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

- IDAA improvements to expand to new use cases
- SQL/SQL PL improvements for next wave of applications
- Relieve table scalability limits
- Simplify large table management
- 5-10% CPU reduction with use of in-memory features
- 2x increase in Insert throughput for non-clustered
- 20-30% CPU reduction for query workloads
- Improve efficiency by reducing other resource consumption
- 80% UNION ALL performance improvement
- Simplify access path management
- Address key customer requirements to expand use of existing features
- Mobile, hybrid cloud, and DevOps enablement
- Remove biggest 24x7 inhibitors
- Security and compliance improvements
- Remove system scaling bottlenecks for high n-way systems
- Serviceability, availability
Quick Hits

• Scale and speed for the next era of mobile applications
  • Over 11 Million Inserts per second measured when hitting “sweet spot”
  • 6 trillion rows in a single table, with agile partition technology

• In Memory database
  • Up to 23% CPU reduction for index lookup with advanced in-memory techniques

• Next Generation application support
  • 360 million transactions per hour through RESTful web API

• Deliver analytical insights faster
  • Up to 25% CPU saving for traditional query workloads
  • Up to 2x speed up for modern (complex OLTP or real-time analytics) workloads
PERFORMANCE FOCUS
TRADITIONAL WORKLOADS

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Performance Enhancements

- **In-memory contiguous buffer pools**
  - Direct page access in-memory, greatly reduced GetPage overhead
  - Hash and LRU chains not maintained
  - Up to 8% CPU reduction measured for OLTP
  - PGSTEAL(NONE) – improved in DB2 12 to avoid LRU and hash chain management overheads
  - Overflow area (10% of VPSIZE, max of 6400 buffers)
    - Used in case objects do not fit
    - Automatically managed by DB2 using FIFO steal algorithm
    - Allocated when buffer pool is allocated, but only backed when used

- **In-memory index for fast traversal (see next slide)**

- **More granular Global Commit LSN and Read LSN**
  - Potential huge improvement in lock avoidance (data sharing)
  - Help space reuse for LOB insert
In-Memory Index Optimization

- A new Index Fast Traverse Block (FTB) is introduced
  - Memory optimized structure for fast index lookups
  - Resides in memory areas outside of the buffer pool
    - New zparm INDEX_MEMORY_CONTROL
      - Default=AUTO (min of 500 MB or 20% of allocated buffer pool storage)
    - UNIQUE indexes only, key size 64 bytes or less
- DB2 automatically determines which indexes would benefit from FTB
- DISPLAY STATS command shows which indexes are using FTBs
- New SYSINDEXCONTROL catalog table
  - Specify time windows to control use of FTBs for an index
- New IFCIDs 389 and 477 to track FTB usage
Simple Index Look-up: Faster & Cheaper

- Up to 23% CPU reduction for index look up using DB2 12 In-memory index tree
Performance Enhancements ...

- **Avoid scheduling unnecessary prefetch**
  - Problem: when all pages are in memory, dynamic prefetch needlessly schedules prefetch
  - Wastes CPU, can cause “out of prefetch engine” condition
  - Attempts to solve this in the past failed - solved in DB2 12
  - Up to 6.8% CPU reduction for OLTP, 4.5% for query
Performance Enhancements ...

- INSERT Algorithm 2 (see next slides)
- RLF control for static packages
- DB2 / DASD synergy enhancements – retrofit to V10, V11
  - Exploit z/OS HyperWrite (PPRC log write accelerator)
    - Up to 30% log write latency reduction
  - Improved Integration with DS8870 Easy Tier multi-temperature management
    - Avoid I/O degradation after REORG
INSERT Algorithm 2 Performance

- Insert workloads are amongst the most prevalent and performance critical
- Performance bottleneck will vary across different insert workloads
  - Index maintenance?
  - Log write I/O?
  - Space search (page p-lock, page latch contention)
  - PPRC disk mirroring
  - Network latency
  - etc
**INSERT Algorithm 2 Performance ...**

- **DB2 12** may potentially deliver significant improvement for non-clustered insert (e.g., journal table pattern where both **concurrent** insert activity and **space search** is the constraint on overall insert throughput
- **Applies to UTS** with MEMBER CLUSTER (both with/without APPEND)
- **Implemented advanced new insert algorithm** to streamline space search
  - Default is to use the new fast algorithm for qualifying table spaces
    - INSERT ALGORITHM zparm can change the default
    - INSERT ALGORITHM table space attribute can override zparm
- **Your mileage will vary**
  - Some insert workloads will see no improvement
  - Some specific insert workloads may see significant improvement
- **Will shift the bottleneck to the next constraining factor**
INSERT Algorithm 2 Performance – Shifting The Bottleneck …
INSERT Algorithm 2 Performance - DB2 11 PMR Recreate ...

UTS PBG with Member Cluster, RLL, with 400 bytes per row, one index, 800 concurrent threads, 10 insert per commit
Performance Enhancements...

- **Buffer Pool advisory mode to simulate larger buffer pools – rollback to V11**
  - Low CPU and real memory overhead
  - Statistics provided to indicate I/O savings
  - Retrofit to V11

- **Streamlined Claim/Declaim processing**
  - Avoid re-claim overhead across multiple commit scopes serially reusing persistent thread running RELEASE(DEALLOCATE)
  - Online REORG and other drainers can still break in
Other Performance Enhancements ...

- **Improvements in pool management to simplify and remove the scalability inhibitors**
  - EDM pools
  - LOB/XML storage
- **Other Improvements**
  - Reducing DGTT DECLARE overhead
  - Remove log force write from identity column and sequence caching in data sharing
System Scaling Enhancements

- **Large n-way scaling**
  - Improved efficiency on LPARs with high number of CPs
  - Log latch contention reduction: testing shows up to 41% CPU reduction and 6% throughput improvement for high contention cases
  - Buffer Pool scaling improvements:
    - LC23 reduction, PLO avoidance
    - 5-30% CPU improvement when accessing hot pages
  - IRLM latch contention reduction
  - EDM DBD and skeleton pool scalability improvements

- **Optimizations for new hardware**
  - Exploitation of z13 decompression enhancement
  - Internal structure changes for cache efficiency, more processor prefetch

- **Raise total buffer pool size limit to 16 TB**

- **>4G size active log datasets**
High level performance expectation

- **System and OLTP performance**
  - 2-3% CPU reduction without Index In-Memory feature
  - 5-10% CPU reduction by exploiting Index In-Memory feature
  - Further reduction is possible with contiguous buffer pools, and / or persistent RELEASE(DEALLOCATE)

- **Query performance**
  - Wide range of improvement
    - Typically 0-20% without new access path
    - Typically 10-40% with new access path
    - Up to 90% reduction is observed in our evaluations

- **Concurrent insert against UTS and MEMBER CLUSTER**
  - 5-10% CPU reduction
  - Throughput improvement if current bottleneck is space search or page contentions
Instrumentation Enhancements

- More granular wait times for IFCIDs 316 (dynamic) and 401 (static)
  - Accumulated wait time due to global contention for locks (broken out by type)
- Enhance IFCIDs 53/58 statement level section for PREPARE
  - Similar to INSERT/UPDATE/DELETE
- Enhance SQL performance tracing adding RDI Section Number in IFCIDs 53/58
- Add batch job STEP name in correlation header
- Add REFRESH TABLE to counts in DSNDQXST (SQL data section)
- Add workfile, tempfile usage information to Accounting trace
- Enhanced precision for IFCID 199 dataset I/O stats - microseconds
Access path (plan) stability

- Dynamic SQL plan stability
- Static plan stability usability
- Preserve local dynamic statement cache at rollback
- Integrated RUNSTATS with optimizer
  - Automated update of statistics profiles by optimizer
- Statistics profile support
  - Automated update for Index DDL
  - Inline stats usage of profiles
- Simplify creation of all tables required by Explain
  - New ADMIN_EXPLAIN_MAINT stored procedure
Dynamic SQL Plan Stability

- **Problem:**
  - Unstable performance of repeating dynamic SQL statements
  - Environmental changes can result in change in access path or performance regression, and this can be tough to manage
    - RUNSTATS
    - Applying software maintenance
    - DB2 release migration
    - zparm changes
    - Schema changes

- **Static SQL has several advantages**
  - Access path established at BIND time
  - Static plan management gives advanced management functions

- **Objective:** extend static SQL advantages to dynamic SQL
Dynamic SQL Plan Stability ... 

- **Base infrastructure**
  - Opaque parameter CACHEDYN_STABILIZATION
  - Capture via -START DYNQUERYCAPTURE STBLGRP(APP1) ...
    - Command with / without monitoring
    - Global variable
  - FREE
  - EXPLAIN (current, invalid)
  - Invalidation
  - LASTUSED (identify stale statements)
  - Instrumentation (query hash, explain, cache + catalog hit ratio)
  - APPLCOMPAT is part of matching criteria

- **Save query and cache structures to catalog for subsequent reuse on cache mis**
Dynamic SQL Plan Stability ...

• **Key limitations**
  • Literal concentration and temporal stabilization not currently included
  • REBIND support not included
    • No PLANMGMT/SWITCH/APREUSE
Static Plan Stability: Usability

- **BIND REPLACE of same version to keep LASTUSED**

- **FREE PACKAGE improvements**
  - Selectively FREE either original or previous
  - Choose to FREE if invalid only
  - Allow FREE of inactive package copies while application is running

- **REBIND PACKAGE improvements**
  - SWITCH to include APREUSESOURCE option so as to choose ORIGINAL or PREVIOUS copy as source for APREUSE
  - Addresses issue of switch accidentally causing invalid copy to become current
  - APREUSESOURCE option avoids the two step process of
    - REBIND SWITCH followed by
    - REBIND APREUSE
RUNSTATS Enhancements for SQL Performance

- **RUNSTATS (for access path selection benefit)**
  - CLUSTERRATIO formula improvements
  - Statement cache invalidation
    - Optional for RUNSTATS (new default)
    - For other utilities ONLY if objects in pending state before utility executed
  - Profile support for inline statistics
  - Automated COUNT for FREQVAL
    - Allow DB2 to collect the skewed values
      - Up to top 100 or until no skew for remaining values
  - Optimizer to automatically update statistics PROFILE with RUNSTATS recommendations
    - DSNACCOX to recommend RUNSTATS after profile update
      - Specify USE PROFILE on RUNSTATS to collect current statistics recommendations
Enhanced statistics profile management

Inline statistics & RUNSTATS

Statistics in Catalog

Table structure in Catalog

Create/Drop Index

Profiles in Catalog

Optimizer

Query

Access Path

All new with V12
PERFORMANCE FOCUS
ENABLING NEW APPLICATIONS
Query Performance Enhancements

• **Up to 25% CPU improvement for traditional query workloads**

• **Up to 2x improvement for modern SQL applications**
  • Performance improvements for next generation SAP applications
  • Real-time analytics, complex OLTP workloads

• **100% zIIP eligibility for parallel query child tasks**

• **Modern applications contain more complex SQL patterns (targeted in DB2 12), and more sorting, joins, stage 2 predicates etc.**
  • These complex patterns are less common in traditional OLTP/batch
Query Workload CPU and Elapsed time Improvement from V11 (%)

- WAS Portal
- SAP SFIORI
- SAP SFIN
- Customer 2
- BIDAY-short
- TPCH 30GB NPI
- Crystal Reports
- TPCH-SQLPL
- Customer 1
- Customer 3
- TPCD
- SAP/Bw
- BIDAY-long

- UNION ALL w/View
- Complex Outer Join, UDF

- Complex reporting, large sort
- Simple query or large data scan

CPU
Elapsed

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High-level Performance Focus

- Query (RDS) focus based upon new(er) workloads
  - Complex views or table UDFs
    - UNION ALL
    - Outer joins
      - Join predicates with (Stage 2) expressions
  - CASE expressions, CAST functions, scalar functions
- Query - General Bottlenecks
  - Sort/workfile reductions
  - Reducing prepare cost and frequency
  - I/O performance
    - Reduce unnecessary prefetch scheduling
Query Performance Focus

- **Improve performance of**
  - UNION ALL and outer join performance enhancements
    - Performance issues are similar with both types of query pattern
    - Reduce materializations
      - Bypass workfile usage when materialization required
      - Trim unnecessary columns from materializations
    - Push predicates inside UNION ALL legs or OUTER JOIN query blocks
    - Push ORDER BY and FETCH FIRST into UNION ALL legs
    - Reorder OUTER JOIN tables to avoid materializations

- **Table UDFs**
  - Improve merge similar to views
  - Indexability of join predicates
Query Performance Focus ...

- **Improve performance of ...**
  - Join predicates with Stage 2 expressions
  - Stage 2 to indexable
    - VARBINARY, COLLATION_KEY IOE
  - Expression evaluation
    - CASE, SUBSTR, etc
    - Expression sharing (SELECT list only)
    - Caching deterministic UDF results
  - Enabling parallelism
    - 100% zIIP offload for parallel child tasks
    - Reduce cost and resource consumption
  - Sort
    - Reduce workfile usage for GROUP BY/DISTINCT
    - Reduce key length for GROUP BY/DISTINCT and sparse index
    - Continued progress towards in-memory for smaller sorts (begun in V9)
Query Performance Focus ...

- **Adaptive index**
  - Simple example of targeted use case
    ```sql
    SELECT * FROM TAB1 WHERE COL1 < ? AND COL2 < ? AND COL3 < ?;
    INDEXES:  IX1 (col1), IX2 (col2), IX3 (col3)
    ```
  - Filtering of the above query is dependent on literals at execution
    - Common pattern for search screens (with BETWEENs or LIKEs)
    - Common that 1 index is filtering unless a highly skewed value is searched
Query Performance Focus ...

- **Adaptive index** ...
  - Allow RID based plans (single index list PF or multi-index) to quickly determine filtering from index
    - Without requiring REOPT(ALWAYS)
    - For list prefetch or multi-index ORing
      - Earlier opportunity to fallback to tablespace scan if large % of table to be read
    - For multi-index ANDing
      - Reorder index legs from most to least filtering
      - Early-out for non-filtering legs, and fallback to rscan if no filtering
  - **Optimizer to use uncertainty to determine risk of a single index plan**
    - Quick evaluation done based upon literals used
    - Any further evaluation of filtering deferred until after 1 RID block retrieved
      - Ensuring that very short running queries do not incur overhead
MIGRATION

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Migration Prerequisites – Hardware & Operating System

- **Processor requirements:**
  - z196, or higher, processors running z/OS V2.1, or later
  - DB2 12 will probably require increased real storage for a workload compared to DB2 11 for z/OS

- **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)

- **Additional details:**
Migration & Catalog

- **Single phase migration process**
  - No ENFM phase
  - New function activated through new command
    - `-ACTIVATE FUNCTION LEVEL` with "V12R1Mnnn" where nnn >= 500
    - 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
Online Migration Improvements

- **Pause statistics externalization during migration to reduce contention (part of fallback SPE)**
  - Real time statistics
  - Stats feedback
  - SYSPACKAGE.LASTUSED

- **Catalog/directory lock duration reduction APARs (impacts online migration, catalog REORGs)**
  - PI43662 – Accelerator resources released in a timely manner
  - PI43916 – DB2 plan allocation locks released in a timely manner
  - PI39053 – Avoid locks from SET statement
  - PI40755 – Dynamic SQL release prepare locks earlier
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