IBM eServer™

zSeries Cryptography

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RACF User Group

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Agenda

- Cryptographic Hardware
- Hardware setup
- ICSF setup
- Callable service APIs
- Functions supported on z990
- Migration considerations
- Why use z/990 and ICSF?
- Hardware cryptography exploiters

Cryptographic Hardware

Cryptographic Hardware

- Cryptographic Coprocessor Feature (CCF)
  - up to two CCFs are standard with most s/390, z900/z800 servers
  - enablement requires a Power On Reset
  - symmetric and asymmetric functions supported
  - certified at FIPS 140-1 level 4
- PCI Cryptographic Coprocessor (PCICC)
  - optional feature with CCF systems
  - non-disruptive enablement
  - symmetric and asymmetric functions supported
  - User Defined Extensions (UDX) support
  - certified at FIPS 140-1 level 4
- PCI Cryptographic Accelerator (PCICA)
  - optional feature with zSeries
  - no enablement feature
  - can be shared across 16 LPARs
  - clear key SSL en/decryption only
- PCI X Cryptographic Coprocessor PCIXCC) Crypto Express2 Coprocessor (CEX2C)
  - optional feature with z990/z890
  - non-disruptive enablement
  - replacement for the CCF and PCICC
  - symmetric and asymmetric functions supported
  - UDX support
  - can be shared across 16 LPARs
  - designed for FIPS 140-2 level 2 certification

CP Assist for Cryptographic Functions

CP Assist for Cryptographic Functions (CPACF) is available on every CP of a z990 or z890.

CPACF functions include:

- SHA-1 hashing
- Modification detection code (MDC) message authentication*
- Clear key DES/TDES encryption/decryption*
  - AES supported in software only by ICSF

*Requires CPACF enablement feature 3863 for export control

New Instructions for CPACF

- 5 new problem state instructions were introduced with the cryptographic assist function:
  - Compute Message Authentication Code (KMAC)
  - Cipher Message (KM)
  - Cipher Message with Chaining (KMC)
  - Compute Intermediate Message Digest (KIMD)
  - Compute Last Message Digest (KLMD)
- Can be used directly in applications without going through ICSF.
- Documented in z/Architecture Principles of Operation, SA22-7832.

Cryptographic Coprocessors

Model	Installed Coprocessors	Optional Coprocessors
G2/G3/G4	CCF	None
G5/G6	CCF	PCICC
z900 z800	CCF	PCICC PCICA
z990 z890	None	PCIXCC CEX2C PCICA

Cryptographic Features

Maximum number of allowable features by model

Coprocessor (number of coprocessors per feature)	G5 G6	z900 z800	z990 z890
PCICC(2)	8	8	-
PCICA(2)	-	6	6
PCIXCC(1)	-	-	4
CEX2C(2)	-	-	8

Maximum number of installed features is 8

Hardware Setup

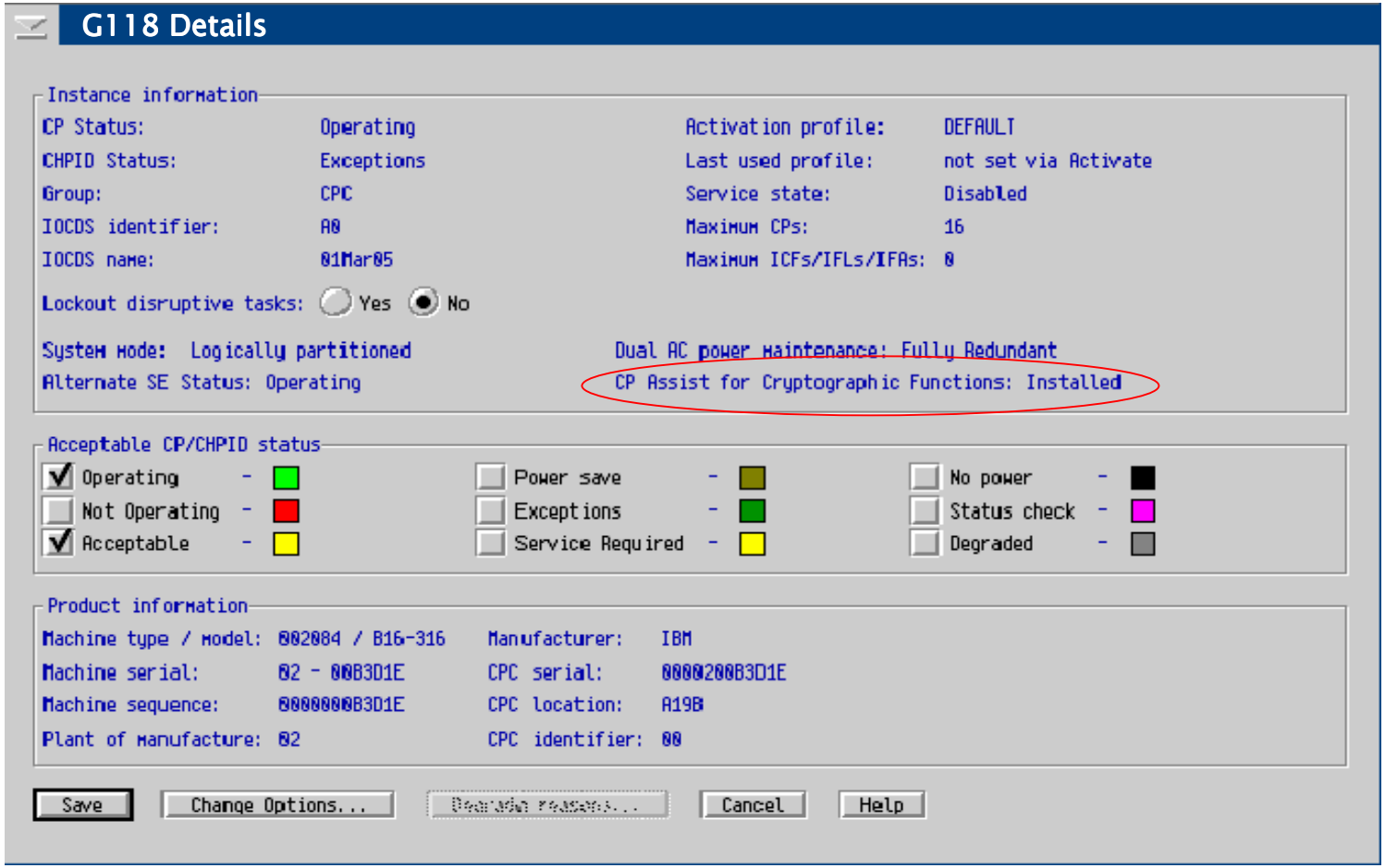
Hardware Setup

Hardware setup from the hardware master console (HMC) requires three basic steps:

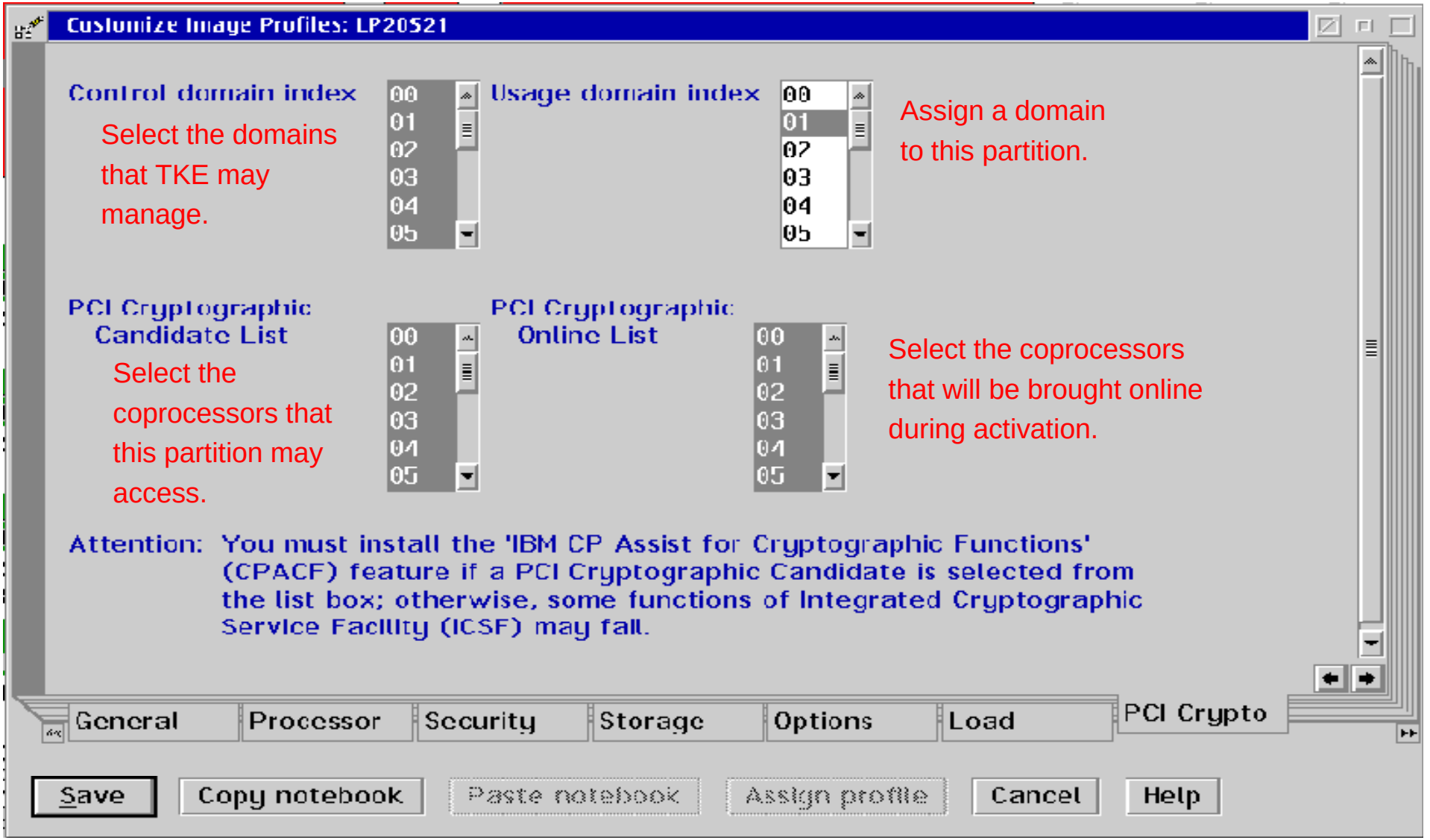
- Hardware installation (done by IBM)
  - installation of CPACF feature 3863
  - installation of PCICA/PCIXCC/CEX2C
- LPAR definition (done by customer)
  - assign domain to partition
  - assign cryptographic feature to the partition
- TKE enablement
  - enable TKE access to secure cryptographic features

CPC Details

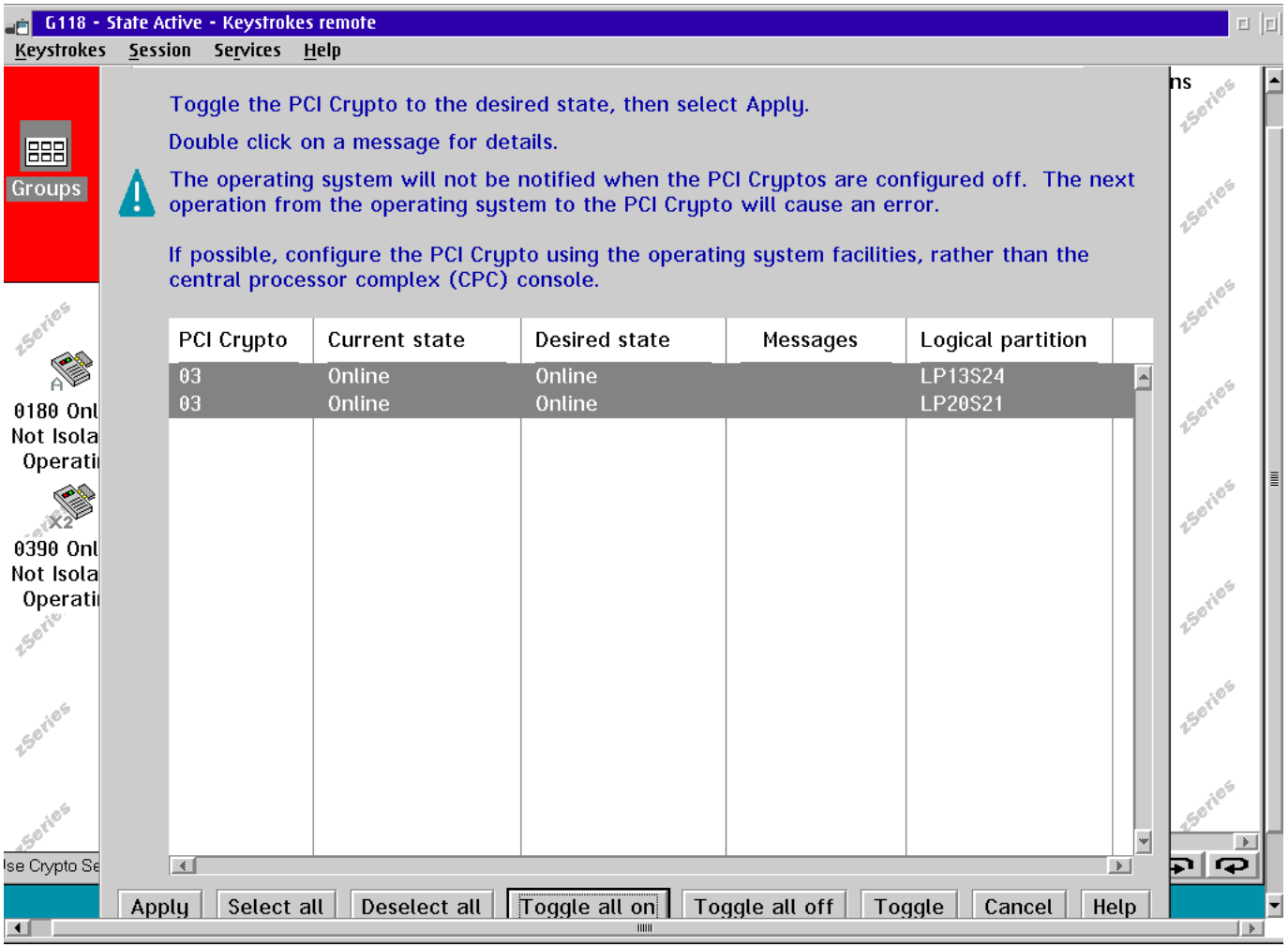
From the Support Element, check that CPACF feature #3863 is installed.



Customize Image Profile

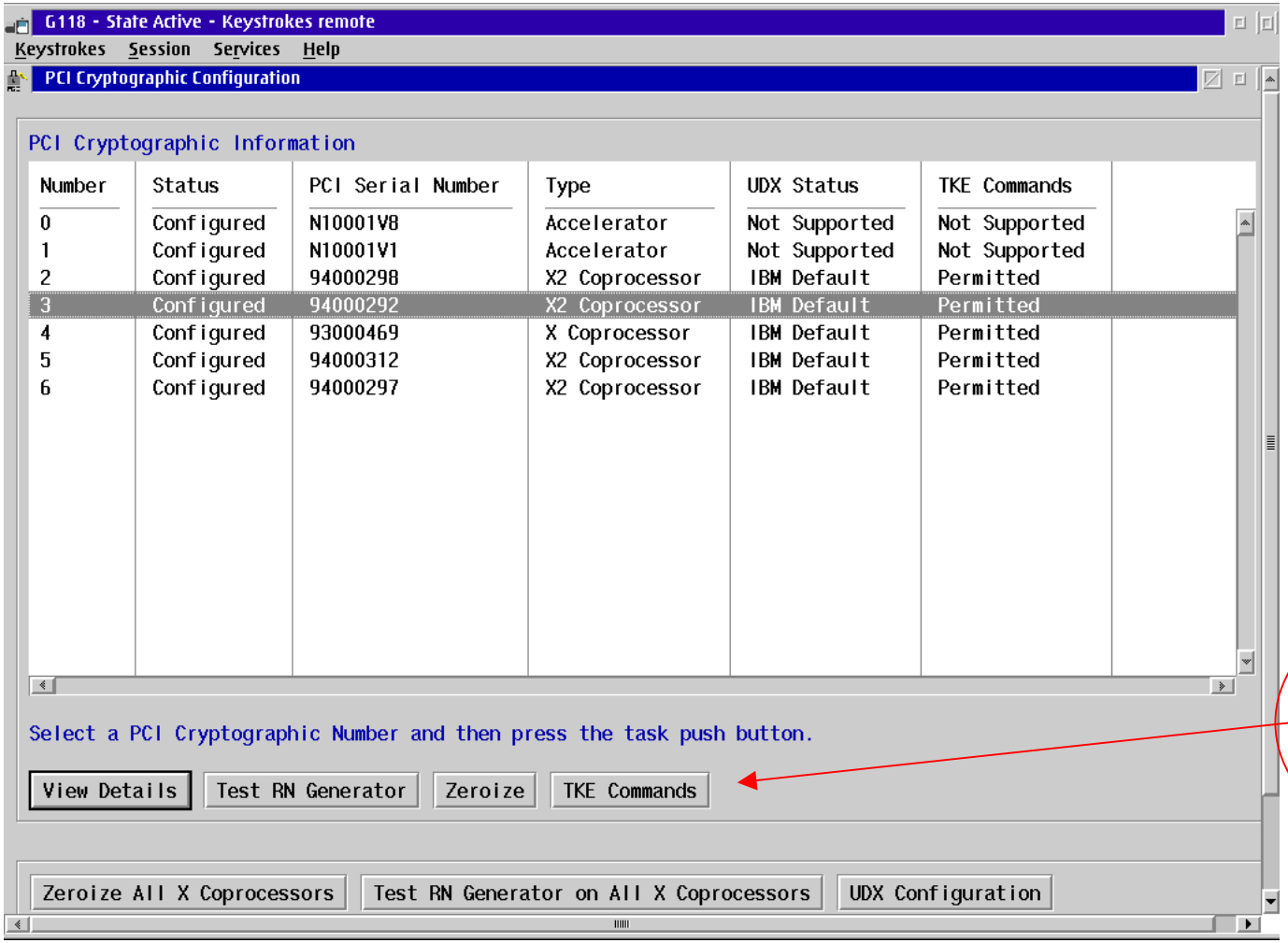


Configure On/Off PCI Crypto



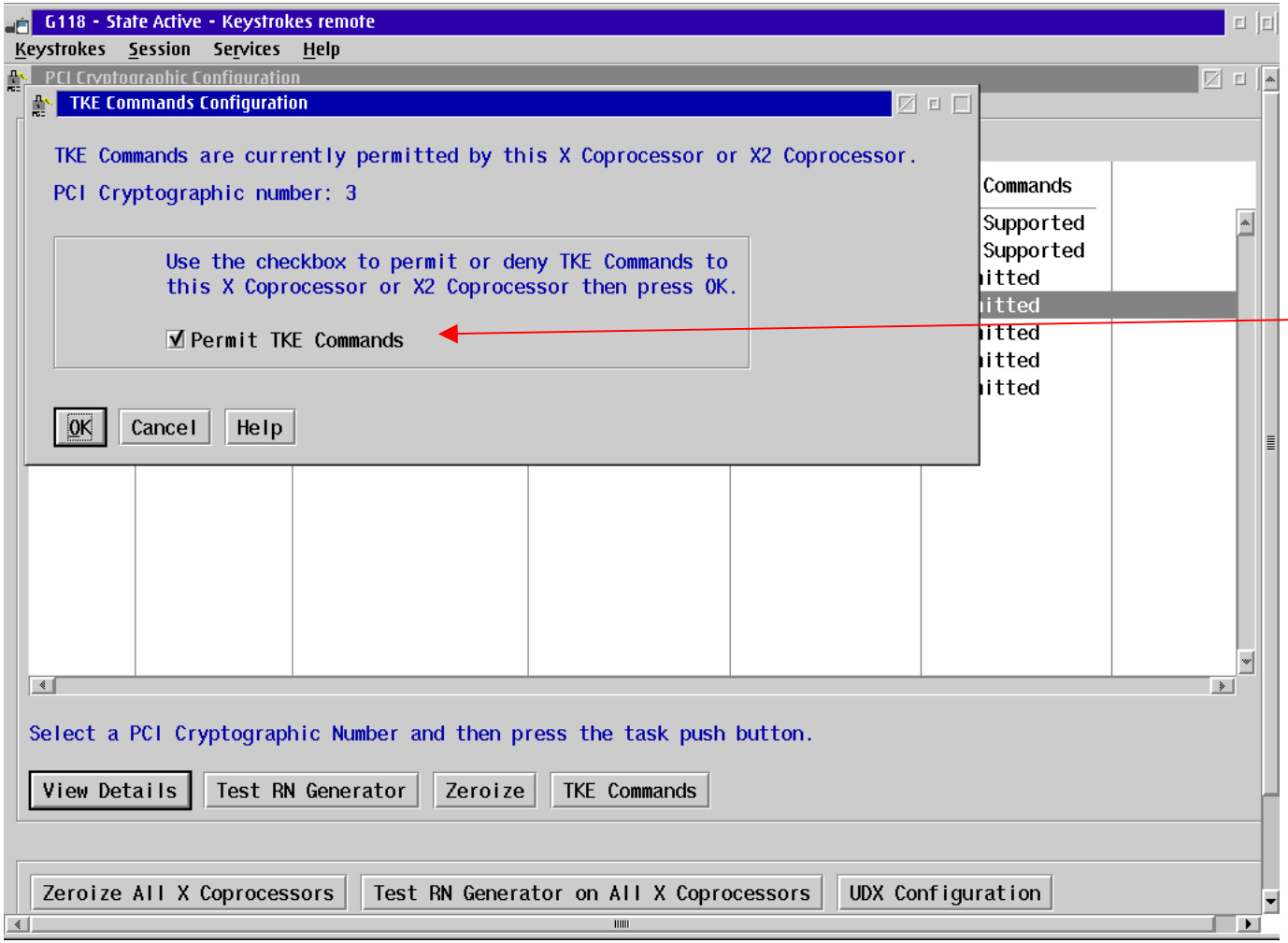
Toggle changes the current state of a PCI crypto – toggle switches from STANDBY to ONLINE and vice-versa.

Enable TKE Commands



Select an X or X2 coprocessor and click on TKE commands

Enable TKE Commands



Must be checked to use TKE.

Integrated Cryptographic Service Facility

- ICSF is the software interface to the cryptographic hardware.
- ICSF is part of the cryptographic server component of z/OS.
- ICSF provides TSO panel interfaces to
  - Enter keys into the tamper-resistant hardware
  - Create and manage keys for application use
  - Display status and manage cryptographic hardware
- ICSF maintains two VSAM data sets for application cryptographic keys.
  - Cryptographic Key Data Set (CKDS) for symmetric keys
  - Public Key Data Set (PKDS) for asymmetric keys
- ICSF provides application interfaces to 70+ callable services.

Trusted Key Entry

- TKE is an optional feature on s/390 and zSeries processors.
- TKE workstation consists of an application on OS/2 with a 4758 card.
- Provides secure remote administration of all cryptographic coprocessors.
  - one TKE workstation can manage multiple systems
- Features include:
  - TCP/IP connection between workstation and host
  - authentication between host and administrators
  - master key and operational key entry in parts
  - key parts are encrypted when sent to host
  - enabling/disabling cryptographic functions
  - protection against replay attacks
  - audit trail of activity

ICSF Setup

ICSF Setup

Refer to the z/OS Program Directory for installation instructions.

The following steps are detailed in the z/OS ICSF System Programmer's Guide, SA22-7520.

- Customize SYS1.PARMLIB
- Allocate the CKDS and PKDS
- Create the installation options data set
- Provide access to the ICSF panels
- Create the ICSF startup procedure
- Start ICSF

Customize SYS1.PARMLIB

- Add CEE.SCEERUN and CSF.SCSFMOD0 to the LNKLST concatenation.
- APF authorize CSF.SCSFMOD0 if LNKAUTH=APFTAB.
- In the IKJTSOxx member, add CSFDAUTH and CSFDPKDS in the AUTHPGM and AUTHTSF parameter lists.
- If using TKE V3.0 or later, add CSFTTKE to the AUTHCMD parameter list.

Allocate the CKDS and PKDS

- The CKDS and PKDS are VSAM data sets. Use the AMS DEFINE CLUSTER command to define the data sets.
- Sample jobs are documented in z/OS ICSF System Programmer's Guide.
- Sample jobs are provided in SYS1.SAMPLIB. The JCL to allocate the CKDS and PKDS are different.
  - Sample job CSFCKDS to allocate the CKDS
  - Sample job CSFPKDS to allocate the PKDS
- Allocate the data sets on a permanently resident volume.
- Ensure this volume is not subject to data set migration.
- Use RACF profiles to protect these data sets.

JCL to allocate a CKDS/PKDS

SYS1.SAMPLIB(CSFCKDS)

```
//CSFCKDS   JOB <JOB CARD PARAMETERS>
//DEFINE  EXEC PGM=IDCAMS,REGION=4M
//SYSPRINT DD  SYSOUT=*
//SYSIN DD *
  DEFINE CLUSTER (NAME(CSF.CSFCKDS)        -
              VOLUMES(XXXXXX)          -
              RECORDS(100 50)          -
              RECORDSIZE(252,252)      -
              KEYS(72 0)               -
              FREESPACE(10,10)         -
              SHAREOPTIONS(2)          -
              UNIQUE)                  -
         DATA (NAME(CSF.CSFCKDS.DATA)   -
              BUFFERSPACE(100000)      -
              ERASE                    -
              WRITECHECK)              -
        INDEX (NAME(CSF.CSFCKDS.INDEX))
/*
```

SYS1.SAMPLIB(CSFPKDS)

```
//CSFPKDS   JOB <JOB CARD PARAMETERS>
//DEFINE  EXEC PGM=IDCAMS,REGION=4M
//SYSPRINT DD  SYSOUT=*
//SYSIN DD *
  DEFINE CLUSTER (NAME(CSF.CSFPKDS)        -
              VOLUMES(XXXXXX)          -
              RECORDS(100,50)          -
              RECORDSIZE(350,2800)     -
              KEYS(72 0)               -
              FREESPACE(0,0)           -
              SHAREOPTIONS(2,3)        -
              UNIQUE)                  -
         DATA (NAME(CSF.CSFPKDS.DATA)    -
              BUFFERSPACE(100000)      -
              ERASE                    -
              CISZ(8192)               -
              WRITECHECK)              -
        INDEX (NAME(CSF.CSFPKDS.INDEX))
/*
```

Installation Options Data Set

- Defines the run time options for ICSF.
- Becomes active when ICSF is started.
- Samples are provided in z/OS ICSF System Programmer's Guide and in SYS1.SAMPLIB(CSFPRM00).
- System symbols are supported.
- Should be stored in SYS1.PARMLIB.

CKDSN(CSF.CSFCKDS)
PKDSN(CSF.CSFPKDS)
} Cryptographic Key Data Sets

COMPAT(NO)
SSM(YES) ← Must be YES for some ICSF functions
DOMAIN(5) ← Domain specified as the usage domain in the LPAR definition Customize Image Profile page
KEYAUTH(NO)
CKTAUTH(NO)
CHECKAUTH(NO)
TRACEENTRY(1000)
USERPARM(USERPARM)
COMPENC(DES)
REASONCODES(ICSF)
PKDSCACHE(64)

Access to ICSF Panels

- Create an ICSF option on the ISPF Primary Option Menu.
- Update TSO logon procedure
  - //SYSPROC DD …
    - add CSF.SCSFCLI0
  - //ISPPLIB DD …
    - add CSF.SCSFPNL0
  - //ISPMLIB DD …
    - add CSF.SCSFMSG0
  - //ISPSLIB DD …
    - add CSF.SCSFSKL0
  - //ISPTLIB DD …
    - add CSF.SCSFTLIB

ICSF Startup Procedure

```
//CSF PROC
//CSF EXEC PGM=CSFMMAIN,REGION=6M,TIME=1440
//CSFLIST DD SYSOUT=A,LRECL=132,BLKSIZE=132,HOLD=YES
//CSFPARM DD DSN=SYS1.PARMLIB(CSFPRM00),DISP=SHR
```

- CSFLIST data set contains messages pertaining to ICSF startup.
  - Messages are documented in z/OS ICSF Messages, SA22-7523.
- CSFPARM points to the installation options data set member.

ICSF First Time Startup Messages

```
S CSF
$HASP373 CSF    STARTED
IEF403I CSF - STARTED - TIME=14.12.39
CSFM507I CRYPTOGRAPHY - THERE ARE NO CRYPTOGRAPHIC COPROCESSORS ONLINE.
CSFM508I CRYPTOGRAPHY - THERE ARE NO CRYPTOGRAPHIC ACCELERATORS ONLINE.
CSFM001I ICSF INITIALIZATION COMPLETE
CSFM400I CRYPTOGRAPHY - SERVICES ARE NOW AVAILABLE.
```

CPACF only

```
S CSF
$HASP373 CSF    STARTED
IEF403I CSF - STARTED - TIME=17.59.05
CSFM101E PKA KEY DATA SET, CSF.CSFPKDS IS NOT INITIALIZED.
CSFM419E INCORRECT MASTER KEY (SYM) ON PCI X CRYPTOGRAPHIC COPROCESSOR
X01, SERIAL NUMBER 93006015.
CSFM434E INCORRECT MASTER KEY (SYM) ON CRYPTO EXPRESS2 COPROCESSOR E02,
SERIAL NUMBER 94006004.
CSFM434E INCORRECT MASTER KEY (SYM) ON CRYPTO EXPRESS2 COPROCESSOR E03,
SERIAL NUMBER 94006026.
CSFM411I PCI CRYPTOGRAPHIC ACCELERATOR A00 IS ACTIVE
CSFM100E CRYPTOGRAPHIC KEY DATA SET, CSF.CSFCKDS IS NOT INITIALIZED.
CSFM001I ICSF INITIALIZATION COMPLETE
CSFM400I CRYPTOGRAPHY - SERVICES ARE NOW AVAILABLE.
```

Master keys are not set and CKDS/PKDS are not initialized.

Master Keys

ICSF uses two master keys to protect application keys:

- Symmetric-keys master key (SYM-MK)
  - 128 bit key
  - protects DES (or symmetric) application keys
- Asymmetric-keys master key (ASYM-MK)
  - 192 bit key
  - protects RSA (or asymmetric) private keys

Stored within the secure hardware boundary of the cryptographic feature on the server

Master Key Entry

There are three methods for ICSF master key entry:

- Pass Phrase Initialization
  - master key values derived from a character string 16 to 64 characters long
  - limited to initializing ICSF only
- Clear master key entry from ICSF panels
  - can be used to initialize or change master keys
  - keys can be entered in parts
  - key values can be generated using the random number generator utility
- Trusted Key Entry (TKE) workstation
  - can manage all cryptographic coprocessors from one TKE workstation
  - keys can be entered in parts
  - key values can be generated and saved to binary files or smart cards

Recommendation for ICSF Initialization

1. Use Pass Phrase to initialize ICSF quickly with minimal effort.
2. Change the master keys using ICSF Clear Master Key entry panels.

Reasons:

- Random number generate is not active until ICSF has been initialized.
- Entering master keys in parts is more secure
  - key parts can be assigned to different people

ICSF Main Panel

```
CSF@PRIM -------------- Integrated Cryptographic Service Facility--------------
OPTION ===>
Enter the number of the desired option.

  1  COPROCESSOR MGMT -  Management of Cryptographic Coprocessors
  2  MASTER KEY       -  Master key set or change, CKDS/PKDS Processing
  3  OPSTAT           -  Installation options
  4  ADMINCNTL        -  Administrative Control Functions
  5  UTILITY          -  ICSF Utilities
  6  PPINIT           -  Pass Phrase Master Key/CKDS Initialization
  7  TKE              -  TKE Master and Operational Key processing
  8  KGUP             -  Key Generator Utility processes
  9  UDX MGMT         -  Management of User Defined Extensions

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Press ENTER to go to the selected option.
Press END   to exit to the previous menu.
```

ICSF Panel Functions

TSO panels are provided to perform the following functions:

- display coprocessor hardware status
- deactivate/activate coprocessors
- load master keys
- initialize or reencipher the CKDS/PKDS
- refresh the CKDS, refresh the PKDS cache
- set or change the symmetric-keys master key
- activate a reenciphered PKDS
- pass phrase initialization
- manage application cryptographic keys in the CKDS using KGUP
- generate random numbers
- calculate checksum
- enable/disable PKA callable services
- enable/disable CKDS/PKDS create, write, delete access
- complete TKE load operations

PF1 from any panel will display HELP panels.

Coprocessor Hardware Status

At first time startup, the status of the secure cryptographic coprocessors is ONLINE and all the master key registers are empty.

Select option 1 COPROCESSOR MGMT from ICSF Main Panel.

```
CSFGCMP0 ----------- ICSF Coprocessor Management ----------- Row 1 to 5 of 5
COMMAND ===>                                                SCROLL ===> PAGE

 Select the coprocessors to be processed and press ENTER.
 Action characters are: A, D, E, K, R and S. See the help panel for details.

    COPROCESSOR      SERIAL NUMBER   STATUS
    -----------      -------------   ------
.   A00                              ACTIVE
s   E02              94006004        ONLINE
s   E03              94006026        ONLINE
s   X01              93006015        ONLINE
****************************** Bottom of data ******************************
```

```
CSFCMP40-------- ICSF - Coprocessor Hardware Status ------- Top of data
COMMAND ===>                                               SCROLL ===> HALF
                                                           CRYPTO DOMAIN: 6
                                                                More:     >
REGISTER STATUS                    COPROCESSOR X01         COPROCESSOR E02

 Crypto Serial Number          : 93006015                  94006004
 Status                        : ONLINE                    ONLINE
 Symmetric-Keys Master Key
   New Master Key register     : EMPTY                     EMPTY
     Verification pattern      :
     Hash pattern              :
                               :
   Old Master Key register     : EMPTY                     EMPTY
     Verification pattern      :
     Hash pattern              :
                               :
   Current Master Key register : EMPTY                     EMPTY
     Verification pattern      :
     Hash pattern              :
                               :
 Asymmetric-Keys Master Key
   New Master Key register     : EMPTY                     EMPTY
     Hash pattern              :
                               :
   Old Master Key register     : EMPTY                     EMPTY
     Hash pattern              :
                               :
   Current Master Key register : EMPTY                     EMPTY
     Hash pattern              :
                               :
```

Pass Phrase Initialization

Select option 6 PPINIT from ICSF Main Panel.

```
CSFPMC10 ---------- ICSF - Pass Phrase MK/KDS Initial  INITIALIZATION COMPLETE
COMMAND ===>

 Enter your pass phrase and the names of the CKDS and PKDS:

   Pass Phrase (16 to 64 characters)
   ===> pass phrase initialization of icsf
   CKDS
   ===> 'csf.csfckds'
   PKDS
   ===> 'csf.csfpkds'

   Initialize the CKDS and PKDS? (Y/N) ===> Y
   Initialize new online coprocessors only ? (Y/N) ===> N

   The master key registers have been loaded.
   Initializing the key data sets...
```

must be 'Y' if CKDS/PKDS are empty

useful if synchronizing master key values in newly plugged PCIXCC or CEX2C

operator console messages indicating that master keys have been successfully loaded

```
CSFM416I BOTH MASTER KEYS CORRECT ON PCI X CRYPTOGRAPHIC COPROCESSOR X01, SERIAL NUMBER 93006015.
CSFM431I BOTH MASTER KEYS CORRECT ON CRYPTO EXPRESS2 COPROCESSOR E02, SERIAL NUMBER 94006004.
CSFM431I BOTH MASTER KEYS CORRECT ON CRYPTO EXPRESS2 COPROCESSOR E03, SERIAL NUMBER 94006026.
```

Coprocessor Hardware Status

The status of the secure coprocessors is now ACTIVE and the current master key registers are VALID.

Select option 1 COPROCESSOR MGMT from the ICSF Main Panel.

```
CSFGCMP0 ----------- ICSF Coprocessor Management ----------- Row 1 to 5 of 5
COMMAND ===>                                                 SCROLL ===> PAGE

 Select the coprocessors to be processed and press ENTER.
 Action characters are: A, D, E, K, R and S. See the help panel for details.

    COPROCESSOR      SERIAL NUMBER   STATUS
    -----------      -------------   ------
.   A00                              ACTIVE
s   E02              94006004        ACTIVE
s   E03              94006026        ACTIVE
s   X01              93006015        ACTIVE
****************************** Bottom of data ******************************
```

```
CSFCMP40 ------------ ICSF - Coprocessor Hardware Status --------------
COMMAND ===>                                          SCROLL ===> HALF
                                                      CRYPTO DOMAIN: 6
                                                           More:     >
REGISTER STATUS                   COPROCESSOR X01     COPROCESSOR E02

 Crypto Serial Number           : 93006015            94006004
 Status                         : ACTIVE              ACTIVE
 Symmetric-Keys Master Key
   New Master Key register      : EMPTY               EMPTY
     Verification pattern       :
     Hash pattern               :
                                :
   Old Master Key register      : EMPTY               EMPTY
     Verification pattern       :
     Hash pattern               :
                                :
   Current Master Key register  : VALID               VALID
     Verification pattern       : A996F8A939403A03    A996F8A939403A03
     Hash pattern               : AC40DD5EDFE94AB6    AC40DD5EDFE94AB6
                                : BA52CECE6B2941C9    BA52CECE6B2941C9
 Asymmetric-Keys Master Key
   New Master Key register      : EMPTY               EMPTY
     Hash pattern               :
                                :
   Old Master Key register      : EMPTY               EMPTY
     Hash pattern               :
                                :
   Current Master Key register  : VALID               VALID
     Hash pattern               : F500D695FAE0ADA7    F500D695FAE0ADA7
                                : A60DB2BDA6F51537    A60DB2BDA6F51537
```

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. **Generate key values using Random Number Generator utility.**
3. **Calculate checksum for key value using checksum utility.**
4. Disable PKA callable services.
5. Enter master key in parts.
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Detailed information on master key entry can be found in the z/OS ICSF Administrator's Guide, SA22-7521.

Random Number Generator and Checksum Utilities

```
CSFRNG00 ------- ICSF - Random Number Generator --------
COMMAND ===>

Enter data below:

  Parity Option  ===> odd                ODD, EVEN, RANDOM
  Random Number1    : FB43CE01E5B5EAFD   Random Number 1
  Random Number2    : 1ACB10BC7F947C85   Random Number 2
  Random Number3    : C1100185C22FA4F4   Random Number 3
```

Enter ODD for odd parity

Select option 5 UTILITY from ICSF Main Panel

```
CSFUTL00 ----------------- ICSF - Utilities -------------------------
OPTION ===>

Enter the number of the desired option.

  1  ENCODE      -  Encode data
  2  DECODE      -  Decode data
  3  RANDOM      -  Generate a random number
  4  CHECKSUM    -  Generate a checksum and verification and
                    hash pattern
  5  PPKEYS      -  Generate master key values from a pass phrase
```

```
CSFMKV00 ----- ICSF - Checksum and Verification and Hash Pattern --------------
COMMAND ===>

Enter data below:

  Key Type        ===> master            (Selection panel displayed if blank)

  Key Value       ===> FB43CE01E5B5EAFD  Input key value 0 - 7
                  ===> 1ACB10BC7F947C85  Input key value 8 - 15
                  ===> 0000000000000000  Input key value 16 - 23(PKA Keys only)

  Checksum           : 29                Check digit for key value
  Key Part VP        : 7ED35DFBA9BA2648  Verification Pattern
  Key Part HP        : 30B9426EAF33A74B  Hash Pattern
                     : 8A74FCF399B641E7
```

Enter MASTER for SYM-MK,
enter PKAMSTR for ASYM-MK,
or leave blank for key type selection panel

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. **Disable PKA callable services.**
5. Enter master key in parts.
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Disable PKA Callable Services

```
CSFACF00 ---------- ICSF - Administrative Control Functions -- Row 1 to 4 of 4
COMMAND ===>                                                 SCROLL ===> PAGE

         Active CKDS: CSF.CSFCKDS
         Active PKDS: CSF.CSFPKDS


 To change the status of a control, enter the appropriate character
 (E - ENABLE, D - DISABLE) and press ENTER.


    FUNCTION                                          STATUS
    --------                                          ------
.   Dynamic CKDS Access                               ENABLED
d   PKA Callable Services                             ENABLED
.   PKDS Read Access                                  ENABLED
.   PKDS Write, Create, and Delete Access             ENABLED
****************************** Bottom of data ********************************
```

PKA callable services must be disabled before entering the ASYM-MK.

Select option 4 ADMINCNTL from the ICSF Main Panel.

```
CSFACF00 ---------- ICSF - Administrative Control Fun    PKA SERVICES DISABLED
COMMAND ===>                                                 SCROLL ===> PAGE

         Active CKDS: CSF.CSFCKDS
         Active PKDS: CSF.CSFPKDS


 To change the status of a control, enter the appropriate character
 (E - ENABLE, D - DISABLE) and press ENTER.


    FUNCTION                                          STATUS
    --------                                          ------
.   Dynamic CKDS Access                               ENABLED
.   PKA Callable Services                             DISABLED
.   PKDS Read Access                                  DISABLED
.   PKDS Write, Create, and Delete Access             DISABLED
****************************** Bottom of data ********************************
```

Note that disabling PKA Callable Services also disables PKDS Read Access and PKDS Write, Create, and Delete Access.

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. **Enter master key in parts.**
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Clear Master Key Entry

```
CSFGCMP0 ----------- ICSF Coprocessor Management ----------- Row 1 to 5 of 5
COMMAND ===>                                                SCROLL ===> PAGE

 Select the coprocessors to be processed and press ENTER.
 Action characters are: A, D, E, K, R and S. See the help panel for details.

    COPROCESSOR      SERIAL NUMBER   STATUS
    -----------      -------------   ------
.   A00                              ACTIVE
e   E02              94006004        ACTIVE
e   E03              94006026        ACTIVE
e   X01              93006015        ACTIVE
***************************** Bottom of data ******************************
```

Select option 1 COPROCESSOR MGMT from ICSF Main Panel.

- Checksum and key value are copied from the random number generate and checksum panel.
- Enter SYM-MK or ASYM-MK for key type.
- Enter the key part – FIRST, MIDDLE, or FINAL.
  - FIRST and FINAL key parts are required.
  - MIDDLE key parts are optional. Multiple MIDDLE key parts are allowed.
  - Enter RESET to clear the master key register to restart the key entry process. Must reload FIRST key part.

```
CSFDKE50 --------------- ICSF - Clear Master Key Entry -----------------------
COMMAND ===>


              Symmetric-keys new master key register          :  EMPTY
              Asymmetric-keys new master key register         :  EMPTY

Specify information below

  Key Type  ===> sym-mk            (SYM-MK, ASYM-MK)

  Part      ===> first             (RESET, FIRST, MIDDLE, FINAL)

  Checksum  ===> 29

  Key Value ===> FB43CE01E5B5EAFD
            ===> 1ACB10BC7F947C85
            ===> 0000000000000000   (ASYM-MK only)
```

Clear Master Key Entry…cont

- Checksum and key value fields are cleared when the key part is loaded.
- Each key part is exclusive or-ed with the contents in the register
- Status of the new master key register is updated.
  - Status of SYM-MK new master key register changes from EMPTY-PART FULL-FULL
  - Status of ASYM-MK new master key register changes from EMPTY-PART FULL-EMPTY. The new ASYM-MK is set when the final key part is entered.

```
CSFDKE60 --------------- ICSF - Clear Master Key Entry ------- KEY PART LOADED
COMMAND ===>

              Symmetric-keys new master key register          :  PART FULL
              Asymmetric-keys new master key register         :  EMPTY


Specify information below

  Key Type  ===> SYM-MK            (SYM-MK, ASYM-MK)

  Part      ===> FIRST             (RESET, FIRST, MIDDLE, FINAL)

  Checksum  ===> 00

  Key Value ===> 0000000000000000
            ===> 0000000000000000
            ===> 0000000000000000   (ASYM-MK only)

Entered key part VP:  7ED35DFBA9BA2648  HP: 30B9426EAF33A74B  8A74FCF399B641E7

                  (Record and secure these patterns)
```

- VP and/or HP of entered key part are displayed at bottom of panel. Record these for verification.
- VP and/or HP of master key register are displayed after the final key part is entered. Record these for verification.

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. Enter master key in parts.
6. **Reencipher CKDS.**
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Reencipher the CKDS

Select option 2 MASTER KEY from ICSF Main Panel

```
CSFMKM00 ---------------- ICSF - Master Key Management -----------------------
OPTION ===> 3

Enter the number of the desired option.

  1  INIT/REFRESH CKDS -  Initialize a Cryptographic Key Data Set or
                          activate an updated Cryptographic Key Data Set
  2  SET MK            -  Set a DES/symmetric-keys master key
  3  REENCIPHER CKDS   -  Reencipher the CKDS prior to changing the DES
                          /symmetric-keys master key
  4  CHANGE MK         -  Change the DES/symmetric-keys master key and
                          activate the reenciphered CKDS

  5  INITIALIZE PKDS   -  Initialize or update a PKDS Cryptographic
                          Key Data Set header record
  6  REENCIPHER PKDS   -  Reencipher the PKA Cryptographic Key Data Set
  7  ACTIVATE PKDS     -  Activate the PKDS after it has been reenciphered
  8  REFRESH CACHE     -  Refresh the PKDS Cache if enabled
```

```
CSFCMK10 ------------------- ICSF - Reencipher CKDS ---- REENCIPHER SUCCESSFUL
COMMAND ===>

To reencipher all CKDS entries from encryption under the current DES/
symmetric-keys master key to encryption under the new master key enter
the CKDS names below.

  Input  CKDS ===> 'CSF.CSFCKDS'

  Output CKDS ===> 'CSF.NEWCKDS'
```

input CKDS is the current active CKDS

output CKDS must be an empty CKDS

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. Enter master key in parts.
6. Reencipher CKDS.
7. **Change the SYM-MK master key.**
8. Reencipher PKDS.
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Change the SYM-MK

Select option 2 MASTER KEY from ICSF Main Panel

```
CSFMKM00 ---------------- ICSF - Master Key Management -----------------------
OPTION ===> 4

Enter the number of the desired option.

  1  INIT/REFRESH CKDS -  Initialize a Cryptographic Key Data Set or
                          activate an updated Cryptographic Key Data Set
  2  SET MK            -  Set a DES/symmetric-keys master key
  3  REENCIPHER CKDS   -  Reencipher the CKDS prior to changing the DES
                          /symmetric-keys master key
  4  CHANGE MK         -  Change the DES/symmetric-keys master key and
                          activate the reenciphered CKDS

  5  INITIALIZE PKDS   -  Initialize or update a PKDS Cryptographic
                          Key Data Set header record
  6  REENCIPHER PKDS   -  Reencipher the PKA Cryptographic Key Data Set
  7  ACTIVATE PKDS     -  Activate the PKDS after it has been reenciphered
  8  REFRESH CACHE     -  Refresh the PKDS Cache if enabled
```

```
CSFCMK20 ------------------ ICSF - Change Master Key ------ MASTER KEY CHANGED
COMMAND ===>

Enter the name of the new CKDS below.

  New CKDS ===> 'CSF.NEWCKDS'

When the master key is changed, the new CKDS will become active.
```

This is the output CKDS from CKDS Reencipher.

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. Enter master key in parts.
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. **Reencipher PKDS.**
9. Activate the new PKDS.
10. Enable PKA callable services, PKDS read and write access.

Reencipher the PKDS

Select option 2 MASTER KEY from ICSF Main Panel

```
CSFMKM00 ---------------- ICSF - Master Key Management -----------------------
OPTION ===> 6

Enter the number of the desired option.

  1  INIT/REFRESH CKDS -  Initialize a Cryptographic Key Data Set or
                          activate an updated Cryptographic Key Data Set
  2  SET MK            -  Set a DES/symmetric-keys master key
  3  REENCIPHER CKDS   -  Reencipher the CKDS prior to changing the DES
                          /symmetric-keys master key
  4  CHANGE MK         -  Change the DES/symmetric-keys master key and
                          activate the reenciphered CKDS

  5  INITIALIZE PKDS   -  Initialize or update a PKDS Cryptographic
                          Key Data Set header record
  6  REENCIPHER PKDS   -  Reencipher the PKA Cryptographic Key Data Set
  7  ACTIVATE PKDS     -  Activate the PKDS after it has been reenciphered
  8  REFRESH CACHE     -  Refresh the PKDS Cache if enabled
```

```
CSFCMK11 ------------------- ICSF - Reencipher PKDS --------------------------
COMMAND ===>

To reencipher all PKDS entries from encryption under the old signature/
asymmetric-keys master key to encryption under the current master key
enter the PKDS names below.

  Input  PKDS ===> 'CSF.CSFPKDS'

  Output PKDS ===> 'CSF.NEWPKDS'
```

input PKDS is the current active PKDS

output PKDS must be an empty PKDS

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. Enter master key in parts.
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. **Activate the new PKDS.**
10. Enable PKA callable services, PKDS read and write access.

Activate the PKDS

Select option 2 MASTER KEY from the ICSF Main Panel.

```
CSFMKM00 ---------------- ICSF - Master Key Management -----------------------
OPTION ===> 7

Enter the number of the desired option.

  1  INIT/REFRESH CKDS -  Initialize a Cryptographic Key Data Set or
                          activate an updated Cryptographic Key Data Set
  2  SET MK            -  Set a DES/symmetric-keys master key
  3  REENCIPHER CKDS   -  Reencipher the CKDS prior to changing the DES
                          /symmetric-keys master key
  4  CHANGE MK         -  Change the DES/symmetric-keys master key and
                          activate the reenciphered CKDS

  5  INITIALIZE PKDS   -  Initialize or update a PKDS Cryptographic
                          Key Data Set header record
  6  REENCIPHER PKDS   -  Reencipher the PKA Cryptographic Key Data Set
  7  ACTIVATE PKDS     -  Activate the PKDS after it has been reenciphered
  8  REFRESH CACHE     -  Refresh the PKDS Cache if enabled
```

```
CSFCMK21 ------- ICSF - Activate PKA Cryptographic Ke          PKDS ACTIVATED
COMMAND ===>

Enter the name of the new PKDS below.

  New PKDS ===> 'CSF.NEWPKDS'
```

This is the output PKDS from PKDS reencipher.

Steps to Change the Master Key

1. Define empty CKDS/PKDS.
2. Generate key values using Random Number Generator utility.
3. Calculate checksum for key value using checksum utility.
4. Disable PKA callable services.
5. Enter master key in parts.
6. Reencipher CKDS.
7. Change the SYM-MK master key.
8. Reencipher PKDS.
9. Activate the new PKDS.
10. **Enable PKA callable services, PKDS read and write access.**

Enable PKA Callable Services

```
CSFACF00 ---------- ICSF - Administrative Control Functions -- Row 1 to 4 of 4
COMMAND ===>                                                  SCROLL ===> PAGE

         Active CKDS: CSF.CSFCKDS
         Active PKDS: CSF.CSFPKDS


 To change the status of a control, enter the appropriate character
 (E - ENABLE, D - DISABLE) and press ENTER.


    FUNCTION                                              STATUS
    --------                                              ------
.   Dynamic CKDS Access                                   ENABLED
e   PKA Callable Services                                 DISABLED
e   PKDS Read Access                                      DISABLED
e   PKDS Write, Create, and Delete Access                 DISABLED
****************************** Bottom of data ********************************
```

Select option 4 ADMINCNTL from the ICSF Main Panel.

- Enable PKA Callable Services
- Enable PKDS Read Access
- Enable PKDS Write, Create, and Delete Access

```
CSFACF00 ---------- ICSF - Administrative Control Fun          FUNCTION CHANGED
COMMAND ===>                                                  SCROLL ===> PAGE

         Active CKDS: CSF.CSFCKDS
         Active PKDS: CSF.CSFPKDS


 To change the status of a control, enter the appropriate character
 (E - ENABLE, D - DISABLE) and press ENTER.


    FUNCTION                                              STATUS
    --------                                              ------
.   Dynamic CKDS Access                                   ENABLED
.   PKA Callable Services                                 ENABLED
.   PKDS Read Access                                      ENABLED
.   PKDS Write, Create, and Delete Access                 ENABLED
****************************** Bottom of data ********************************
```

Current Hardware Status

```
CSFCMP40 ------------- ICSF - Coprocessor Hardware Status ---------------------
COMMAND ===>                                          SCROLL ===> HALF
                                                      CRYPTO DOMAIN: 6
                                                            More:     >
REGISTER STATUS                  COPROCESSOR X01        COPROCESSOR E02
 Crypto Serial Number          : 93006015               94006004
 Status                        : ACTIVE                 ACTIVE
 Symmetric-Keys Master Key
   New Master Key register     : EMPTY                  EMPTY
     Verification pattern      :
     Hash pattern              :
                               :
   Old Master Key register     : VALID                  VALID
     Verification pattern      : A996F8A939403A03       A996F8A939403A03
     Hash pattern              : AC40DD5EDFE94AB6       AC40DD5EDFE94AB6
                               : BA52CECE6B2941C9       BA52CECE6B2941C9
   Current Master Key register : VALID                  VALID
     Verification pattern      : BD5E728126997F5B       BD5E728126997F5B
     Hash pattern              : E75CC4B9272B9FAD       E75CC4B9272B9FAD
                               : C58E77315B67D713       C58E77315B67D713
 Asymmetric-Keys Master Key
   New Master Key register     : EMPTY                  EMPTY
     Hash pattern              :
                               :
   Old Master Key register     : VALID                  VALID
     Hash pattern              : F500D695FAE0ADA7       F500D695FAE0ADA7
                               : A60DB2BDA6F51537       A60DB2BDA6F51537
   Current Master Key register : VALID                  VALID
     Hash pattern              : 6EFB491489F70232       6EFB491489F70232
                               : 6DD949CEB1D17656       6DD949CEB1D17656
```

- At first time startup, all master key registers were empty.
- After Pass Phrase, the current master key register is valid.
- Key parts are loaded to the new master key register.
- After changing the master keys, the content of the current master key register is moved to the old master key register, the content of the new master key register is moved to the current master key register, and the new master key register is cleared.

Update Installation Options Data Set

- Change your installation options data set to point to your new CKDS and PKDS for next start up of ICSF.
  - Change CKDSN and PKDSN parameters

Installation Options Display

- Displays the installation options that are active since the last start of ICSF.
- Some options have defaults.

```
CSFSOP10 ------------- ICSF - Installation Option Display -- Row 1 to 13 of 13
COMMAND ===>                                                  SCROLL ===> PAGE
         Active CKDS: CSF.NEWCKDS
         Active PKDS: CSF.NEWPKDS
  OPTION                                                  CURRENT VALUE
  ------                                                  -------------
  CHECKAUTH     RACF check authorized callers             NO
  COMPAT        Allow CUSP/PCF compatibility              NO
  DOMAIN        Current domain index or usage domain index  6
  KEYAUTH       Key Authentication in effect              NO
  CKTAUTH       CKT Authentication in effect              NO
  SSM           Allow Special Secure Mode                 YES
  TRACEENTRY    Number of trace entries active            1000
  USERPARM      User specified parameter data             USERPARM
  REASONCODES   Source of callable services reason codes  ICSF
  PKDSCACHE     PKDS Cache size in records                64
  WAITLIST      Source of CICS Wait List if CICS installed  default

****************************** Bottom of data ********************************
```

Select option 3 OPSTAT from ICSF Main Panel.

Select option 1 OPTIONS to display installation options.

RACF Protection of Keys and Services

Use RACF to control which applications can use specific keys and services.

- Protect key labels using CSFKEYS general resource class.
- Protect ICSF callable services and TSO panels using CSFSERV general resource class.

```
RDEFINE CSFKEYS label UACC(NONE)
RDEFINE CSFSERV service_name UACC(NONE)
PERMIT label CLASS(CSFKEYS) ID(userid) ACCESS(READ)
PERMIT service_name CLASS(CSFSERV) ID(userid) ACCESS(READ)
```

Refer to the z/OS ICSF Administrator's Guide for a list of *service_names* that can be protected.

Refer to the z/OS Security Server RACF Command Language Reference, SA22-7686 for RACF commands.

CKDS/PKDS Sharing Considerations

- CKDS must have been initialized on a CCF (z900/z800) system.
  - can not share a z990/z890 initialized CKDS with a CCF system.
- Master keys *must* match.
  - the CCF DES master key must match the PCIXCC/CEX2C symmetric-keys master key (SYM- MK)
  - the CCF Signature Master Key (SMK) must match the PCIXCC/CEX2C asymmetric-keys master key (ASYM-MK)
  - the CCF Key Management Master Key (KMMK) must match the SMK
- Detailed information about CKDS/PKDS sharing can be found in the z/OS ICSF Administrator's Guide.

Callable Service APIs

ICSF Callable Services

ICSF provides over 70 application callable services.

Symmetric Algorithm Services
- Encryption/Decryption using DES, TDES, AES
- Hashing – SHA-1, MDC-2, MDC-4, MD5

Symmetric Key Management
- Key generation
- Key distribution via DES and RSA, including SSL handshakes

Financial Services
- PIN generation/verification/translation
- CVV generation/verification
- EMV processing

Asymmetric Algorithm Services
- RSA key generation
- Digital signature generation/verification

CKDS/PKDS key management services

Callable Service API

```
CALL CSNBENC (
                    return_code,
                    reason code,
                    exit_data_length,
                    exit_data,
                    key_identifier,
                    text_length,
                    clear_text,
                    initialization_vector,
                    rule_array_count,
                    rule_array,
                    pad_character,
                    chaining_vector,
                    cipher_text       )
```

Languages supported:

- Assembler H
- C
- COBOL
- Fortran
- PL/1

Refer to the z/OS ICSF Application Programmer's Guide for a list of the callable services supported.

Functions available with z/990

These functions were added to the z990/z890. A PCIXCC/CEX2C with January 2005 or later version of Licensed Internal Code (LIC) and ICSF FMID HCR7720 is required.

- 19-digit PANs to support VISA™ card-verification value (CVV) and the MasterCard™ card-verification code (CVC)
- Enhanced key management for Crypto Assist functions
- 64-bit callers for a subset of callable services
- Callable service PIN Change/Unblock (CSNBPCU) to support VISA Integrated Circuit Card Specification
- Callable service Transaction Validation (CSNBTRV) to support American Express card security codes
- Callable service Diversified Key Generate (CSNBDKG) enhanced to support EMV 2000 Circuit Card Specification
- Derived Unique Key Per Transaction (DUKPT) for double-length PIN keys as defined by ANSI X9.24 standard

Migration Considerations

If migrating from a CCF system the following are no longer supported on z990/z890:

- DSA signatures and key generation
- Cipher Text Translate callable service (CSNBCTT)
- CDMF (40 bit encryption)
- German Bank Pool PIN Offset (GBP-PINO)
- ANSI x9.17 services and key type
- CSFUDK callable service (replaced with CSNBDKG)

Refer to the z/OS ICSF System Programmer's Guide for detailed information about migration.

Why use z990/z890 and ICSF?

- Saves MIPs at the CP by offloading cryptographic computations to coprocessors with improved performance
- Non-disruptive scalability
- Designed for FIPS 140-2 level 4 certification
- Callable services APIs conform to IBM Common Cryptographic Architecture
- Support industry standard algorithms (DES, TDES, AES, RSA, SHA-1, MD5)
- Applications are routed to available and appropriate coprocessor transparent to the application
- CPU affinity problem eliminated

Hardware Cryptography Exploiters

- BSAFE Toolkit 3.1 (or later)
- z/OS System SSL
- z/OS Open Cryptographic Services Facility (OCSF)
- IBM HTTP Server for z/OS
- z/OS LDAP server and client
- CICS Transaction Server and CICS Transaction Gateway
- z/OS TN3270 server
- z/OS Firewall Technologies
- z/OS DCE
- Payment processing products
- VTAM Session Level Encryption
- RACF
- Crypto Based Transactions (CBT) banking solution
- Java cryptography
- z/OS Public Key Infrastructure (PKI) services
- z/OS Network Authentication Service (Kerberos)

Related Publications

• z/OS ICSF Overview	• SA22-7519
• z/OS ICSF System Programmer's Guide	• SA22-7520
• z/OS ICSF Administrator's Guide	• SA22-7521
• z/OS ICSF Application Programmer's Guide	• SA22-7522
• z/OS ICSF Messages	• SA22-7523
• z/OS TKE Workstation User's Guide	• SA22-7524
• Program Directory for ICSF – FMID HCR7720	• GI11-2845
• z/OS Security Server RACF Command Language Reference	• SA22-7686
• Support Element Operations Guide	• SC28-6831
• PR/SM Planning Guide	• SB10-7036
• IBM eServer zSeries 990 (z990) Cryptography Implementation	• SG24-7070

Acronyms

ASYM-MK	Asymmetric-keys Master Key
CCF	Cryptographic Coprocessor Feature
CDMF	Commerical Data Masking Facility
CEX2C	Crypto Express2 Coprocessor
CKDS	Cryptographic Key Data set
CP	Central Processor
DES	Data Encryption Standard
HMC	Hardware Master Console
ICSF	Integrated Cryptographic Services Facility
LIC	Licensed internal code
PAN	Personal account number
PCICA	PCI Cryptographic Accelerator
PCICC	PCI Cryptographic Coprocessor
PCIXCC	PCI X Cryptographic Coprocessor
PKA	Public Key Algorithm
PKDS	PKA Key Data Set
PPINIT	Pass Phrase Initialization
RACF	Resource Access Control Facility
RSA	Rivest-Shamir-Adelman
SSL	Secure Sockets Layer
SYM-MK	Symmetric-Keys Master Key
TDES	Triple DES
TKE	Trusted Key Entry