DB2 12 — The ultimate enterprise database for business-critical transactions and analytics

DB2 12 for z/OS
Technical Overview
Part 2

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Logistics and Questions

• The presentation is available for download from the resources list

• The webcasts will be available on replay

• You can submit questions by typing into the questions area of your webcast control panel at least 15 minutes before the end of the webcast.

• Questions will be answered as time permits

• Any questions not answered due to time constraints will be answered after the webcast and added to the “Resources list”
Objectives

- Introduce and discuss the new features of DB2 12 for z/OS
- Provide planning information for migration
- Understand the new performance features
Agenda

- Introduction
- Performance focus – traditional workloads
- Performance focus – enabling modern applications
- Migration
- Application enablement
- Reliability, availability, scalability, security
APPLICATION ENABLEMENT
DB2 for z/OS adapting to modern Application Development paradigms

- Many modern application developers work with REST services and JSON data formats
- **DB2 Adaptor for z/OS Connect** provides the means to do this
- Beta in progress, planned for DB2 10 and 11 as well as DB2 12

```json
{"customer": {
  "ID": "32537",
  "Name": "Bob Rady Enterprises"
}}
```

HTTP Request:
```
```
Getting REST and JSON into your mainframe environment in a way that enables you to best take advantage of the assets that exist there:

- Liberty Profile Server

IBM BlueMix

Cloud-based Services

Enterprise Systems Integration

Cloud/Mobile integration with DB2 and z/OS Connect

Provides a common and consistent entry point for mobile access to one or many backend systems

Simplifies front-end functions by allowing them to pass RESTful and JSON rather than be aware of or involved in data transformation

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Latest News

- Native DB2 REST API with DB2 11 APARs PI66828 & PI70477
Motivation for Integrated Solution in DB2

- **DB2 integrated REST API functionality maintaining z/OS Connect externals as applicable for**
  - Reuse of DDF functionality that provides a highly available, highly scalable and highly serviceable network interface
  - Support of clientInfo fields
  - DDF provides security, auditing, and data transformation as being provided using z/OS Connect
    - PERMIT DSN.REST CLASS(DSNR) ID(DB2USER) ACCESS(READ)
  - DDF Rest API would be ready out of the box
  - Allows a database administrator to manage services
    - New catalog table
    - Static execution pattern – authorisation checking, object dependency tracking
RESTful Service Support in DB2

- Application
- Data Server Client
- RESTful JSON
- z/OS Connect EE
- RESTful API
- DDF
- DRDA parsing
- Auth check
- Thread Creation
- SQL execution
- DB2 z/OS
- DRDA

z/OS Connect EE

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Native DB2 REST API Support

- **CREATE|DROP|START|STOP Service using either Data Studio V1 support, or direct DB2 DDF REST API**
  - Sample
    POST https://<host>:<port>/services/DB2ServiceManager
    {"requestType": "createService"....}

- **Discover all services and discover details for a specific service using direct DB2 DDF REST API**
  - POST https://<host>:<port>/services/DB2ServiceDiscover
  - { ["collectionID": ":<collectionID>"}

- **DB2 REST Service invocation**
  - DB2 Adapter for z/OS Connect V1 invocation API syntax
  - New direct DB2 DDF REST invoke API

- **Supported INSERT, UPDATE, DELETE and cursor based SELECT**
- **CALL support with IN/OUT/INOUT parameters und resultsets**
- **All of the various DB2 base SQL types**
Application Related Enhancements

- **DRDA Fast Load** – callable command for fast streaming of data into DB2
- **System profiling enhancements**
  - Auto start of system profiles
  - Set global variables based on profiles (e.g. transparent archiving)
- **New MODIFY DDF PKGREL(BNDPOOL) option**
  - Pool high performance DBATs at connection termination
- **DSNULI support for IMS Attach**
- **Long list of SQL and XML improvements**
DRDA Fast Load

- **Problem:**
  - DB2 provides the DSNUTILU stored procedure to load data from a client
  - But this is difficult to use, application must transfer data to z/OS file

- **Solution:**
  - DB2 Client API (CLI and CLP) for remote load into DB2
  - Easy and fast loading of data from file that resides on client
  - Internal format (SAP), as well as delimited and spanned (LOB data)
  - Applicable for some “cloud” use cases
  - Overlap network operations with data ingest on the DB2 server
  - Measured results show as fast or faster than DB2 LOAD utility

- **Plans to use this feature for fast write from Spark**
SQL Enhancements

- Simple VALUES using dynamic SQL – V10, V11
- JDBC/ODBC Type 2 performance Enhancements
- ODBC driver improvements:
  - TIMESTAMP with TIMEZONE support
  - Multi context support using ASSOCIATE/DISSOCIATE THREAD
  - Ability to preserve dynamic statement cache after rollback
- SQL Pagination syntax support – OFFSET n and LIMIT
- Support prepareAttribute literal replacement as BIND PACKAGE option
SQL Enhancements ...

- Keep views, UDFs intact on DDL for underlying tables
- Increase maximum number of tables referenced in view, UDF, statement
- Enhanced MERGE support (see next slide)
- SQL pagination improvements
- New built in functions
  - HEX2BIN (V11)
  - MEDIAN, PERCENTILE_CONT, PERCENTILE_DISC
  - COUNT(DISTINCT x)
  - GENERATE_UNIQUE – new optional length parm
  - HASH functions (CRC32, MD5, SHA1, SHA256)
Enhanced Merge Support

- **DB2 z/OS initial support for MERGE statement with limited functionality was delivered with Version 9:**
  - Limited to UPDATE and INSERT and only one of each
  - Focused on use of host variable column arrays to provide multiple rows of input data
- **In DB2 12, DB2 z/OS MERGE statement will be aligned with behavior defined in SQL Standard and DB2 family**
  - Source data as a *table-reference*
  - Multiple MATCHED clauses
  - Additional Predicates with [NOT]MATCHED
  - Support DELETE operation
  - Allow IGNORE and SIGNAL
SQL Pagination

• With the growth of web and mobile applications, application developers are looking for more efficient ways to develop good performing applications

• Numeric-based pagination
  • SELECT * FROM tab OFFSET 10 ROWS FETCH FIRST 10 ROWS ONLY

• Data-dependent pagination
  • Existing syntax:
    WHERE (LASTNAME = :lname AND FIRSTNAME >= :fname) OR (LASTNAME > :lname)

  • New equivalent syntax
    WHERE (LASTNAME, FIRSTNAME) >= (:lname, :fname)
SQL Enhancements ...

- Unicode columns in EBCDIC tables
- Piecemeal DELETE – allow for interim commits
- MQ UDF enhancements: allow MQ message header to be passed
- BiTemporal enhancements
  - Auditing enhancements – V11
  - Inclusive/inclusive for business time
  - Logical transaction for system time
  - Temporal RI
Piece-wise Modification of Data

- Mitigate the effects of locking and logging when potentially millions of rows could be affected by a simple statement like:
  "DELETE FROM T1 WHERE C1 > 7"

- Solution
  - Support fullselect as the target of a DELETE statements where the fullselect allows for the FETCH FIRST N ROWS ONLY to be specified.
  - DELETE FROM (SELECT * FROM T1 WHERE C1 > 7 FETCH FIRST 5000 ROWS ONLY)
SQL Enhancements ...

• **APPLCOMPAT support for DB2 12: V12R1Mnnn where nnn >= 500**

• **Global variable enhancements**
  - Array Global Variables
  - LOB Global Variable
  - FETCH statement and global variables as a target
  - EXECUTE statement and global variables
  - OPEN statement and Global Variables

• **SQL PL**
  - SQL PL in triggers, including trigger versioning and debugging support
  - Support for constants
  - SQL PL obfuscation
  - Dynamic SQL in SQL PL UDFs and stored procedures
  - DBMS_OUTPUT for UDF tracing – V11
DB2 12 SQL PL Triggers

- **Rich capability in trigger body**
  - Allow SQL PL control statements
    - IF-THEN-ELSE, LOOP, REPEAT, ...
  - Allow more SQL statements, dynamic SQL, variables, handlers
  - Easier porting of triggers from other DBMSes
  - DEBUGGER support
  - VERSIONs support
    - Provides a better way to change a trigger without DROP, CREATE
    - Can change trigger online and maintain trigger activation order

- **Richer capability means some performance overhead compared to an equivalent traditional trigger**
XML Improvements

Improve the performance of the XML queries by choosing optimal access:

76% / 77% reduction in the Class 1 / Class 2 time respectively.

Improve the performance of XMLTable that conducts the pivot-like operation to XML data with name-value pair pattern:

90% CL2 CPU improvement using customer's xml data/queries

Improve performance and developer productivity by allowing multiple update inside XMLModify function:

Up to 90% improvement in ET; up to 97% improvement in CPU time (when comparing to semantics equivalent single update)

XSLTRANSFORM function for XML extender users

Allow for easy migration to pureXML
DB2 for z/OS existing support for JSON

- **Store data from web/mobile applications in its native form**
  - Many web applications use JSON for storing and exchanging information
  - JSON is often the preferred data format for mobile application back-ends

- **Move from development to production in no time**
  - Ability to create and deploy flexible JSON schemas
  - Gives power to dependency on IT
    - No need to pre-determine schemas and create/modify tables
    - Ideal for agile, rapid development and continuous integration

- **DB2 provides two ways for working with JSON**
  - Java driver for JSON API
  - SQL extensions – DB2 11, with enhancements in DB2 12

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JSON Enhancement

>>-JSON_VAL—(--json-value--,--search-string--,--result-type--)-------->>

To extract and retrieve JSON data into SQL data types from BSON

In DB2 12, we remove the requirement that 1st parameter has to be a BLOB column (already retrofit to V11 in PI39003)

Example (before):

```
JSON_VAL(column1,'PO.customer.@cid', 'i:na')
```

In V12, we support more options as 1st parameter:
- view column
- CASE expression
- table expression with union all
- trigger transition variable
- SQL PL variable/parameter
RELIABILITY, AVAILABILITY, SCALABILITY, SECURITY
Lifting Partition Limits – Problem Statement

- Maximum number of partitions is dependent on DSSIZE and page size
  - e.g., If DSSIZE = 256 GB and page size = 4K then maximum number of parts is 64
- Running out of space in a partition is an application outage
- When altering DSSIZE, REORG must run on entire table space
- DSSIZE is at table space Level and not at part level
  - All parts inherit the same DSSIZE set at table space level
  - No ability to have differing partition sizes
  - Rebalance must run against multiple partitions
- Maximum table size limited to 16TB
Lifting Partition Limits – Solution

- New UTS PBR tablespace structure called ‘UTS PBR RPN’
  - Use relative page numbers (RPN) instead of absolute page numbers
  - Simplicity, usability, availability, scalability
  - Remove dependency between number of partitions and partition size
  - 7-byte RIDs (2 byte part number, 5 byte page number)
    - Up to 256 trillion rows in a single table
    - New REORG mapping table format, optional until new function enabled
  - Support up to 1TB partition size
  - Maximum table size increased from 16TB (4K page size) to 4PB
    - Architected to go even larger
  - Increasing DSSIZE is supported at partition-level
  - New DSSIZE support for indexes
Lifting Partition Limits – Considerations

• **Conversion / Exploitation:**
  - zparm to control whether creation of range partitioned uses relative page numbering
  - PAGENUM RELATIVE/ABSOLUTE option on CREATE & ALTER TABLESPACE
  - Conversion is pending alter - requires tablespace-level online REORG
  - Online alter to increase DSSIZE – immediate, non-disruptive
  - Online alter to decrease DSSIZE - pending alter requiring table space-level REORG

• **Log record formats changed to support 7 byte RIDs**
  - Improved serviceability, DSN1LOGP now formats partition number explicitly
  - New log record format written in “CM”, requiring fallback toleration support in V11
  - Not just for RPN page sets!
Online Schema

- Insert partition (see next slide)
- Online deferred ALTER INDEX COMPRESS YES
  - Previously placed indexes in RBDP
- Option to defer column-level ALTERs
  - Materialise through online REORG
  - Avoid availability constraints & conflict with other deferred alters
Insert Partition

• **Problem statement**
  - Large range-partitioned tables often have hot spots and rebalancing across entire set of partitions is onerous
  - Partitioning scheme chosen in the past may no longer be optimal

• **Solution**
  - Ability to insert a new partition with specified limitkey value
    - ALTER TABLE ADD PARTITION ENDING AT xxx
  - Split existing partition, distribute data between new and old
  - Online change through pending alter
  - Only affected partition(s) need to be REORGed
  - No PIT recovery prior to materializing REORG
Pending Column Level Alter

- **Problem statement**
  - Some column-level alters result in application impact
    - e.g. indexes placed in RBDP
  - Immediate alters conflict with pending alters
    - Additional REORGs required to materialize pending alters to avoid DDL failures

- **Solution**
  - Allow existing immediate alters to become pending alters, UTS only
  - All pending alters accumulated and materialized through online REORG
  - New zparm
    - ALWAYS IMMEDIATE: Existing behavior for existing alters
    - ALWAYS PENDING: Current immediate alters are converted to pending alters
  - ALTER COLUMN type to avoid RBDP on indexes
Security & General Enhancements

- LOB compression
  - zEDC hardware requirement
- Improved LOB handling for ISO(UR) queries to avoid SQLCODE +100
- TRANSFER OWNERSHIP
- Permit installation, migration without Install SYSADM authority to limit data access
- New UNLOAD privilege
- Support long, camel-cased DBRM names
- IFCID 306 log records returned in the correct version
Utilities

- REORG
  - Improved Flashcopy management
    - REORG with only a FLASHCOPY inline image copy (no traditional ICs) now causes REORG to fail (RC=8) if the flashcopy fails
  - Improved part-level UTS PBG REORGs
    - Supports creation of new PBG partition for overflow rows during a part level reorg
  - Prevent copy-pending on LOB tablespace during REORG of UTS PBGs
    - Avoid leaving copy pending on LOB table spaces when new PBG partitions grown during log phase of REORG
  - REORG-level management of delete of UTS PBG partitions
    - Add a new keyword, DROP_PART, for REORG empty UTS PBG partition pruning when zparm alteration is not feasible
  - Support new COMPRESSRATIO catalog column
    - Add LOAD/REORG/RUNSTATS ability to gather average compress ratio at the record level instead of the page saved level
Utilities …

- **REORG …**
  - Up to 17% additional offload to zIIP
    - The reload phase can now be zIIP offloaded
  - New mapping table format support
    - The new format supports 7 bytes RIDs needed with UTS PBR RPN support
  - Permit REORG against RO page sets
    - REORG with any SHRLEVEL can be run against any RO table space and index
    - Retrofitted back to service level with APAR PI46774)
  - Display claimer information on each drain failure, not just last retry
Utilities ...

**LOAD**

- LOAD PART REPLACE with dummy input against empty PBR partition
  - NPI processing optimized to not scan the whole NPI to find keys to be deleted for the partition being REPLACEd if it was already empty
  - Reduces elapsed time and CPU time significantly if there were a lot of keys for the other logical parts of the NPI
  - Up to 99% CPU 98% Elapsed Time reduction

- LOAD SHRLEVEL CHANGE PARALLEL support for UTS PBG
  - Modified to remove the single input parallelism restriction for PBG table spaces for LOAD SHRLEVEL CHANGE
  - Lab measurements saw up to 76% elapsed time savings with some CPU overhead
  - LOAD SHRLEVEL NONE PBG PARALLEL is still a restriction

- Up to 90% additional zIIP offload
  - RELOAD phase of the LOAD utility can be zIIP offloaded
  - This includes the data conversion and loading of the record into the page set
Utilities ...

• LOAD ...
  • LOAD RESUME SHRLEVEL NONE BACKOUT YES to avoid RECP for page set on failure
    • New option to allow backout of rows already loaded upon encountering an error (such as conversion, LOB/XML, duplicate key, RI constraint) without leaving the page set in RECP
  • PREFORMAT support for aux tables
    • Indicates the remaining pages are preformatted up to the high-allocated RBA in the table space and index spaces that are associated with the table that is specified in table-name
Utilities ...

- LOAD ...
  - Maintain MAXASSIGNEDVAL for identity columns
    - This enhancement maintains the MAXASSIGNEDVAL for user provided input and also will reset the value if a LOAD REPLACE on the table space is run
  - Eliminate data sharing overhead with UNLOAD ISO(UR) REGISTER NO option
    - New option to bypass page registration in the Coupling Facility and avoid any data sharing overhead
  - LOAD REPLACE support for COMPRESSRATIO column
    - Gathers the average compress ratio at the record level instead of the page saved level
Utilities ...

- **Backup & Recovery**
  - PIT recovery support for UTS PBG table spaces
    - Allow recovery of PBG UTS to a PIT prior to a REORG that materialized these physical pending alters: page size (buffer pool), DSSIZE, SEGSIZE, MEMBER CLUSTER
  - **FLASHCOPY_PPRCP** parameter for RESTORE and RECOVER
    - Allows users to specify/override the preserve mirror option for PPRC (sync disk mirroring) on the utility statement
    - Previously: RESTORE SYSTEM used HSM default; RECOVER used zparm FLASHCOPY_PPRC
  - Option to skip PIT recovery for non-updated page sets
    - New *default* behavior for PIT RECOVER utility - objects which were not updated *after* the recovery point are skipped and not recovered
    - Reasoning: the data in these objects still reflect that PIT, so no need to recover
    - Saves CPU resource consumption and elapsed time
    - This default behavior can be overridden with SCOPE(ALL)
Utilities ...

• **Backup & Recovery ...**

  • System Level Backup support for multiple copypools
    • BACKUP SYSTEM and RESTORE SYSTEM now support multiple copypools
    • Allows the user to keep daily “golden copy” or backup for critical events
  • DFSMSHsm messages included in utility job output for BACKUP/RESTORE SYSTEM
    • Improved messaging for BACKUP SYSTEM and RESTORE SYSTEM
    • HSM and DSS messages are included in the DB2 utility job output so that the user does not have to look in the (separate) HSM job logs for messages
    • Available with z/OS V2.2
  • COPY option to specify **FASTREPLICATION(REQUIRED)**
    • A new COPY utility zparm COPY_FASTREPLICATION REQ|PREF|NONE allows the user control of whether FlashCopy is required during creation of the FlashCopy image copy
    • With FASTREPLICATION REQUIRED, DSS will allocate target data set within same DASD box, ensuring that FlashCopy can be used
    • Previously COPY defaulted to FASTREPLICATION PREFERRED
Utilities ...

- **RUNSTATS**
  - Use PROFILE support for inline stats in REORG & LOAD
  - COLGROUP inline stats support for LOAD PARALLEL
  - INVALIDATECACHE option to avoid dynamic statement cache invalidation
    - Default behavior has changed to not invalidate prepared statements
  - COLGROUP performance – 25% CPU, 15% Elapsed Time reduction
    - When COLGROUP column specifications are redundant with INDEX columns, the duplicate COLGROUP is ignored in lieu of the index processing
Utilities ...

- **RUNSTATS** ...
  - New DSNUTILV stored procedure support CLOB input >32MB
    - The DSNUTILV UTSTMT utility statement parameter is now a CLOB instead of a VARCHAR, so DB2 now supports a 4 byte length (up to 2 GB)
    - For existing applications still passing a VARCHAR, DB2 will do the conversion from VARCHAR to CLOB
  - DSNACCOX changes for REORG avoidance
    - Number of recommendations reduced by changing the default for recommending REORG based on the number of inserts and pseudo deletes since the last REORG to off
    - Removes the criteria of recommending a REORG based on REORGLASTTIME, LOADRLASTTIME, or REBUILDLASTTIME being NULL
  - Improved utility concurrency for MODIFY, COPYTOCOPY, MERGECOPY
    - Allows MODIFY RECOVERY, COPYTOCOPY, MERGECOPY, and exclusive utilities like LOAD and REORG to run concurrently on the same target objects
Data Sharing Improvements

- Support for global transactions
- DDF shared session data across group
  - DDF transaction re-routing, session token for client fail-over
- Data sharing performance improvements:
  - Improved lock avoidance checking to reduce CF lock requests
  - In-memory indexes can reduce GetPages and CF GBP requests
  - Improved insert space search can avoid P-lock contention and streamline inserts
  - RUNSTATS and UNLOAD ISOLATION(UR) to avoid CF page registration
Data Sharing Improvements ...

- **New data sharing peer recovery option**
- **Retry of automatic LPL and GRECP recovery**
- **Asynchronous CF Lock duplexing (not yet enabled)**
  - Reduces overhead for system managed duplexing of CF LOCK1 and SCA structures
  - Secondary structure updates are performed *asynchronously* with respect to primary updates
  - DB2 will sync up with z/OS to ensure data integrity i.e., all modify locks have been “hardened” in the secondary lock structure before the corresponding undo/redo record for the update is written to DB2 the active log on DASD
  - Increases the practical distance for multi-site sysplex operations whilst duplexing of CF LOCK1 and SCA structures
- Planned as 4Q 2016 deliverable with
  - z/OS 2.2 APAR
  - z13 GA2 CFCC 21
Data Sharing Improvements ...

- Synchronous CF lock structure duplexing – how it works today

1. Request in
2. Request out
3. Communication
4. Response
5. Response out
Data Sharing Improvements ...

- **Asynchronous CF lock structure duplexing – how it will now work**

Diagram:

1. Request in
2. Request out
3. Response
4. Response out
5. Communication
6. Ordered execution

- IBM XES
- IRLM and DB2
- z/OS
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Now ... Live Q&A with John Campbell