IBM Replication Solutions for Business Continuity Part 2 of 2

DFSMS Copy Services

Continuous Data Protection for DB2
- zCDP for DB2

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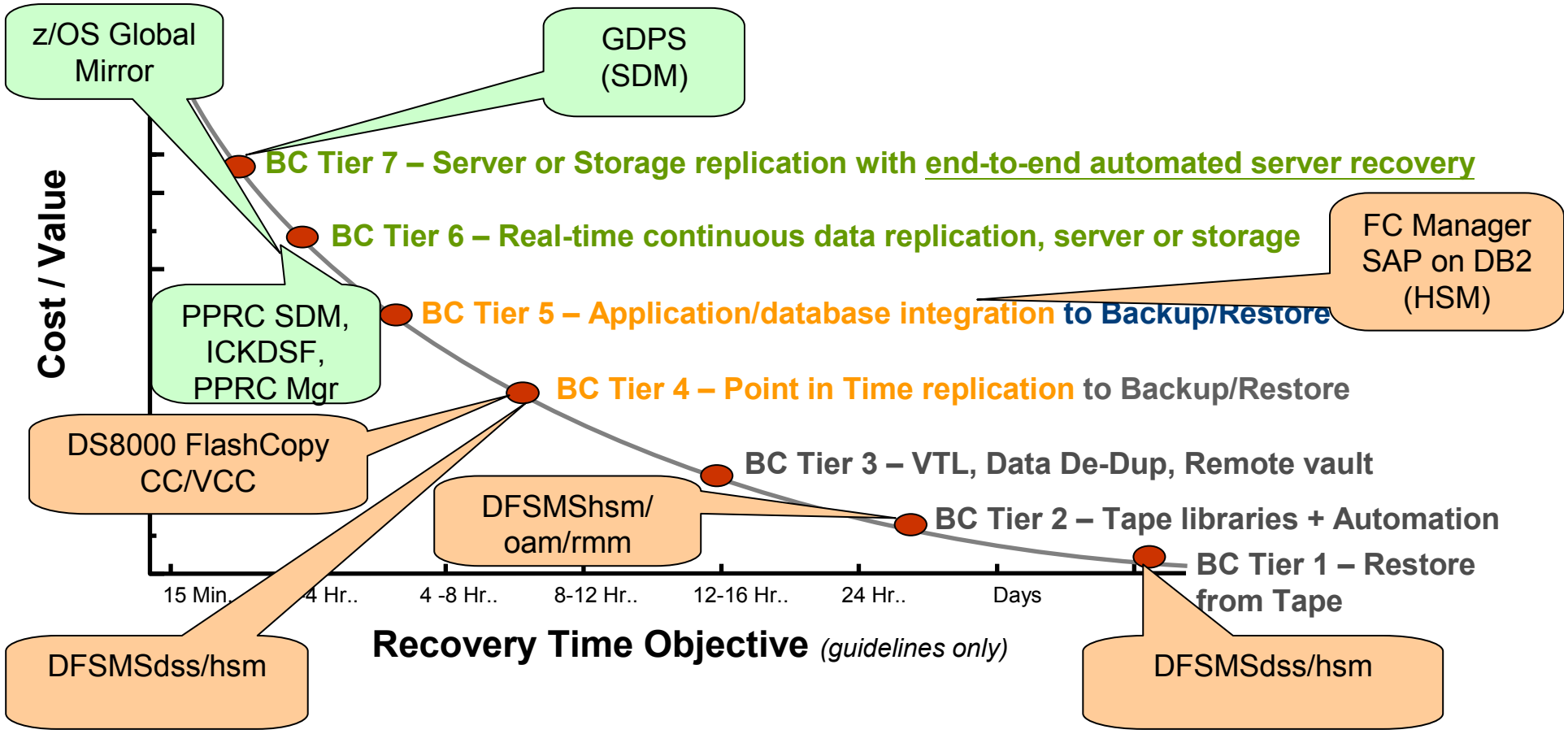
Agenda

- **Business Continuity Overview**
- **DFSMS Copy Services**
  - System Data Mover
  - DFSMSdss
- **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



DFSMS positioning within the BC Tiers

System Data Mover

- **Point-in-time Products**
  - FlashCopy
  - Concurrent Copy
  - Virtual Concurrent Copy (IBM) / Snapshot (OEM)

- **Continuously Mirrored Products**
  - PPRC
    - Metro Mirror for ESS, aka (synchronous) Peer-to-Peer Remote Copy (PPRC)
    - Global Mirror for ESS, aka (asychronous) Peer-to-Peer Remote Copy
    - Global Copy for ESS, aka PPRC-Extended distance (PPRC-XD)
    - Metro/Global Copy for ESS, aka synchronous PPRC combined with PPRC-XD
    - Metro/Global Mirror, aka synchronous PPRC combined with Global
    - Mirror
  - XRC
    - Global Mirror for zSeries, aka Extended Remote Copy (XRC)

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)
  - DFSMdss 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)
    - FCTOPPRCPRIMARY
      - 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, DEFRAG, and CONSOLIDATE

DFSMSdss: Incremental FlashCopy

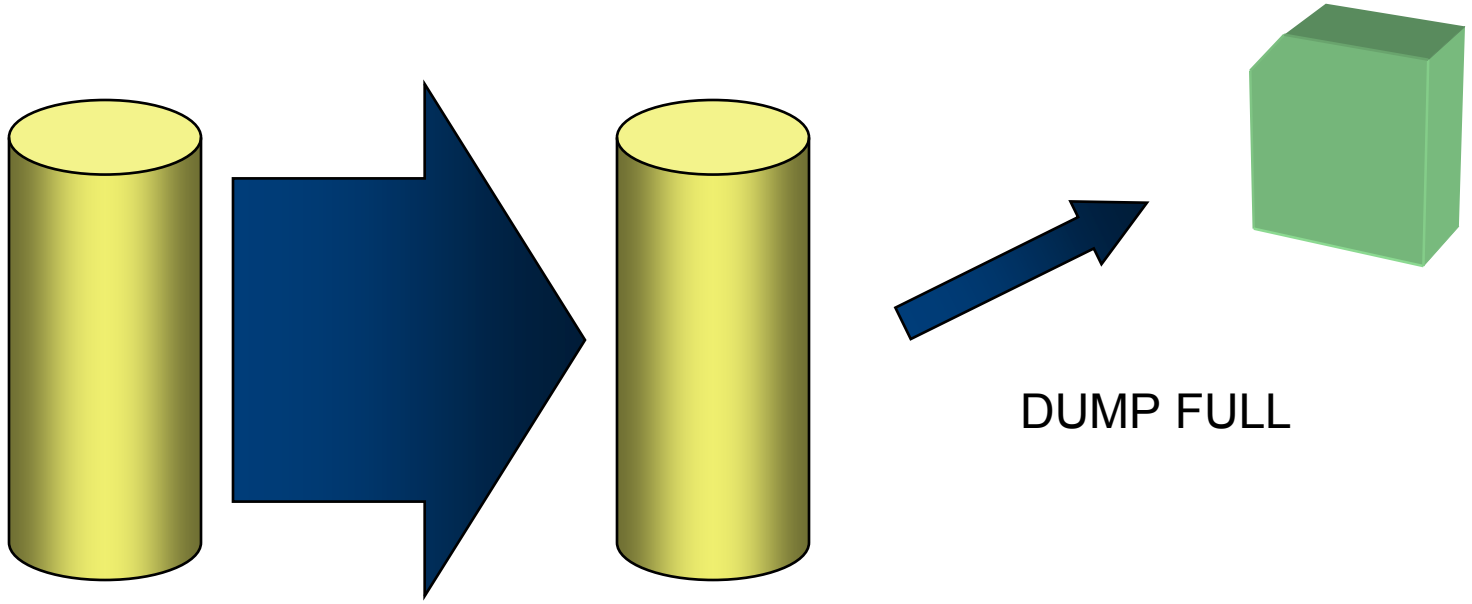
- Limits background copy to tracks that have changed since the previous Incremental FlashCopy
  - First Incremental FlashCopy results in full background copy and initiates change recording
  - Subsequent Incremental FlashCopies either:
    - Refresh the target: only the changed tracks being copied

    or
    - 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

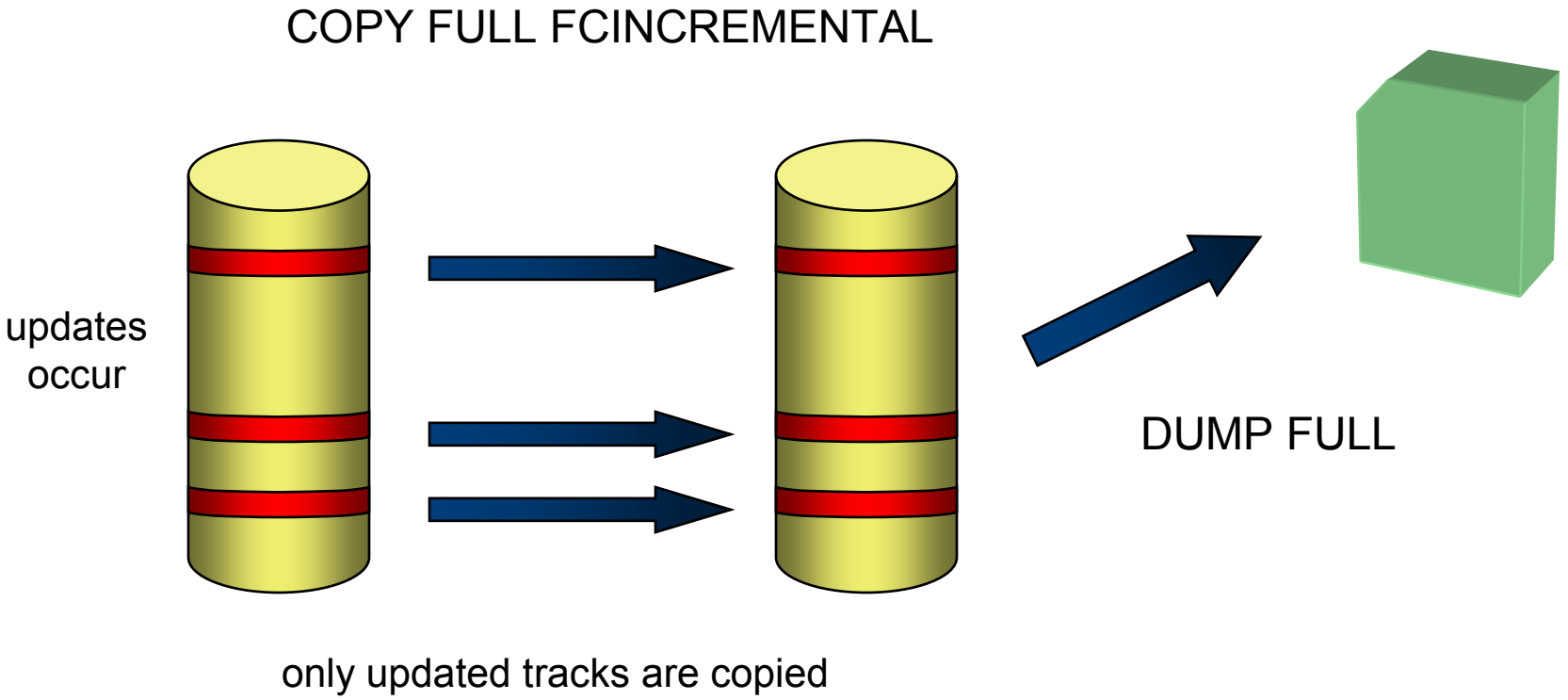


DUMP FULL

First time, all data is copied

DFSMSdss: Incremental FlashCopy

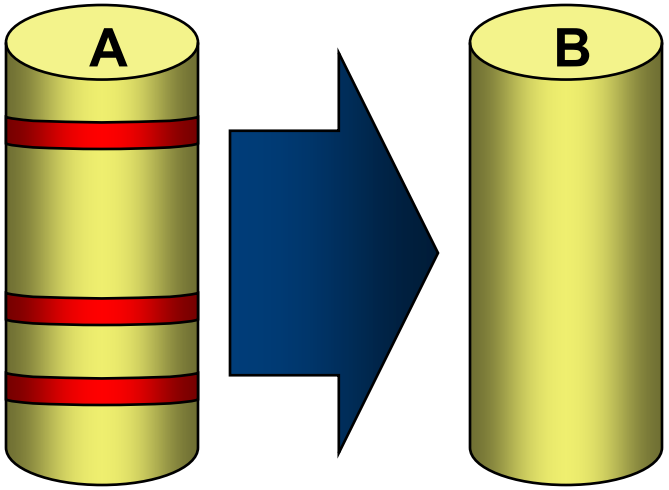
Usage Scenario 1: Periodic Dumps to Tape



DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

COPY FULL FCINCREMENTAL A TO B
EXECUTE BATCH STEP 1

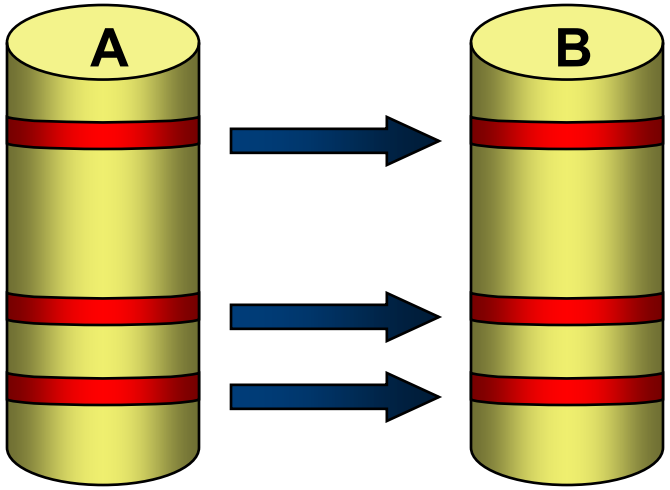


all data is copied

DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

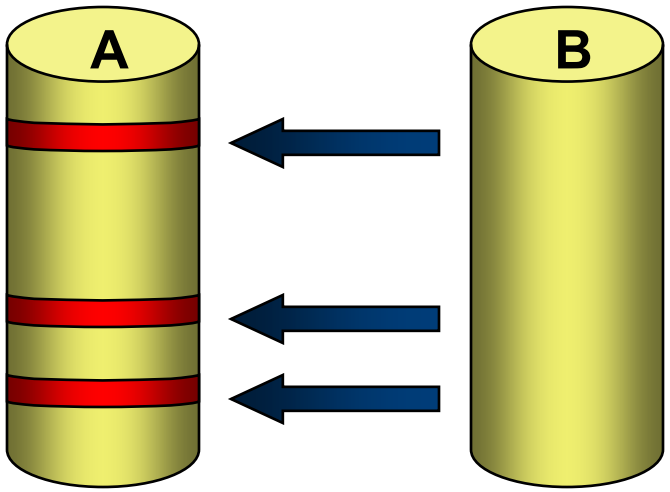
- COPY FULL FCINCREMENTAL A TO B
- EXECUTE BATCH STEP 1
- COPY FULL FCINCREMENTAL A TO B
- EXECUTE BATCH STEP 2



only updates are copied

DFSMSdss: Incremental FlashCopy

Usage Scenario 2: Batch Checkpoints

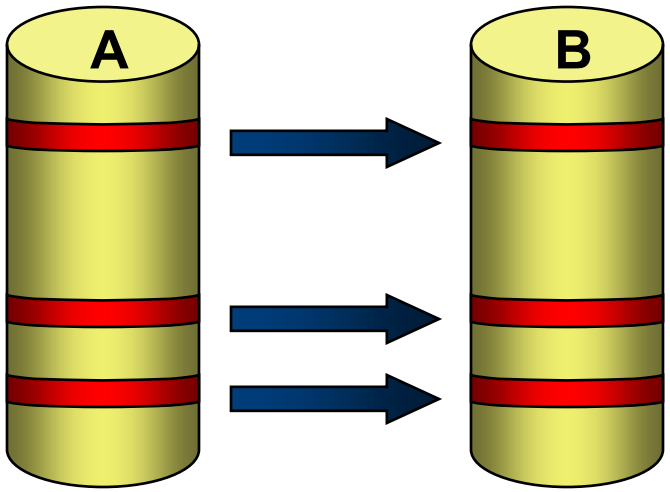


updates are removed

- 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

DFSMSdss: Incremental FlashCopy

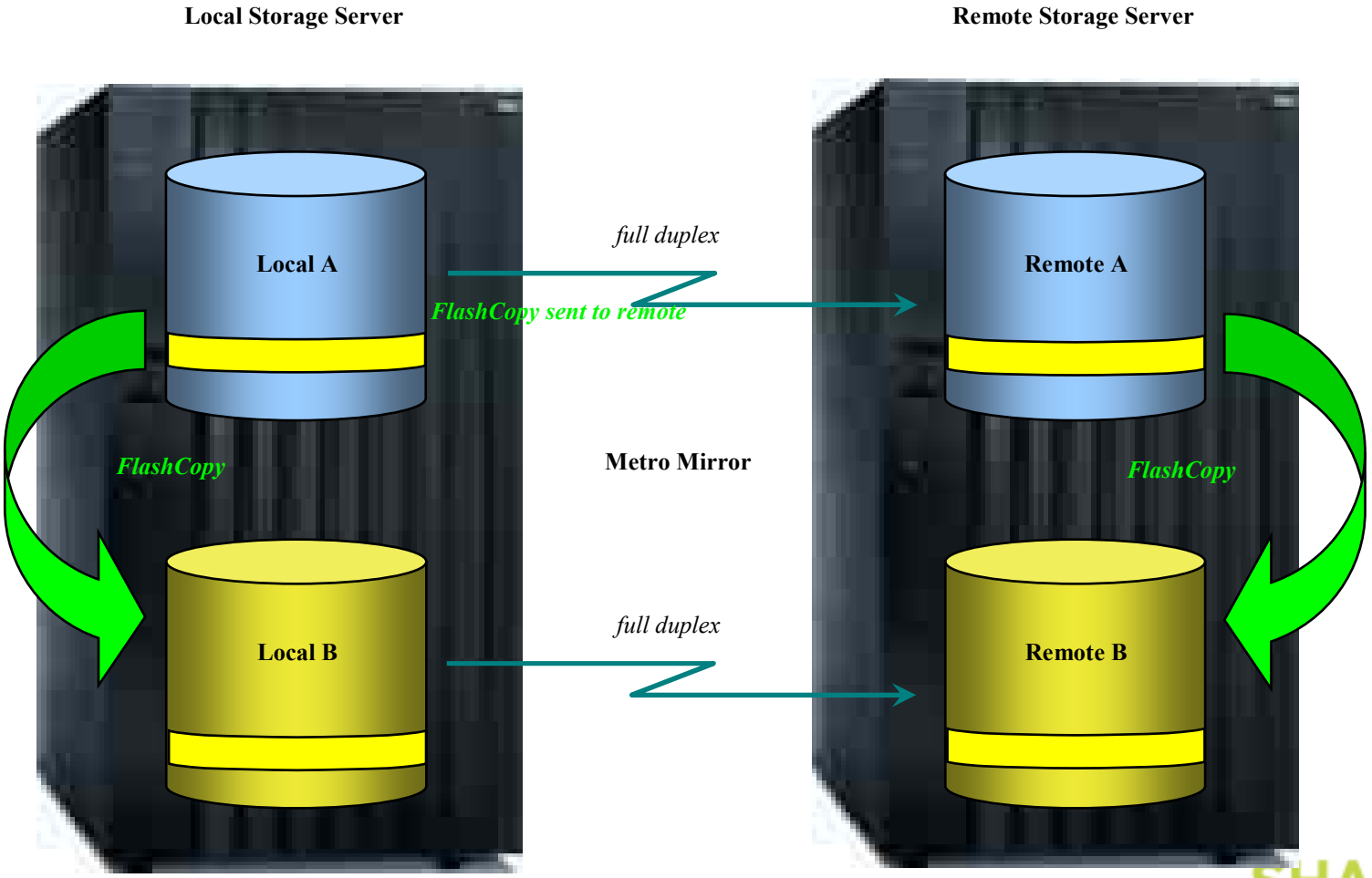
Usage Scenario 2: Batch Checkpoints



only updates are copied

- 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

FlashCopy to PPRC Primary using Preserve Mirror



Continuous Data Protection for DB2

zCDP for DB2

Business Continuity Overview

Business Continuity

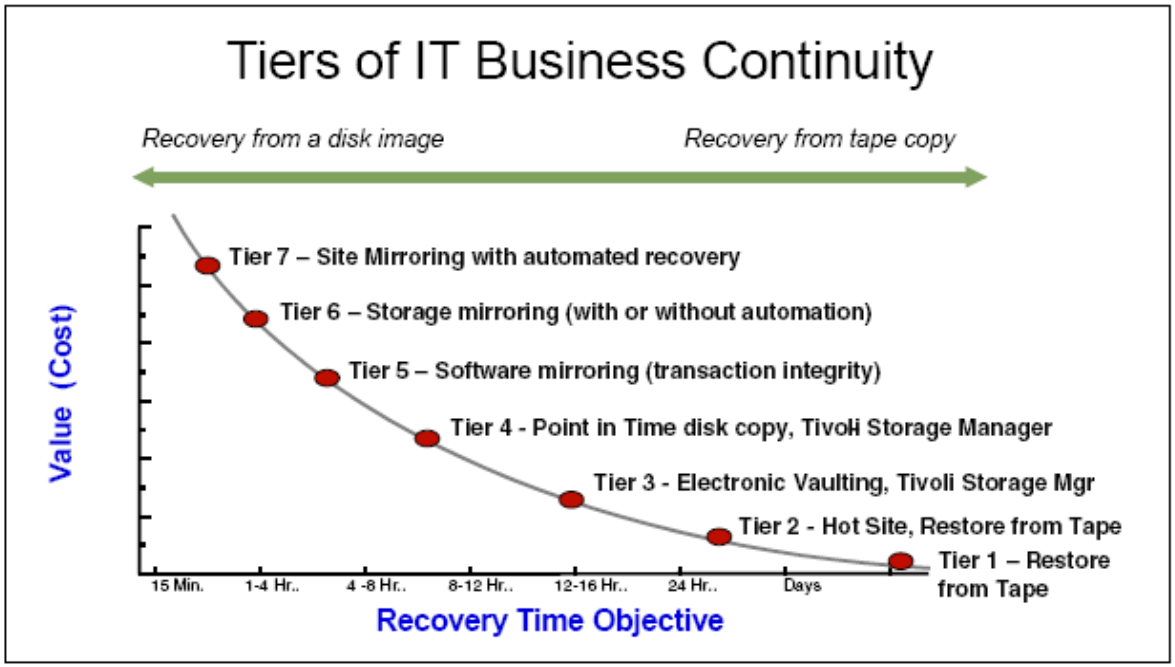
Maintaining business operations in the event of an outage – with processes and infrastructure that are responsive, highly available and scalable

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

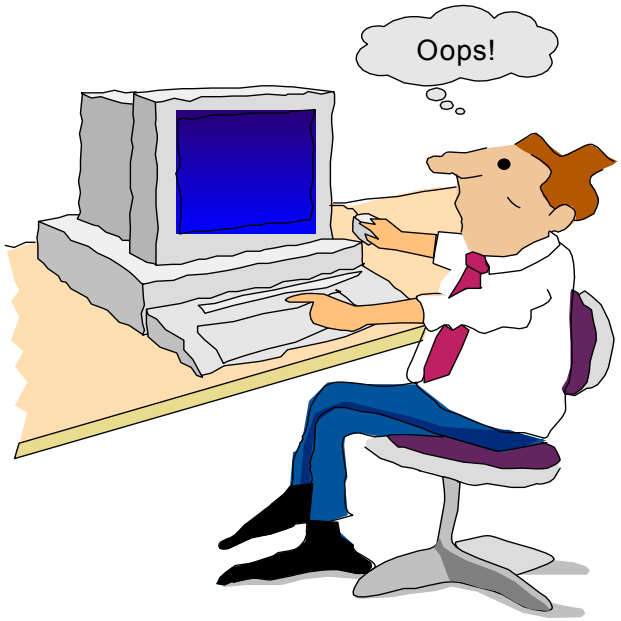
Business Continuity Overview *(continued)*

- **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



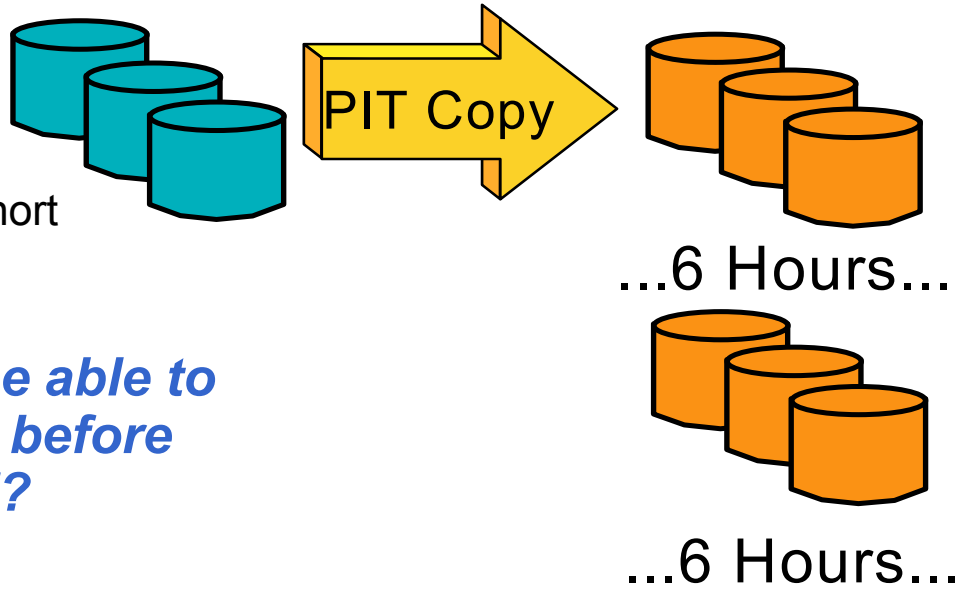
Business Continuity Overview *(continued)*

- **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

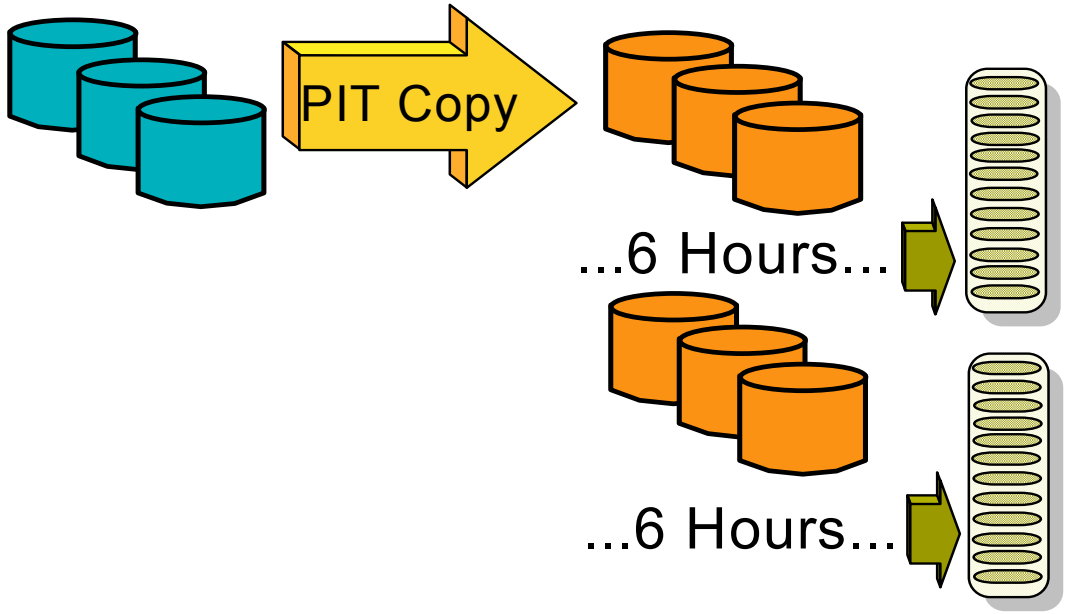
- **Traditional Point-in-Time Backup**
  - Taken at specific time or data points
  - Only captures data at the point of the backup
  - Low RPO
  - RTO varies
    - Disk – Short
    - Tape - Long
  - BWO varies
    - Point-in-Time Copy – Short
    - Standard I/O – Long



- ***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

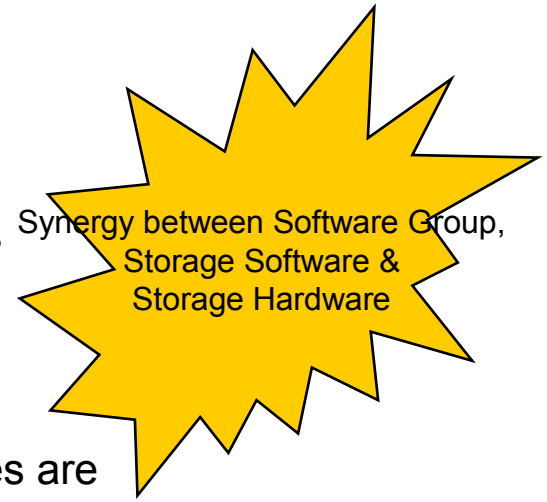


Types of Continuous Data Protection

- **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

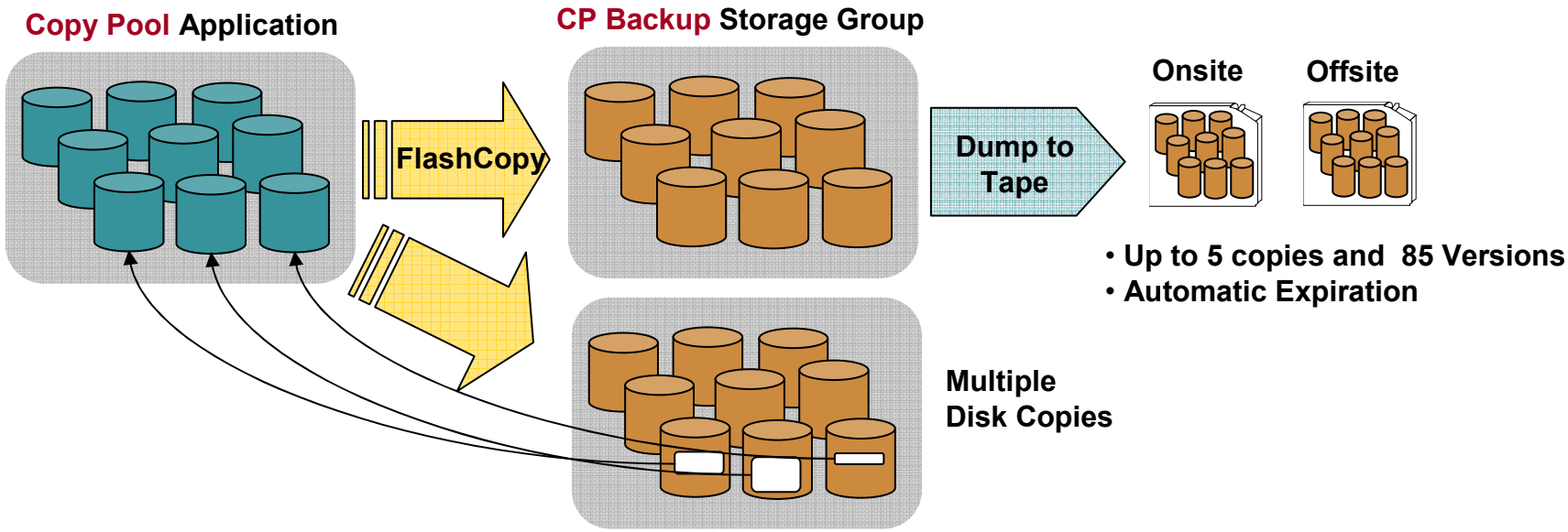
- ***Application based*** **CDP for DB2 on System z**
  - Joint solution between DFSMS and DB2
- **Solution based on Point-in-Time (PIT) backups combined with DB2 logging**
  - ★ Eliminates need for DB2 Log Suspend
    - Only Object-level creates, extends, renames and deletes are suspended
    - Hundreds 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)



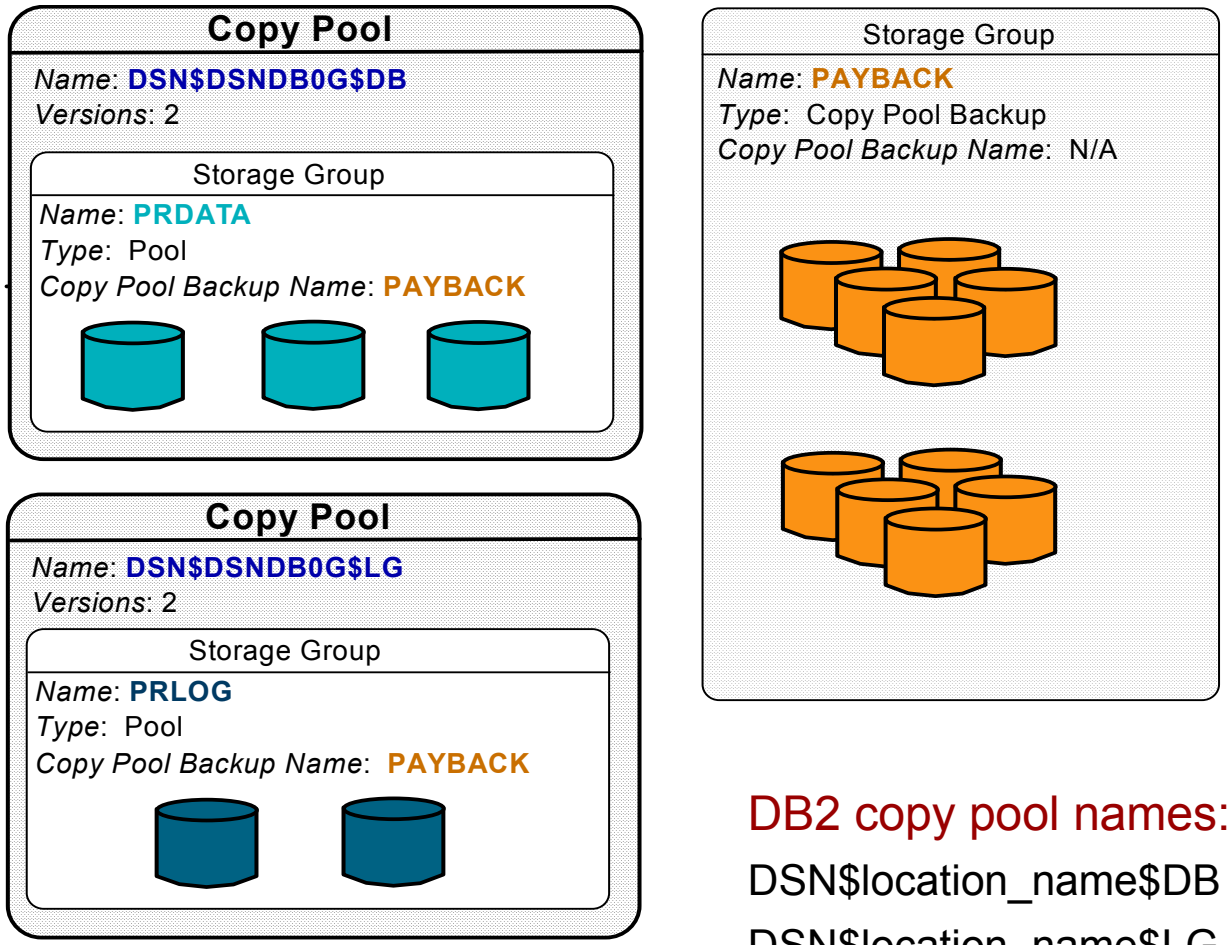
★Recovery at all levels from either disk or tape!

- 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**

SMS Enhancements *(continued)*



DB2 copy pool names:

DSN$location_name$DB

DSN$location_name$LG

SMS Enhancements *(continued)*

- **New "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)*

- **New "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

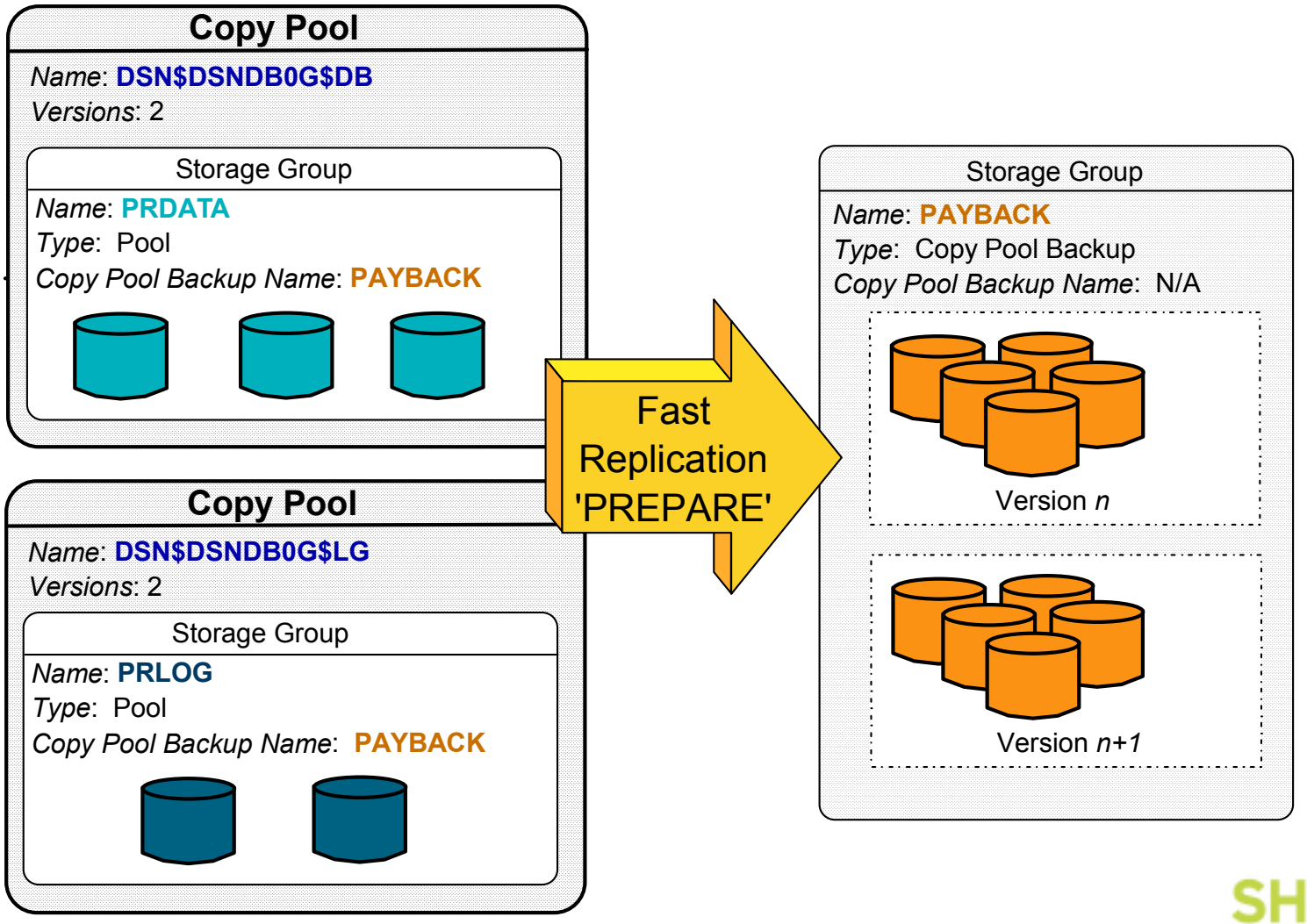
DFSMShsm Support

- **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)

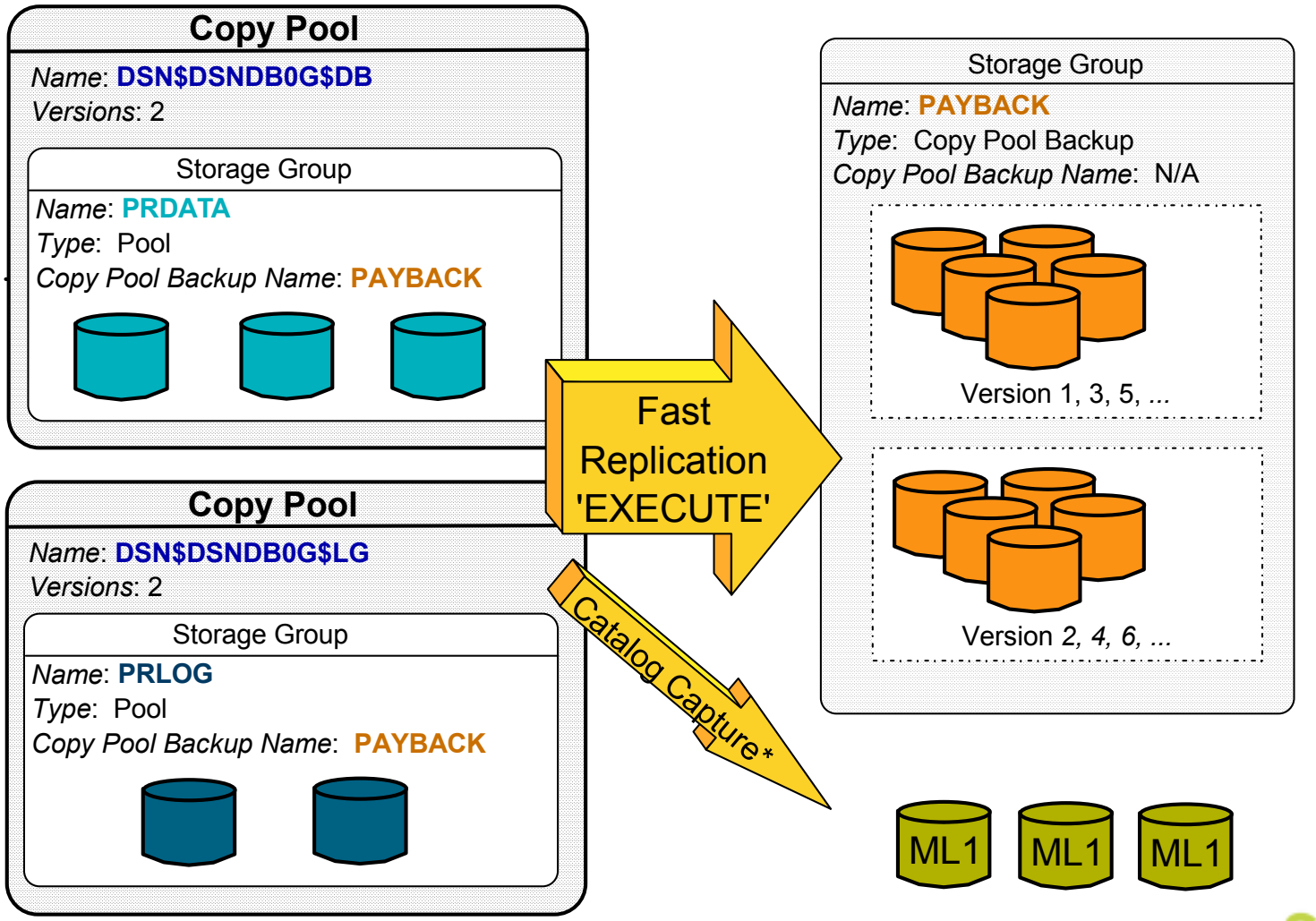


Creating a Fast Replication Backup

- **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)



*V1R11 and higher

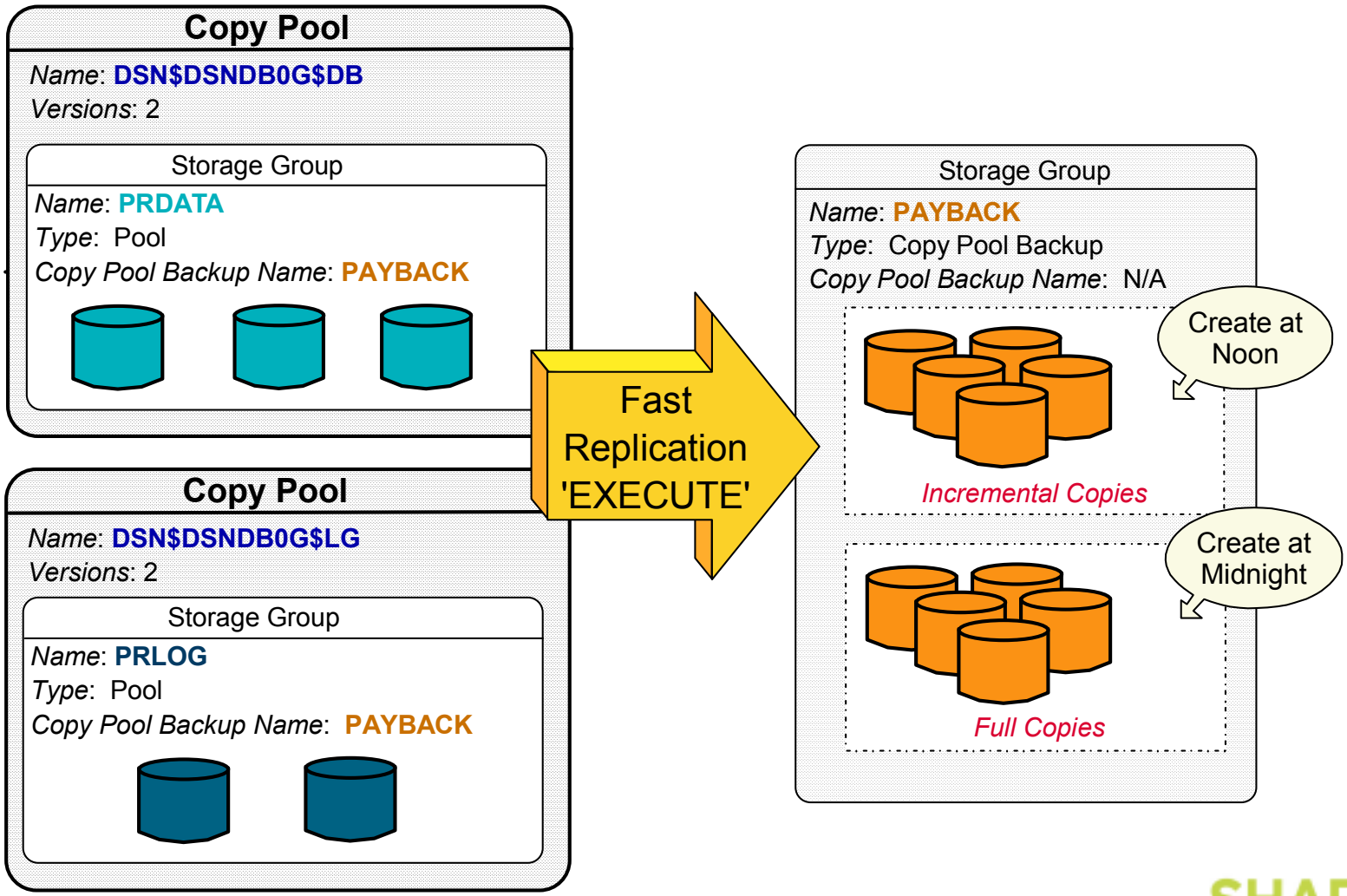
Creating a Fast Replication Backup
(continued)

- **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)



Query

- QUERY COPYPOOL indicates background copy percent complete

```
ARC1820I THE FOLLOWING VOLUMES IN COPY POOL CP1, VERSION 003,
         HAVE AN ACTIVE FLASHCOPY BACKGROUND COPY
ARC1820I (CONT.) SGNAME   FR-PRIMARY FR-BACKUP PCT-COMP
ARC1820I (CONT.) SGRP1    SRC01B     TGT01B     70
ARC1820I (CONT.) SGRP1    SRC02B     TGT02B     80
```

Fast Replication Backup Tape Support

- **DFSMShsm 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 DFSMShsm Dump function used to create copies
    - Dump Classes used to define policies
- **Maintain up to 85 versions**
  - Up to 5 copies per version

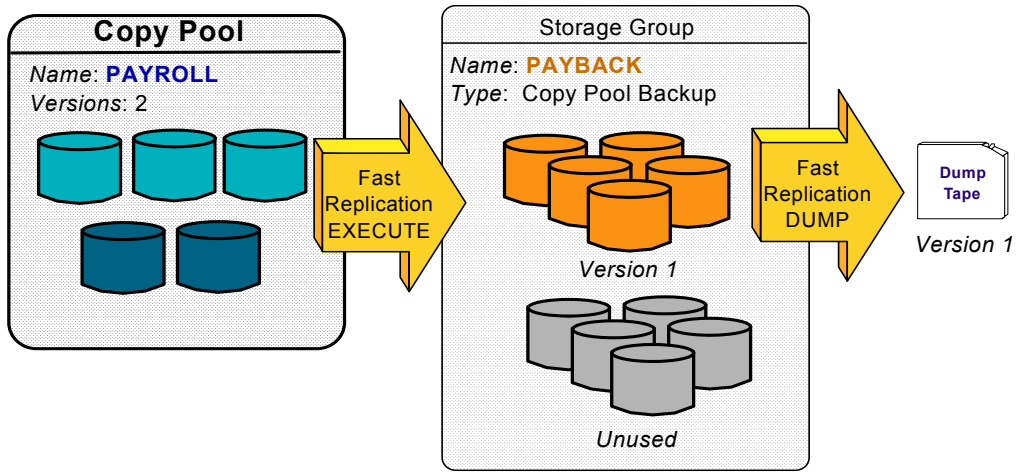
Fast Replication Backup Tape Support
(continued)

- **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

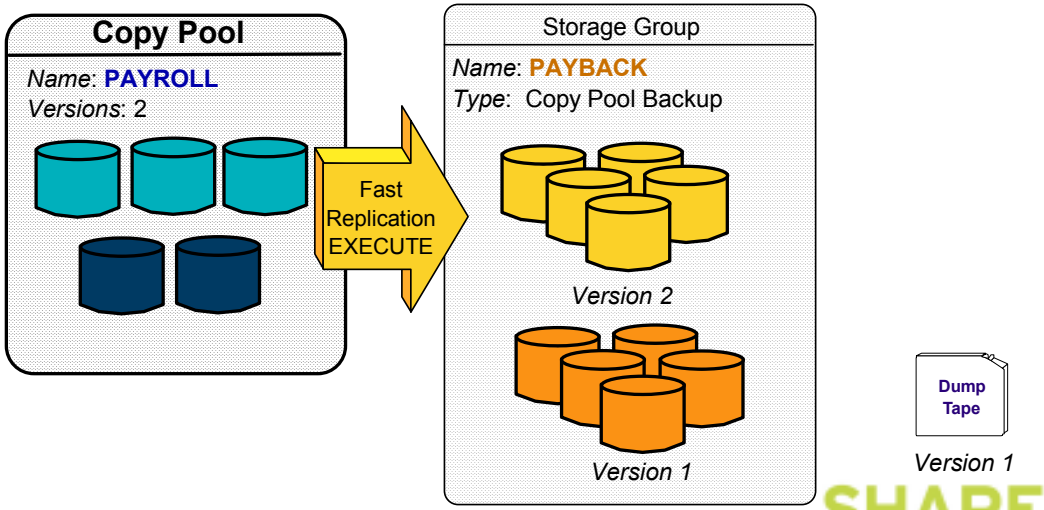
★ **Recommendation – Define new dump classes for fast replication**

Example

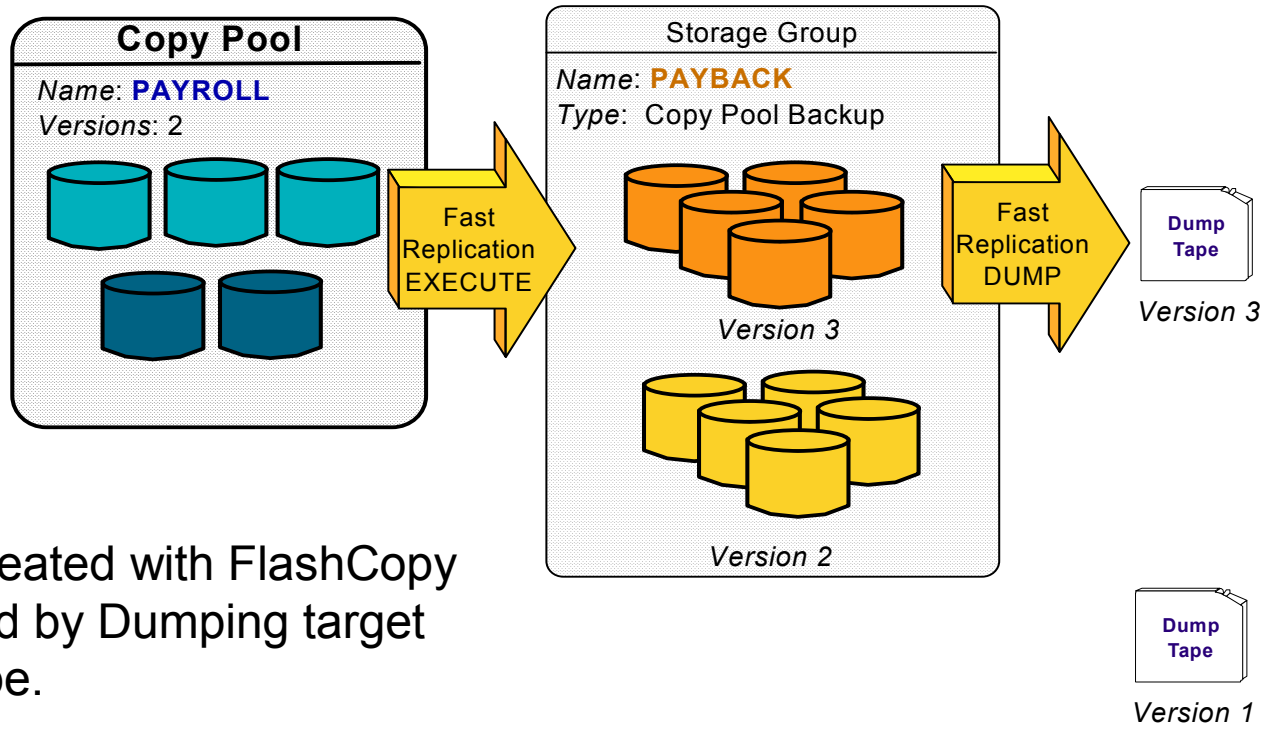
Step 1:
Version 1 is created with FlashCopy to disk followed by Dumping target volumes to tape.



Step 2:
Version 2 is created with FlashCopy to disk only.



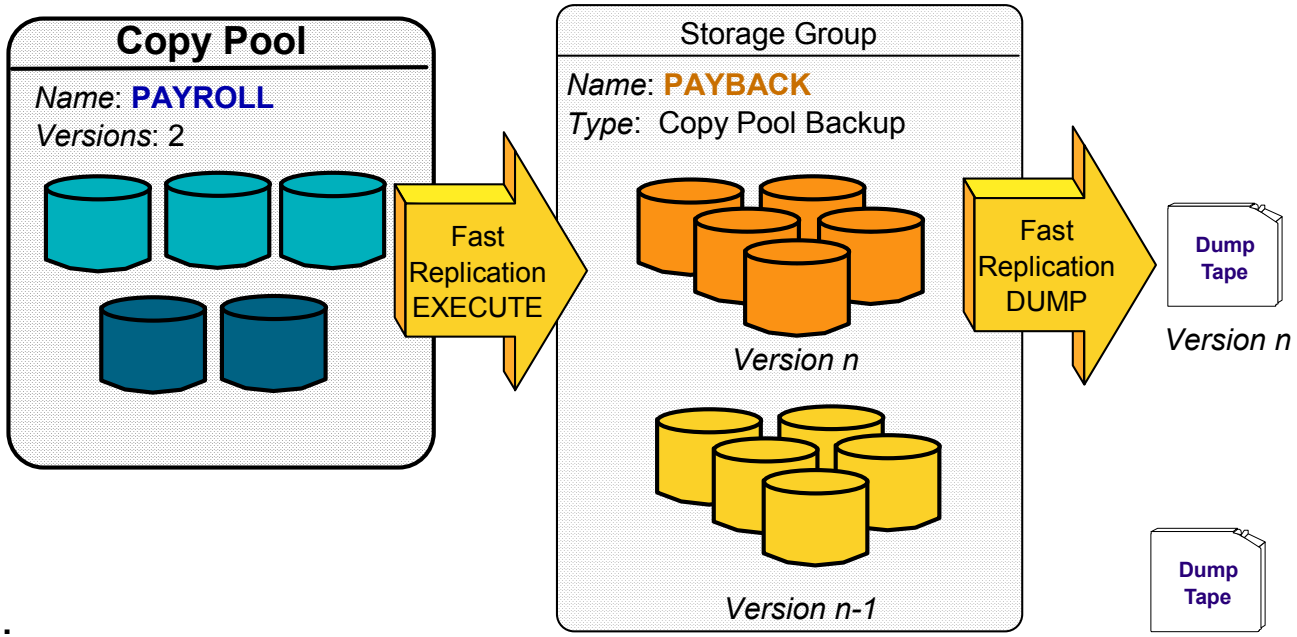
Example *(continued)*



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, DFSMShsm 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
    - DFSMShsm 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)

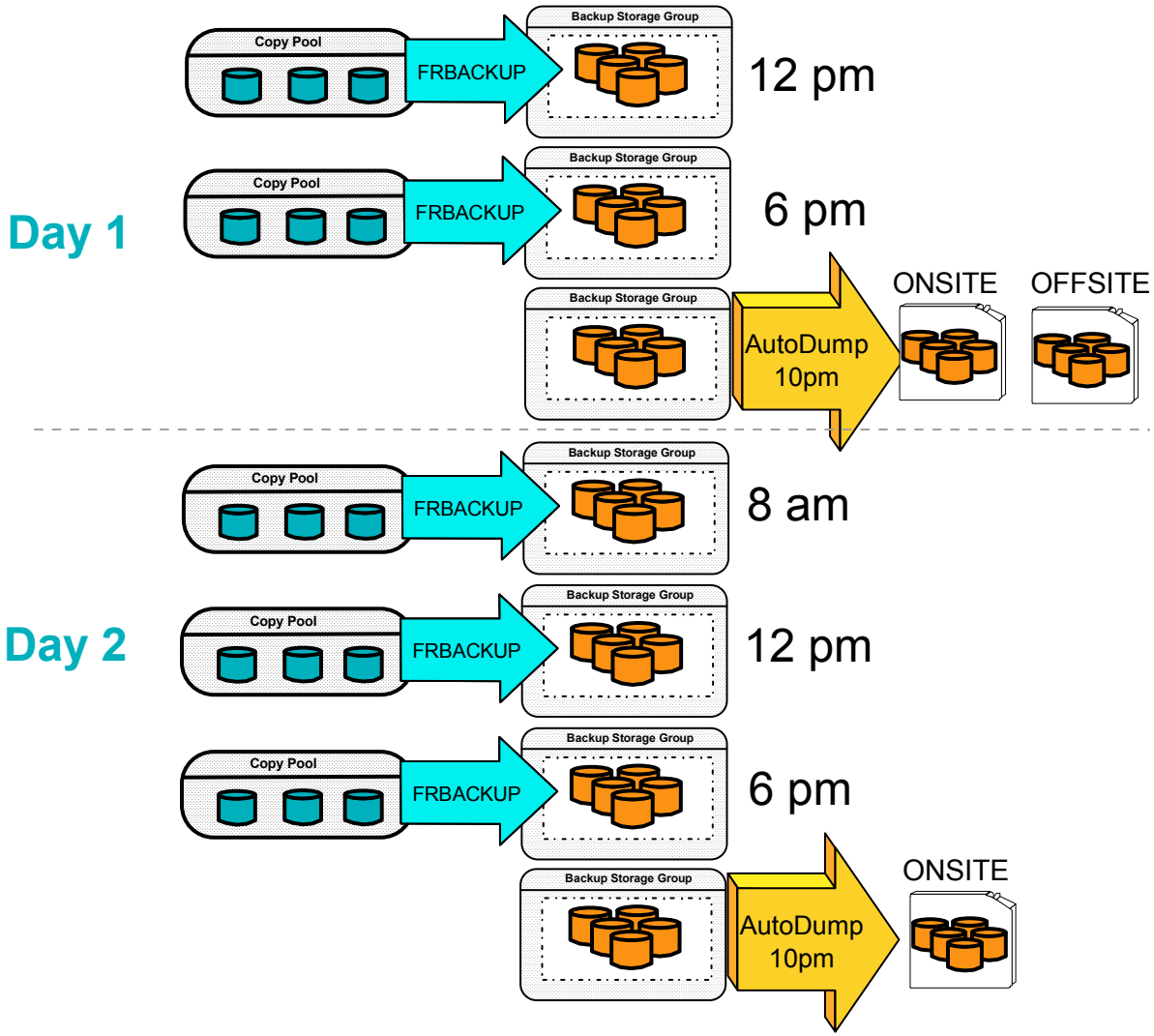
- **FRBACKUP COPYPOOL(cpname) DUMPONLY**
  - Does *NOT* establish FlashCopy relationships, *ONLY* creates a dump copy of an *existing* disk copy
  - Use this command to
    - ★Create the dump copy at a time other than when the FlashCopy is created
    - ★Create additional dump copies
    - ★Retry failed 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)



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!

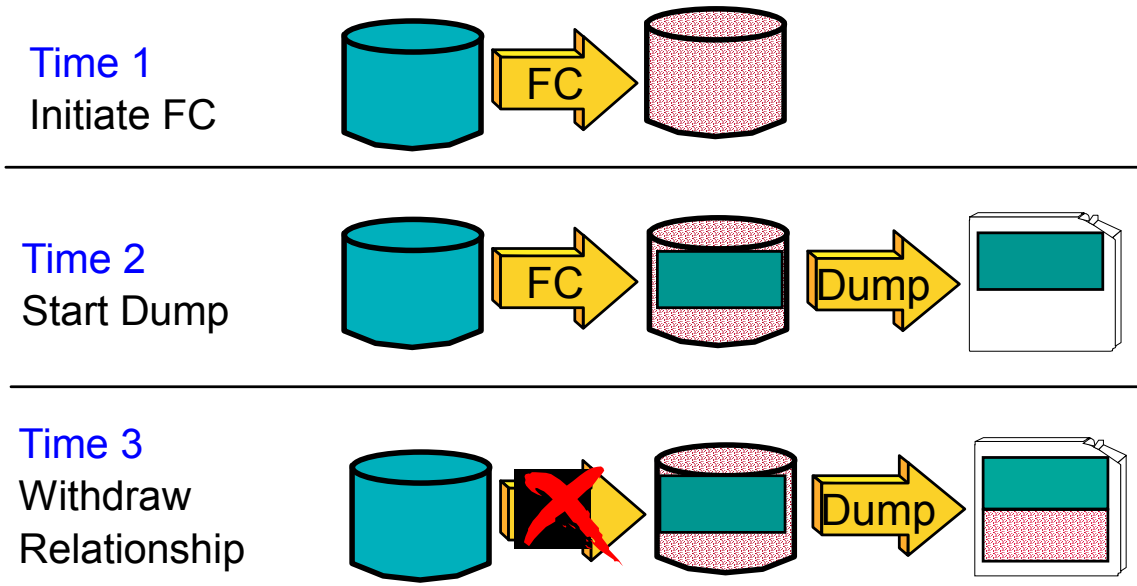
  DFSMShsm prevents these!

- **Withdrawing a background copy while creating a dump copy creates a data integrity exposure**

  DFSMShsm prevents this!

Data Integrity *(continued)*

- **Scenario: Relationship is Withdrawn**



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

DFSMShsm prevents this!

(When Withdraw done with DFSMShsm)

Recovering a Fast Replication Backup

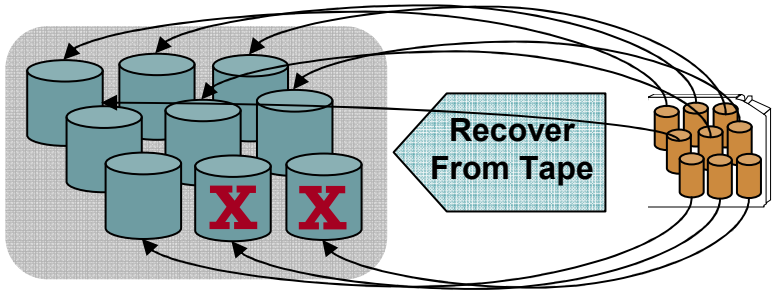
- **Target volumes cannot be used as a source volume**
  - Dump conditioned volumes
- **DFSMShsm FRRECOV command must be used to recover target *disk* volume back to the source**
  - ★Data is immediately available after the FlashCopy initialization completes (High RTO!)
  - ★DB2 fast log apply can begin 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

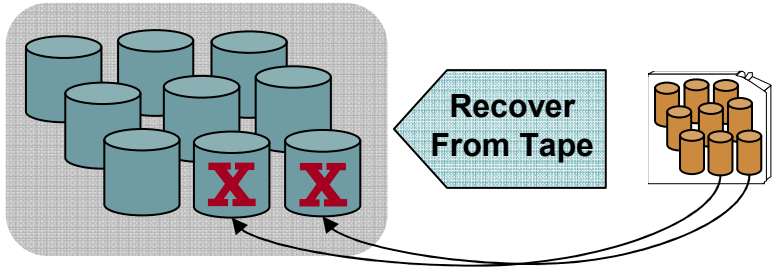
(continued)

Retry Logic

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



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



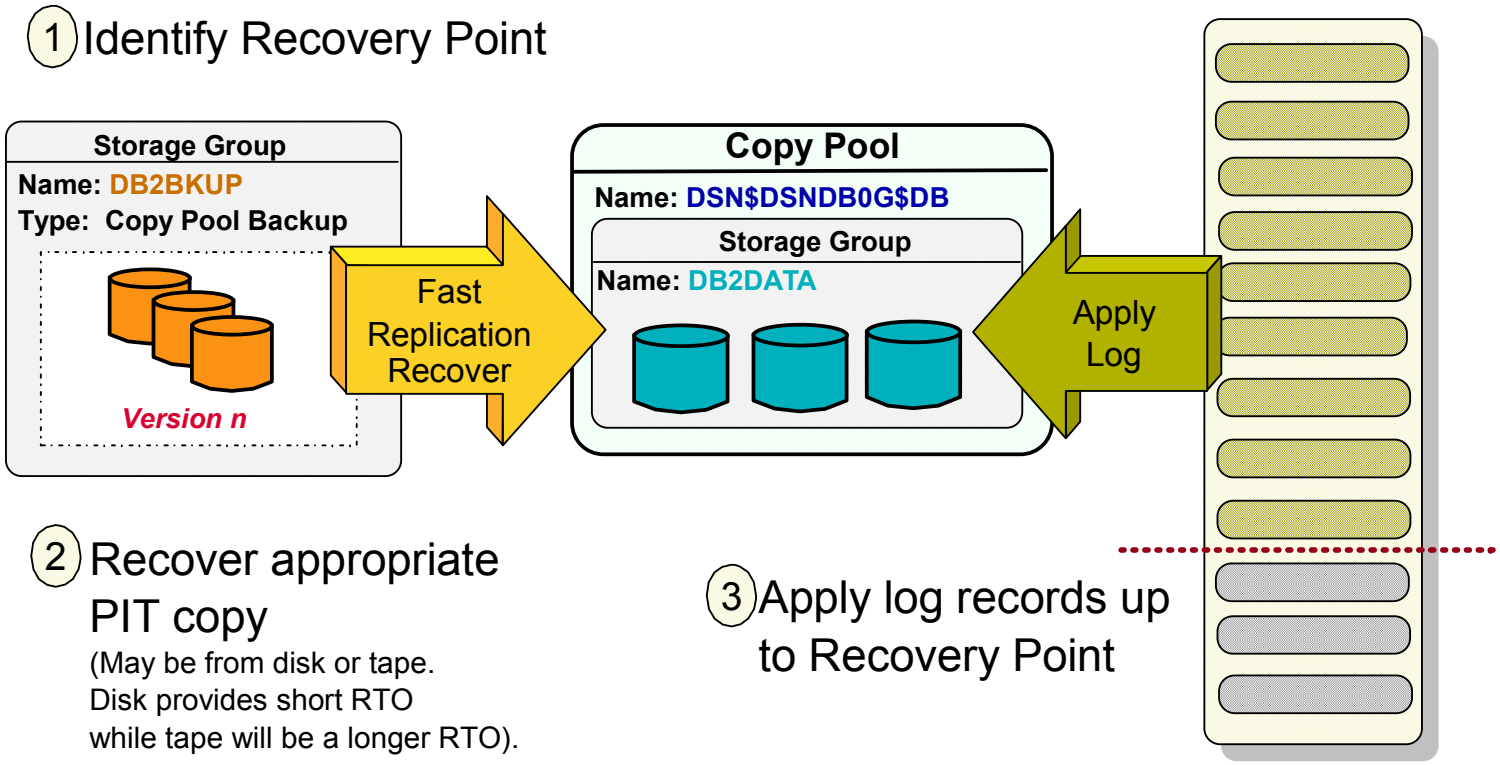
RESUME(NO) option to retry all volumes

(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



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