
# Universal Table Spaces – Matching the Right Type to Our Data

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# Agenda – Universal Table Spaces

- When do you choose UTS – Range-partitioned vs. UTS Partition by growth?
- Discuss the advantages and disadvantages of each
- What SQL advantages will there be in using UTS's?
- How to convert to each type?
- How to choose which type to convert to?
- Does using a UTS Partition by growth with a key like ADD-TS to push all new rows to the end hurt when you read?
- Partition-By-Range - Relative Page Numbering (PBR RPN) in Db2 12


# Table Space – Which One?

- What type of Tables and table space?
- Segmented
- Classic partitioned
- UTS PBR (Partitioned By Range)
- UTS PBG (Partitioned By Growth)
- UTS HASH
- XML
- LOB


# Well, What Type of Index?

- What type of index?
- NPSI
- DPSI
- PI
- Unique
- Index on expression


# Questions?

- How large should the objects be?
  - Should the objects be partitioned?
  - Should the objects be compressed?
- What should the relationship between table space and index attributes be?
- What page size for the table?
- How many indexes if any?


# Universal Table Spaces

- Table space that is both segmented and partitioned
  - Bit Maps from Segmented and Partition data
- Two types of universal table spaces are available:
  - The partition-by-growth table space
  - The range-partitioned table space


# Universal Table Spaces

- Combination of segmented with partitioning options (hybrid approach)
  - Better space management
  - Support of mass deletes / TRUNCATE
  - One table per table space
- Two options: –
- Range-partitioned (PBR)
  - All the features of classic partitioning •Table controlled partitioning only (no Partitioning Indexes (PI) •Using partition column(s)
- Partition-by-growth (PBG)
  - •Partitions added as space is needed •No partitioning key •Partitioned and segmented •DROP / CREATE to migrate existing page sets
    ALTER allowed under some circumstances starting in DB2 V10

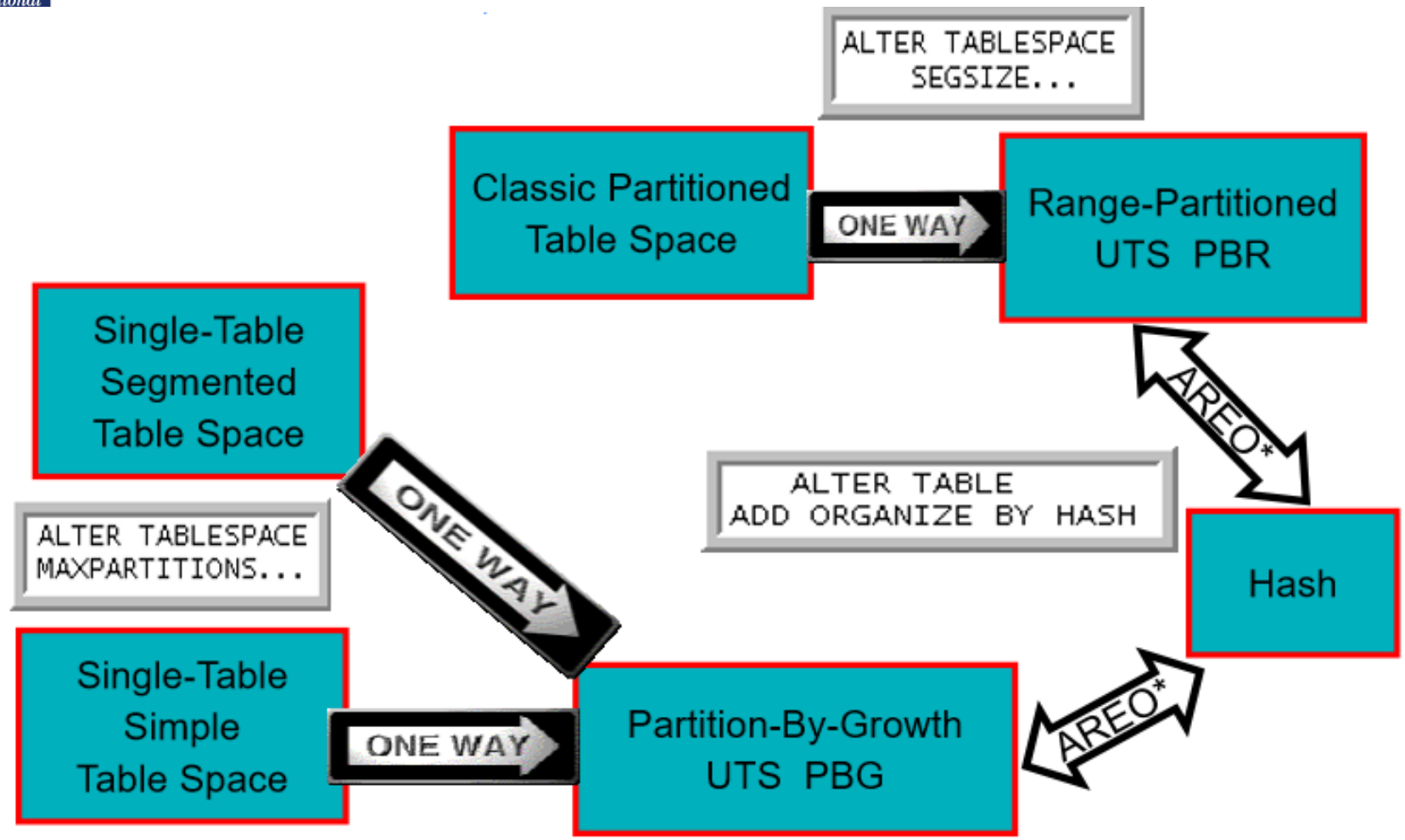
 


# Universal Table Space

- The key functions of segmented and partitioned table spaces have been combined in the new universal table space (UTS)
- Reordered Row Format
  - Think about this for a moment (not BRF)
  - DSN1COPY problems we get into
- UTS can be defined with two options:
  - The option to partition by growth (PBG) allows segmented tables to be partitioned as they grow, without needing key ranges, this became the default in DB2 10
  - The option partition by range (PBR) defines the UTS

# ALTER Table Space



# Catalog Table Information

- SYSIBM.SYSTABLESPACE
- TYPE column
  - G = Partitioned by Growth Universal Table Space
  - O = Table space is a LOB
  - P = Implicit table space created for pureXML columns
  - R = Range Partitioned Universal Table Space
- MAXPARTITIONS
  - Maximum number of partitions
    - Zero if NOT partition by growth
- PARTITIONS
  - The Number of physical partitions (dataset) that currently exist

# Universal Table Space Options

- *Partition By Growth – PBG*
  - DSSIZE = Partition Size
  - CREATE TABLESPACE … (explicit specification)
  - MAXPARTITIONS integer
    - maximum number of partitions in the PBG table space
  - CREATE TABLE … (implicit specification)
    PARTITIONED BY SIZE EVERY integer G
- *Partition By Range - PBR*
  - CREATE TABLESPACE … SEGSIZE integer NUMPARTS integer
    - SEGSIZE


# Universal Table Spaces

- NUMPARTS and SEGSIZE are specified, the table space that is created is a *partition-by-range (UTS) table space*
- If MAXPARTITIONS or MAXPARTITIONS and SEGSIZE are specified, the table space that is created is a *partition-by-growth universal table space*


# Partition by Growth

- UTS
  - Partitioned-by-growth UTS have better space management and improved delete performance than traditional partitioned table spaces due to their segmented space organization
  - Managed by DB2 depending on the DSSIZE and MAXPARTITIONS chosen
  - Space must be STOGROUP defined, and only non-partitioning indexes (NPIs) are allowed to be defined on PBG UTS

# CREATE TABLESPACE statement for PBG

CREATE TABLESPACE TS1 IN DB1

MAXPARTITIONS 55

*SEGSIZE 64*

*DSSIZE 8G*

LOCKSIZE ANY;

- MAXPARTITIONS –
  - Specifies the maximum # of partition for a table space
  - MAXPARTITIONS can be changed by ALTER TABLESPACE
  - Keep in mind that ALTER MAXPARTITIONS may require down time because it needs to physically close the datasets


# Table Size Limits

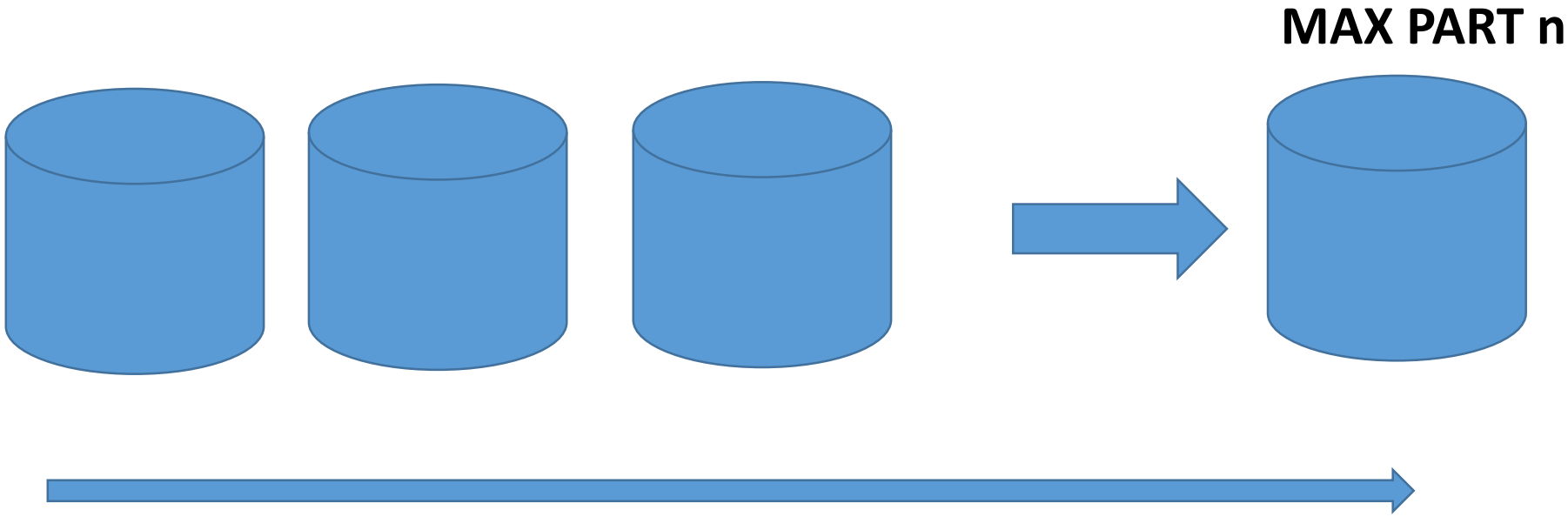
- DB2 11, a single table is limited to 16TB
- RID changes in DB2 12 have allowed IBM to increase this limit to 4PB
- Customers at or approaching the current size limit,
  - Enhancement can avoid the need to implement costly and intrusive solutions such as splitting large tables into multiple smaller ones

- How large should the objects be?
  - What type of Table Space should I choose?

# Partition By Growth

- The Table Space starts with one partition
- Additional  partitions will be added on demand until the maximum partition is reached



# ALTER TABLESPACE

- The following ALTER TABLESPACE options can cause pending changes to the definition of the table space under certain conditions:
- BUFFERPOOL
- DSSIZE
- MAXPARTITIONS
- MEMBER CLUSTER
- SEGSIZE

# Reducing the Size of PBG

PROBLEM DESCRIPTION:

- Users experience storage management issues due to partition-by-growth (PBG) table spaces defined with large

*MAXPARTITIONS value*

- Users may experience difficulty with storage management because internal control blocks were taking up storage for PBG table spaces defined with large MAXPARTITIONS value
- Plans bound with the ACQUIRE ALLOCATE option that refer to the table space will be invalidated when the MAXPARTITIONS value is altered – see APAR PM57001
- You can increase the value of MAXPARTITIONS keyword with the ALTER SQL statement but you **CANNOT** reduce the value of the MAXPARTITIONS keyword
- The warning will be that if you pick very high values for MAXPARTITIONS, something like 4096, you cannot change it without a drop/create table space

# Partition By Growth

- DB2 12 will now allow ALTER TABLESPACE MAXPARTITIONS to a smaller value
  - Previously, SQLCODE -644 was issued to restrict this case altogether
- Now DB2 allows the ALTER, but will still issue SQLCODE -644 if the MAXPARTITIONS value is altered to a number lower than the physical partitions allocated
- Dependent plans defined with the ACQUIRE ALLOCATE option will be invalidated on ALTER TABLESPACE MAXPARTITIONS
- DB2 allocates the storage necessary per thread for the partition-by-growth table space based on the value set in MAXPARTITIONS.
  - Using a value of 4096 caused a good chunk of storage to get initially allocated for each thread

# Partition by Range

- UTS have better space management and improved delete performance due to their segmented space organization
- PBR RPN –Db2 12
  - This new type of table space is called Partition-By-Range - Relative Page Numbering
  - **PBR RPN** table spaces can have a maximum partition size of 1 TB
  - New 7 byte RIDs
- New system parameter called PAGESET_PAGENUM is also introduced by this enhancement.
  - It controls whether page numbering of newly created PBR table spaces is relative or absolute by default


# Terms

- Data Partitioned Secondary Indexes
  - DPSI's
- Non-Partitioned Secondary Indexes
  - NPSI's


# Terminology

- Partitioned Table Space
  - Any TS with multiple physical partitions
- Partitioned Index
  - Any index that has multiple physical partitions
- Partitioning Index
  - Left most columns match the partitioning key of the TS
  - The index might, might not be partitioned


# Breaking Up Is Hard to Do

- Partitioned TS
  - Separating the clustering from the partitioning
  - Need not be clustered by the partitioning limit key
  - We have Table partitioning vs. Index Partitioning
  - We will look at both


# Table Spaces

- Maximum number of partitions raised in V11
  - From 254 to 4096
  - Table space must have LARGE or DSSIZE to go beyond 254 parts
  - Max table size determined based on page size, DSSIZE and number of parts


# DSSIZE

- Value in gigabytes that indicates the maximum size for each partition
  - If you specify DSSIZE you must also specify NUMPARTS or LOB
- IF DSSIZE or LARGE is omitted then
  - MAX SIZE depends on value of NUMPARTS


# DSSIZE

- DSSIZE
  - Recommended using over LARGE parameter
  - Controls whether ‘LARGE’ or ‘NOT LARGE’
  - Specify the maximum size for each partition, LOB or data set
  - If you use, you must specify
    - NUMPARTS or LOB
  - Specify value > 4GB, TS must be EA-enabled


# LARGE - V11

- LARGE
  - Use DSSIZE instead
  - Only for partitioned table spaces
  - When specified more than 64GB of data can be stored in a table space
- RIDs are 5 bytes instead of 4 bytes in TS Increases space of Index as well
- Can have a TS of
  - 128 Terabytes with a page size of 32K

# Db2 12 DSSIZE and NUMPARTS

| DSSIZE value | 4K page size | 8K page size | 16K page size | 32K page size |
|---|---|---|---|---|
| **1G - 4G (1 GB to 4 GB)** | 4096 | 4096 | 4096 | 4096 |
| **8G (8 GB)** | 2048 | 4096 | 4096 | 4096 |
| **16G (16 GB)** | 1024 | 2048 | 4096 | 4096 |
| **32G (32 GB)** | 512 | 1024 | 2048 | 4096 |
| **64G (64 GB)** | 254 | 512 | 1024 | 2048 |
| **128G (128 GB)** | 128 | 256 | 512 | 1024 |
| **256G (256 GB)** | 64 | 128 | 256 | 512 |

| Value of NUMPARTS | Maximum partition size (default for DSSIZE) |
|---|---|
| 1 to 16 | 4GB (4G) |
| 17 to 32 | 2GB (2G) |
| 33 to 64 | 1GB (1G) |
| 65 to 254 | 4GB (4G) |


# Db2 12 - Maximum number of partitions table space with absolute numbering

| Type of RID | Page size | DSSIZE | Maximum number of partitions | Total table space size |
|---|---|---|---|---|
| 5-byte EA | 4KB | 1GB | 4096 | 4TB |
| 5-byte EA | 4KB | 2GB | 4096 | 8TB |
| 5-byte EA | 4KB | 4GB | 4096 | 16TB |
| 5-byte EA | 4KB | 8GB | 2048 | 16TB |
| 5-byte EA | 4KB | 16GB | 1024 | 16TB |
| 5-byte EA | 4KB | 32GB | 512 | 16TB |
| 5-byte EA | 4KB | 64GB | 256 | 16TB |
| 5-byte EA | 4KB | 128GB | 128 | 16TB |
| 5-byte EA | 4KB | 256GB | 64 | 16TB |
| 5-byte EA | 8KB | 1GB | 4096 | 4TB |
| 5-byte EA | 8KB | 2GB | 4096 | 8TB |
| 5-byte EA | 8KB | 4GB | 4096 | 16TB |
| 5-byte EA | 8KB | 8GB | 4096 | 32TB |
| 5-byte EA | 8KB | 16GB | 2048 | 32TB |
| 5-byte EA | 8KB | 32GB | 1024 | 32TB |

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Continued……..

# Db2 12 - Maximum number of partitions table space with absolute numbering …

| | | | | |
|---|---|---|---|---|
| 5-byte EA | 8KB | 64GB | 512 | 32TB |
| 5-byte EA | 8KB | 128GB | 256 | 32TB |
| 5-byte EA | 8KB | 256GB | 128 | 32TB |
| 5-byte EA | 16KB | 1GB | 4096 | 4TB |
| 5-byte EA | 16KB | 2GB | 4096 | 8TB |
| 5-byte EA | 16KB | 4GB | 4096 | 16TB |
| 5-byte EA | 16KB | 8GB | 4096 | 32TB |
| 5-byte EA | 16KB | 16GB | 4096 | 64TB |
| 5-byte EA | 16KB | 32GB | 2048 | 64TB |
| 5-byte EA | 16KB | 64GB | 1024 | 64TB |
| 5-byte EA | 16KB | 128GB | 512 | 64TB |
| 5-byte EA | 16KB | 256GB | 256 | 64TB |
| 5-byte EA | 32KB | 1GB | 4096 | 4TB |
| 5-byte EA | 32KB | 2GB | 4096 | 8TB |
| 5-byte EA | 32KB | 4GB | 4096 | 16TB |
| 5-byte EA | 32KB | 8GB | 4096 | 32TB |
| 5-byte EA | 32KB | 16GB | 4096 | 64TB |
| 5-byte EA | 32KB | 32GB | 4096 | 128TB |
| 5-byte EA | 32KB | 64GB | 2048 | 128TB |
| 5-byte EA | 32KB | 128GB | 1024 | 128TB |
| 5-byte EA | 32KB | 256GB | 512 | 128TB |
| 5-byte (non-EA) LARGE | 4KB | (4GB) | 4096 | 16TB |

# Maximum Partition Size V11

| DSSIZE value | 4K page size | 8K page size | 16K page size | 32K page size |
|---|---|---|---|---|
| **1G - 4G (1 GB to 4 GB)** | 4096 | 4096 | 4096 | 4096 |
| **8G (8 GB)** | 2048 | 4096 | 4096 | 4096 |
| **16G (16 GB)** | 1024 | 2048 | 4096 | 4096 |
| **32G (32 GB)** | 512 | 1024 | 2048 | 4096 |
| **64G (64 GB)** | 254 | 512 | 1024 | 2048 |
| **128G (128 GB)** | 128 | 256 | 512 | 1024 |
| **256G (256 GB)** | 64 | 128 | 256 | 512 |

| Value of NUMPARTS | Maximum partition size (default for DSSIZE) |
|---|---|
| 1 to 16 | 4GB (4G) |
| 17 to 32 | 2GB (2G) |
| 33 to 64 | 1GB (1G) |
| 65 to 254 | 4GB (4G) |

NUMPARTS integer must be a value between
1 and 4096 inclusive and
must be less than or equal to the value that is specified
for the MAXPARTITIONS clause.

 

# Maximum partition size depending on page size - V11

| Page size | Maximum partition size (default for DSSIZE) |
|---|---|
| 4K | 4GB (4G) |
| 8K | 8GB (8G) |
| 16K | 16GB (16G) |
| 32K | 32GB (32G) |

 


# Data Set Naming

- VCAT.DSNDBC.DBNAME.TSNAME.I0001.A001 (A001 - A999)
- Dataset naming convention
  - ‘Axxx’ – partitions 1- 999
  - ‘Bxxx’ - partitions 1000 – 1999
  - ‘Cxxx’ - partitions 2000 – 2999
  - ‘Dxxx’ - partitions 3000 – 3999
  - ‘Exxx’ – partitions 4000 – 4096

 

# The Real Size of a Table Space?

- Row Length and Number of Rows
  - For a 4K page size
  - EX: 400 bytes * 2M rows / bytes in page size - 22
  - 197,238.65 pages just to load the data
    - Number of rows + the number of rows(100*PCTFREE)
    - Add the number of free pages
    - Add the Header, Bit Map, System page
  - Now get this into PRIQTY value with growth
- Growth - Need to know
  - Insert/Delete activity, how it grows over time
  - Get this to a PCTFREE value to add back
  - You will also have pages for Header, several Bit Maps, System page, and if you use compression, 16 pages max.

 


# Running Out of Space

- Table space fills, no space available
- Why?
  - Page is Hot
  - Really is Full!
- Secondary Extent is Built for Data
  - These keep being allocated at the same size

 


# How to Make TS Larger?

- PRIQTY
  - ALTER command to increase
  - Use ADM Tool
- Do you have the disk space?
- What about PCTFREE and FREEPAGE?
- Make the change
  - Does not go into effect immediately
  - REORG uses the new parameter

 


# Standards?

- Do you have a defaults,  for
  - PRIQTY or SECQTY
  - Do you estimate growth rates?
    - Your Small, Medium, Large tables?
    - For FREESPACE, PCTFREE?

 


# Extent Sizes

- ZParm's parameter MGEXTSZ
  - For Storage Group Managed TS's
  - Default is NO
  - Enable Sliding Secondary Quantity
- TSQTY / IXQTY
  - Specify default primary allocation for TS / IX

 


# Sliding SECQTY

DSNZPARMS

- TSQTY
  - TSQTY specifies the number of space in KB for the *primary space allocation quantity* for DB2-managed table spaces that are created without the USING clause.
  - A value of 0 (zero) indicates that you want to use standard defaults (now 1 cylinder)
- IXQTY
  - IXQTY fulfils a similar role but for index spaces.

 

# Secondary Sliding Scale

- Sliding Scale
  - A sliding scale means that the first secondary extent allocations are smaller than later secondary allocations
- This feature delivers autonomic selection of data set extent sizes with a goal of preventing extent errors before reaching maximum data set size

 


# Secondary Extents

- OPTIMIZE EXTENT SIZING
  - specifies whether secondary extent allocations for DB2-managed data sets are to be sized according to a sliding scale that optimizes the likelihood of reaching the maximum data set size before secondary extents are exhausted.
  - If you select NO, the default value, you will manage secondary extent allocations manually
  - YES, DB2 will automatically optimize the secondary extent allocations

 

# PBG – When and Limitations

When?

- No obvious partitioning column exists
- Space on Demand
- Table requiring > 64G

Limits?

- No shrinking of partitions
  - Even if there are only empty partitions at the end of the table space
  - These could have header page, space map pages, dictionary page and system pages

 

# PBG

COPY

- Copies made at the part level or the table space level
- Empty partitions will be copied

 

# PBG - DSN1COPY

- Partition number may be inconsistent between
  - DSN1COPY and Target table space

  - Partition number of Target Table Space > Number of Source table space
  - We use TRUNCATE TABLE on the target before DSN1COPY – Now Empty

  - Partition number of Target < partition number of Source table space
  - DSN1COPY cannot be used!
  - UNLOAD/LOAD *can be used*

 


# Well, Are We There Yet?

- When do you choose UTS – Range-partitioned vs. UTS Partition by growth?
- Discuss the advantages and disadvantages of each
- What SQL advantages will there be in using UTS's?
- How to convert to each type?
- How to choose which type to convert to?
- Does using a UTS Partition by growth with a key like ADD-TS to push all new rows to the end hurt when you read?
- Partition-By-Range - Relative Page Numbering (PBR RPN) in Db2 12

 


# Thanks!

Hope you enjoyed the presentation !!!!

- Let me know if you have additional questions
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- Check out our schedule of classes at CBI
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