Db2 12 for z/OS and Beyond

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• IBM’s statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM’s sole discretion.

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Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon many factors, including considerations such as the amount of multiprogramming in the user’s job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve results similar to those stated here.
Agenda

• Db2 12 for z/OS status update
• IBM z14 and Db2
• Quick review of Db2 12 most interesting features
• Recent deliveries
• Beyond Db2 12 – continuous delivery
Db2 12 GA October, 2016

Db2 12 adoption rate about the same as V11

Quality metrics, continuous improvement: V12 better than V11 which is better than V10
Db2 12 for z/OS Highlights
Redefining enterprise IT for digital business and the mobile app economy

Scale and speed for the next era of mobile applications
Super fast ingest rate -- over 11 Million Inserts per second for IOT, Mobile and Cloud*
280 trillion rows in a single Db2 table, with agile partition technology
DRDA Fast Load for easier loading of data from distributed clients

In-Memory database
Advanced in-memory techniques in Db2 12 means faster transactions with less CPU

Deliver analytical insights faster, expand to more applications
2-10x improvement for modern analytics workloads
Individual modern analytic queries may see up to 100x improvement**
JSON data management improvements
SQL improvements such as SQL pagination, enhanced MERGE, piece-wise DELETE

Easier to manage, higher availability
Db2aaS APIs and automation for self-service provisioning of resources
Automated admin operations such as RUNSTATS
More schema and partition flexibility
TRANSFER OWNERSHIP for easier security admin
Dynamic SQL plan stability

The launch pad for Continuous Delivery

*: Under dedicated environment using 12 way data sharing on z13, insert against one table (PBR/Member Cluster) from zLinux clients. All partitions were GBP dependent and logging enabled. Our record is, 11.7 million insert per second without index, 5.3 million insert per second with index defined.

** Modern analytics queries evaluated include SQL constructs such as UNION ALL, outer joins, complex expressions (CASE, CAST, scalar functions etc)
Db2 for z/OS and IBM z14 Hardware Synergy

DBMS Technology Leadership

- Db2 for z/OS is differentiated in the marketplace through hw/sw integration
- z14 includes several new hardware features which benefit Db2 workloads
- Integration points for Db2:
  - Crypto hw acceleration for faster transparent data encryption
  - zHyperLinks for ultra-fast Db2 log write I/O and database read I/O
  - New hardware for improved data compression for Db2 tables
  - More large memory – up to 32TB single server
  - New hw for order-preserving compression for Db2 indexes
  - IDAA on IBM Z
IBM z14: Performance that Changes the Game for Security

Performance with Integrated Cryptographic Hardware

- 7x faster encryption for like modes and data sizes with enhanced on-chip (CPACF) cryptographic performance compared to z13\(^1\)
- 2X the SSL handshake performance on z14 with Crypto Express6S compared to z13 with Crypto Express5S\(^1\)

Datasets automatically protected with z/OS Dataset Encryption

- Protect z/OS data sets\(^2\) automatically throughout their life cycle
- Enforce consistent policy over access to encrypted content

Protection in the sysplex

- Data encrypted/decrypted at a host, protected in flight and at rest inside the Coupling Facility (CF)\(^3\)

Db2 Transparent Data Encryption support

- Db2 will use z/OS Dataset Encryption for tables, indexes, logs, image copies
- V11, V12: basic support for DFSMS and RACF controls for TDE
- V12: plan to add DBA controls with an upcoming V12 new function level

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\(^1\) Based on preliminary internal IBM lab measurements on a standalone dedicated system in a controlled environment and compared to the z13. Results may vary.

\(^2\) On October 4th, 2016 IBM announced a Statement of Direction to deliver z/OS dataset encryption capability in z/OS V2.2 (Announcement Letter)

\(^3\) IBM z/OS 2.3 Preview Announcement Letter
Db2 Transparent Data Encryption (TDE)

- Pervasive encryption for tables, indexes, logs, image copies.
  - Using DFSMS dataset encryption

- Data encrypted on disk and in-transit over I/O links.
  - z/OS 2.1 or above. Any z hw, z14 gives substantial performance improvements.

- Security Administrator grants access to the key labels

- Data sets are encrypted by specifying key label for the DFSMS DATACLAS, or when the data set is allocated
  - Db2 support: APARs PI81900 (v11) and PI81907 (v12)

- Db2 12 New Function Level 50x (TBD) will deliver Db2-centric controls
  - CREATE and ALTER TABLESPACE, STOGROUP with KEYLABEL
  - New zparm for logs, catalog, and utility datasets
What is IBM zHyperLink?

- zHyperLink Express is a direct connect short distance IBM Z I/O feature designed to work in conjunction with a FICON or High Performance FICON SAN infrastructure

- IBM zHyperLink dramatically reduces latency by interconnecting the z14 CPC directly to the I/O Bay of the DS8880

- zHyperLink improves application response time, cutting I/O sensitive workload response time by up to 50% without requiring application changes

1 This performance data was measured in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user’s job stream, the I/O configuration, the storage configuration, and the workload processed.
Db2’s Use of zHyperLink

- Db2 plans to exploit for log write I/O and random DB read I/O
  - Phase1: database reads. V12 APAR PI82575
  - Phase2: active log writes. tbd, based on DS8K readiness

- I/O completion is synchronous with respect to CPU
  - Avoids asynchronous I/O interrupt processing
  - Avoids re-dispatching the work unit

- Mostly beneficial for OLTP and some batch workloads

- Random database reads:
  - DASD cache hit required. Initially 4K page size only. Larger pages planned in future
  - New ZHYPERLINK zparm
  - New instrumentation counters report zHyperLink usage
  - New instrumentation to help with planning:
    - New fields to report read I/O with DASD cache hit
    - zBNA tool: SMF 42-6 to indicate the data base I/O which are zHyperLink eligible
  - Prereqs:
    - H/W: z14, DS8K, zHyperLink Express link connection
    - S/W updates: z/OS 2.1 and above, DFSMS, Db2 V12

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IBM z14: Improved on-chip compression coprocessor

On-chip compression coprocessor

- Enhancements to enable Huffman encoding which can improve compression ratios for Db2 tables for DASD, buffer pool, log savings
- New order-preserving compression. In the future\(^1\) Db2 plans to enable new order-preserving compression for Db2 indices using compression coprocessor

Db2’s use of z14 Huffman Compression

- Goal: better compression with no additional overhead compared to existing technique
- Planned for future V12 function level
- Zparm and Table Space level controls
- Revised compression dictionary structure
- If z14 hw not available, then sw is used to expand a Huffman compressed row (performance overhead)

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IBM Z Data Compression Accelerator

- IBM Z provides special instruction for dictionary-based data compression
  - Tailored towards short data (e.g. database rows) but employed broadly also for file & tape compression
  - Reduced storage cost, and improved performance (disk bandwidth, Db2 buffer pool efficiency, etc)
  - Implemented as firmware and co-processor specialized hardware

- z14 performance improvements in both start-up latency, and peak throughput
  - Optimized data load & store (same as crypto engine)
  - Optimized compression status return to firmware
  - Parallel search of dictionary for multiple symbols

- New architectural features to further improve data compression efficiency
  - Huffman Coding
  - Order Preserving Compression

![Disk reduction from Huffman Coding over Traditional Compression](image)
Db2 Use of z14 HW support for Huffman Compression …

- New zparm TS COMPRESSION TYPE
  - FIXED_LENGTH or HUFFMAN (default = FIXED_LENGTH)
  - Indicates compression algorithm to use when creating new compressed table space or reorganizing existing compressed table space

- Recommendation: Enable Huffman compression only after all members in the data sharing group have hardware support for it (>=z14)
  - A warning message is written upon DB2 start if the zPARM is enabled on z13 or lower
  - Records will be stored uncompressed if zPARM is enabled on z13 or lower.
  - Software based expansion will be used if Huffman compressed data is accessed on z13 or lower.
  - Consider disaster recovery as well

- Prereqs: z14, z/OS 2.1 and later with OA49967, Db2 12 FL 503 (tentative)
Max Memory on System Z Processors

- ZEC9: 512GB
- Z10: 1.5TB
- Z196: 3TB
- ZEC12: 3TB
- Z13: 10TB
- Z14: 32TB

Excellent match for Db2 large buffer pools and Db2 12 in-memory optimizations
IBM Z with IDAA: best-of-breed Hybrid Transactional/Analytical Processing

- Real-time processing on real-time data on “best-of-breed” technologies for transactional and analytical workload
- Leverage Db2 data on the IBM Db2 Analytics Accelerator without recognizable latency
- Unique-in-industry, heterogeneous scale-out solution for enterprise-grade HTAP
- Complement with non-Db2 data on the IBM Db2 Analytics Accelerator
IBM Db2 Analytics Accelerator Version 5.1
Continuous expansion of analytics use cases and business value

New capabilities!

Improving operational excellence of use cases

- **Online Add Column Support** Eliminate need to reload tables after adding a column
- **Multi Row Insert support** performance improvements

New Accelerator use cases (Q3/Q4 2017)

- **Federation**: Integrate multiple Db2 subsystems
- **True HTAP**: No need to manage latency
Announcing Db2 Analytics Accelerator Version 7.1
Delivering new flexible, integrated deployment options

High-speed analysis of your enterprise data for real-time insight under the control and security of IBM Z

- Introduces new flexible, integrated deployment options
  - **Accelerator on IBM Z**
    - Unified homogeneity of service, support and operations
    - Flexible Capacity
  - **Accelerator on IBM Integrated Analytics System**
    - Fast, simple deployment on pre-configured hardware and software
    - Flexible and elastic data storage
- Based on IBM’s premier analytical engine, Db2 Warehouse software
- Transition easily between deployment options
  - One API
  - One database engine
Cloud computing is an information technology (IT) paradigm that enables

- **ubiquitous access** to shared pools of configurable system resources, and

- higher-level services that can be **rapidly provisioned with minimal management effort**.

Enable organizations to focus on their **core businesses** instead of expending resources on infrastructure and maintenance.
Evolution of how workloads are built & delivered

By 2018, Over 60% of New Apps will use cloud-enabled continuous delivery and cloud-native application architectures to enable faster innovation and business agility.

(IDC Prediction)
Db2 for z/OS support for Cloud & Microservices

Db2aaS
Db2-as-a-Service

- SYSTEM PROVISIONING: INSTALL, MIGRATION, HOUSEKEEPING
- RESOURCES PROVISIONING: DB, TABLES, INDEXES, DATA
- APP DEV LIFECYCLE: SINGLE OR MULTI PLATFORM APPLICATION DEPLOYMENT
- APP DEV ENVIRONMENT: DEDICATED ENVIRONMENT ON OR OFF PREMISES

DaaS
Db2 Data-as-a-Service

Digital & Modern Enterprise Applications
Native RESTful APIs

- Db2aaS: APIs and automation to enable self-service and improved productivity for developers and administrators
- Microservices Architectures: RESTful API support for next generation application development

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Db2aaS DevOps and Cloud Provisioning Goals

Db2 and Db2 Tools are providing APIs and automation to enable Db2aaS for developers and admins

Improve developer productivity via self-services
- Provision, Configure, Manage
- Use Db2 for z/OS resources
- Dramatically reduce the occasions where developer is waiting on administrator

Improve administrators’ productivity
- Database design, tuning activities
- Automated business rule enforcement
- Integrated review and approval of changes and deployment processes
- Developer self-services for provisioning, management, and housekeeping activities
- Automated Db2 release upgrades
Goal: make it as easy to develop on Db2 for z/OS as any other DBMS … without sacrificing quality control & oversight
Example of Provisioned Db2 Schema (IBM Cloud Private)
Mainframe aaS Architecture Overview

Developer Portal (e.g. IBM Cloud Private)

Catalog (Marketplace)
- MWaaS: CICS, DB2, MQ, WAS
- IaaS: Linux on z
- SaaS: BLaaS, DBaaS, BaaS, DRaaS, EaaS, MLaaS, sCaaS

Consumer capability
- Start, Stop, Delete service

Provider capability
- Manage service provisioning

Dotted lines represent remote call boundaries

UI / REST API
0 Workflow Engine
1 System Definitions, Registry
2 Tenant Mgmt
3 Resource Mapping Services
4 Resource
5 Team
6 Resource

0) z/OSMF workflow based automation for pre-defined middleware templates
1) Publish Services in secure Catalog
2) Define Service-consuming Tenants
3) Pre-define z/OS Resource Pools
4) Resource Mapping Orchestration
5) Optional Cloud Portal Subscribe
6) Provisioned Service-Instance Registry

Software Defined Environments

Linux on z Operating System

z/OS Operating System

IBM Analytics

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z/OSMF

DevOps for Db2 for z/OS

An optimized and automated process for rapid deployment of applications and database schema changes to simplify and speed the delivery of critical operational environments for exceptional business value

SPEED
• Reduce time and cost to deploy application changes
• Deploy more frequently with more autonomy and control
• Automated. Accelerated.

SIMPLICITY
• Reduce errors of manual process
• Frees up resources by allowing other users to deploy
• Collaborative. Accurate.

SECURITY
• Safeguard valuable assets under the control and security of Db2 for z/OS
• Transparent and auditable review built into process
• Protected. Secured.

Delivered via IBM Change Management Solution Pack
4Q2016 Generally Available
Db2 Data as a Service
Db2 Cloud/Mobile modernization with RESTful APIs and JSON

• Many modern application developers work with REST services and JSON data formats
• Db2 12 and Db2 11 support Native REST services
  • Easier DBA management of Db2 RESTful services, means easier adoption
  • z/OS Connect Enterprise Edition (zCEE) integration

Serving mobile data directly from z/OS is 40% less expensive than exporting to a system of engagement
Db2 12 Index In Memory Optimization

- Fast Traverse Block (FTB) contains non-leaf pages
  - Unique index with size of 64 bytes or less
- Turned on as default with upper limit control by user. Daemon process monitors index usage to identify which indexes are best to cache
  - Object level control overrides possible through catalog table
Db2 12 for Simple Look-up: Faster & Cheaper

Up to 23% CPU reduction for index look up using Db2 12 In-memory index tree (FTBs)
Using Index in Memory – 2way Data Sharing OLTP (IRWW)

Key Observations
- About 3.5% average Db2 CPU/transaction reduction without FTB
- FTB usage adds additional saving of 3%
- 45% getpage reduction
- Real storage increase total was 300MB per member
Db2 12: CPU Reductions for Transactions

Index Fast Traversal with OLTP workloads
CPU improvement in Db2 12 compared to Db2 11

- CICS - OLTP (RTW) - 2way
- CICS - OLTP (RTW) - 1way
- IBM Brokerage workload
- Distributed stored procedure workload
- Classic IRWW - 2way
- Classic IRWW - 1way

CPU Time % diff

FTB enabled
FTB disabled
Db2 12 Performance Expectations

CPU Saving by Workload Types
% Db2 saving compared to Db2 11

- OLTP without index memory optimization
- OLTP with index memory optimization
- Queries after rebind
- High volume concurrent insert
Db2 12 Contiguous Buffer Pools for In-memory Tables

Db2 11
PGSTEAL(NONE), PGSTEAL(LRU)

PGSTEAL(NONE) in V12

Oldest sequential buffer

T1

T2

T3

Overflow area
Contiguous Buffer Pools and Overflow Area

- Much better performance/scaling for very large buffer pools
  - No more chain maintenance for in-memory objects
- Frequently accessed tables with stable size are the best candidates
- VPSIZE includes overflow area
  - OVERFLOW ALLOC is 10% of VPSIZE, but 6400 buffers max
    - \( \text{SUM(Number of pages of objects in this BP)} + 6400 = \text{VPSIZE} \)
- DSNB604I – New Message is used when pages are read into overflow area
- Statistics trace now contains the overflow usage
**Db2 12: Other Examples Utilizing Memory**

### RLF
- RLF tables are cached in memory
- Avoids catalog accesses during SQL processing
- Applies both dynamic and static RLF

### DGTT
- Db2 catalogs requires to declare DGTTs are cached in memory
- Avoids accessing catalog and directories during declare

### UDF
- DETERMINISTIC, NO EXTERNAL ACTION and not MODIFIES SQL DATA
- Avoids invoking UDF again for the same input
INSERT Performance

Insert workloads are amongst the most prevalent and performance critical.

Db2 12 delivers significant improvements for Non-clustered insert: journal table pattern:

- UTS, MEMBER CLUSTER

Advanced new insert algorithm to streamline space search:

- Default is to use the new fast algorithm for qualifying table spaces
  - DEFAULT_INSERT_ALGORITHM zparm can change the default
  - INSERT_ALGORITHM table space attribute can override zparm
DB2 12: Introducing New Insert Algorithm 2

In memory Structure (Insert Pipe)

Page A

Thread-1
Thread-2
Thread-3

A ✔  B ✔  C ✔  D

Thread-1
Thread-2
Thread-3

Page A
Page B
Page C
Page D
Simulated stock exchange transactions (row size = 200 bytes)
- Utilizing Db2 12 features: New insert algorithm and scalability enhancements
- All done with single z13 box
- 12 way Db2 data sharing with 4 way sysplex with high availability
- 7 DS8870 control units: logs spread across 6, tables/indexes separate
- 2GB/sec total logging
- 5.3 M inserts per second after adding an index
- About 2x faster than V11 on average
- Relieves bottlenecks that can arise with the old insert algorithm
PBG/Member Cluster with 800 concurrent clients

Throughput (insert/sec)

- PBG with Member Cluster, RLL, with 400 bytes per row, one index, 800 concurrent threads, 10 insert per commit
Db2 12: CPU Reductions for Query Workloads vs. Db2 11

Query - Db2 12 CPU saving (%) after Rebind

- SAP CDS FIORI
- Was portal - selective
- Crystal Reports
- Customer -1
- SAP CDS FIN
- IBM BIDAY-short
- Customer -2
- IBM Retail DW
- Customer -3
- Customer -4
- IBM Retail DW with SQLPL
- IBM Retail DW set 2
- SAP/BW
- IBM BIDAY-long

- UNION ALL w/View
- Complex Outer Join, UDF
- Complex reporting, large sort
- Simple query or large data scan

% CPU Change
Db2 12: Performance and Scalability

- LOB compression – uses zEDC hardware
- Much larger active log data sets – up to 768 GB
- Larger buffer pools – up to 16TB
- Query parallelism child tasks – now 100% zIIP eligible
- Avoid log force for identity columns in data sharing
Db2 12: Simplicity and RAS

Dynamic SQL Plan Stability
- Stabilize performance of repeating dynamic SQL statements

DRDA Fast Load
- Callable command for fast load of data into Db2 directly from files on distributed client

RUNSTATS automation
- Optimizer automatically update profile with RUNSTATS recommendations

RLF control for static packages

Automatic management of LOB and XML pools

Avoid failures due to EDM pool storage exhaustion
Db2 12: Simplification: RUNSTATS Automation

- Optimizer & DDL direct update of stats profiles
- Other RUNSTATS improvements:
  - USE PROFILE support for inline stats in REORG & LOAD
  - Inline stats support for LOAD PARALLEL
  - INVALIDATECACHE option to avoid dynamic cache invalidation
  - COLGROUP performance – 25% CPU, 15% ET reduction
Db2 12: application enablement

Several SQLPL Improvements

- SQLPL in triggers, including versioning and debug support
- SQLPL obfuscation
- Support for constants
- Dynamic SQL in SQLPL UDFs and stored procedures

ARRAY and LOB global variables

JSON function improvements for easier retrieval of JSON data
Db2 12: Application Enablement…

• Enhanced MERGE support

• New SQL Pagination syntax

• Piece-wise modification of data (DELETE)

• Hashing functions

• XMLModify multiple update support

• Bi-temporal improvements
  • Inclusive/inclusive support
  • Temporal RI
  • Logical transaction for system time
Db2 12 Lifting the Limits

- New PBR tablespace structure called ‘PBR RPN’
- Relative page numbers (RPN) instead of absolute
- Remove dependency between #partitions & partition size
- New RID is Relative RID
  - Part Number stored in Partition Header Page
  - Page number stored in Data Page, relative to start of the partition
- Up to 1TB Partition Size, or 4 Petabytes (PB) per table space
- Maximum number of rows with 4K pages increased from 1.1 to 280 Trillion
  - @1,000 rows inserted per second, more than 8800 years to fill!
- Allows for increasing DSSIZE with zero application impact
- Increasing DSSIZE is supported at partition-level and for indexes
- Positions Db2 for future enhancements
  - Increase in partition limits, increase number of rows per page
  - Attribute variance by partition, schema changes via REORG PART
Db2 12 Online Schema Improvements

Insert partition

Online deferred ALTER INDEX COMPRESS YES
  • Previously placed indexes in RBDP

Option to defer column-level ALTERs
  • Materialize through online REORG
  • Avoid availability constraints & conflict with other deferred alters

TRANSFER OWNERSHIP
Hidden ROWID Support to Partition (V12 and V11)

- Problem: no appropriate column to partition

- ROWID can be used as a partitioning column

- Application impact if ROWID cannot be hidden
  - APARs to support to define a hidden ROWID
    - PI76972, PI77310, PI77302 (V12)
    - PI77718, PI77719, PI77360 (V11)

```sql
CREATE TABLE akiko.ZISCNTP0 (
    CLIENT VARCHAR(3) NOT NULL,
    WI_ID VARCHAR(12) NOT NULL,
    LENGTH SMALLINT,
    DATA VARCHAR(1000),
    ROW_ID ROWID NOT NULL IMPLICITLY HIDDEN generated always
) PARTITION BY (ROW_ID)
    (PARTITION 1 ENDING AT (X'0FFF'),
    PARTITION 2 ENDING AT (X'1FFF'),
    PARTITION 3 ENDING AT (X'2FFF'),
    PARTITION 4 ENDING AT (X'3FFF'),
    ...)
```
IBM Db2 12 Utilities – Key to enabling Db2 function

Continuing evolution of REORG utility

Diminishing importance of data re-clustering for application performance
  • Optimizer improvements, I/O performance improvements, caching improvements, contiguous buffer pools

Increasing use of IBM REORG for schema evolution
  • Insert partition
  • PBR RPN conversion
  • Deferred column-level alter
  • LOB compression

Improved PBG partition management
  • Overflow to new PBG partition to ensure successful partition-level REORG of PBGs
Db2 12 Utilities

Maximizing Efficiency & Eliminating Application Impact

Improved efficiency

- Further CPU cost reduction, more zIIP offload
  - REORG up to 57% zIIP offload
  - LOAD up to 90%
- REGISTER NO option to eliminate data sharing overhead for RUNSTATS, UNLOAD
- COLGROUP statistics CPU cost reduced by up to 25%, elapsed time up to 15%
- More efficient handling of compressed data to reduce CPU and elapsed time across range of utilities
- REORG avoidance: Immediate increase of partition DSSIZE with PBR RPN
- Improved FlashCopy support
  - Multiple DFSMS COPYPOOL support for SLBs & better messaging
  - Improved FlashCopy handing in REORG & template support for MGMTCLAS, STORCLAS

Eliminating application impact

- Improved LOAD utility support for sequences with automatic handling of MAXASSIGNEDVAL
- Online LOAD REPLACE – non-disruptive refresh of reference tables
- Skip invalidation of cached statements by RUNSTATS
- Removed recoverability restrictions for PBG table spaces
Utility zIIP Offload – Load and Reorg
Db2 12, and now Db2 11 with PI73882

Utility zIIP offload rate (%)

Db2 11 without PI73882

LOAD TS/PART 1  LOAD TS/PART 2  LOAD TS/PART 3  REORG 1  REORG 2  REORG 3  REORG 4  REORG 5  REORG 6  REORG 7  REORG 8  REORG 9

V11
V12
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
  - 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 while duplexing of CF LOCK1 structure

Requirements:
  - z/OS 2.2 SPE with PTFs for APARs OA47796 and OA49148
  - CFCC Level 21 (z13)
  - Db2 12
Asynchronous CF Lock Structure Duplexing

Current: Synchronous Duplexing

1. Request in
2. Req out
3. Communication
4. Response
5. Response

New: Asynchronous Duplexing (much faster)

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

* Requires CF on z13 GA2
Async Lock Duplexing – OLTP without Distance
Migration Prerequisites – Hardware & Operating System

Processor requirements:
  • z196 class processors or higher

Software Requirements:
  • z/OS V2.1 Base Services, (5650-ZOS), or later
  • DFSMS V2.1, or later
  • Language Environment Base Services
  • z/OS V2.1 Security Server (RACF), or later
  • IRLM Version 2 Release 3 (Delivered with Db2 12)

No more single version charging

Additional details:
Migration & Catalog

Single phase migration process

- No ENFM phase
- New function activated through new command: ACTIVATE FUNCTION LEVEL
- BNFA vs. ANFA
- APPLCOMPAT rules, fallback rules continue to apply

BSDS conversion to support 10 byte log RBA is pre-requisite

No pre-V10 bound packages

- Get rid of 31-bit runtime, some performance improvements

BRF is deprecated

- BRF page sets still supported, but zparm and REORG options are removed

Temporal RTS tables

- Defined in catalog, enablement is optional
Db2 for z/OS Focus Areas for the Future

**Analytics**
- HTAP
- Db2/IDAA integration

**Cloud**
- Application developer self-service
- DevOps improvements
- System simplification and autonomic
- Embedded Machine Learning

**Modern Application Development**
- Leading edge features for strategic applications

**Technology Leadership**
- Security
- Performance, scalability, z integration
- Continuous availability

Next Gen workloads with our world class Qualities of Service
2017 Deliveries

- **IDAA**
  - Special Register and Bind Option for User-Specified Accelerator – February 2017
  - CAST of GRAPHIC/VARGRAPHIC support for IDAA – February 2017
  - Multi-Row Insert for Accelerator Only Tables – March 2017
  - IDAA Federation – July 2017
  - IDAA V6/V7 – October 2017
  - IDAA HTAP Dynamic Query Support – October 2017

- **z14 Synergy**
  - HyperLink Support for Random Database Reads – September 2017 (Phase 1), December 2017 (Phase 2 - planned)
  - Transparent Dataset Encryption Support – October 2017 (V11, V12), December 2017 (V12 FL - planned)
  - Huffman Data Compression Support – January 2018 (planned)

- **Performance Enhancements**
  - zIIP enablement for RELOAD phase of LOAD and REORG Utilities – February 2017
  - IMS Attach Connection Pooling Support – February 2017
  - Partition by hidden ROWID columns – May 2017
  - zIIP enablement for LOAD PARALLEL RELOAD phase – June 2017
  - RUNSTATS Performance Improvement for Single Colgroups – August 2017 (V11), November 2017 (V12)
  - CHECK LOB Utility Performance Improvement – August 2017
  - Access Path Improvement To Encourage The Tables With Good Filtering To Be Joined Earlier – October 2017
  - REORG Performance Improvement during UTS conversions – October 2017
  - Analytics integration into OLTP queries – November 2017
2017 Deliveries

- Utility Enhancements
  - Support new INVALIDATECACHE option in M100 – January 2017
  - Table Schema Checking Enhancement for Repair Catalog – February 2017
  - Additional LOAD IGNORE Options for Ignoring Rejected Records – May 2017
  - Support for Incremental or Full Inline IC When Loading Data Incrementally – November 2017

- Serviceability Enhancements
  - Enhanced Monitoring for in Index In-Memory Optimization – May 2017
  - Improved Reporting of Real Storage Statistics – July 2017
  - Set Partition Key Columns as Updateable for Tables Created Prior to V5 – August 2017
  - Enhanced Monitoring for Insert Algorithm 2 Capabilities – October 2017
  - Disable or Re-enable Insert Algorithm 2 Capability via ZPARM – November 2017
  - Enhanced Metadata Self-Description Capability (Storing Version 0 Info) – November 2017 (V12), January 2018 (V11)

- Application Developer self-service and productivity
  - LISTAGG Support via FL501 – March 2017
  - DB2aaS improvements: Provision Schema With z/OSMF Workflows – March 2017
  - Native REST Client Certificate Support – June 2017
  - Native REST Trusted Context Support – June 2017
  - Native REST Persistent Connection Support – November 2017
  - Native REST TSO BIND/FREE Service Support – November 2017

- GDPS Active/Active with zero data loss
  - GDPS Active/Active – CDDS Online Recovery and Cleanup – November 2017
Db2 12 Function Levels – Our Future Delivery Model

Start slow, speed up as we go

- Quality, stability is priority #1
- Some features will be retrofit to V11, this will diminish over time
- Function levels (FLs) are the mechanism to activate new features on V12
  - FL 500 is base V12 NFM. FLs 501, 502, … beyond that
  - Goals: faster delivery, easier to consume for customers (compared to traditional release migration)

FL 501 – 1st post-GA delivery

- LISTAGG
- SAP published certification for FL 501 in Sept., 2017

FL 502 – 2nd delivery (planned 2Q18)

- TDE usability improvements, casting numeric to GRAPHIC/VARGRAPHIC
- New catalog level
Near-term Focus Areas

- **Simplification for app dev**
  - Db2aaS: more APIs and automation for self-service
    - Create schema-like with data
    - De-provision a Db2 application environment
    - Configure automated backups, ...
  - DevOps
    - Urban Code Deploy (UCD) plugin improvements for automated Db2 app deployments
    - DDL concurrency & 24x7 improvements
    - CREATE OR REPLACE for SQLPL stored procedures
  - Db2 Native RESTful services improvements
    - REBIND support, Monitoring services using profiles, IDAA support
    - Start/Stop/Display Service, versioning support
  - COBOL PL/I Co-processor from HFS
  - zLOAD error handling improvements
  - ODBC improvements for node.js

Vision: app developers can work with Db2 as easily as any other DBMS, on-prem or cloud
Near-term Focus Areas…

- **Simplification for app dev…**
  - SQL functional enhancements
    - Explicit casting from numeric to GRAPHIC or VARGRAPHIC
    - Support VALUES as part of fullselect or stand-alone VALUES clause
  - SQL performance improvements
    - Query performance improvements for join predicate pushdown
      - V12 APAR PI89564. 40 SAP Core Banking queries tested:

<table>
<thead>
<tr>
<th></th>
<th>V12 Base (As-is)</th>
<th>After enhancement (To-be)</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average elapsed time</td>
<td>625.285</td>
<td>0.521</td>
<td>-99.9%</td>
</tr>
<tr>
<td>Average cpu time</td>
<td>341.389</td>
<td>0.446</td>
<td>-99.9%</td>
</tr>
</tbody>
</table>

- Allow MODIFIES SQL DATA function to be invoked in a fullselect
- Improvements for UDF and SP tracing (during development): DBMS_OUTPUT
Near-term Focus Areas…

- Simplification for DBAs and Sysprogs
  - Embedded ML for Smarter Optimizer
    - Expand ML techniques to other areas in Db2 in the future
  - Zparm simplification (too many knobs that few know how to intelligently set)
    - 1st step: collect customer zparm data and remove some zparms
  - Vision:
    - Db2 automatically manages its resources, removing the need for knobs
    - Provides knobs to allow for some manual overrides, making them much easier to set than the archaic Zparm mechanism
  - Quality and RAS improvements
    - V12 Insert algorithm 2 robustness
    - Online catalog migration improvements, instrumentation to assist with planning
    - Extend APREUSE to Autobind
    - Command to contract the large memory object & discard real frames

Vision: Db2 becomes a self-managing system and a leading choice for 24x7 DB services in cloud environments
Machine Learning

- Identifies patterns in historical data
- Builds behavioral models from patterns
- Makes predictions on new data

Idea: why not embed this technology into Db2 for a more self-managing, self-optimizing system?

Machine learning is everywhere, influencing nearly everything we do

Waze personalized driving experience

Netflix personalized movie recommendations

ROBO ADVISORS

7 out of 10 financial customers would take recommendations from a robo advisor
## Potential Embedded ML Use Case Domains

<table>
<thead>
<tr>
<th>Domain Area</th>
<th>Prediction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimizer access path decisions (actively prototyping)</td>
</tr>
<tr>
<td></td>
<td>Buffer pool, Rid pool, Workfile, etc. configuration and tuning</td>
</tr>
<tr>
<td></td>
<td>FTB / In-memory caching decisions</td>
</tr>
<tr>
<td></td>
<td>Free space, Page Splitting decisions</td>
</tr>
<tr>
<td></td>
<td>Etc. (ML could be invoked from any component within Db2)</td>
</tr>
<tr>
<td></td>
<td>Online</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utilities (Reorg, Copy, Runstats, etc.) – integrate with existing tools where it makes sense</td>
</tr>
<tr>
<td></td>
<td>Rebinds (for performance or PTF)</td>
</tr>
<tr>
<td></td>
<td>Software maintenance (PTFs, etc.) Management</td>
</tr>
<tr>
<td></td>
<td>Online / Batch</td>
</tr>
<tr>
<td><strong>Recommendations</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>360 Best practices (e.g. disaster recovery)</td>
</tr>
<tr>
<td></td>
<td>Schema recommendations (e.g. reduce locking, improve performance)</td>
</tr>
<tr>
<td></td>
<td>Db2 application best practices (e.g. SQL coding recommendations)</td>
</tr>
<tr>
<td></td>
<td>Batch</td>
</tr>
</tbody>
</table>
Near-term Focus Areas...

- Simplification for DBAs and Sysprogs...
  - Utilities improvements
    - Inline image copy for LOAD RESUME (v11, v12)
    - REORG TAPEUNITS support
    - LOAD support for multiple SYSREC datasets through TEMPLATE
    - COPYTOCOPY option to delete source
    - LOAD SHRLEVEL CHANGE parallelism retry logic
  - RUNSTATS profile usability, performance
  - Improved RUNSTATS management, removal of stale, unnecessary stats
    - Close gap between RUNSTATS RESET ACCESSPATH and new stats collection
  - Creating stats profile from existing stats to exclude old SYSCOLDIST entries
  - Improvements for replication of temporal history tables
Near-term Focus Areas…

- DBMS Technology Leadership
  - Column encryption improvements
  - More z14 integration
    - HyperLinks for active log writes – much faster commits
    - Order Preserving Compression for better Db2 index compression
  - HTAP leadership
    - IDAA queries see latest committed data – phased delivery
    - IDAA becomes more tightly integrated with Db2
Db2 for z/OS News from the Lab

Common Criteria certification for Db2 12 for z/OS

By Barbara Thorne and Paul McWilliams. We’re proud to announce that Db2 12 for z/OS has joined Db2 11 in achieving an important milestone: Common Criteria EAL4+ certification, on 12 December, 2017. The Common Criteria is an internationally recognized ISO standard (ISO 15408) for evaluating the security properties of IT products. The certification means that clients, especially governmental organizations, can procure and use Db2 12 in the evaluated configuration with assurance, without their own further... [More]

Tags: db2z12 security

Introducing Hybrid Transactional Analytical Processing support for Db2 11 for z/OS

By Roy Smith and Eric Radzinski. Due to limitations with existing analytics technology, the standard approach to data analytics has been to mine insights from data that has been copied to a data warehouse or similar type of repository. This approach introduces data latency, which prevents organizations from basing critical business decisions on real-time data and sometimes causes them to make inaccurate decisions. Additionally, because there’s no guarantee that the real-time transactional data in the database is fully synchronized... [More]
Accelerate Your Upgrade to Db2 12 for z/OS!

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Target Audience: Technical Architects, DBA Managers, Project Managers, Leaders

Db2 12 for z/OS Technology Workshop (free)
- Comprehensive review of capabilities, considerations, preparations & project planning for Db2 12. Contact your IBM account team or send email to Surekha@uk.ibm.com
Db2 12 – More Information

Db2 for z/OS product home page

Whitepaper: Db2 12 for z/OS The In-memory Enterprise Database for Transactions and Analytics
http://ibm.biz/BdsyaT

IDUG Db2 12 Technical whitepaper
http://www.idug.org/db2v12whitepaper

“Scaling Progressive SAP Solutions with Db2 12 – Immediate SAP Certification of Db2 12 at IBM General Availability”

Db2 12 GA Announcement
https://www-01.ibm.com/common/ssi/rep_ca/7/897/ENUS216-077/ENUS216-077.PDF

World of Db2
http://www.worldofdb2.com/
Db2 12 – More Information….

YouTube channel for Db2 videos
https://www.youtube.com/user/IBMDb2forzOS/videos

Redbook: Db2 12 for z/OS Technical Overview

Redbook: Db2 12 for z/OS Technical Overview and Highlights

Redbook: Db2 12 for z/OS Performance Topics

Redbook: Db2 12 for z/OS Optimizer

Redbook: Introducing the z14