The DB2 for z/OS Catalog Gets a Makeover

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The DB2 for z/OS Catalog Gets a Makeover

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Most Significant Catalog Changes in 27 Years

- Database 2 (DB2 Version 1) to DB2 10 for z/OS
  - Increased the number of table spaces
    - 11 table spaces to 90
  - Increased the number of tables
    - 25 tables to 137
  - Links to no links
  - Now uses a new table space structure (UTS in DB2 9)
  - LOBs (DB2 V6)
  - Reordered Row Format
  - Row level locking
  - Unicode
  - All DB2 10 Catalog/Directory objects are DB2 managed
To Appreciate Today’s Changes….

• DB2 10 for z/OS
• Available since October, 2010
  • Upgrade paths available from
    • DB2 Version 8 New Function Mode (NFM)
      • DB2 V8 End of Service (EoS) is April 2012
    • DB2 9 NFM

We Have to Start Here….

• Database 2 – DB2 Version 1
How the DB2 Catalog has Changed

<table>
<thead>
<tr>
<th>DB2 Version</th>
<th>Table Spaces</th>
<th>Tables</th>
<th>Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>11</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>11</td>
<td>43</td>
<td>5</td>
</tr>
<tr>
<td>V4</td>
<td>11</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>V5</td>
<td>12</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>V6</td>
<td>15</td>
<td>65</td>
<td>9</td>
</tr>
<tr>
<td>V7</td>
<td>20</td>
<td>84</td>
<td>19</td>
</tr>
<tr>
<td>V8</td>
<td>21</td>
<td>87</td>
<td>2</td>
</tr>
<tr>
<td>V9</td>
<td>32</td>
<td>108</td>
<td>19</td>
</tr>
<tr>
<td>V10</td>
<td>90</td>
<td>137</td>
<td>29</td>
</tr>
</tbody>
</table>
All of Those Fun Pointers
Prior to DB2 10

- Which table spaces used links
  - SYSDBASE, SYSPLAN, SYSDBAUT, SYSVIEW, SYSGROUP and DBD01
    - These table spaces used page level locking because of the links
  - Using SYSDBASE as an example:
    - SYSCOLAUTH, SYSCOLUMNS, SYSFIELDS
    - SYSFOREIGNKEYS, SYSINDEXES, SYSINDEXPART
    - SYSKEYS, SYSRELS, SYSSYNONYMS,
    - SYSTABAUTH, SYSTABLEPART, SYSTABLES,
    - SYSTABLESPACE
  - A change to any of the above tables could lock all of the tables

What do we mean by links or pointers? Next slide…
All of Those Pointers… Shades of IMS

• Using SYSTABLES as an example
  • SELECT * against SYSTABLES returns NAME for first column the first

• DSN1PRNT shows something a little different
  • Output of data page in a SYSDBASE containing a SYSTABLES row *
    • 4-byte forward ring pointer to next SYSTABLES record or SYSTABLESPACE record
    • 4-byte backward ring pointer to the previous SYSTABLES record or SYSTABLESPACE record
    • 4-byte child pointer pointing to a SYSCOLUMNS record
    • 4-byte child pointer pointing to a SYSRELS record
    • 4-byte child pointer pointing to a SYSINDEXES record
    • 4-byte child pointer pointing to a SYSTABAUTH record
    • 4-byte child pointer pointing to a SYSSYNONYMS record.

* Examined using DSN1PRNT and the Diagnosis Guide and Reference (licensed materials)
Have Links, Need Check

• DB2 Version 2 enhancement for catalog
  • DB2 link checker added
    • Stand-alone utility DSN1CHKR
    • The integrity of the DB2 directory and catalog table spaces can now be verified

• You’ll still need to check links one more time
  • As part of the migration
    • Run DSN1CHRK against SYSDBASE, SYSPLAN, SYSDBAUT, SYSVIEW, and SYSGROUP
    • Run DSN1COPY with CHECK option against all catalog/directory table space
    • Run CHECK INDEX against all catalog/directory indexes
    • Run catalog queries in member DSNTESQ in SDSNSAMP
      • Use DSNTEP2 so you can retain results
  • Make sure stuff is correct before attempting to migrate it
DB2 10 Catalog...

- Processed during enabling new function mode (ENFM*)
  - SYSDBASE, SYSPLAN, SYSDBAUT, SYSVIEW, SYSGROUP and DBD01 (because of links)
  - Plus SPT01, SYSOBJ, and SYSPKAGE
- Above table spaces are removed and their tables are moved to new partition by growth table spaces with these characteristics:
  - Row level locking
  - New row format
  - Partition-by-growth
  - Referential Integrity in place of links
  - One table per table space
  - DSSIZE 64 G
  - MAXPARTS 1

*Uses migration job DSNTIJEN
DB2 10 Catalog...

- Converting to ENFMx
  - V10EN8 / V10EN9
    - 7 Table Spaces dropped
    - SYSIBM.SYSVTREE / SYSVLTREE dropped (moved to SYSVIEWs BLOB)
    - 72 Table Spaces added
      - SYSPLUXA / SYSPLUXB

LOBs for Routines from SYSOBJ

- SYSDBASE
- SYSTSTSP
- SYSTSTAB
- SYSTSSYN
- SYSTSKEY
- SYSTSIXS
- SYSTSFAU
- SYSTSCOL
- SYSTSTPT
- SYSTSFLD
- SYSTSREL
- SYSTSTAU
- SYSTSFOR
- SYSTSIPT

- SYSDBAUT
- SYSTSDBA
- SYSTSDBU
- SYSOBJ
- SYSTSAUX
- SYSTSDEP
- SYSTSPRM
- SYSTSTRG
- SYSTSCON
- SYSTSTBC
- SYSTSDAT
- SYSTSKYC
- SYSTSRAU
- SYSTSSCM
- SYTSSROU
- SYTSSVol

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DB2 10 Catalog...

- Converting to ENFMx
  - V10EN8 / V10EN9
DB2 10 Catalog...

- Compare / Contrast

<table>
<thead>
<tr>
<th>DB2_VERSION_MODE</th>
<th>TS Count</th>
<th>Column Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>V8NFM</td>
<td>22</td>
<td>1281</td>
</tr>
<tr>
<td>V10C8</td>
<td>30</td>
<td>1705</td>
</tr>
<tr>
<td>V10EN</td>
<td>95</td>
<td>2046</td>
</tr>
<tr>
<td>V10NF</td>
<td>95</td>
<td>2046</td>
</tr>
</tbody>
</table>

Based on tables that are “SYSIBM” tables
Does not include several “User” tables added post-migrations
-Like the tables in DSNXSR (DSNTIJNX)

<table>
<thead>
<tr>
<th>DB2_VERSION_MODE</th>
<th>TS Count</th>
<th>Column Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>V9NFM</td>
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</tr>
<tr>
<td>V10C9</td>
<td>30</td>
<td>2057</td>
</tr>
<tr>
<td>V10EN</td>
<td>95</td>
<td>2387</td>
</tr>
<tr>
<td>V10NF</td>
<td>95</td>
<td>2387</td>
</tr>
</tbody>
</table>

This V9 system had several of “User” tables, tools-tables, DB2 stored procedure-tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Space Count</th>
<th>Column Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>V8 NM</td>
<td>22</td>
<td>1281</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>V10 CM</td>
<td>30</td>
<td>1705</td>
</tr>
<tr>
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<td>+</td>
<td>72</td>
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<td></td>
<td>-</td>
<td>7</td>
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<td>V10 ENFM</td>
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<td>2046</td>
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<td>0</td>
</tr>
<tr>
<td></td>
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<td>28</td>
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<tr>
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<td>95</td>
<td>2387</td>
</tr>
</tbody>
</table>

Overall Delta: 73 / 765

Overall Delta: 67 / 384
DB2 10 Catalog...

- Migrating to CM
  - V10CM8 or V10CM9
    - 8 or 2 Table Spaces Added
      - SYSCONTX Trusted Context Definitions
      - SYSPLUXA Aux Space with BLOB for SYSROUTINES.TEXT
      - SYSROLES Roles Definitions
      - SYSRTCSTS Real Time Statistics
      - SYSTARG Extended Index Definitions
      - SYSTSASC ASCII SYSDUMMYA
      - SYSTSUNI Unicode SYSDUMMYU
      - SYSEXML XML Definitions
        - (Node IDs, Schema IDs, etc.)
  - No Table Spaces Dropped

Underlined items occur in a V9 to V10 migration
DB2 10 Catalog...

• Migrating to CMx
  • V10CM8 / V10CM9
    • SYSCOPY
      • Logging information (V9)
    • SYSCOLUMNS
      • Hash information
      • XML Type Modifier
    • SYINDEXES / HIST
      • DATAREPEATFACTOR (V9)
      • Compression
      • Index on Expression
      • Hash
    • SYSTABLEPART
      • Hash
    • SYSTABLES
      • Hash
      • Versioning / Temporal
    • Columns for Roles added throughout
    • RELEASE Created throughout

• SYSTABLESPACE
  • Hash
  • Member Cluster
  • Clone (V9)
  • PBG (V9)

• SYSDATABASE
  • Implicit (V9)

• LOCATIONS
  • Trusted Context

• SYSSTOGROUP
  • SMS (V9)

• SYSINDEXES / HIST
  • DATAREPEATFACTOR (V9)
  • Compression
  • Index on Expression
  • Hash

• SYSTABLESPACE
  • Hash
  • Member Cluster
  • Clone (V9)
  • PBG (V9)

• SYSDATABASE
  • Implicit (V9)

• LOCATIONS
  • Trusted Context

• SYSSTOGROUP
  • SMS (V9)

• SYSINDEXES / HIST
  • DATAREPEATFACTOR (V9)
  • Compression
  • Index on Expression
  • Hash

• Summary of catalog changes
  • Underlined items occur in a V9 to V10 migration
DB2 10 Catalog...

- Converting to ENFMx
  - V10EN8 / V10EN9
    - SYSROUTINES_TREE
      - BLOB on SYSROUTINES
    - Real Time Statistics are moved into the Catalog
      - SYSINDEXSPACESTATS
        - TOTALENTRIES now BIGINT
        - Various new stats
      - SYSTABLESPACESTATS
        - TOTALROWS and SPACE now BIGINT
        - Various new stats
    - SYSAUDITPOLICIES
    - SYSAUDITALERTS / OUT
    - SYSAUTOTIMEWINDOWS
    - SYSCONTROLS / DESC

- SYSPENDINGDDL
- SYSPENDINGOBJECTS
- SYSPACKCOPY
- SYSQUERY
- SYSQUERYPLAN
- SYSQUERYOPTS
- SYSTABLES_PROFILES
- SYSXMLTYPMOD
- Several places where text or control info is included as CLOB or BLOB
DB2 10 Catalog...

- Convert to NFM
  - V10NFM
    - No additional changes noted
    - This is where more SYSIBM user tables would be created
      - Database DSNXSR (DSNTIJNX – V8)
      - Resource Limit facility
      - Profiles
      - Explain tables
      - Etc…
DB2 10 Catalog...

- V10 catalog restructure provides greater concurrency for catalog operations
  - Concurrent binds
- V8 migrations will include new Catalog table spaces for
  - Real-Time Statistics
  - New page size for SYSOBJ
  - XML
  - Trusted Context
  - Extended Index definitions
- V8 and V9 migrations see many table space changes for the catalog restructure
- Several LOB columns
  - Using Inline LOBs
DB2 10 Catalog...

- Summary
  - 55 spaces are UTS Partition By Growth
  - All are Unicode, except
    - SYSCOPY
    - SYSEBCDC
    - SYSTSASC
  - All are row level locking, except the following (page level):
    - SYSEBCDC
      - Contains SYSDUMMY1 & SYSDUMMYYE
    - SYSSEQ
      - Has MAXROWS set to 1
  - 68 are RRF
  - 18 LOB Columns
    - 6 use Inline LOBs
A Little More on that Migration Stuff…
DB2 10 for z/OS Migration Modes from V8

- Once started on the V8 to V10 path (DSNTIJTC) this path is committed.
- Falling back to V8 does not allow a subsequent migration to V9.
- Fallback can only be to V8.
- There can be no DB2 9 members during data sharing coexistence.

V8 Catalog

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DB2 10 for z/OS Migration Modes from V9

- Fallback can only be to DB2 9.
- There can be no DB2 V8 members during data sharing coexistence.

V9 Catalog

V10 CM9 Catalog

V10 Catalog

V10 Catalog

The DB2 for z/OS Catalog Gets a Makeover
DB2 10 Modes

• CMx Considerations (1)
  • Address Incompatibilities before migration
  • Fall back SPE must be on all members (and restarted)
  • Catalog is tailored
  • Data Sharing group
    • V8 & CM8
    • V9 & CM9
  • Test, test, test
  • Fallback possible (CM8 to V8 OR CM9 to V9)
    • CM8 fall back to V8 CANNOT subsequently migrate to CM9
    • Fallback from CMx* not allowed
  • Backup and Recover catalog objects in the specified order of the “migrate from” version.
    • Add new objects per: http://publib.boulder.ibm.com/infocenter/dzichelp/v2r2/topic/com.ibm.db2z10.doc.inst/db2z_modifydsntijic.htm
DB2 10 Modes

- CM8 Considerations
  - RUNSTATS
    - Collects DATAREPEATFACTOR added in V9
    - New Cluster Ratio formula

- CMx Considerations (2)
  - REBIND
    - Re-enable XPROCs
    - Find additional incompatibilities
    - Potential virtual storage and performance improvements
DB2 10 Modes

• ENFMx Considerations
  • This is running the same code as CMx
  • Catalog conversion takes place
  • All members of a data sharing group must be at the CMx level before converting to ENFMx
  • Can revert to CMx from ENFMx
  • Beyond CMx, Backup and Recover objects V10 specified order

• NFM Considerations
  • Can revert to ENFMx* or CMx*
    • Must be the same ENFM or CM mode as previous executed
      • CM8 / CM9
      • ENFM8 / ENFM9
  • REORG TABLESPACE for LOBs SHRLEVEL NONE no loner supported.
    • As of NFM, these jobs will complete with an RC=0, but will not do anything
DB2 Managed Catalog & Directory
Table Spaces
Catalog Must be DB2 (DFSMS*) Managed

- Catalog must be DB2 managed
  - BEFORE moving to DB2 10 conversion mode (CM)
  - Before upgrading or a new installation
- DFSMS is a set of IBM software products that automatically manages your data *(see slide xx)*
- With DB2 10 DFSMS will manage and control
  - All new catalog changes
  - All conversions to universal table spaces
  - All new catalog and directory indexes and table spaces
- All the new indexes and table spaces being added in DB2 10 will also use Extended Addressability (EA).

* Data Facility Storage Management System
Catalog Must be DB2 Managed

- Migration job DSNTIJSS
  - Provides DFSMS classes for customers currently not using DFSMS
  - Environment created by DSNTIJSS only for the DB2 catalog and DB2 directory objects
  - No other DB2 data sets are covered
  - DSNTIJSS must be completed before the installation/migration jobs DSNTIJTC or DSNTIJEN are executed.

- No conversion step to SMS is required
  - Data sets are converted when related table space is next reorganized
Storage Definitions

• Installation/migration panel DSNTIPA2
  • Panel contains SMS data classes, management classes, and storage classes needed for DB2 10 catalog, directory, and their indexes
    • Similar to what’s currently available on the DB2 9 panel DSNTIPA3
• DB2 10 DSNZPARM parameters for
  • Catalog and directory
    • CATDDACL, CATDMGCL, and CATDSTCL on the DSN6SPRM macro
  • Catalog and directory indexes
    • CATXDAACL, CATXMGCL, and CATXSTCL also on the DSN6SPRM macro
Storage Definitions

• Storage administrator should provide data classes, management classes, storage classes, and Automatic Class Selection (ACS) routines

• SMS must be configured to allocate all DB2 catalog and directory data sets in extended format using extended addressability (EA)
What Makes Up DFSMS*?

- **DFSMSdfp** (Data Facility Product), the biggest and only non-optional component on this list, provides the data, storage, program, and device management. It includes the following subcomponents: Extended Remote Copy (XRC), Peer-to-Peer Remote Copy (PPRC), Network File System (NFS), FlashCopy, SnapShot, and Concurrent Copy.

- **DFSMSdss** (Data Set Services) is the high-speed data mover used, among other things, to copy data from disk to disk or disk to tape.

- **DFSMShsm** (Hierarchical Storage Manager) quickly and automatically assists in moving data to less costly devices.

- **DFSMSrmm** (Removable Media Manager) helps deal with removable media.

- **DFSMSstvs** (Transactional VSAM Services) covers data integrity for shared VSAM by batch and CICS.

* Data Facility Storage Management System
References

• **DB2 10 for z/OS Migration**
  • IBM Migration Planning Workshop
  • Paul Bartak, Senior Certified Executive IT Specialist, DB2 Advisor

• **The DB2 Catalog Gets a Makeover**
  • December 2010 / January 2011 issue of z/Journal Magazine

• **My DB2 for z/OS Blog**
  • [http://it.toolbox.com/blogs/db2zos/](http://it.toolbox.com/blogs/db2zos/)
Willie Favero
Senior Certified Consulting IT Software Specialist
Dynamic Warehousing on System z Swat Team
IBM Silicon Valley Laboratory
IBM Academic Initiative Ambassador for System z
IBM Certified Database Administrator - DB2 Universal Database V8.1 for z/OS
IBM Certified Database Administrator – DB2 9 for z/OS
IBM Certified System Administrator – DB2 9 for z/OS
IBM Certified Database Administrator – DB2 10 for z/OS
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