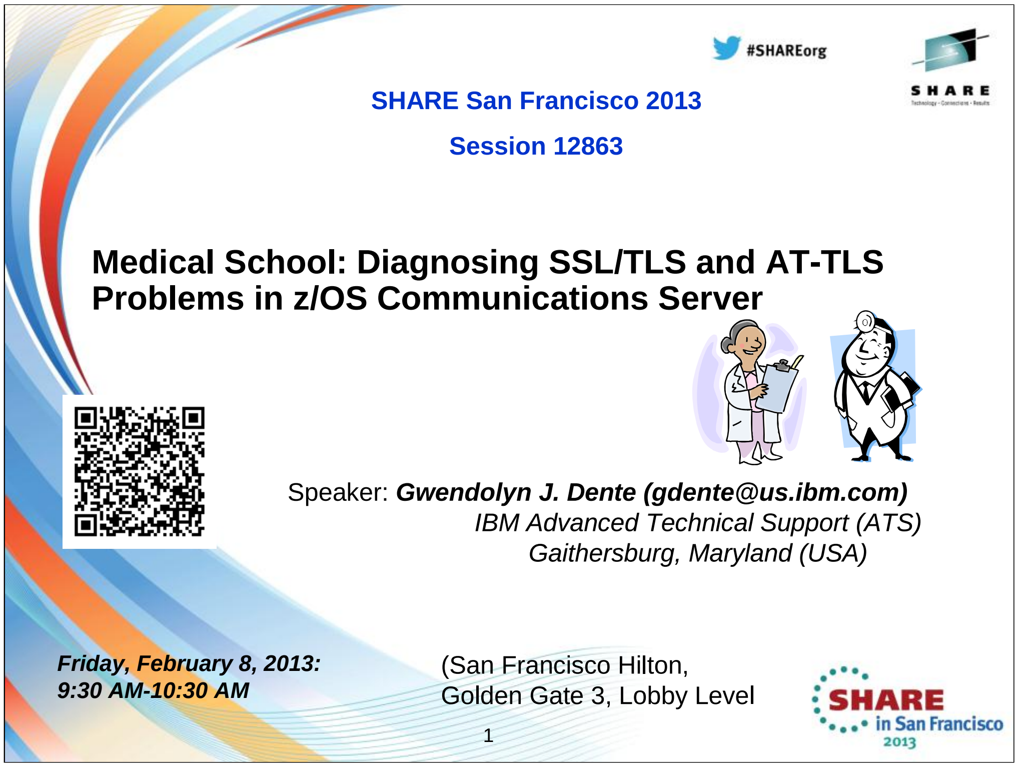


#SHAREorg

SHARE San Francisco 2013

Session 12863

Medical School: Diagnosing SSL/TLS and AT-TLS Problems in z/OS Communications Server

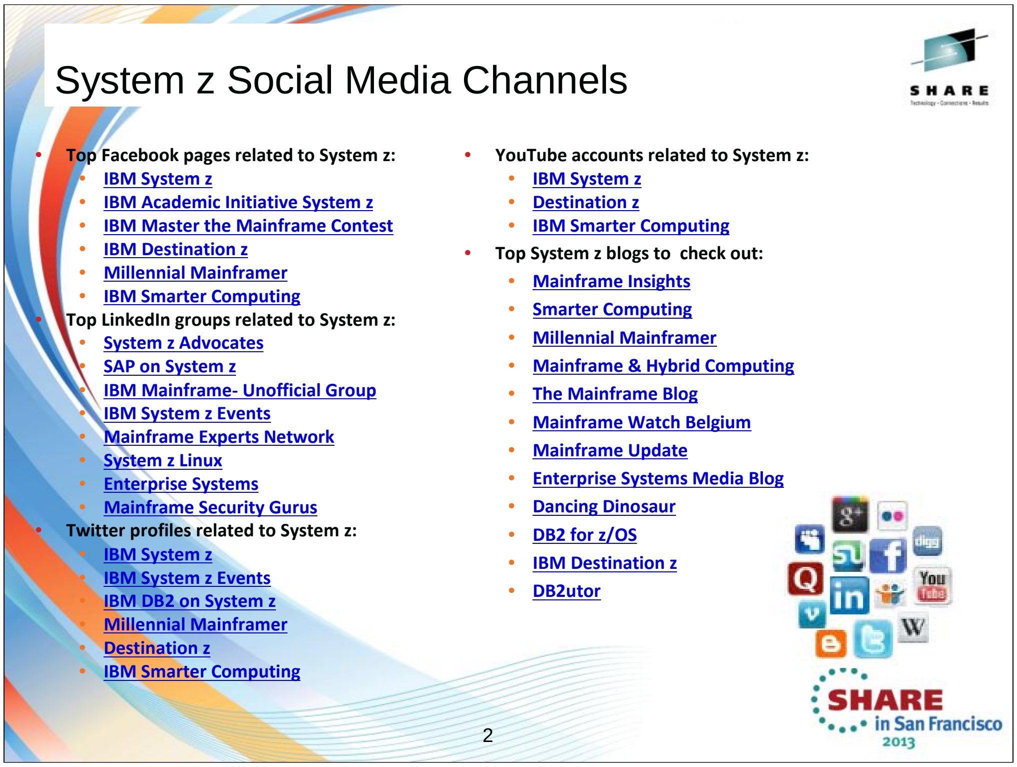
Speaker: ***Gwendolyn J. Dente (gdente@us.ibm.com)***
IBM Advanced Technical Support (ATS)
Gaithersburg, Maryland (USA)

Friday, February 8, 2013:
9:30 AM-10:30 AM

(San Francisco Hilton,
Golden Gate 3, Lobby Level

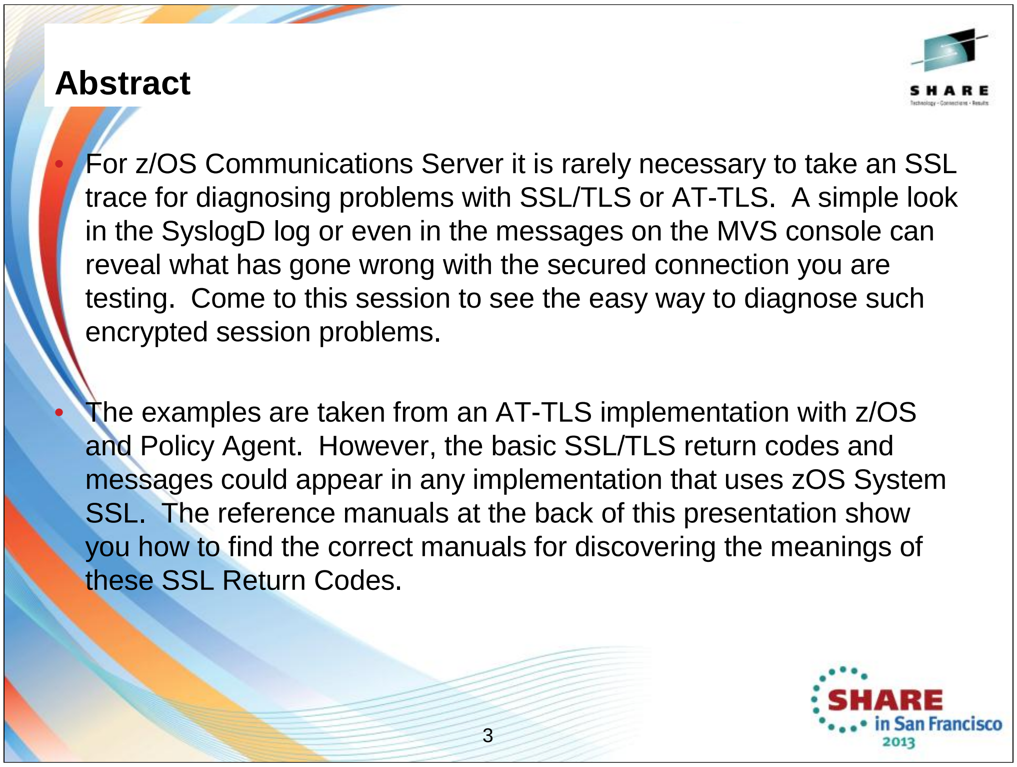
SHARE in San Francisco 2013

1



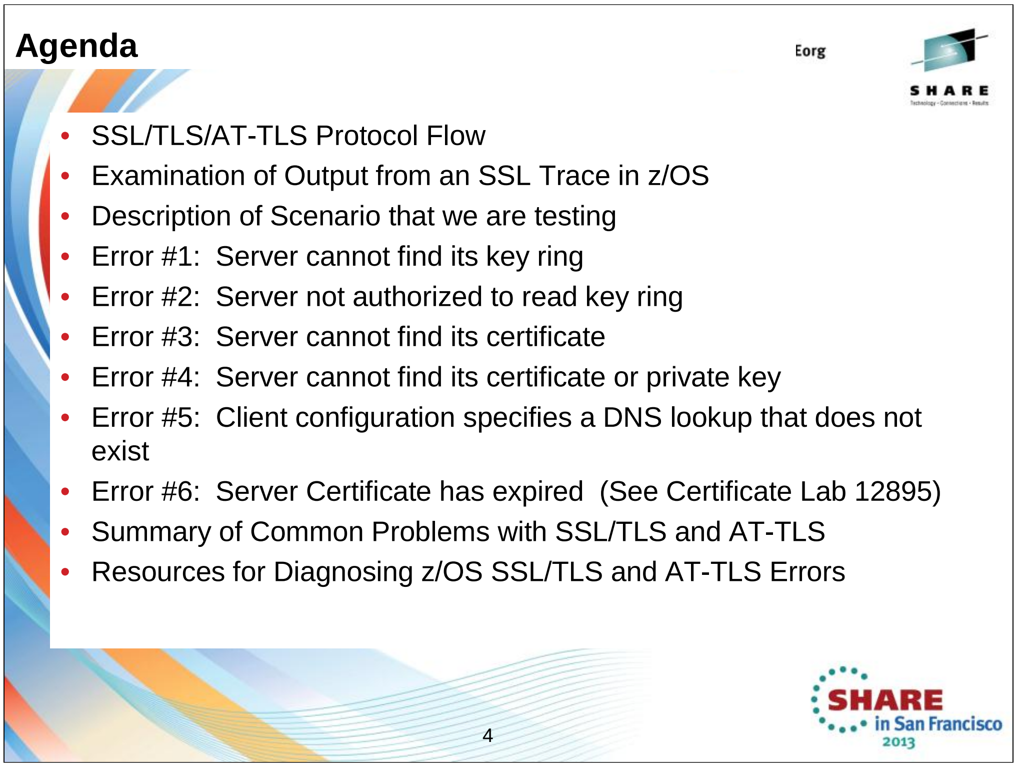
System z Social Media Channels

- Top Facebook pages related to System z:
  - IBM System z
  - IBM Academic Initiative System z
  - IBM Master the Mainframe Contest
  - IBM Destination z
  - Millennial Mainframer
  - IBM Smarter Computing
- Top LinkedIn groups related to System z:
  - System z Advocates
  - SAP on System z
  - IBM Mainframe- Unofficial Group
  - IBM System z Events
  - Mainframe Experts Network
  - System z Linux
  - Enterprise Systems
  - Mainframe Security Gurus
- Twitter profiles related to System z:
  - IBM System z
  - IBM System z Events
  - IBM DB2 on System z
  - Millennial Mainframer
  - Destination z
  - IBM Smarter Computing
- YouTube accounts related to System z:
  - IBM System z
  - Destination z
  - IBM Smarter Computing
- Top System z blogs to check out:
  - Mainframe Insights
  - Smarter Computing
  - Millennial Mainframer
  - Mainframe & Hybrid Computing
  - The Mainframe Blog
  - Mainframe Watch Belgium
  - Mainframe Update
  - Enterprise Systems Media Blog
  - Dancing Dinosaur
  - DB2 for z/OS
  - IBM Destination z
  - DB2utor



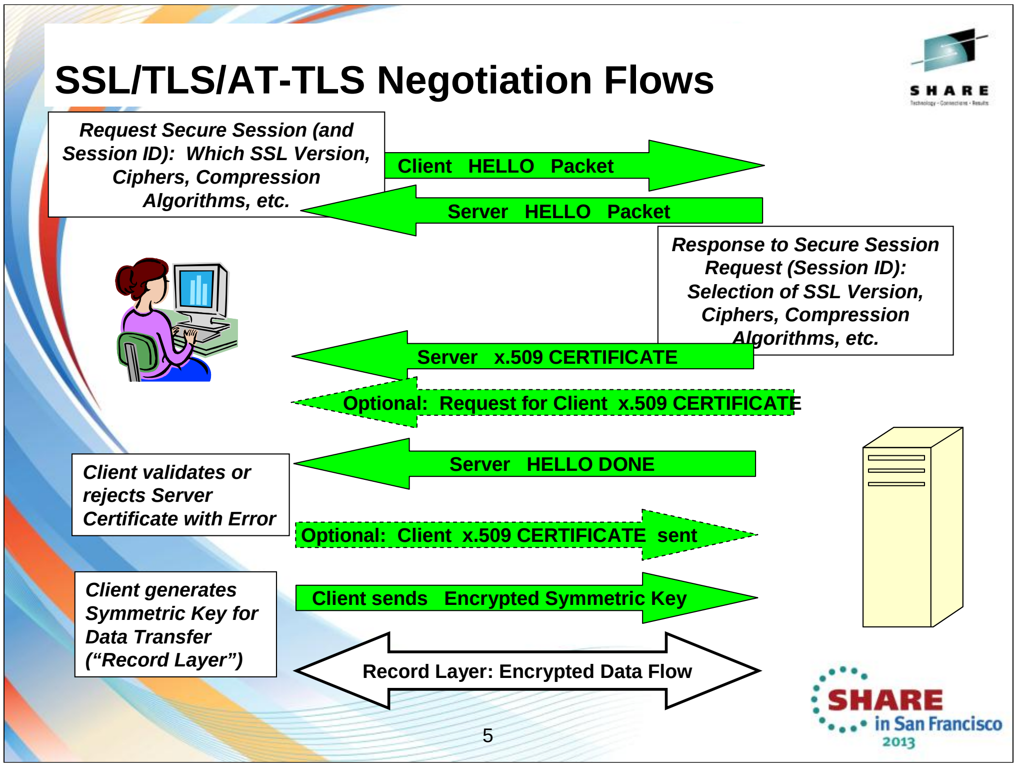
Abstract

- For z/OS Communications Server it is rarely necessary to take an SSL trace for diagnosing problems with SSL/TLS or AT-TLS. A simple look in the SyslogD log or even in the messages on the MVS console can reveal what has gone wrong with the secured connection you are testing. Come to this session to see the easy way to diagnose such encrypted session problems.
- The examples are taken from an AT-TLS implementation with z/OS and Policy Agent. However, the basic SSL/TLS return codes and messages could appear in any implementation that uses zOS System SSL. The reference manuals at the back of this presentation show you how to find the correct manuals for discovering the meanings of these SSL Return Codes.



Agenda

- SSL/TLS/AT-TLS Protocol Flow
- Examination of Output from an SSL Trace in z/OS
- Description of Scenario that we are testing
- Error #1: Server cannot find its key ring
- Error #2: Server not authorized to read key ring
- Error #3: Server cannot find its certificate
- Error #4: Server cannot find its certificate or private key
- Error #5: Client configuration specifies a DNS lookup that does not exist
- Error #6: Server Certificate has expired (See Certificate Lab 12895)
- Summary of Common Problems with SSL/TLS and AT-TLS
- Resources for Diagnosing z/OS SSL/TLS and AT-TLS Errors



SSL/TLS/AT-TLS Negotiation Flows

Request Secure Session (and Session ID): Which SSL Version, Ciphers, Compression Algorithms, etc.

Client HELLO Packet

Server HELLO Packet

Response to Secure Session Request (Session ID): Selection of SSL Version, Ciphers, Compression Algorithms, etc.

Server x.509 CERTIFICATE

Optional: Request for Client x.509 CERTIFICATE

Server HELLO DONE

Client validates or rejects Server Certificate with Error

Optional: Client x.509 CERTIFICATE sent

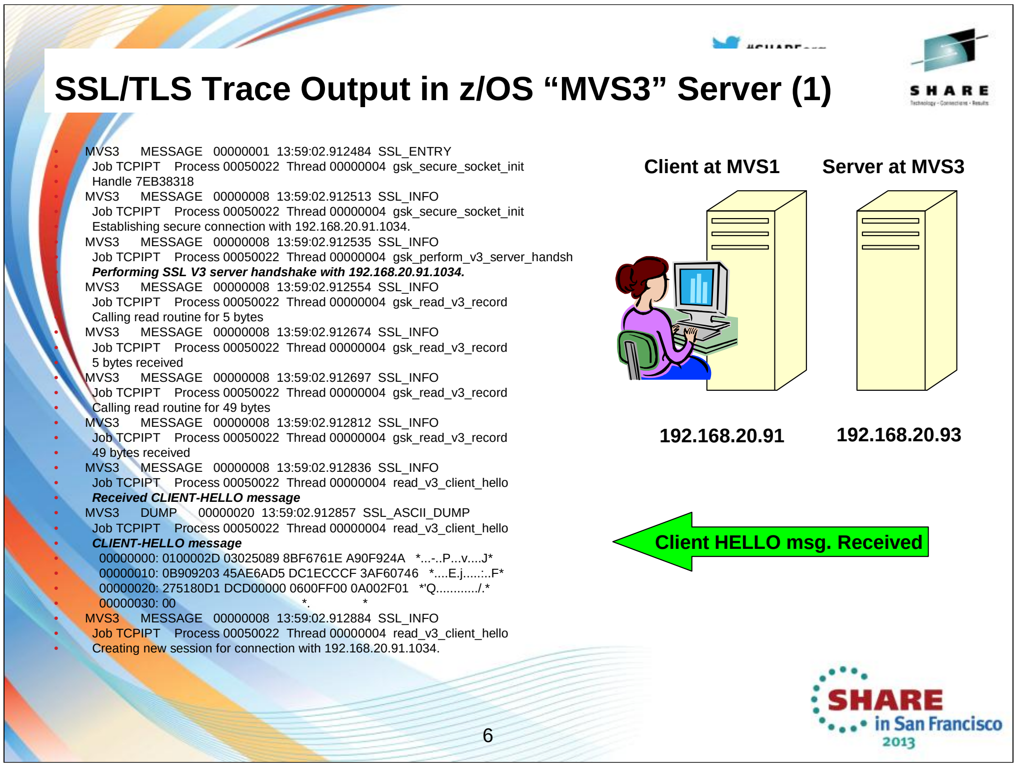
Client generates Symmetric Key for Data Transfer ("Record Layer")

Client sends Encrypted Symmetric Key

Record Layer: Encrypted Data Flow

SHARE in San Francisco 2013

This page shows the approximate flow of the SSL/TLS negotiation for a secure session; this is called the HANDSHAKE LAYER and is negotiated with the HELLO Exchange. It is followed by the RECORD LAYER, in which the production data is encrypted using the Symmetric Key



SSL/TLS Trace Output in z/OS “MVS3” Server (1)

```
MVS3     MESSAGE   00000001  13:59:02.912484  SSL_ENTRY
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_secure_socket_init
  Handle 7EB38318
MVS3     MESSAGE   00000008  13:59:02.912513  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_secure_socket_init
  Establishing secure connection with 192.168.20.91.1034.
MVS3     MESSAGE   00000008  13:59:02.912535  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_perform_v3_server_handsh
  Performing SSL V3 server handshake with 192.168.20.91.1034.
MVS3     MESSAGE   00000008  13:59:02.912554  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
  Calling read routine for 5 bytes
MVS3     MESSAGE   00000008  13:59:02.912674  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
  5 bytes received
MVS3     MESSAGE   00000008  13:59:02.912697  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
  Calling read routine for 49 bytes
MVS3     MESSAGE   00000008  13:59:02.912812  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
  49 bytes received
MVS3     MESSAGE   00000008  13:59:02.912836  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
  Received CLIENT-HELLO message
MVS3     DUMP     00000020  13:59:02.912857  SSL_ASCII_DUMP
  Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
  CLIENT-HELLO message
   00000000: 0100002D 03025089 8BF6761E A90F924A   *...-..P...v....J*
   00000010: 0B909203 45AE6AD5 DC1ECCCF 3AF60746   *....E.j.....:..F*
   00000020: 275180D1 DCD00000 0600FF00 0A002F01   *'Q.........../.*
   00000030: 00                                    *.              *
MVS3     MESSAGE   00000008  13:59:02.912884  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
  Creating new session for connection with 192.168.20.91.1034.
```

Client at MVS1

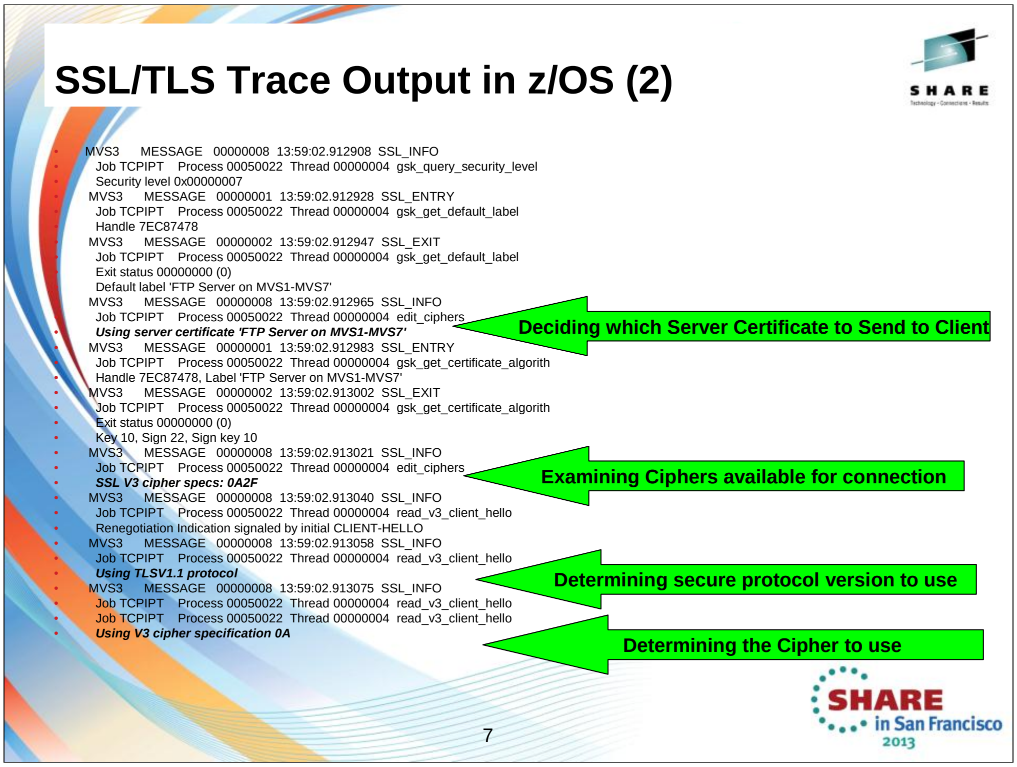
Server at MVS3

192.168.20.91

192.168.20.93

Client HELLO msg. Received

The GSKSRVR SSL Trace provides complete and very valuable information on what is happening with an SSL or TLS flow. However, if one does not know the protocols, it can be difficult to read. Frequently it is possible to solve an SSL/TLS problem just by turning on AT-TLS tracing in the AT-TLS policy, which provides more understandable messages about what may have gone awry in an encrypted setup or flow. In addition, the MVS console and the RACF messages there also provide meaningful clues. If the “easier messages” from the trace and MVS logs do not yield the information you need to solve a problem, you can look at the messages on the partner side of the connection. And, yes, there are times when you must produce an SSL/TLS GSKSRVR trace in order to examine the contents of the certificates that have been exchanged during the setup of the secured session. Therefore, in this session, we do not discount the value of an SSL Trace. We just point out that without the necessary background, it can simply be a lot easier to solve problems by using other tools that we show you here.



SSL/TLS Trace Output in z/OS (2)

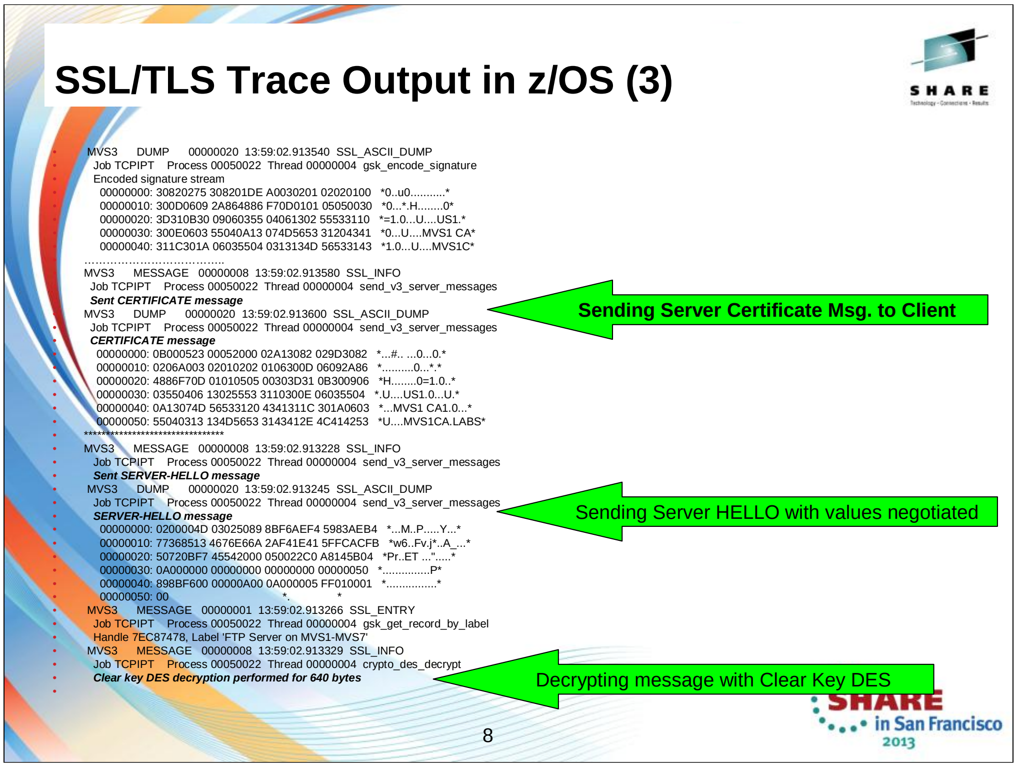
```
MVS3      MESSAGE   00000008  13:59:02.912908  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_query_security_level
   Security level 0x00000007
 MVS3      MESSAGE   00000001  13:59:02.912928  SSL_ENTRY
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_default_label
   Handle 7EC87478
 MVS3      MESSAGE   00000002  13:59:02.912947  SSL_EXIT
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_default_label
   Exit status 00000000 (0)
   Default label 'FTP Server on MVS1-MVS7'
 MVS3      MESSAGE   00000008  13:59:02.912965  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  edit_ciphers
   Using server certificate 'FTP Server on MVS1-MVS7'
 MVS3      MESSAGE   00000001  13:59:02.912983  SSL_ENTRY
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_certificate_algorith
   Handle 7EC87478, Label 'FTP Server on MVS1-MVS7'
 MVS3      MESSAGE   00000002  13:59:02.913002  SSL_EXIT
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_certificate_algorith
   Exit status 00000000 (0)
   Key 10, Sign 22, Sign key 10
 MVS3      MESSAGE   00000008  13:59:02.913021  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  edit_ciphers
   SSL V3 cipher specs: 0A2F
 MVS3      MESSAGE   00000008  13:59:02.913040  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
   Renegotiation Indication signaled by initial CLIENT-HELLO
 MVS3      MESSAGE   00000008  13:59:02.913058  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
   Using TLSV1.1 protocol
 MVS3      MESSAGE   00000008  13:59:02.913075  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_hello
   Using V3 cipher specification 0A
```

Deciding which Server Certificate to Send to Client

Examining Ciphers available for connection

Determining secure protocol version to use

Determining the Cipher to use



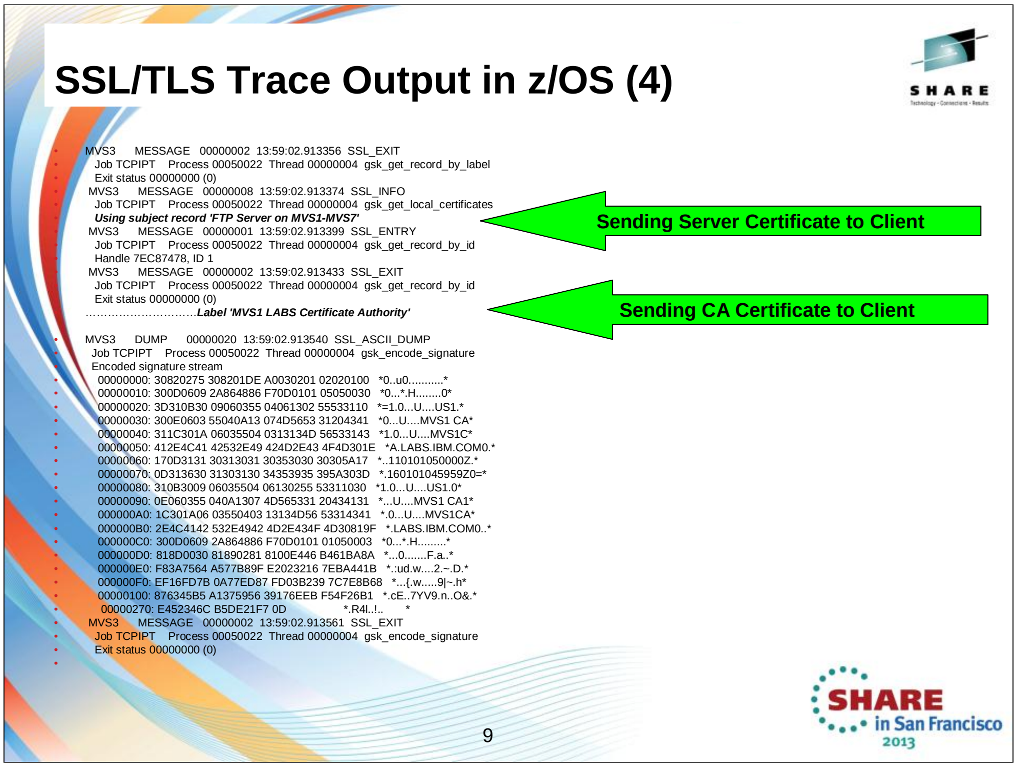
SSL/TLS Trace Output in z/OS (3)

```
 MVS3      DUMP      00000020  13:59:02.913540  SSL_ASCII_DUMP
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_encode_signature
   Encoded signature stream
     00000000: 30820275 308201DE A0030201 02020100   *0..u0...........*
     00000010: 300D0609 2A864886 F70D0101 05050030   *0...*.H........0*
     00000020: 3D310B30 09060355 04061302 55533110   *=1.0...U....US1.*
     00000030: 300E0603 55040A13 074D5653 31204341   *0...U....MVS1 CA*
     00000040: 311C301A 06035504 0313134D 56533143   *1.0...U....MVS1C*
…………………………………..
MVS3      MESSAGE   00000008  13:59:02.913580  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
  Sent CERTIFICATE message
MVS3      DUMP      00000020  13:59:02.913600  SSL_ASCII_DUMP
  Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
  CERTIFICATE message
    00000000: 0B000523 00052000 02A13082 029D3082   *...#.. ...0...0.*
    00000010: 0206A003 02010202 0106300D 06092A86   *..........0...*.*
    00000020: 4886F70D 01010505 00303D31 0B300906   *H........0=1.0..*
    00000030: 03550406 13025553 3110300E 06035504   *.U....US1.0...U.*
    00000040: 0A13074D 56533120 4341311C 301A0603   *...MVS1 CA1.0...*
    00000050: 55040313 134D5653 3143412E 4C414253   *U....MVS1CA.LABS*
********************************
MVS3      MESSAGE   00000008  13:59:02.913228  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
   Sent SERVER-HELLO message
 MVS3      DUMP      00000020  13:59:02.913245  SSL_ASCII_DUMP
   Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
   SERVER-HELLO message
     00000000: 0200004D 03025089 8BF6AEF4 5983AEB4   *...M..P.....Y...*
     00000010: 77368513 4676E66A 2AF41E41 5FFCACFB   *w6..Fv.j*..A_...*
     00000020: 50720BF7 45542000 050022C0 A8145B04   *Pr..ET ...".....*
     00000030: 0A000000 00000000 00000000 00000050   *...............P*
     00000040: 898BF600 00000A00 0A000005 FF010001   *................*
     00000050: 00                                    *.               *
 MVS3      MESSAGE   00000001  13:59:02.913266  SSL_ENTRY
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_record_by_label
   Handle 7EC87478, Label 'FTP Server on MVS1-MVS7'
 MVS3      MESSAGE   00000008  13:59:02.913329  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  crypto_des_decrypt
   Clear key DES decryption performed for 640 bytes
```

Sending Server Certificate Msg. to Client

Sending Server HELLO with values negotiated

Decrypting message with Clear Key DES

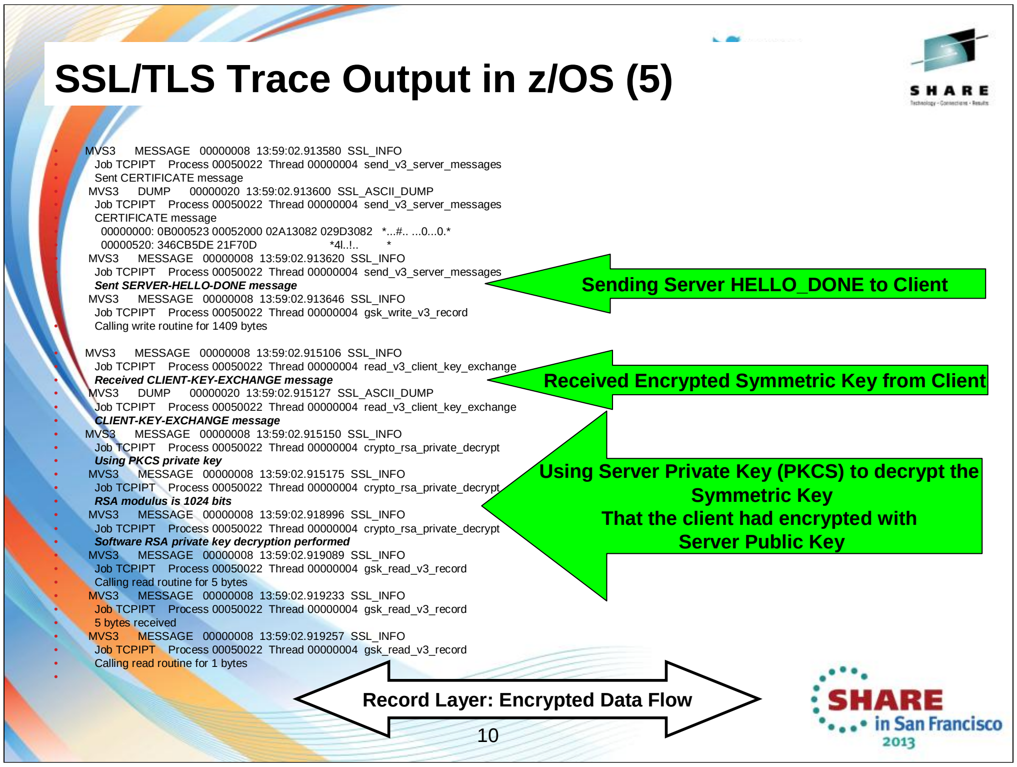


SSL/TLS Trace Output in z/OS (4)

```
MVS3     MESSAGE   00000002  13:59:02.913356  SSL_EXIT
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_record_by_label
  Exit status 00000000 (0)
 MVS3     MESSAGE   00000008  13:59:02.913374  SSL_INFO
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_local_certificates
  Using subject record 'FTP Server on MVS1-MVS7'
 MVS3     MESSAGE   00000001  13:59:02.913399  SSL_ENTRY
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_record_by_id
  Handle 7EC87478, ID 1
 MVS3     MESSAGE   00000002  13:59:02.913433  SSL_EXIT
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_get_record_by_id
  Exit status 00000000 (0)
………………………….Label 'MVS1 LABS Certificate Authority'

MVS3     DUMP     00000020  13:59:02.913540  SSL_ASCII_DUMP
 Job TCPIPT    Process 00050022  Thread 00000004  gsk_encode_signature
 Encoded signature stream
   00000000: 30820275 308201DE A0030201 02020100   *0..u0...........*
   00000010: 300D0609 2A864886 F70D0101 05050030   *0...*.H........0*
   00000020: 3D310B30 09060355 04061302 55533110   *=1.0...U....US1.*
   00000030: 300E0603 55040A13 074D5653 31204341   *0...U....MVS1 CA*
   00000040: 311C301A 06035504 0313134D 56533143   *1.0...U....MVS1C*
   00000050: 412E4C41 42532E49 424D2E43 4F4D301E   *A.LABS.IBM.COM0.*
   00000060: 170D3131 30313031 30353030 30305A17   *..110101050000Z.*
   00000070: 0D313630 31303130 34353935 395A303D   *.160101045959Z0=*
   00000080: 310B3009 06035504 06130255 53311030   *1.0...U....US1.0*
   00000090: 0E060355 040A1307 4D565331 20434131   *...U....MVS1 CA1*
   000000A0: 1C301A06 03550403 13134D56 53314341   *.0...U....MVS1CA*
   000000B0: 2E4C4142 532E4942 4D2E434F 4D30819F   *.LABS.IBM.COM0..*
   000000C0: 300D0609 2A864886 F70D0101 01050003   *0...*.H.........*
   000000D0: 818D0030 81890281 8100E446 B461BA8A   *...0.......F.a..*
   000000E0: F83A7564 A577B89F E2023216 7EBA441B   *.:ud.w....2.~.D.*
   000000F0: EF16FD7B 0A77ED87 FD03B239 7C7E8B68   *...{.w.....9|~.h*
   00000100: 876345B5 A1375956 39176EEB F54F26B1   *.cE..7YV9.n..O&.*
    00000270: E452346C B5DE21F7 0D                 *.R4l..!..       *
 MVS3     MESSAGE   00000002  13:59:02.913561  SSL_EXIT
  Job TCPIPT    Process 00050022  Thread 00000004  gsk_encode_signature
  Exit status 00000000 (0)
```

Sending Server Certificate to Client

Sending CA Certificate to Client



SSL/TLS Trace Output in z/OS (5)

```
MVS3     MESSAGE   00000008  13:59:02.913580  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
   Sent CERTIFICATE message
 MVS3     DUMP      00000020  13:59:02.913600  SSL_ASCII_DUMP
   Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
   CERTIFICATE message
     00000000: 0B000523 00052000 02A13082 029D3082   *...#.. ...0...0.*
     00000520: 346CB5DE 21F70D                       *4l..!..        *
 MVS3     MESSAGE   00000008  13:59:02.913620  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  send_v3_server_messages
   Sent SERVER-HELLO-DONE message
 MVS3     MESSAGE   00000008  13:59:02.913646  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_write_v3_record
   Calling write routine for 1409 bytes

MVS3     MESSAGE   00000008  13:59:02.915106  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_key_exchange
   Received CLIENT-KEY-EXCHANGE message
 MVS3     DUMP      00000020  13:59:02.915127  SSL_ASCII_DUMP
   Job TCPIPT    Process 00050022  Thread 00000004  read_v3_client_key_exchange
   CLIENT-KEY-EXCHANGE message
MVS3     MESSAGE   00000008  13:59:02.915150  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  crypto_rsa_private_decrypt
   Using PKCS private key
 MVS3     MESSAGE   00000008  13:59:02.915175  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  crypto_rsa_private_decrypt
   RSA modulus is 1024 bits
 MVS3     MESSAGE   00000008  13:59:02.918996  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  crypto_rsa_private_decrypt
   Software RSA private key decryption performed
 MVS3     MESSAGE   00000008  13:59:02.919089  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
   Calling read routine for 5 bytes
 MVS3     MESSAGE   00000008  13:59:02.919233  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
   5 bytes received
 MVS3     MESSAGE   00000008  13:59:02.919257  SSL_INFO
   Job TCPIPT    Process 00050022  Thread 00000004  gsk_read_v3_record
   Calling read routine for 1 bytes
```

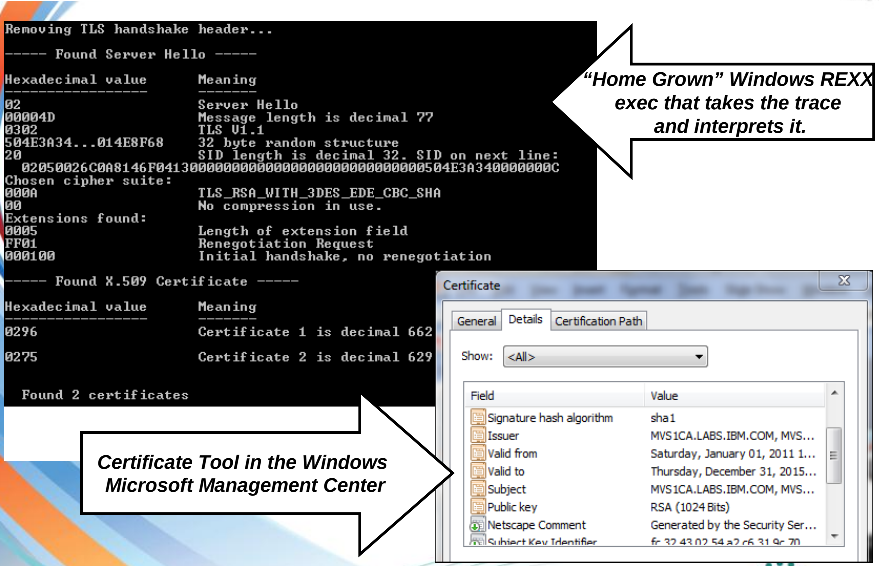
Sending Server HELLO_DONE to Client

Received Encrypted Symmetric Key from Client

Using Server Private Key (PKCS) to decrypt the Symmetric Key That the client had encrypted with Server Public Key

Record Layer: Encrypted Data Flow

Formatting SSL Trace Flows; Viewing Certificates



```
Removing TLS handshake header...

----- Found Server Hello -----

Hexadecimal value       Meaning
-----------------       -------
02                      Server Hello
00004D                  Message length is decimal 77
0302                    TLS V1.1
504E3A34...014E8F68     32 byte random structure
20                      SID length is decimal 32. SID on next line:
  02050026C0A8146F04130000000000000000000000000000504E3A340000000C
Chosen cipher suite:
000A                    TLS_RSA_WITH_3DES_EDE_CBC_SHA
00                      No compression in use.
Extensions found:
0005                    Length of extension field
FF01                    Renegotiation Request
000100                  Initial handshake, no renegotiation

----- Found X.509 Certificate -----

Hexadecimal value       Meaning
-----------------       -------
0296                    Certificate 1 is decimal 662

0275                    Certificate 2 is decimal 629


  Found 2 certificates
```

"Home Grown" Windows REXX exec that takes the trace and interprets it.

Certificate

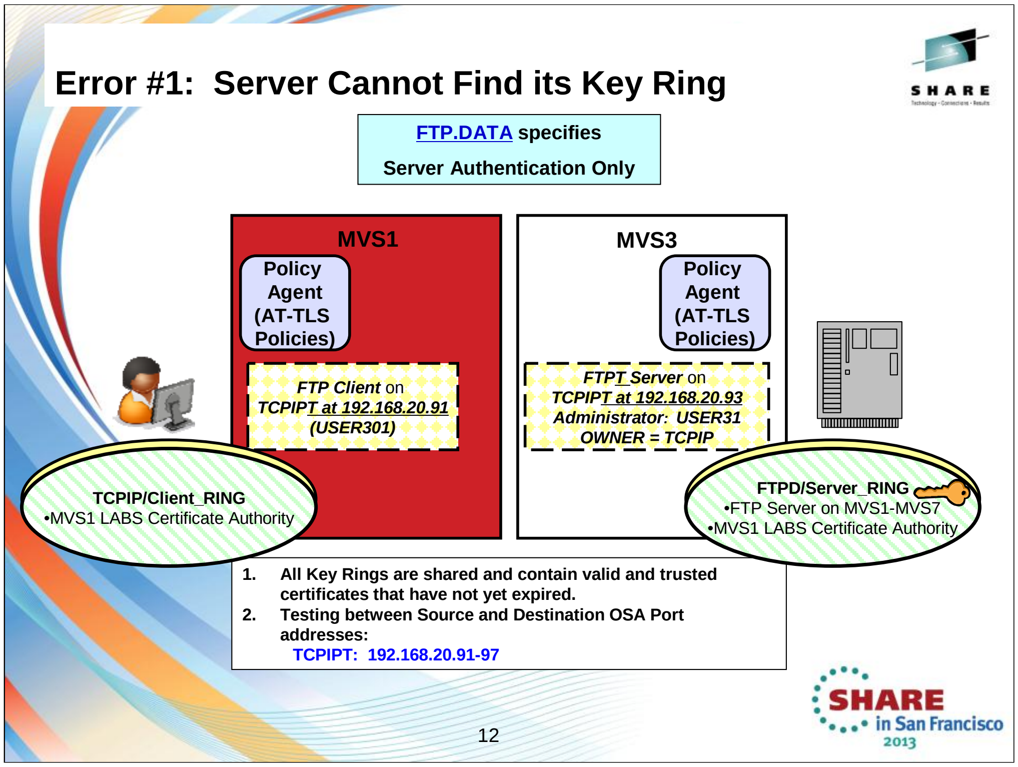
General | Details | Certification Path

Show: <All>

Field	Value
Signature hash algorithm	sha1
Issuer	MVS1CA.LABS.IBM.COM, MVS...
Valid from	Saturday, January 01, 2011 1...
Valid to	Thursday, December 31, 2015...
Subject	MVS1CA.LABS.IBM.COM, MVS...
Public key	RSA (1024 Bits)
Netscape Comment	Generated by the Security Ser...
Subject Key Identifier	fc 32 43 02 54 a2 c6 31 9c 70

Certificate Tool in the Windows Microsoft Management Center

This page illustrates a "home-grown" exec that strips out TLS wrappers and line formatting, and then converts the certificate into binary so that the Windows formatter can read it…



Error #1: Server Cannot Find its Key Ring

FTP.DATA specifies
Server Authentication Only

MVS1

Policy Agent (AT-TLS Policies)

FTP Client on
TCPIPT at 192.168.20.91
(USER301)

MVS3

Policy Agent (AT-TLS Policies)

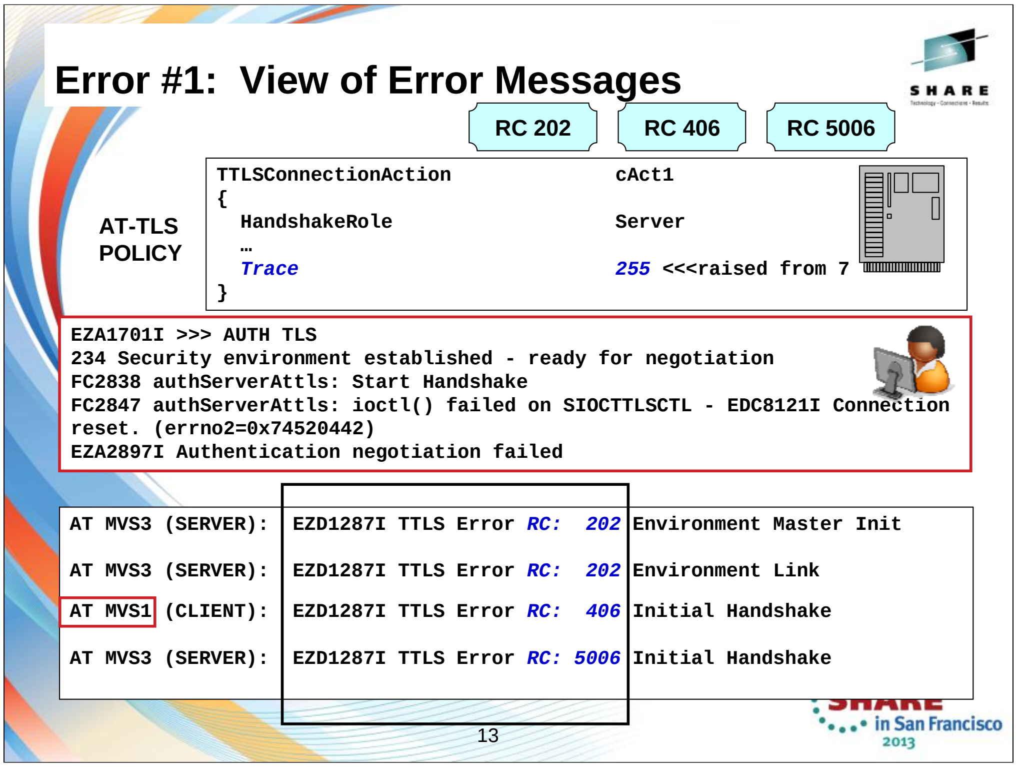
FTPT Server on
TCPIPT at 192.168.20.93
Administrator: USER31
OWNER = TCPIP

TCPIP/Client_RING
•MVS1 LABS Certificate Authority

FTPD/Server_RING
•FTP Server on MVS1-MVS7
•MVS1 LABS Certificate Authority

1. **All Key Rings are shared and contain valid and trusted certificates that have not yet expired.**
2. **Testing between Source and Destination OSA Port addresses:**
   TCPIPT: 192.168.20.91-97

Both FTP Servers are sharing the same Key Ring across all MVS Images. The Client Key Ring is also shared across all clients and MVS images.



Error #1: View of Error Messages

RC 202 RC 406 RC 5006

AT-TLS POLICY

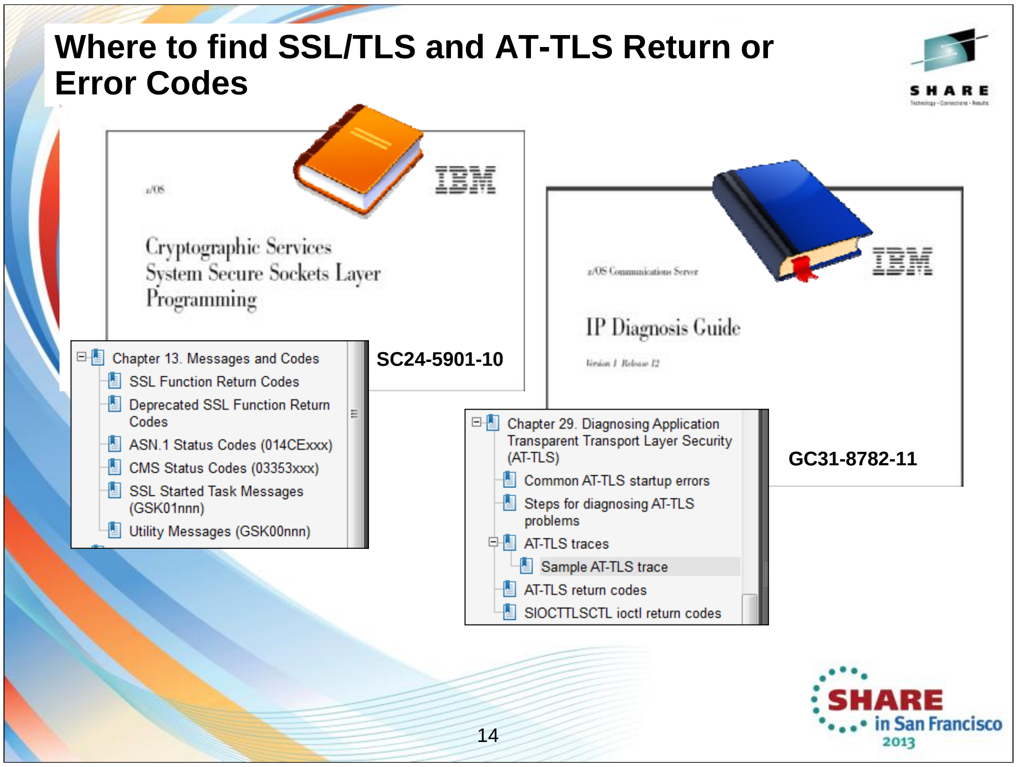
```
TTLSConnectionAction                cAct1
{
  HandshakeRole                     Server
  …
  Trace                             255 <<<raised from 7
}
```

```
EZA1701I >>> AUTH TLS
234 Security environment established - ready for negotiation
FC2838 authServerAttls: Start Handshake
FC2847 authServerAttls: ioctl() failed on SIOCTTLSCTL - EDC8121I Connection
reset. (errno2=0x74520442)
EZA2897I Authentication negotiation failed
```

```
AT MVS3 (SERVER): EZD1287I TTLS Error RC:  202 Environment Master Init

AT MVS3 (SERVER): EZD1287I TTLS Error RC:  202 Environment Link
AT MVS1 (CLIENT): EZD1287I TTLS Error RC:  406 Initial Handshake

AT MVS3 (SERVER): EZD1287I TTLS Error RC: 5006 Initial Handshake
```

We raised the trace level in the AT-TLS policy from 7 to 255, but perhaps we did not need to. Perhaps the messages on the MVS console are enough to solve this problem.

The server reset the connection – not the client. In addition, the server reported more errors than the client on the MVS console. We must examine the meaning of all these messages and the return codes.



Where to find SSL/TLS and AT-TLS Return or Error Codes

z/OS

Cryptographic Services
System Secure Sockets Layer
Programming

IBM

- Chapter 13. Messages and Codes
  - SSL Function Return Codes
  - Deprecated SSL Function Return Codes
  - ASN.1 Status Codes (014CExxx)
  - CMS Status Codes (03353xxx)
  - SSL Started Task Messages (GSK01nnn)
  - Utility Messages (GSK00nnn)

SC24-5901-10

z/OS Communications Server

IP Diagnosis Guide

Version 1 Release 12

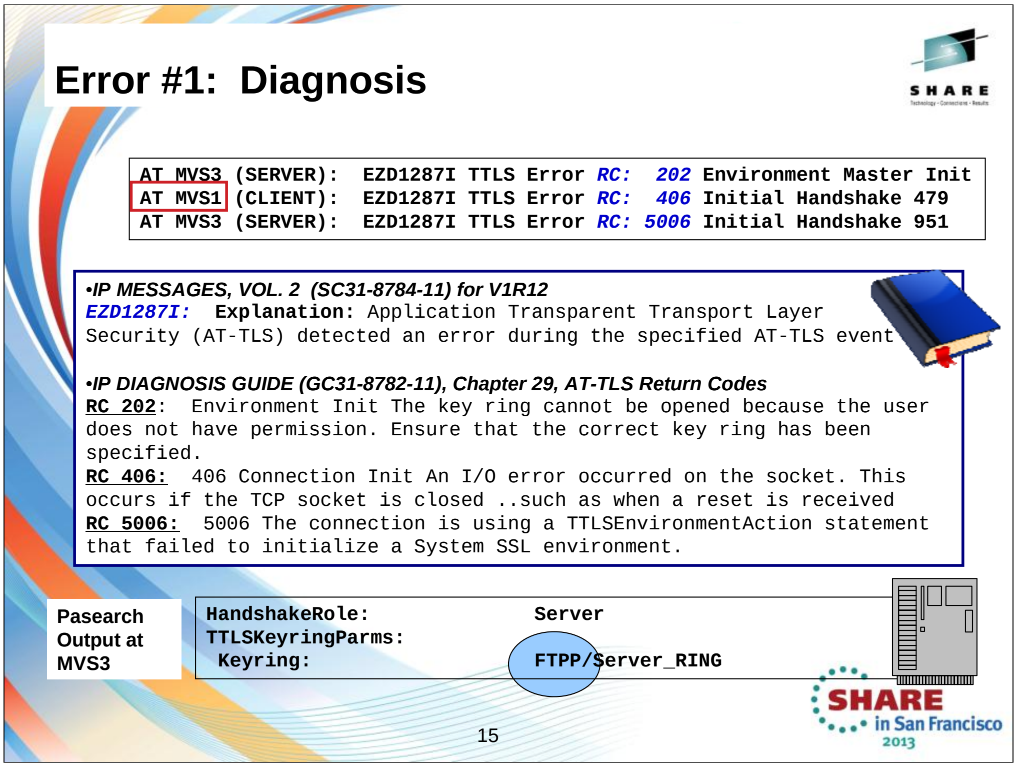
IBM

- Chapter 29. Diagnosing Application Transparent Transport Layer Security (AT-TLS)
  - Common AT-TLS startup errors
  - Steps for diagnosing AT-TLS problems
  - AT-TLS traces
    - Sample AT-TLS trace
  - AT-TLS return codes
  - SIOCTTLSCTL ioctl return codes

GC31-8782-11

14

Please reference all the materials listed in the appendix of this presentation. For now, these two documents suffice for our problem determination steps, as they contain the meanings of the SSL and AT-TLS return codes.



Error #1: Diagnosis

```
AT MVS3 (SERVER):  EZD1287I TTLS Error RC:  202 Environment Master Init
AT MVS1 (CLIENT):  EZD1287I TTLS Error RC:  406 Initial Handshake 479
AT MVS3 (SERVER):  EZD1287I TTLS Error RC: 5006 Initial Handshake 951
```

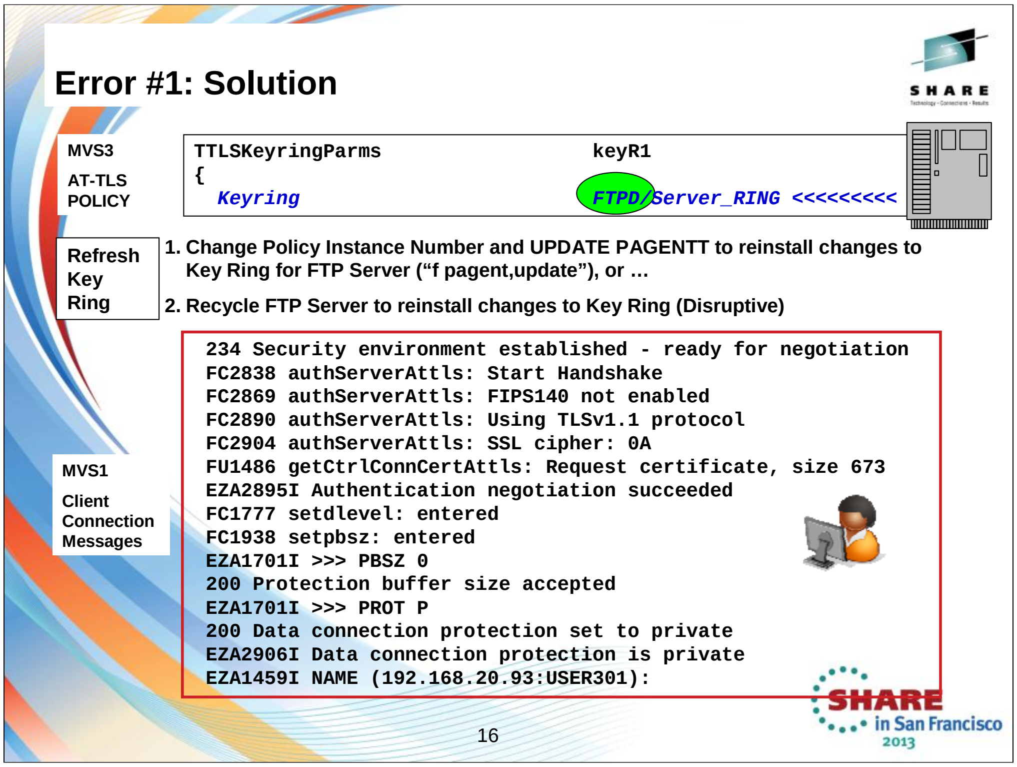
•*IP MESSAGES, VOL. 2 (SC31-8784-11) for V1R12*
EZD1287I: **Explanation:** Application Transparent Transport Layer Security (AT-TLS) detected an error during the specified AT-TLS event

•*IP DIAGNOSIS GUIDE (GC31-8782-11), Chapter 29, AT-TLS Return Codes*
RC 202: Environment Init The key ring cannot be opened because the user does not have permission. Ensure that the correct key ring has been specified.
RC 406: 406 Connection Init An I/O error occurred on the socket. This occurs if the TCP socket is closed ..such as when a reset is received
RC 5006: 5006 The connection is using a TTLSEnvironmentAction statement that failed to initialize a System SSL environment.

Pasearch Output at MVS3

```
HandshakeRole:                     Server
TTLSKeyringParms:
 Keyring:                          FTPP/Server_RING
```

The error messages and the return codes all point toward a problem at the Server side of the connection. The problem is related to the Handshake. We know that integral to the handshake is the exchange of negotiation parameters and certificates. The RC of 202 points to a problem that indicates that the server may not be able to find its keyring. And, in fact, that is the problem; There is a typo in the AT-TLS policy where the owner of the Key Ring was spelled wrong. The correct spelling is “FTPD” and not “FTPP.” We change the policy and we force System SSL to reinstall the keyring knowledge by raising what is called an INSTANCE Number for AT-TLS.



Error #1: Solution

MVS3

AT-TLS POLICY

```
TTLSKeyringParms                  keyR1
{
  Keyring                         FTPD/Server_RING <<<<<<<<<
```

Refresh Key Ring

1. Change Policy Instance Number and UPDATE PAGENTT to reinstall changes to Key Ring for FTP Server (“f pagent,update”), or …
2. Recycle FTP Server to reinstall changes to Key Ring (Disruptive)

MVS1

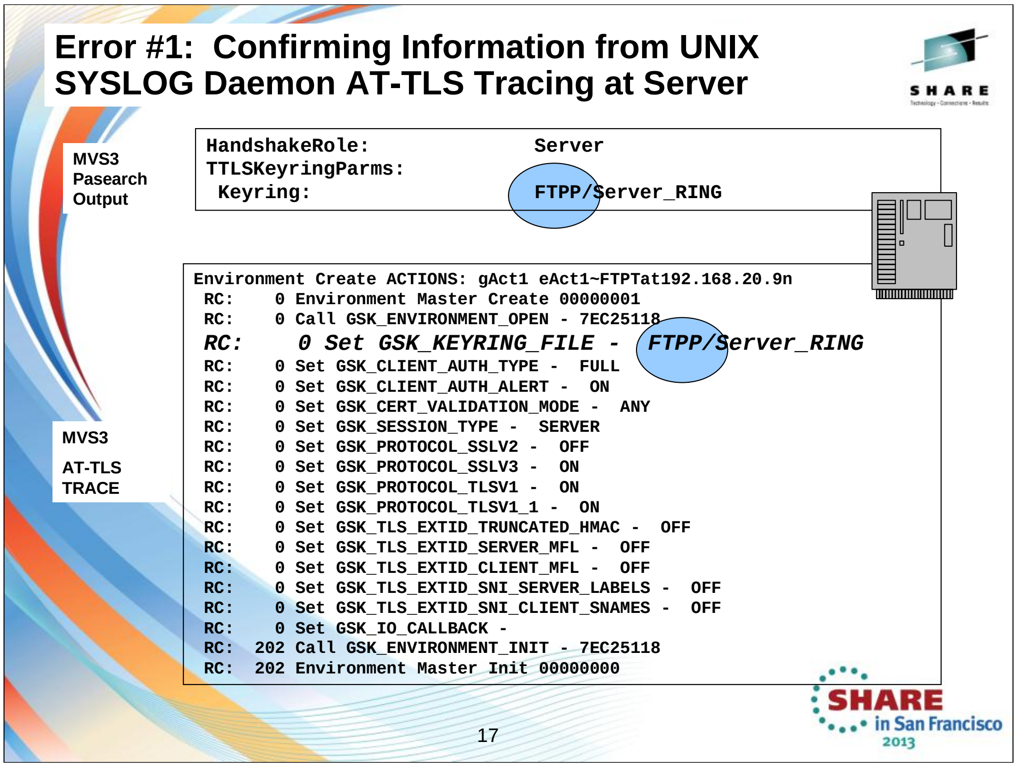
Client Connection Messages

```
234 Security environment established - ready for negotiation
FC2838 authServerAttls: Start Handshake
FC2869 authServerAttls: FIPS140 not enabled
FC2890 authServerAttls: Using TLSv1.1 protocol
FC2904 authServerAttls: SSL cipher: 0A
FU1486 getCtrlConnCertAttls: Request certificate, size 673
EZA2895I Authentication negotiation succeeded
FC1777 setdlevel: entered
FC1938 setpbsz: entered
EZA1701I >>> PBSZ 0
200 Protection buffer size accepted
EZA1701I >>> PROT P
200 Data connection protection set to private
EZA2906I Data connection protection is private
EZA1459I NAME (192.168.20.93:USER301):
```

We discovered that the key ring for the server was incorrectly specified as belonging to a USERID of FTPP. We corrected this to identify the true owner of this Key Ring (FTPD). When our client establishes a secured FTP connection this time, he is successful. The messages that the client sees due to our setup of the Client FTP.DATA file, we even recognize the actual cipher and TLS protocol that we are using for the sucessful negotiation and establishment.

This is an excerpt from the policy where you see we have increased the policy instance number for the server so that any update or refresh of the PAGENT procedure will cause System SSL to refresh the image of the Key Ring that is in memory for the FTP Server to use:

```
TTLSEnvironmentAction          eAct1~FTPTat192.168.20.9n
{
  HandshakeRole                Server
  EnvironmentUserInstance      1  <<<<<<<<<<<<<<<<<<<<<<<<  was 0 before
<<<<<<<<<<<<<<<<<<<<<<<<<<<<
  TTLSKeyringParmsRef          keyR1
}
```



Error #1: Confirming Information from UNIX SYSLOG Daemon AT-TLS Tracing at Server

MVS3
Pasearch
Output

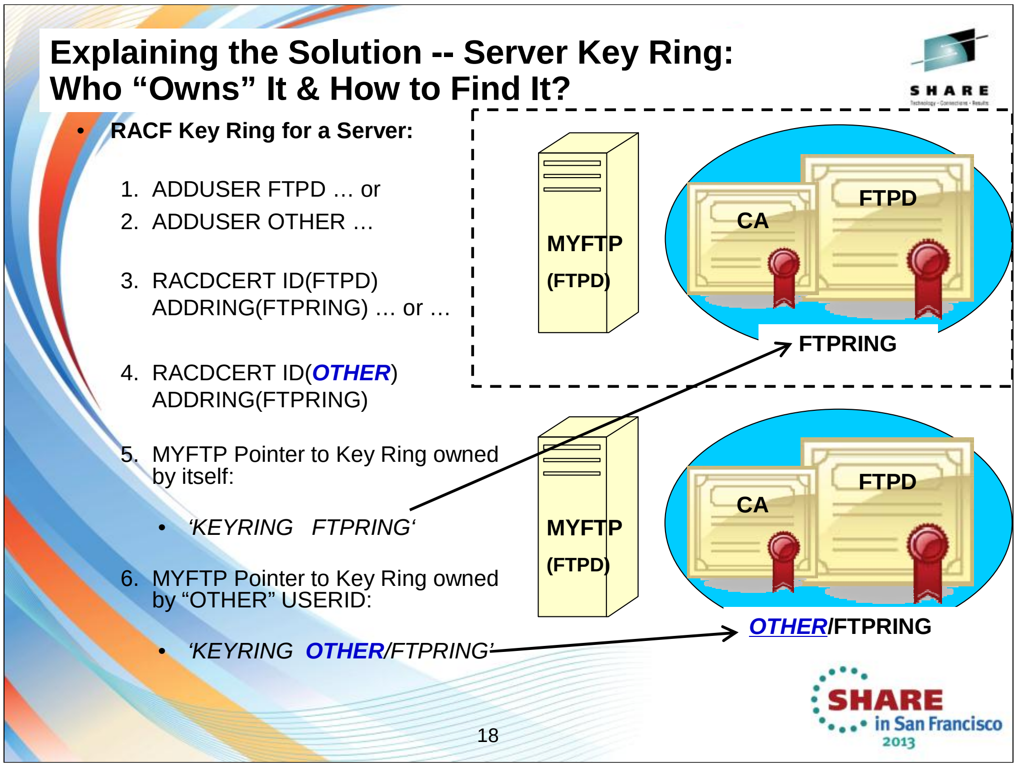
```
HandshakeRole:                  Server
TTLSKeyringParms:
 Keyring:                       FTPP/Server_RING
```

MVS3

AT-TLS
TRACE

```
Environment Create ACTIONS: gAct1 eAct1~FTPTat192.168.20.9n
 RC:     0 Environment Master Create 00000001
 RC:     0 Call GSK_ENVIRONMENT_OPEN - 7EC25118
 RC:     0 Set GSK_KEYRING_FILE -  FTPP/Server_RING
 RC:     0 Set GSK_CLIENT_AUTH_TYPE -  FULL
 RC:     0 Set GSK_CLIENT_AUTH_ALERT -  ON
 RC:     0 Set GSK_CERT_VALIDATION_MODE -  ANY
 RC:     0 Set GSK_SESSION_TYPE -  SERVER
 RC:     0 Set GSK_PROTOCOL_SSLV2 -  OFF
 RC:     0 Set GSK_PROTOCOL_SSLV3 -  ON
 RC:     0 Set GSK_PROTOCOL_TLSV1 -  ON
 RC:     0 Set GSK_PROTOCOL_TLSV1_1 -  ON
 RC:     0 Set GSK_TLS_EXTID_TRUNCATED_HMAC -  OFF
 RC:     0 Set GSK_TLS_EXTID_SERVER_MFL -  OFF
 RC:     0 Set GSK_TLS_EXTID_CLIENT_MFL -  OFF
 RC:     0 Set GSK_TLS_EXTID_SNI_SERVER_LABELS -  OFF
 RC:     0 Set GSK_TLS_EXTID_SNI_CLIENT_SNAMES -  OFF
 RC:     0 Set GSK_IO_CALLBACK -
 RC:   202 Call GSK_ENVIRONMENT_INIT - 7EC25118
 RC:   202 Environment Master Init 00000000
```

We were able to solve the problem without looking at the AT-TLS trace output from Policy Agent and the policy. But we show you that this trace would have also provided valuable information to solve the issue. And… this trace is easier to set up and take, with fewer steps, than the SYSTEM SSL Trace. However, there are times when you must provide a System SSL trace, and so it is wise to learn how to set one of these up. (System SSL trace is not a subject of this presentation.)



Explaining the Solution -- Server Key Ring: Who "Owns" It & How to Find It?

- **RACF Key Ring for a Server:**

1. ADDUSER FTPD … or
2. ADDUSER OTHER …
3. RACDCERT ID(FTPD) ADDRING(FTPRING) … or …
4. RACDCERT ID(***OTHER***) ADDRING(FTPRING)
5. MYFTP Pointer to Key Ring owned by itself:
   - *'KEYRING FTPRING'*
6. MYFTP Pointer to Key Ring owned by "OTHER" USERID:
   - *'KEYRING **OTHER**/FTPRING'*

18

1) Key Ring for a Server or a Client:

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER FTPD    DFLTGRP(OMVSGRP) OMVS(UID(0) HOME('/'))
NOPASSWORD
```

Create a Started Class definition for the Server and associate it with its OMVS Segment (i.e., its USERID or OWNER)

```
RDEFINE  STARTED  MYFTP*.*       STDATA(USER(FTPD))
```

Associate an x.509 Server Certificate with its OMVS Segment OWNER

```
RACDCERT ID(FTPD) GENCERT …
```

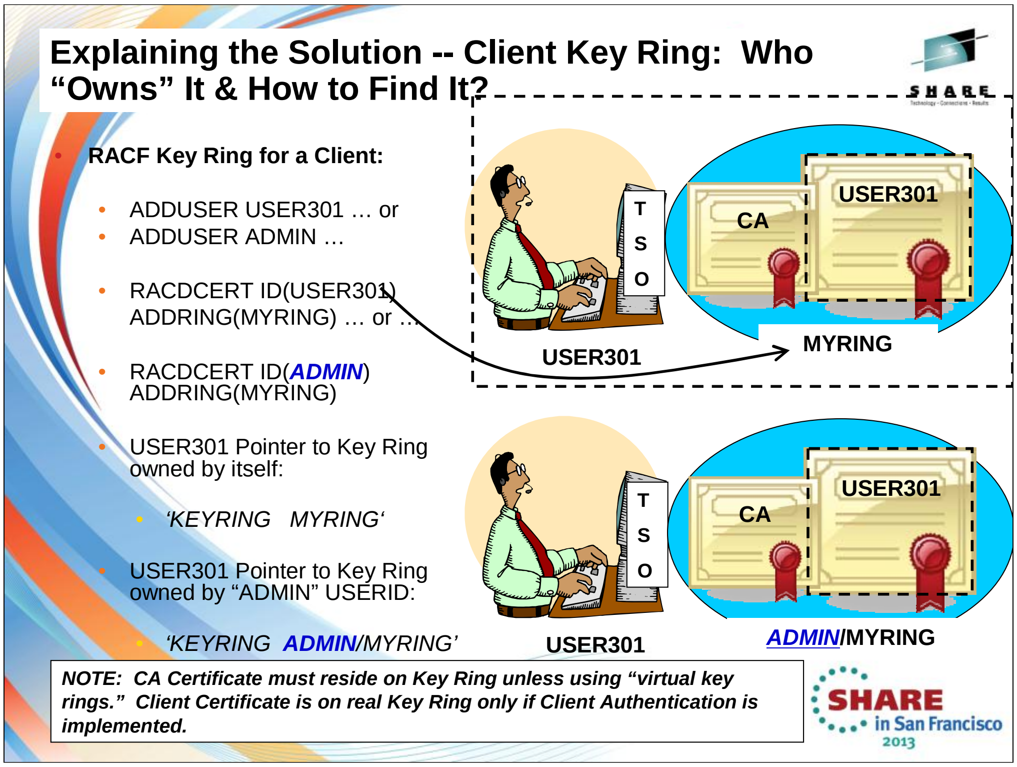
2) PERSONAL Certificate for a Client (Assumption: Client is a human user)

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER USER71    DFLTGRP(OMVSGRP) OMVS(UID(707) HOME('/u/user71'))
         …
```

Associate an x.509 Client Certificate with its OMVS Segment OWNER

```
RACDCERT ID(USER71) GENCERT …
```



Explaining the Solution -- Client Key Ring: Who "Owns" It & How to Find It?

- RACF Key Ring for a Client:
  - ADDUSER USER301 … or
  - ADDUSER ADMIN …
  - RACDCERT ID(USER301) ADDRING(MYRING) … or …
  - RACDCERT ID(***ADMIN***) ADDRING(MYRING)
  - USER301 Pointer to Key Ring owned by itself:
    - *'KEYRING MYRING'*
  - USER301 Pointer to Key Ring owned by "ADMIN" USERID:
    - *'KEYRING **ADMIN**/MYRING'*

NOTE: CA Certificate must reside on Key Ring unless using "virtual key rings." Client Certificate is on real Key Ring only if Client Authentication is implemented.

1) Key Ring for a Server or a Client:

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER FTPD    DFLTGRP(OMVSGRP) OMVS(UID(0) HOME('/'))
NOPASSWORD
```

Create a Started Class definition for the Server and associate it with its OMVS Segment (i.e., its USERID or OWNER)

```
RDEFINE  STARTED  MYFTP*.*       STDATA(USER(FTPD))
```

Associate an x.509 Server Certificate with its OMVS Segment OWNER

```
RACDCERT ID(FTPD) GENCERT …
```

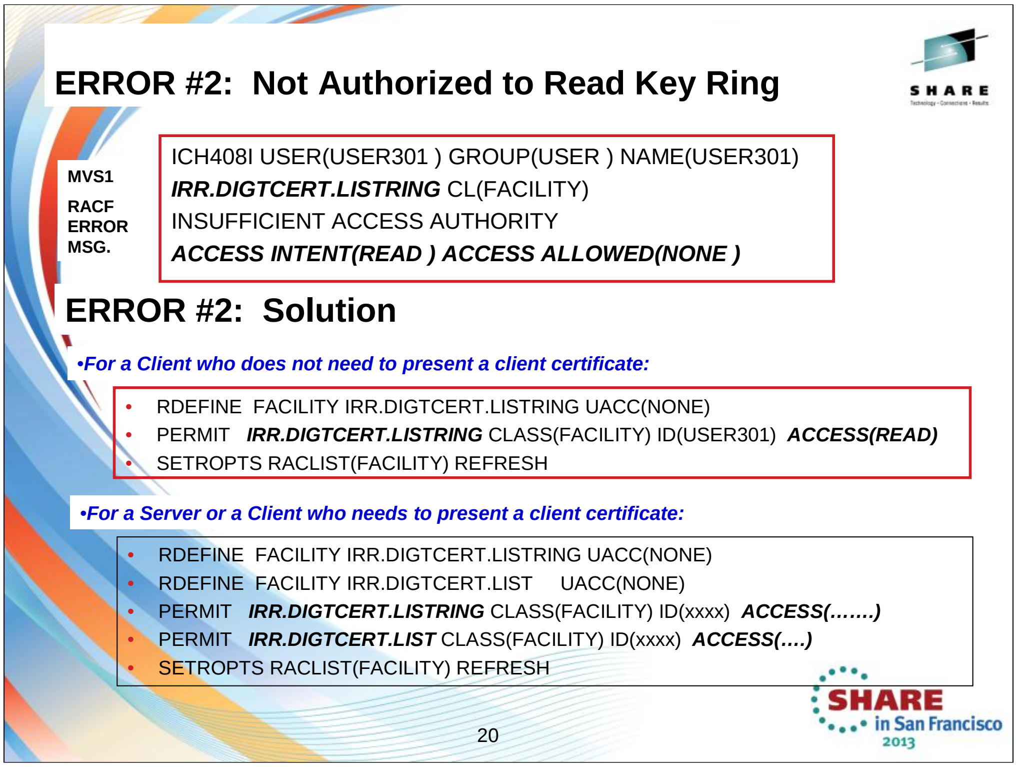
2) PERSONAL Certificate for a Client (Assumption: Client is a human user)

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER USER301    DFLTGRP(OMVSGRP) OMVS(UID(707)
HOME('/u/user301'))
         …
```

Associate an x.509 Client Certificate with its OMVS Segment OWNER

```
RACDCERT ID(USER301) GENCERT …
```



ERROR #2: Not Authorized to Read Key Ring

MVS1

RACF ERROR MSG.

```
ICH408I USER(USER301 ) GROUP(USER ) NAME(USER301)
IRR.DIGTCERT.LISTRING CL(FACILITY)
INSUFFICIENT ACCESS AUTHORITY
ACCESS INTENT(READ ) ACCESS ALLOWED(NONE )
```

ERROR #2: Solution

•For a Client who does not need to present a client certificate:

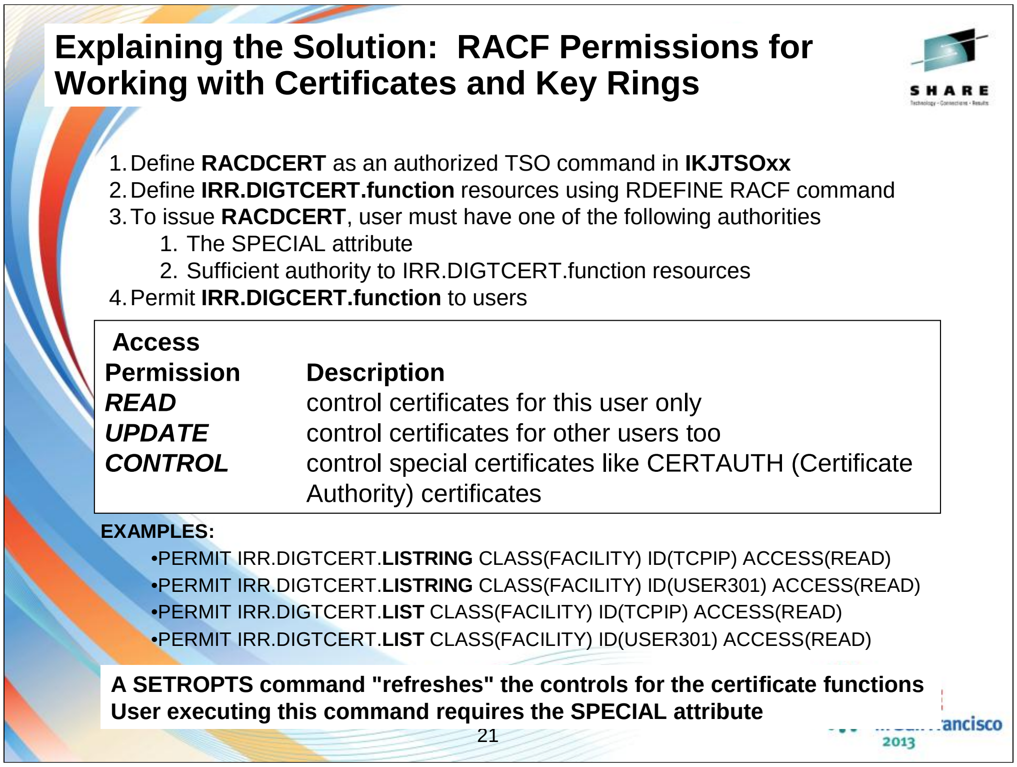
- RDEFINE FACILITY IRR.DIGTCERT.LISTRING UACC(NONE)
- PERMIT   ***IRR.DIGTCERT.LISTRING*** CLASS(FACILITY) ID(USER301) ***ACCESS(READ)***
- SETROPTS RACLIST(FACILITY) REFRESH

•For a Server or a Client who needs to present a client certificate:

- RDEFINE FACILITY IRR.DIGTCERT.LISTRING UACC(NONE)
- RDEFINE FACILITY IRR.DIGTCERT.LIST   UACC(NONE)
- PERMIT   ***IRR.DIGTCERT.LISTRING*** CLASS(FACILITY) ID(xxxx) ***ACCESS(…….)***
- PERMIT   ***IRR.DIGTCERT.LIST*** CLASS(FACILITY) ID(xxxx) ***ACCESS(….)***
- SETROPTS RACLIST(FACILITY) REFRESH

SHARE in San Francisco 2013

Here you see that the User could not open the key ring to be able to validate the received Server certificate against the client's stored copy of the CA certificate that signed the Server Certificate. The solution was simply to authorize the users of the key rings to open and read the key rings. RACF since V1R8 can also permit users to key rings on a more granular basis than what is depicted here. In our example we are permitting the users globally to real any key ring.



Explaining the Solution: RACF Permissions for Working with Certificates and Key Rings

1. Define **RACDCERT** as an authorized TSO command in **IKJTSOxx**
2. Define **IRR.DIGTCERT.function** resources using RDEFINE RACF command
3. To issue **RACDCERT**, user must have one of the following authorities
    1. The SPECIAL attribute
    2. Sufficient authority to IRR.DIGTCERT.function resources
4. Permit **IRR.DIGCERT.function** to users

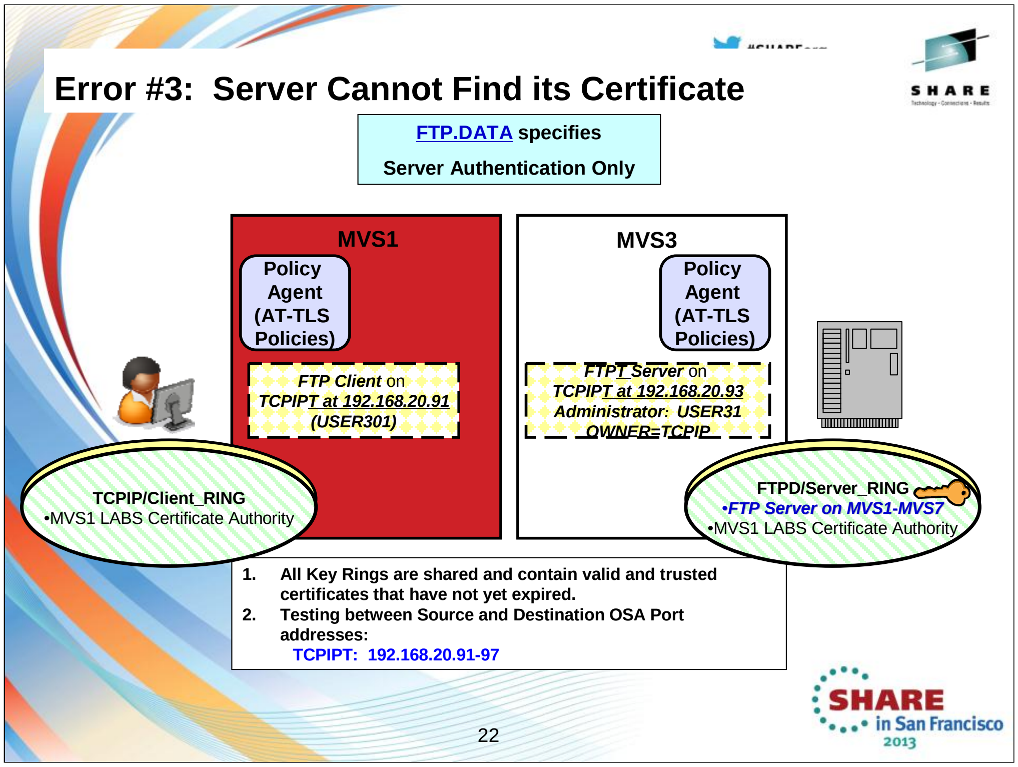
Access Permission	**Description**
READ	control certificates for this user only
UPDATE	control certificates for other users too
CONTROL	control special certificates like CERTAUTH (Certificate Authority) certificates

EXAMPLES:

- •PERMIT IRR.DIGTCERT.**LISTRING** CLASS(FACILITY) ID(TCPIP) ACCESS(READ)
- •PERMIT IRR.DIGTCERT.**LISTRING** CLASS(FACILITY) ID(USER301) ACCESS(READ)
- •PERMIT IRR.DIGTCERT.**LIST** CLASS(FACILITY) ID(TCPIP) ACCESS(READ)
- •PERMIT IRR.DIGTCERT.**LIST** CLASS(FACILITY) ID(USER301) ACCESS(READ)

A SETROPTS command "refreshes" the controls for the certificate functions
User executing this command requires the SPECIAL attribute

RACF since V1R8 can also permit users to key rings on a more granular basis than what is depicted here. In our example we are permitting the users globally to real any key ring.



Error #3: Server Cannot Find its Certificate

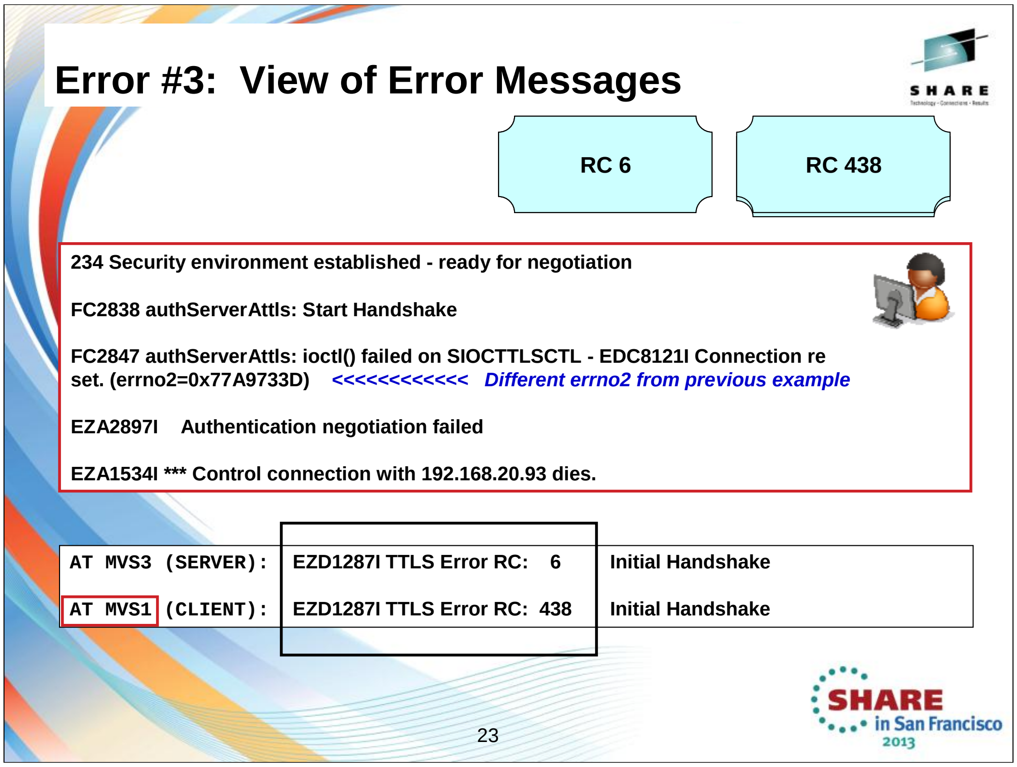
FTP.DATA specifies

Server Authentication Only

MVS1
Policy Agent (AT-TLS Policies)
FTP Client on TCPIPT at 192.168.20.91 (USER301)
TCPIP/Client_RING
•MVS1 LABS Certificate Authority
MVS3
Policy Agent (AT-TLS Policies)
FTPT Server on TCPIPT at 192.168.20.93 Administrator: USER31 OWNER=TCPIP
FTPD/Server_RING
•FTP Server on MVS1-MVS7
•MVS1 LABS Certificate Authority

1. All Key Rings are shared and contain valid and trusted certificates that have not yet expired.
2. Testing between Source and Destination OSA Port addresses:
   TCPIPT: 192.168.20.91-97

In this scenario, the FTP Server is unable to find the certificate it is supposed to present to the client during Server Authentication. The label of the certificate stored in RACF is “FTP Server on MVS1-MVS7”. The Key Ring name remains the same for FTPT server, but something has changed on the ring!



Error #3: View of Error Messages

RC 6

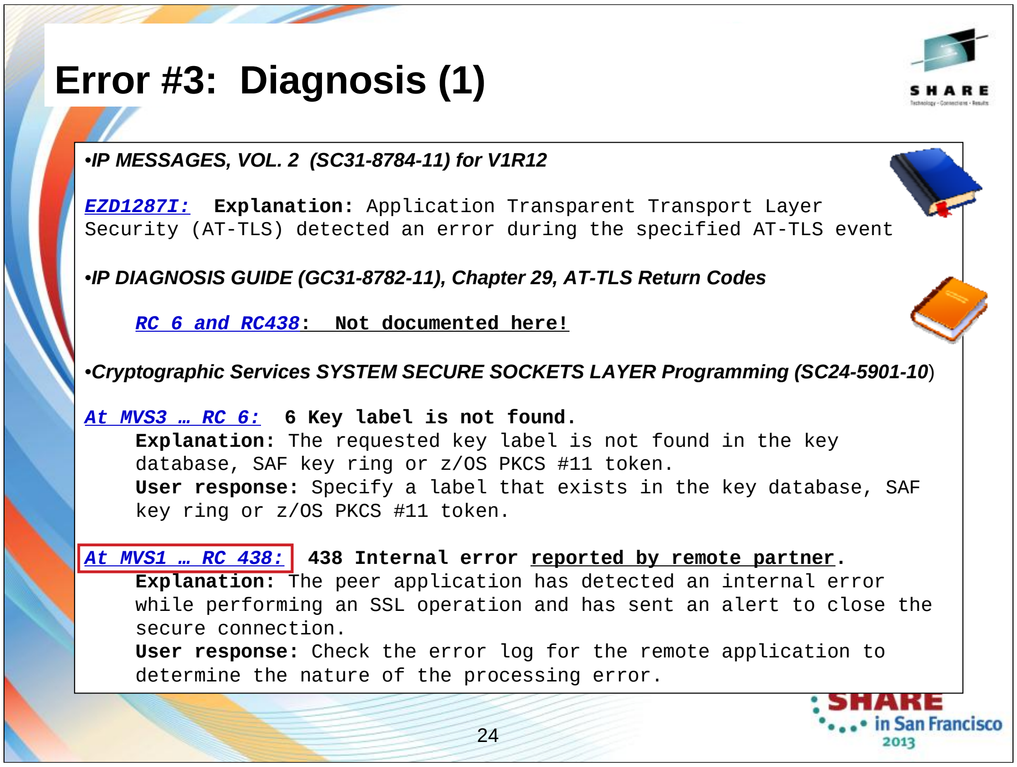
RC 438

```
234 Security environment established - ready for negotiation

FC2838 authServerAttls: Start Handshake

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

EZA2897I    Authentication negotiation failed

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

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

The FC2847 error with EDC8121I is difficult to diagnose, since these errno2 codes are not easy to find.

We must examine the meaning of all these SSL messages and the return codes. It appears that the remote end of the connection (The server) reset the connection. The server probably does not “like” what it saw when it tried to establish this connection.



Error #3: Diagnosis (1)

- *IP MESSAGES, VOL. 2 (SC31-8784-11) for V1R12*

EZD1287I: **Explanation:** Application Transparent Transport Layer Security (AT-TLS) detected an error during the specified AT-TLS event

- *IP DIAGNOSIS GUIDE (GC31-8782-11), Chapter 29, AT-TLS Return Codes*

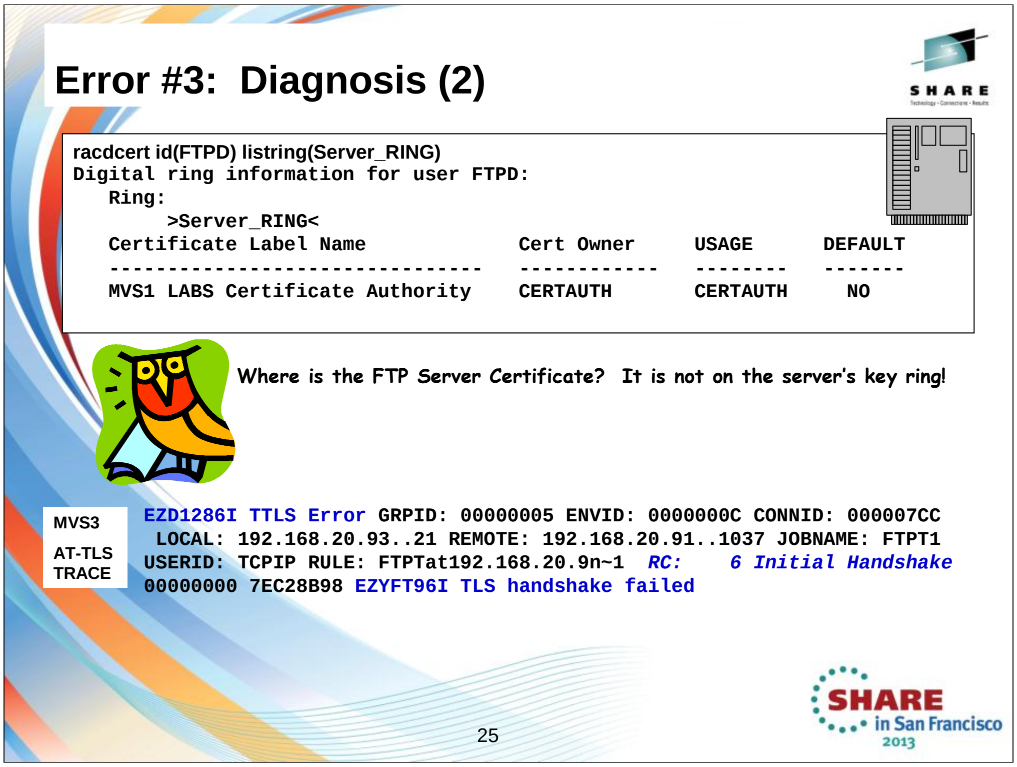
RC 6 and RC438: **Not documented here!**

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

At MVS3 … RC 6: **6 Key label is not found.**
Explanation: The requested key label is not found in the key database, SAF key ring or z/OS PKCS #11 token.
User response: Specify a label that exists in the key database, SAF key ring or z/OS PKCS #11 token.

At MVS1 … RC 438: **438 Internal error reported by remote partner.**
Explanation: The peer application has detected an internal error while performing an SSL operation and has sent an alert to close the secure connection.
User response: Check the error log for the remote application to determine the nature of the processing error.

The server reset the connection – not the client. RC438 seen at MVS1 confirms this. RC6 at MVS3 indicates a problem with finding the correct key label in the key database or ring. We need to look at the FTP Server's key ring on MVS3.



Error #3: Diagnosis (2)

racdcert id(FTPD) listring(Server_RING)

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

Where is the FTP Server Certificate? It is not on the server's key ring!

MVS3

AT-TLS TRACE

```
EZD1286I TTLS Error GRPID: 00000005 ENVID: 0000000C CONNID: 000007CC
 LOCAL: 192.168.20.93..21 REMOTE: 192.168.20.91..1037 JOBNAME: FTPT1
USERID: TCPIP RULE: FTPTat192.168.20.9n~1  RC:    6 Initial Handshake
00000000 7EC28B98 EZYFT96I TLS handshake failed
```

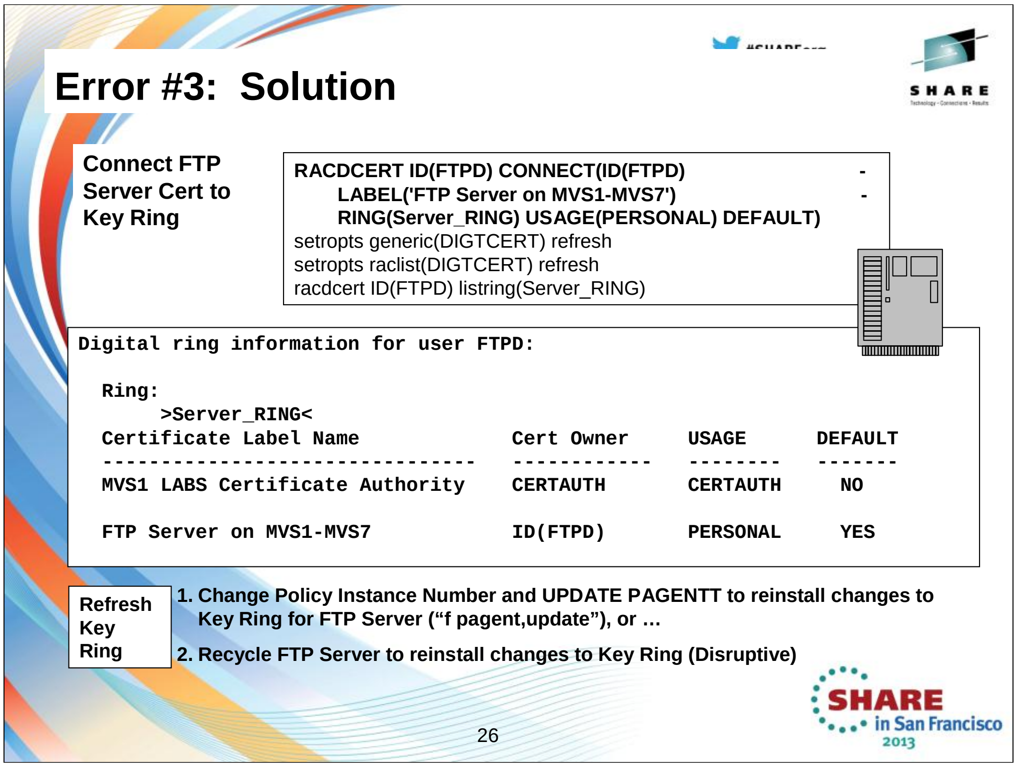
25

SHARE in San Francisco 2013

We already suspect that there is something wrong with the key ring at MVS3, and so we display it and discover that the FTP Server certificate, which has been requested by the Client to establish secure communications, has been omitted from the appropriate key ring.

The AT-TLS log or trace does not provide us with any more information than we already had; it just confirms that there was a problem with the initial handshake.

We can correct the error as you see with our JCL on the next visual.



Error #3: Solution

Connect FTP Server Cert to Key Ring

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

```
Digital ring information for user FTPD:

  Ring:
       >Server_RING<
  Certificate Label Name                Cert Owner     USAGE      DEFAULT
  --------------------------------      ------------   --------   -------
  MVS1 LABS Certificate Authority       CERTAUTH       CERTAUTH     NO

  FTP Server on MVS1-MVS7               ID(FTPD)       PERSONAL     YES
```

Refresh Key Ring

1. Change Policy Instance Number and UPDATE PAGENTT to reinstall changes to Key Ring for FTP Server ("f pagent,update"), or …
2. Recycle FTP Server to reinstall changes to Key Ring (Disruptive)

RACDCERT connects the missing certificate to the appropriate Key Ring; when we next display the key ring the certificate is finally there. We then need to refresh the FTP Server's knowledge of a changed key ring and certificate with one of the two steps at the bottom of the page.

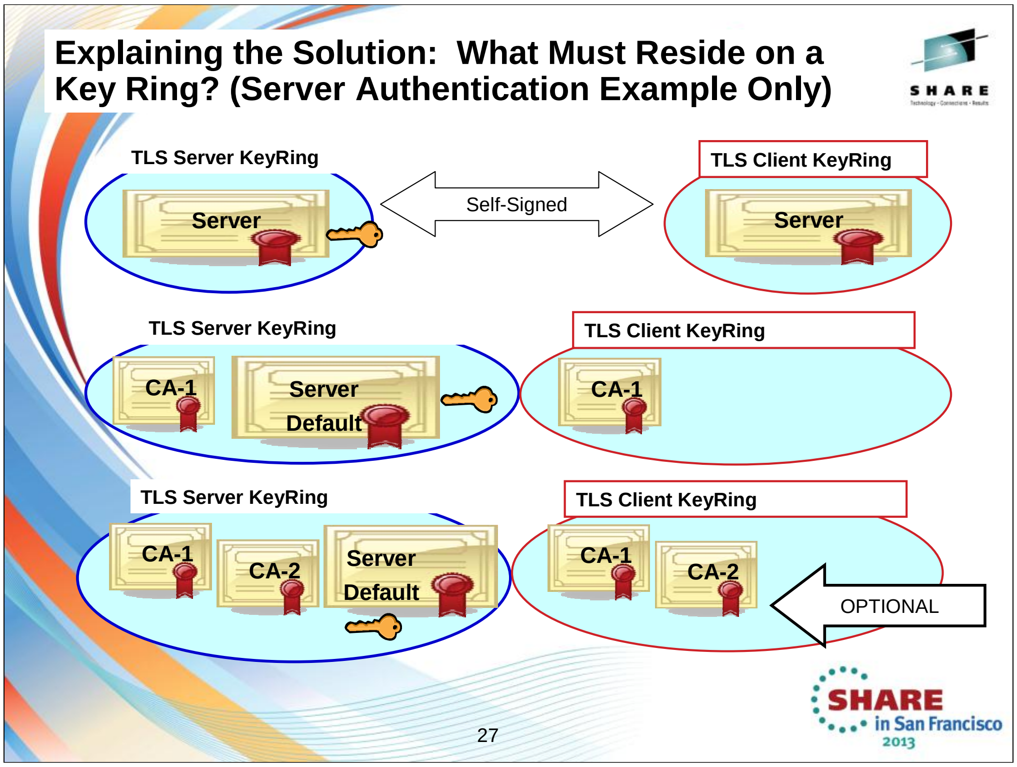
On the next visual you will see what needs to be on a key ring. These notes on this page contain the initial introduction to the concepts and the next visual provides more detail.

INTRO: What needs to be on a key ring or associated with a key ring??

A sender's key repository must contain all certificates that represent the full chain of trust for that sender.

A recipient's key repository must contain only the ROOT certificate associated with the sender's full chain of trust.

We show you here three examples of key ring configurations when using Server Authentication only for SSL/TLS or AT-TLS. In general, a TRUSTED Certificate or Certificate Chain and the PRIVATE Key of the End-Entity that owns the certificate is required. But whether or not the PRIVATE KEY need be available depends on whether mutual authentication is required or not. You see in the three examples that the client keyring needs no PRIVATE key associated with it if only Server Authentication is in use.



Explaining the Solution: What Must Reside on a Key Ring? (Server Authentication Example Only)

TLS Server KeyRing

Server

Self-Signed

TLS Client KeyRing

Server

TLS Server KeyRing

CA-1

Server Default

TLS Client KeyRing

CA-1

TLS Server KeyRing

CA-1

CA-2

Server Default

TLS Client KeyRing

CA-1

CA-2

OPTIONAL

SHARE in San Francisco 2013

Read the INTRO to this concept in the notes on the previous page.

In the first example, you see that we have deployed only a server certificate. In this case, the server's key ring or key repository must have access to the server's private key as well as to its own server certificate.

The Client's key ring needs a copy of the self-signed server certificate in order to validate the certificate that the Server sends to it during SSL/TLS or AT-TLS negotiation.

In the second example, you see that we have deployed a server certificate that has been signed by a CA certificate (CA1). In this case, the server's key ring or key repository must have access to the server's private key as well as to its own server certificate. It must also have access to the CA certificate that has signed the server certificate.

The Client's key ring needs a copy of the ROOT CA certificate that has signed the Server certificate in order to validate the certificate that the Server sends to it during SSL/TLS or AT-TLS negotiation.

In the third example, you see that we have deployed a server certificate that has been signed by a CA certificate (CA2), which itself has been signed by another root CA certificate (CA1). In this case, the server's key ring or key repository must have access to the server's private key as well as to its own server certificate. It must also have access to both CA certificates.

The Client's key ring needs a copy of the Server's ROOT CA certificate, but to avoid problems in case the Server does not send the full chain of trust, both CA certificates (Root and Intermediate) that were used to sign the server certificate are included on the keyring.

EXAMPLE:

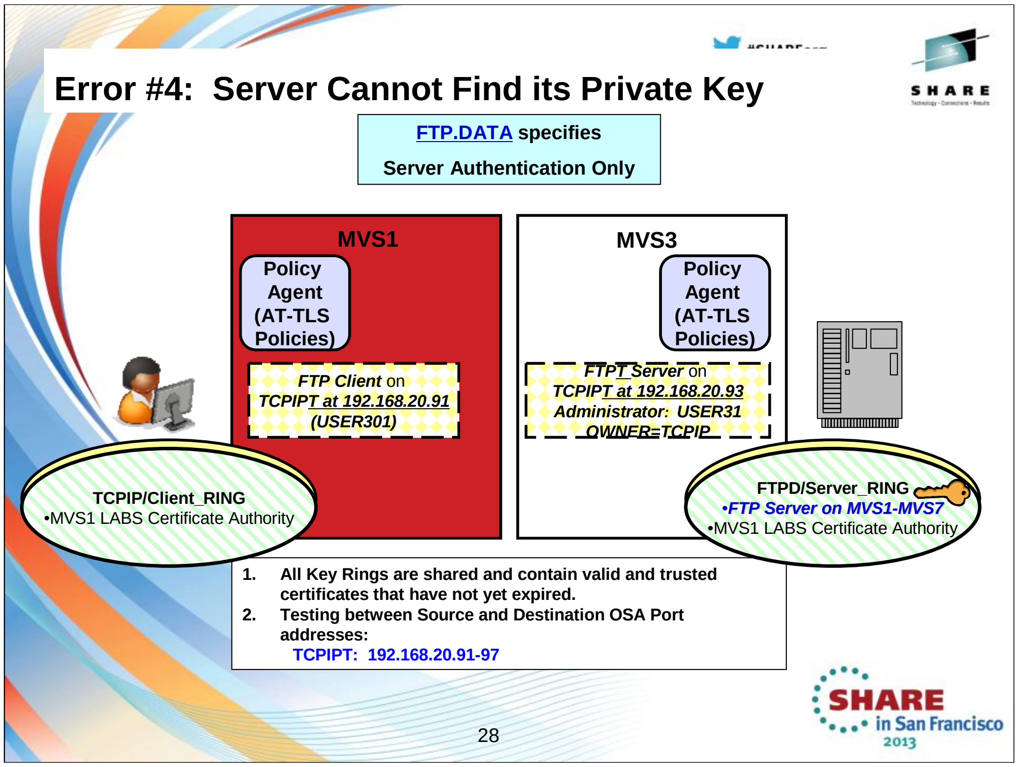
A local server key ring should contain:

The server certificate for the local End Entity.

The CA certificate that signed the local End Entity certificate.

The CA certificate that signed a remote End Entity certificate, if the negotiation requests Client Authentication.

The CA certificates that may have signed an Intermediate CA certificate that resides on the ring.



Error #4: Server Cannot Find its Private Key

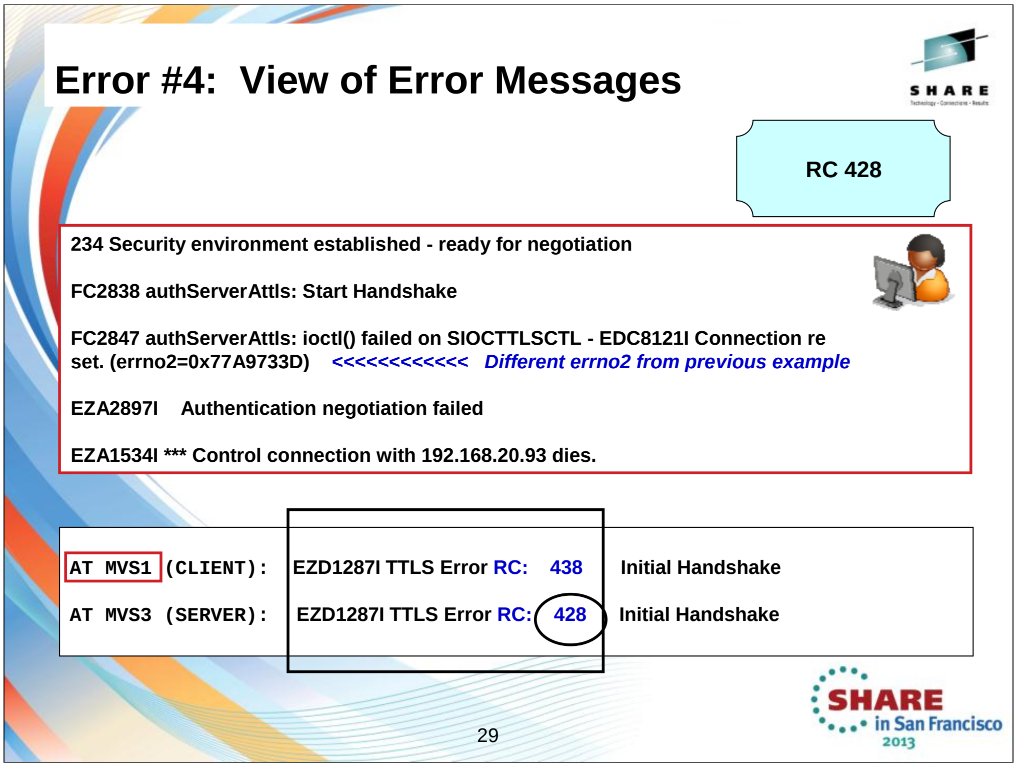
FTP.DATA specifies

Server Authentication Only

MVS1
Policy Agent (AT-TLS Policies)
FTP Client on TCPIPT at 192.168.20.91 (USER301)
TCPIP/Client_RING
•MVS1 LABS Certificate Authority
MVS3
Policy Agent (AT-TLS Policies)
FTPT Server on TCPIPT at 192.168.20.93 Administrator: USER31 OWNER=TCPIP
FTPD/Server_RING
•FTP Server on MVS1-MVS7
•MVS1 LABS Certificate Authority

1. All Key Rings are shared and contain valid and trusted certificates that have not yet expired.
2. Testing between Source and Destination OSA Port addresses:
   TCPIPT: 192.168.20.91-97

In this scenario, the FTP Server is still unable to find the certificate it is supposed to present to the client during Server Authentication. The label of the certificate stored in RACF is "FTP Server on MVS1-MVS7". The Key Ring name remains the same for FTPT server, but something has changed again on the ring!



Error #4: View of Error Messages

RC 428

234 Security environment established - ready for negotiation

FC2838 authServerAttls: Start Handshake

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

EZA2897I   Authentication negotiation failed

EZA1534I *** Control connection with 192.168.20.93 dies.

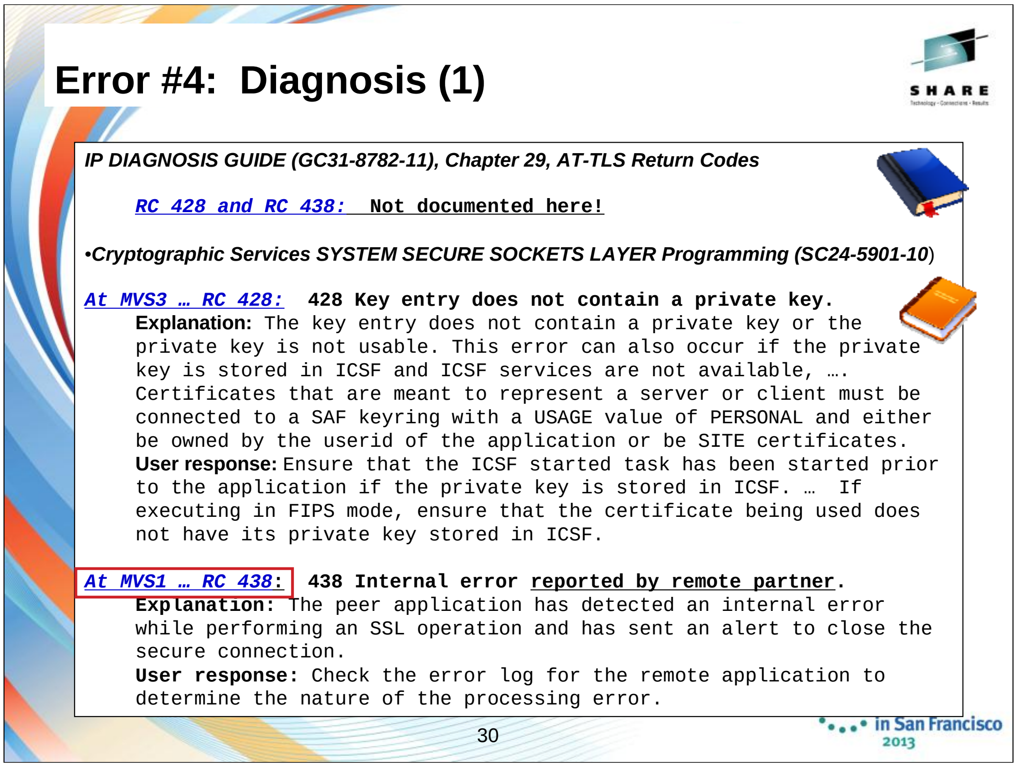
`AT MVS1 (CLIENT):`	EZD1287I TTLS Error RC: 438	Initial Handshake
`AT MVS3 (SERVER):`	EZD1287I TTLS Error RC: 428	Initial Handshake

SHARE in San Francisco 2013

As before, the FC2847 error with EDC8121I is difficult to diagnose, since these errno2 codes are not easy to find.

We must examine the meaning of all these SSL messages and the return codes again. Once again, It appears that the remote end of the connection (the server) reset the connection. The server probably does not “like” what it saw when it tried to establish this connection.

However, now we have a different TTLS Return Code to look at: RC 428.



Error #4: Diagnosis (1)

IP DIAGNOSIS GUIDE (GC31-8782-11), Chapter 29, AT-TLS Return Codes

RC 428 and RC 438: **Not documented here!**

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

At MVS3 … RC 428: **428 Key entry does not contain a private key.**

Explanation: The key entry does not contain a private key or the private key is not usable. This error can also occur if the private key is stored in ICSF and ICSF services are not available, …. Certificates that are meant to represent a server or client must be connected to a SAF keyring with a USAGE value of PERSONAL and either be owned by the userid of the application or be SITE certificates.

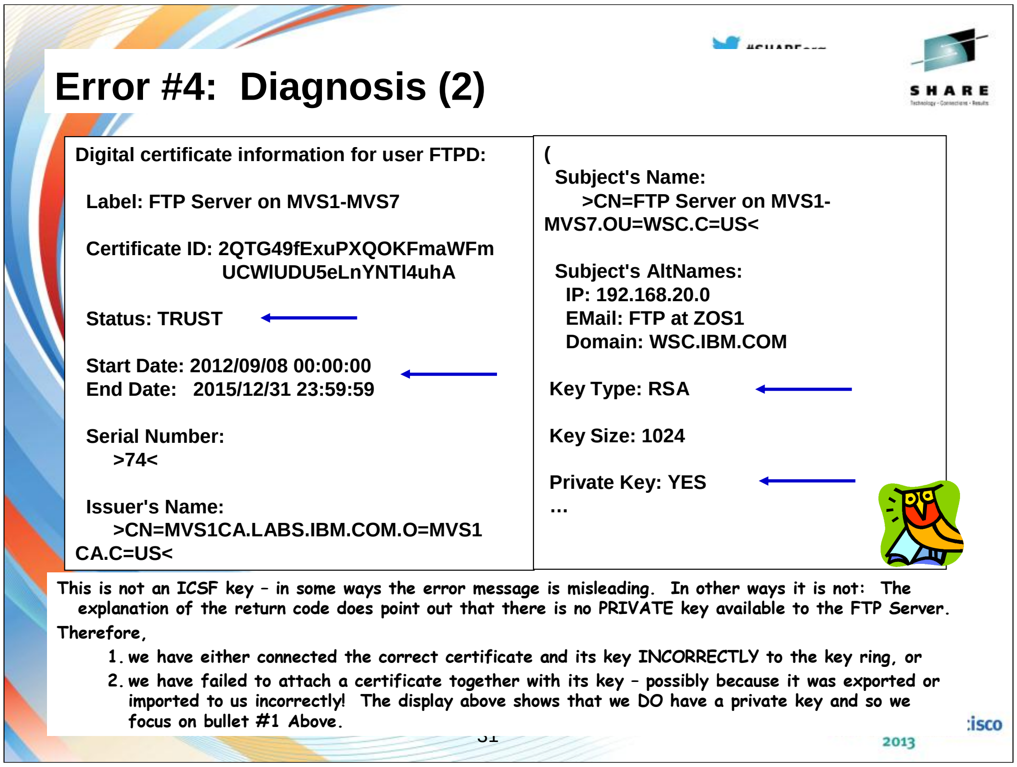
User response: Ensure that the ICSF started task has been started prior to the application if the private key is stored in ICSF. … If executing in FIPS mode, ensure that the certificate being used does not have its private key stored in ICSF.

At MVS1 … RC 438: **438 Internal error reported by remote partner.**

Explanation: The peer application has detected an internal error while performing an SSL operation and has sent an alert to close the secure connection.

User response: Check the error log for the remote application to determine the nature of the processing error.

The server reset the connection – not the client. RC438 seen at MVS1 confirms this. RC428 at MVS3 indicates a problem with finding the correct private key associated with the certificate that is supposed to be owned by the FTPT1 server. What we will discover is that RC of 428 can also mean simply that the certificate has been incorrectly added to the Key Ring – which is why the server cannot find the private key it needs.



Error #4: Diagnosis (2)

Digital certificate information for user FTPD:

Label: FTP Server on MVS1-MVS7

Certificate ID: 2QTG49fExuPXQOKFmaWFm
UCWlUDU5eLnYNTl4uhA

Status: TRUST

Start Date: 2012/09/08 00:00:00
End Date: 2015/12/31 23:59:59

Serial Number:
>74<

Issuer's Name:
>CN=MVS1CA.LABS.IBM.COM.O=MVS1
CA.C=US<

(
Subject's Name:
>CN=FTP Server on MVS1-
MVS7.OU=WSC.C=US<

Subject's AltNames:
IP: 192.168.20.0
EMail: FTP at ZOS1
Domain: WSC.IBM.COM

Key Type: RSA

Key Size: 1024

Private Key: YES
…

This is not an ICSF key – in some ways the error message is misleading. In other ways it is not: The explanation of the return code does point out that there is no PRIVATE key available to the FTP Server.

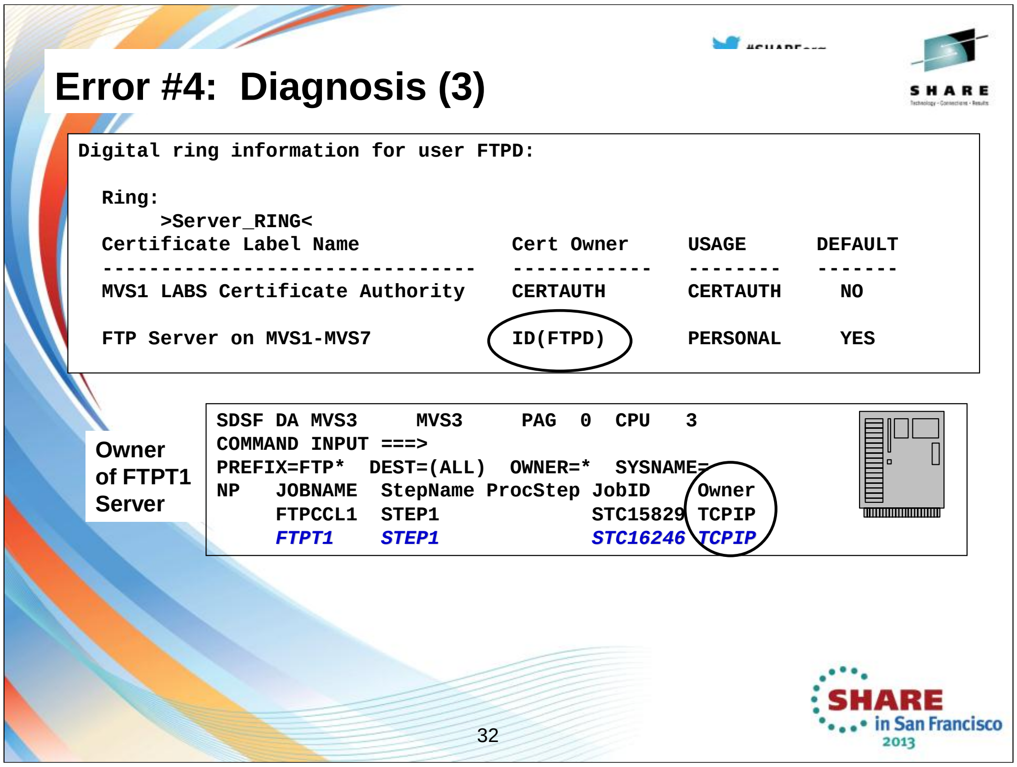
Therefore,

1. we have either connected the correct certificate and its key INCORRECTLY to the key ring, or
2. we have failed to attach a certificate together with its key – possibly because it was exported or imported to us incorrectly! The display above shows that we DO have a private key and so we focus on bullet #1 Above.

We once again display the FTPD/Server_RING Key Ring to verify that the certificate for the FTP server resides on the correct ring. We also reissue the SETROPTS commands to verify that address space storage has been updated with the correct copy of the key ring. We also re-issue the commands to Policy Agent to have it re-read what is in storage. We test the client again, and obtain the same error.

Then we look at the contents of the Certificate to see if we find anything unusual there – for example, are we actually using ICSF keys when we thought we were not? Are the dates fine -- although this is a long shot, since our error codes are not indicating expired certificates? Is the certificate in TRUST status? What type of Key are we using for the private key? (Not an ICSF key.) Therefore, the error messages indicating that perhaps ICSF was required in order to correct the problem was misleading in our case.

Something else is wrong. What is it?



Error #4: Diagnosis (3)

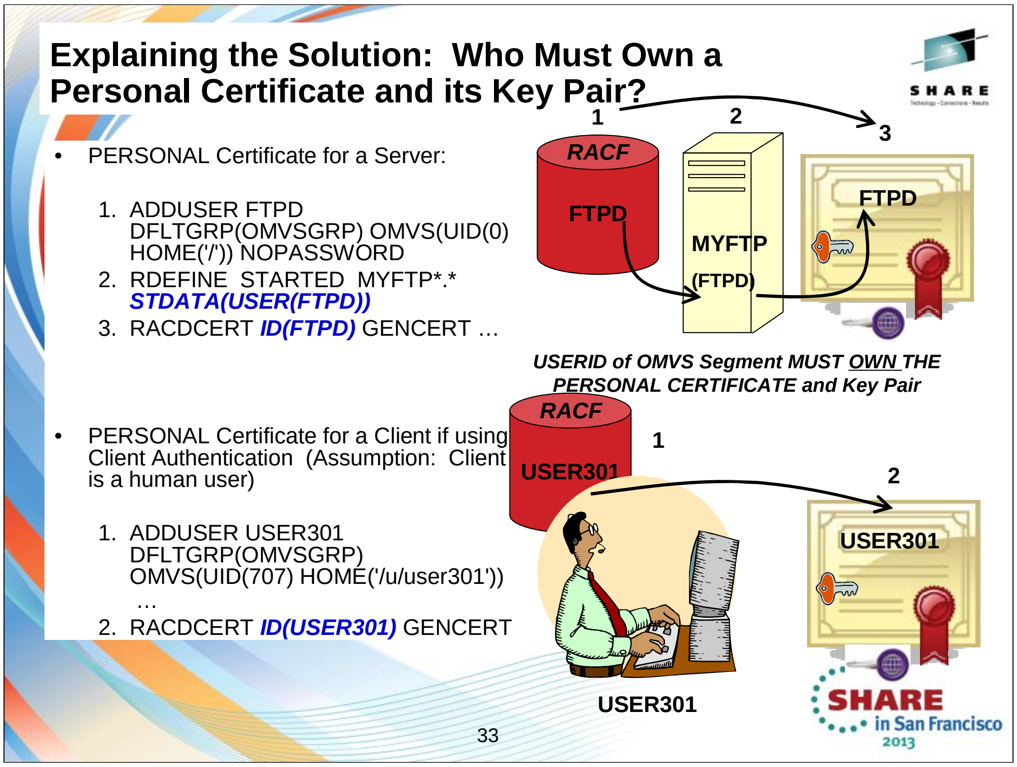
```
Digital ring information for user FTPD:

  Ring:
       >Server_RING<
  Certificate Label Name                Cert Owner     USAGE      DEFAULT
  --------------------------------      ------------   --------   -------
  MVS1 LABS Certificate Authority       CERTAUTH       CERTAUTH     NO

  FTP Server on MVS1-MVS7               ID(FTPD)       PERSONAL     YES
```

Owner of FTPT1 Server

```
SDSF DA MVS3     MVS3     PAG  0  CPU   3
COMMAND INPUT ===>
PREFIX=FTP*  DEST=(ALL)  OWNER=*  SYSNAME=
NP   JOBNAME  StepName ProcStep JobID    Owner
     FTPCCL1  STEP1             STC15829 TCPIP
     FTPT1    STEP1             STC16246 TCPIP
```

32

The ICSF clue was a false lead. We must look for something else that does not look right. And we find it when we look at the key ring and look at the FTPT1 server. There it is: The server is running with an OMVS segment that identifies TCPIP as the owner; but the Certificate has been attached to the RACF key ring indicating something quite different: There, the certificate owner is identified as “FTPD” and not “TCPIP.”



Explaining the Solution: Who Must Own a Personal Certificate and its Key Pair?

- PERSONAL Certificate for a Server:

  1. ADDUSER FTPD DFLTGRP(OMVSGRP) OMVS(UID(0) HOME('/')) NOPASSWORD
  2. RDEFINE STARTED MYFTP*.* ***STDATA(USER(FTPD))***
  3. RACDCERT ***ID(FTPD)*** GENCERT …

USERID of OMVS Segment MUST OWN THE PERSONAL CERTIFICATE and Key Pair

- PERSONAL Certificate for a Client if using Client Authentication (Assumption: Client is a human user)

  1. ADDUSER USER301 DFLTGRP(OMVSGRP) OMVS(UID(707) HOME('/u/user301')) …
  2. RACDCERT ***ID(USER301)*** GENCERT

The PUBLIC key of the key pair resides in the Personal Certificate; the PRIVATE key of the key pair is associated with the Personal Certificate and its OMVS Segment Owner.

1) PERSONAL Certificate for a Server:

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER FTPD    DFLTGRP(OMVSGRP) OMVS(UID(0) HOME('/'))
NOPASSWORD
```

Create a Started Class definition for the Server and associate it with its OMVS Segment (i.e., its USERID or OWNER)

```
RDEFINE  STARTED  MYFTP*.*        STDATA(USER(FTPD))
```

Associate an x.509 Server Certificate with its OMVS Segment OWNER

```
RACDCERT ID(FTPD) GENCERT …
```

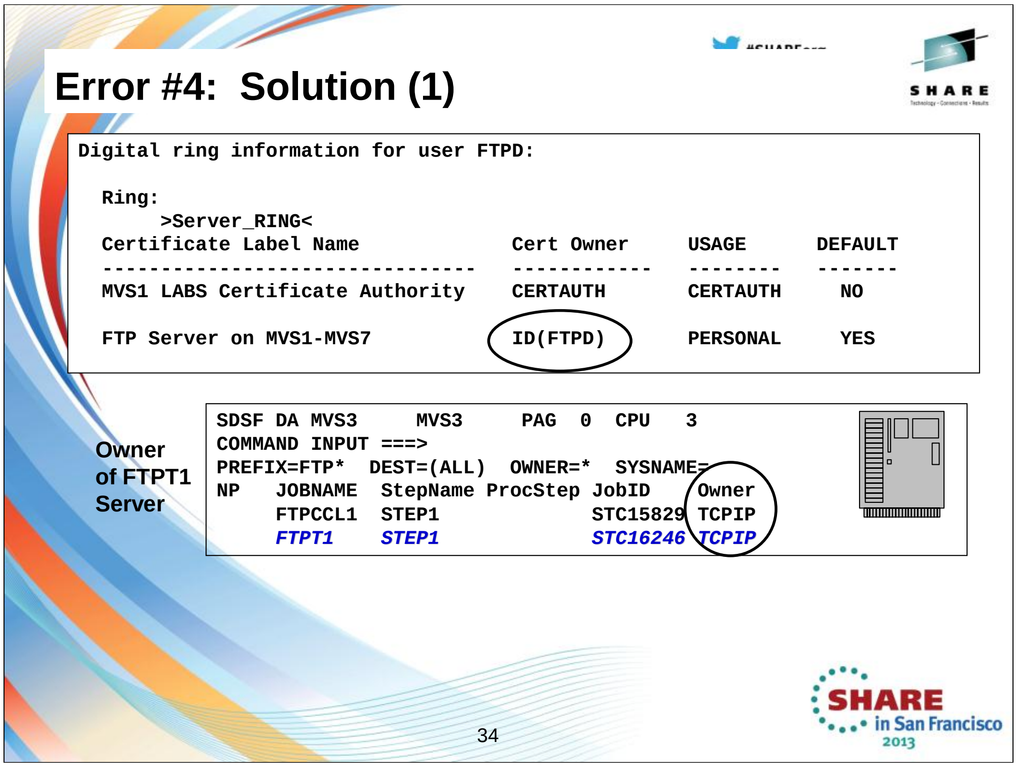
2) PERSONAL Certificate for a Client (Assumption: Client is a human user)

Define a USERID and assign an OMVS (UNIX) Identity to it:

```
ADDUSER USER71    DFLTGRP(OMVSGRP) OMVS(UID(707) HOME('/u/user71'))
        …
```

Associate an x.509 Client Certificate with its OMVS Segment OWNER

```
RACDCERT ID(USER71) GENCERT …
```



Error #4: Solution (1)

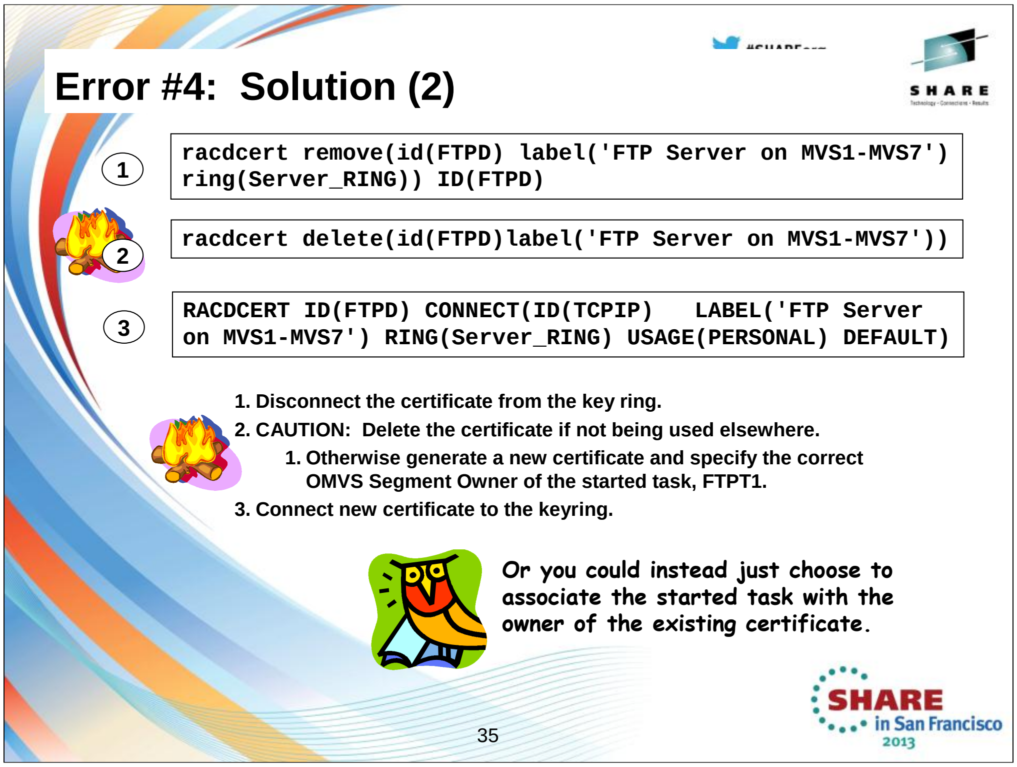
```
Digital ring information for user FTPD:

  Ring:
       >Server_RING<
  Certificate Label Name              Cert Owner     USAGE      DEFAULT
  --------------------------------    ------------   --------   -------
  MVS1 LABS Certificate Authority     CERTAUTH       CERTAUTH     NO

  FTP Server on MVS1-MVS7             ID(FTPD)       PERSONAL     YES
```

Owner of FTPT1 Server

```
SDSF DA MVS3     MVS3     PAG  0  CPU   3
COMMAND INPUT ===>
PREFIX=FTP*  DEST=(ALL)  OWNER=*  SYSNAME=
NP   JOBNAME  StepName ProcStep JobID    Owner
     FTPCCL1  STEP1             STC15829 TCPIP
     FTPT1    STEP1             STC16246 TCPIP
```

The ICSF clue was a false lead. We must look for something else that does not look right. And we find it when we look at the key ring and look at the FTPT1 server. There it is: The server is running with an OMVS segment that identifies TCPIP as the owner; but the Certificate has been attached to the RACF key ring indicating something quite different: There, the certificate owner is identified as “FTPD” and not “TCPIP.”

For the solution we choose to disconnect the certificate from the key ring and then reconnect it while specifying the correct OMVS Segment Userid.



Error #4: Solution (2)

1
```
racdcert remove(id(FTPD) label('FTP Server on MVS1-MVS7')
ring(Server_RING)) ID(FTPD)
```

2
```
racdcert delete(id(FTPD)label('FTP Server on MVS1-MVS7'))
```

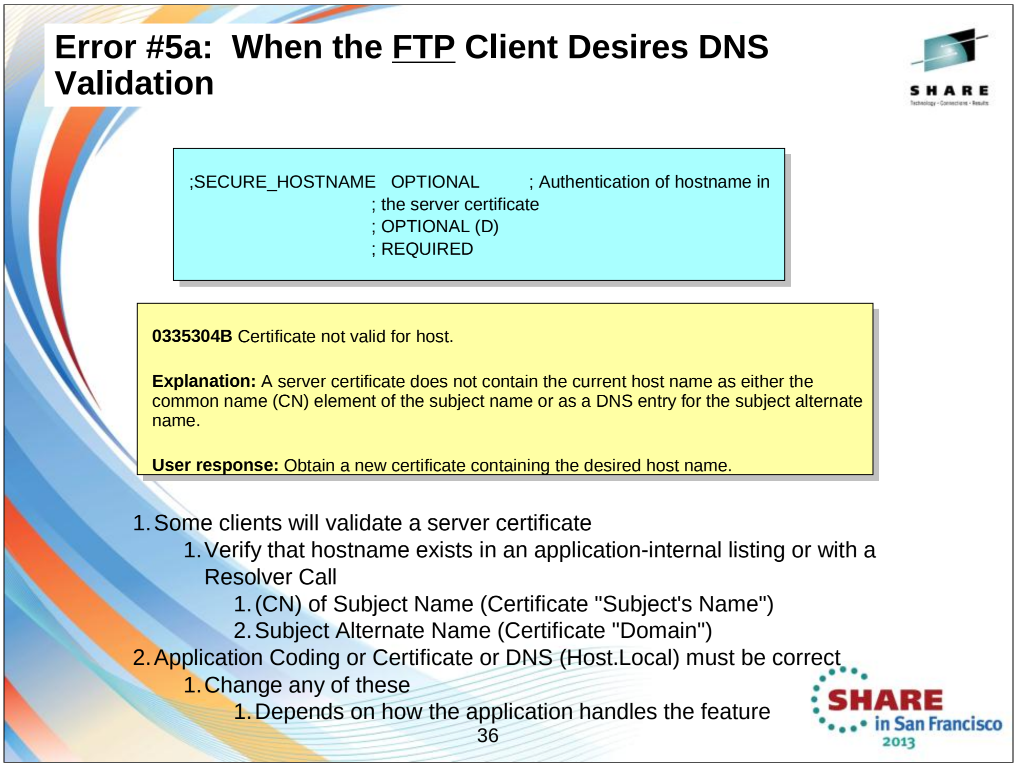
3
```
RACDCERT ID(FTPD) CONNECT(ID(TCPIP)   LABEL('FTP Server
on MVS1-MVS7') RING(Server_RING) USAGE(PERSONAL) DEFAULT)
```

1. Disconnect the certificate from the key ring.
2. CAUTION: Delete the certificate if not being used elsewhere.
   1. Otherwise generate a new certificate and specify the correct OMVS Segment Owner of the started task, FTPT1.
3. Connect new certificate to the keyring.

Or you could instead just choose to associate the started task with the owner of the existing certificate.

35

This visual describes the steps you could take to correct the problem.



Error #5a: When the FTP Client Desires DNS Validation

```
;SECURE_HOSTNAME   OPTIONAL         ; Authentication of hostname in
                                    ; the server certificate
                                    ; OPTIONAL (D)
                                    ; REQUIRED
```

0335304B Certificate not valid for host.

Explanation: A server certificate does not contain the current host name as either the common name (CN) element of the subject name or as a DNS entry for the subject alternate name.

User response: Obtain a new certificate containing the desired host name.

1. Some clients will validate a server certificate
    1. Verify that hostname exists in an application-internal listing or with a Resolver Call
        1. (CN) of Subject Name (Certificate "Subject's Name")
        2. Subject Alternate Name (Certificate "Domain")
2. Application Coding or Certificate or DNS (Host.Local) must be correct
    1. Change any of these
        1. Depends on how the application handles the feature

36

Here you see an example of an option you can set in the FTP Client.

Not all clients avail themselves of this feature to request validation of a server certificate by checking to see if its entries match anything in the Client's DNS or Host.Local file.

You must know your client before you request a certificate ... or you must plan for all cases and use the ALTNAME certificate extensions so that, if necessary, you can update a DNS or a Host Local file with a new entry. This is usually less expensive that buying a new certificate. (If you are creating your own certificates expense or time delays are probably not an issue.)

System SSL will validate the host name against the DNS entry in the subject alternate name extension.

The host name in the certificate can be

•a fully-qualified name (e.g., 'dcesec4.endicott.ibm.com'),

•a domain suffix (e.g., '.endicott.ibm.com') or

•a wildcard name beginning with an asterisk (e.g., '*.endicott.ibm.com').

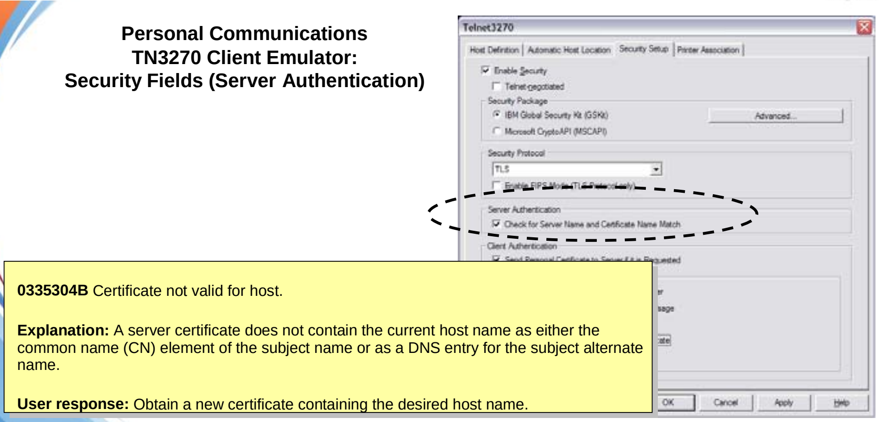
A case-sensitive comparison is performed between the supplied host name and the host name in the certificate. A fully-qualified name must be the same as the supplied host name. A domain suffix matches any host name with the same suffix but does not match the suffix itself. For example, '*.endicott.ibm.com'

The status code in the example is a Certificate Management Services (CMS) Status Codes as documented in the Cryptographic Services System Secure Sockets Layer Programming manual (SC24-5901-07).

This type of feature allows an application to provide a list of hostnames that AT-TLS will compare against the hostname in the certificate. A return code back to the application indicates whether a match was found or not. Based on that return code, the application can decide whether or not to continue the session. Obviously, though, this approach relies on the application to determine the acceptable hostnames, be it through DNS or any other method.

Error #5b: When the TN3270 Client Desires DNS Validation

Personal Communications
TN3270 Client Emulator:
Security Fields (Server Authentication)



Telnet3270

☑ Enable Security
☐ Telnet-negotiated

Security Package
● IBM Global Security Kit (GSKit)
○ Microsoft CryptoAPI (MSCAPI)

Security Protocol
TLS
☐ Enable FIPS Mode (TLS Protocol only)

Server Authentication
☑ Check for Server Name and Certificate Name Match

Client Authentication
☑ Send Personal Certificate to Server if it is Requested

0335304B Certificate not valid for host.

Explanation: A server certificate does not contain the current host name as either the common name (CN) element of the subject name or as a DNS entry for the subject alternate name.

User response: Obtain a new certificate containing the desired host name.

1. Some clients will validate a server certificate
    1. Verify that hostname exists in an application-internal listing or with a Resolver Call
        1. (CN) of Subject Name (Certificate "Subject's Name")
        2. Subject Alternate Name (Certificate "Domain")
2. Application Coding or Certificate or DNS (Host.Local) must be correct
    1. Change any of these
        1. Depends on how the application handles the feature

Here you see an example of an option you can set in the TN3270 Server.

Not all clients avail themselves of this feature to request validation of a server certificate by checking to see if its entries match anything in the Client's DNS or Host.Local file.

You must know your client before you request a certificate ... or you must plan for all cases and use the ALTNAME certificate extensions so that, if necessary, you can update a DNS or a Host Local file with a new entry. This is usually less expensive that buying a new certificate. (If you are creating your own certificates expense or time delays are probably not an issue.)

System SSL will validate the host name against the DNS entry in the subject alternate name extension.

The host name in the certificate can be

•a fully-qualified name (e.g., 'dcesec4.endicott.ibm.com'),

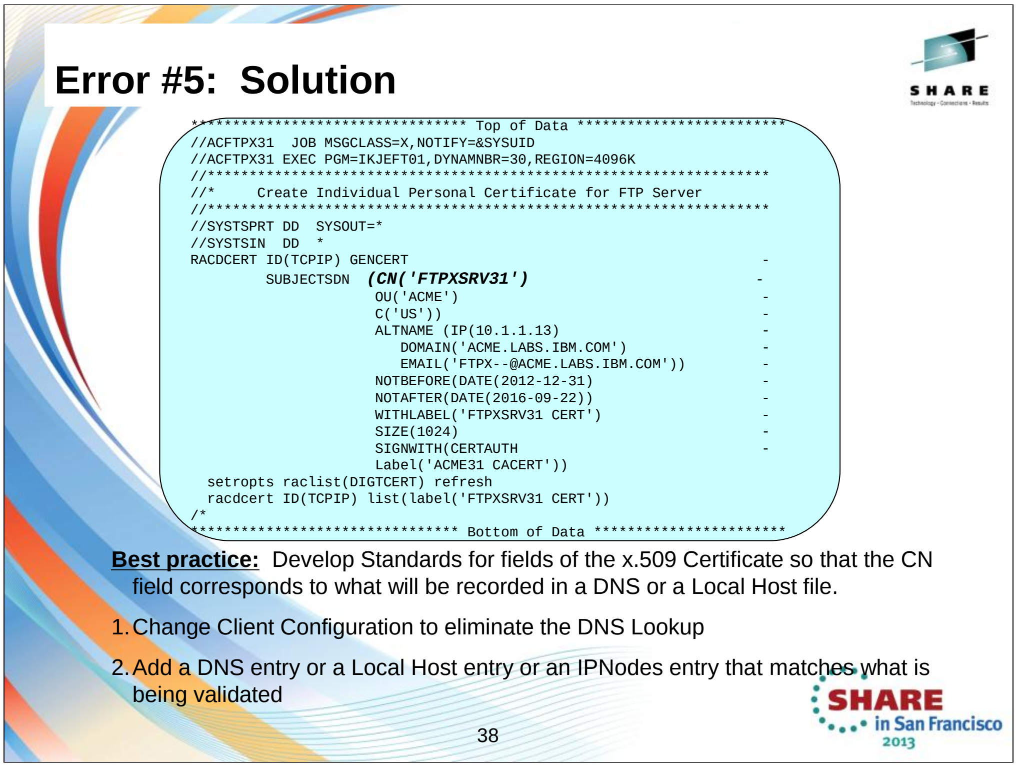
•a domain suffix (e.g., '.endicott.ibm.com') or

•a wildcard name beginning with an asterisk (e.g., '*.endicott.ibm.com').

A case-sensitive comparison is performed between the supplied host name and the host name in the certificate. A fully-qualified name must be the same as the supplied host name. A domain suffix matches any host name with the same suffix but does not match the suffix itself. For example, '*.endicott.ibm.com'

The status code in the example is a Certificate Management Services (CMS) Status Codes as documented in the Cryptographic Services System Secure Sockets Layer Programming manual (SC24-5901-07).

This type of feature allows an application to provide a list of hostnames that AT-TLS will compare against the hostname in the certificate. A return code back to the application indicates whether a match was found or not. Based on that return code, the application can decide whether or not to continue the session. Obviously, though, this approach relies on the application to determine the acceptable hostnames, be it through DNS or any other method.



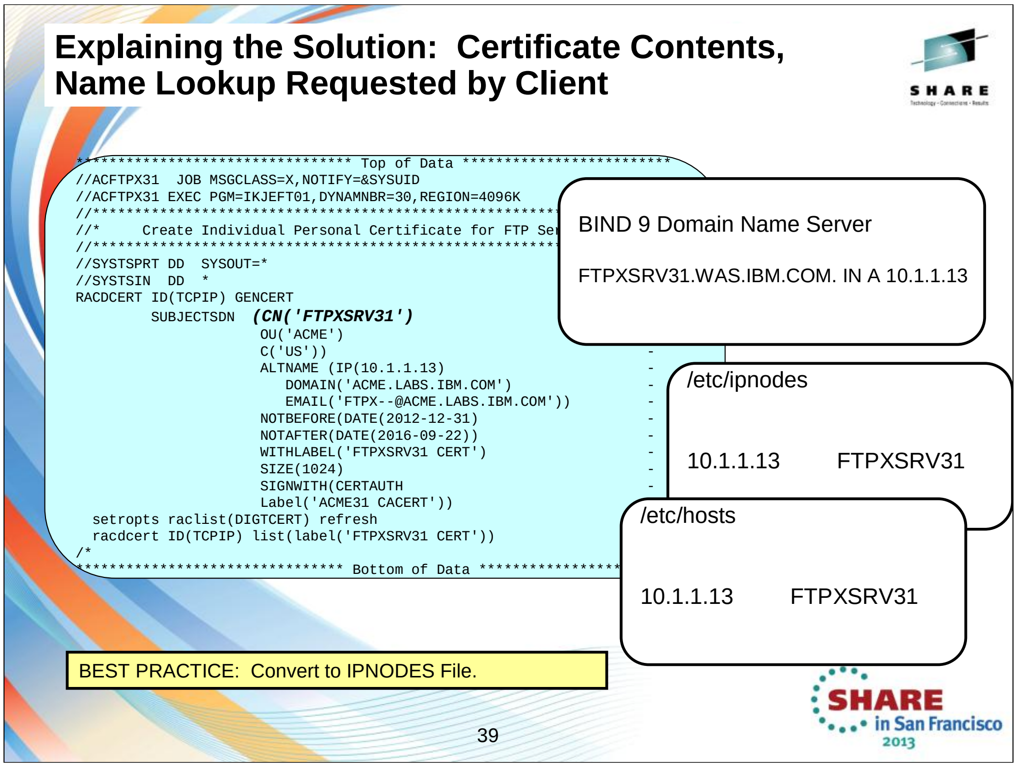
Error #5: Solution

```
********************************* Top of Data *************************
//ACFTPX31  JOB MSGCLASS=X,NOTIFY=&SYSUID
//ACFTPX31 EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*******************************************************************
//*     Create Individual Personal Certificate for FTP Server
//*******************************************************************
//SYSTSPRT DD  SYSOUT=*
//SYSTSIN  DD  *
RACDCERT ID(TCPIP) GENCERT                                         -
         SUBJECTSDN  (CN('FTPXSRV31')                              -
                      OU('ACME')                                   -
                      C('US'))                                     -
                      ALTNAME (IP(10.1.1.13)                       -
                         DOMAIN('ACME.LABS.IBM.COM')               -
                         EMAIL('FTPX--@ACME.LABS.IBM.COM'))        -
                      NOTBEFORE(DATE(2012-12-31)                   -
                      NOTAFTER(DATE(2016-09-22))                   -
                      WITHLABEL('FTPXSRV31 CERT')                  -
                      SIZE(1024)                                   -
                      SIGNWITH(CERTAUTH                            -
                      Label('ACME31 CACERT'))
  setropts raclist(DIGTCERT) refresh
  racdcert ID(TCPIP) list(label('FTPXSRV31 CERT'))
/*
******************************** Bottom of Data ***********************
```

Best practice: Develop Standards for fields of the x.509 Certificate so that the CN field corresponds to what will be recorded in a DNS or a Local Host file.

1. Change Client Configuration to eliminate the DNS Lookup
2. Add a DNS entry or a Local Host entry or an IPNodes entry that matches what is being validated

This visual shows you the contents of a certificate and advises your company to establish standards for the fields that comprise the x.509 certificate.



Explaining the Solution: Certificate Contents, Name Lookup Requested by Client

```
******************************** Top of Data *************************
//ACFTPX31  JOB MSGCLASS=X,NOTIFY=&SYSUID
//ACFTPX31 EXEC PGM=IKJEFT01,DYNAMNBR=30,REGION=4096K
//*****************************************************************
//*     Create Individual Personal Certificate for FTP Se
//*****************************************************************
//SYSTSPRT DD  SYSOUT=*
//SYSTSIN  DD  *
RACDCERT ID(TCPIP) GENCERT
         SUBJECTSDN  (CN('FTPXSRV31')
                      OU('ACME')
                      C('US'))                                      -
                      ALTNAME (IP(10.1.1.13)                        -
                         DOMAIN('ACME.LABS.IBM.COM')                -
                         EMAIL('FTPX--@ACME.LABS.IBM.COM'))         -
                      NOTBEFORE(DATE(2012-12-31)                    -
                      NOTAFTER(DATE(2016-09-22))                    -
                      WITHLABEL('FTPXSRV31 CERT')                   -
                      SIZE(1024)                                    -
                      SIGNWITH(CERTAUTH                             -
                      Label('ACME31 CACERT'))
  setropts raclist(DIGTCERT) refresh
  racdcert ID(TCPIP) list(label('FTPXSRV31 CERT'))
/*
******************************* Bottom of Data *****************
```

BIND 9 Domain Name Server

FTPXSRV31.WAS.IBM.COM. IN A 10.1.1.13

/etc/ipnodes

10.1.1.13   FTPXSRV31

/etc/hosts

10.1.1.13   FTPXSRV31

BEST PRACTICE: Convert to IPNODES File.

SHARE
Technology · Connections · Results
SHARE in San Francisco 2013

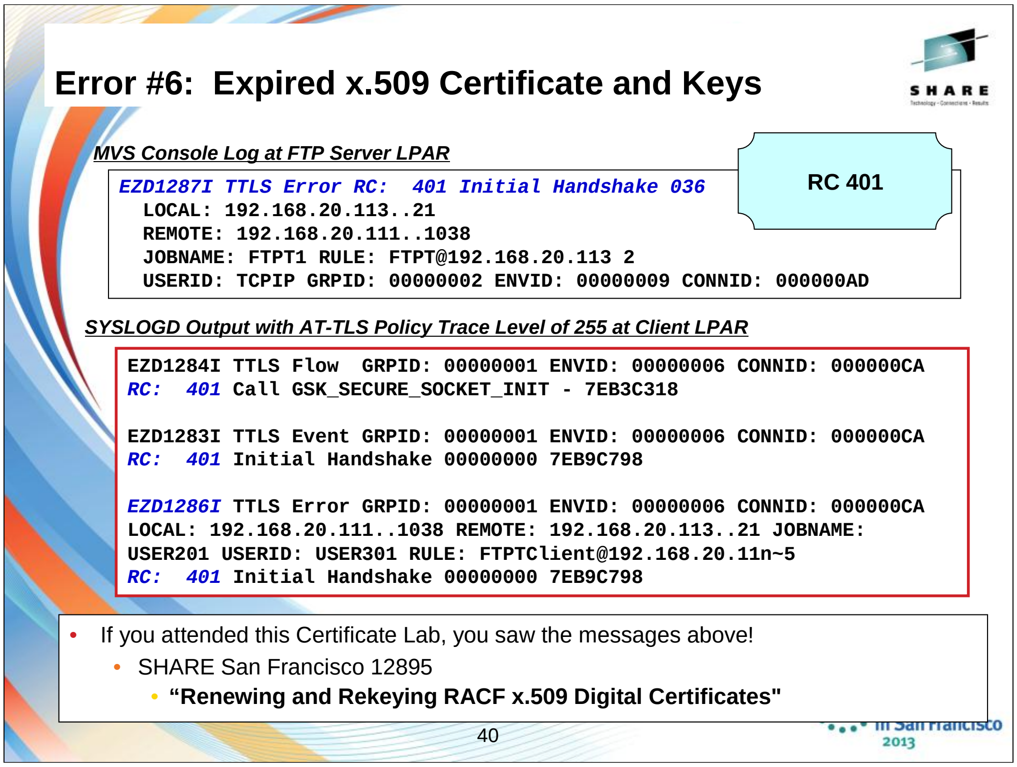
You see in the visual above how there is a DNS entry that matches the name in “CN” portion of the distinguished name on the certificate. In some implementations, it is only necessary that there be a matching name, but the IP address if mentioned in the certificate or if used on the connection request need not correspond to the name. With IPSec, you can still have a DNS or local host matching error, but in cases here the IP address must match the endpoint address of the connection partner.

You may also use a local host file or an ipnodes file if the name lookup with such a file is preferred or is being used. Best Practice is to avoid use of the UNIX /etc/hosts file or the MVS hlq.HOSTS.ADDRINFO and hlq.HOSTS.SITEINFO and use the IPNODES file that is identified in the System Resolver Setup File. Together with the COMMONSEARCH parameter in the RESOLVER SETUP file, the IPNODES file is able to be used for both UNIX and MVS searches as well as for IPv4 and IPv6 searches.

(NOTE: The MVS Versions –ADDRINFO and SITEINFO – are created with the MAKESITE command that is executed against the hlq.HOSTS.LOCAL file.)

Example of HOSTS.LOCAL File entry that will produce the appropriate ADDRINFO and SITEINFO files:

HOST : 10.1.1.13: FTPXSRV31 ::::



Error #6: Expired x.509 Certificate and Keys

MVS Console Log at FTP Server LPAR

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

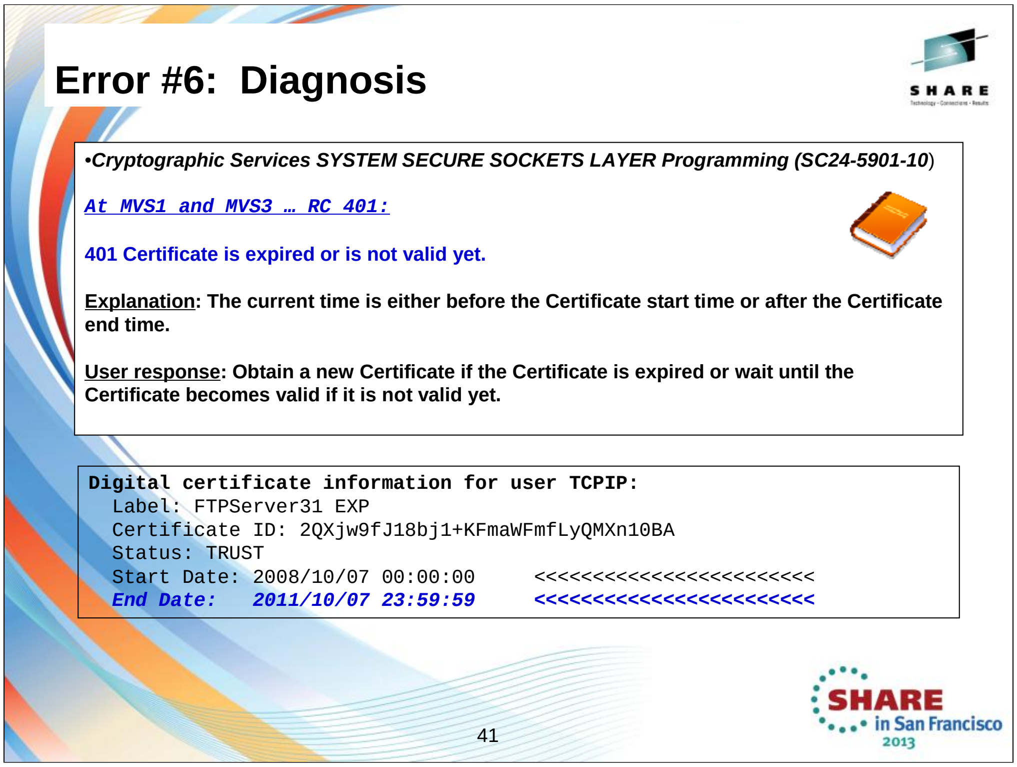
RC 401

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

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

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

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

- If you attended this Certificate Lab, you saw the messages above!
  - SHARE San Francisco 12895
    - **“Renewing and Rekeying RACF x.509 Digital Certificates"**

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



Error #6: Diagnosis

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

At MVS1 and MVS3 … RC 401:

401 Certificate is expired or is not valid yet.

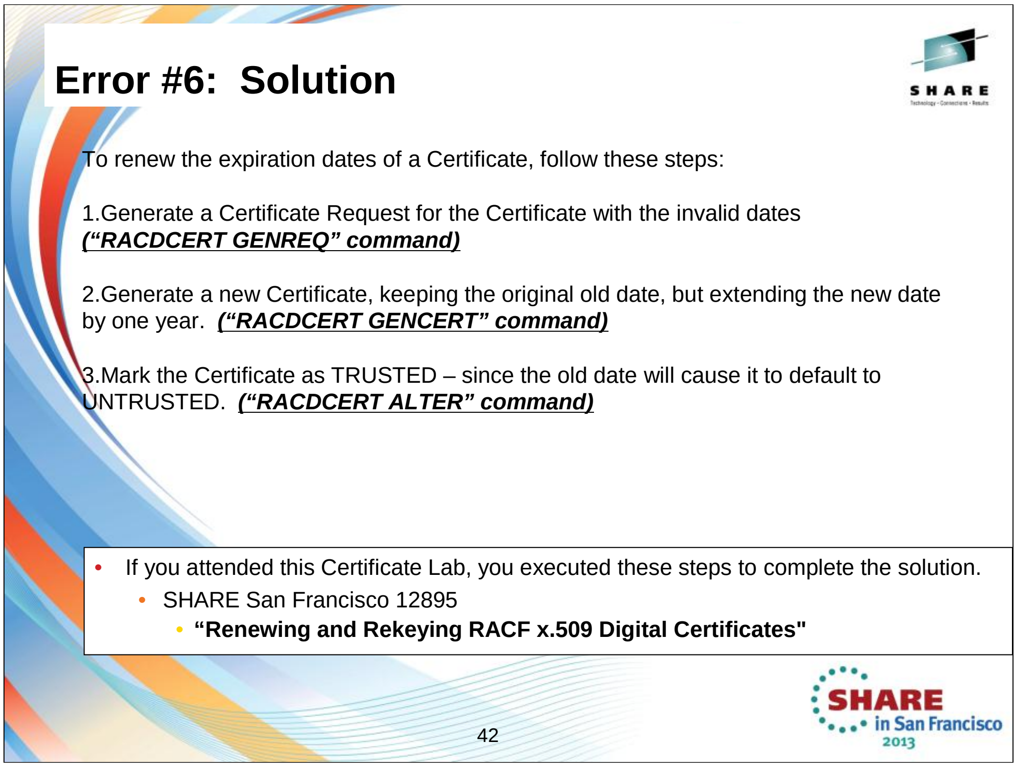
Explanation: The current time is either before the Certificate start time or after the Certificate end time.

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

```
Digital certificate information for user TCPIP:
  Label: FTPServer31 EXP
  Certificate ID: 2QXjw9fJ18bj1+KFmaWFmfLyQMXn10BA
  Status: TRUST
  Start Date: 2008/10/07 00:00:00     <<<<<<<<<<<<<<<<<<<<<<<<
  End Date:   2011/10/07 23:59:59     <<<<<<<<<<<<<<<<<<<<<<<<
```

SHARE in San Francisco 2013

During the handshake the FTP Server sent the client its Certificate and this Certificate is not valid. We display the Certificate on the shared RACF database to determine what the validity dates are and discover that the certificate has expired dates.



Error #6: Solution

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

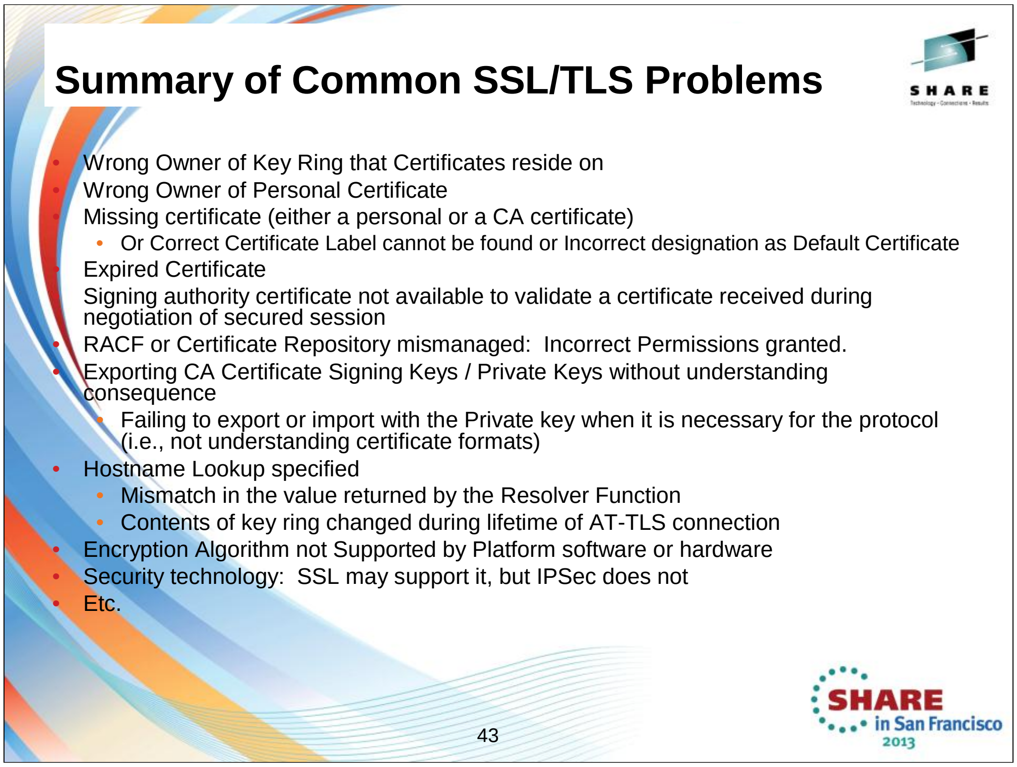
1.Generate a Certificate Request for the Certificate with the invalid dates ***(“RACDCERT GENREQ” command)***

2.Generate a new Certificate, keeping the original old date, but extending the new date by one year. ***(“RACDCERT GENCERT” command)***

3.Mark the Certificate as TRUSTED – since the old date will cause it to default to UNTRUSTED. ***(“RACDCERT ALTER” command)***

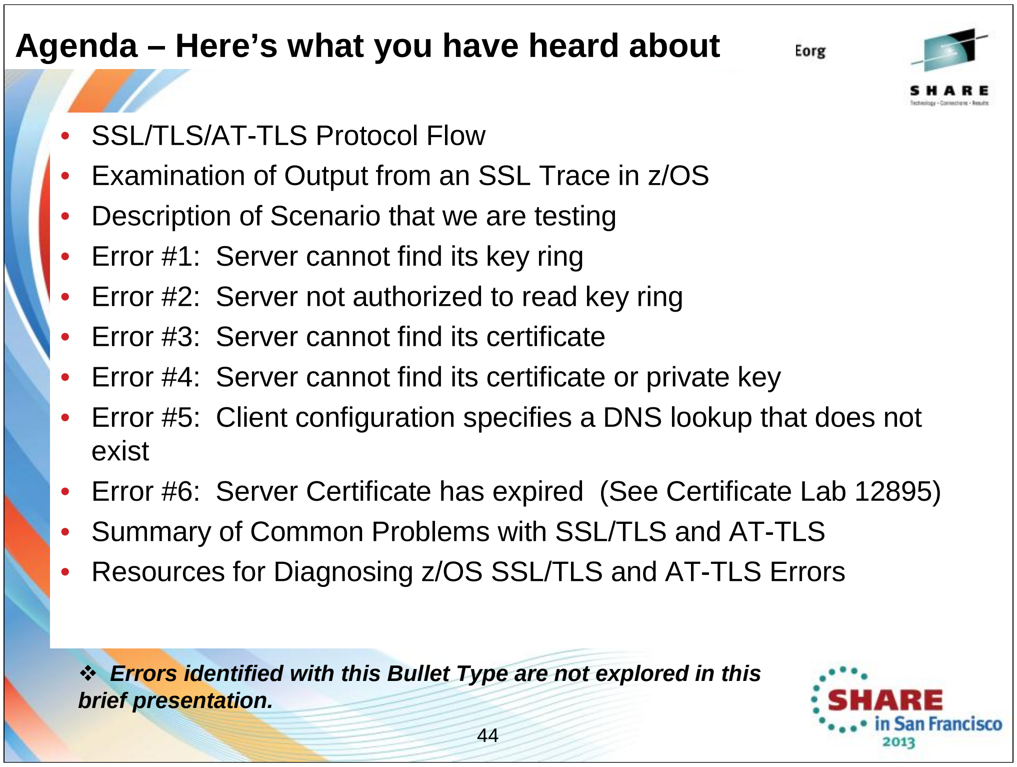
- If you attended this Certificate Lab, you executed these steps to complete the solution.
  - SHARE San Francisco 12895
    - **“Renewing and Rekeying RACF x.509 Digital Certificates"**

Here we show you the steps to extend the lifetime of the certificate by changing the expiration date but retaining the original key pair.



Summary of Common SSL/TLS Problems

- Wrong Owner of Key Ring that Certificates reside on
- Wrong Owner of Personal Certificate
- Missing certificate (either a personal or a CA certificate)
  - Or Correct Certificate Label cannot be found or Incorrect designation as Default Certificate
- Expired Certificate
- Signing authority certificate not available to validate a certificate received during negotiation of secured session
- RACF or Certificate Repository mismanaged: Incorrect Permissions granted.
- Exporting CA Certificate Signing Keys / Private Keys without understanding consequence
  - Failing to export or import with the Private key when it is necessary for the protocol (i.e., not understanding certificate formats)
- Hostname Lookup specified
  - Mismatch in the value returned by the Resolver Function
  - Contents of key ring changed during lifetime of AT-TLS connection
- Encryption Algorithm not Supported by Platform software or hardware
- Security technology: SSL may support it, but IPSec does not
- Etc.



Agenda – Here’s what you have heard about

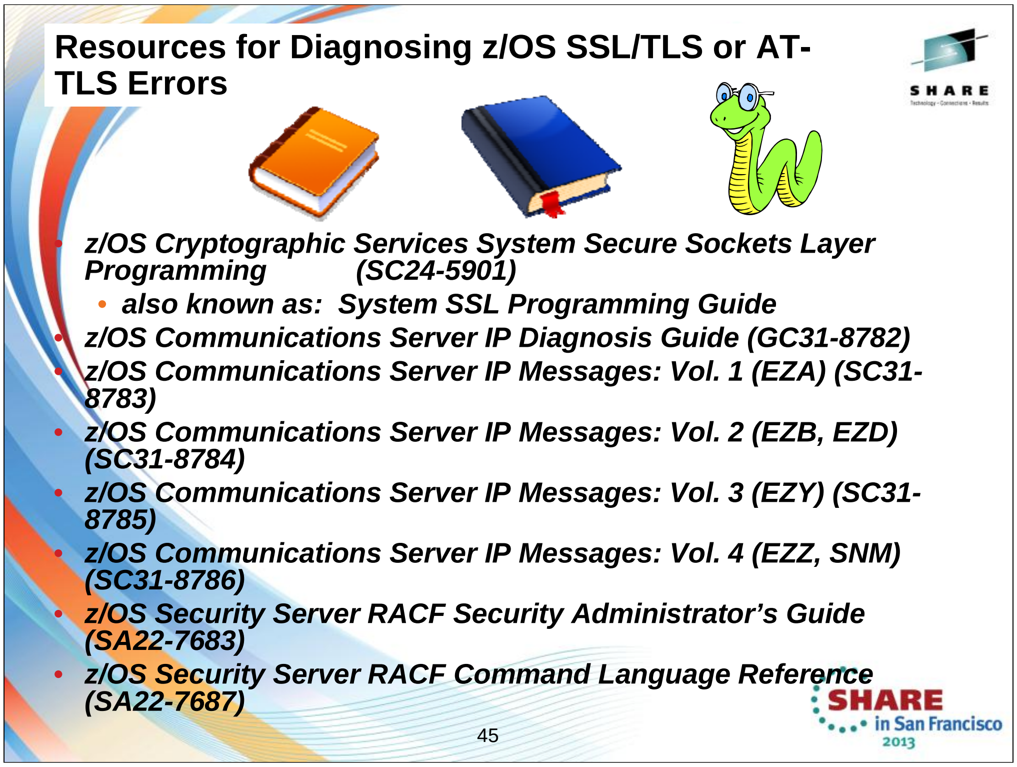
Eorg

- SSL/TLS/AT-TLS Protocol Flow
- Examination of Output from an SSL Trace in z/OS
- Description of Scenario that we are testing
- Error #1: Server cannot find its key ring
- Error #2: Server not authorized to read key ring
- Error #3: Server cannot find its certificate
- Error #4: Server cannot find its certificate or private key
- Error #5: Client configuration specifies a DNS lookup that does not exist
- Error #6: Server Certificate has expired (See Certificate Lab 12895)
- Summary of Common Problems with SSL/TLS and AT-TLS
- Resources for Diagnosing z/OS SSL/TLS and AT-TLS Errors

❖ ***Errors identified with this Bullet Type are not explored in this brief presentation.***

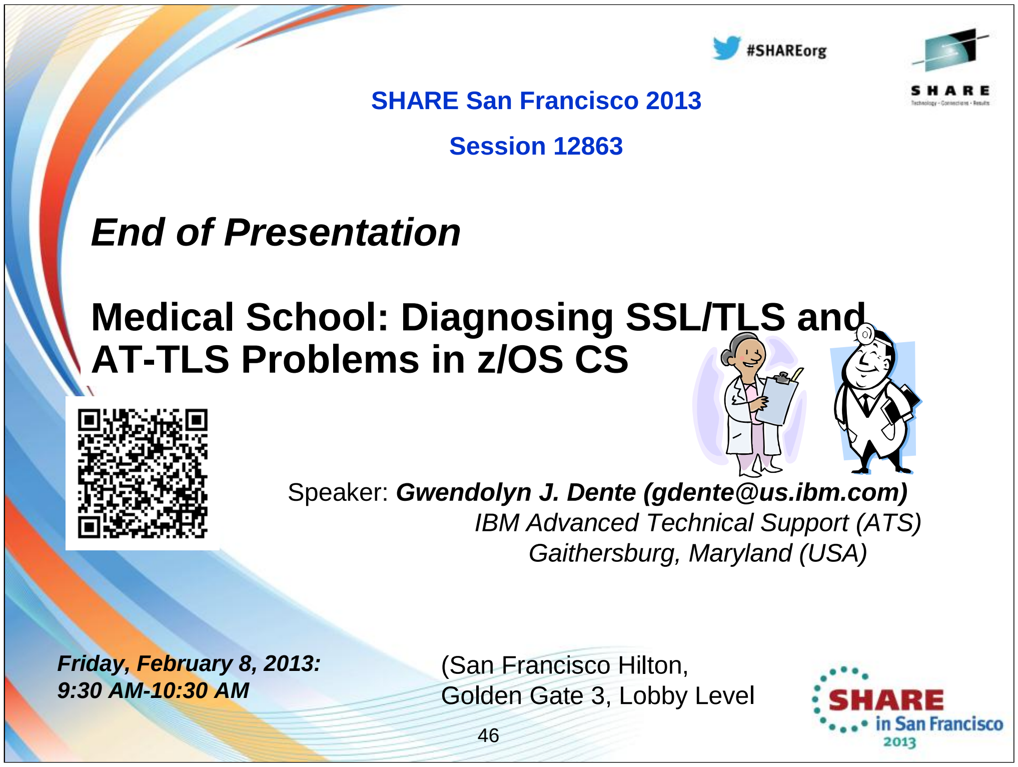
44

This recaps what you have heard about here. It emphasizes that you need to know a bit about the protocols to be able to perform problem determination, but you may not have to resort to taking a System SSL trace to solve a problem. It could be that simpler diagnostic tools – like logs, messages, and documentation on the meaning of those messages may be enough, as you have seen here.



Resources for Diagnosing z/OS SSL/TLS or AT-TLS Errors

- *z/OS Cryptographic Services System Secure Sockets Layer Programming (SC24-5901)*
  - *also known as: System SSL Programming Guide*
- *z/OS Communications Server IP Diagnosis Guide (GC31-8782)*
- *z/OS Communications Server IP Messages: Vol. 1 (EZA) (SC31-8783)*
- *z/OS Communications Server IP Messages: Vol. 2 (EZB, EZD) (SC31-8784)*
- *z/OS Communications Server IP Messages: Vol. 3 (EZY) (SC31-8785)*
- *z/OS Communications Server IP Messages: Vol. 4 (EZZ, SNM) (SC31-8786)*
- *z/OS Security Server RACF Security Administrator’s Guide (SA22-7683)*
- *z/OS Security Server RACF Command Language Reference (SA22-7687)*



#SHAREorg

SHARE San Francisco 2013

Session 12863

End of Presentation

Medical School: Diagnosing SSL/TLS and AT-TLS Problems in z/OS CS

Speaker: ***Gwendolyn J. Dente (gdente@us.ibm.com)***
IBM Advanced Technical Support (ATS)
Gaithersburg, Maryland (USA)

Friday, February 8, 2013:
9:30 AM-10:30 AM

(San Francisco Hilton,
Golden Gate 3, Lobby Level

46