Effective Backups: Selecting the Right Backup Mechanism to Match the Business Requirement

Session 17454

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Session Abstract

Backups are a core part of any availability management and disaster recovery strategy. They are also crucial for long-term retention of critical data to conform with regulatory requirements that your company or installation may have. During this session the speaker will discuss different backup options available and their suitability to fulfill the various requirements to ensure a complete and compliant solution.

Agenda

- Why backup?
- Who is responsible?
- Types of backup
- DFSMShsm
- DFSMSdss
- Other options
- Auditing backups

Why Backup?

- Availability Management
  - Data has been created and backup is required
  - Data has changed and backup is needed to capture changes
- Disaster Purposes
  - The need to access data at another location
- Long-term retention
  - Ensure compliance for data availability for regulatory purposes

Chris Taylor “Pearl of Wisdom”

- Data is not important
- Until you need it!!

- We tend to focus on the backup requirements and often neglect recovery considerations

Monday morning phone call to Storage Admin

- “Job ABC abended over the weekend and we need to recover the data. We thought we had a backup but job XYZ did not run and so we are hoping that you have one in HSM”

- Have you ever received such a call?

Question #1: Who is responsible?

- Applications or Centralized Storage management?

- Application groups are often responsible for their own backups
  - They have a better understanding of their data
  - They have control over the JCL and choice of backup utility

- Storage Admins control HSM or other centralized backups
  - Ensure backups are taken of critical data
  - Retained for correct amount of time

Question #2: What kind of backup is needed?

- Point-in-time backup
  - Executed as part of batch process
  - Has to run at a specific point in the cycle
  - Easy recoverability for restart/rerun purposes
- Often under the control of application group
- Can also be used for long-term retention
  - Make sure that correct data is being retained
  - Daily production backups may not suffice for long-term retention

What kind of backup needed? (cont.)

- Availability Backup
  - Backup can be taken at any time
    - As long as a backup is taken
  - Often performed with DFSMShsm, CA-Disk, FDRABR, etc.
  - Performed during production “slow” time
- Controlled by Storage Administration group
  - DFSMS constructs ensure centralized policy management
    - Correct retention policies applied
- SMS and HSM are the policy enforcers
  - Business requirements determine the retention policies

What kind of backup needed? (cont.)

- Long-term Retention
  - Taken for regulatory purposes
    - 7 or 10 years retention requirement not unusual
  - Onsite or offsite storage
    - Which backup utility program will be used?
  - If offsite, encryption usually required
- How do you know that the required backup is being retained correctly?
- It is possible to retain data too long!
  - “We never delete anything” probably means you’re not compliant with published retention policies

What kind of backup needed? (cont.)

- DR Backup
  - Full volume backup approach
  - Flashcopy and subsequent dump
  - Encryption
    - If using physical tape or offsite disk storage
    - Cloud??

Using DFSMShsm

Backup methods using DFSMShsm

- Data set/Application backups
  - Automatic Backup
  - Data set level backup
  - ABARs
- Full volume backups
  - Automatic Volume Dump
  - Fast Replication/Continuous Data Protection (zCDP)

Automatic Backup

- Controlled by storage admin group
- Usually runs every day
- Time determined by other activities
- Can be run from different HSM hosts within the HSMplex
  - Storage groups can be managed from different systems
    - Test vs production
- Managed by rules defined in management class and storage group

Benefits of Automatic Backup

- Centrally controlled policy
  - "Business requirements define the policy"
  - "SMS and HSM enforce the policy"
- Number of backup versions and length of time retained determined by business requirements
  - Data retained too long can be a compliance violation
- Once set up, takes the responsibility away from applications
- Activities and results can be monitored by tools
  - Activity logs, SMF records (FSR), etc.

Automatic Backup concerns during backup

- Activity time may not be appropriate for all applications
  - Nowadays more 7X24 availability necessary
  - Backup may interfere with batch processing
- Data sets could always be in use
  - Standard HSM approach is using an ARCCMDxx parm and applies to all backups
    - Serialization(preferred) could end up in a fuzzy backup
  - ARCBDEXT exit can be used for a more granular approach
- Without the right tools/reporting, backup errors may not be noticed

Automatic Backup concerns during recovery

- Data set may not be there!
  - Error during backup or in use
- Backup was taken before latest update
- Difficult to recover
  - HRECOVER command syntax?
  - Are end-users allowed to recover data sets?
- If used at DR, application recovery may take a long time
  - Data located on multiple tapes
  - Conversely, tape contention when trying to recover multiple applications

DFSMShsm data set backups

- HBACKDS command
- Allows data sets to be processed explicitly or using patterns
- Can be setup as part of application process
  - Controlled by application user
- Optional parameters can also be supplied
  - CHANGEDONLY, CC, SPHERE, etc.

HBACKDS examples

- HBACKDS ‘CHRIS.APPL1.**’ WAIT
  - Backup data sets using mask and wait for backup to complete
- HBACKDS ‘CHRIS.APPL1.**’ CHANGEDONLY NOWAIT
  - Send data sets backup command to HSM for changed data sets but do not wait for completion
  - Backup may or may not be successful
- HBACKDS ‘CHRIS.APPL1.**’ TARGET(TAPE) CC(PREFERRED)
  - Backup to tape with (virtual) concurrent copy if available

Data set backups (cont.)

- Inline backup
- Also known as ARCINBAK
- Backups can be performed in the middle of a job
- Overcomes some of the problems seen with IKJEFT01 approach
  - Relative generation number not allowed for GDG
  - Enqueue issues with data sets created within same job
    - ARCINBAK will process as unserialized

ARCINBAK example

```
  File  Edit  Edit_Settings  Menu  Utilities  Compilers  Test  Help
------------------------------------------------------------------------------
EDIT       P390.JCL.CNTL(ARCINBK3) - 01.01               Columns 00001 00072
Command ===> _____________________________________________ Scroll ===> CSR
****** ***************************** Top of Data ********************************
000001 //P390I JOB (OCOP),'CHRIS',
000002 // NOTIFY=P390,REGION=6M,MSGCLASS=X,CLASS=A
000003 //*
000004 //GEN1         EXEC PGM=IEBGENER,REGION=4M
000005 //SYSPRINT     DD SYSOUT=*
000006 //SYSUT1       DD DISP=SHR,DSN=P390.LOG.MISC
000007 //SYSUT2       DD DISP=(,CATLG),DSN=P390.TESTGDG(+1),
000008 //    UNIT=SYSDA,SPACE=(TRK,(1,1))
000009 //SYSIN        DD DUMMY
000010 //*
000011 //STEP2     EXEC PGM=ARCINBAK,PARM=('RETAINDAYS(00001),
000012 //               TARGET(TAPE),CC=(PREFERRED,PHYSICALEND)')
000013 //ARCPRINT DD  SYSOUT=*
000014 //ARCSNAP  DD  SYSOUT=*
000015 //BACK01   DD  DSN=*.GEN1.SYSUT2,DISP=SHR
000016 //*
****** **************************** Bottom of Data ******************************
_

  *DSLIST
```

ARCINBAK example comments

- DDs for backup in format BACKxxxx
  - //BACK01 DD DSN=*.GEN1.SYSUT2,DISP=SHR
- Concurrent copy parms can also be included
  - CC=(PREFERRED,PHYSICALEND)
  - TARGET can be specified
    - TARGET(TAPE)
- Use of TARGET, NEWNAME and RETAINDAYS can be protected with RACF (or other security system)

Long-term data retention for data sets using HSM

- Normal HSM backup processing limited to max. 100 versions
  - Greater number rolls off

- Copy data set to new name and migrate for x years
  - Allows both migration and backup
  - GDS, datestamp?

RETAINDAYS for long-term retention

Data set backup was enhanced in z/OS DFSMS V1R11 to enable a specific retention period to be assigned to a backup copy

- Specified Retention value overrides Management Class and SETSYS settings for retention
- Retention value can be used to keep a backup copy for a *shorter or longer* than normal period of time

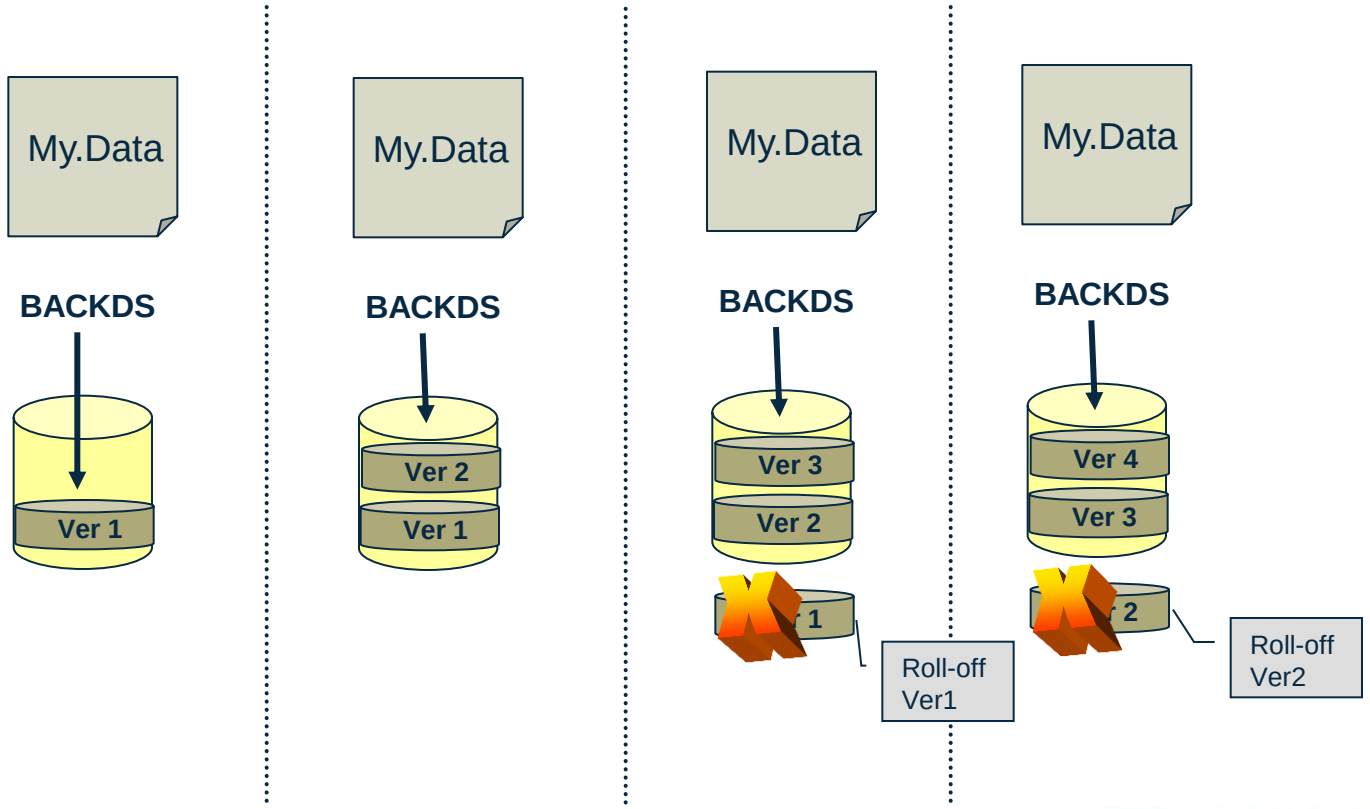
Data Set Backup Terminology

- **Active Copy:** A backup version that is within the maximum number of backup copies specified by the Management Class or SETSYS value
- **Management Class Retention Period:** The *maximum* number of days to maintain a backup copy
- **RETAINDAYS *(new)*:** The *minimum* number of days to maintain a backup copy. (This value takes precedence).
- **Retained Copy:** A backup copy that has rolled-off from being an active copy, but has not yet met its RETAINDAYS value

DS Backup RETAINDAYS

How it works without RETAINDAYS

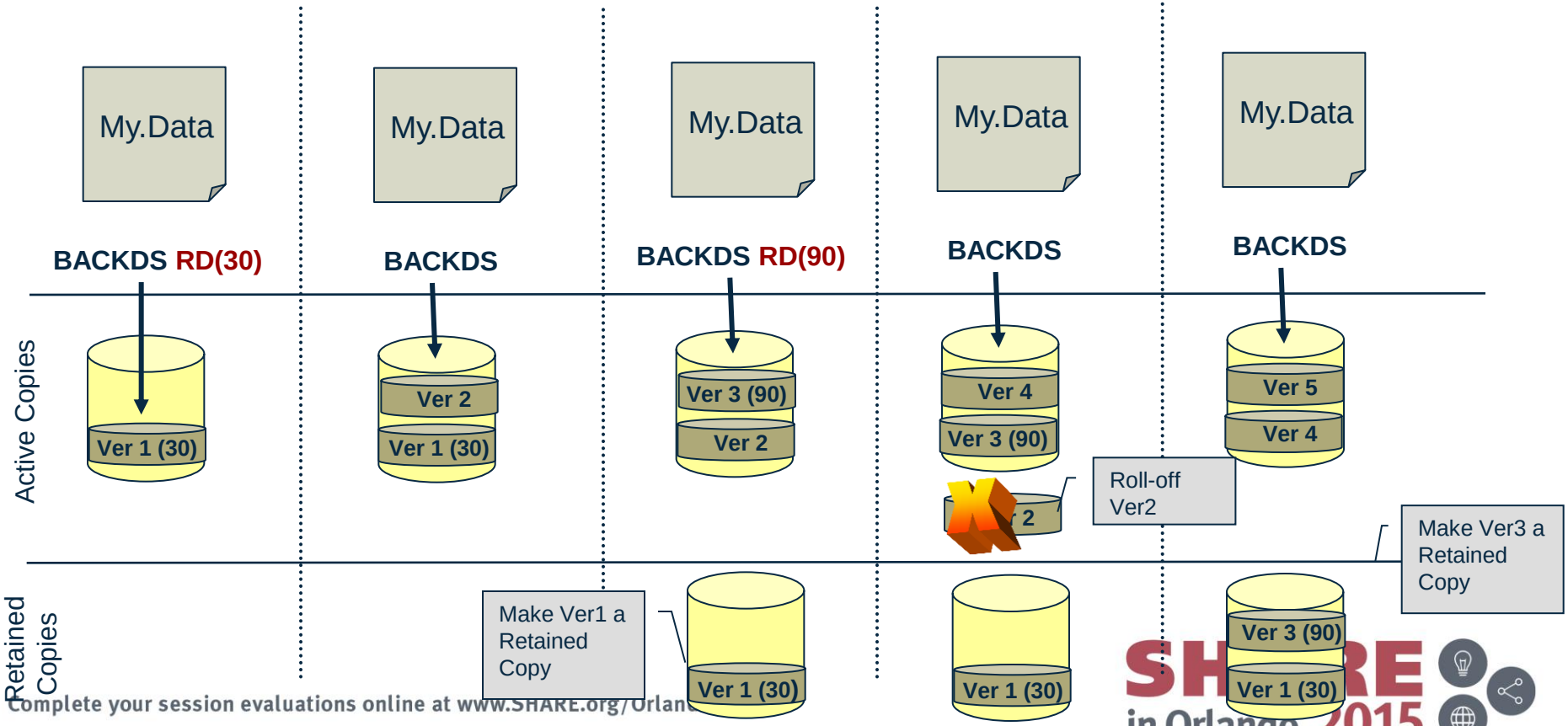
- Maximum 2 Backup Copies



DS Backup RETAINDAYS

How it works with RETAINDAYS

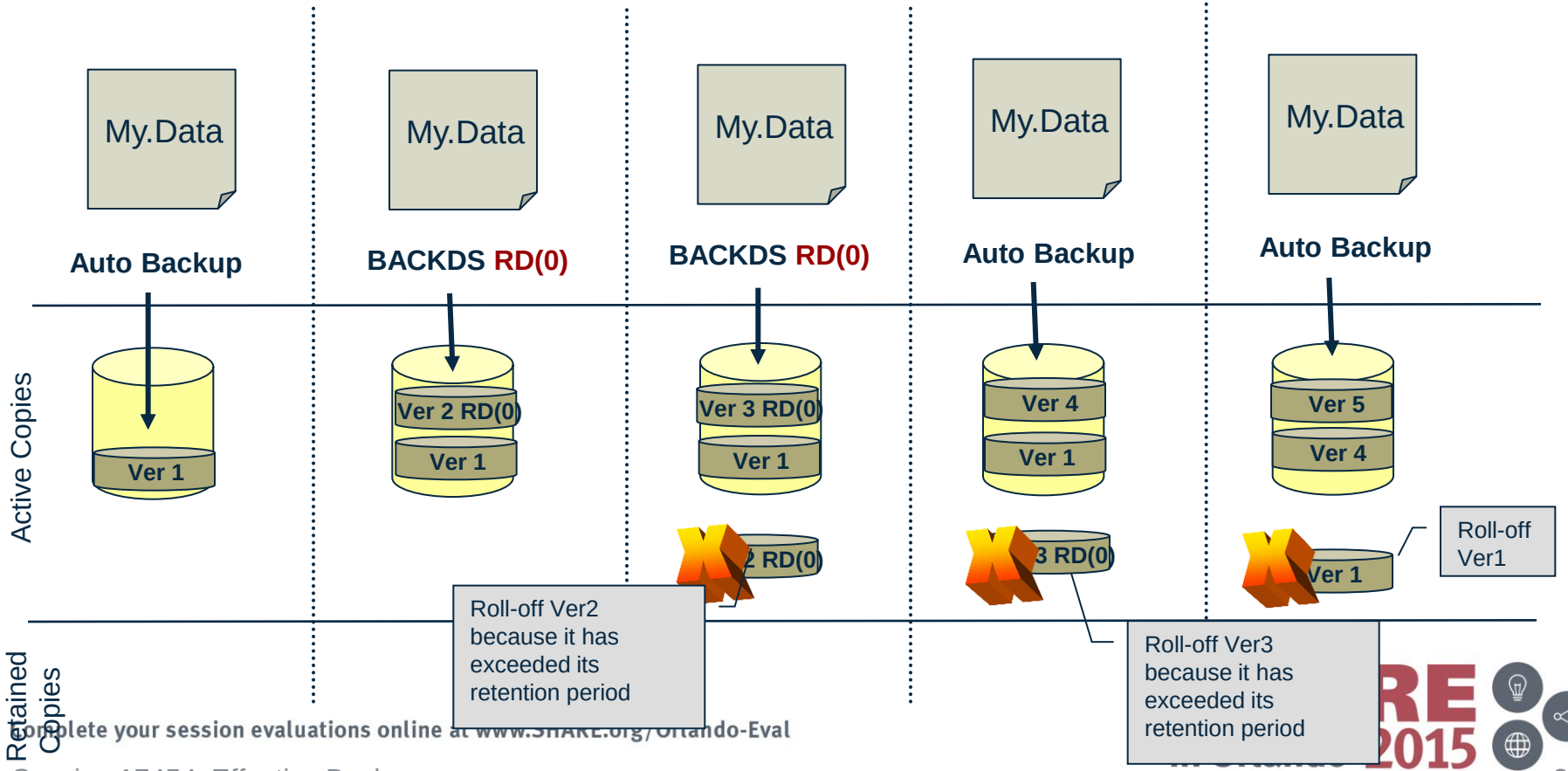
- Maximum 2 Backup Copies
- Keep Retained Backup Copies *longer* than normal



DS Backup RETAINDAYS

How it works with RETAINDAYS

- Maximum 2 Backup Copies
- Keep Retained Backup Copies *shorter* than normal



DS Backup RETAINDAYS

RETAINDAYS are examined during Roll-off and EXPIREBV

- **Roll-Off processing**
  - Roll-off processing occurs when the creation of a new backup copy causes the maximum number of ‘active copies’ to be exceeded
  - First, all ‘active copies’ (except the one that was just created) are examined to determine if any of them have met their RETAINDAYS value
    - If so, they are deleted
  - If the maximum number of ‘active copies’ has still been exceeded, then all excess versions are examined to determine if they have an unmet RETAINDAYS value
    - Versions with unmet RETAINDAYS values are converted to ‘retained copies’
      - Backup copy is no longer tracked by version number and is managed via another record internally to HSM
    - Otherwise, the excess versions rolls-off

★ **EXPIREBV**
  - EXPIREBV *must be run* to expire ‘retained copies’ that have met their RETAINDAYS value

DS Backup RETAINDAYS

DFSMShsm can now maintain a *nearly unlimited* number of backup copies

- 'Active Copies' are still limited to 100 per data set
- 'Retained Copies' are nearly unlimited per data set
- New 'MCBR' record – Mirrors MCB record

RETAINDAYS(*nnnnn*) can be specified on all Data Set Backup commands

- BACKDS
- HBACKDS
- ARCINBAK
- ARCHBACK

- Can also be applied during Automatic Backup using ARCBDEXT exit

RETAINDAYS Values

- Valid values: 0-50000 or 99999
- 99999 means 'Never Expire'

DS Backup RETAINDAYS

‘Retained Copies’ can only be referenced by Date and Time

- Version number would not be unique
- Version and Generation not listed in LIST output
- Data Set Recover and BDELETE commands updated to accept TIME

LIST

- By default, both ‘active’ and ‘retained’ backup copies will be listed
- SELECT option enables only ‘active’ or only versions with a RETAINDAYS value to be listed
  - Using SELECT(RETAINDAYS) enables you to view all of the backup copies for which a RETAINDAYS value has been specified

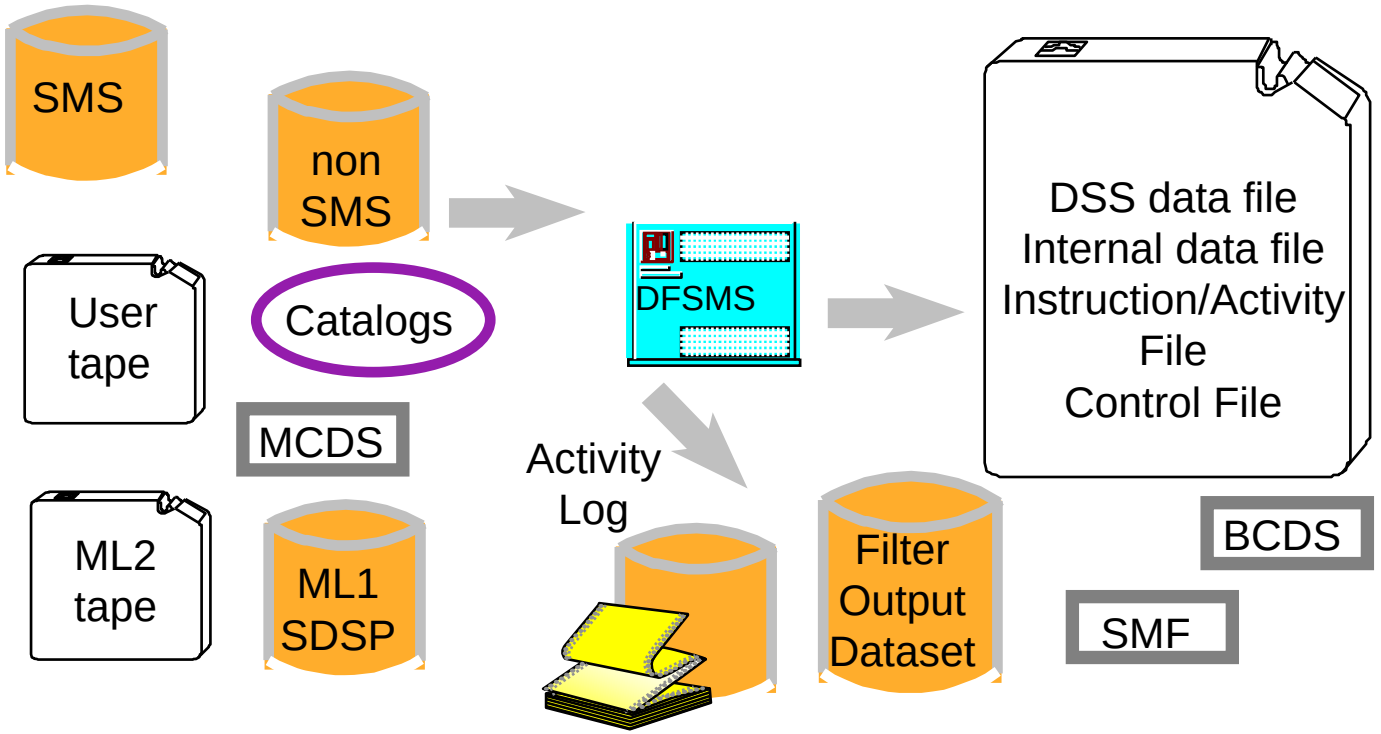
New Facility Class Profiles:

- STGADMIN.ARC.ENDUSER.HBACKDS.RETAINDAYS
- STGADMIN.ARC.BACKDS.RETAINDAYS

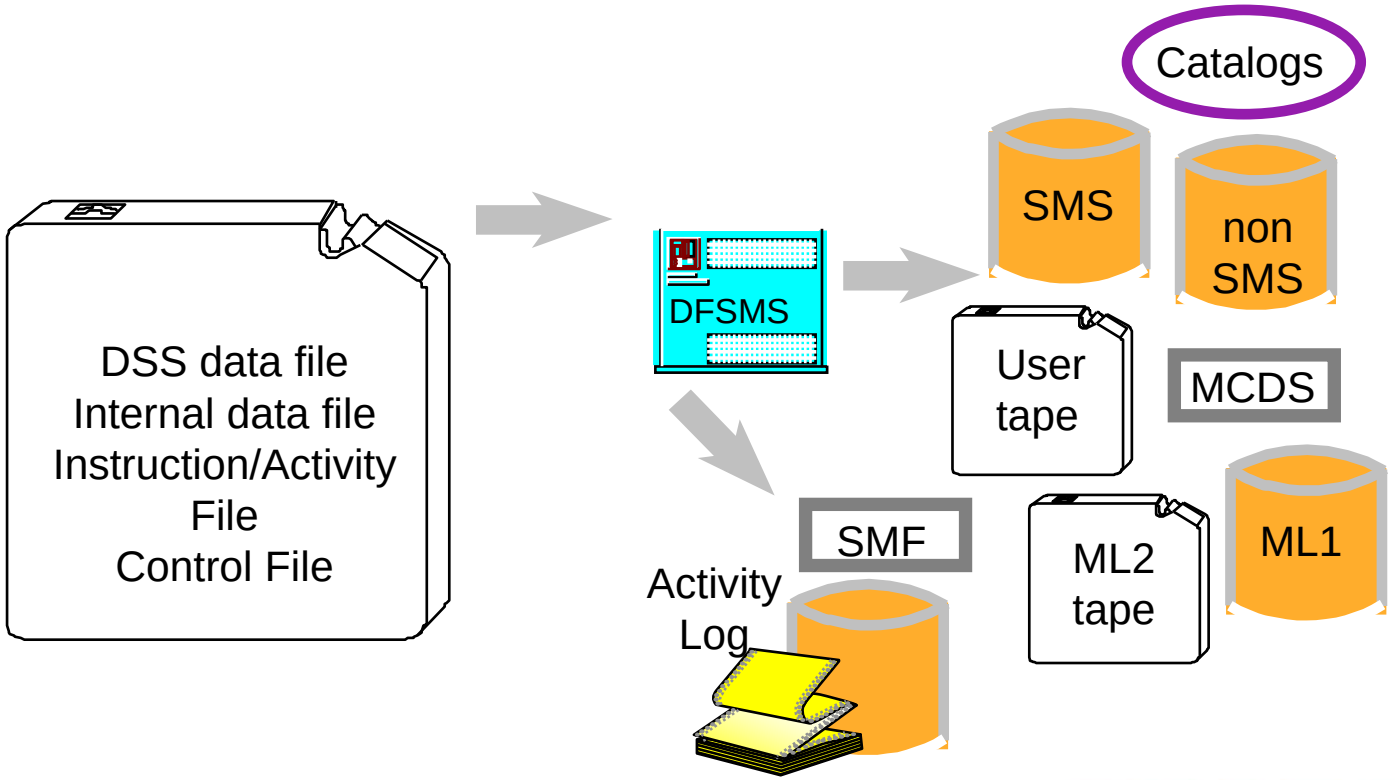
Other HSM backup methods - ABARS

- Allows data sets to be grouped together during backup
  - Easier recovery of application (aggregate)
- Data can be backed up from primary disk, ML1, ML2 and tape
  - Migrated data is processed directly from disk or tape
  - Not recalled to primary disk
- HSM data is not immediately accessible at recovery site
  - ARECOVER needs to run first
- Single data set recovery is possible
- ABARS is best used with an ABARS management tool
  - E.g. Tivoli Advanced Backup and Recovery for z/OS

The ABACKUP process



The ARECOVER process

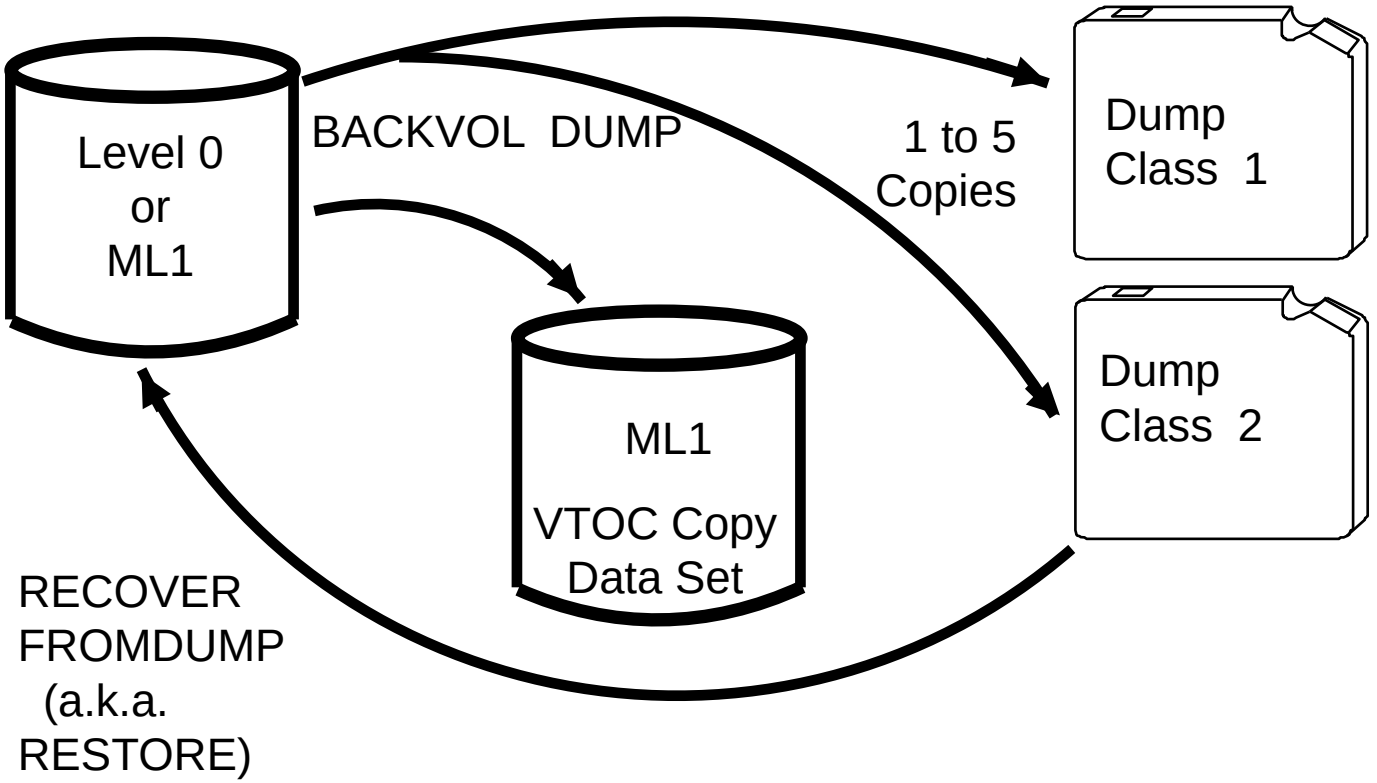


Other HSM backup methods - Full Volume Dump

- Why Volume Availability is necessary
  - Disk Volume device unavailable

- Full Volume Dump intended for
  - System Packs required for IPL at cold site
  - Migration Level 1 DASD (ML1)
  - Non-SMS volumes with single-volume data sets
  - SMS volumes with read-only or slow-changing data
  - Dump to tape of HSM fast replication backups

Dump Data Flow

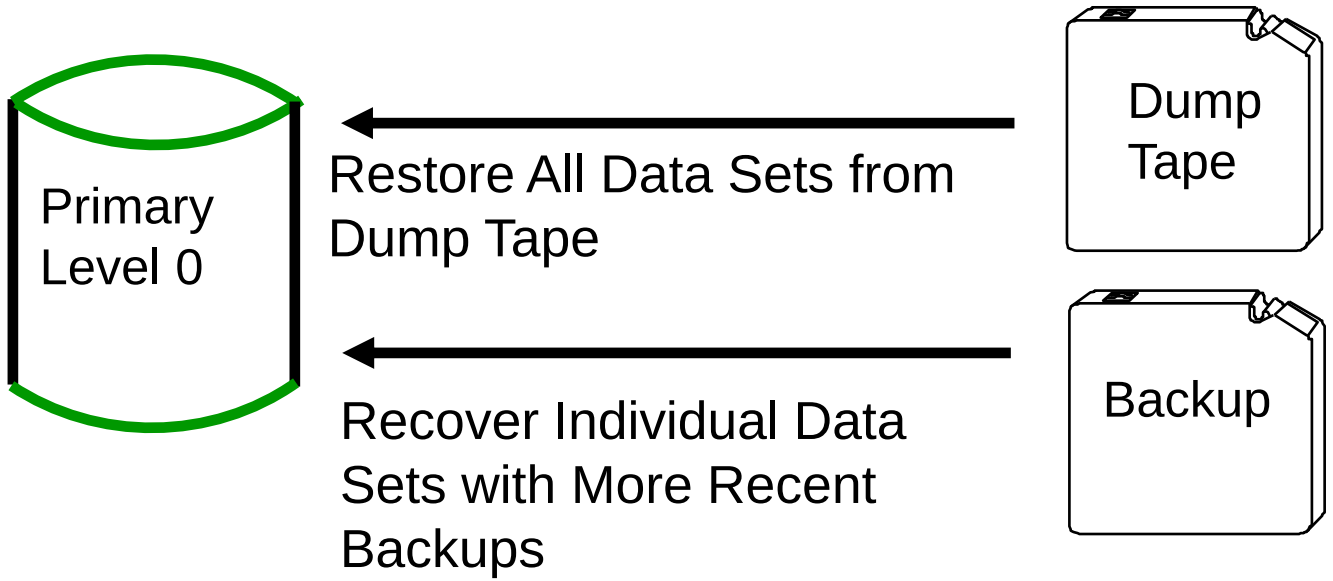


Types of Full Volume Dump

- Automatic Dump
  - Expire Dump Tapes and Return to Scratch pool
  - Dump Level 0 and ML1 DASD volumes
  - Roll-off Excess Dump VTOC Copy data sets created on ML1 DASD
- Command Volume Dump
  - Specify Volume list or Storage groups
  - Stacking determined by Dumpclass or BACKVOL parameter override

Scenario - Lost Volume

RECOVER * TOVOLUME(PRIM37) UNIT(3390)
FROMDUMP(APPLYINCREMENTAL)



Business Continuity and Continuous Data Protection

Business Continuity Overview

Business Continuity

Maintaining business operations in the event of an outage – with processes and infrastructure that are responsive, highly available and scalable

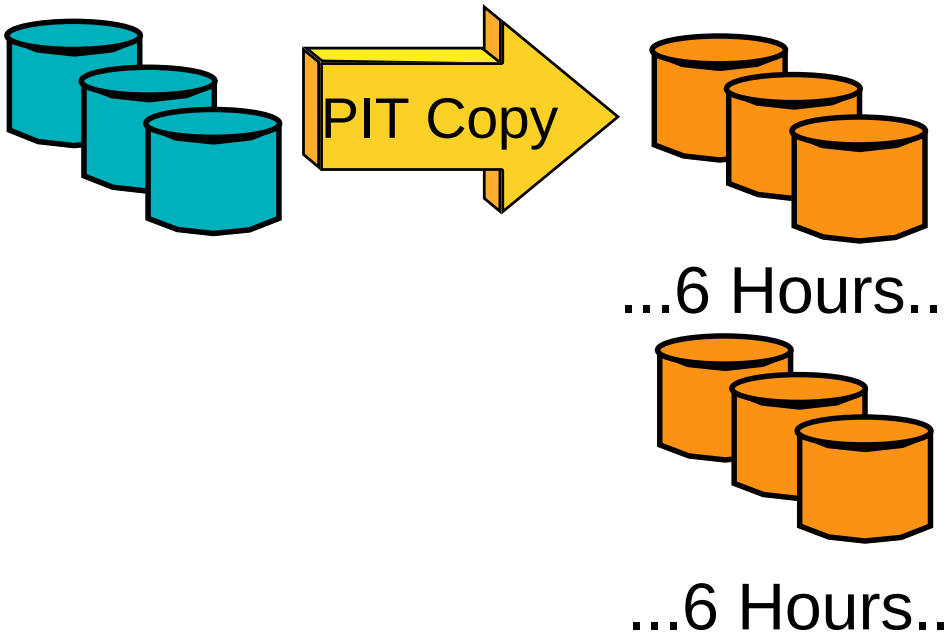
Three key characteristics

- ✓ Recovery Time Objective (RTO)
  - The *acceptable* amount of time you can afford to be without your data
- ✓ Recovery Point Objective (RPO)
  - The amount of data that can be *acceptably* recreated
- ✓ Backup Window Objective (BWO)
  - The *acceptable* amount of time operations can be quiesced to create a copy

Introduction to Continuous Data Protection

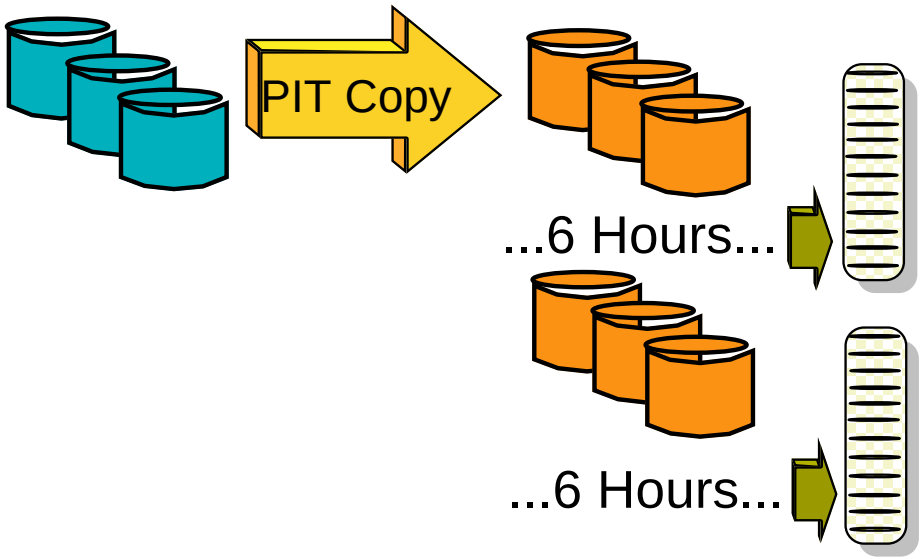
- Traditional Point-in-Time Backup
  - Taken at specific time or data points
  - Only captures data at the point of the backup
  - Long RPO
  - RTO requirements vary
    - Disk – Short
    - Tape - Long
  - BWO requirements vary
    - Point-in-Time Copy – Short
    - Standard I/O – Long

- *Wouldn't it be nice to be able to recover to a point right before the data was corrupted?*



Introduction to Continuous Data Protection *(continued)*

- Continuous Data Protection (CDP):
  - ★Continuously captures all changes
    - Journaling combined with Point-in-Time copies
  - ★Eliminates backup window
    - Short/Transparent BWO
  - ★Short RPO
  - ★*Generally* short RTO
    - Long from tape



Types of Continuous Data Protection

- Block Based
  - Capture done at *storage level*
  - Time-ordered capture of every block write
  - Capturing process does not '*understand*' the data
    - Post processing may be required for a *data consistent* recovery
  - *True* CDP
- Software Based
  - Specific *software* journals every update
  - Recovery is tightly integrated with the software
  - Enables data consistent recovery
  - *True* CDP
- File Based
  - Runs on application host (Linux, AIX, Windows, etc)
  - Backup created when file is written to disk
  - Policies can be based on needs of various file types
  - *Near* CDP

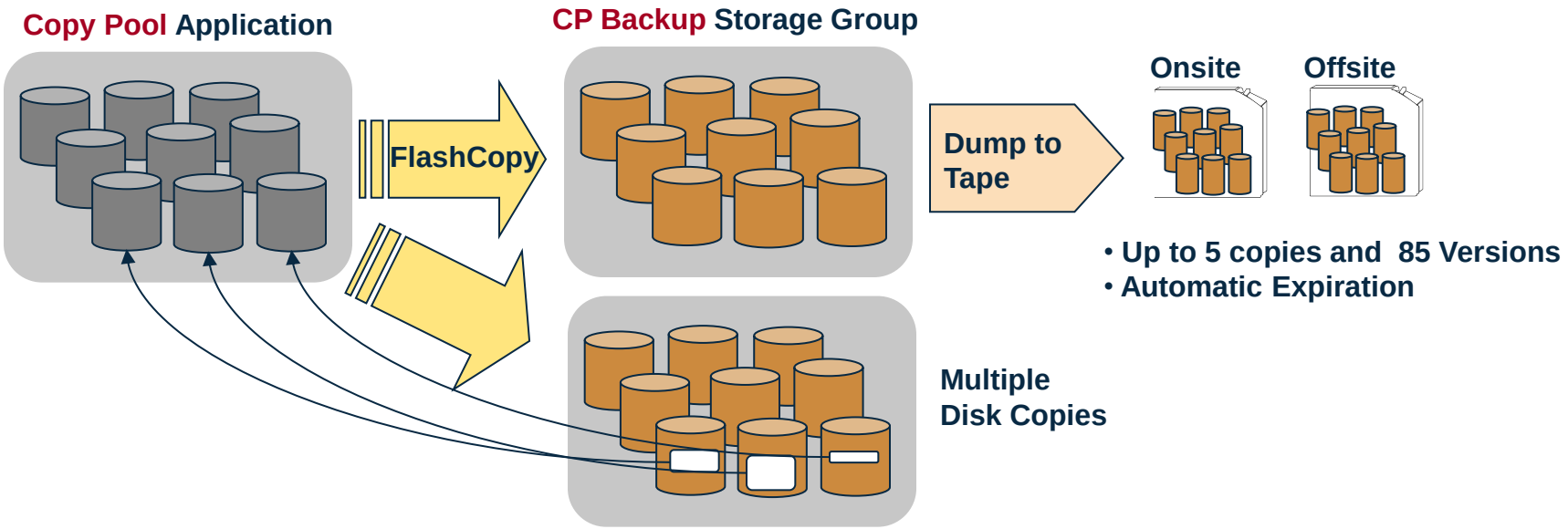
zCDP for DB2

- *Software based* CDP for DB2 on System z
  - Joint solution between DFSMS and DB2
- Solution based on Point-in-Time (PIT) backups combined with DB2 logging
  - ★ Eliminates need for DB2 Log Suspend
    - Only Object-level creates, extends, renames and deletes are suspended
    - Hundreds of volumes backed up in a matter of minutes
  - ★ Managed tape copies created from PIT copies
  - ★ Recovery at the System or Tablespace level
- Base Support: DB2 V8, z/OS V1R5 (2003)
- Enhanced Support: Current z/OS and DB2 releases

zCDP for DB2

HSM function that manages Point-in-Time copies

- Combined with DB2 BACKUP SYSTEM, provides non-disruptive backup and recovery to any point in time for DB2 databases and subsystems (SAP)

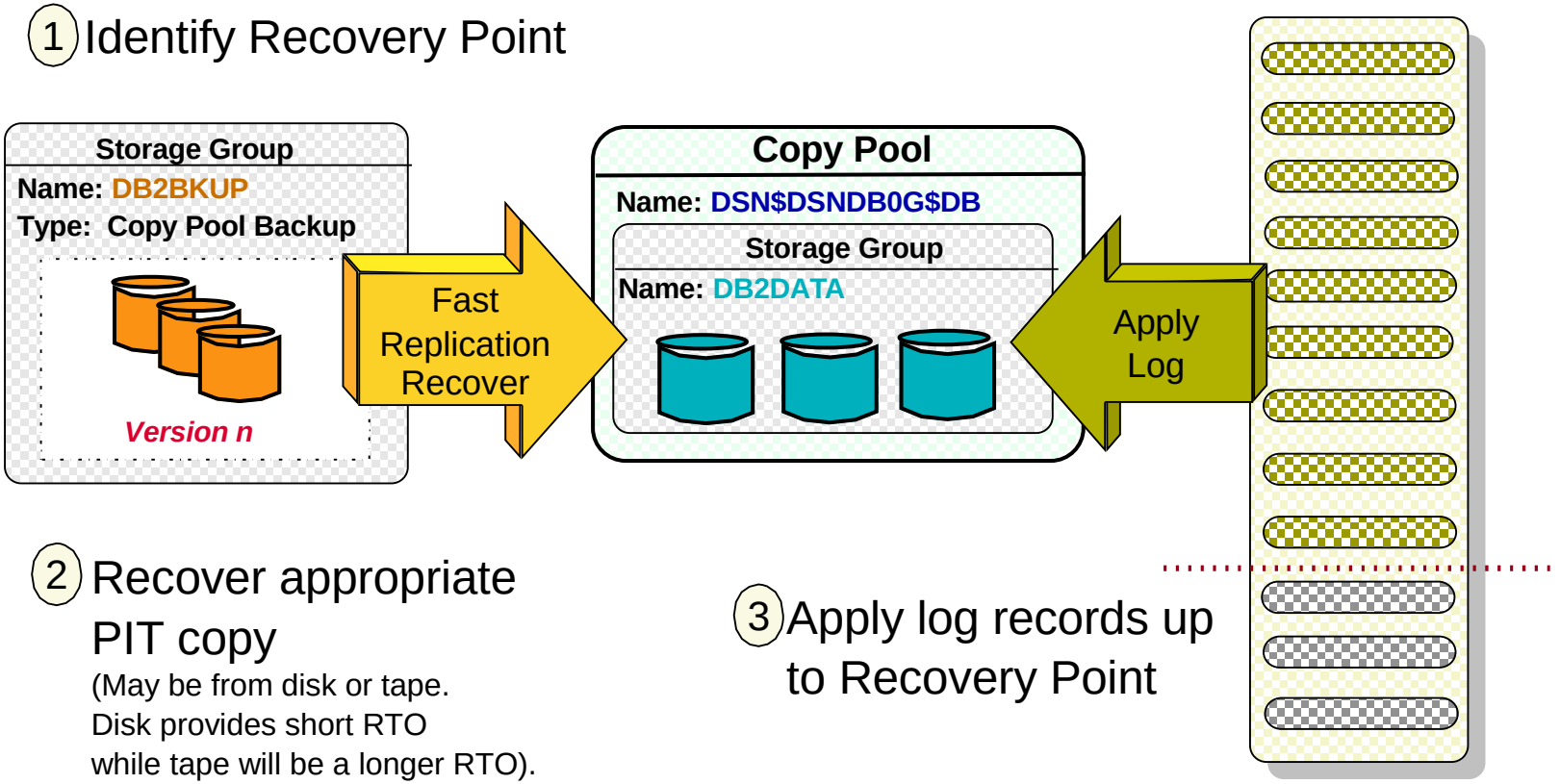


★Recovery at all levels from either disk or tape!

- Entire copy pool, individual volumes and …
- Individual data sets

DB2 RESTORE SYSTEM

1 Identify Recovery Point

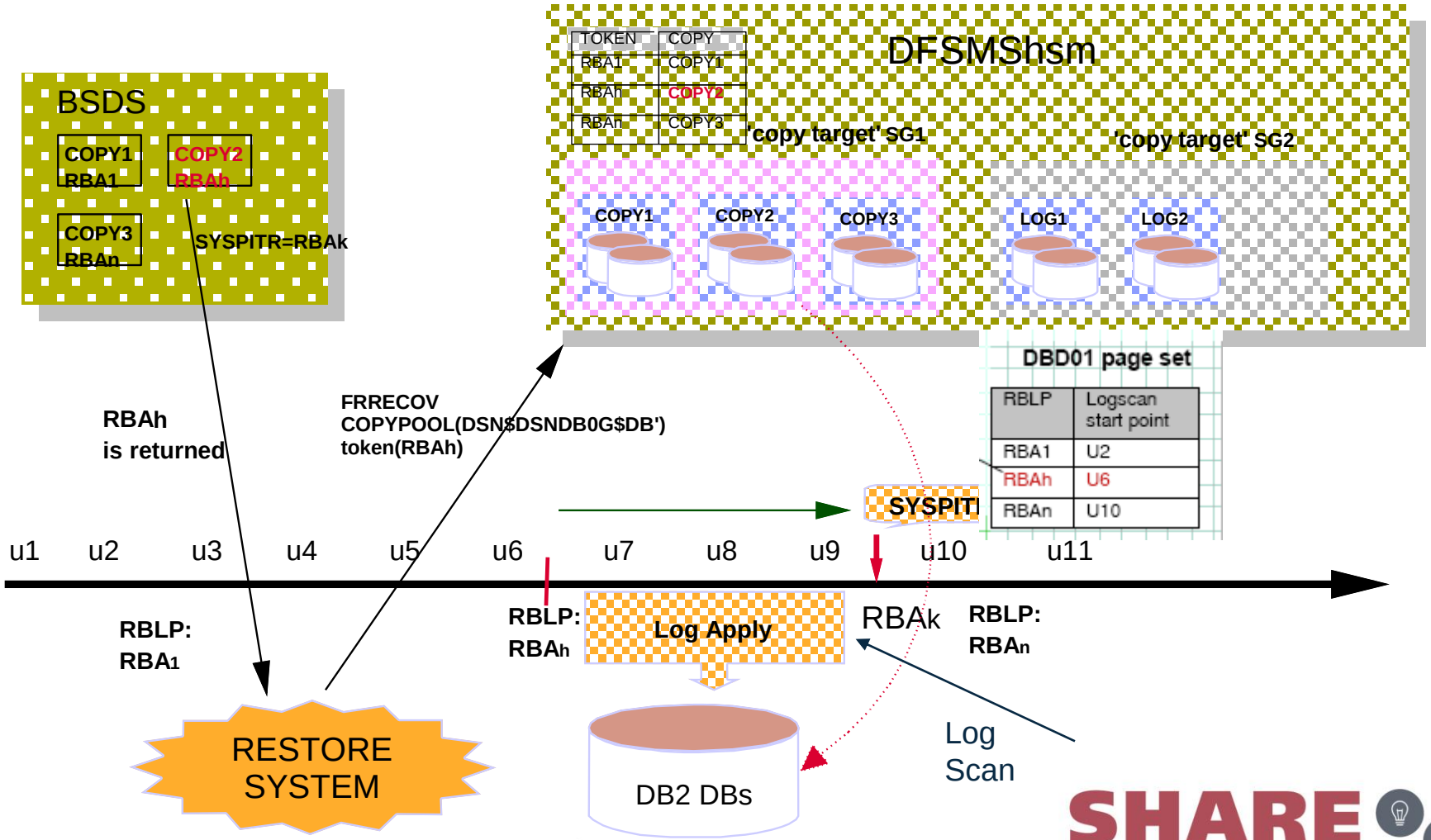


2 Recover appropriate PIT copy

(May be from disk or tape.
Disk provides short RTO
while tape will be a longer RTO).

3 Apply log records up to Recovery Point

DB2 RESTORE SYSTEM



Using DFSMSdss

DFSMSdss Terms

- **Physical Processing**
  - Volume view for task
- **Logical Processing**
  - Dataset view for task
- **Data Set Filtering**
  - INCLUDE list consists of what data sets you want processed
    - Specific data set names (fully qualified), wildcards (*, **, %)
  - EXCLUDE list contains data sets you don't want processed
    - Specific data set names (fully qualified), wildcards (*, **, %)
  - BY Filtering
    - Check data set type, size, catalog status, SMS class, etc.
  - FILTERDD
    - DD Statement points to data set containing INCLUDE/EXCLUDE/BY filtering

DFSMSdss Dump

- Used to backup data to tape or disk
  - One or more input datasets will be written out to a single sequential output file
- Supports data set name and attribute filters
- Process all associated VSAM components using SPHERE keyword
- Will utilize best available technique, Concurrent Copy, SnapShot, Flashcopy

Dump Keywords (abbreviated list)

- CANCELERROR: Specifies that a dump is to be terminated if an input I/O error is encountered
- CONCURRENT: Specifies that the dump is to use concurrent copy if possible
  - Snapshot may be used depending on input device
- DYNALLOC: Specifies that dynamic allocation is to be used for serialization instead of enqueue
- LOGINDYNAM: Specifies that volumes containing the input dataset names are to be dynamically allocated
- SELECTMULTI: Determines how multivolume datasets are to be processed
  - All: requires that the volume list contain all volumes which contain part of the input dataset being processed (default)
  - Any: requires that the volume list contain any volume which contains part of the input dataset being processed
  - First: requires that the volume list contain the volume which contains the first part of the input dataset being processed
  - Input list to be determined by LOGINDDNAME, LOGINDYNAM or STORGRP
- OUTDDNAME: Specifies the output dataset to be used for the dump
- RESET: Specifies that the change flag be reset for datasets successfully processed
- SHARE: Specifies that dataset is available for read processing during dump operation
- SPHERE: Specifies that all components of a VSAM dataset are to be processed including associated AIX clusters and paths
- TOLERATE: Specifies that processing should continue even if an shared or exclusive access fails

Filter attributes

- Further filtering supported by data set attribute (BY)
  - Allocation unit
  - Catalog status
  - Backup status
  - Create, Last reference or Expiration date
  - Single or multi-volume data set
  - Data set organization
  - SMS contruct name
  - Extent or track utilization
  - Use with EQ, NE, GT, LT, GE, LE

Filter BY Attribute Examples

- This is a subset of support attribute filters:
  - **CREDT** Creation date (absolute or relative)
  - **DSCHA** Whether the data-set-changed flag is on or off
  - **DSORG** Data set organization (SAM, PAM, PDS, PDSE, BDAM, HFS, EXCP, ISAM, VSAM or zFS)
  - **REFDT** Last-referenced date (absolute or relative)
  - **DATACLAS** Data class for SMS
  - **MGMTCLAS** Management class for SMS
  - **STORCLAS** Storage class for SMS
- Use with OP keyword
  - **BY((ALLOC EQ CYL) (CATLG EQ YES))** you receive all cataloged data sets with cylinder allocation.
  - **BY(FSIZE GE 100)** you receive all data sets whose size is greater than or equal to 100 tracks.
  - **BY(DSORG EQ (PAM,SAM))** DFSMSdss selects all partitioned and sequential data sets.

Dump Examples …

Example 1: Dumping Data Sets Constantly in Use

```
//JOB1     JOB   accounting information,REGION=nnnnK
//STEP1    EXEC  PGM=ADRDSSU
//SYSPRINT DD    SYSOUT=A
//DASD1    DD    UNIT=3380,VOL=(PRIVATE,SER=111111),DISP=OLD
//DASD2    DD    UNIT=3380,VOL=(PRIVATE,SER=222222),DISP=OLD
//TAPE     DD    UNIT=3480,VOL=SER=TAPE02,
//  LABEL=(1,SL),DISP=(NEW,CATLG),DSNAME=USER2.BACKUP
//SYSIN    DD    *
 DUMP  LOGINDDNAME(DASD1) OUTDDNAME(TAPE) -
       DATASET(INCLUDE(**)) TOL(ENQF) WAIT(0,0)
/*
```

DFSMSdss does not wait (WAIT(0,0)) if a data set is in use. Instead, it processes the data set without serialization or enqueuing (TOL(ENQF)).

Dump Examples …

Example 3: Logical Data Set Dump Operation with Catalog Filtering

```
//JOB3     JOB   accounting information,REGION=nnnnK
//STEP1    EXEC  PGM=ADRDSSU
//TAPE     DD    UNIT=3480,VOL=SER=TAPE04,
//   LABEL=(1,SL),DISP=(NEW,CATLG),DSN=USER3.BACKUP
//SYSPRINT DD    SYSOUT=A
//SYSIN    DD    *
 DUMP OUTDD(TAPE) -
   DS(INCL(USER1.**))
/*
```

All data sets cataloged in the standard search order whose first-level qualifier is USER1 are to be dumped. Because some of these data sets are multivolume, source DASD volumes are not specified, resulting in data set selection by catalog.

Example 3 can be modified as follows to dump only data sets changed since the last backup. In addition, data sets that end with a qualifier of LISTING are not to be dumped (EXCL(**.LISTING)).

```
//SYSIN   DD  *
 DUMP OUTDD(TAPE) -
   DS(INCL(USER1.**) -
      EXCL(**.LISTING) -
      BY((DSCHA EQ 1)))
/*
```

VSAM Backups

- IDCAMS is the standard utility for VSAM processing
- DFSMSdss can also be used to perform logical backups
  - Trying to change options during restore can be “challenging”
- Several VSAM and Catalog products available from vendors
  - Allow additional selection criteria during backup
  - VSAM attributes can be modified during restore
  - Care should be taken when backing up open VSAM data sets
    - A “fuzzy backup” may not be appropriate for the application

Auditing and monitoring backups

- Consider investing in a backup auditing tool
- It should:
  - Track backups to identify critical data sets that do not have a backup
    - Tracking performed regardless of backup mechanism/tool
      - IEBGENER, DFSMShsm, SORT, DFSMSdss, FDR, etc.
  - Identify data sets that have duplicate backups
  - Assist with recovery from local, unplanned outages and facilitate remote recovery at DR site
  - Provide reporting capabilities to show backed up data sets
    - Both successful and exceptions

Reference material

- z/OS DFSMShsm Managing Your Own Data
  - SC23-6870-00 (V2R1)
  - SC35-0420-10 (V1R13)

- z/OS DFSMShsm Storage Administration
  - SC23-6871-02 (V2R1)
  - SC35-0421-13 (V1R13)

- z/OS DFSMSdss Storage Administration
  - SC23-6868-02 (V2R1)
  - SC35-0423-17 (V1R13)

What was discussed in this session

- Why backup?
- Who is responsible?
- Types of backup
- DFSMShsm
- DFSMSdss
- Other options
- Auditing backups

Questions?

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Effective Backups: Selecting the Right Backup Mechanism to Match the Business Requirement

Session 17454

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