Simplify and Improve Database Administration by Leveraging Your Storage System

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Session Agenda

- Database and Storage Integration Overview
- System-Level Backup Methodologies and Storage Integration
- Cloning Database Systems Using Storage-Based Fast Replication
- Refreshing DB2 Objects and IMS Databases by Leveraging Your Storage Facilities
- Implementation Planning Considerations
- Session Summarization
Database and Storage Administration
Trends and Directions

- Large Database systems require high availability
  - Fast and non-intrusive backup and cloning facilities are required
  - Fast recovery capabilities are required to minimize downtime and promote high availability
  - Most backup, recovery and cloning solutions do not leverage storage-based fast-replication facilities

- Storage-based fast-replication facilities are under-utilized
  - Tend to be used by storage organizations
  - Tend not to be used by database administrators (DBAs)

- Storage aware database products allow DBAs to use fast-replication in a safe and transparent manner
  - Provides fast and non-intrusive backup and cloning operations
  - Simplifies recovery operations and reduces recovery time
  - Simplifies disaster recovery procedures
Database and Storage Integration

- Mainframe Database Systems
  - Storage-Aware Database Tools
  - Application and Database Management Domain
  - Storage Administration and Business Continuity Domain

Source
- Backup, Clone, DR

Backup, Clone, DR
- Source Database

- • Organizational Integration
  - • New Backup Methods
  - • New Recovery Strategies
  - • Business Recovery Monitoring
  - • Cloning Automation
  - • Disaster Restart Solutions

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Database and Storage Integration

Operational Advantages

- Reduce backup, recovery, and cloning administration costs
- Reduce host CPU and I/O resource utilization
- Perform backups and create clone copies instantly
- Fast restore and parallel recovery reduces recovery time
- Simplify disaster recovery operations and procedures
- DBMS and storage-based fast-replication integration
  - Leverage storage processors and fast-replication investments
    - IBM, EMC, HDS, STK
  - Expose fast-replication capabilities to the DBAs **safely and transparently** using “storage-aware” database utilities
- Provide a sophisticated infrastructure and metadata to manage the DBMS and storage processor coordination
System Level Backup Methodologies

- Backup complete database systems as a unit without affecting running applications
  - Backup components include:
    - Active and archive logs
    - Recovery metadata (DB2 BSDS, IMS RECONs)
    - All database data sets
    - Appropriate libraries, and system data sets
    - IMS system data sets including ACBLIBs, DBDLIBs, PGMLIBs, etc.
    - All associated ICF User catalogs

- Backups performed instantly using storage-based fast replication

- System-level backups are the foundation for federated backup and recovery solutions

- System backup and cloning methodologies are difficult to implement without sophisticated automation
  - “Split mirror” backup methodologies pioneered in late 1990s
  - Valuable concept - but hard to implement
Integrate DB2 and IMS backup, restore, and recovery process with storage-based fast replication.

Provide easy and fast backup and restore of DB2 and IMS systems and applications.

Support common storage systems:
- IBM – FlashCopy (FC)
- EMC – TimeFinder/Mirror/Clone/Snap, FC
- HDS – Shadow Image, FC

Feature requirements include:
- DB2 and IMS system discovery and configuration management
- DB2 and IMS system backup and recovery operations
- System backup validation
- Application and object data set backup (DB2)
- Image copy creation (DB2)
- DB2 object and application recovery
- IMS database and application recovery
- Active metadata repository
- Encrypted tape offload support
- DR preparation and management
System Level Backup Overview

- Storage-based backup reduces processing and administration costs
- Fast replication is used to perform database backup and restore functions
  - Full system backups complete in seconds
  - Backup performed without host CPU or I/O
- Back up large groups of databases with no application affect or down time
  - Backup windows are reduced or eliminated
  - Extend online or batch processing windows
- Data consistency ensured
  - Database suspend process
  - Storage-based consistency functions
  - DB2 BACKUP SYSTEM
- Automated backup offload management
DB2 Application and Object Backup Using Data Set Based Fast-Replication

- DB2 backups performed at application or object level
- Supports share levels reference and change
- Backups performed using data set fast replication facilities
- Backups can be registered in repository and used for fast restore and parallel recovery
- DB2 image copies can be created and registered
DB2 Image Copy Creation

- Image copies created from a system level backup
  - Eliminate batch window requirements
  - Image copies can be created and registered in DB2 syscopy
  - Eliminates I/O contention to maintain production performance
  - All image copies created at the same point in time
  - Reduces recovery time

- Image copy created from a data set fast-replication
  - Can be share level change or reference
  - Share level reference performs tablespace quiesce before data set fast-replication operations
  - FlashCopy copies can be deleted after image copy creation
  - Fast-replication backups can be persistent, registered in repository, and used for restore and recovery operations
• Recover DB2 / IMS systems or application objects from disk or tape automatically
• Intelligent Recovery Manager (DB2 / IMS) invoked to optimize recovery plans
• Faster recovery
  – Instantaneous system-restore process
  – Coordinated and parallel restore and DBMS recovery operations minimize system downtime
• System backup can be used for object (DB2), database (IMS) or application recovery
  – Data sets snapped to restore data
  – Parallel log apply reduces recovery time
• One system backup used for system, application, and disaster recovery
Managed IMS Application Recovery

IMS RE V2.1 Intelligent Recovery Manager

- Data Set Restore
- DBRC Notifications
- Change Accumulation Utility
- Database Recovery Utility
- Index Rebuilder
- HALDB ILDS/Index Rebuild
- Post Recovery Image Copy

<table>
<thead>
<tr>
<th>IBM Flashcopy</th>
<th>EMC SNAP</th>
<th>IBM DFSMS/SS</th>
<th>HPCA</th>
<th>USER</th>
<th>DRF</th>
<th>USER</th>
<th>IIB</th>
<th>USER</th>
<th>IMS</th>
<th>USER</th>
<th>HPIC/HPPC</th>
<th>USER</th>
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Fast-replication Data Set Restore

IMS RE V2.1 Invoked Recovery Processes
System Level Backup
Disaster Recovery Benefits

- Simplifies disaster recovery operations
  - System level backup for restart
  - System level backup and roll forward
- System backup is “restartable”
  - Restore volumes containing the last SLB
  - Performs recovery during normal DB2 database initialization process or during IMS emergency restart procedures
  - Disaster recovery is as simple as restarting from a power failure
- Intelligent Disaster Recovery Manager (DB2 / IMS)
  - Prepares recovery assets and manages remote restore and recovery operations
- Reduced recovery time at a DR site
- Transform disaster recovery procedures into a tape-based disaster restart process
  - Similar benefits as storage-based remote replication solutions

“Restartable DBMS Copy”
A system backup used for multiple functions
  - Saves storage and processing resources
- Leverages storage-processor and fast-replication software investments
- Expose fast copy capabilities to the DBAs safely and transparently using “storage-aware” database utilities
- Provides a sophisticated infrastructure and metadata to manage DB2 and IMS storage processor coordination
- Multiple storage vendor support
  - IBM - FlashCopy
  - EMC - TimeFinder/Mirror/Clone/Snap, FlashCopy
  - HDS – ShadowImage, FlashCopy
  - IBM RAMAC Virtual Array, STK - SnapShot
Cloning DB2 and IMS Systems

- Performs DB2 and IMS cloning automation
  - Simplifies database system cloning processes
  - Reduces cloning time and administration costs
- Leverages fast-replication facilities to clone data
  - Data can be cloned while online or offline
- Performs rapid volume reconditioning and data set renaming on cloned database volumes
  - Critical component of the database system cloning process
- Adjusts DB2 target database system to accommodate and accept the cloned data
  - DB2 catalog, directory, BSDS, active / archive log, etc.
- Adjusts target IMS system to accommodate and accept the cloned data
  - IMS RECONs, PROCLIB, JOBS, JCL, MDA members
Refreshing DB2 Objects

- Performs automated DB2 table and index space refresh operations
  - Fast refresh of database objects
  - DB2 RI relationships, LOBS, and Identity columns
- Verifies source and target database compatibility
- Objects copied using storage-based data set fast replication
  - Target takes up the same amount of space as the source
- Performs object ID translations and target system metadata management
Refresh IMS Databases

- Performs automated IMS database refresh operations
  - Fast refresh of IMS databases
  - IMS DB support (FF, HALDB, DEDB)
- Verifies source and target database compatibility
- Databases copied using storage-based data set fast-replication
  - Target takes up the same amount of space as the source
- Performs target system metadata management
Storage-aware Database Products

- IBM DB2 Recovery Expert for z/OS
  - DB2 for z/OS backup and recovery
- IBM DB2 Cloning Tool for z/OS
  - DB2 system cloning and tablespace refresh
- IBM IMS Recovery Expert for z/OS
  - IMS for z/OS backup and recovery
- IBM - IMS Cloning Tool for z/OS
  - IMS system cloning and database refresh
- Mainstar Database Backup and Recovery for DB2 on z/OS
  - DBR for DB2 – DB2 for z/OS backup and recovery
- Mainstar Database Backup and Recovery for IMS
  - DBR for IMS – IMS backup and recovery
- Mainstar Volume Clone and Rename
  - VCR – DB2 system cloning automation
- Mainstar Fast Tablespace Refresh
  - FTR – DB2 tablespace refresh automation
- Mainstar Clone and Rename for IMS
  - ICR - IMS system Cloning Automation
- Mainstar Rapid Database Refresh
  - RDR – IMS database refresh automation
- EMC - Rocket Backup and Recovery for DB2 on z/OS (EMC Select product)
  - RBR – DB2 for z/OS backup and recovery
Implementation Planning Considerations

- System level backup usage
  - Determine how SLB(s) will be used
- SLB type
  - Determine full, data-only, or partial SLB requirements
- Backup frequency and space utilization
  - Determine backup frequency, performance, and space efficient fast-replication requirements
- Disaster restart considerations
  - Determine offsite disaster restart resources and preferences (RTO, RPO) to define appropriate disaster recovery profiles
- Copy blade selection
  - Determine storage processor capabilities, available facilities and fast-replication preferences
System Level Backup Usage
and Data Set Layout Considerations

- SLB used for local system recovery
  - Database data and recovery structure isolation required
  - Database system isolation may be required
    - Non-database data sets will get restored when DB2 or IMS system is restored
    - User catalogs will get restored

- SLB used for application, DB2 object, or IMS database recovery
  - Data and recovery structure isolation is not required

- SLB used for remote disaster restart operations
  - Recovery structure isolation is not required
  - Database system isolation may be required
    - Non-database data sets will get restored when DB2 or IMS system is restored
    - User catalogs will get restored
DB2 System Level Backup Usage
Data Set Layout for Full Backup / System Recovery

DB2 on z/OS System and Database Environment

DB2 Source Volume Isolation Required

DB2 Recovery Structures
- ICF User Catalogs
- BSDS
- Active Logs
- Archive Logs

DB2 System and Application Structures
- ICF User Catalogs
- DB2 Catalog
- DB2 Directory
- DB2 Databases

DB2 System Backup Volumes
- ICF User Catalogs
- BSDS
- Active Logs
- Archive Logs
- DB2 Catalog
- DB2 Directory
- DB2 Databases

SMS Group, DB2 System Backup Volume Pool, Target Unit Range
DB2 System Level Backup Usage
Data Set Layout for Data Only / Application Recovery

DB2 on z/OS System and Database Environment

DB2 Source Volume Isolation not Required

ICF User Catalogs
Active Logs
BSDS

ICF User Catalogs
DB2 Directory
DB2 Catalog
DB2 Data Set

DB2 System and Application Structures

ICF User Catalogs
DB2 Catalog
DB2 Directory
DB2 Data Set

DB2 System Backup Volumes
SMS Group, DB2 System Backup Volume Pool, Target Unit Range
IMS System Level Backup
Data-Set Layout for System Recovery

IMS Application Environment

IMS Source Volume Isolation Required

IMS Recovery Structures
- ICF User Catalogs
- RECONs
- Active Logs
- Archive Logs

IMS System and Application Structures
- ICF User Catalogs
- IMS Databases
- Active Logs
- Archive Logs

IMS System and Database Backup Volumes
- ICF User Catalogs
- RECONs
- IMS Databases
- Active Logs
- Archive Logs

SMS Group or Target Unit Range
IMS System Level Backup
Data-Set Layout for Application Recovery

IMS Application Environment

IMS Source Volume Isolation Not Required

IMS System and Application Structures

IMS System and Database Backup Volumes

SMS Group or Target Unit Range
Partial System Level Backup

- Partial system level backup (PSLB)
  - Backup volumes representing a subset of the database system
  - PSLB’s used for database or application recovery only
  - Data set fast replication used to restore data
  - Log and data isolation not required
  - Desired application database data should be grouped on volumes as a best practice
- PSLB cannot be used for system recovery
  - System recovery requires all volumes in SLB
- PSLB usage
  - Large databases or applications having unique backup requirements
  - Creating image copies from a PSLB
  - Reduce disk utilization
  - Support more backup generations
DB2 Partial System Level Backup
Data Set Layout for Application Recovery

DB2 on z/OS System and Database Environment

DB2 Source Volumes
- ICF User Catalogs
- BSDS
- Active Logs
- Archive Logs
- ICF User Catalogs
- DB2 Catalog

DB2 Recovery Structures

DB2 Backup Volumes
- SMS Group, DB2 System Backup Volume Pool, Target Unit Range

Application Structures
Implementation Planning
Backup Frequency, Space, and Resource Usage

- SLB type: full, data-only, or partial – shown in previous slides
- Determine optimal backup frequency
- Determine number of backups to keep online (on disk)
  - Establish online backup duration requirements
    - SLB or PSLB used for IC creation may be deleted after ICs complete
- Determine offline (tape) backup requirements
- Consider incremental fast-replication options to reduce background copy time and resources
- Consider using one set of volume targets to support multiple database systems – next slide
  - Saves fast-replication target volume storage requirements
- Consider using space efficient fast-replication methods like EMC VDEVs to save space – later slides
- Consider cloning database systems to space efficient volumes using a full volume clone or SLB as the source – later slides
One Set of Backup Volumes for Multiple DBMS Systems (DB2 Example)

- **Backup DB2–1**
  - SLB-1 created on disk
  - Archive SLB-1
  - Backup volumes are available after archive completes

- **Backup DB2–2**
  - SLB-2 created on disk
  - Archive SLB-2
  - Backup volumes are available after archive completes

- Repeat for DB2-1
- Repeat for DB2-2
Create SLBs and Clone DB Systems
Full and Space Efficient Volumes

- Full volume fast-replication copy
  - Full volume copy
    - *Target is same size as source*
  - Relationship can be retained with production volume
  - Allows incremental resynchronization
- Space efficient copy
  - Change tracks copied before update
  - Allows incremental restore
  - Can have multiple space-efficient volumes associated with production volume
Space Efficient Usage Economics
Enable Frequent SLB or Clone Copies

Full-volume SLB or clone copies

Source
3 TB

6:00 a.m.
3 TB

12:00 p.m.
3 TB

6:00 p.m.
3 TB

12:00 a.m.
3 TB

Requires 12 TB of additional capacity

Space-efficient SLB or clone copies

Source
3 TB

Save Area
~900 GB

Based on a 30%
change rate

6:00 a.m.

9:00 a.m.

12:00 p.m.

3:00 p.m.

6:00 p.m.

9:00 p.m.

12:00 a.m.

3:00 a.m.

Requires ~900 GB of additional capacity
Full Volume and Space Efficient Usage Example

- Full system-level backup created using full volume fast-replication
- Clone operations performed using SLB backup volumes as source
- Cloned database systems use space efficient target devices
  - SLB volumes are used to service I/O for clone access
  - Clone writes (few) go to save pool
  - SLB writes (none) go to save pool
- Storage-aware database tools provides infrastructure and metadata to manage database and storage processor coordination
Perform full volume DB2 / IMS cloning automation
  - Requires same amount of space as the source
Perform space efficient clone operations
  - Use full volume clone as the source
  - No real space used for space efficient clones unless they are updated
Operational automation may be required to re-instantiate space efficient clones when the full volume clone is re-instantiated
Implementation Planning
Disaster Restart Considerations

- SLB should contain database system data only
  - Can contain other data that is restarted together
    - *Recovering database and other data together may require using a storage based consistency function to create the SLB*
    - *Cannot roll forward if database and other data require consistency*

- Use disaster recovery profiles to prepare for roll-forward recovery at the DR site
  - Disaster recovery profiles specify options on how to copy log data for DR site, etc.
  - Ensure disaster recovery metadata is taken offsite with archive logs and image copies (Example DBR for DB2 DR PDS)
  - Reduces recovery point objectives (RPO)
Using SLBs for a Tertiary DR Site

Primary Production Site
- DB2 / IMS
- Storage-Aware Backup and Recovery
- Storage Processor APIs
- Source Database Volumes
- System Level Backup
- Offload
- Tape Processing
- SLB

Secondary Production Site
- Remote Replication PPRC, SRDF

Tertiary Production Site
- PTAM or V-Tape Replication

Primary Disaster Restart Site
(remote disk-based disaster restart)

Secondary Disaster Restart Site
(tape-based Disaster restart)
Implementation Planning
Copy Blade Selection

- Know your storage processing infrastructure
  - What fast-replication facilities are licensed and preferred
- Determine storage blade and fast-replication facilities to use
  - DB2 Backup System Blade
  - DFSMSdss Blade
  - IBM FlashCopy Blade
  - EMC TimeFinder Blade
  - HDS ShadowImage Blade
- Determine which type of consistency function is best for your environment
  - Database suspend, storage-based consistency
Session Summary

- Storage-aware database utilities provide storage integration to simplify database administration tasks
- System-level backup solutions leverage storage-based fast-replication facilities and investments
  - Fast and non-intrusive backup operations with less administration
  - Reduces host CPU, I/O and storage utilization
  - Backups can be used for system, application, disaster restart
  - Parallel recovery reduces system and application recovery time
- Database system cloning automation allows production data to be leveraged easily and effectively
- DB2 table and index spaces and IMS databases refreshed easily
- Less skills required to implement advanced backup, recover, disaster recovery, and cloning solutions
- Implementation planning is important to optimize the benefits