

# DB2 for z/OS: Utilities Update

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## Agenda

- **Availability**
- **Performance**
- **Features & function**
- **Summary**

## Availability

- **Ensure utilities are non-disruptive**
- **Introduction of shadow page set technology**
- **Introduction of claim & drain processing**
- **Exploitation of ISO(UR) processing**
- **SHRLEVEL NONE**
- **SHRLEVEL REFERENCE**
- **SHRLEVEL CHANGE**

## Availability – what has changed recently?

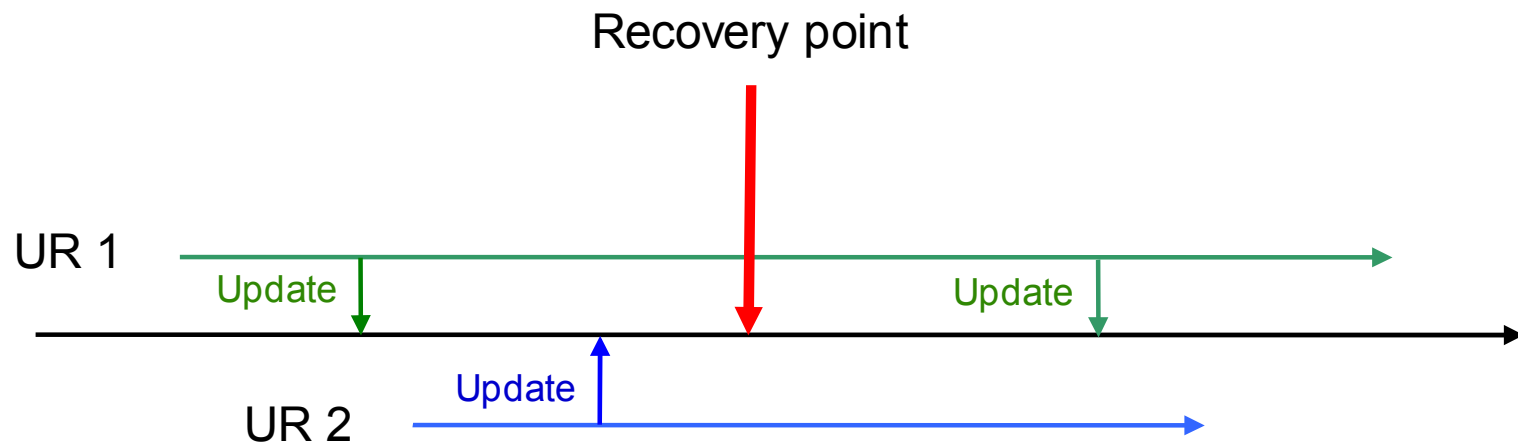
- **Online create or rebuild of non-unique indexes**
  - REBUILD INDEX SHRLEVEL CHANGE
- **Eliminate outage for partition-level REORGs**
  - Eliminate BUILD2 phase
  - New restriction on concurrent part level REORGs
- **REORG avoidance for data compression**
  - (copy dictionary from PART to EMPTY part)
  - LOAD COPYDICTIONARY
  - PK63324 & PK63325 (V9) JUNE '08
- **Online data consistency checking and repair**
  - CHECK DATA SHRLEVEL CHANGE
  - CHECK LOB SHRLEVEL CHANGE
  - REPAIR LOCATE... SHRLEVEL CHANGE

## Availability – what has changed recently?

- **Run data consistency checks without impacting BACKUP SYSTEM or disk mirroring**
  - allows creation of SHADOW COPY outside COPY POOL
  - PK41711 (V9) NOV '08
- **Avoid CHKP after PIT recovery of RI set in V9**
  - PK80304 (V9) MAY '09
    - PIT recovery left TS in RECP

## Availability – what has changed recently?

- **Replace data with virtually no outage**
  - **CLONES** effectively provide LOAD REPLACE SHRLEVEL CHANGE
  - UTS only
- **Read LOB data during REORG**
  - REORG SHRLEVEL **REFERENCE** for LOBs
- **RECOVER to point in time with consistency**
  - **Avoid** need for QUIESCEs



## Performance

- **Elapsed time**
  - DB2 enhancements
  - z/OS & architecture improvements
  - Parallelism (log apply across PARTs)
- **CPU cost**
  - DB2 enhancements
  - z/OS & architecture improvements
  - zIIP enablement

## Performance – what has changed recently?

- **Faster REORGs**
  - Parallel unload of partitions
  - Parallel reload of partitions
  - Parallel log apply
    - ▶ Greater likelihood of REORG keeping up with logging rates
- **Faster CHECK INDEX SHRLEVEL REFERENCE**
  - Parallel index processing
- **Up to 40% faster COPY & RECOVER RESTORE phase to/from tape**
  - Support Large Block Interface for image copies to tape
- **Reduced impact on applications when running COPY**
  - COPY uses MRU for buffers to improve BP hit ratio for online applications (pgs from copy STOLEN b4 app pgs)
- **Reduced impact on applications when running LOAD & REORG**
  - Auto-invalidate of cached dynamic statements on completion of LOAD & REORG
  - PK47083 (V8 & V9) APRIL '08

## Performance – what has changed recently?

- **Greater utility parallelism with SORTNUM elimination (UTSORTAL=YES IGNSORTN=YES)**
  - PK45916 (V8), PK41899 (V9) JULY '08
  - Major improvement in utility sort processing/
  - Simpler, more efficient, more reliant on **RTS**
- **SORTBLD performance improvement**
  - PK60956 (V8 & V9) MARCH '08
  - Up to 20X performance improvement in SORTBLD for indexes with small SECQTY
- **LOAD & REORG performance improvement**
  - PK61759 (V8 & V9) MAY '08
  - 10% CPU & elapsed time improvement in RELOAD phase
  - 10% CPU reduction in SORT phase
- **COPY performance improvement**
  - PK74993 (V9) APRIL '09
  - 20% elapsed time improvement for copy of multiple small datasets to tape

## Performance – what has changed recently?

- **Crossloader performance improvement for CCSID data conversion** (incorrect conversion WIN/Z)
  - PK76860 (V8 & V9) APRIL '09
- **LOAD/UNLOAD LOB file reference variable performance** (incorrect OPEN/CLOSE DS fro each row)
  - PK75216 (V9) JAN '09
  - PDS only, not HFS
  - 56% ET reduction on UNLOAD, 93% ET reduction on LOAD
- **UNLOAD performance for multi-table table spaces**
  - UTILINIT phase – use DBD rather than catalog lookup
  - PK77313 (V8 & V9) JAN '09
  - In one case 1.5 hours -> 11 secs
- **COPY performance with large LISTDEF lists** (redundant check pointing against catalog)
  - PK78865 (V8 & V9) APR '09
  - Reduce writes to SYSUTILX

## Performance – what has changed recently?

- **REORG PART of empty partition performance**
  - Avoid NPI scan
  - PK67154 (V8 & V9) MAR '09
  - Sample SORTBLD phase: 98% CPU reduction, 70% ET reduction
- **COPY of partitioned tablespace with many parts**
  - PK81232 (V9) APR '09
  - Correct CPU regression in V9 - up to 80% CPU reduction
- **COPY SHRLEVEL CHANGE performance improvement for LOBs**
  - PK83096 (V9) JULY '09
- **LOAD and UNLOAD to/from virtual file**
  - USS named pipe support with templates
  - PK70269 (V8 & V9) MAR '09

## Performance – what has changed recently?

- **DSN1COPY performance**

- Improved VSAM buffer allocation for page sets with cylinder allocation
- Up to 20% ET improvement
- PK78516 (V8 & V9) FEB '09

- **RUNSTATS histogram statistics**

- Improved query optimization for non-uniform distribution
- Example - 1, 3, 3, 4, 4, 6, 7, 8, 9, 10, 12, 15 (sequenced), cut into 3 quantiles

Seq No	Low Value	High Value	Cardinality	Frequency
1	1	4	3	5/12
2	6	9	4	4/12
3	10	15	3	3/12

## Performance – what has changed recently?

- **CPU cost reduction in V9**
  - 10-20% for COPY & RECOVER
  - 5-30% for LOAD, REORG, REBUILD INDEX
  - 20-60% for CHECK INDEX
  - 35% for LOAD partition
  - 30-40% for RUNSTATS INDEX
  - 40-50% for REORG INDEX
  - 70% for LOAD REPLACE partition with dummy input
- **zIIP enablement for utility index processing in V8**

## Performance – what has changed recently?

- **In spite of CPU reduction in V9, there is continued focus on CPU consumption for utilities**
- **Sort can consume ~60% of total utility CPU time**
- **DB2 in concert with DFSORT will provide zIIP offload of DB2 utility memory-object fixed-length record sort processing**
- **Requirements:**
  - DB2 APAR PK85889 (V8 or V9) AUG '09
  - DFSORT APAR PK85856 AUG '09
  - z/OS 1.10 required
- **PTFs can be applied independently of each other**
- **Exploitation is automatic**

## Features & function

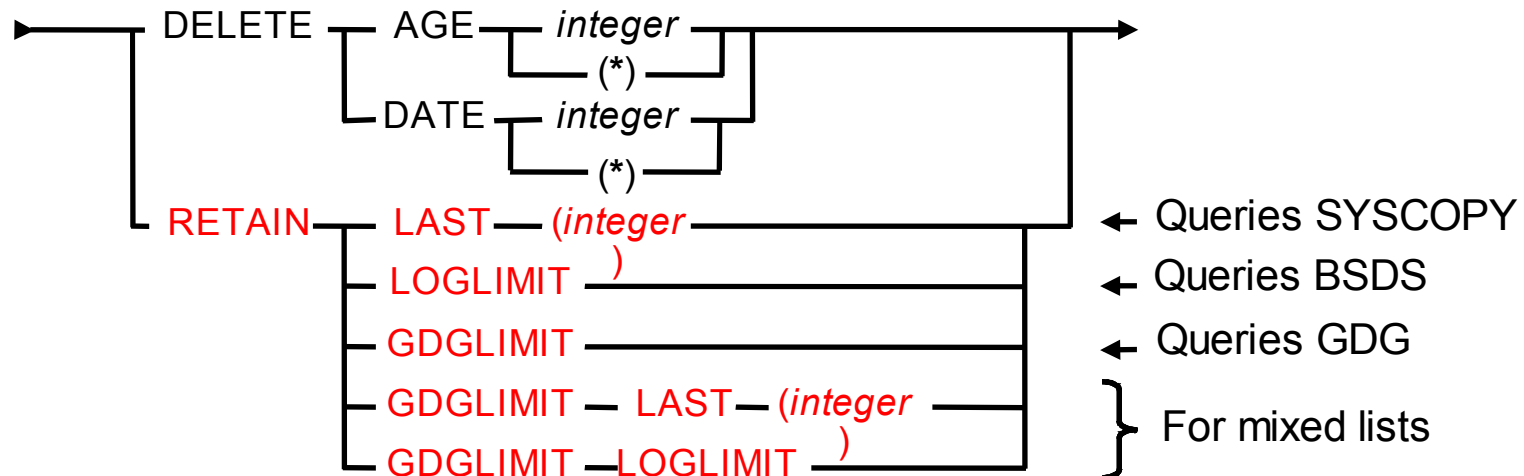
- **More powerful utilities for greater flexibility...**
- **... yet simpler utilities for reduced complexity**
- **New utilities & more options**
  - COPYTOCOPY
  - BACKUP SYSTEM & RESTORE SYSTEM
  - LISTDEF
  - TEMPLATE
  - File Reference Variables
  - ...
- **Intelligent defaults**
- **Autonomics**
- **Synergy with Information Management Tools**

## Features & function – what has changed recently?

- **BACKUP SYSTEM & RESTORE SYSTEM enhancements**
  - Support for tape
  - Support for incremental FlashCopy
- **Object-level recovery from system-level backup**
- **RECOVER to any point in time with consistency**
- **SORTNUM elimination**
  - Simplified utility invocation
- **Remove restriction on REORG of >254 compressed parts**
  - ZPARM restricts LOAD in V9 – restriction removed in X
- **Better information for DPROPR/QRep or other IFI 306 readers**
  - Write diag log record at utility termination so IFCID 306 readers can trigger refresh
  - PK78558 (V9)

## Features & function – what has changed recently?

- **MODIFY RECOVERY simplification & safety**



- **Template switching for COPY utility**

- E.g. copy to disk if small, to tape if large

```

TEMPLATE LRG DSN &DB..&TS..D&DA..T&TI. UNIT=TAPE
TEMPLATE SML DSN &DB..&TS..D&DA..T&TI. UNIT=SYSALLDA LIMIT(20 CYL, LRG)
COPY TABLESPACE SMALL.TS COPYDDN(SML)
COPY TABLESPACE LARGE.TS COPYDDN(SML)
  
```

## Features & function – what has changed recently?

- **Permit use of ALIASes for LOAD, RUNSTATS and UNLOAD**
  - PK77061 (V9) MAR '09
- **New DSNACCOX stored procedure to gather statistics from catalog and make utility recommendations**
  - See PK44133 FEB '08
  - DSNACCOR still supported
- **More information**
  - All utility messages in job output have julian date & timestamp
  - -DISPLAY UTILITY enhanced to show progress of logapply

**DSNU116I csect-name RECOVER LOGAPPLY PHASE DETAILS:**

**STARTING TIME = timestamp**

**START RBA = ss START LRSN = rr**

**END RBA = ee END LRSN = nn**

**LAST COMMITTED RBA = cc LAST COMMITTED LRSN = ll**

**ELAPSED TIME = hh:mm:ss**

## What's coming?

- **Remove usability restrictions for REORG**
  - LOBs
  - PBG
  - Catalog/directory SHRLEVEL CHANGE REORG
  - Rebalance of partitioned page sets with LOB columns
  - Disparate parts
- **REORG avoidance**
- **Remove UTSERIAL lock for greater utility concurrency**
- **RTS enhancements & greater reliance upon RTS**
- **Intelligent & autonomic statistics gathering**
- **BACKUP SYSTEM / RESTORE SYSTEM enhancements**

## What's coming?

- **FlashCopy exploitation**
- **Faster & better COPY processing**
  - Incremental, CHANGELIMIT, FlashCopy
- **LOAD & UNLOAD enhancements**
  - Improved LOB/XML processing
  - Performance options
- **CHECK utility enhancements**
  - XML, availability, data correction,...
- **Faster point in time recovery**
- **... and more**

## Summary

- **Continued delivery of performance improvements & features of real value**
- **Toleration, support & exploitation of new features from day 1**
- **Ensure utilities are non-disruptive**
  - ▶ Eliminate outages
  - ▶ Improve performance
  - ▶ Reduce resource cost
- **Reduce complexity & improve automation**



# DB2 9 – A Rich, Features Filled Release

- SHRLEVEL(REFERENCE) for REORG of LOB table spaces
- Online RENAME COLUMN
- Online RENAME INDEX
- Online CHECK DATA and CHECK LOB
- Online REBUILD INDEX
- Online ALTER COLUMN DEFAULT
- More online REORG by eliminating BUILD2 phase
- Faster REORG by intra-REORG parallelism
- 256K tape block size
- Renaming SCHEMA, VCAT, OWNER, CREATOR
- LOB Locks reduction
- Skipping locked rows option
- Tape support for BACKUP and RESTORE SYSTEM utilities
- Recovery of individual table spaces and indexes from volume-level backups
- Enhanced STOGROUP definition
- Conditional restart enhancements
- Histogram Statistics collection and exploitation
- WS II OmniFind based text search
- DB2 Trace enhancements
- WLM-assisted Buffer Pools management
- . . .
- Global query optimization
- Generalizing sparse index and in-memory data caching method
- Optimization Service Center
- Autonomic reoptimization
- Logging enhancements
- LOBs network flow optimization
- Faster operations for variable-length rows
- NOT LOGGED table spaces
- Index on expressions
- Universal table spaces
- Partition-by-growth table spaces
- APPEND option at insert
- Autonomic index page split
- Different index page sizes
- Support for optimistic locking
- Faster and more automatic DB2 restart
- RLF improvements for remote application servers such as SAP
- Preserving consistency when recovering individual objects to a prior point in time
- CLONE Table: fast replacement of one table with another
- Index compression
- Index key randomization
- . . .
- DECIMAL FLOAT
- BIGINT
- VARBINARY, BINARY
- TRUNCATE TABLE statement
- MERGE statement
- FETCH CONTINUE
- ORDER BY and FETCH FIRST n ROWS in sub-select and full-select
- ORDER OF extension to ORDER BY
- INTERSECT and EXCEPT Set Operations
- Instead of triggers
- Various scalar and built-in functions
- Cultural sort
- LOB File Reference support
- XML support in DB2 engine
- Enhancements to SQL Stored Procedures
- SELECT FROM UPDATE/DELETE/MERGE
- Enhanced CURRENT SCHEMA
- IP V6 support
- Unified Debugger
- Trusted Context
- Database ROLES
- Automatic creation of database objects
- Temporary space consolidation
- 'What-If' Indexes
- . . .

**TCO Reduction**

**Continuous Operations**

**Performance**

**Scalability**

**SQL**

**Portability**

# Agenda

## • Administration

- Partition By Growth
- Reordered Row Format
- Merged workfile/temp space
- Utilities

## • LOBs and XML

- What is pureXML?
- Progressive LOB streaming
- Fetch Continue
- File Reference Variables
- LOB Append

## • Index Management

- Large page sizes
- Compression
- What if?

## ■ SQL

- Native SQL procedures
- Select from Update/Delete/Merge
- Order By and Fetch First
- New data types
- Skipping locked rows
- Append
- Truncate table
- Merge

# Administration



# Universal Table Spaces – Partition By Growth

- **Why use PBG?**
  - PBG is a better answer for partitioning than key range partitioning when the size is unknown or no natural partitioning key exists
    - DB2 automatically adds partitions on demand
  - Support of fast mass deletes
- **To use PBG specify MAXPARTITIONS**
  - If SEGSIZE is not specified, DB2 will use the default SEGSIZE
  - Single table only
- **DROP / CREATE to migrate existing page sets**
- **Simple table spaces can not be created**
  - Default table space is now Segmented (CM) or PBG (NFM)
- **Incompatible with MEMBER CLUSTER, ADD PARTITION, ROTATE PARTITION**

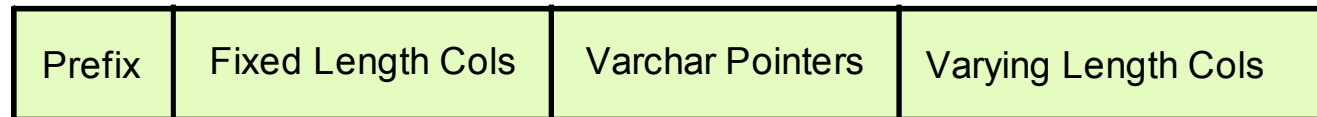
# Partition By Growth – Reorg Considerations

- **MAXPARTITIONS** can be **ALTERed** but observe the limits that are dependent from page size and **DSSIZE**

Page Size DSSIZE	4K	8K	16K	32K
1 – 4 GB	4096	4096	4096	4096
8 GB	2048	4096	4096	4096
16 GB	1024	2048	4096	4096
32 GB	512	1024	2048	4096
64 GB	256	512	1024	2048

- **REORG** can add new partitions (except if there are **LOB** or **XML** columns).
- **REORG** will not remove empty partitions, but it can shrink them to contain a header and space map page, again, subject to absence of **LOB** and **XML** columns
- If a table space contains a **LOB/XML** column, **REORG** cannot move a row from one partition to another

## Reordered Row Format (RRF) ...



- **Potential for significant reduction in CPU resource consumption when accessing many rows with many varying length columns**
  - Implements CPU tuning recommendation to place fixed length columns ahead of varying length columns
  - Provides for direct access to each varying length column
  - In some few cases may lead to increased logging volume
- **On by default in DB2 9 (NFM) and applies to all table space types**
- **Application transparent**
- **REORG and LOAD REPLACE utilities override KEEPDICTIONARY during first time migration when using data compression of variable-length rows**
- **RRF may not compress as well as BRF (Basic Row Format) if the row has many small VARCHARs (e.g. VARCHAR(1))**

## Reordered Row Format (RRF) ...

- **Recommend applying APARs PK78958, PK78959, PK79127, PK87348, PK85881**
- **SPRMRRF opaque online changeable zparm**
  - Default value is `SPRMRRF=ENABLE`
- **CREATE honors SPRMRRF, except XML table spaces are always RRF**
- **Adding a partition honors SPRMRRF except:**
  - For existing table space with Editproc, always use the format of existing partitions

## Reordered Row Format (RRF) ...

- **REORG and LOAD REPLACE**
  - If `SPRMRRF=ENABLE`, converts from BRF to RRF
  - If `SPRMRRF=DISABLE`, does not convert
  - Compression attribute does not affect the choice of format
  - A new utility keyword `ROWFORMAT` (RRF or BRF) may be specified to choose the format
  - Requires NFM, no affect on catalog, directory, LOB, XML, UTS participating in a CLONE relationship

# More Efficient Workfiles Usage

## V8

- 4K-page workfiles are used whenever row is smaller than 4KB
- Since work file access is often sequential, using larger page size can be more efficient
- E.g. for 2050-byte records:  
15 records on one 32K page  
vs.  
8 records on eight 4K pages

## V9

- 32K-page workfiles are used much more aggressively
- 4K-page workfiles are now used only for small records
  - where the limit of 255 rows per page results in waste of space
  - e.g. over 90% wasted space on 32K page for 10-byte records
- Recommendations
  - ✓ Assign a larger 32K workfile buffer pool
  - ✓ Allocate more 32K workfile space
  - ✓ If 4K workfile buffer pool activity is significantly lower, then the corresponding buffer pool size and work file datasets can be reduced.
  - ✓ Monitor new statistics on how often more optimal 32K workfiles ran out and 4K workfiles had to be used instead, or vice versa

## Large tape block sizes

- **Specify TAPEBLKSZLIM=262144 in DEVSUPxx parmlib member**
- **Use system determined block size**
  - Don't specify BLKSIZE parameter
- **Use for image copies and all input/output files used by LOAD and UNLOAD**
- **Up to 170 MB/sec using IBM 3592 tape drives, faster than DASD**

# BACKUP, RESTORE and RECOVER

- **BACKUP DUMP**

- DUMP keyword causes HSM to dump the current backup or previous backup to tape

- **BACKUP FINCREMENTAL**

- Creates a persistent backup, and each subsequent use of that backup incrementally updates it
- Only one persistent backup allowed. Best used with VERSIONS=1 for the SMS Copy Pool
- Since the backup is updated, the backup cannot be use to recover to a point in time prior to the last increment
- To recover to an older point in time, you can restore from a different backup

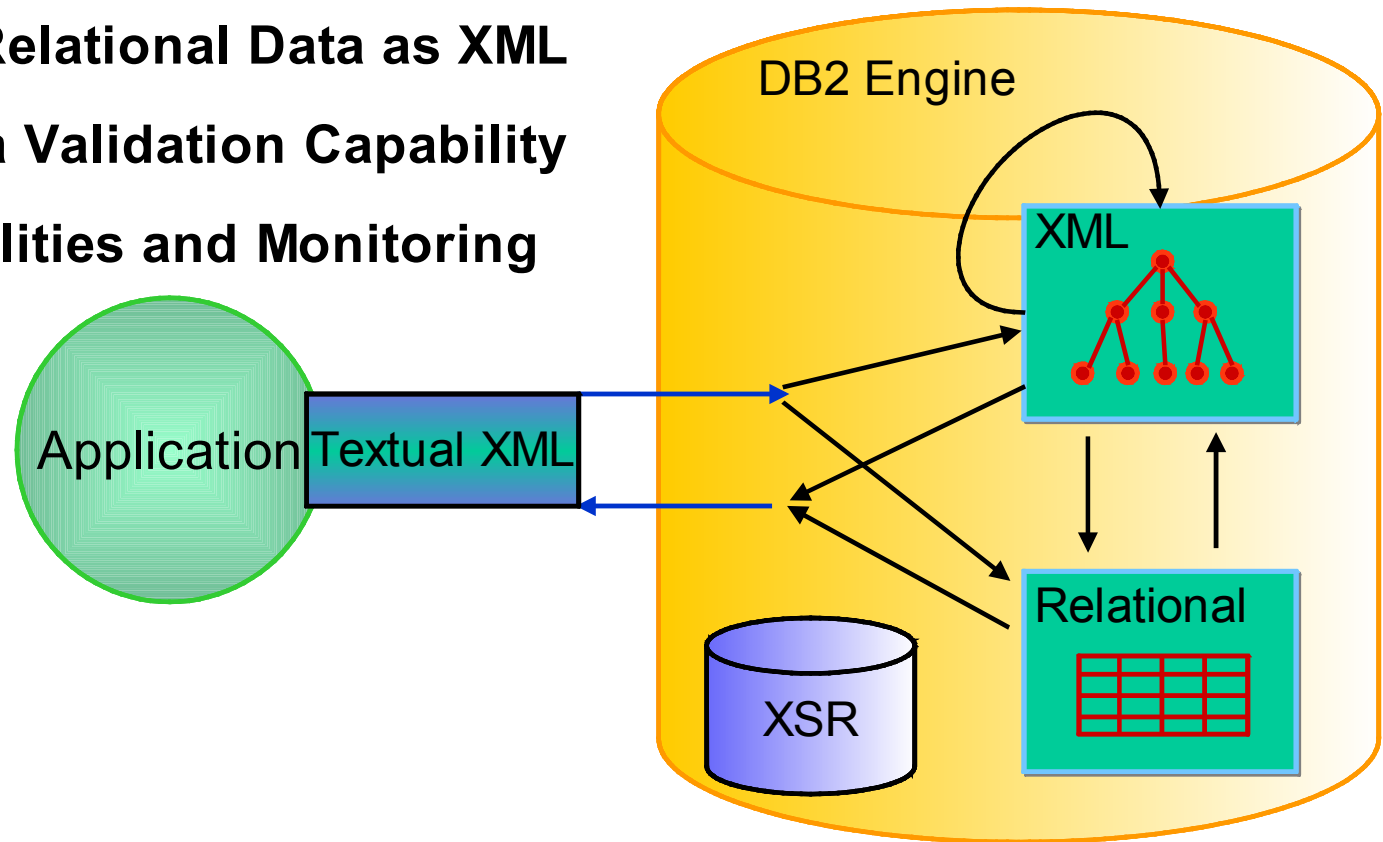
- **RECOVER**

# LOBs and XML



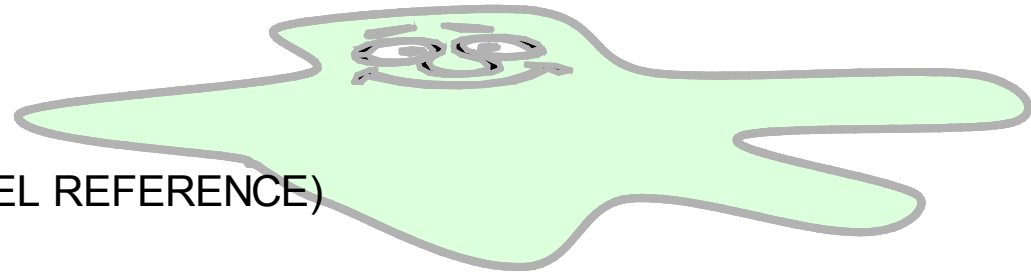
# What is pureXML?

- XML native storage
- Query Capability
- Indexing Inside of XML Documents
- Publishing Relational Data as XML
- XML Schema Validation Capability
- Database Utilities and Monitoring



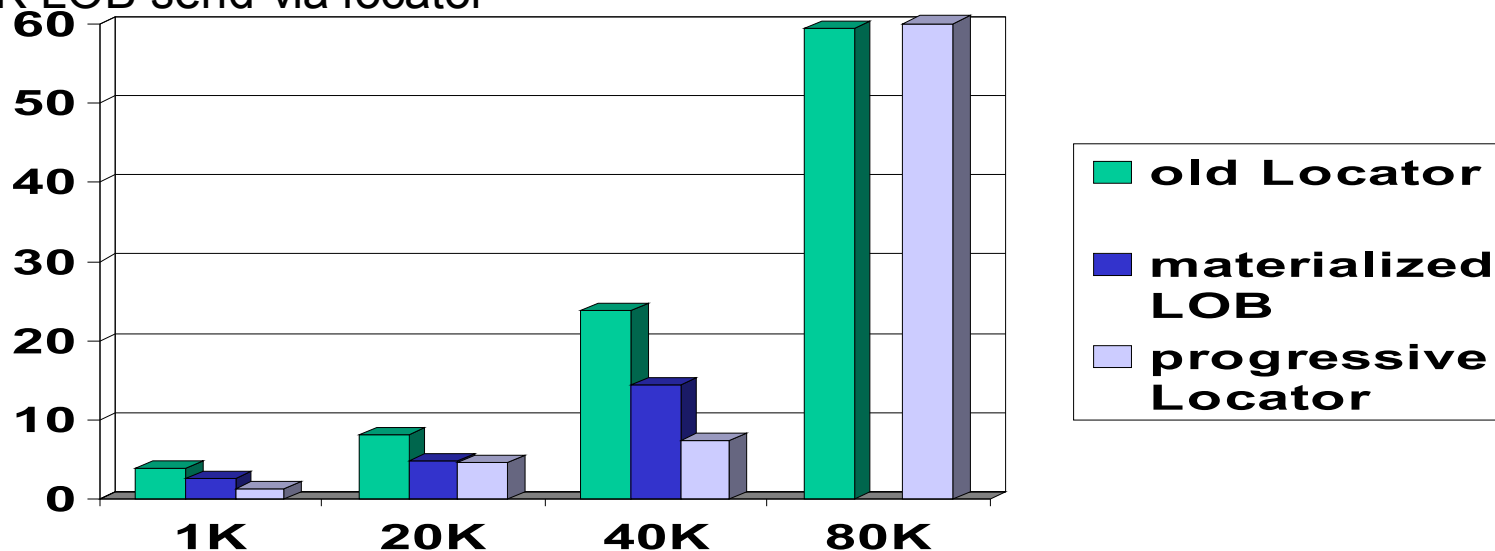
## LOB Improvements: Faster & Easier

- **Progressive Streaming for LOB Locator Values**
  - DB2 uses LOB size to determine whether to send LOB data to Java or DB2 CLI clients in one (<32KB), in chunks (<1MB) or as LOB locator (>=1MB) [Transparent to application using LOB locators]
- **Reduced use of LOB locks**
- **Utility Changes**
  - REORG LOB reclaim space (SHRLEVEL REFERENCE)
  - Logging for > 1GB LOBs
  - Online CHECK LOB and DATA using Flashcopy
  - Better performance of LOB file reference variables
- **Implicit object creation (SET CURRENT RULES = 'STD')**
- **SQL support for LOB file reference variables**
  - SQL supports sequential data sets on DASD or tape
- **FETCH CONTINUE**



# LOB Streaming Performance Results

- Elapsed time to retrieve 1000 CLOB values of varying size  
`streamBufferSize=70000`
- Progressive Locator processing
  - 1K LOB send inlined in query result
  - 20K and 40K LOB send chained to query result
  - 80K LOB send via locator



## New Technique to Retrieve LOBs: FETCH CONTINUE

- **Why use it?**

- A method of reading a large LOB sequentially, without needing to use locators or SUBSTR function
  - No need to free a locator variable
  - DB2 returns the LOB/XML length and indicates if there was truncation
- A fast method of scanning rows when
  - most LOBs can be skipped, or
  - most LOBs are small enough to fit in a host variable, or
  - only the first piece of most LOBs need to be examined.

- **Cannot use with multi-row fetch with FETCH CONTINUE**

- **Use locator variables to randomly position within a LOB**

- **How to use**

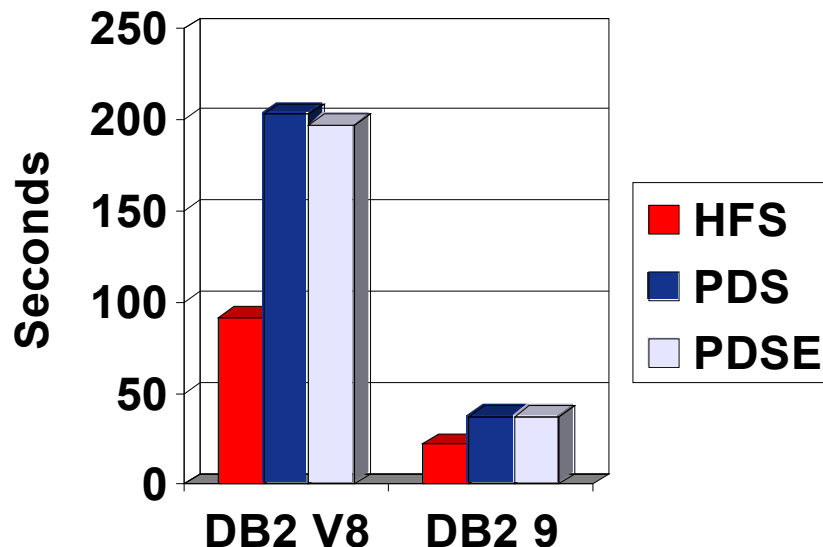
- FETCH WITH CONTINUE to fetch base row information
- FETCH CURRENT CONTINUE if LOB was truncated

## File Reference Variables

- **Unload and Load utilities limited to PDS/PDSE and USS file systems (HFS or zFS)**
- **Recommend USS over PDS or PDSE**
  - USS file systems can be multi-volume
  - USS file systems have no limitation on directory size
    - PDSE limited to 512K members
    - PDS limited to 64K tracks
  - USS file systems are faster for small LOBs than PDS or PDSE

## Unload using File Reference Variables for 20,000 x 200 byte LOBs

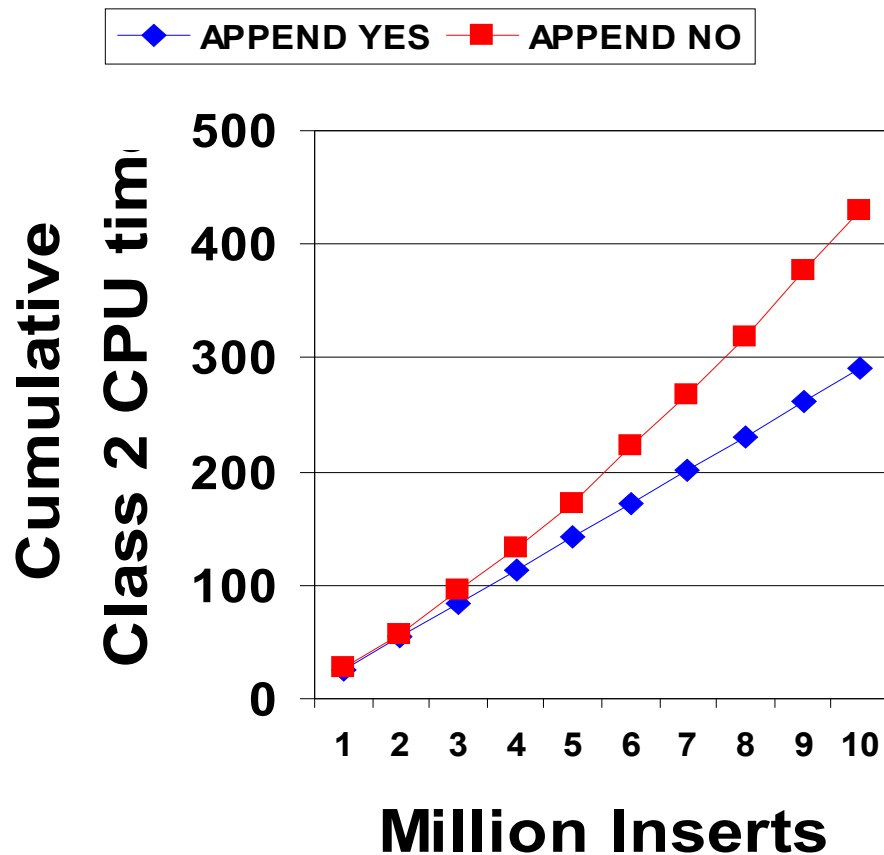
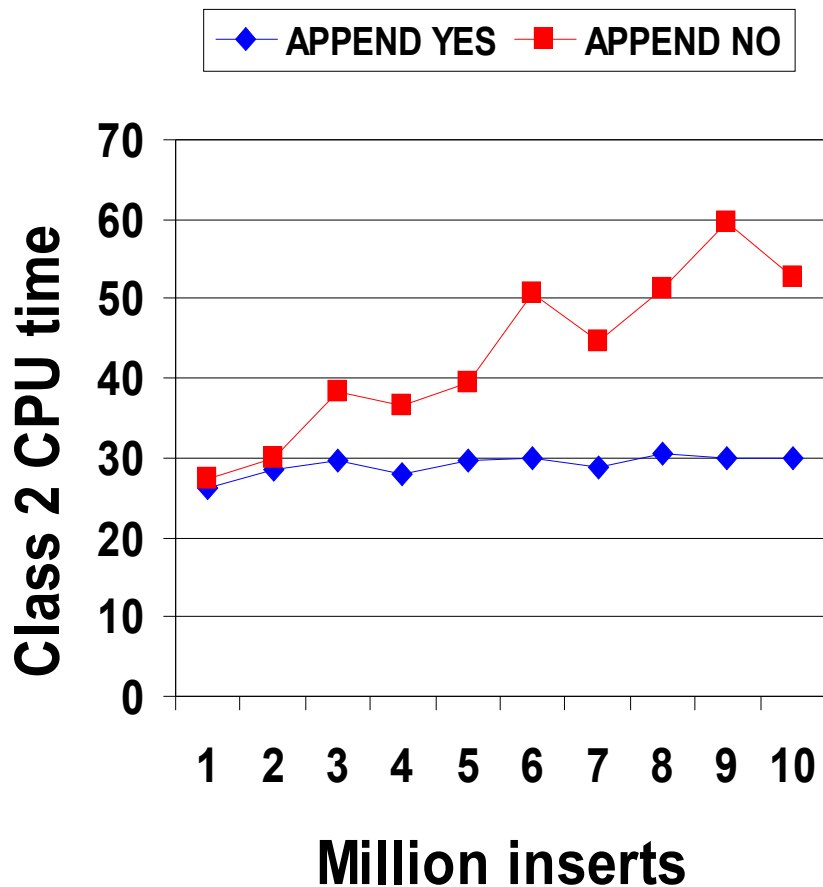
## Elapsed Time



- DB2 9 is 4 times faster than V8
- HFS and zFS are faster than PDS/PDSE (especially for Unload, not so much for Load)

- With PK83992 (V8 and 9), SYSREC is much faster than FRV, but to use SYSREC the row size including LOBs cannot exceed the block size.

# LOB APPEND using small LOBs

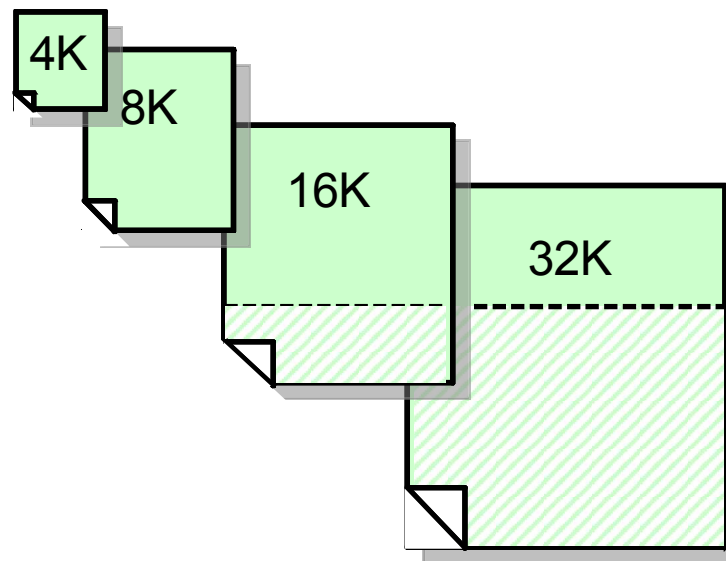


# Index Management



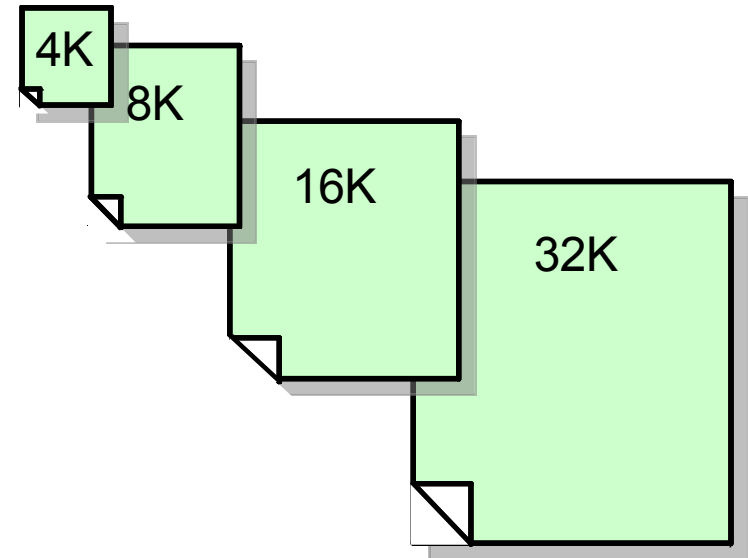
## Indexing enhancements

- **Larger index pages**
- **Index compression provides page-level compression**
  - Data is compressed to 4K pages on disk
  - 32K/16K/8K pages results in up to 8x/4x/2x disk savings
  - No compression dictionaries
    - Compression on the fly
    - No LOAD or REORG required
- **Rebuild Index SHRLEVEL CHANGE**



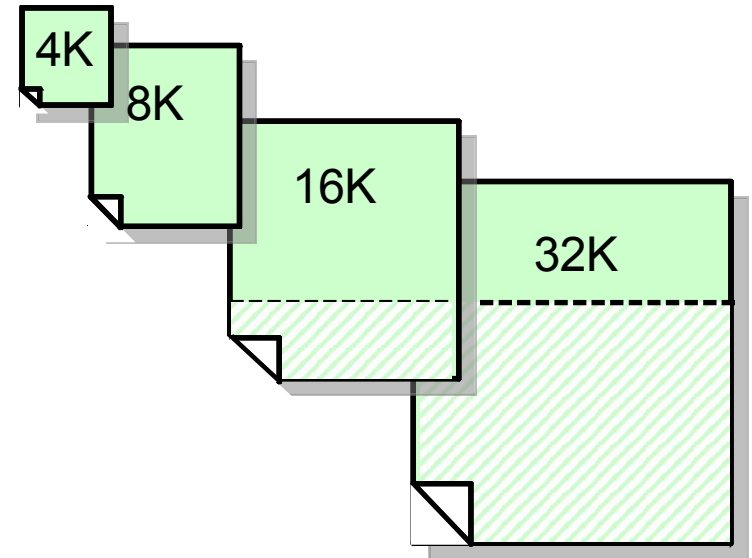
## Large index page size

- **Benefits**
  - Fewer page splits
  - Potentially fewer index levels
  - Faster sequential I/O
- **Large page size may cause**
  - Worse buffer hit ratio
  - More deferred writes, which could be especially bad with remote writes



## Index Compression

- **VSAM CI size is always 4K**
- **8K page size is usually best.**
- **Larger page size may cause**
  - Worse buffer hit ratio
  - More deferred writes, which could be especially bad with remote writes
- **Run DSN1COMP before using index compression to see how different page sizes affect the compression and storage usage**

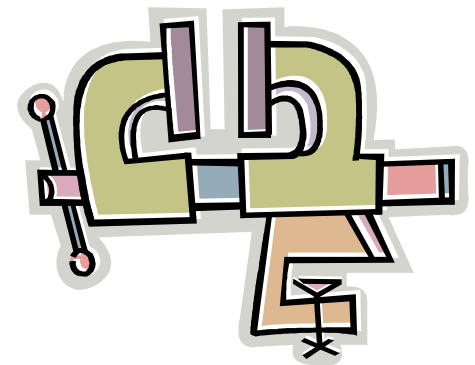


# Comparing table space vs. index compression

	<b>Table space</b>	<b>Index</b>	<b>Remarks</b>
<b>Unit of compression</b>	<b>Row</b>	<b>Page</b>	Index non-leaf pages are not compressed, but that's typically less than 5% of the entire index
<b>Where is data compressed</b>	<b>on disk, in buffer pools, in logs</b>	<b>on disk only</b>	
<b>compression timing</b>	<b>at insert and fetch</b>	<b>at I/O</b>	Hence, CPU overhead affected by BP hit ratio. Larger buffer pools strongly recommended for compressed indexes. Do not use page-fix for these buffer pools
<b>Hardware assist</b>	<b>Yes</b>	<b>No</b>	Index compression uses sophisticated software compression algorithms
<b>Page size restrictions</b>	<b>No</b>	<b>Only for 8K, 16K and 32K-page indexes</b>	Page size on DASD: <ul style="list-style-type: none"> <li>• for table spaces, equivalent to page size in the associated buffer pool</li> <li>• for indexes, always 4K</li> </ul>
<b>Compression dictionary used</b>	<b>Yes</b>	<b>No</b>	
<b>When does compression start</b>	<b>After the first Reorg or Load</b>	<b>At the first insert or update</b>	
<b>Compression CPU cost reported in</b>	<b>Accounting</b>	<b>Accounting &amp; DBM1 SRB Statistics</b>	No changes in accounting CPU time if index pages brought in by prefetch
<b>Typical ratio for compression</b>	<b>10 – 90%</b>	<b>25 – 75%</b>	Maximum CR limited by index page size: 50% for 8K, 75% for 16K and 87.5% for 32K Use DSN1COMP to predict compression ratio

## Compression Rules of Thumb

- **Calculate disk space used by indexes**
- **Avoid high IO situations or add memory to compensate**
- **Choose large indexes, over 10 MB**
  - Especially if long index keys (over 400 bytes), or padded indexes
- **Use DSN1COMP to estimate compression**
- **Where compression is**
  - Over 45% and under 70%, use 8K pages
  - Over 70% and under 85%, use 16K pages
  - Over 85% use 32K pages
- **Test and stage in implementation**



# Identifying Unused Indexes

## V8

- In order to improve the performance of different types of queries, some customers create many indexes just in case one of them can be useful.
- However, there is a significant cost in maintaining such indexes during Insert, Delete, Load, Reorg, ...
- Some of the indexes are no longer needed and they could be dropped, but how can we be sure that they have not been used for a very long time?

## V9

- For each index, a new real-time statistics column (LASTUSED) is maintained in table SYSIBM.SYSINDEXSPACESTATS
- It is updated whenever the index is used in
  - SELECT/FETCH
  - searched UPDATE/DELETE
  - Referential Integrity checking
- The column is not updated for INSERT, LOAD, etc.
- If an index has not been used for a period that covers the entire applications life-cycle (e.g. do not forget periodic processes such as period closing), it can be safely dropped
- Be careful with indexes that enforce uniqueness

# Virtual Indexes a.k.a. 'What If' Indexes

## V8

How to determine that a new index would benefit a given **dynamic SQL** query?

How to determine that dropping an index will not negatively affect a given query?

- In many cases predicting based on modeling is not reliable due to query complexity
- Indiscriminate adding of indexes creates permanent overhead for most operations (SQL and utilities)
- Creating a new index is obtrusive for concurrent operations
- Using a test system for experimenting lacks potentially crucial environmental factors that affect access path selection

## V9

- Virtual i.e. hypothetical indexes can be specified and made visible to statement EXPLAIN STATEMENT FOR
- Table DSN\_VIRTUAL\_INDEXES is used to specify virtual indexes
  - Table columns include selected columns from SYSINDEXES and SYSKEYS
  - Users need to create the table manually, unless tooling such as Index Advisor does it automatically. Appropriate script is provided.
  - To create/drop an index, the table needs to be populated with a row that provides an appropriate description of index
- At EXPLAIN time, during query optimization, the virtual indexes compete with regular indexes on the tables in a cost-based fashion and the dropped indexes are not considered

<b>TBCREATOR</b>	Authorization ID of owner (or schema in V9) of table on which the index is being created/dropped
<b>TBNAME</b>	Name of the table on which the index is being created or dropped
<b>IXCREATOR</b>	Authorization ID (or schema in V9) of the owner of the index
<b>IXNAME</b>	Name of the index
<b>ENABLE</b>	Whether this index specification will be processed ('Y') or not ('N').
<b>MODE</b>	Whether the index is being created ('C') or dropped ('D')
<b>UNIQUERULE</b>	Whether the index is unique: D for No (duplicates are allowed); U for Yes
<b>COLCOUNT</b>	The number of columns in the key
<b>CLUSTERING</b>	Whether the index is clustered ('Y' or 'N')
<b>NLEAF</b>	Number of active leaf pages in the index. If unknown, the value must be -1.
<b>NLEVELS</b>	Number of levels in the index tree. If unknown, the value must be -1.
<b>INDEXTYPE</b>	The index type: '2' - NPSI; 'D' - DPSI
<b>PGSIZE</b>	Size, in bytes, of the leaf pages in the index: 4K, 8K, 16K, 32K
<b>FIRSTKEYCARDF</b>	Number of distinct values of the first key column. If unknown, the value must be -1.
<b>FULLKEYCARDF</b>	Number of distinct values of the key. If unknown, the value must be -1.
<b>CLUSTERRATIOF</b>	Clustering ratio. . If unknown, the value must be -1.
<b>PADDED</b>	Indicates whether keys within the index are padded for varying-length column data ('Y' or 'N')
<b>COLNO1</b>	Column # of the first column in the index key
<b>ORDERING1</b>	Ordering ('A' or 'D') of the first column in the index key
...	...
<b>COLNO64</b>	Column # of the last column in the index key. Needs to be populated only when # index keys = 64
<b>ORDERING64</b>	Ordering ('A' or 'D') of the last column in the index key.



## Native SQL Procedures

- **Potential for significant reduction in CPU resource consumption by avoiding**
  - Overhead of stored procedure invocation overhead
  - Overhead of roundtrip between WLM and DBM1 address spaces for each SQL call
- **Short running SQL procedure could achieve up to an 40% ITR improvement**
- **But little or no improvement for long-running SQL procedure**
- **zIIP-eligible if DRDA as it runs in DBM1, not WLM, address space under DDF enclave SRB**
- **Easy to code, develop and manage**
- **Conversion from external SQL procedures to native SQL procedures is easy**

# SELECT FROM UPDATE/DELETE/MERGE

V8

## SELECT FROM INSERT

Retrieves columns values created by INSERT in a single SELECT statement including:

- Identity columns
- Sequence values
- User-defined defaults
- Expressions
- Columns modified by BEFORE INSERT trigger
- ROWIDs

Avoids possible expensive access path that separate SELECT might be using

V9

## SELECT FROM INSERT UPDATE DELETE MERGE

One SQL call to DB2 modifies the table contents and returns the resultant changes to the application program.

E.g. we can now code destructive read from a table when a SELECT FROM DELETE statement is included. This feature is particularly useful when a table is used as a data queue.

# ORDER BY and FETCH FIRST in Subselect

**V8**

ORDER BY and FETCH FIRST can be specified only as part of select-statement, i.e. one can write:

```
SELECT * FROM T1  
ORDER BY C1  
FETCH FIRST 1 ROW ONLY
```

but not the following:

```
INSERT INTO T2  
(SELECT * FROM T1  
ORDER BY C1  
FETCH FIRST 1 ROW ONLY)
```

This will give a syntax error

**V9**

The restriction has been removed – the clauses can be specified in either a subselect or fullselect.

Interesting example: a loop over the statement followed by a COMMIT deletes rows without acquiring too many locks

```
DELETE FROM T1 X  
WHERE EXISTS  
(SELECT * FROM T1 Y  
WHERE X.KEY1=Y.KEY1  
AND X.KEY2=Y.KEY2  
AND delete_predicate  
FETCH FIRST 10000  
ROWS ONLY)
```

## New Data Types

- **BIGINT, 8 byte integer**
- **BINARY, 1 to 255 bytes**
- **VARBINARY, 1 to 32704 bytes**
  - Unlike FOR BIT DATA the new BINARY and VARBINARY use x'00' as a padding character
  - Comparison rule:
    - If two strings are equal up to the length of the shorter string , the shorter string is considered less than the longer string.
- **DECFLOAT**
  - IEEE 754r number with a decimal point. The position of the decimal point is stored in each decimal floating-point value. The maximum precision is 34 digits.

# Skipping Locked Rows

## V8

Application does not scale well due to increased lock contention.

Application semantics requires committed and **available** rows only.

An example of such an application is a messaging system:

- only committed and available messages can be processed
- those locked at the time will be processed later.

## V9

New SQL clause: **SKIP LOCKED DATA**

Applies to:

- select-statements, SELECT INTO, PREPARE, searched UPDATE, searched DELETE, UNLOAD utility
- Isolation levels CS or RS
- Row or page level locking

It allows a transaction to skip over rows that are incompatibly locked by other transactions, without being blocked.

An interesting usage scenario is serializing access to any kind of object:

- Create a table and insert a row for each object to be controlled
- Code: SELECT ... FOR UPDATE OF ... SKIP LOCKED DATA
- The object unavailability is identified by return code +100 (without any wait)

## APPEND

## V8

All of the following applies:

- Critical, high insert rate workload needs better performance and all the conventional tuning steps have already been applied.
- Clustering is either not beneficial or more frequent reorganizations are acceptable
- *MC00* insert algorithm is still not fast enough or the prerequisites cannot be satisfied:
  - MEMBER CLUSTER
  - FREEPAGE=PCTFREE=0

## V9

CREATE TABLE ... APPEND YES | NO

ALTER TABLE ... APPEND YES | NO

- APPEND YES avoids CPU cost of space search at the cost of DASD space
- After populating with the APPEND option, space may be reclaimed or reused by Reorg or altering APPEND off
- Make sure PK81471 is applied
- Note that MC00 is still valid, but make sure that PK81470 is applied
- Apply UK41212 for LOB Append

# TRUNCATE TABLE

## V8

Alternative way of deleting the entire table is needed for any of these reasons:

- DELETE without WHERE clause is not fast enough as the table includes delete triggers
- Using LOAD REPLACE with empty input data set (even when called via DSNUTILS) is not DBMS agnostic
- Storage occupied by deleted rows should be released faster

## V9

New DML statement:

**TRUNCATE** table  
DROP | REUSE STORAGE  
IGNORE | RESTRICT DELETE TRIGGERS  
IMMEDIATE

Under the cover it's DELETE without WHERE clause, but without delete triggers processing overhead.

Therefore it is fast for tables in segmented and universal table spaces for which there are no CDC, MLS and VALIDPROC enabled attributes.

# MERGE Statement

## V8

For a set of input rows update the target table when the key exists and insert the rows for which keys do not exist.

E.g.

- For activities whose description has been changed, update the description in table **archive**.
- For new activities, insert into **archive**.

Prior to V9 this has been coded as a loop over conditional INSERT and UPDATE statements

## V9

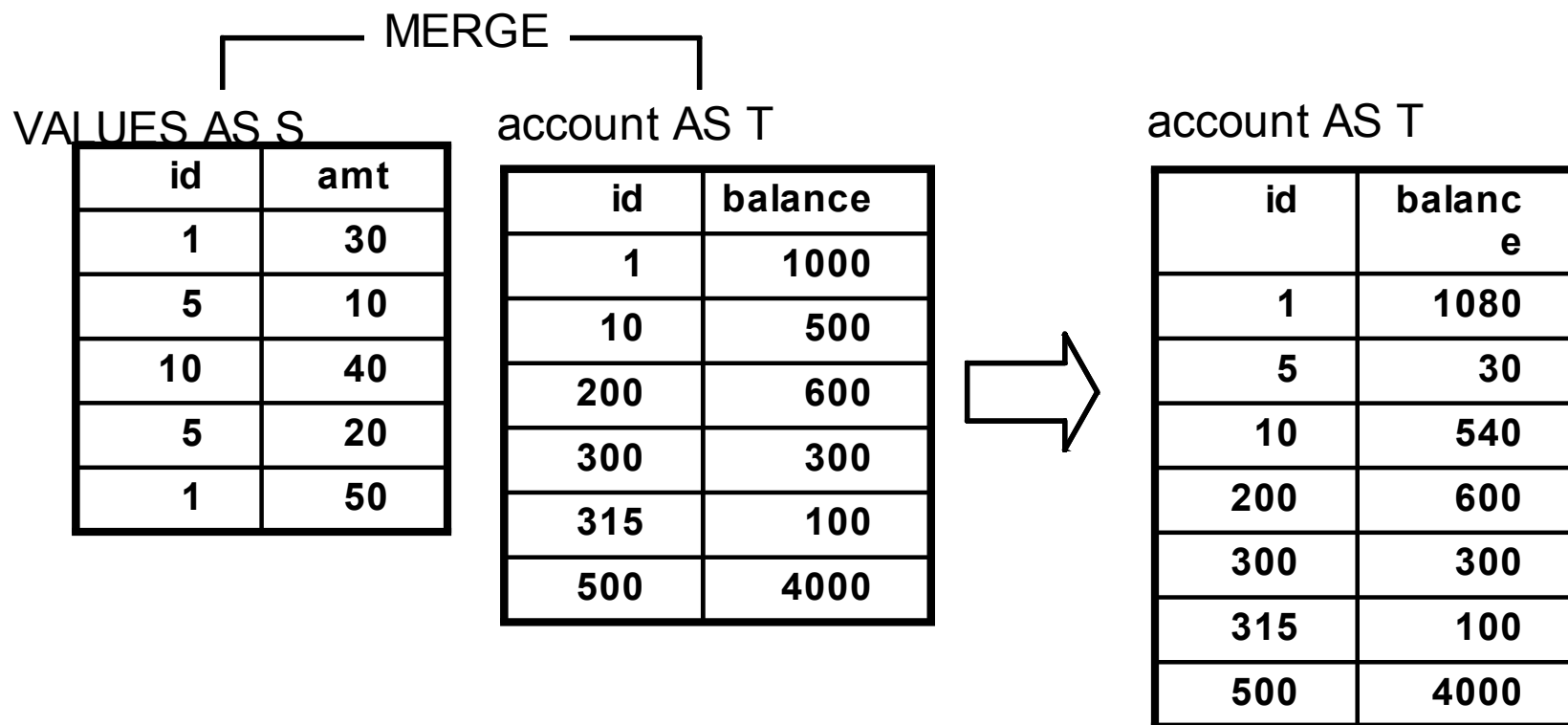
```
MERGE INTO archive AR
  USING VALUES (:hv_activity, :hv_description) FOR :hv_nrows ROWS
  AS AC (ACTIVITY, DESCRIPTION)
  ON (AR.ACTIVITY = AC.ACTIVITY)
  WHEN MATCHED THEN UPDATE SET DESCRIPTION = AC.DESCRPTION
  WHEN NOT MATCHED THEN INSERT (ACTIVITY, DESCRIPTION)
                                VALUES (AC.ACTIVITY, AC.DESCRPTION)
  NOT ATOMIC CONTINUE ON SQLEXCEPTION
```

## MERGE Example

```

MERGE INTO account AS T
USING VALUES (:hv_id, :hv_amt) FOR 5 ROWS AS S (id, amt)
ON T.id = S.id
WHEN MATCHED      THEN UPDATE SET balance = T.balance + S.amt
WHEN NOT MATCHED THEN INSERT (id, balance) VALUES (S.id, S.amt)
NOT ATOMIC CONTINUE ON SQLEXCEPTION

```



## DB2 9 for z/OS at a glance

### Application Enablement

- pureXML
- Optimistic locking for WebSphere
- LOB performance, usability
- Native SQL procedural language
- SQL improvements that simplify porting

### RAS, Performance, Scalability, Security

- More online schema changes
- Online REBUILD index, Online REORG improvements
- Clone tables
- Trusted contexts and ROLES
- Parallel sysplex clustering improvements
- 64-bit virtual storage enhancements

### Simplification, Reduced TCO

- Index compression
- Partition by growth tables
- Package stability
- Volume based backup / recovery
- Automatic object creation

### Dynamic Warehousing

- Many SQL improvements
- Dynamic index ANDing
- Histogram statistics
- New built-in OLAP expressions
- Optimizer service center

## References

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