What zDMF 3.4 Does for Pervasive Encryption

Rebecca Levesque
CEO and President
21st Century Software
rebeccal@21csw.com

John Hogan
TDMF/zDMF Senior Developer
21st Century Software
johnh@21csw.com

Mike Moss
TDMF/zDMF Developer
21st Century Software
mikem@21csw.com

Tuesday 5 November 2019
14:00-15:00 Vale
Session DD

What we will cover today

- IBM Strategic Partnership with 21st Century Software
- Business Problem to be Solved
- zDMF Overview and Demo
- Key Takeaways

IBM Strategic Partnership with 21st Century Software

Committed to driving continuous product improvement, focused on value to our clients

IBM – 21st Century Software: Strategic Partnership

- **Headquartered in Wayne, Pennsylvania**
  - 21st Century Software has over 30 years of expertise in developing innovative mainframe analytics solutions
- **TDMF/zDMF development based in the US**
  - Re-established original team with expert knowledge and understanding of all key components
  - TDMF and zDMF are the 'gold standard' for volume and data set level migrations, used for thousands of successful data movement engagements
- **IZDS/IZDS CP Development Lab located in Perth, Australia**
  - Re-established original team with expert knowledge and understanding of all key components
  - To bring more value to IBM customers by accelerating product roadmap innovation of TDSz
- **IZBR development based in the US**
  - State-of-the-art batch resiliency solution announced May 2019
- **IBM will continue to sell these products as it does today**
  - Customers will continue to access support through IBM, while all technical support and development will be performed by 21st Century Software
  - 21st Century Software will assist IBM with go-to-market and services

Business Problem to be Solved

Why customers need non-disruptive data migration

What's the overarching problem?

Year of Digital Disruption

CIOs are struggling to balance these two competing pressures

1. Provide stable, secure, high performance services
2. Deliver, innovative, technology-intensive services quickly

http://www.gartner.com/smarterwithgartner/six-cio-responsibilities-for-digital-business-leadership/

IT Operations goals are to improve quality and reduce cost while supporting growth and change

But…

- 53% of IT Operations cite managing technology changes as their biggest challenge, especially in large legacy environments
- 43% feel that insufficient skills and resources are their biggest issue
- 34% are most concerned about having insufficient capacity to absorb more change

Source: Gartner Leadership Vision for 2019: Infrastructure and Operations Leader

Digital transformation is impacting all areas of the enterprise

33% of outages cost > $1M per hour

- IT is **held accountable to maintain availability** while managing **increasingly complex** workloads
- There is **no margin of error for outages**; whether from upgrades gone wrong or **even planned change windows**

The mainframe is underlying 72% of customer facing apps, but challenges to manage it are mounting

- The sheer size of mainframe environments make it **impossible to 'manage by human', automation of repeatable tasks** is the only option
- Even **downtime for scheduled tasks is minimal** – any means to make them **non-disruptive** is important to the business

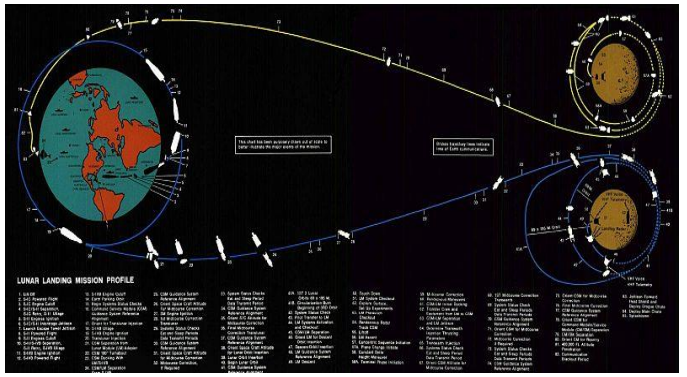
56% of customers have no succession plan their mainframe skills

- Organizations face **skills issues** as they go through a generational shift
- **Manual processes** place additional burden on staff and **increase the risk of error**

Who's still using the mainframe?

- One of the first customers was NASA who used it to land on the moon
- 85% of all credit card transactions
- 30 billion transactions per day
- 29 billion ATM transactions per year
- 92 of the top 100 banks
- 23 of the 25 top airlines
- 10 of the world's top 10 insurers
- 71 percent of Fortune 500 companies
- 12 billion passenger flights are booked
- More transactions per day than Google searches (1.3 million/second on CICS vs. 68,542/second on Google)

1969



…to 2019

Mainframes consume only 6.2 percent of worldwide IT spend. Yet, they run 68 percent of production workloads and an estimated 220Bn lines of code, with the highest levels of security and reliability

Source: ZDNet 'IBM z15 release shines light on how much is still being run on a mainframe' - September 2019 and SHARE blog 'Mainframe Matters: How Mainframes Keep the Financial Industry Up and Running' – January 2019

What are our clients telling us?

Data security concerns are driving the need to be more granular…
volume-level encryption isn't enough anymore

They need to have easier options to encrypt data without an extended outage

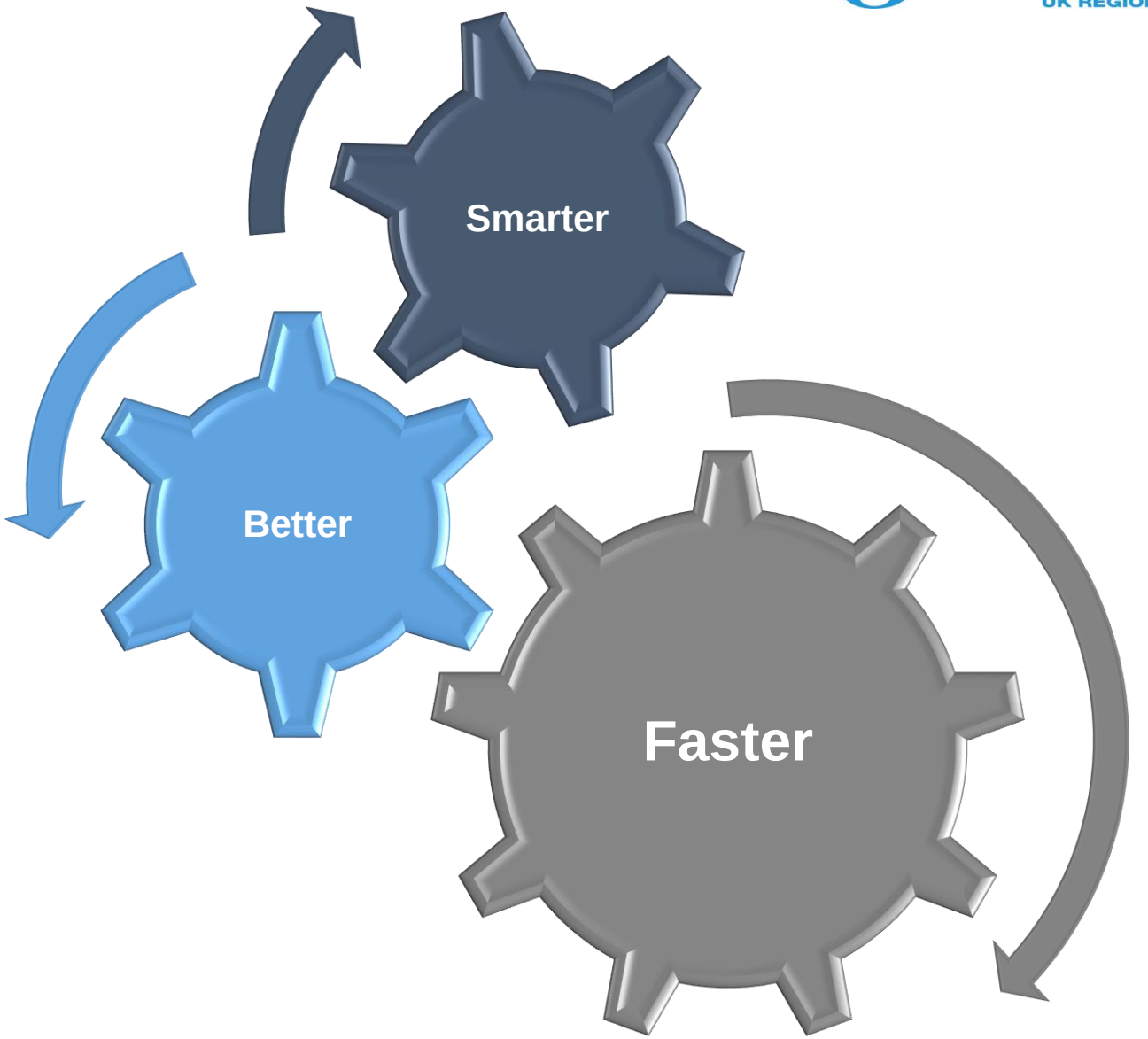
They need to be able to consolidate data onto larger devices to take advantage of new technologies

zDMF can do all of this and more….

zDMF in a nutshell

zDMF provides a **smarter, better, faster** data set level migration process that can help you on your digital transformation journey by:

1) Accelerating the benefit of new technologies
2) Providing agility in responding to environmental changes
3) Enabling an easier method to protect your data

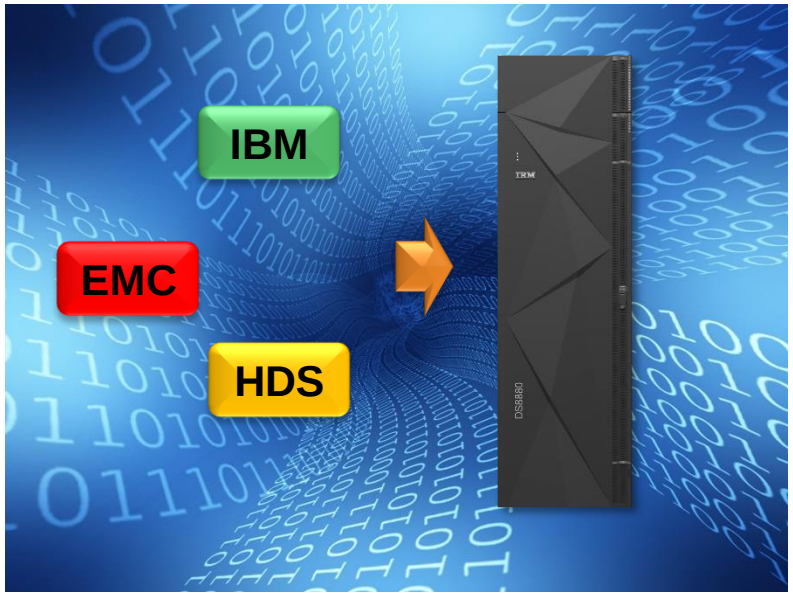


Move mainframe data effectively with optimal application availability

zDMF solutions for IBM Z provide local or global data migration for storage attached to IBM Z mainframes across multivendor environments with continuous business operations

zDMF:

- **Enables non-disruptive or minimally-disruptive data migration at the data set (logical) level**
- **Data Set level migration simplifies encryption of data sets (pervasive encryption)**



zDMF Overview

Data Set Level migration solution

zDMF Data Migration Solutions Features today

- **Non-disruptive data set moves** - in many cases data sets can be moved while open without requiring any application outage/downtime
- **Data set level encryption** – encrypt data sets during migration with little or no application downtime
- **Early completion of unallocated data sets –** unallocated data sets bypass zDMF mirror phase and are migrated and completed immediately upon completion of copy
- **Reduced application downtime for data set moves -** When application downtime is required to complete the move, the downtime is significantly reduced compared to the downtime required when using traditional tools such as DFSMSdss, FDR, et. al.

zDMF Data Migration Solutions Features today

- **Volume consolidation** – move data sets from multiple small volumes to a single larger volume; helps with UCB limits
- **Multi-volume data set consolidation** - convert multi-volume data set to single volume data set
- **Data set extent consolidation** – move a data set with many extents to data set with fewer extents or single extent; reduce volume fragmentation
- **Move non-EAV to EAV** – move track-managed data sets to cylinder-managed space based on Extended Address Space allocation rules

zDMF Data Migration Solutions Features today

- **Move non-SMS data set to SMS data set** – honors SMS ACS rules for data set placement
- **Move SMS data set to non-SMS**
- **Data set placement** – quickly resolve contention issues by moving problem data sets to other volumes
- **Facilitate storage tiering** - move data sets to different storage types – solid state, enterprise, nearline

What zDMF 3.4 does for Pervasive Encryption

zDMF 3.4 Release (GA December 2018) aligns with IBM's Pervasive Encryption strategy to protect mainframe data by enabling clients to transparently encrypt data sets.

Data protection and compliance are business imperatives

Clients are relying on encryption to protect their data, but implementing encryption can be a complex process

Delivered December 2018

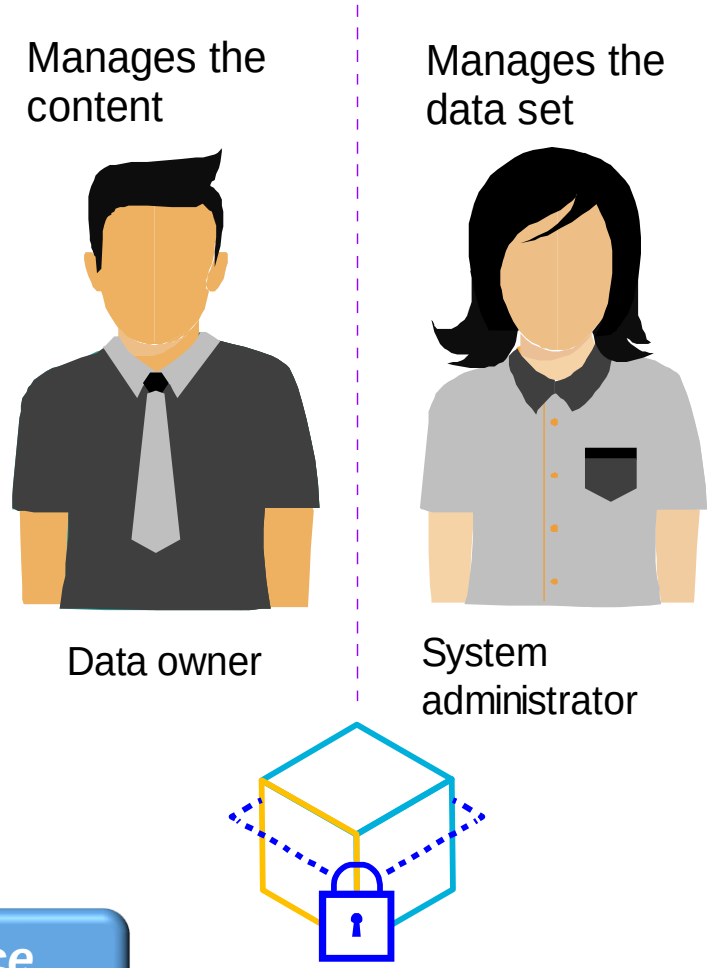
- zDMF encrypts Extended Format data sets while they are in use by mirroring I/O to an encrypted version of the data set
- zDMF obtains the KEYLABEL for data sets to be encrypted using the same search order as DFSMS
- zDMF control cards to encrypt data sets are easier and faster than coding DFDSS or IDCAMS control cards to copy and encrypt data sets

Coming 4th Quarter 2019

- zDMF will have the ability to perform key rotation (switch a data set from one encryption key to another)

Access control – Segregation of duties

- **Data owners** who ***must*** **access content** will need authority access to the data set ***as well as*** access to the encryption key label
- **Storage administrators** who only ***manage*** **the data sets** need access to the data set ***but not*** access to the key label (thus protecting access to the content)
- Different keys can be used to protect different data sets – ideal for multiple tenants or data set specific policies
- Prevent administrators from accessing the content
- Many utilities can process data preserving encrypted form:
  - COPY, DUMP and RESTORE
  - Migrate/Recall, Backup/Recover, Dump/Data Set Restore
  - PPRC, XRC, FlashCopy®, Concurrent Copy, etc.



Limit access to data in clear! Remove certain roles from compliance scope by controlling access to the data through SAF permissions.

How does data set encryption work without zDMF?

1. Stop any applications using the data set(s)
2. Unload the data set(s) or find a current unloaded version

```
//REPROS  EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//OUT   DD DSN=JHSRC.ENCTWX02.C0000001.REPRO,DISP=(,CATLG),
//      STORCLAS=LDMFTSC2,SPACE=(CYL,(100,100),RLSE),
//      DCB=(BLKSIZE=0,LRECL=32760,RECFM=FB,DSORG=PS)
//SYSIN DD *
   REPRO          -
   INDATASET('JHSRC.ENCTWX02.C0000001')   -
   OUTFILE(OUT)
```

3. Delete the data set(s)
4. Redefine the data set(s)

```
//DELDEF   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN DD *
   DELETE          JHSRC.ENCTWX02.C0000001
   DEFINE CL (NAME(JHSRC.ENCTWX02.C0000001) -
   SHR(2,3) -
   RECSZ(32760 32760)    -
   STORCLAS(LDMFTSC1) -
   DATACLAS(JHEXTF) -
   CYL(150 10)   -
   CISZ(4096)       -
   FREESPACE(00 00)   -
   KEYS(8 0))
```

5. Reload the data set(s) from the unloaded copy

```
//RESTORE EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//IN    DD DSN=JHSRC.ENCTWX02.C0000001.REPRO,DISP=SHR
//SYSIN DD *
   REPRO          -
   INFILE(IN)     -
   OUTDATASET('JHSRC.ENCTWX02.C0000001')
```

6. Restart the applications

The application is unavailable while the data set is unloaded, redefined and reloaded

zDMF solution that works

With zDMF

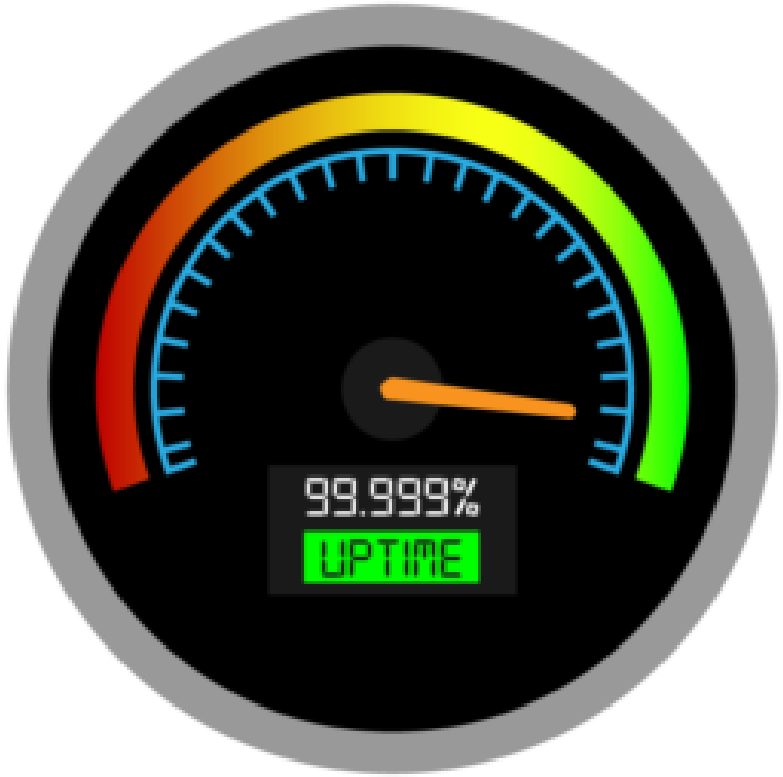
1. Activate a zDMF group with the data set. It will find the key name from RACF, SMS or its own control card
2. Anytime after the zDMF group reaches the I/O MIRROR phase, stop the application
3. DIVERT the zDMF group which takes less than a second per data set
4. Restart the application(s)

Note: DFSMSdss can't do this, it retains a track image

What it means to the applications

The value of zDMF is

- Application doesn't have to be down while the data is being copied and encrypted
- Don't have to code or find unload JCL for data sets
- Don't have to code or find allocation JCL/IDCAMS to define data set
- Don't have to code or find restore JCL for data sets



Data set types

- Data set types supported by data set encryption
  - VSAM extended format
  - Sequential extended format
- Data set types NOT supported by data set encryption
  - VSAM non-extended format
  - Sequential basic format
  - Sequential large format
  - PDS/PDSE
  - BDAM
  - Sequential tape data sets
  - HFS

Why you encrypt your data

This is a screen shot of what your data looks like on disk. Anyone in the installation with DASD admin or SYSPROG type authority can see the data. It's at CYL 0078 track 00 on volume TD5E5D. This information obtained from a LISTVTOC.

```
*** TRACK(CCHH)  00780000        R0 DATA  0000000000000000
    COUNT  0078000001000070
 0000  D1D6C8D5 4040C4D6 C54040F4 F3F2F140  40D4C1D7 D3C54040 C1E5C540 40C3C1D9  *JOHN..DOE..4321..MAPLE..AVE..CAR*
 0020  C5C6D9C5 C54040F9 F1F2F0F7 4040F4F3  F5F3F4F5 F7F8F3F4 40F2F3F7 60F8F860  *EFREE..91207..4353457834.237-88-*
 0040  F4F4F4F4 40404040 F0F0F0F6 F0F0F1F3  00500000 00000000 00001000 00000000  *4444....00060013.&.............*
 0060  00000000 00000000 0000C8DD 065A5AA5                                      *.........H..!!v                *
```

This is a screen shot of the same data encrypted.

```
*** TRACK(CCHH)  00780000        R0 DATA  0000000000000000
    COUNT  0078000001000070
 0000  60D83FAC 6563B147 8B8F31BC 83D089BB  3CE7A77E 1797D9BF 74819EFA CF1B6E93  *-Q.........c}i..Xx=.pR..a.³..>l*
 0020  3548CDF4 CC0BCFEA BB6C8B00 335CEF00  7DD5B54C 102E0EA4 1687BDFF C57E8B63  *...4.....%...*..'N.<...u.g..E=..*
 0040  4A1B8F1C 6130E3FB 4FE3CA06 B5D8A214  00500000 00000000 00001400 00000000  *¢.../.T.|T...Qs..&.............*
 0060  00000000 00000000 0000BC5F E65A5AA5                                      *..........¬W!!v                *
```

zDMF 3.4 Data Set Encryption Demo

zDMF Installation

- ZDMF has 6 installation data sets; 5 of them contain the executable code to run the product and one is a sample library
- The libraries use IBM standard installation names (LLIB, ELIB etc..)
- The load library must be APF authorized
- The zDMF server must have access to the encryption keys and to the DFSMS facility that allows data set encryption
- The other data sets are used by the ISPF user interface except for the samplib data set

```
JHH60.IBM.HGZD340.SGZDELIB
JHH60.IBM.HGZD340.SGZDLLIB
JHH60.IBM.HGZD340.SGZDMLIB
JHH60.IBM.HGZD340.SGZDPLIB
JHH60.IBM.HGZD340.SGZDTLIB
```

zDMF Address Space

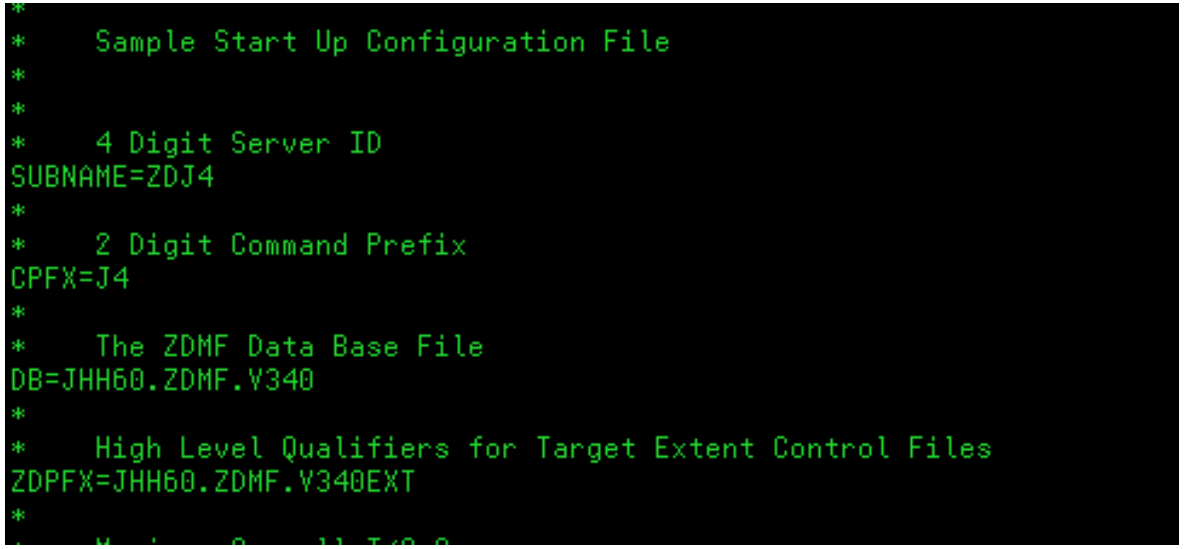
- ZDMF has a server address space that must run on every system that has access to the data being migrated
- The zDMF server proc GZDPROC should be added to a system proclib
- The server proc points to the initialization parms, and the load library

```
BROWSE    GZD.V340REL.SAMPLIB(GZDZPROC) - 01.20    Line 0000000
Command ===> _____________________________________________________ S
/ZDMF    EXEC PGM=GZDMAIN,COND=(0,LT),REGION=0M,TIME=NOLIMIT,
/             PARM=('CFG=&CHLQ..&VER..SGZDSAMP(&MEM)',
/             'START=&START')
/*
/*
/*        Following is the zDMF Load Library
/*
/STEPLIB  DD  DISP=SHR,DSN=&CHLQ..&VER..SGZDLLIB
/*
/*
/*        Following is the zDMF Security Library
/*
/GZDKEY   DD  DISP=SHR,DSN=&CHLQ..&VER..SGZDLLIB
/*
```

- The server JCL for running zDMF as an STC is member GZDZPROC in SAMPLB
- The STEPLIB and GZDKEY point to your loadlib

zDMF Configuration

The CFG data set contains the zDMF configuration parms:



Change the DB(database HLQ), SUBNAME(subsystem name) and CPFX (z/OS command prefix) and the Target HLQ parameters as follows:

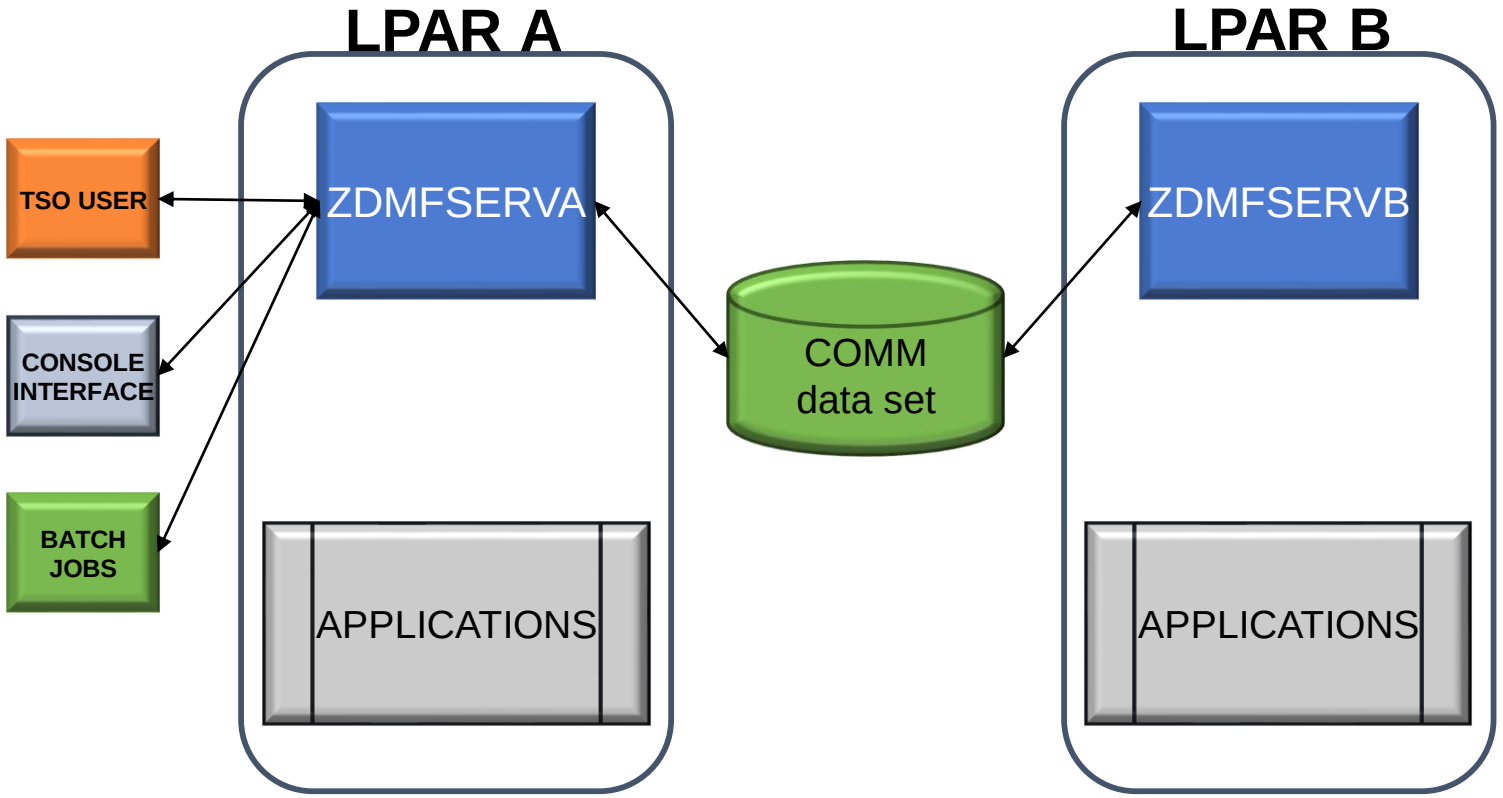
1. DB HLQ – Your data base contains group definitions and is a communication data set between multiple systems
2. SUBNAME – Is any valid available subsystem name on your system
3. CPFX – A 2-4 character z/OS command prefix to communicate to your server
4. ZDPFX – An HLQ used to allocate 'extent map' data sets on your target volumes

zDMF Server Overview

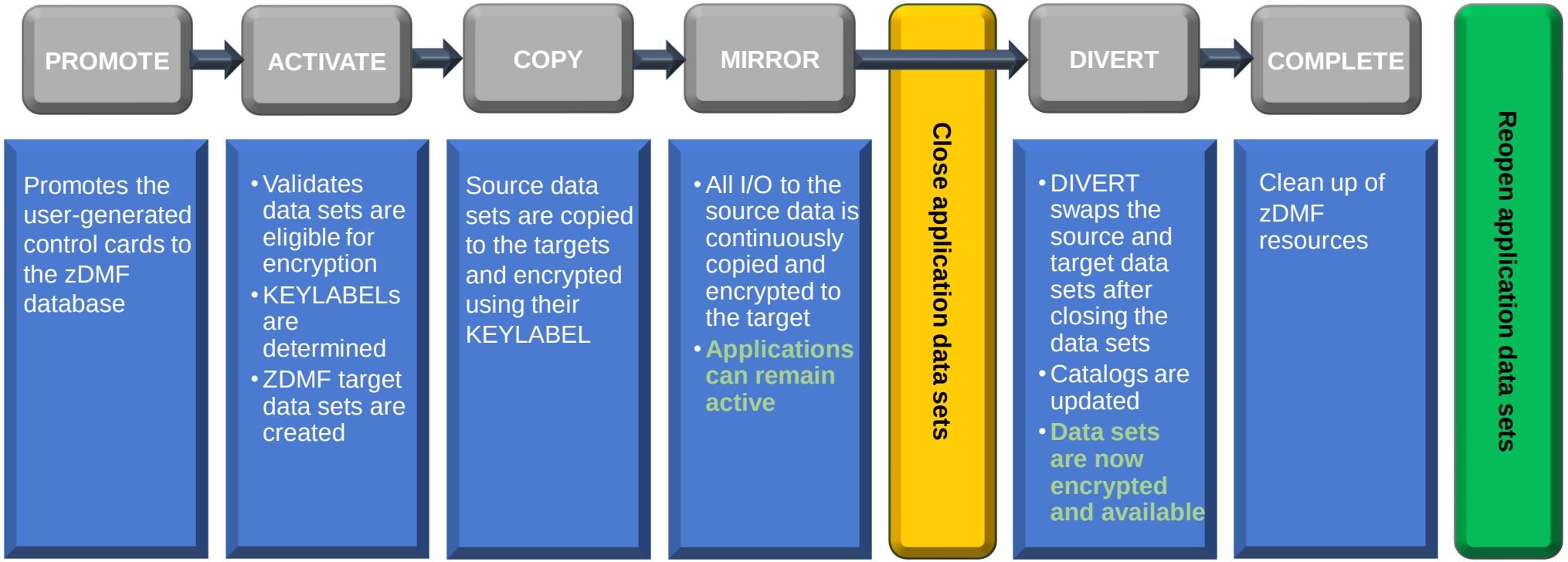
There is a zDMF server for each LPAR in the sysplex

zDMF Server functions are:

- Install/Monitor tracks
- Activate/terminate groups
- Communicate data set extent changes
- Communicate group status changes



Best Practice for Data set level migration and encryption with zDMF



- This process provides the safest means to migrate and encrypt data sets, with minimal disruption
- Applications can remain active through all phases
- At the end of the DIVERT and COMPLETE phases (approximately a 2-minute outage), the application data sets can be reopened

zDMF PROMOTE Phase

ZDMF uses a 'GROUP' to identify data sets to be migrated/and encrypted and their target volumes/storage class.

```
//PROMOTE  EXEC PGM=GZDBAT,PARM='CPFX=J4,DEBUG=NO',COND=(7,LE)
//STEPLIB  DD   DISP=SHR,DSN=JHH60.IBM.HGZD340.SGZDLLIB
//SYSPRINT   DD   SYSOUT=*
//SYSUDUMP   DD   SYSOUT=*
//SYSIN      DD   *
 PROMOTE DLM=ZZ
 GROUP (ENCTWX02) -
   DELETE_EXISTING_TARGET_DATASETS (YES) -
   EARLY_DATA_SET_COMPLETION (NO) -
 SET -
   SPHERE (YES) -
   TOLERATE_SOURCE_VALIDATE_FAILURE (NO) -
   MIGRATE_ONLY_SPECIFIED_VOLUMES (NO) -
      ENCRYPT(YES)                     -
      KEYLABEL (TDM.AES256.DATA)   -
   SOURCE (DSN (JHSRC.ENCTWX02.C0000001)) -
   TOLERATE_TARGET_CREATE_FAILURE (NO) -
   TARGET (DSN (JHTGT) -
         STORAGECLASS(LDMFTSC1))
ZZ
```

To point to your zDMF server all that is required is the command prefix. In this example J4 is the command prefix used. This JOB will store the GROUP in your ZDMF data base where you can later ACTIVATE it to start the migration/encryption process.

After PROMOTING the GROUP, it can be displayed with the Display Groups command, or with the ISPF interface:

```
RESPONSE=TDM1
 GZD1100I Command received from userid: JHH61
 GZD1101I  D G
 NAME     1ST-PAIR   DSNS  STATUS          OWNER
 ENCTWX02 0000/0000     0  NEVER ACTIVE
 ENCTWX04 0000/0000     0  NEVER ACTIVE
```

```
                    Subsystem J4   Groups          Row 1 to 19 of 30
 Command ===> _                                    Scroll ===> CSR

   Group                                                    TDM1
     Data Set                                               Status
         Extents

 _ ENCTWX02                                                 Inactive

 _ ENCTWX04                                                 Inactive
   Activate, Divert, and Terminate reports available
```

zDMF ACTIVATE Phase

The ACTIVATE phase determines where to migrate the data sets and obtains KEYLABELS via RACF, user definition or SMS Dataclas. During this phase a TARGET data set is created that is a clone of the SOURCE data set except that the target will contain the encryption definitions in the VVDS, VTOC, etc. The TARGET data set uses the TARGET DSN HLQ and generates a name that includes the GROUP name for a data set.

```
JHH61    00000290  J4 ACT ENCTWX02
STC01196 00000090  GZD1100I Command received from userid: JHH61 310
     310 00000090  GZD1101I  ACT ENCTWX02
     310 00000090  GZD3530I Group ENCTWX02 ACTIVATED
STC01196 00000090  GZD2024I ENCTWX02 is now ACTIVE (00->80) at CMD_ACTIVATE+0284
STC01196 00000090  GZD0169I GROUP ENCTWX02 WAITING FOR TDM2/ZDJ4
STC01196 00000090  GZD1101I  GROUP (ENCTWX02) -
STC01196 00000090  GZD1101I    DELETE_EXISTING_TARGET_DATASETS (YES) -
STC01196 00000090  GZD1101I    EARLY_DATA_SET_COMPLETION (NO)
STC01196 00000090  GZD1101I  SET -
STC01196 00000090  GZD1101I    SPHERE (YES) -
STC01196 00000090  GZD1101I    TOLERATE_SOURCE_VALIDATE_FAILURE (NO) -
STC01196 00000090  GZD1101I    MIGRATE_ONLY_SPECIFIED_VOLUMES (NO) -
STC01196 00000090  GZD1101I       ENCRYPT(YES)                  -
STC01196 00000090  GZD1101I       KEYLABEL (TDM.AES256.DATA)    -
STC01196 00000090  GZD1101I    SOURCE (DSN (JHSRC.ENCTWX02.C0000001)) -
STC01196 00000090  GZD1101I    TOLERATE_TARGET_CREATE_FAILURE (NO) -
STC01196 00000090  GZD1101I    TARGET (DSN (JHTGT) -
STC01196 00000090  GZD1101I          STORAGECLASS(LDMFTSC1))
STC01196 00000090  GZD0118I Command parse successful
```

This is the result of an ACTivate command in the SYSLOG. The GROUP is activated, and TARGET data sets are allocated. An OPEN is done for the TARGET data set using the encryption key therefore the zDMF server must have access to that encryption key.

```
STC01196 00000090  GZD2024I ENCTWX02 is now ACT-PND (80->C0) at SYNC_PHASE1+0292
STC01196 00000090  GZD0170I Heartbeat task is now activating group ENCTWX02 on 2 system(s).
STC01196 00000090  GZD2024I ENCTWX02 is now MIR-PND (C0->C8) at SYNS_RESUME+091A
```

zDMF ACTIVATE Phase

Messages in the ACTIVATE phase describe the steps taken during activation of the group

```
02/11/2019 03:01:23.221 GZD4160I DATA SET JHSRC.RACF.ENCR0003.C0000001
                                 TO GROUP ENCR0003 VIA SOURCE DATASET
                                 STATEMENT JHSRC.RACF.ENCR0003.C0000001
02/11/2019 03:01:23.226 GZD4212I FOUND A DATAKEY IN DFP SEGEMENT FOR
                                 DSN=JHSRC.RACF.ENCR0003.C0000001
                                 RACF_PROFILE=JHSRC.RACF.ENCR0003.C*
                                 KEYLABEL=TDM.AES256.DATA.KEY3
02/11/2019 03:01:23.255 GZD4148I SMS VOLUME TD5349 IN STORAGE GROUP
                                 ADDED TO TARGET VOLUME LIST
02/11/2019 03:01:23.256 GZD4146I ACS ROUTINE MSG= IGD01008I USER
                                 STORAGE CLASS LDMFTSC1 RETAINED.
02/11/2019 03:01:23.372 GZD4166I THE TARGET DATA SET
                                 JHTGT.ENCR0003.D9042.T0301232.S00001
                                 FOR SOURCE DATA SET
                                 JHSRC.RACF.ENCR0003.C0000001 ALLOCATED
02/11/2019 03:01:23.372 GZD4153I THE ACTIVATION ECSA CONTROL BLOCK
                                 PHASE IS BEING ENTERED FOR ENCR0003
02/11/2019 03:01:23.376 GZD4154I ACTIVATION PASSING CONTROL TO HEARTBEAT
                                 TASK FOR GROUP ENCR0003
```

1. Determine what source data sets are to be included in the group
2. Find the KEYLABEL
3. Find the target volumes using SMS ACS call
4. Allocate the target data set
5. ACTIVATE the group

zDMF ACTIVATE Phase

A J4 D DSN ENCTWX02 z/OS command will show the data set details. You can see the encryption key name used by the SOURCE and TARGET volumes and their corresponding extent locations on those volumes.

```
RESPONSE=TDM1
 GZD1100I Command received from userid: JHH61
 GZD1101I  D DSN
 DSNAME SOURCE->TARGET                                GROUP
  EXT    SRC/TGT     cccCCCCH  STATUS     TRKS/%  DSCB-CCHHR
 JHSRC.ENCTWX02.C0000001                              ENCTWX02
  -> JHTGT.ENCTWX02.D8255.T2148205.S00001
    *** VSAM Cluster
    KEYLABEL=TDM.AES256.DATA
 JHSRC.ENCTWX02.C0000001.DATA                         ENCTWX02
  -> JHTGT.ENCTWX02.D8255.T2148205.S00001.DATA
    1 C632(TD2727) 00006660  MIRROR      2250  0000000702
      C647(TD277B) 0000B2E0              100%   0000000529
    2 C632(TD2727) 00006070  MIRROR       750
      C647(TD277B) 0000BC40              100%
    3 C632(TD2727) 00006430  MIRROR       150
      C647(TD277B) 0000BF60              100%
    4 C632(TD2727) 00008E10  MIRROR       300  000000080B
      C647(TD277B) 0000C000              100%   0000000607
 JHSRC.ENCTWX02.C0000001.INDEX                        ENCTWX02
  -> JHTGT.ENCTWX02.D8255.T2148205.S00001.INDX
    1 C632(TD2727) 000048C3  MIRROR        20  0000000806
```

At this point a LISTCAT of the TARGET data set shows a valid encrypted data set.

```
CLUSTER ------- JHTGT.ENCTWX02.D8255.T2148205.S00001
     IN-CAT --- JH.UCAT.TGT.JH5607
     HISTORY
       DATASET-OWNER-----(NULL)      CREATION--------2018.255
       RELEASE----------------2      EXPIRATION------0000.000
     SMSDATA
       STORAGECLASS ---LDMFTSC1      MANAGEMENTCLASS---(NULL)
       DATACLASS --------JHEXTF      LBACKUP ---0000.000.0000
       CA-RECLAIM---------(YES)
       EATTR-------------(NULL)
       BWO STATUS------00000000      BWO TIMESTAMP---00000 00:00:00.0
       BWO---------------(NULL)
     RLSDATA
       LOG ---------------(NULL)   RECOVERY REQUIRED --(NO)     FRLOG
       VSAM QUIESCED -------(NO)   RLS IN USE ---------(NO)     LOGREP
       LOGSTREAMID-----------------------------(NULL)
       RECOVERY TIMESTAMP LOCAL-----X'0000000000000000'
       RECOVERY TIMESTAMP GMT-------X'0000000000000000'
     ENCRYPTIONDATA
       DATA SET ENCRYPTION----(YES)
       DATA SET KEY LABEL-----TDM.AES256.DATA
     PROTECTION-PSWD-----(NULL)      RACF----------------(NO)
     ASSOCIATIONS
       DATA-----JHTGT.ENCTWX02.D8255.T2148205.S00001.DATA
       INDEX----JHTGT.ENCTWX02.D8255.T2148205.S00001.INDX
```

zDMF COPY Phase

The next zDMF phase of migration is COPY this is where the SOURCE data is copied to the TARGET volume and the blocks/CIs are encrypted during COPY. The length of this phase is dependent upon the amount of data being migrated and for small data sets can pass without notice.

```
GZD2024I ENCTWX02 is now MIR-PND (C0->C8) at SYNS_RESUME+091A
GZD0215I Synchronization for TD2727 (C632 -> C647) completed (3,470
tracks).
GZD2024I ENCTWX02 is now MIRROR (C8->88) at IS_GROUP_MIRACT+0136
```

Note that COPY starts with MIR-PND and ends when the GROUP moves to the MIRROR phase.

After the COPY phase if the EARLY_dataset_COMPLETE option is set to YES any data sets in the GROUP that are not in use are DIVERTed and COMPLETEd.

```
                          Subsystem J4   Groups          Row 1 to 19 of 31
Command ===>                                            Scroll ===> CSR

  Group                                                        TDM1
    Data Set                                                   Status
        Extents

_ ENCTWX02  Owning System: TDM1                    Moved=  0% Copy
  Activate report available

_ ENCTWX04                                                     Inactive
  Activate, Divert, and Terminate reports available
```

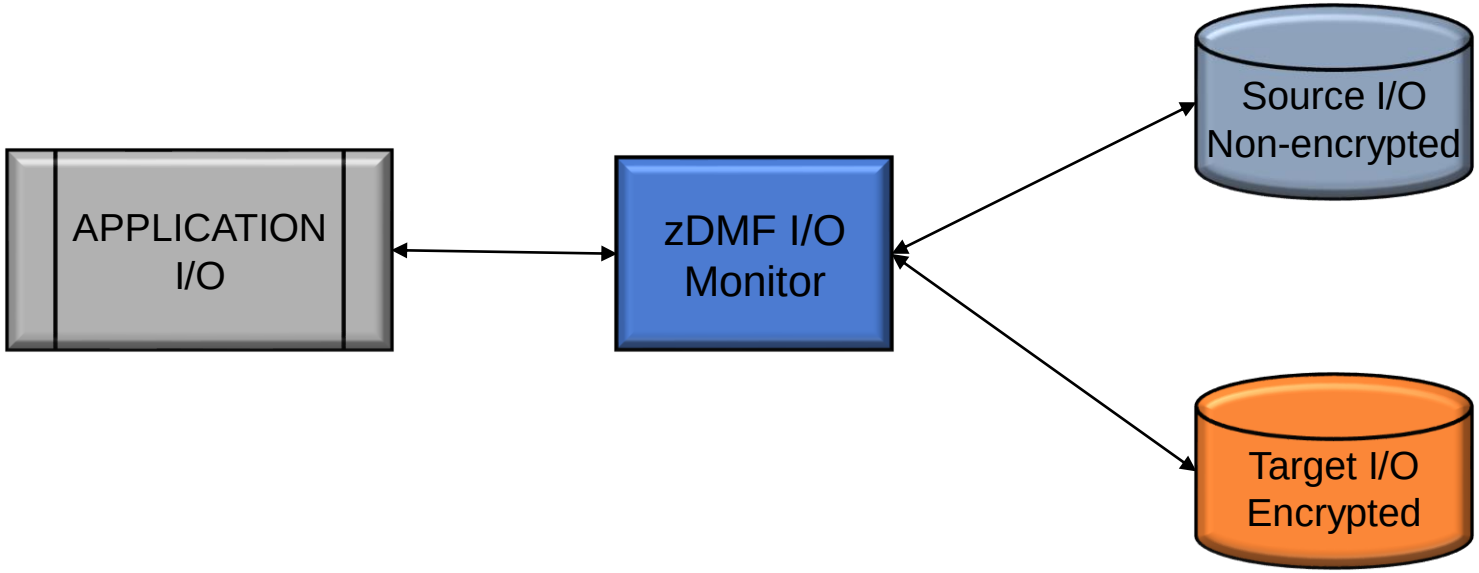
zDMF MIRROR Phase

During this phase write I/O to the SOURCE data set(s) extents are mirrored to the TARGET data set and extents that represent encrypted data sets have their TARGET I/O buffers encrypted.

A DFDSS print of the tracks that comprise the TARGET data set will show encrypted data with an MMSX that has the encrypt bit set.

zDMF MIRROR Phase

During this phase write I/O to the SOURCE data set(s) extents are mirrored to the TARGET data set and extents that represent encrypted data sets have their TARGET I/O buffers encrypted



zDMF DIVERT Phase

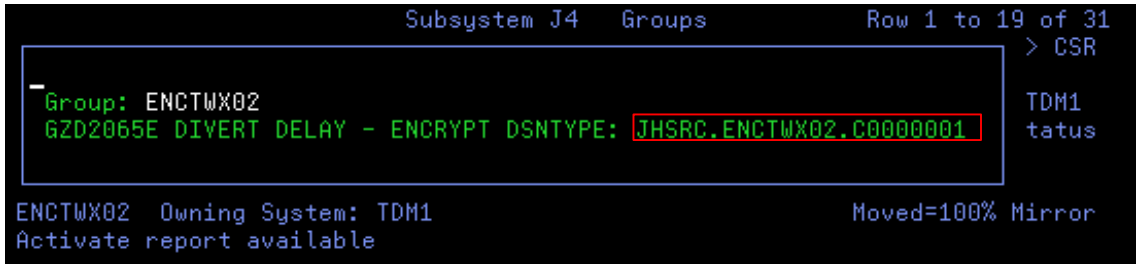
During the DIVERT phase the SOURCE and TARGET data sets are 'swapped' by catalog, VVDS and VTOC updates.

*Note: *** Currently the SOURCE data sets must be closed and unallocated before DIVERT can take place ***. This will be changed in a future release.*

If a data set is in use, you will see the following:

```
J4 DIVERT ENCTWX02
GZD2065E DIVERT delay - ENCRYPT dsntype: JHSRC.ENCTWX02.C0000001
GZD1100I Command received from userid: JHH61 538
GZD1101I  DIVERT ENCTWX02
GZD0169I Group ENCTWX02 waiting for TDM2/ZDJ4
```

In ISPF you will see:



Once the data set(s) is closed and unallocated:

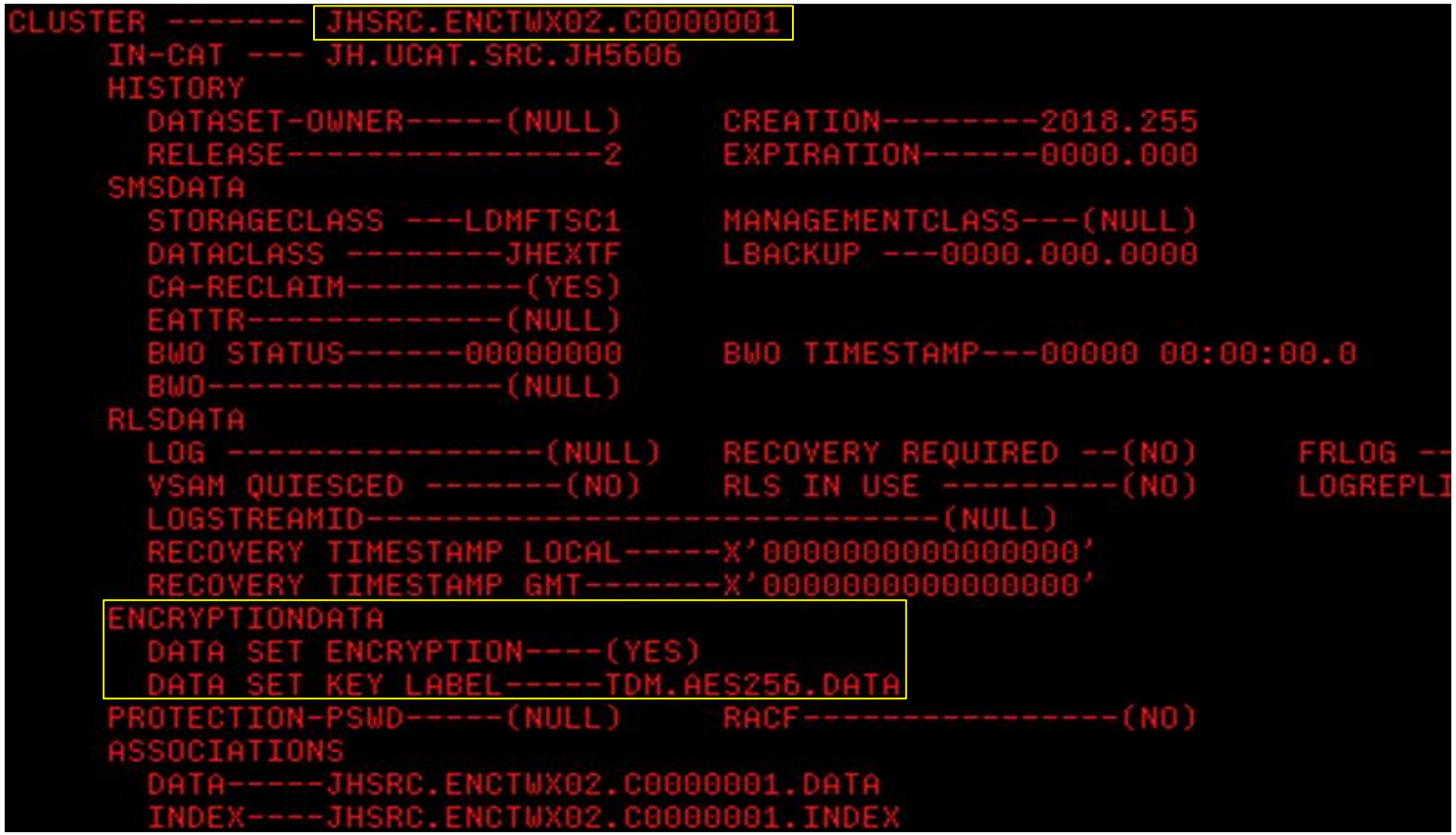
```
J4 DIVERT ENCTWX02
GZD1100I Command received from userid: JHH61 565
GZD1101I  DIVERT ENCTWX02
GZD3530I GROUP ENCTWX02 Divert process starting
GZD2024I ENCTWX02 is now DIV-PND (88->C4) at CHECK_GROUP_STATUS+0256
GZD0577I Heartbeat task is now diverting group ENCTWX02 on 2 system(s).
GZD4000I DIVERT for GROUP ENCTWX02 started.
GZD4001I DIVERT for GROUP ENCTWX02 ended     0 Data Sets failed DIVERT
GZD2024I ENCTWX02 is now DIVERT (C4->84) at ES_DIVERT+0364
```

Since there are no allocations to the data set(s) the GROUP will enter the zDMF complete phase where the zDMF resources will be freed.

```
GZD2024I ENCTWX02 is now CMP-ALLP (84->C2) at LOG_OUR_STATUS+0812
GZD2024I ENCTWX02 is now COMPLETE (C2->02) at TERMINATE_ALL+021C
GZD0589I Heartbeat task setting group ENCTWX02 to a status of terminated
```

zDMF DIVERT Phase

At this point the SOURCE data set(s) now reside on the TARGET volumes and a LISTCAT of the SOURCE data sets(s) show that it is encrypted.



zDMF Multi-LPAR Sysplex Operation

A zDMF server needs to be running on every system that can do I/O to any data set being migrated/encrypted. Other than the STC or JOB name, the server JCL is the same for each system in the SYSPLEX. ZDMF will detect and report when a zDMF server has terminated and will also report on individual servers during GROUP phase changes such as ACTIVATE and DIVERT.

Example of a D HOSTS command.

```
RESPONSE=TDM1
 GZD1100I Command received from userid: JHH61
 GZD1101I  D HOSTS
 CPUID       SMFID SSID CMD-PFX  HEARTBEAT
 322CE73906   TDM2 ZDJ4 J4       01:49:00 09/13/18
 052CE73906   TDM1 ZDJ4 J4       01:49:05 09/13/18
```

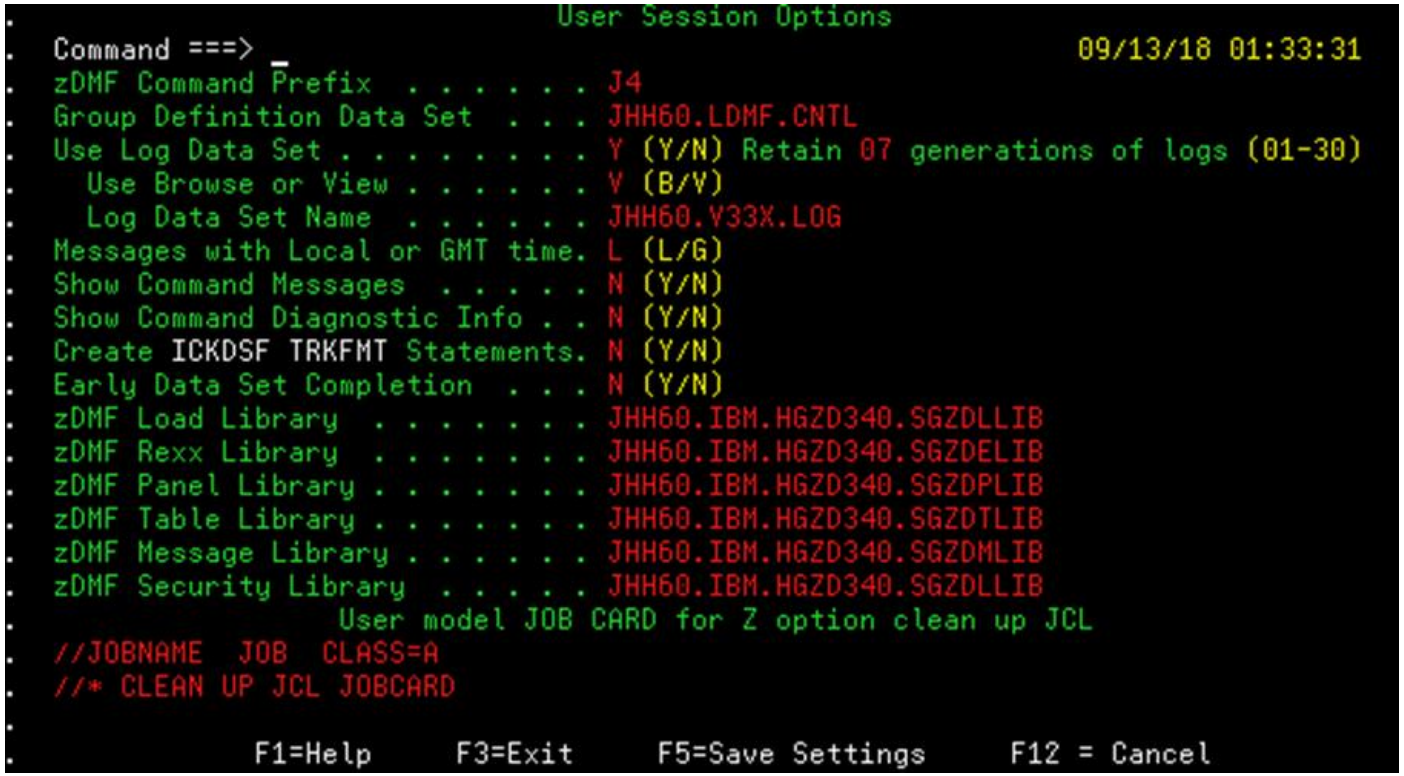
Example of a D HOSTS after a server has been brought down. At this point GROUPs will not ACTIVATE or DIVERT until the server is either removed 'J4 REMOVE TDM2' or brought back up.

```
GZD2027I Server ZDJ4TDM2 now considered IDLE
J4 D HOSTS
GZD1100I Command received from userid: JHH61 608
GZD1101I  D HOSTS
CPUID       SMFID SSID CMD-PFX  HEARTBEAT
322CE73906   TDM2 ZDJ4 J4       01:51:05 09/13/18 IDLE
052CE73906   TDM1 ZDJ4 J4       01:52:15 09/13/18
```

zDMF ISPF Panels

To start the ISPF interface EXEC ‘xxx.IBM.HGZD340.SGZDELIB(GZDZDMF)’. On your first entry you will be prompted for user session options. Your command prefix is the connection from ISPF to your server.

The HELP panels have most any detail needed. Note that PF5 will save your settings.



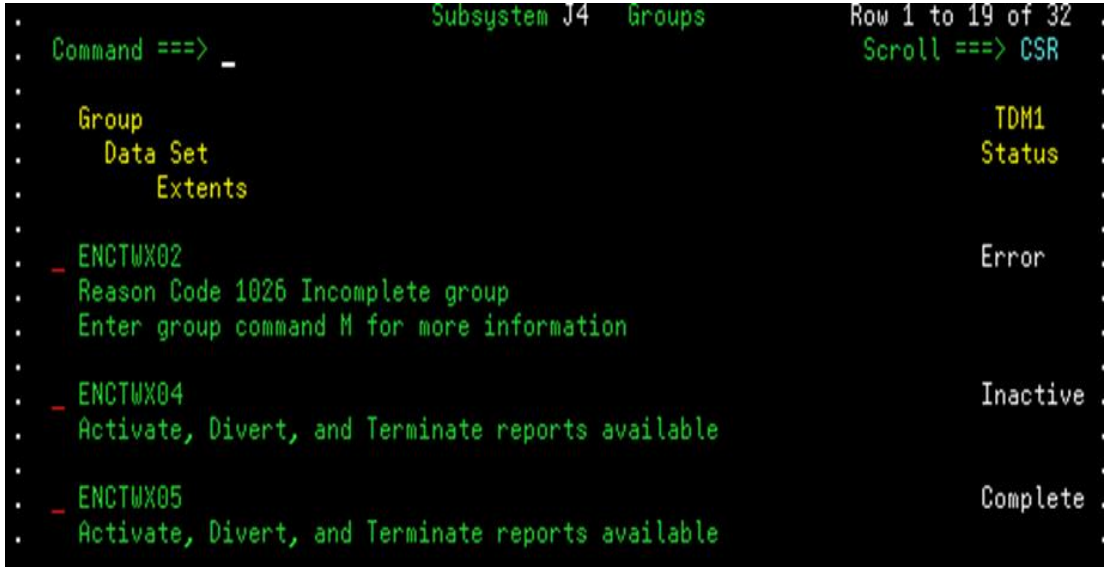
zDMF ISPF Panels

The ISPF main panel is shown below:

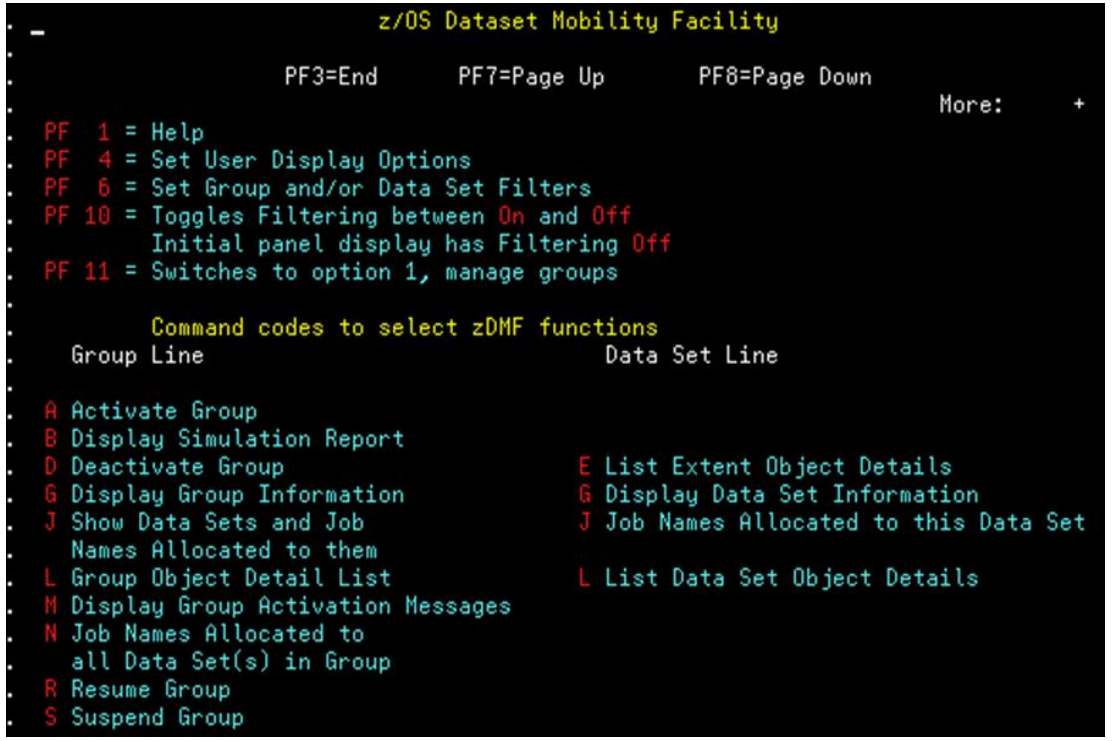
Option 2 is where most of the work gets done by ACTIVATING, DIVERTing and monitoring GROUPS. Don't be fooled by Option 1, it just allows you to create JCL/GROUP definitions in a data set and then PROMOTE those GROUPs to your database.

zDMF ISPF Panels

The Option 2 panel is shown below.



The help screens for the Option 2 panel are shown below:



zDMF – Key Rotation

Rotating KEYLABELs on a periodic basis for encrypted data is not just best practice it's often an audit requirement. zDMF can simplify the process to rotate keys using data set level migration.

- zDMF will rotate the KEYLABEL by using (in order):
  1. RACF control segment
  2. zDMF control statement
  3. DFSMS DATACLAS
- If one of those returns a different KEYLABEL when a data set is migrated with zDMF, it will rotate the keys
- RACF cannot be overridden, it's always honored
- zDMF can decrypt a data set with ROTATE YES when there is no longer a key in the RACF DFP segment, zDMF control statement or DFSMS DATACLAS

** ROTATE KEYLABEL - APAR OA57257*

```
GROUP (ROTATE) -
  DELETE_EXISTING_TARGET_DATASETS (YES) -
  EARLY_DATA_SET_COMPLETION (NO)
SET -
  SPHERE (YES) -
  TOLERATE_SOURCE_VALIDATE_FAILURE (NO)  -
  MIGRATE_ONLY_SPECIFIED_VOLUMES (NO) -
        ROTATE (YES)  -
        KEYLABEL (TDM.AES256.DATA.KEY2)  -
  SOURCE (DSN (JHSRC.ROTATE.KEYR.C0000001))  -
  TOLERATE_TARGET_CREATE_FAILURE (NO) -
  TARGET (DSN (JHTGT) -
        STORAGECLASS(LDMFTSC1))
```

zDMF - Non-extended to Extended Format Conversion Example

The new zDMF GROUP parameter CONVERT_TO_EXTENDED_FORMAT(YES/NO) can be used with or without encryption to convert non-extended format data sets to extended format.

```
GROUP (BASICI2) -
  DELETE_EXISTING_TARGET_DATASETS (YES) -
  EARLY_DATA_SET_COMPLETION (NO)
SET -
  SPHERE (YES) -
  TOLERATE_SOURCE_VALIDATE_FAILURE (NO) -
  MIGRATE_ONLY_SPECIFIED_VOLUMES (NO) -
  CONVERT_TO_EXTENDED_FORMAT(YES)  -
  ENCRYPT(YES)                     -
  SOURCE (DSN (JHSRC.BASICI2.C0000001)) -
  TOLERATE_TARGET_CREATE_FAILURE (NO) -
  TARGET (DSN (JHTGT) -
        STORAGECLASS(LDMFTSC1))
```

Note: *Converting a data set to extended format adds a 32-byte suffix to the data set. Some data sets may have a blocksize that would prevent the addition of 32 bytes to their physical blocksize and those data sets will not qualify for this feature*

zDMF – How to plan for Pervasive Encryption

Before you encrypt a single data set:

1. **You must be committed to Pervasive Encryption (at least for some applications)**
2. **You must have identified a 'pilot' application to try**

An example scenario for encrypting a group of data sets follows.

1. The pilot application General Ledger is selected with a data set name mask of PROD.GL.**.
2. The KEYLABEL (encryption key name) must be defined to RACF or SMS). Once this happens data sets that recreated will start to be encrypted.
3. There are 600 PROD.GL data sets identified in a generated list.
   - 100 are DB2 related - (use DB2 RE-ORG to encrypt)
   - 100 are GDGs that get encrypted as they are created
   - 100 are other sequential and VSAM data sets that get recreated, and encrypted, during normal application processing
4. That leaves 300 data sets that are eligible for encryption with zDMF.
5. Assuming 1 hour for each data set to: unload it, delete it, define it, reload it, monitor the jobs, ensure you have access…..

Spend 300 staff hours or use zDMF….DFSMSdss can't do this

Roadmap & Strategy

IBM Z Data Set Mobility Facility looking forward

zDMF Data Migration Solutions Roadmap

✓ *DELIVERED*

- Dynamic data set level encryption
- Support for moving multi-volume data sets to EAV Extended Address
- Toleration support for zHyperlink

- Key rotation
- Basic/large format conversion to extended format
- Smart data set selector (native support or interface with other 21st products)

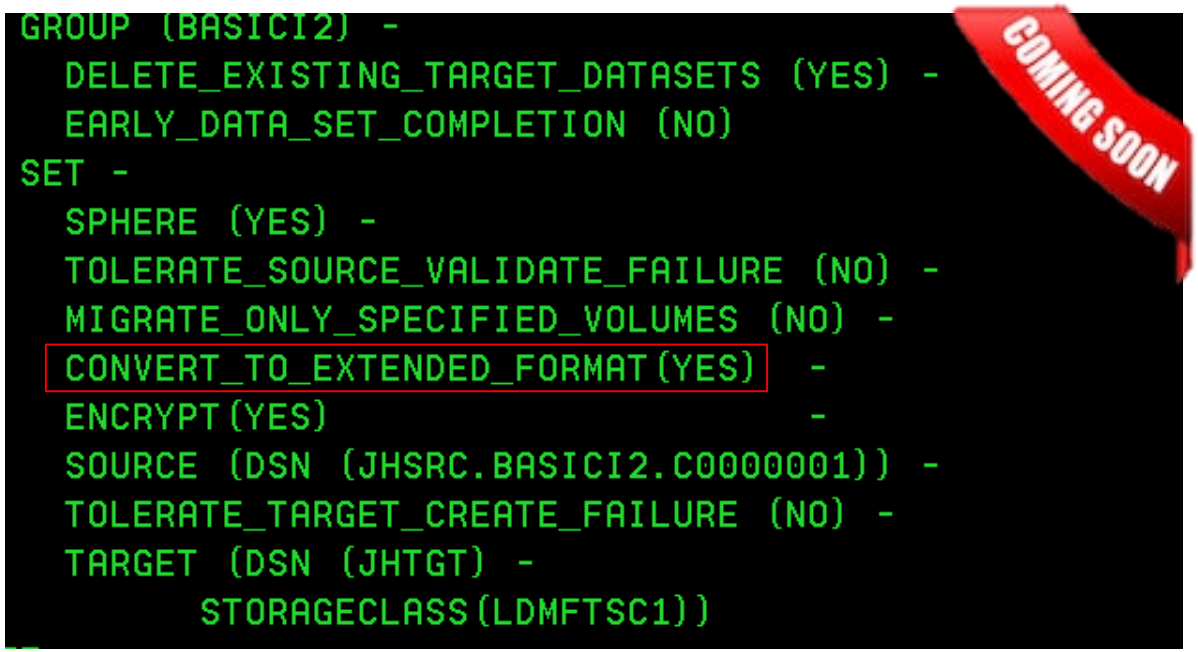
- Support additional data set types for auto-completion (no application stop/start required)
- Dynamic data set compression option
- Move catalogs non-disruptively

We're listening!

Please let us know what you need in the product and how you use it

zDMF - Non-extended to Extended Format conversion example

The new zDMF GROUP parameter CONVERT_TO_EXTENDED_FORMAT(YES/NO) can be used with or without encryption to convert non-extended format data sets to extended format.



Note: Converting a data set to extended format adds a 32-byte suffix to the data set. Some data sets may have a blocksize that would prevent the addition of 32 bytes to their physical blocksize and those data sets will not qualify for this feature

Key Takeaways

Answers to user challenges

zDMF data set encryption capabilities reduce effort and service interruption required to protect data

zDMF is the gold standard tools for non-disruptive movement of data sets

zDMF enables faster data set level migration to take advantage of new technologies

Further information

- z/OS Data Set Mobility Facility: https://www.ibm.com/us-en/marketplace/zos-data-set-mobility-facility
- How to Migrate and Encrypt a Data Set Using zDMF: https://www.youtube.com/watch?v=lvSq-A_mytk

Thank you!

Rebecca Levesque – CEO and President,
21st Century Software
rebeccal@21csw.com

John Hogan – TDMF/zDMF Senior Developer, 21st Century Software
johnh@21csw.com

Mike Moss – TDMF/zDMF Developer, 21st Century Software
mikem@21csw.com

+1-610-971-9946

21csw.com

GUIDE SHARE EUROPE UK REGION

Please submit your session feedback!

Do it online at:
http://conferences.gse.org.uk/2019/feedback/dd

This session is DD

1. What is your conference registration number?

This is the three digit number on the bottom of your delegate badge

2. Was the length of this presention correct?

1 to 4 = "Too Short" 5 = "OK" 6-9 = "Too Long"

1 2 3 4 5 6 7 8 9

3. Did this presention meet your requirements?

1 to 4 = "No" 5 = "OK" 6-9 = "Yes"

1 2 3 4 5 6 7 8 9

4. Was the session content what you expected?

1 to 4 = "No" 5 = "OK" 6-9 = "Yes"

1 2 3 4 5 6 7 8 9

Notices and disclaimers

- © 2019 International Business Machines Corporation. No part of this document may be reproduced or transmitted in any form without written permission from IBM.
- **U.S. Government Users Restricted Rights — use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM.**
- Information in these presentations (including information relating to products that have not yet been announced by IBM) has been reviewed for accuracy as of the date of initial publication and could include unintentional technical or typographical errors. IBM shall have no responsibility to update this information. **This document is distributed "as is" without any warranty, either express or implied. In no event, shall IBM be liable for any damage arising from the use of this information, including but not limited to, loss of data, business interruption, loss of profit or loss of opportunity.** IBM products and services are warranted per the terms and conditions of the agreements under which they are provided.
- IBM products are manufactured from new parts or new and used parts.
  In some cases, a product may not be new and may have been previously installed. Regardless, our warranty terms apply."
- **Any statements regarding IBM's future direction, intent or product plans are subject to change or withdrawal without notice.**
- Performance data contained herein was generally obtained in a controlled, isolated environments. Customer examples are presented as illustrations of how those
- customers have used IBM products and the results they may have achieved. Actual performance, cost, savings or other results in other operating environments may vary.
- References in this document to IBM products, programs, or services does not imply that IBM intends to make such products, programs or services available in all countries in which IBM operates or does business.
- Workshops, sessions and associated materials may have been prepared by independent session speakers, and do not necessarily reflect the views of IBM. All materials and discussions are provided for informational purposes only, and are neither intended to, nor shall constitute legal or other guidance or advice to any individual participant or their specific situation.
- It is the customer's responsibility to insure its own compliance with legal requirements and to obtain advice of competent legal counsel as to the identification and interpretation of any relevant laws and regulatory requirements that may affect the customer's business and any actions the customer may need to take to comply with such laws. IBM does not provide legal advice or represent or warrant that its services or products will ensure that the customer follows any law.

Notices and disclaimers continued

- Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products about this publication and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products. IBM does not warrant the quality of any third-party products, or the ability of any such third-party products to interoperate with IBM's products. **IBM expressly disclaims all warranties, expressed or implied, including but not limited to, the implied warranties of merchantability and fitness for a purpose.**
- The provision of the information contained herein is not intended to, and does not, grant any right or license under any IBM patents, copyrights, trademarks or other intellectual property right.
- IBM, the IBM logo, ibm.com and [names of other referenced IBM products and services used in the presentation] are trademarks of International Business Machines Corporation, registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at: www.ibm.com/legal/copytrade.shtml