb.com.br/PKIServ/ssl-cgi-bin/caretrieve.rexx?TransactionId=1j4qgIsG3rVaY6faUE%2B%2B%2B%2B%2B%2B&Template=1-ANO+CONTINGENCIA+S

Autoridade Certificadora Intermediária 02 LAB

After customization

Receber Certificado do tipo:
1-ANO CONTINGENCIA SSL BROWSER

Sugestão: Caso seu Certificado ainda não esteja disponível, acrescente esta página aos seus "Favoritos". Com isto, na próxima verificação, o browser irá mostrar automaticamente o ID da transação, facilitando verificar o status e a recepção de seu certificado.

Informe o ID da transação
1j4qgIsG3rVaY6faUE++++++

Digite a senha informada quando da solicitação do Certificado
•••

Clique aqui para receber e instalar o certificado

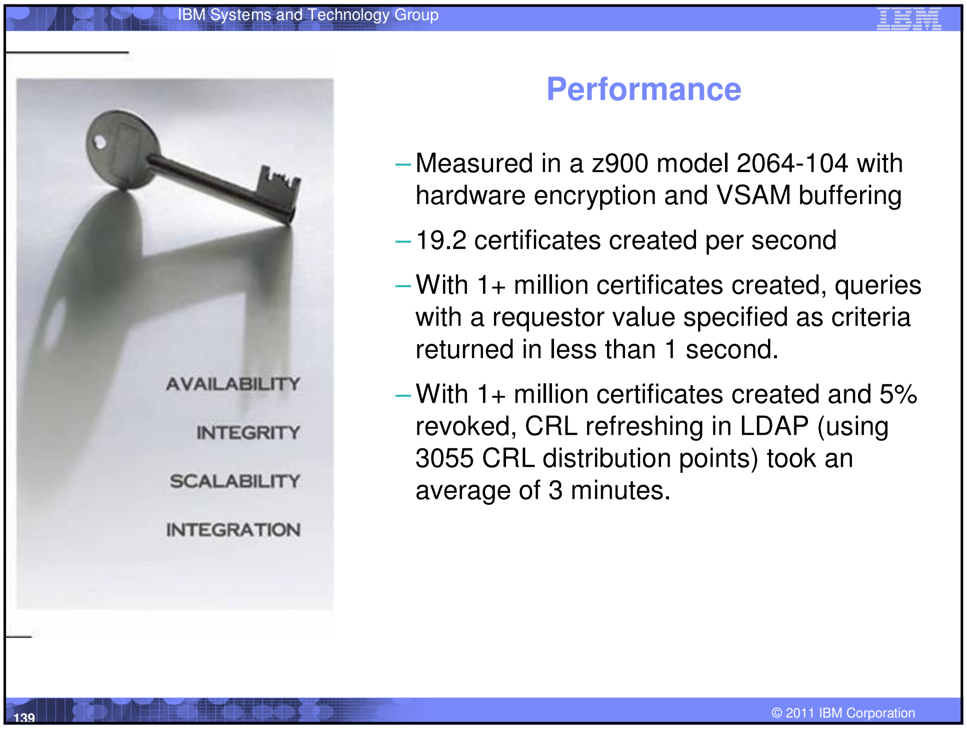
Atenção usuários dos navegadores Firefox, Mozilla e Netscape: Após clicar no botão acima, estes navegadores não retornam mensagem informando que o certificado foi instalado com sucesso.

Para verificar se seu certificado está corretamente instalado siga os procedimentos abaixo:

Firefox 1.5- Clique Ferramentas -> Opções -> Avançado -> Segu rança -> Certificados -> Seus certificados -> Dê um duplo clique em seu certificado para para obter informações mais detalhadas sobre o mesmo.
Internet Explorer V5- Clique em Ferramentas -> Opções da Internet -> Conteúdo -> Certificados -> Dê um duplo clique em seu certificado para obter informações mais detalhadas sobre o mesmo.

Banco do Brasil Solution(4 of 4)

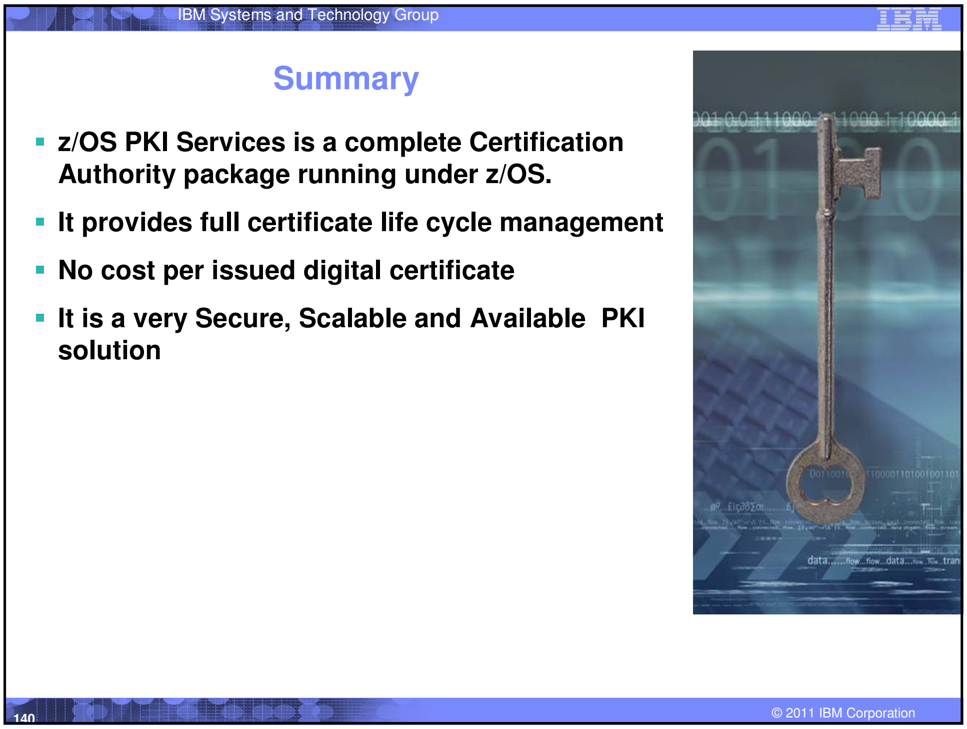
- **Both telephone companies that outsourced Banco do Brasil network request and receive the VPN digital certificates through PKI Services web interface**
- **The phone companies send the serial numbers of the routers that need certificates to a manager**
- **They then use the RACF IDs in the Bank's system to request certificates for the routers**
- **The administrator checks if there's an email from the manager on the routers before the requests are approved**
- **The certificates are issued with 1 to 2 years' validity period**



Performance

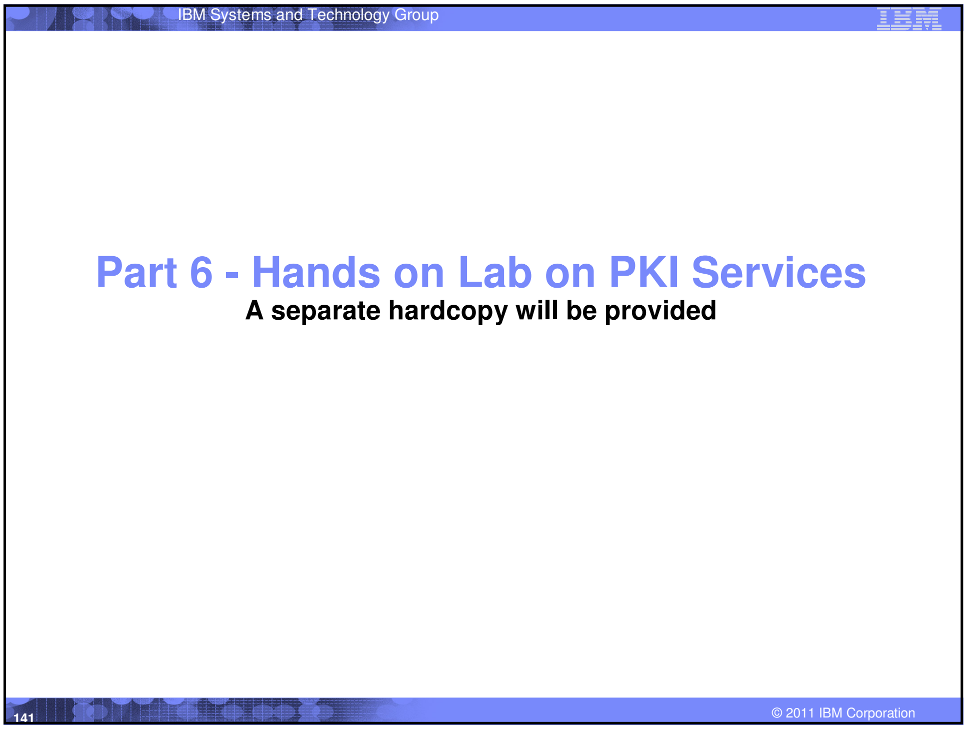
AVAILABILITY
INTEGRITY
SCALABILITY
INTEGRATION

- Measured in a z900 model 2064-104 with hardware encryption and VSAM buffering
- 19.2 certificates created per second
- With 1+ million certificates created, queries with a requestor value specified as criteria returned in less than 1 second.
- With 1+ million certificates created and 5% revoked, CRL refreshing in LDAP (using 3055 CRL distribution points) took an average of 3 minutes.



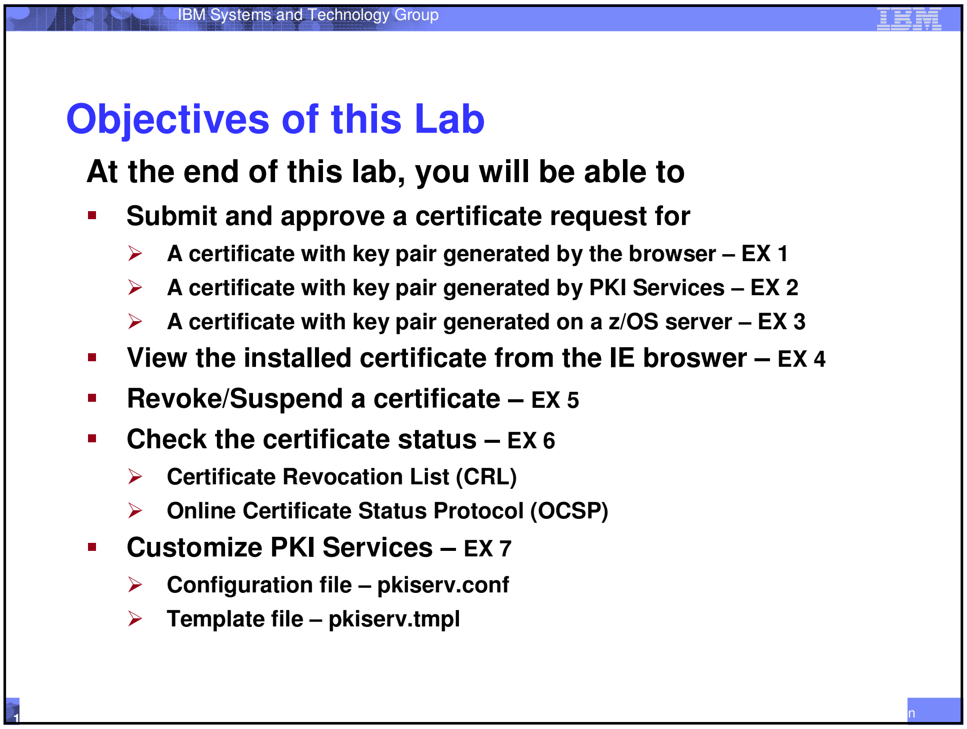
Summary

- **z/OS PKI Services is a complete Certification Authority package running under z/OS.**
- **It provides full certificate life cycle management**
- **No cost per issued digital certificate**
- **It is a very Secure, Scalable and Available PKI solution**



Part 6 - Hands on Lab on PKI Services

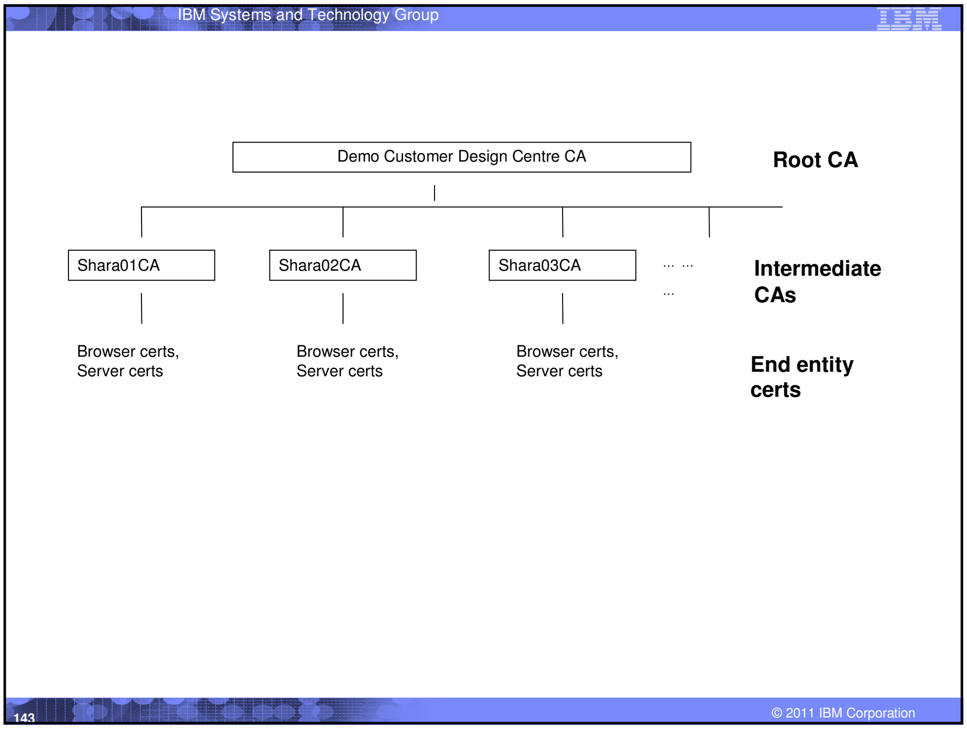
A separate hardcopy will be provided



Objectives of this Lab

At the end of this lab, you will be able to

- Submit and approve a certificate request for
  - A certificate with key pair generated by the browser – EX 1
  - A certificate with key pair generated by PKI Services – EX 2
  - A certificate with key pair generated on a z/OS server – EX 3
- View the installed certificate from the IE broswer – EX 4
- Revoke/Suspend a certificate – EX 5
- Check the certificate status – EX 6
  - Certificate Revocation List (CRL)
  - Online Certificate Status Protocol (OCSP)
- Customize PKI Services – EX 7
  - Configuration file – pkiserv.conf
  - Template file – pkiserv.tmpl



Demo Customer Design Centre CA

Root CA

Shara01CA

Shara02CA

Shara03CA

… …

…

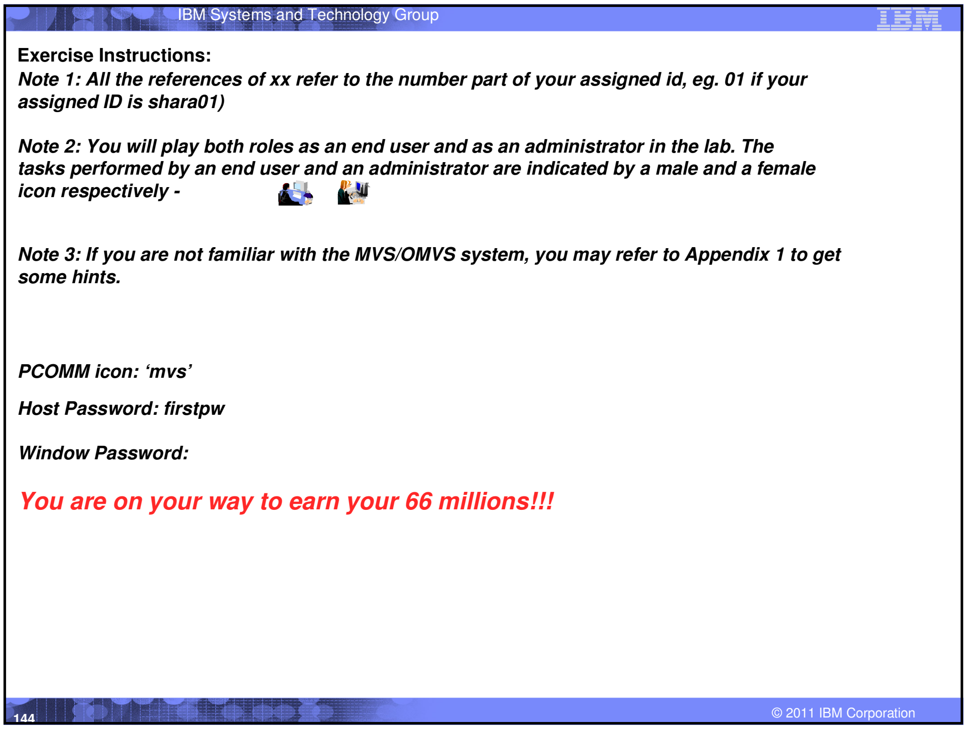
Intermediate CAs

Browser certs, Server certs

Browser certs, Server certs

Browser certs, Server certs

End entity certs



Exercise Instructions:

Note 1: All the references of xx refer to the number part of your assigned id, eg. 01 if your assigned ID is shara01)

Note 2: You will play both roles as an end user and as an administrator in the lab. The tasks performed by an end user and an administrator are indicated by a male and a female icon respectively -

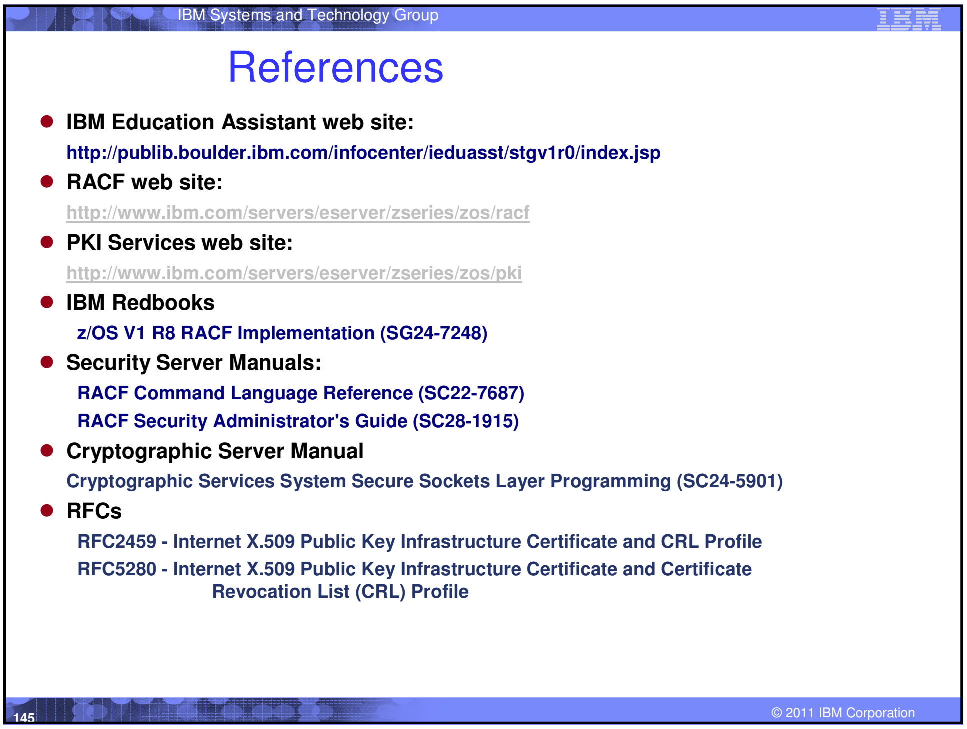
Note 3: If you are not familiar with the MVS/OMVS system, you may refer to Appendix 1 to get some hints.

PCOMM icon: 'mvs'

Host Password: firstpw

Window Password:

You are on your way to earn your 66 millions!!!



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