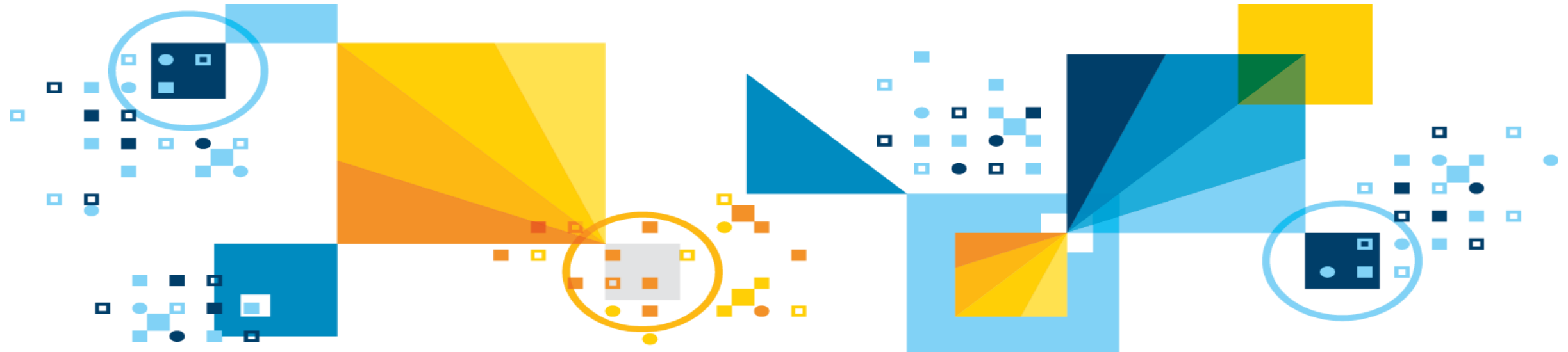April, 2019

Db2 for z/OS Latest News and Future Directions

Jeff Josten
Distinguished Engineer, Db2 for z/OS Development

Please Note

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

- Information regarding potential future products is intended to outline our general product direction and it should not be relied on in making a purchasing decision.

- The information mentioned regarding potential future products is not a commitment, promise, or legal obligation to deliver any material, code or functionality. Information about potential future products may not be incorporated into any contract.

- The development, release, and timing of any future features or functionality described for our products remains at our sole discretion.

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.

Db2 for z/OS Strategy

Db2 for z/OS is investing for leadership in the AI, cloud, and analytics era, extending our Z platform heritage of 24x7 availability, security, scalability and performance, and simplifying and modernizing to maintain Db2 as a top choice for next-gen IT professionals without requiring deep Z skills

Db2 for z/OS Strategy

AI, ML, Advanced Analytics

- Db2ZAI
- IDAA integration, HTAP
- Expanded OLAP

Make Db2 data simple for AI and Analytics.
Embed AI to make Db2 smarter.

Modern Application Development

- Developer experience
- DB2aaS, cloud provisioning
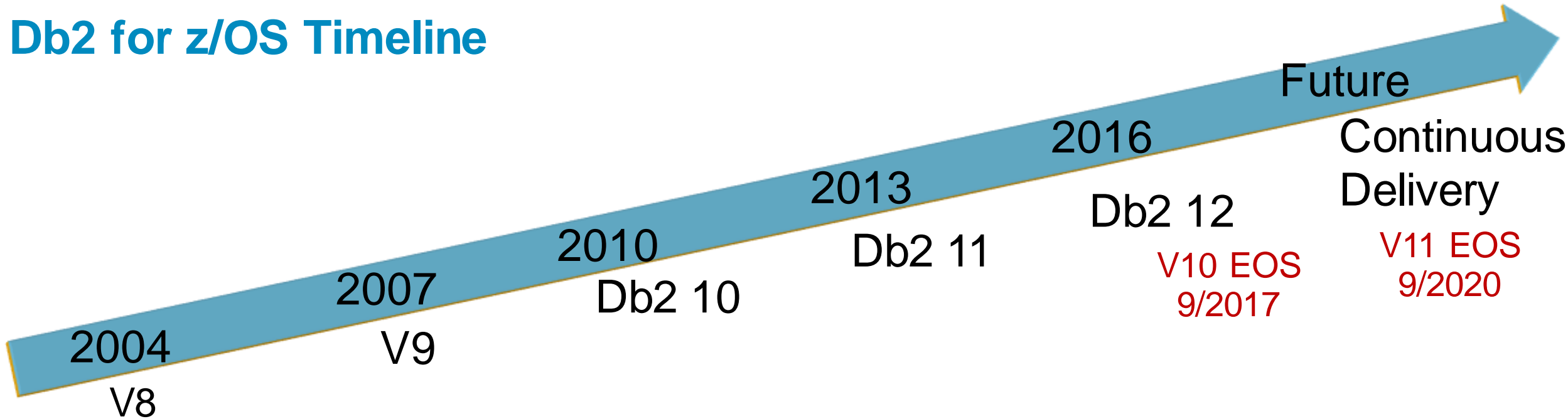- DevOps, online schema
- Enhanced REST services
- SQL improvements

Simplification & modernization for
application development

DBMS Technology Leadership

- Z platform optimization
- Admin Simplification
- Online catalog migration
- Enhanced Compression
- In-memory, performance

Leadership in resiliency, availability, security, performance, scalability.
Make the system easier to manage.

Db2 for z/OS Timeline

Future

2016

Continuous
Delivery

2013

Db2 12

2010

Db2 11

V11 EOS
9/2020

2007

Db2 10

V10 EOS
9/2017

2004

V9

V8

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

Scale and speed for the next era of applications

Insert algorithm 2 for fast unclustered inserts
UTS PBR RPN for larger, more flexible partitioned tables
DRDA Fast Load for easier loading of data from distributed clients
Larger active log size
LOB Compression

In-Memory database

FTBs for advanced in-memory technology for faster transactions consuming less CPU

Deliver analytical insights faster, expand to more applications

2-10x improvement for modern analytics workloads*
SQL improvements such as SQL pagination, enhanced MERGE, piece-wise DELETE
Native REST services

Easier to manage, higher availability

Db2aaS APIs and automation for self-service provisioning of resources
Automated admin operations such as RUNSTATS
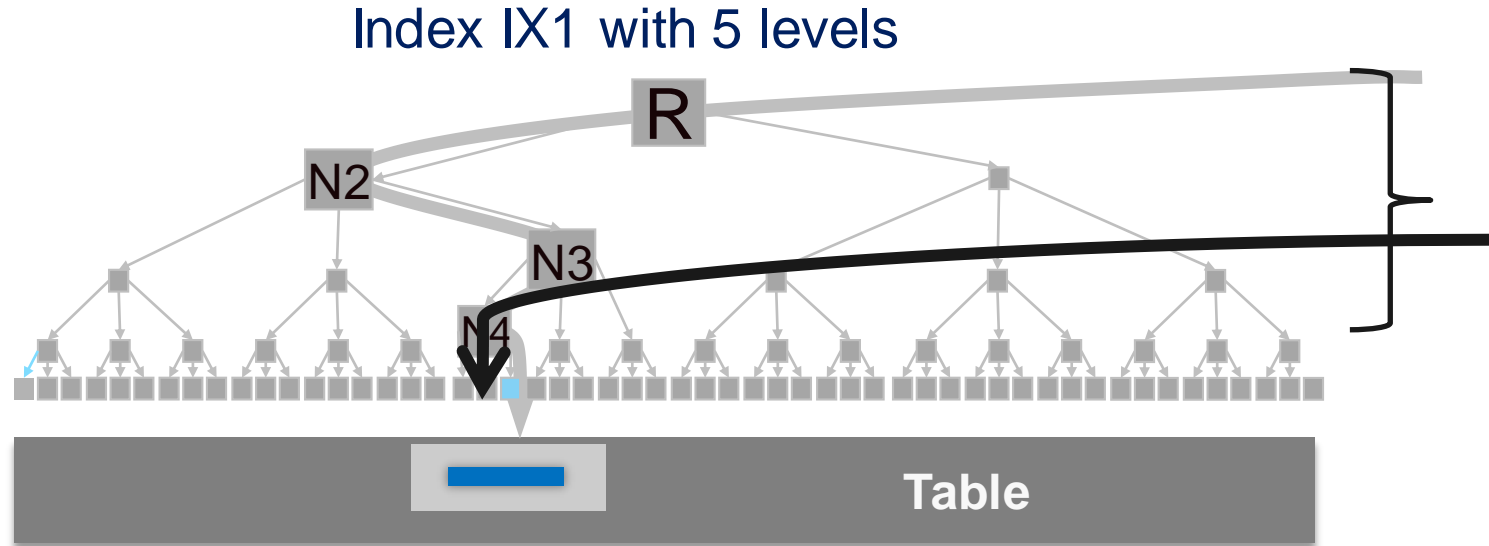Insert partition and more schema and partition flexibility
TRANSFER OWNERSHIP for easier security admin
Dynamic SQL plan stability

The launch pad for Continuous Delivery

* Modern analytics queries evaluated include SQL constructs such as UNION ALL, outer joins, complex expressions (CASE, CAST, scalar functions etc)

Db2 12 Index In Memory Optimization

Index IX1 with 5 levels

In Memory Structure
(Fast Traverse Block)

Table

- 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
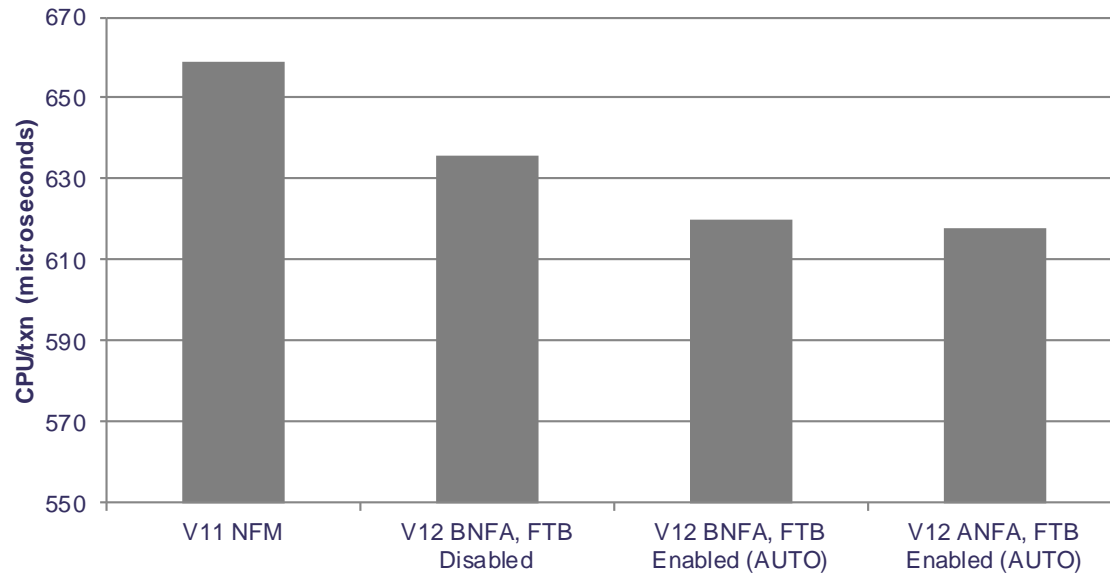 - Object level control overrides possible through catalog table

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 BP 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

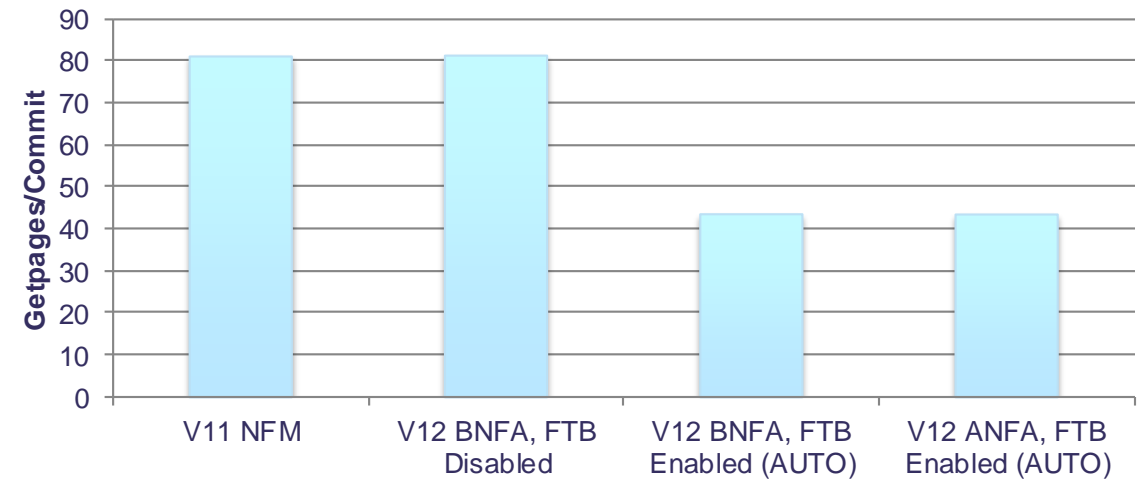- New IFCIDs 389 and 477 to track FTB usage

Using Index in Memory – 2way Data Sharing OLTP (IRWW)

**Classic IRWW 2-way: Db2 CPU/Transaction
(Class2 + MSTR + DBM1 + IRLM)**

Classic IRWW 2-way: Getpages/Commit

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

INSERT Performance

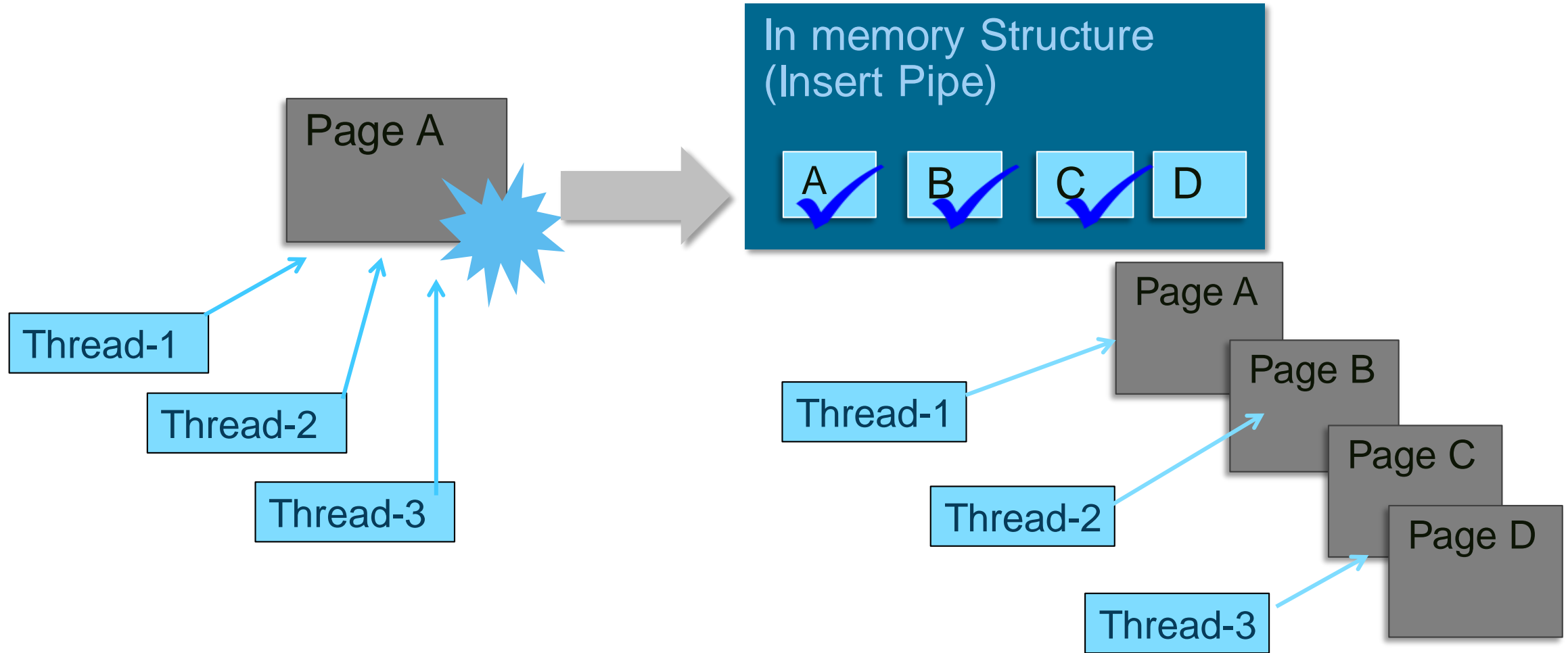Insert workloads are amongst the most prevalent and performance critical

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

- UTS, MEMBER CLUSTER

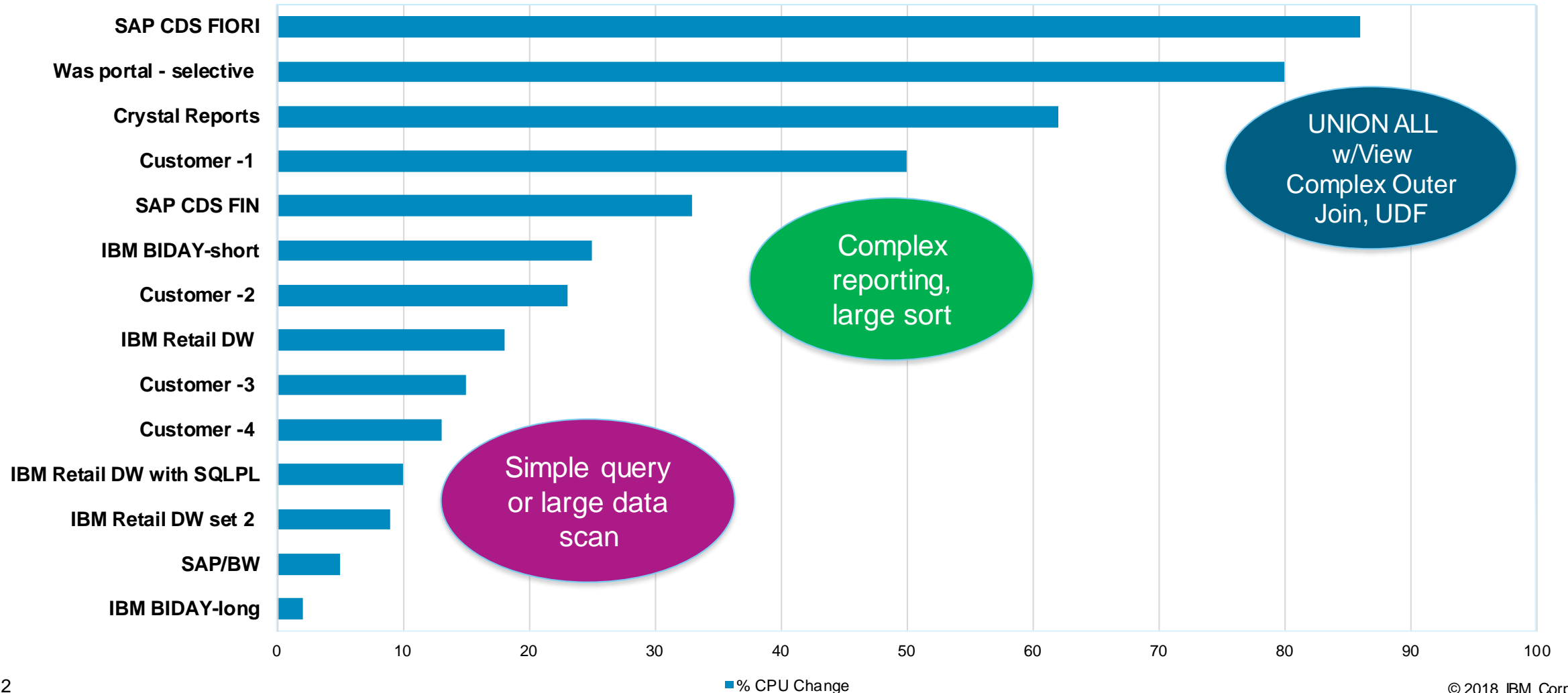Advanced new insert algorithm to streamline space search

- 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

Page A

In memory Structure
(Insert Pipe)

A ✔ B ✔ C ✔ D

Thread-1

Thread-2

Thread-3

Page A

Page B

Page C

Page D

Thread-1

Thread-2

Thread-3

Db2 12: CPU Reductions for Query Workloads vs. Db2 11

Query - Db2 12 CPU saving (%) after Rebind

■% CPU Change

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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

Migration & Catalog

Single phase migration process

- No ENFM phase
- New function activated through new command: -ACTIVATE FUNCTION LEVEL
- 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 12 for z/OS Migration Support Services

- ▪ IBM Lab Services available to assist you in Db2 12 migration
  - Deep skills – 20-30+ years of Db2 experience
  - Assessment, support, and migration services offered

- ▪ Logical follow-up Db2 12 Technology Workshop
  - Develop detailed migration plan based on workshop output
  - Assist with issue resolution identified in pre-migration reports
  - Provide support throughout migration (sandbox, development, production)
  - Provide post-migration validation and support
    - Validate system health and performance
  - Participate in planning for Continuous Delivery exploitation
  - Offering flexibility: from assessment to support to performing the migration

- ▪ How to engage IBM Lab Services
  - IBM Lab Services website: https://www.ibm.com/analytics/us/en/services/
  - Click 'contact us' to request more details

IBM Analytics

IBM

Goals: faster delivery, easier to consume for customers

• Quality, stability is priority #1

• Function levels (FLs) are the mechanism to activate new features on V12

- System level and application level controls
- FL 500 is base V12 "NFM". FLs 501, 502, … beyond that

FL 501 – 1st post-GA delivery

• LISTAGG

FL 502 – April, 2018. APAR PI95511

• Transparent Dataset Encryption: Db2 DBA controls

• Casting numeric to GRAPHIC/VARGRAPHIC

FL 503 – Sept, 2018. APAR PH00506

• Db2 AI for z/OS (Db2ZAI)

• Migration support on DATA CHANGE OPERATION for temporal auditing

• Enablement for replication of system-period temporal tables and generated expression columns

FL 504 – Mar, 2019. APAR PH07672

• Huffman data compression

• New SQL syntax alternatives

• Prevent new deprecated objects

• Passthru of Built-In Functions (OLAP and REGEX) to IDAA

Many other features delivered in this timeframe (v11 & v12) that were not tied to a Function Level

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
  - IDAA on IBM Z

Db2 Transparent Dataset 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 502 deliver Db2-centric controls
  - CREATE and ALTER TABLESPACE, STOGROUP with KEY LABEL
  - New zparm for logs, catalog, and utility datasets

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 504

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
  - 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

IBM z14 System

IBM DS8880

Major reduction in I/O latency

IBM **Analytics**

- IDAA
  - Special Register and Bind Option for User-Specified Accelerator
  - CAST of GRAPHIC/VARGRAPHIC support for IDAA
  - Multi-Row Insert for Accelerator Only Tables
  - IDAA Federation
  - IDAA V6/V7
  - IDAA HTAP Dynamic Query Support
- z14 Synergy
  - HyperLink Support for Random Database Reads – (V11, V12)
  - Transparent Dataset Encryption Support – (V11, V12),
- Performance Enhancements
  - zIIP enablement for RELOAD phase of LOAD and REORG Utilities
  - IMS Attach Connection Pooling Support
  - Partition by hidden ROWID columns
  - zIIP enablement for LOAD PARALLEL RELOAD phase
  - RUNSTATS Performance Improvement for Single Colgroups – (V11, V12)
  - CHECK LOB Utility Performance Improvement
  - Access Path Improvement To Encourage The Tables With Good Filtering To Be Joined Earlier
  - REORG Performance Improvement during UTS conversions

- Utility Enhancements
  - Support new INVALIDATECACHE option in M100
  - Table Schema Checking Enhancement for Repair Catalog
  - Additional LOAD IGNORE Options for Ignoring Rejected Records
  - Inline image copy for LOAD RESUME (v11, v12)
- Serviceability, Availability, Usability Enhancements
  - Enhanced Monitoring for in Index In-Memory Optimization
  - Improved Reporting of Real Storage Statistics
  - Set Partition Key Columns as Updateable for Tables Created Prior to V5
  - Enhanced Monitoring for Insert Algorithm 2 Capabilities
  - Insert Algorithm 2 Robustness improvements, and Zparm option
  - Enhanced Metadata Self-Description Capability (Storing Version 0 Info) – (V11, V12)
- GDPS Active /Active with zero data loss
  - CDDS Online Recovery and Cleanup
  - CDDS print utility and recovery enhancement

IBM Analytics

- Application Developer self-service and productivity
  - DB2aaS improvements: Provision Schema With z/OSMF Workflows - (V11, V12)
  - Native REST Client Certificate Support – (V11, V12)
  - Native REST Trusted Context Support - (V11, V12)
  - Native REST Persistent Connection Support – (V11, V12)
  - Native REST TSO BIND/FREE Service Support – (V11, V12)
  - COBOL PL/I Co-processor from HFS
  - Query performance improvements for join predicate pushdown –
    - V12 APAR PI89564. 40 SAP Core Banking queries tested:

	V12 Base (As-is)	Epic 47830 (To-be)	Delta After enhancement
Average elapsed time	625.285	0.521	-99.9%
Average cpu time	341.389	0.446	-99.9%

  - Allow MODIFIES SQL DATA function to be invoked in a fullselect – March 2018

Db2 Recent Deliveries Not Tied to Function Levels

- AI, ML, Advanced Analytics
    - IDAA HTAP phase2 support
    - Db2ZAI V1.2 (Db2 System Assessment and Optimizer improvements)
    - Db2aaS integration with ICP for Data
- Modern Application Development
    - IBM Db2 DevOps Experience for z/OS GA
    - ALTER concurrency with dynamic SQL
    - ODBC support for node.js on z/OS
    - RESTful services enhancements
        - New start/stop/display service commands, Service versioning support
- Core Technology Leadership
    - z14 zHyperLink read support rolled back to V11
    - Db2 system provisioning services
    - Insert algorithm 2 improvements

What is IBM Db2 AI for z/OS (Db2ZAI)?

Db2ZAI V1.1 was introduced in Sept. '18 to empower the Db2 for z/OS optimizer to improve query access paths based on your workload characteristics using machine learning

Learns the patterns from the collected data from workloads in customer's unique operating environment and make better predictions about the optimal access paths for SQL statements

Built on top of the Watson Machine Learning for z/OS (WMLz) stack
- Leveraging all the services without requiring data scientist support
- Db2 generates the training data, deploys and monitors/retrains models with WMLz
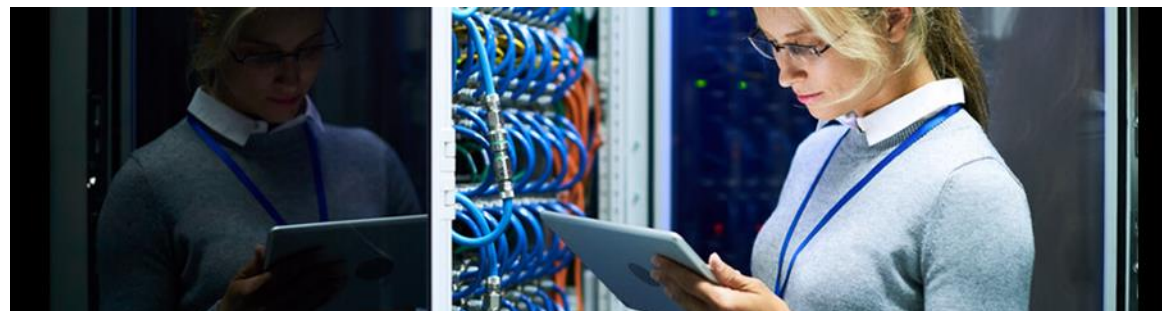- Up to 25% CPU reduction for queries

More info: www.ibm.com/ca-en/marketplace/db2-ai-for-zos

Announcing … Db2ZAI V1.2

Db2 AI for z/OS 1.2
Announced Feb. 12
GA March 15

Problem

Db2 produces over 1200 statistics counters, requiring deep technical skills to understand. A Db2 system programmer or a performance analyst often does not have the time or expertise to fully utilize the metrics to tune the Db2 systems or identify early symptoms of performance issues.
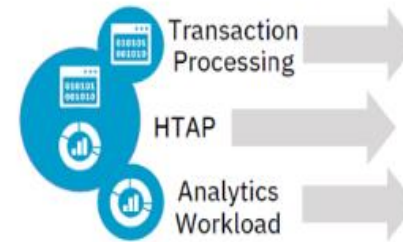
Hill

A Db2 system programmer can validate performance impact and understand possible corrective actions from Db2 application changes, maintenance, or system upgrades without needing significant Z expertise or going through numerous performance metrics.

Db2 Analytics Accelerator enhancement preview

Innovative business processes enabled through real-time insights within a highly-affordable, flexible infrastructure

- Pervasive integration of Db2 for z/OS and Db2 Analytics Accelerator delivers an industry-unique implementation of hybrid transaction/analytical processing (HTAP)

  - Unmatched performance through best-of-breed hybrid integration
  - Unmatched scaling through complete workload isolation
  - Enhanced analytic capabilities through extended SQL support

- Analytic processing includes all committed data, up to the point of query execution

- Enables new forms of real-time business-driven decision-making processes, against real-time transactional data, to fully realize the business benefits of running accelerated analytics directly on IBM Z

- Eliminate replication and maintenance of multiple data copies to reduce cost, complexity and security breach risk

Transaction Processing

HTAP

Analytics Workload

Db2

Db2 Analytics Accelerator for z/OS

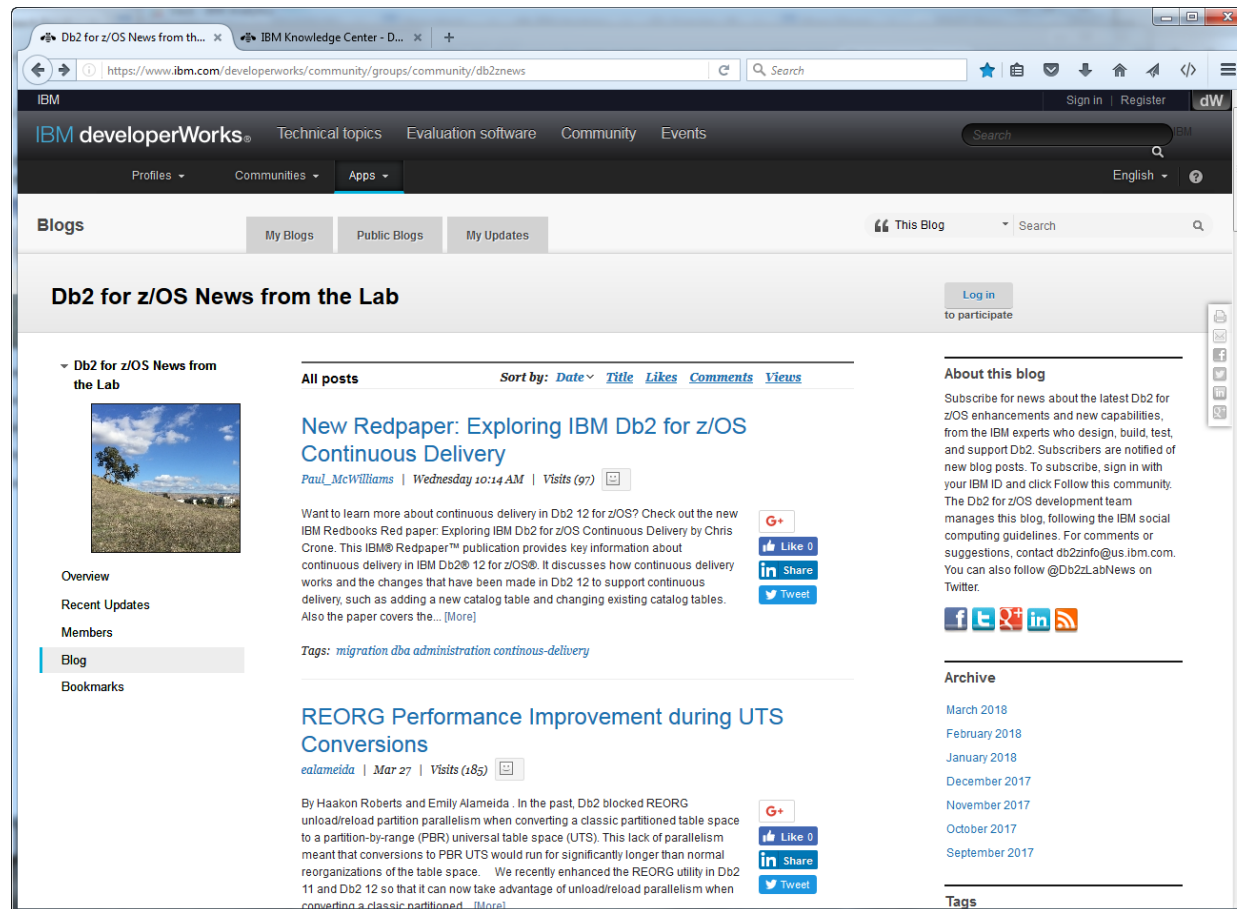# Db2 for z/OS News from the Lab blog
http://ibm.biz/db2znews

Get the latest news from the IBMers who design and build Db2!

- New capabilities in Db2 12 for z/OS continuous delivery
- Enhancements in Db2 11 for z/OS
- Helpful tips and best practices from Db2 for z/OS development

– Join the conversation

- Subscribe to follow the blog
- Become a member to comment
- Follow us on Twitter: @Db2zLabNews

Db2 12 – More Information

Db2 for z/OS product home page
https://www.ibm.com/analytics/db2/zos

Db2 Knowledge Center
https://www.ibm.com/support/knowledgecenter/en/SSEPEK_12.0.0/home/src/tpc/db2z_12_prodhome.html

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

SAP whitepaper: immediate certification of Db2 12 at general availability
https://www.sap.com/documents/2016/10/cecef6df-917c-0010-82c7-eda71af511fa.html

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 for z/OS

For mission critical data providing secure, seamless integration for analytics, mobile and cloud.

Db2 12 – More Information….

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

Redbook: Db2 12 for z/OS Technical Overview
http://www.redbooks.ibm.com/abstracts/sg248383.html?Open

Redbook: Db2 12 for z/OS Technical Overview and Highlights
http://www.redbooks.ibm.com/abstracts/redp5444.html?Open

Redbook: Db2 12 for z/OS Performance Topics
http://www.redbooks.ibm.com/abstracts/sg248404.html?Open

Redbook: Db2 12 for z/OS Optimizer
http://www.redbooks.ibm.com/abstracts/redp5445.html?Open

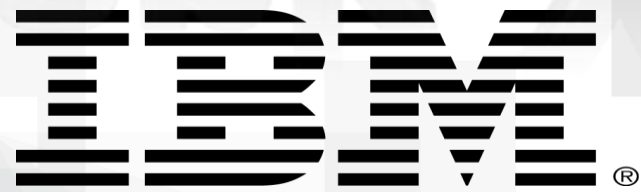Redbook: Introducing the z14
http://www.redbooks.ibm.com/redbooks.nsf/pages/z14?Open

DB2 12 for z/OS

For mission critical data providing secure, seamless integration for analytics, mobile and cloud.