Preserve System Integrity for Your Business With IBM Replication Solutions for Business Continuity

Part 2 of 2
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Jeff Suarez  
IBM Corporation  
jrsuarez@us.ibm.com

Glenn Wilcock  
IBM Corporation  
wilcock@us.ibm.com
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<thead>
<tr>
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<th>Enterprise Storage Server*</th>
<th>IP PrintWay</th>
<th>RMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>CICS*</td>
<td>ES/9000*</td>
<td>Language Environment*</td>
<td>S/370</td>
</tr>
<tr>
<td>DB2*</td>
<td>FlashCopy*</td>
<td>Lotus*</td>
<td>S/390*</td>
</tr>
<tr>
<td>DB2 Universal Database</td>
<td>GDPS*</td>
<td>Multiprise*</td>
<td>Tivoli*</td>
</tr>
<tr>
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<td>HiperSockets</td>
<td>MVS</td>
<td>TotalStorage*</td>
</tr>
<tr>
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<td>IBM*</td>
<td>Notes*</td>
<td>WebSphere*</td>
</tr>
<tr>
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<td>IBM eServer</td>
<td>OS/390*</td>
<td>z/Architecture</td>
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<td>IBM e(logo)server*</td>
<td>Parallel Sysplex*</td>
<td>z/OS*</td>
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<td>zSeries*</td>
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<tr>
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<td>IMS</td>
<td>RAMAC*</td>
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<tr>
<td>Domino</td>
<td>InfoPrint*</td>
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Agenda

- Business Continuity Overview
- DFSMSdss
  - Overview
  - Commands
  - FlashCopy
- Introduction to Continuous Data Protection
  - Overview
  - Types
  - DB2 Solution
- SMS Copy Pool
- DFSMSHsm
  - Fast Replication Backup
  - Fast Replication Recover
- DB2 Overview
**DS8000 Business Continuity technology by Tiers**

*Balancing recovery time objective with cost / value*

<table>
<thead>
<tr>
<th>Recovery Time Objective (guidelines only)</th>
<th>DFSMS positioning within the BC Tiers</th>
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</thead>
<tbody>
<tr>
<td>15 Min. 1-4 Hr. 4-8 Hr. 8-12 Hr. 12-16 Hr. 24 Hr. Days</td>
<td>DFSMSdss/hsm</td>
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</tbody>
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- **BC Tier 7** – Server or Storage replication with end-to-end automated server recovery
- **BC Tier 6** – Real-time continuous data replication, server or storage
- **BC Tier 5** – Application/database integration to Backup/Restore
- **BC Tier 4** – Point in Time replication to Backup/Restore
- **BC Tier 3** – VTL, Data De-Dup, Remote vault
- **BC Tier 2** – Tape libraries + Automation
- **BC Tier 1** – Restore from Tape

**Cost / Value**

- **DFSMSdss/hsm**
- **DFSMSdss/hsm**
- **PPRC SDM, ICKDSF, PPRC Mgr**
- **GDPS (SDM)**
- **DS8000 FlashCopy CC/VCC**
- **z/OS Global Mirror**
- **FC Manager SAP on DB2 (HSM)**

**DFSMSdss/hsm**

**DFSMSdss/hsm**
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 Interfaces

• **Batch JCL**
  - PGM=ADRDSSU

• **Application Programming Interface (API)**
  - DFSMSdss may be invoked by other programs for any of its functions (except for Stand Alone Restore)
  - Invoking program can pass address of a User Interaction Module (UIM)
  - DFSMSdss calls the UIM at various exit points throughout processing
  - UIM may direct DFSMSdss processing via these exit points

• **Cross Memory API**
  - Method to get DFSMSdss functionality without paying the penalty of having the DFSMSdss processing (and memory usage) in your own address space
  - Client / Server model with a small client in the invoking program’s address space, and a server in its own address space that attaches ADRDSSU tasks to fulfill the client’s request
  - May be invoked via Batch JCL (PGM=ADRXMAIA)
DFSMSdss Commands

- BUILDSA
- CGCREATED *
- COMPRESS
- CONSOLIDATE *
- CONVERTV
- COPYDUMP

- DEFRAG *
- PRINT
- RELEASE
- COPY *
- DUMP *
- RESTORE

* Exploits Fast Replication function
DFSMSdss FlashCopy

• Functions that exploit FlashCopy
  • COPY
    • Full volume
      • DUMPCONDITIONING available to provide online volume clone to be used for backup purposes
    • Data Set level
      • Logical or Physical
        • Physical allows copying back a set of files using FC on a volume basis
      • DataSet DUMPCONDITIONING
        • Can Rename data sets to a temporary name at COPY time, and at DUMP time have the ability to rename them back to its original name
  • DEFRAG and CONSOLIDATE
    • Default is to use FlashCopy if possible, can revert to using CC,VCC, and traditional I/O
    • Updates catalog and performs serializations
    • Volume and data set level
DFSMSdss FlashCopy Functions

- DFSMSdss FlashCopy Functions, Commands, Keywords
  - For COPY
    - FCNOCOPY and FCNOCOPYTOCOPY
    - FCFREEZE and CGCREATE
    - FCINCREMENTAL, FCINCREMENTALLAST
    - FCINCRVERIFY(REVERSE|NOREVERSE) and FCWAIT
    - FCSETGTOK(FAILRELATION)
    - FCTOPPRCPRIMAR
      - Preserve Mirror Options
    - FCFASTREVERSERESTORE and FCFULLVOLUMERELATION (New)
  - For DUMP
    - FCWITHDRAW (includes INIT and Space Release for SE Volumes)
  - Debugging Keywords for Fast Replication
    - DEBUG(FRMSG(DTL|SUMM|NO))
    - Valid for COPY, DEFRAAG, and CONSOLIDATE
DFSMSdss: Incremental FlashCopy

• Limits background copy to tracks that have changed since the previous Incremental FlashCopy
  • First Incremental FlashCopy results in full background copy and initiates change recording
  • Subsequent Incremental FlashCopies either:
    • Refresh the target: only the changed tracks being copied
    • Restore the source: changed tracks are copied back, removing updates
• Incremental relationships are persistent (remain after background copy is complete)
• Only one incremental relationship per volume
  • Can exist with other non-incremental relationships
DFSMSdss: Incremental FlashCopy

Usage Scenario 1: Periodic Dumps to Tape

COPY FULL FCINCREMENTAL

First time, all data is copied
DFSMSdss: Incremental FlashCopy

Usage Scenario 1: Periodic Dumps to Tape

COPY FULL FCINCREMENTAL

updates occur

only updated tracks are copied

DUMP FULL
DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

COPY FULL FCINCREMENTAL A TO B
EXECUTE BATCH STEP 1

all data is copied
DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

☑ COPY FULL FCINCREMENTAL A TO B
☑ EXECUTE BATCH STEP 1
☑ COPY FULL FCINCREMENTAL A TO B
☒ EXECUTE BATCH STEP 2

only updates are copied
DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

- COPY FULL FCINCREMENTAL  A  TO B
- EXECUTE BATCH STEP 1
- COPY FULL FCINCREMENTAL  A  TO B
- EXECUTE BATCH STEP 2
- COPY FULL FCINCREMENTAL  B  TO A
  FCINCRVERIFY(REVERSE) FCWAIT(2)
- RESTART BATCH STEP 2

updates are removed
DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

- COPY FULL FCINCREMENTAL A TO B
- EXECUTE BATCH STEP 1
- COPY FULL FCINCREMENTAL A TO B
- EXECUTE BATCH STEP 2
- COPY FULL FCINCREMENTAL B TO A
  FCINCRVERIFY(REVERSE) FCWAIT(2)
  RESTART BATCH STEP 2
- COPY FULL FCINCREMENTAL A TO B
  FCWAIT(2)
  EXECUTE BATCH STEP 3

only updates are copied
FlashCopy to PPRC Primary using Preserve Mirror
Continuous Data Protection for DB2

zCDP for DB2
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
Business Continuity Overview (continued)

- Most Business Continuity discussions focus on the Physical Loss perspective
  - Power Outages, Fire, Natural Disasters, etc
  - Much money & resources are spent to ensure high RPO and short RTO *if* such a physical loss should occur
Business Continuity Overview (continued)

• **Responsiveness to **Logical** data loss is sometimes overshadowed**

  • Data corruption, User errors, Application errors, Localized data loss, etc
  
  - What are your RTO / RPO / BWO for these types of data loss?
  
  - Data-mirroring solutions do not help
    
    ! *The corruption is just instantly copied from the local site to the remote site*
  
  - *Not a question of if it will happen, but rather when it will happen*
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
  - Low RPO
  - RTO varies
    - Disk – Short
    - Tape - Long
  - BWO varies
    - 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
  - High 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*

• **Application Based**
  • Specific *application* journals every update
  • Recovery is tightly integrated with the application
  • 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

- **Application 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:** DB2 9, z/OS V1R8, V1R11, V1R12, & V1R13
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
SMS Constructs

- **“Copy pool” SMS construct**
  - Defines which *storage groups* should be processed collectively for point-in-time functions

- **“Copy pool backup” storage group type**
  - Defines which volumes DFSMSHsm may select as target volumes for point-in-time backup versions

- **Defined via ISMF and Naviquest**
DB2 copy pool names:
DSN$location_name$DB
DSN$location_name$LG
SMS Enhancements (continued)

- “copy pool” SMS construct
  - Contains from 1 to 256 storage groups
    - Backup processed at storage group level because it is a track-level function
    - Requires data base data to be separated by storage groups
  - Specifies the number of disk backup copies to maintain
    - 0 – 85 copies
      - DB2 limit is 50
    - Minimum of 2 copies is recommended
      - Creation of new copy overwrites existing copy

- Storage group volumes dynamically retrieved at time of each backup
  - Ensures that every volume is included in the backup copy
SMS Enhancements *(continued)*

- **“copy pool backup” storage group type**
  - Defines candidate target volumes for DFSMSHsm fast replication
  - Cannot be assigned for allocation by SMS ACS selection routines
    - Protects data from being overwritten
  - For each source volume to be copied in a storage group:
    - There must exist enough eligible target volumes in copy pool backup storage group to satisfy the needs of the # of specified backup versions
DFSMShsm Support

- DFSMShsm invokes volume-level *fast replication* to create backup versions for sets of volumes
  - DFSMShsm manages disk and tape copies
- **Generic term of “Fast Replication”**
  - Multiple Point-in-Time copy functions supported by DFSMSdss
    - FlashCopy
    - SnapShot
    - Any vendor disk that supports these interfaces
Preparing for Fast Replication Backup

- **PREPARE** option provided to *validate environment* and *reduce elapsed* time of actual backup window

- **When PREPARE is specified on FRBACKUP command:**
  - For each version > 0, DFSMShsm pre-assigns a target volume to each source volume in every storage group assigned to the copy pool
  - Pairings are maintained in DFSMShsm control data sets

- **The PREPARE function *should be performed* whenever there is a change in the environment, such as:**
  - Volumes are added to a storage group
  - # of backup versions changes
  - Storage groups are added to the copy pool

- **If PREPARE is not performed, target volume selection occurs during backup window**
Preparing for Fast Replication Backup
(continued)

Copy Pool
Name: DSN$DSNDB0G$DB
Versions: 2

Storage Group
Name: PRDATA
Type: Pool
Copy Pool Backup Name: PAYBACK

Copy Pool
Name: DSN$DSNDB0G$LG
Versions: 2

Storage Group
Name: PRLOG
Type: Pool
Copy Pool Backup Name: PAYBACK

Storage Group
Name: PAYBACK
Type: Copy Pool Backup
Copy Pool Backup Name: N/A

Fast Replication 'PREPARE'
Creating a Fast Replication Backup

- **DFSMShsm command - FRBACKUP**
  - FRBACKUP COPYPOOL(cpname) EXECUTE TOKEN(token)

- **DB2 issues command programmatically via their Utility**

- **Command is considered successful only after a fast replication relationship has been established for every source volume**

- **If one or more volumes fail:**
  - Version is marked as a failure
  - Failed version will be the target of the next FRBACKUP command
    - Version number does NOT increment until successfully created
Creating a Fast Replication Backup
(continued)

Copy Pool
Name: DSN$DSNDB0G$DB
Versions: 2

Storage Group
Name: PRDATA
Type: Pool
Copy Pool Backup Name: PAYBACK

Copy Pool
Name: DSN$DSNDB0G$LG
Versions: 2

Storage Group
Name: PRLOG
Type: Pool
Copy Pool Backup Name: PAYBACK

Storage Group
Name: PAYBACK
Type: Copy Pool Backup
Copy Pool Backup Name: N/A

Fast Replication 'EXECUTE'

Catalog Capture*

ML1 ML1 ML1

*V1R11 and higher
Creating a Fast Replication Backup

(continued)

• **Versions = 1 to 85**
  - Default is to use FlashCopy Full for each source volume
  - **FCINCREMENTAL** keyword used to specify a volume set for which FlashCopy Incremental should always be used
    - FCINCREMENTAL only needs to be specified once
    - Each time that volume set is Flashed, an Incremental copy is made

• **Versions = 0**
  - NOCOPY option is used to create FlashCopy
  - Source to Target relationship is Withdrawn after the target volume is dumped to tape

★ **Target volumes are available to be used by different copy pools**
Creating a Fast Replication Backup
(continued)

Copy Pool
Name: DSN$DSNDB0G$DB
Versions: 2

Storage Group
Name: PRDATA
Type: Pool
Copy Pool Backup Name: PAYBACK

Copy Pool
Name: DSN$DSNDB0G$LG
Versions: 2

Storage Group
Name: PRLOG
Type: Pool
Copy Pool Backup Name: PAYBACK

Storage Group
Name: PAYBACK
Type: Copy Pool Backup
Copy Pool Backup Name: N/A

Fast Replication 'EXECUTE'

Create at Noon
Incremental Copies

Create at Midnight
Full Copies
Query

- QUERY COPYPOOL indicates background copy percent complete

```
ARC1820I THE FOLLOWING VOLUMES IN COPY POOL CP1, VERSION 003,
HAVE AN ACTIVE FLASHCOPY BACKGROUND COPY

<table>
<thead>
<tr>
<th>SGNAME</th>
<th>FR-PRIMARY</th>
<th>FR-BACKUP</th>
<th>PCT-COMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGRP1</td>
<td>SRC01B</td>
<td>TGT01B</td>
<td>70</td>
</tr>
<tr>
<td>SGRP1</td>
<td>SRC02B</td>
<td>TGT02B</td>
<td>80</td>
</tr>
</tbody>
</table>
```
Fast Replication Backup Tape Support

- DFSMSshsm manages copying FlashCopy target volumes to tape
  - By command, immediately after FlashCopy version is created
  - By command, some time after the FlashCopy version is created
  - During Automatic Dump window
- Tape copies are ‘Dump’ copies
  - DFSMSdss Full-volume physical dump
  - Existing DFSMSShsm Dump function used to create copies
    - Dump Classes used to define policies
- Maintain up to 85 versions
  - Up to 5 copies per version
Fast Replication Backup Tape Support

(continued)

- **Dump Class Example**
  - **Name:** ONSITE – Copy that is kept onsite
    - **Frequency:** 0 – Create as often as necessary
    - **Retain:** 10 Days – Keep for ten days
    - **Stacking:** 10 – Max volumes on single tape (Higher level of recovery parallelism)
    - **Encryption:** Yes – Use software encryption on tape
  - **Name:** OFFSITE – Copy that is taken offsite
    - **Frequency:** 7 – Create once a week
    - **Retain:** NOLIMIT – Let the copy roll-off
    - **Stacking:** 255 – 255 volumes on single tape
    - **Encryption:** Yes

★ **Recommendation** – Define new dump classes for fast replication
Example

Step 1:
Version 1 is created with FlashCopy to disk followed by Dumping target volumes to tape.

Step 2:
Version 2 is created with FlashCopy to disk only.
Step 3:
Version 3 is created with FlashCopy to disk followed by Dumping target volumes to tape.

Notice that Version 1 disk copy was overlaid to create Version 3.
Example (continued)

Step $n$:
Version $n$ is created with FlashCopy to disk followed by Dumping target volumes to tape.

There is a dump tape for every other version
Fast Replication Backup Tape Support (continued)

• **FRBACKUP COPYPOOL(cpname) DUMP**
  - After FlashCopy relationships are *successfully* established for every source volume, DFSMSShsm dumps the *target* volumes to tape
  - Target volumes are DFSMSdss dump conditioned volumes
    - When dump conditioned volumes are dumped to tape, the tape will look as if the source volume was dumped directly
    - DFSMSShsm records will show the dump tape as a dump of the *source* volume, not the target volume
    - *Recovery is done directly back to the source!*

• **Incremental FlashCopy**
  - Reduces Read I/Os against production volumes for Dump processing
  - For performance reasons, some customers wait until background copy is complete before beginning dump copy of target volumes
Fast Replication Backup Tape Support
(continued)

- **FRBACKUP COPYPOOL(cpname) DUMPONLY**
  - Does *NOT* establish FlashCopy relationships, *ONLY* creates a dump copy of an *existing* disk copy
  - Use this command to
    - Create the dump copy at a time other than when the FlashCopy is created
    - Create additional dump copies
    - Retry failed dump copies – only dumps previous failures
  - Default is to dump Generation 0 – Most recent disk copy
    - GENERATION(*gennum*)
    - VERSION(*vernum*)
    - DATE(*date*)
    - TOKEN(*token*)
  - The disk copy must be Valid to issue DUMPONLY against it
Fast Replication Backup Tape Support (continued)

- **Copy Pool definition determines if target volumes are dumped during Automatic Dump window**
  - Dumps Generation(0) only
    - If Generation(0) disk copy is failed, then copy pool is not dumped
  - Copy Pool volumes are processed before storage groups and nonSMS volumes
  - System Affinity can be specified in copy pool definition
    - Dump workload is spread across systems
- **Using Automatic Dump is a good way to create a single daily tape copy when multiple FlashCopies are created throughout the day**
Fast Replication Backup Tape Support
(continued)

Day 1

Day 2
Data Integrity

- Once a dump copy has started, DFSMSHsm prevents the target volumes from being overlaid with a new FlashCopy until all volumes have been dumped successfully:
  - Overlaying the target volumes in the middle of the dump creates a data integrity exposure.
  - Once the target volumes have been overlaid, it is impossible to complete a dump copy! *DFMSHsm prevents these!*

- Withdrawing a background copy while creating a dump copy creates a data integrity exposure.
  *DFMSHsm prevents this!*
Data Integrity (continued)

- **Scenario: Relationship is Withdrawn**

  - **Time 1**
    - Initiate FC

  - **Time 2**
    - Start Dump

  - **Time 3**
    - Withdraw Relationship

Tape is corrupt. Data copied after the withdraw is residual.

**DFSMShsm prevents this!**

(When Withdraw done with DFSMShsm)
Recovering a Fast Replication Backup

- **Target volumes cannot be used as a source volume**
  - Dump conditioned volumes

- **DFSMShsm FRRECOV** command must be used to recover target *disk* volume back to the source
  - Data is immediately available after the FlashCopy initialization completes (High RTO!)
  - DB2 fast log apply can begin within minutes

- **FRRECOV COPYPOOL**(cpname) **VERIFY**(Y)
  - Recovers all of the volumes from the named copy pool

- **FRRECOV DSNAME**(dsname1, dsname2, …) **REPLACE**
  - Recovers one or more data sets
  - Prefers disk recovery if both disk and tape are available
Recovering a Fast Replication Backup

(continued)

Retry Logic

• If there is an error recovering one or more volumes…

• Correct the problem
• Reissue the FRRECOV command
  ★ DFSMSshm will only process those volumes that previously failed
  ★ LIST COPYPOOL output indicates if a particular version recovery is resumable

RESUME(NO) option to retry all volumes
(YES) is the default
LIST Command

- **LIST COPYPOOL**
  - Returns version information for each copy pool that has at least one attempted backup

- **LIST COPYPOOL**(cpname)
  - Detailed version information for each backup version for the specified copy pool name
  - Options: FRVOLS, NOVOLS, DUMPVOLS, ALLVOLS

- **LIST COPYPOOLBACKUPSTORAGEGROUP**(cpbsgname)
  - Information regarding which volumes in copy pool backup storage group that DFSMSHsm is using

- **SELECT** based on state of the version
  - **FASTREPLICATIONSTATE**
    - Recoverable, NonRecoverable, Failed, None
  - **DUMPSTATE**
    - AllComplete, RequiredComplete, Partial, None
DB2 RESTORE SYSTEM

1. Identify Recovery Point

   - Storage Group
     - Name: DB2BKUP
     - Type: Copy Pool Backup
   - Copy Pool
     - Name: DSN$DSNDB0G$DB
     - Storage Group
       - Name: DB2DATA
   - Fast Replication Recover

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
Summary

- IBM solution for Continuous Data Protection
  - Cross-Product synergy
- Future enhancements will exploit new advanced features of Disk
- References
  - ‘Casebook: DB2 backup, recovery and cloning for SAP environments’
    https://www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/e0b13d2b-0a89-2b10-918b-bc7aff0a1905
  - z/OS Host Topics Issue 16, February 2007
  - Redbook: DFSMShsm Fast Replication Technical Guide