# The DB2 for z/OS Catalog Gets a Makeover

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Monday, March 8, 2011: 3:00 PM-4:00 PM
Session 9539

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# Why?

# 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

| DB2 Version | Table Spaces | Tables | Added |
|:---:|:---:|:---:|:---:|
| V1 | 11 | 25 | |
| V3 | 11 | 43 | 5 |
| V4 | 11 | 46 | 3 |
| V5 | 12 | 54 | 8 |
| V6 | 15 | 65 | 9 |
| V7 | 20 | 84 | 19 |
| V8 | 21 | 87 | 2 |
| V9 | 32 | 108 | 19 |
| V10 | 90 | 137 | 29 |

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# 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 / <u>SYSPLUXB</u>*          *LOBs for Routines from SYSOBJ*

**SYSDBASE**

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

2 additional LOB spaces

**SYSDBAUT**
SYSTSDBA
SYSTSDBU

**SYSOBJ**
SYSTSCON   SYSTSTBC
SYSTSAUX   SYSTSDEP   SYSTSPRM   SYSTSTRG
SYSTSDAT   SYSTSKYC   SYSTSRAU   SYSTSENV
SYSTSROU   SYSTSSCM   3 additional LOB spaces
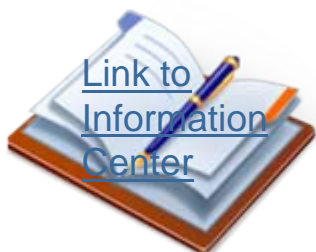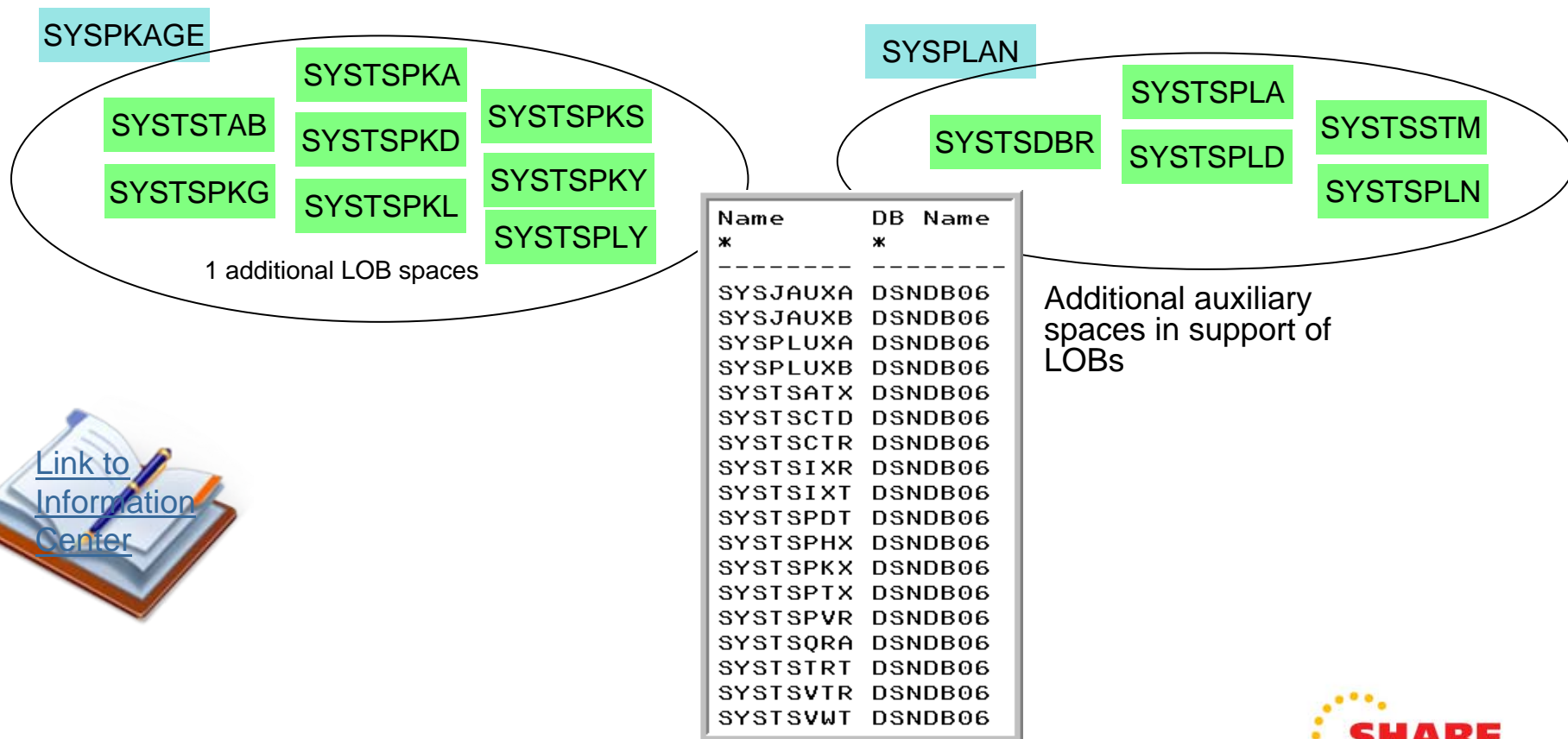
**SYSGROUP**
SYSTSSTG
SYSTSVOL

**SYSVIEWS**
SYSTSVWD
SYSTSVEW
2 additional LOB spaces

Underlined items occur in a V9 to V10 migration

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# DB2 10 Catalog...

- ## Converting to ENFMx
  - ### V10EN8 / V10EN9

SYSPKAGE

SYSTSPKA

SYSTSTAB   SYSTSPKD   SYSTSPKS

SYSTSPKG   SYSTSPKL   SYSTSPKY

SYSTSPLY

1 additional LOB spaces

SYSPLAN

SYSTSPLA

SYSTSDBR   SYSTSPLD   SYSTSSTM

SYSTSPLN

```
Name        DB  Name
*           *
--------    --------
SYSJAUXA    DSNDB06
SYSJAUXB    DSNDB06
SYSPLUXA    DSNDB06
SYSPLUXB    DSNDB06
SYSTSATX    DSNDB06
SYSTSCTD    DSNDB06
SYSTSCTR    DSNDB06
SYSTSIXR    DSNDB06
SYSTSIXT    DSNDB06
SYSTSPDT    DSNDB06
SYSTSPHX    DSNDB06
SYSTSPKX    DSNDB06
SYSTSPTX    DSNDB06
SYSTSPVR    DSNDB06
SYSTSQRA    DSNDB06
SYSTSTRT    DSNDB06
SYSTSVTR    DSNDB06
SYSTSVWT    DSNDB06
```

Additional auxiliary spaces in support of LOBs

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# DB2 10 Catalog...

- Compare / Contrast

| DB2_VERSION_MODE | TS Count | Column Count |
|---|---|---|
| V8NFM | 22 | 1281 |
| V10C8 | 30 | 1705 |
| V10EN | 95 | 2046 |
| V10NF | 95 | 2046 |

| DB2_VERSION_MODE | TS Count | Column Count |
|---|---|---|
| V9NFM | 28 | 2003 |
| V10C9 | 30 | 2057 |
| V10EN | 95 | 2387 |
| V10NF | 95 | 2387 |

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

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

| | Table Space Count | Column Count |
|---|---|---|
| V8 NFM | 22 | 1281 |
| + | 8 | 424 |
| - | 0 | 0 |
| V10 CM8 | 30 | 1705 |
| + | 72 | 349 |
| - | 7 | 8 |
| V10 ENFM8 | 95 | 2046 |
| + | 0 | 0 |
| - | 0 | 0 |
| V10 NFM | 95 | 2046 |
| | | |
| Overall Delta | 73 | 765 |

| | Table Space Count | Column Count |
|---|---|---|
| V9 NFM | 28 | 2003 |
| + | 2 | 54 |
| - | 0 | 0 |
| V10 CM9 | 30 | 2057 |
| + | 72 | 338 |
| - | 7 | 9 |
| V10 ENFM9 | 95 | 2387 |
| + | 0 | 0 |
| - | 0 | 0 |
| V10 NFM | 95 | 2387 |
| | | |
| Overall Delta | 67 | 384 |

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# 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*
      - *SYSRTSTS   Real Time Statistics*
      - *SYSTARG    Extended Index Definitions*
      - <u>*SYSTSASC   ASCII SYSDUMMYA*</u>
      - <u>*SYSTSUNI    Unicode SYSDUMMYU*</u>
      - *SYSXML       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*
    - SYSINDEXES / 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)*
- SYSCOLDIST / HIST
  - *Histograms (V9)*
- SYSJAVAPATHS
- SYSDATATYPES
  - *Inline LOBs*
- SYSDEPENDENCIES
- SYSENVIRONMENT
- SYSROUTINES
  - *NSPs (V9)*
  - *Inline routines*
  - *SECURE*
- SYSROUTINESTEXT

- SYSTRIGGERS
  - *SQL PL*
  - *SECURE*
- SYSPACKAGE
  - *Temporal*
  - *APR*
  - *Plan Management*
  - *Extended Ind.*
  - *Concurrent Access*
  - *LASTUSED*
- SYSPLAN
  - *Concurrent Access*
- SYSPACKSTMT
  - *Statement ID*
  - *Text*
- RTS
- SYSDUMMYE
- SYSDUMMYA
- SYSDUMMYU
- SYSUSERAUTH
  - *New Authorities*
- SYSXMLRELS
- SYSXMLSTRINGS

Summary of catalog changes
Underlined items occur in a V9 to V10 migration

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# DB2 10 Catalog...

- Converting to ENFM*x*
  - 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 & SYSDUMMYE*
    - SYSSEQ
      - *Has MAXROWS set to 1*
  - 68 are RRF
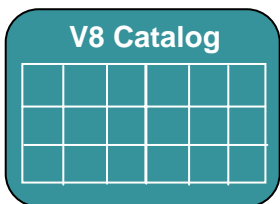  - 18 LOB Columns
    - 6 use Inline LOBs

```
TABLENAME          COLNAME            INLINE_LENGTH
---------+---------+---------+---------+--------
SYSPACKSTMT        STATEMENT                  15360
SYSPACKSTMT        STMTBLOB                    7168
SYSCONTROLS        RULETEXT                   16000
SYSCONTROLS        DESCRIPTOR                 12000
SYSQUERY           STMTTEXT                    2048
SYSVIEWS           PARSETREE                  27670
```
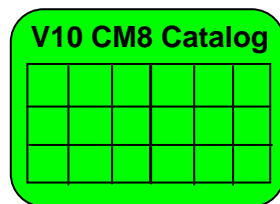
# A Little More on that Migration Stuff…

# DB2 10 for z/OS Migration Modes from V8

| DB2 for z/OS V8 NFM | → DSNTIJTC → | DB2 10 CM8 | → DSNTIJEN → | DB2 10 ENFM8 | → DSNTIJNF → | DB2 10 for z/OS NFM |
|---|---|---|---|---|---|---|

DSNTIJEN (ENFM8 ↕ CM8*)
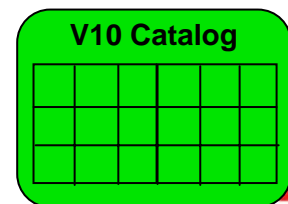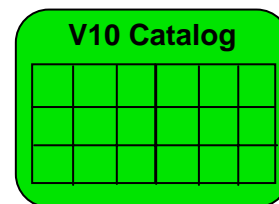
DSNTIJCS

DSNTIJNF (NFM ↕ ENFM8*)
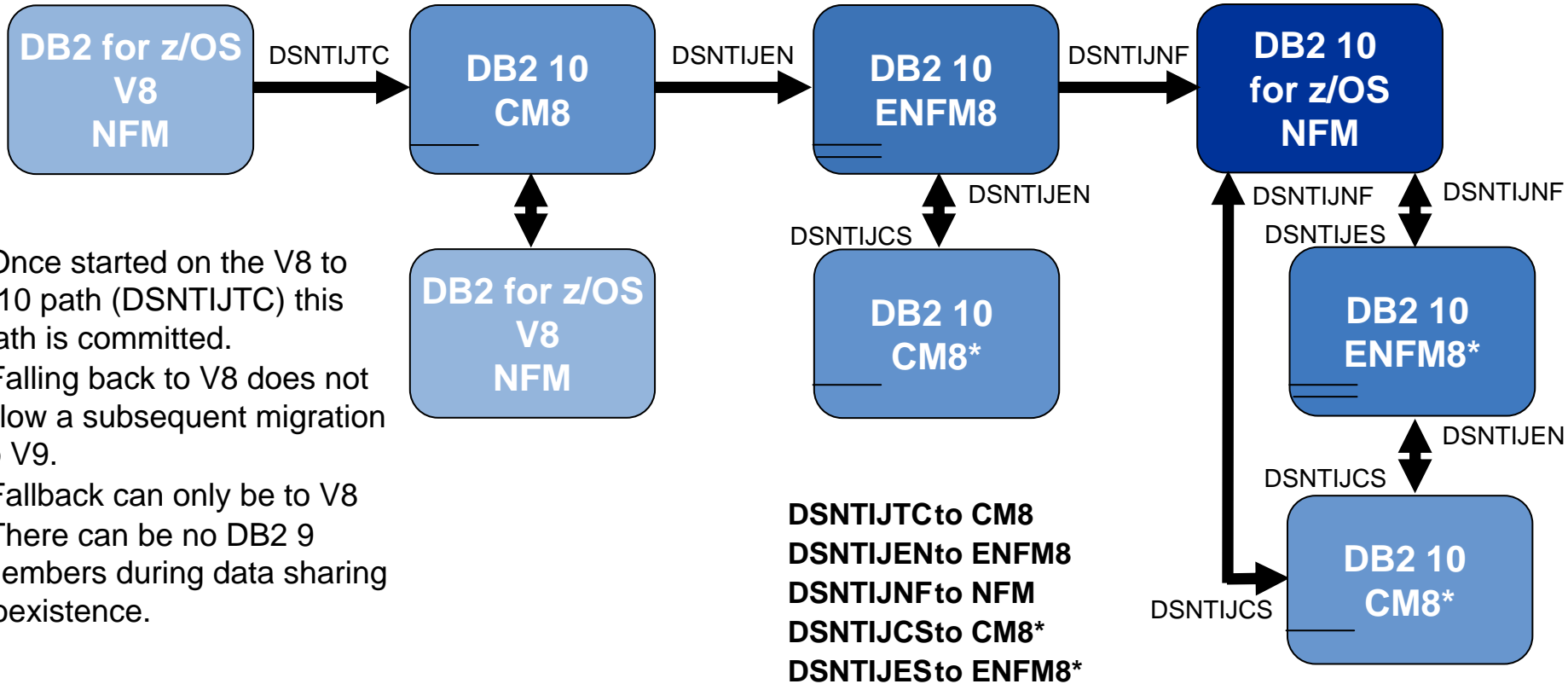
DSNTIJES

DSNTIJNF

- 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
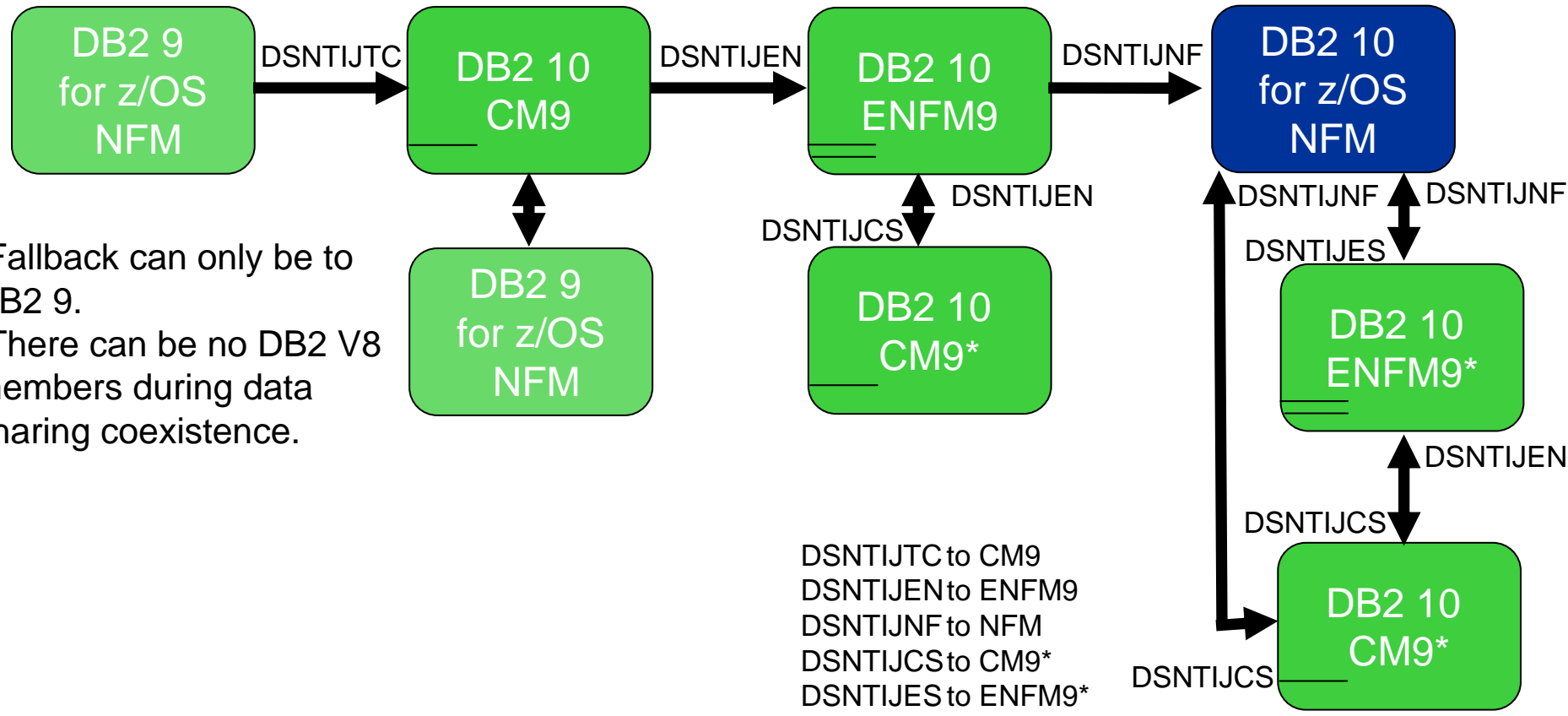- There can be no DB2 9 members during data sharing coexistence.

**DB2 for z/OS V8 NFM**

**DB2 10 CM8***

**DB2 10 ENFM8***

**DB2 10 CM8***

DSNTIJEN

DSNTIJCS

DSNTIJCS

**DSNTIJTC to CM8**
**DSNTIJEN to ENFM8**
**DSNTIJNF to NFM**
**DSNTIJCS to CM8***
**DSNTIJES to ENFM8***

| V8 Catalog | V10 CM8 Catalog | V10 Catalog | V10 Catalog |
|---|---|---|---|

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# DB2 10 for z/OS Migration Modes from V9



DB2 9 for z/OS NFM → DSNTIJTC → DB2 10 CM9 → DSNTIJEN → DB2 10 ENFM9 → DSNTIJNF → DB2 10 for z/OS NFM

DB2 10 CM9 ↕ DB2 9 for z/OS NFM

DB2 10 ENFM9 ↕ DSNTIJEN / DSNTIJCS → DB2 10 CM9*

DB2 10 for z/OS NFM ↕ DSNTIJNF / DSNTIJES → DB2 10 ENFM9* ↕ DSNTIJEN / DSNTIJCS → DB2 10 CM9* → DSNTIJCS

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

DSNTIJTC to CM9
DSNTIJEN to ENFM9
DSNTIJNF to NFM
DSNTIJCS to CM9*
DSNTIJES to ENFM9*

**V9 Catalog**

**V10 CM9 Catalog**

**V10 Catalog**

**V10 Catalog**

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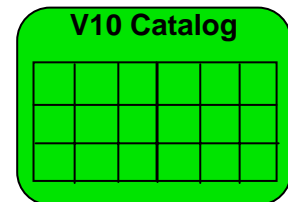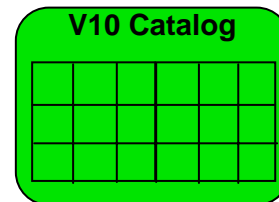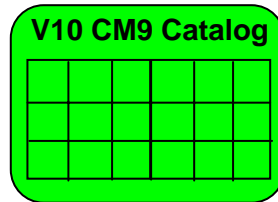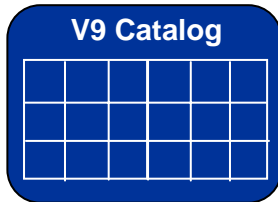
# DB2 10 Modes

- ## 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.db2
      z10.doc.inst/db2z_modifydsntijic.htm

| V8 to V10 CM8 New Table Spaces |
| --- |
| 8 |
| TSNAME |
| SYSCONTX |
| SYSPLUXA |
| SYSROLES |
| SYSRTSTS |
| SYSTARG |
| SYSTSASC |
| SYSTSUNI |
| SYSXML |

E
Results

| V9 to V10 CM8 New Table Spaces |
| --- |
| 2 |
| TSNAME |
| SYSTSASC |
| SYSTSUNI |

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# 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

- ## ENFM*x* Considerations
  - This is running the same code as CM*x*
  - Catalog conversion takes place
  - All members of a data sharing group must be at the CM*x* level before converting to ENFM*x*
  - Can revert to CM*x* from ENFMx
  - Beyond CM*x*, Backup and Recover objects V10 specified order
- ## NFM Considerations
  - Can revert to ENFM*x*\* or CM*x*\*
    - 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
    - CATXDACL, 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.

- **DFSMStvs** (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
    - http://www.mainframezone.com/it-management/the-db2-catalog-gets-a-makeover


- **My DB2 for z/OS Blog**
  - http://it.toolbox.com/blogs/db2zos/

धन्यवाद
Hindi

多謝
Traditional Chinese

ขอบคุณ
Thai

Спасибо
Russian

Gracias
Spanish

*Thank You*
English

شكراً
Arabic

**Merci**
French

Obrigado
Brazilian Portuguese

Bedankt
Nederlands

多谢
Simplified Chinese

Danke
German

நன்றி
Tamil

ありがとうございました
Japanese

감사합니다

SHARE
in Orlando
2011

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