

Latest from the lab: Db2 11.1.4.4 and Db2 11.5 Core Engine Enhancements

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Db2



IDUG

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Agenda

Data and AI. Meet The Family

Db2 Strategy And Roadmap

Version 11.1

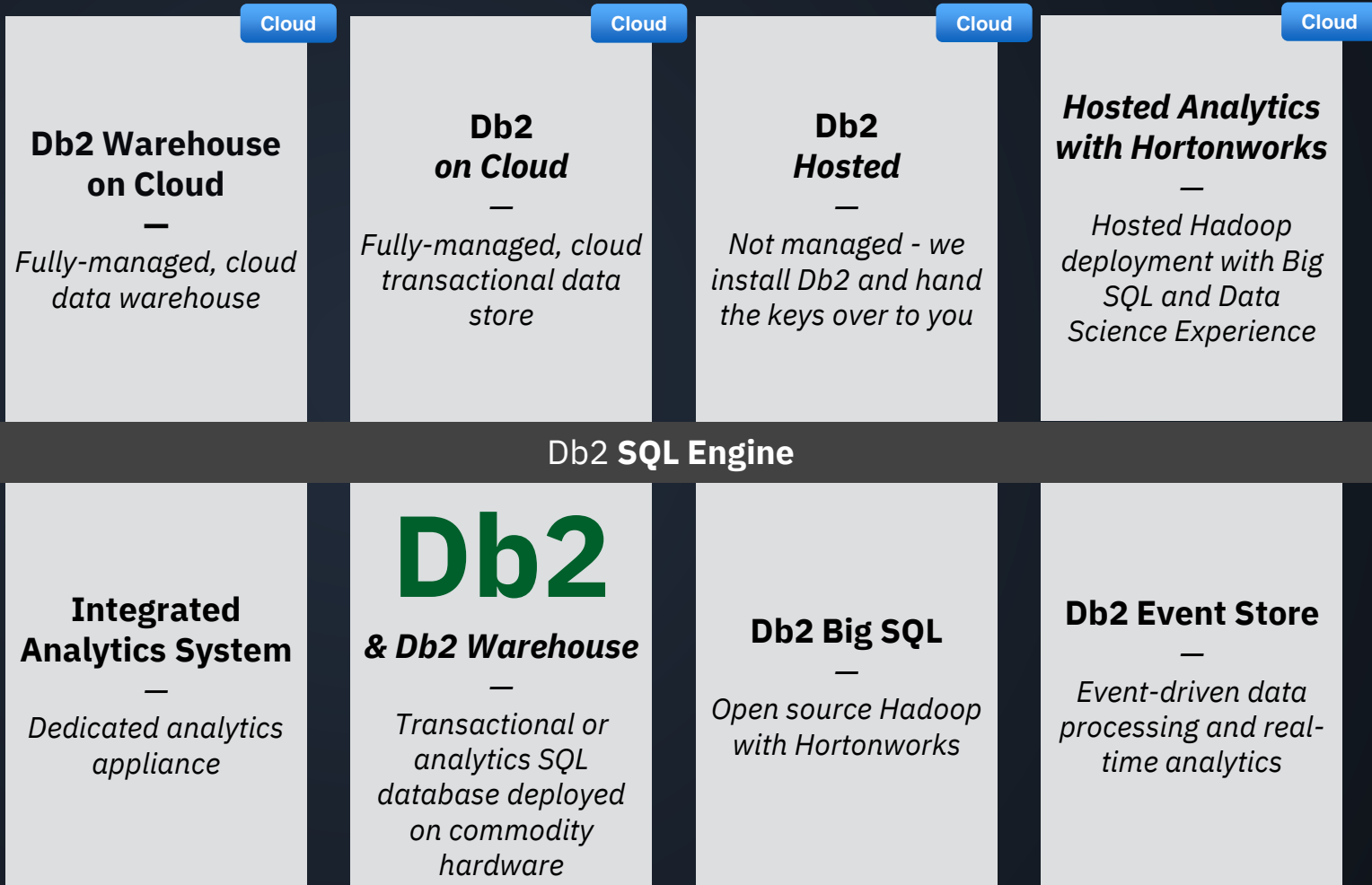
- Review: Continuous Delivery and Mod 4!

Version 11.5

- Goals: Convergence! Convergence! Convergence!
- Platform Support
- Planned GA Content
- Looking Forward

Our family of
**Hybrid Data
Management**
solutions
built on the **Db2**
common SQL
engine

*Write your SQL once
deploy against any
form factor
run anywhere*



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Db2 Strategy ...in 60 seconds or less....

- Core Database Capabilities, Resiliency, Security
 - Compatibility and gap closing, Simplicity, and other features
 - Resiliency, Availability and pureScale enhancements
 - Performance, performance, performance
 - Security Enhancements
 - Hardware support & exploitation
- Developer Focus
 - Ease of deployment, new languages, preferred IDEs
 - Samples and other getting started materials
- Cognitive Capabilities (aka AI)

Want to know more detail ?

- **Stick around for the next 70minutes!**
- **But... things can (and do) change. So to keep up-to-date:**
 - We revisit development priorities frequently (e.g. every quarter) in response to customer and market demand/feedback
 - Public roadmap:
 - <http://ibm.biz/AnalyticsRoadmaps>
 - We want to hear from you!
 - <http://ibm.biz/IBMAAnalyticsIdeasPortal>

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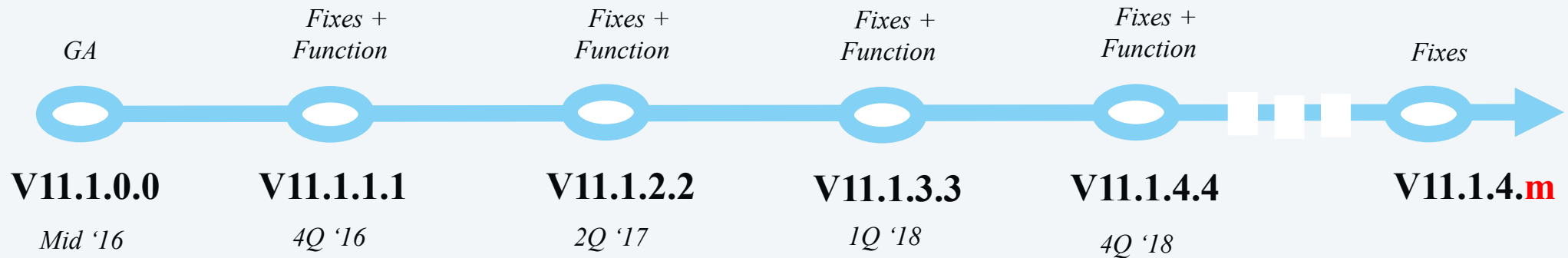
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Db2 11.1: Was a new beginning

- With Db2 11.1, Db2 changed to a “continuous delivery” model
 - Explicit plan to deliver function throughout the active development lifetime of a version
 - New versions will still happen occasionally for various reasons. At which point the new version becomes the target for new deliveries
- What does this mean to you?
 - Introduction of Modification levels to the product signature
 - Function delivered continuously during a version’s lifecycle
 - No more “big gulps”, just a series of “little bites”

The Db2 11.1 lifecycle



Regular fix/mod pack deliveries (every 6-12 months)

- With overriding focus on stability for immediate production deployment
- Modifications will contain select functional enhancements (often off by default)
- Spacing likely to start spreading out a bit more as we move to fixes only

What about getting critical fixes in between official updates?

- To ensure that critical fixes are made available as soon as possible, we have introduced the concept of an interim fix (aka “iFix”)
- An iFix is an update based on the last shipped update + a select set of critical updates (Hiper, Security, and “high impact” APARs)
 - Cumulative (i.e. Db2 11.1.2.2 iFix002 contains Db2 11.1.2.2 iFix001)
 - Reset after each new official update (i.e. the first iFix after Db2 11.1.3.3 was Db2 11.1.3.3 iFix001)
- To be released every 2-3 months until the next update occurs
 - Again, spacing likely to increase as we move to fixes only.

GA, FP1, FP2, FP3 Highlights: Mission Critical Workloads

Comprehensive Enterprise Security



Enterprise Encryption

- Centralized Key Managers (KMIP)
- PKCS#11 HSM support
- SSL Encryption for non-pS HADR (Linux x86, ALL platforms)

Mainframe Class Availability

pureScale “for the Masses”



- Up and running in hours
- Zero data loss DR with HADR
- Multi-switch GDPC (no SPOF)
- Seamless HADR pureScale upgrades
- Restore REBUILD
- Online Index Create
- Add/Drop CF

- Faster MCR by default
- Improved sockets performance
- Multiple hosts in maintenance mode
- Recover HADR Standby w/ tbspc restore (now for pS)
- Improved XA performance

HADR ease of use:

- Export HADR TSAMP configuration to XML file

Even Greater Availability

- Online Crash Recovery
- Faster Rollback of Multiple and Large Txn
- ADMIN_MOVE_TABLE advances
- Better tablespace state and replay window monitoring with HADR
- Per partition OLR
- Avoid Lock Escalation
- Timeout support for vendor Archive

Significant Core Database Advances



Increased Serviceability

- 16x increase in active log space capability
- Enhanced monitoring for lock and logging events

Additional Core Function

- Workload Manager (WLM) multi-tenancy extensions
- Federation simplification and integration

Simpler, Faster, More Online Upgrades

- Faster, no need for offline backup
- Streamlined HADR upgrade
- DB2 Version 9.7 direct to 11.1

Very Large Database Performance

- Higher user throughput

GA, FP1, FP2, FP3 Highlights: SQL & Warehousing Workloads

SQL and Compatibility



PDF manuals for DB2 LUW v11

Multi-Lingual SQL Advances

- **BINARY, EXTENDED ROWSIZE**
- **CHAR(255)**

BLU Restriction Removal

- **Automatic Dictionary Creation improvements**
- **ALTER VARCHAR/VARGRAPHIC length support**
- **Codepage 819**

Richer and Even More Compatible SQL

- **JSON support**
- **BOOLEAN data type**
- **Common table expression (Db2 for z/OS compatibility)**
- **WITH and SELECT INTO support**
- **Alias for XML**

Massive Scale Warehousing at In-Memory Performance



MPP BLU Scalability

- **PB scale in-memory warehousing**

Next Gen In-Memory Performance, Function and Workloads



- **Faster ELT/ETL performance**
- **More Query Workloads Optimised**
- **More Function supported**
 - **Generated Columns**
 - **RCAC**
 - **User maintained temporal tables**

Continued Performance Improvements

- **Synopsis table enhancements**
- **Additional SIMD exploitation**
- **Aggregation enhancements, sort elimination**
- **INSERT from sub-select – multi-core parallelism improvements**
- **BLU Secondary Index**

Db2 11.1.4.4

Continuous Delivery – 4Q18 New Capabilities

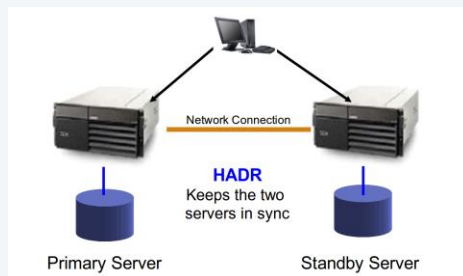
- Extent reclaim support for Db2 pureScale
- ALTER TABLESPACE ... REDUCE



- ISO JSON SQL functions – Part 1
- Following public standards SQL:2016



- HADR Read on Standby (RoS) enhancements



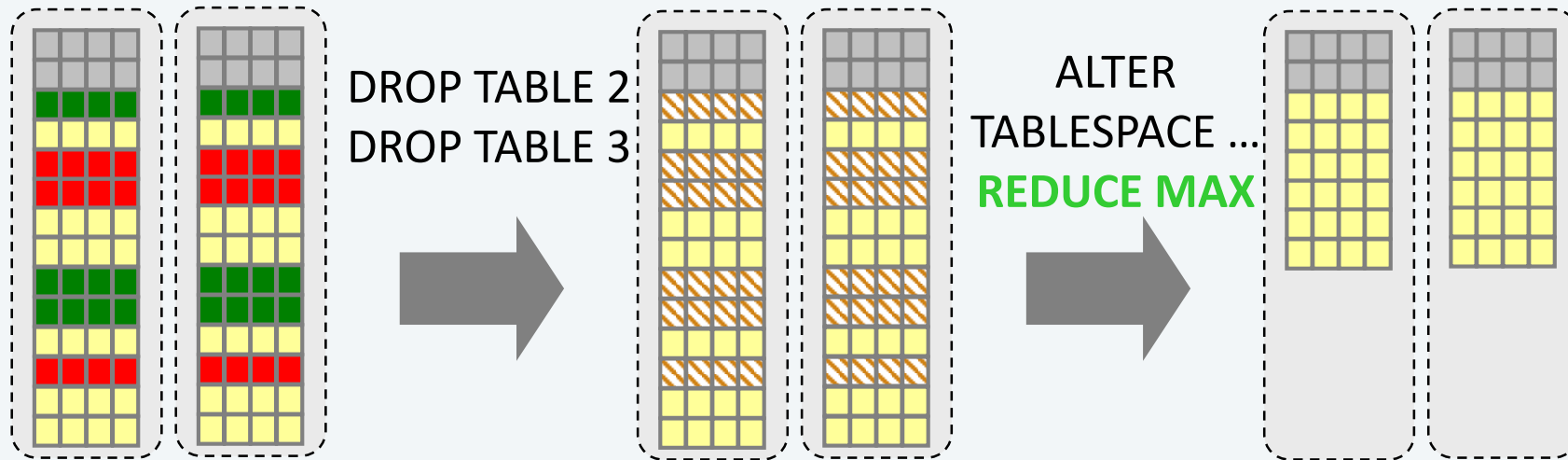
- Preview: Support for storage devices using 4K sector size


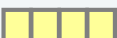





Extent reclaim support for pureScale

- When table objects are dropped, the storage may not be immediately available to be released from the tablespace
 - Only space above the tablespace high water mark (HWM) can be released
- The ALTER TABLESPACE ... REDUCE statement attempts to reduce the high water mark for the table space by moving live extents to unused ones lower in the tablespace
 - Supported with reclaimable storage DMS table spaces (created in Db2 9.7 or newer)

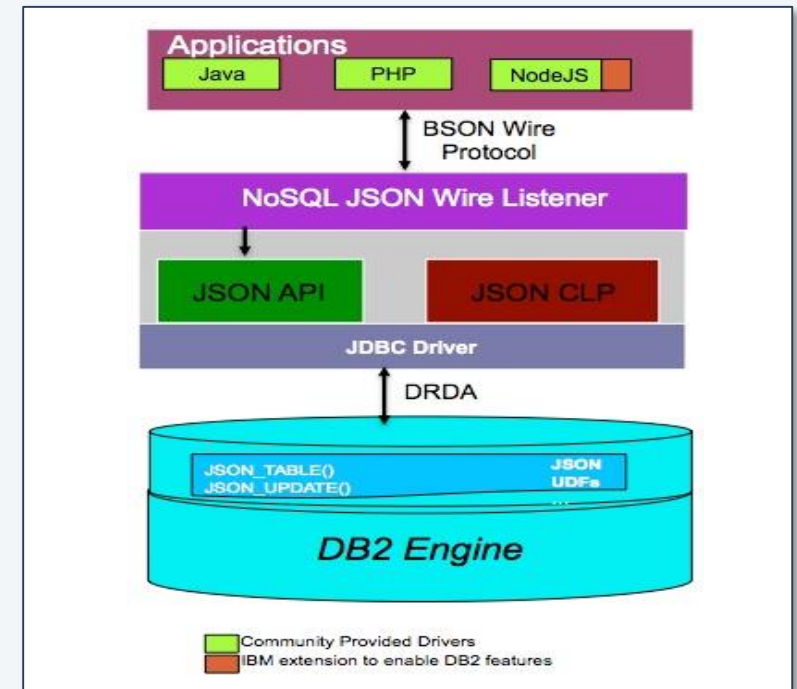
Extent reclaim



-  Internal table space metadata extents
-  Table 1
-  Table 2
-  Table 3
-  Extent that is allocated to a table space, but not to a table

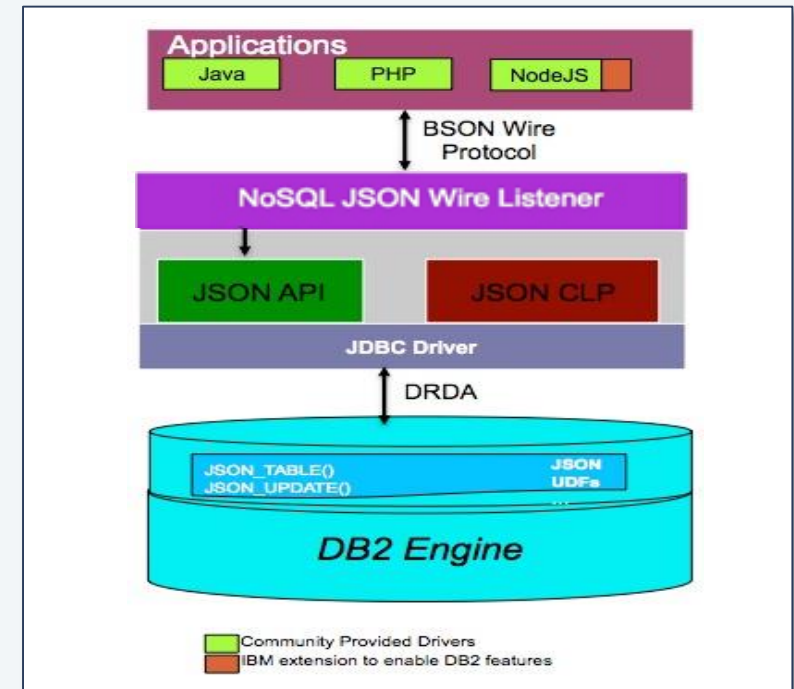
A brief history of Db2 & JSON (Part 1)

- Db2 10.5 FP1 introduced JSON NoSQL support
 - Focused on allowing Db2 to participate in the NoSQL paradigm
- This support used undocumented, proprietary JSON SQL functions in Db2 server
 - aka “SYSTOOLS” JSON SQL functions



Enhancements to JSON NoSQL support in Db2 11.1.4.4

- Db2 NoSQL JSON wire listener is enhanced to support latest mongo db client (3.6.3)
- Added support for Kerberos Authentication to wire listener
- Enhanced wire listener script to enable jcc and nosql trace using command line options.



A brief history of Db2 & JSON (Part 2)

Our customers also asked for native SQL support for JSON in Db2

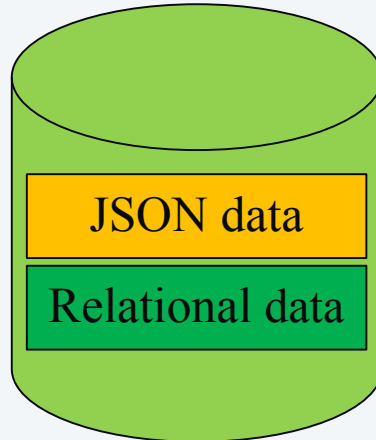


“Modern”
applications

JSON



DB2®



Relational



“Traditional”
applications



As a tactical response, we revealed our proprietary “SYSTOOLS” JSON SQL functions in DB2 11.1

First wave of new built-in JSON SQL functions!

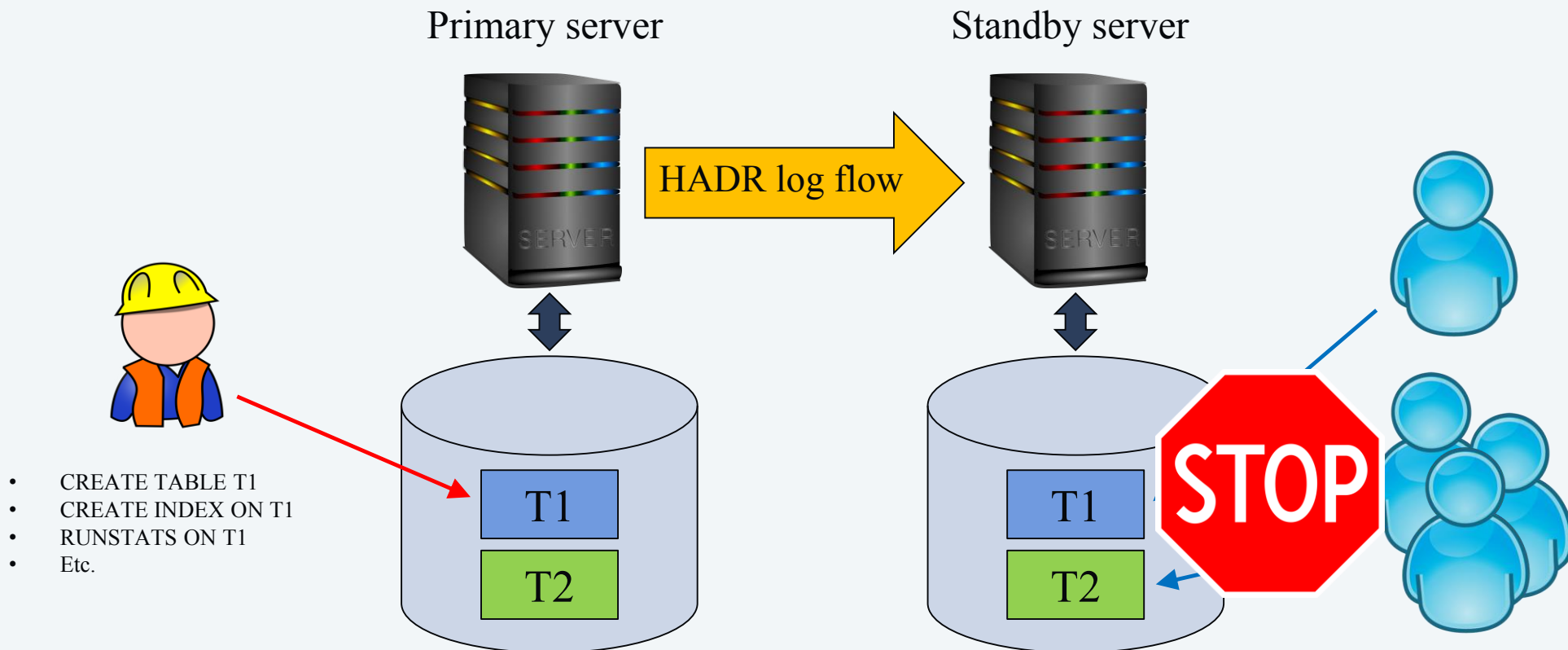
- New implementations of JSON SQL functions based on recent ISO report on SQL support for JavaScript Object Notation (JSON)
- The (proprietary) SYSTOOLS functions will be de-emphasized but will continue to be supported

Schema	Name	Comments
<i>SYSIBM</i>	BSON_TO_JSON	Convert BSON formatted document into JSON strings
<i>SYSIBM</i>	JSON_TO_BSON	Convert JSON strings into a BSON document format
<i>SYSIBM</i>	JSON_ARRAY	Creates JSON array from input key value pairs
<i>SYSIBM</i>	JSON_OBJECT	Creates JSON object from input key value pairs
<i>SYSIBM</i>	JSON_VALUE	Extract an SQL scalar value from a JSON object
<i>SYSIBM</i>	JSON_QUERY	Extract a JSON object from a JSON object
<i>SYSIBM</i>	JSON_TABLE	Creates relational output from a JSON object
<i>SYSIBM</i>	JSON_EXISTS	Determine whether a JSON object contains the desired JSON value

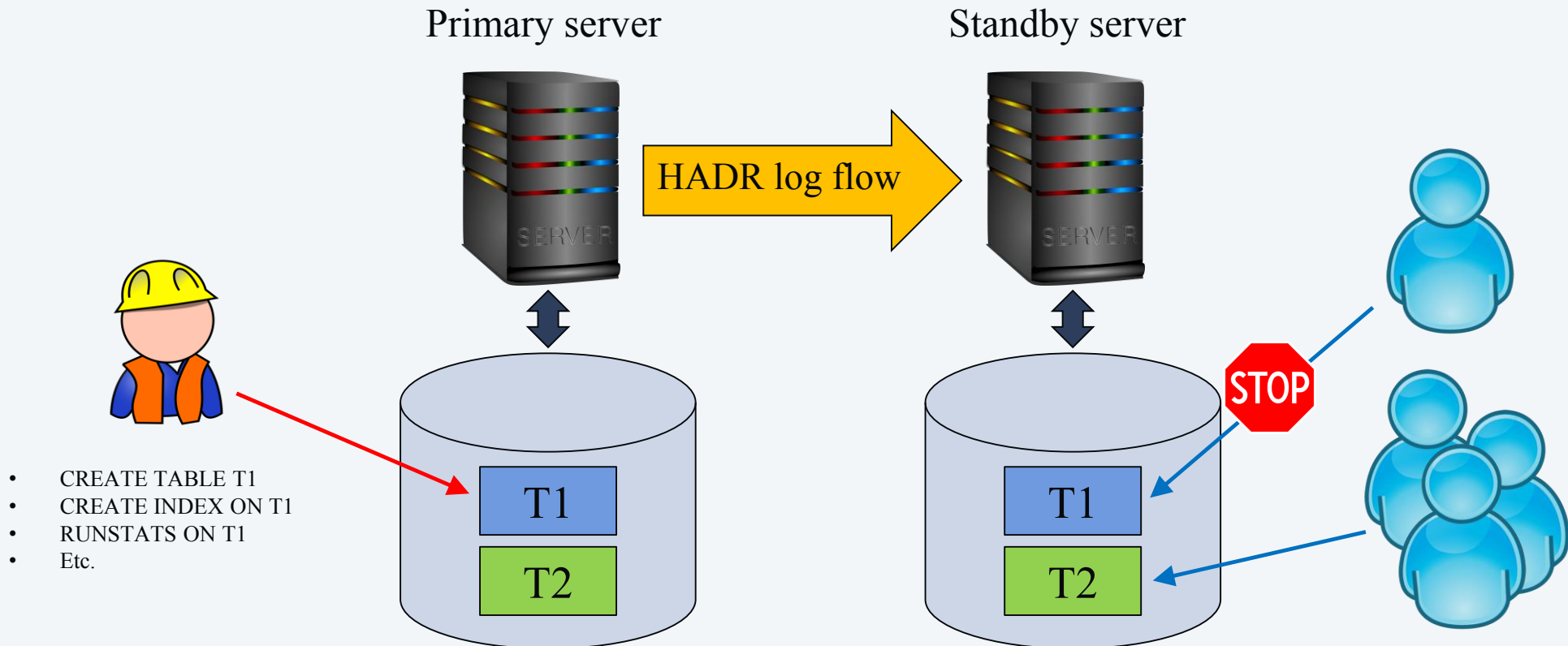
What makes these JSON SQL functions different/better?

- Following a public “standard” (ISO technical report)
- Easier to use
 - No need to qualify or add SYSTOOLS to function path
 - No need to grant EXECUTE privilege
- Simpler and more flexible storage options
 - You choose the stored format: JSON or BSON
 - You choose the table organization: row or column
 - You choose the column data type
 - BLOB, CHAR, CLOB, VARBINARY, VARCHAR
 - Normal Db2 mechanisms can be used to load JSON (or BSON) data into tables (e.g. INSERT, Load, etc..)
 - Conversion functions are now complimentary not mandatory

HADR Read on Standby (RoS) in Mod3 and earlier...



HADR Read on Standby (RoS) in 11.1 Mod 4 !



Preview: Support for storage devices using 4K sector size

- This support can be enabled by setting the `DB2_4K_DEVICE_SUPPORT` registry variable to ON
- This feature is not supported for production use at this time
 - Try it out and let us know!
- Restrictions and limitations:
 - Single node and DPF only
 - The use of DMS Raw containers is not supported
 - Backup and load copy files will be slightly larger
 - There may be a performance penalty accessing:
 - LOB data stored on 512-byte sector storage
 - Backup or load copy files created prior to the enablement of 4K device support

GoLang for Db2

- Now available @ https://github.com/ibmdb/go_ibm_db

How to run sample program

example1.go:-

```
package main

import (
    _ "github.com/ibmdb/go_ibm_db"
    "database/sql"
    "fmt"
)

func main(){
    con:="HOSTNAME=host;DATABASE=name;PORT=number;UID=username;PWD=password"
    db, err:=sql.Open("go_ibm_db", con)
```


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Db2 11.5



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Version 11.5

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- Platform Support
- Planned GA Content
 - Core Database Capabilities, Resiliency, Security
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Convergence

Move all Db2 family members to the same version of the Db2 Common SQL Engine with continuous delivery model

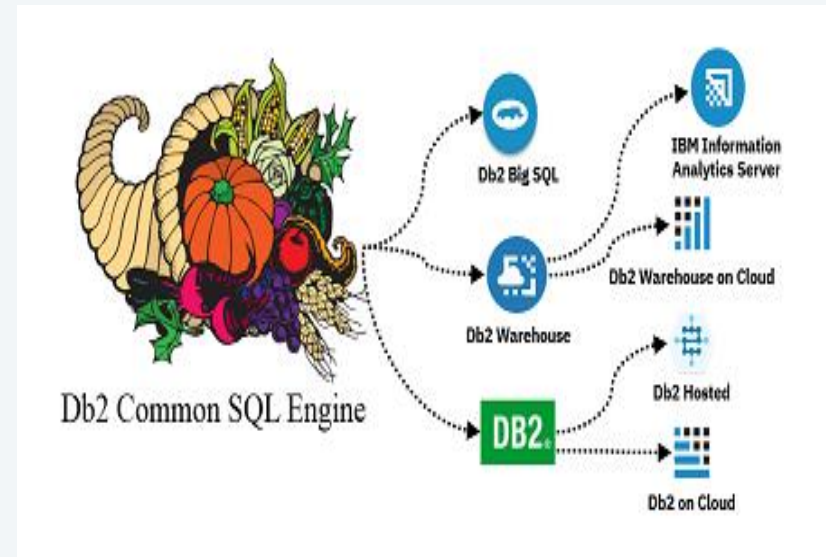
- Consistent experience
- Reduced latency in feature availability

Wider availability of existing Db2 Common SQL Engine capabilities across Db2 family

- Consistent experience

Individual family members pick up updates at different intervals

- E.g. Db2 offers modification updates every 6-12 months while IIAS, Cloud, and docker-based environments (can) move to a new level every 1-2 months
- Monthly Early Access Program (EAP) updates



Db2 11.5

We plan to release a new version of Db2 in 1H 2019

- This will get all our Db2 and Db2 Warehouse offerings on the same level of the Db2 common SQL engine
- Db2 11.1 will be 3 years old in 2019!!

We will continue to follow the “**continuous delivery**” paradigm started with Db2 11.1

- GA will include any enhancement that is “ready to go” for on-premise environments plus a number of tech previews
- Steady release of function through subsequent modification updates
- Note: Db2 11.1 shipped 4 modification updates since GAing in 2016, and going forward is planned to be fix packs only

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Version 11.5

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- **Platform Support**
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Platform Server Support -- non-pureScale

Linux:

RHEL 7.(5), SLES 12 SP(3), Ubuntu 16.(4) LTS :

Intel x86-64, System Z, Power 8,9 (compat-mode only) LE

Potential futures → RHEL 8.0 , SLES 15, Ubuntu 18.4 LTS



AIX:

AIX 7.1 TL(5) SP(3): Power 7 and 8

AIX 7.2 TL(3) SP(2): Power 7, 8, and 9



(x) = “and up” at this level.

e.g. 7.(5) would include 7.6 but not 8.*

Platform Server Support -- non-pureScale

Windows Server 2012, 2012R2, 2016: x86-64

Potential future → Windows 2019

Windows Desktop 8, 8.1 and 10: x86-64



Platform Support -- non-pureScale

Solaris – **Dropped**

CentOS – **Dropped**

Platform Server Support -- pureScale

Linux:

RHEL 7.(5) : Intel x86-64, Power 8,9 (compat mode only) LE

SLES 12 SP(3) : Intel x86-64

*** Also added: CX-4 RoCE & IB adapter support on Intel.

Potential futures → RHEL 8.0 , SLES 15

AIX:

AIX 7.1 TL5 SP(3): Power 7 and 8

AIX 7.2 TL3 SP(2): Power 7, 8, and 9



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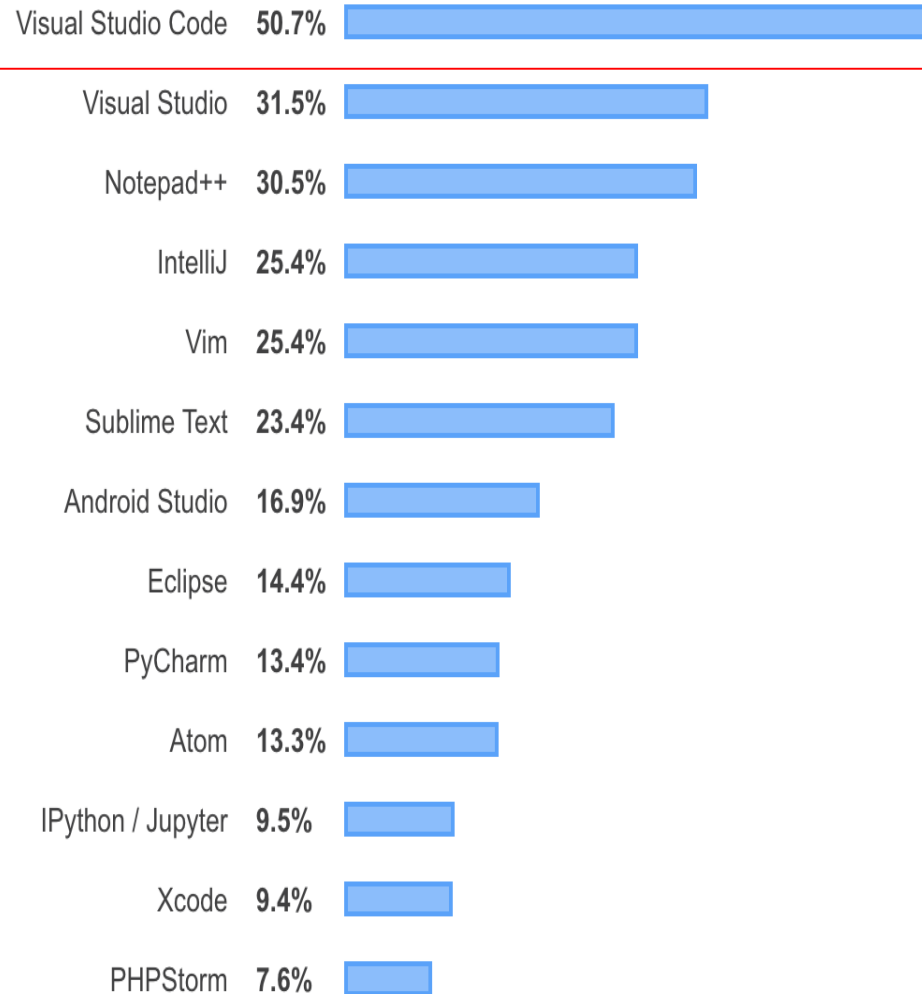
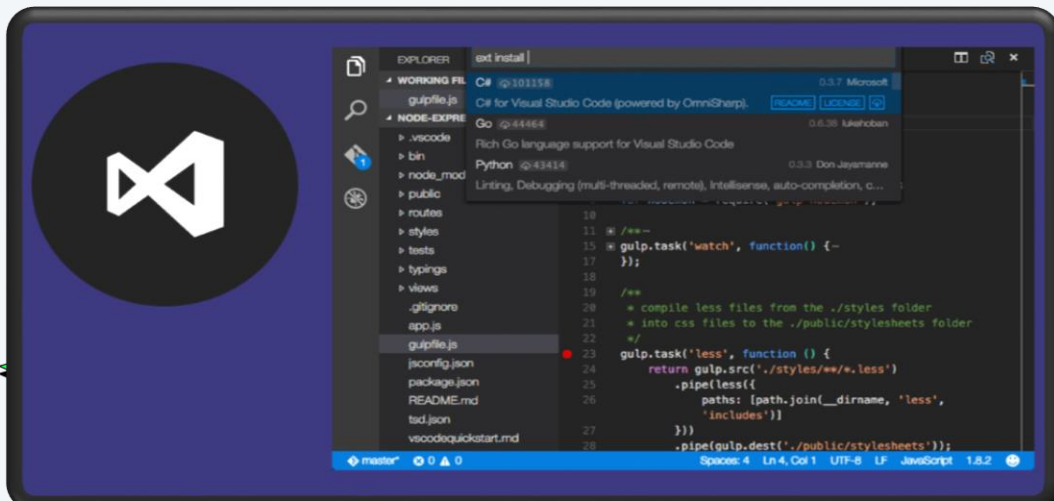
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*Developer: Programming IDE

- Bridging the gap between developers and Db2 application development
- Install Visual Studio Code and install Db2 Extension (link: ibm.co/2wvxcGs)
- Connect with Db2 and test your application



Support for storage devices using 4K sector size

This support can be enabled by setting the `DB2_4K_DEVICE_SUPPORT` registry variable to `ON`

Allows Db2 databases to be created on devices that only allow 4k IOs.

Restrictions and limitations:

- The use of DMS Raw containers is not supported
- Backup and load copy files will be slightly larger
- There may be a small performance penalty accessing:
 - Small non-inlined LOBs
 - Backup or load copy files created prior to the enablement of 4K device support

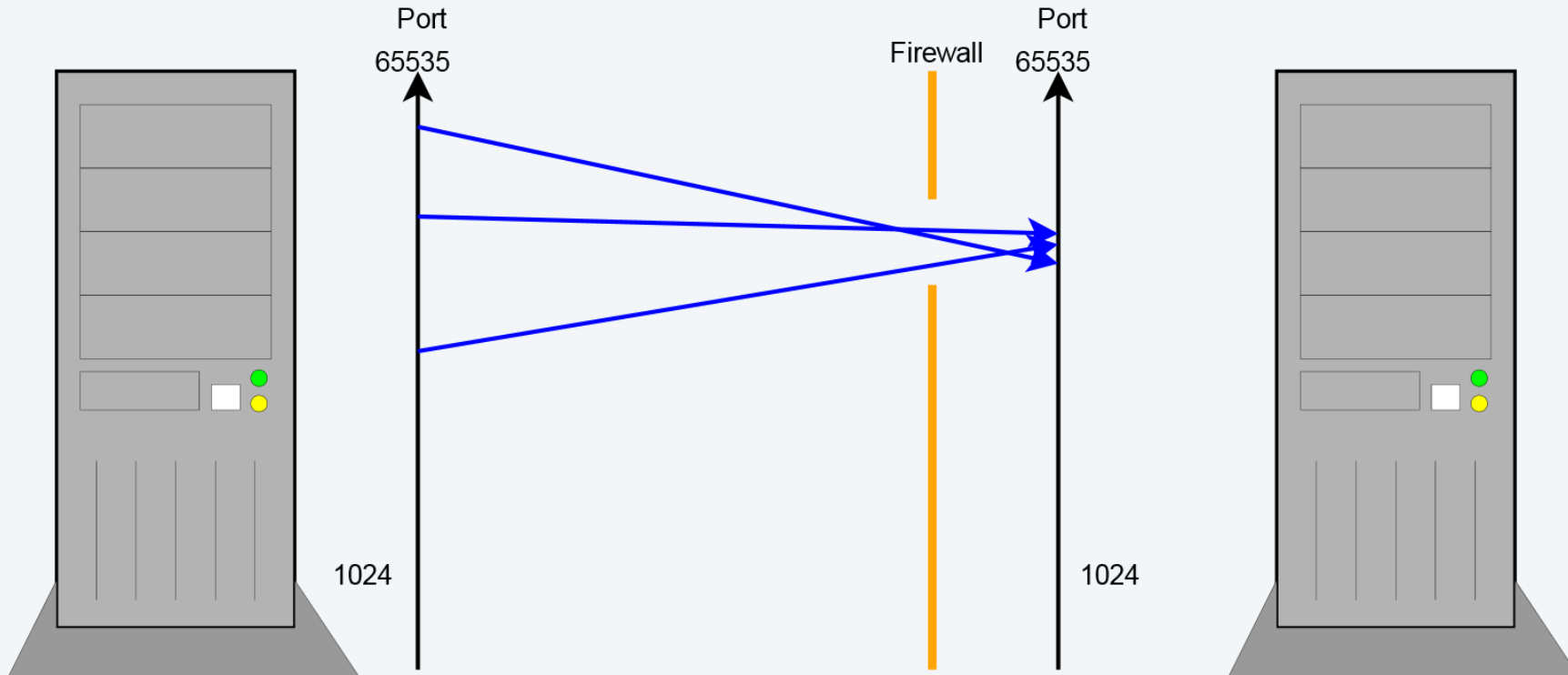
Security - pureScale Support for host-based firewalls

1/2

- One setting and DONE
 - In Db2 11.5, users can specify a port range for which will be used for all Db2 activities, from before install throughout deployment and during production.
- Configurable options
 - `db2set DB2_FIREWALL_PORT_RANGE=<StartPort>-<EndPort>`

Security - pureScale Support for host-based firewalls

2/2



Simplicity - pS cluster wide free space management

Reuse free space regardless of mix of deleting and inserting members.

Free space indicator has been moved to the CF

- All the members can check for new free space efficiently and reliably

This is the new default behavior starting in Db2 v11.5 GA.

The following registry variable can be set to revert back to old behavior of free space searching:

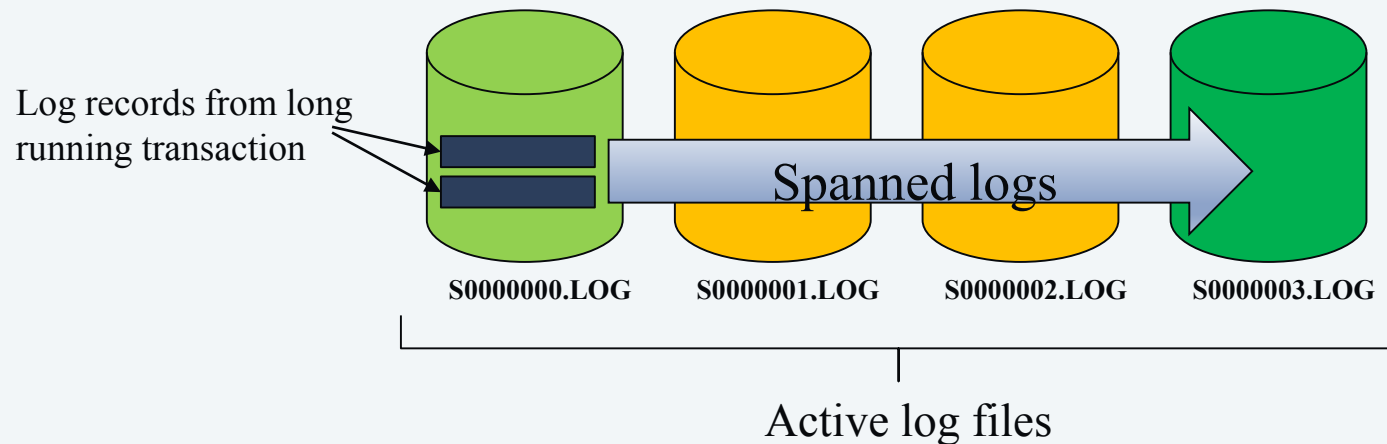
```
db2set DB2_SD_DISABLE_GLOBAL_SPACE_SEARCH=TRUE
```

Simplicity - Advanced Log Space Management (Tech Preview)

1/2

As part of a focus on simplifying log management, the first delivery will result from a focus on avoiding “log full” scenarios caused by long running, low volume transactions hold up log space

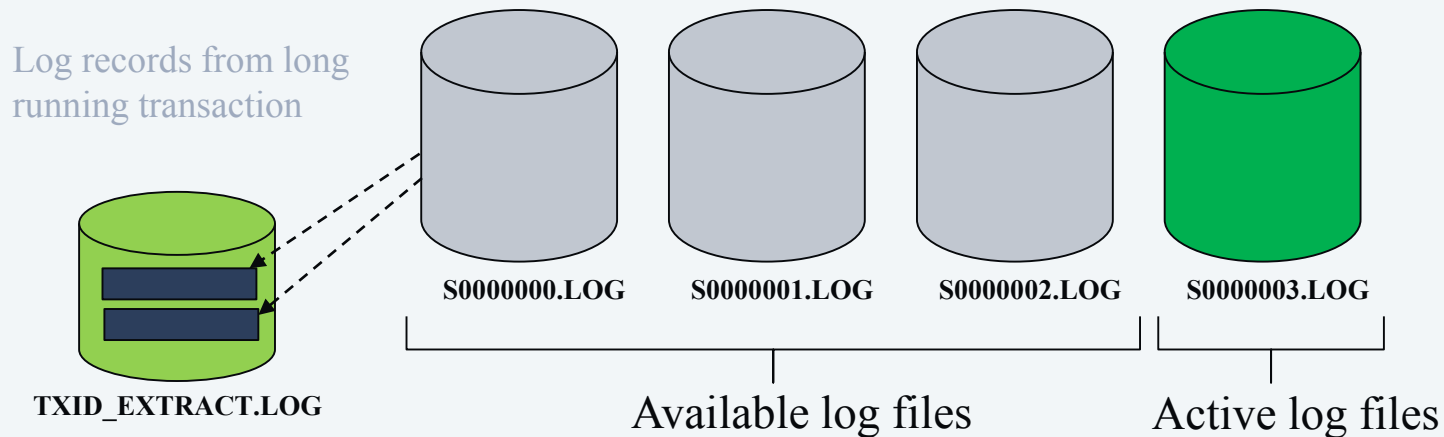
E.g. transactions that span multiple log files with little content in the intermediate files



Simplicity - ALSM (Tech Preview)

2/2

Solution is to extract log records for long running active transactions to a separate file and allow intermediate log files to be closed, archived, and reused

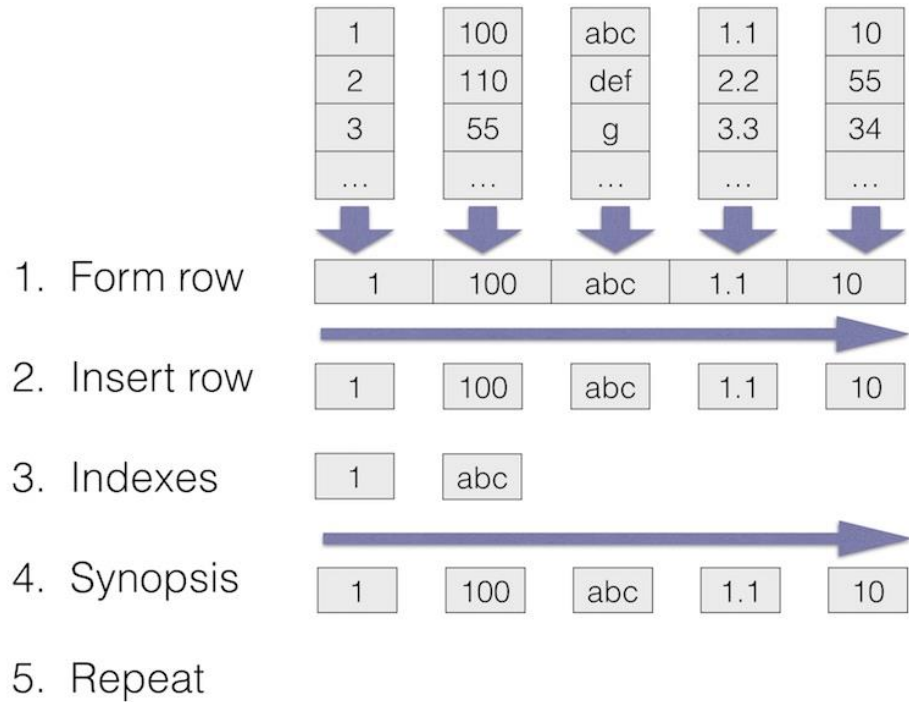


Performance - Columnar Insert/Update/Delete

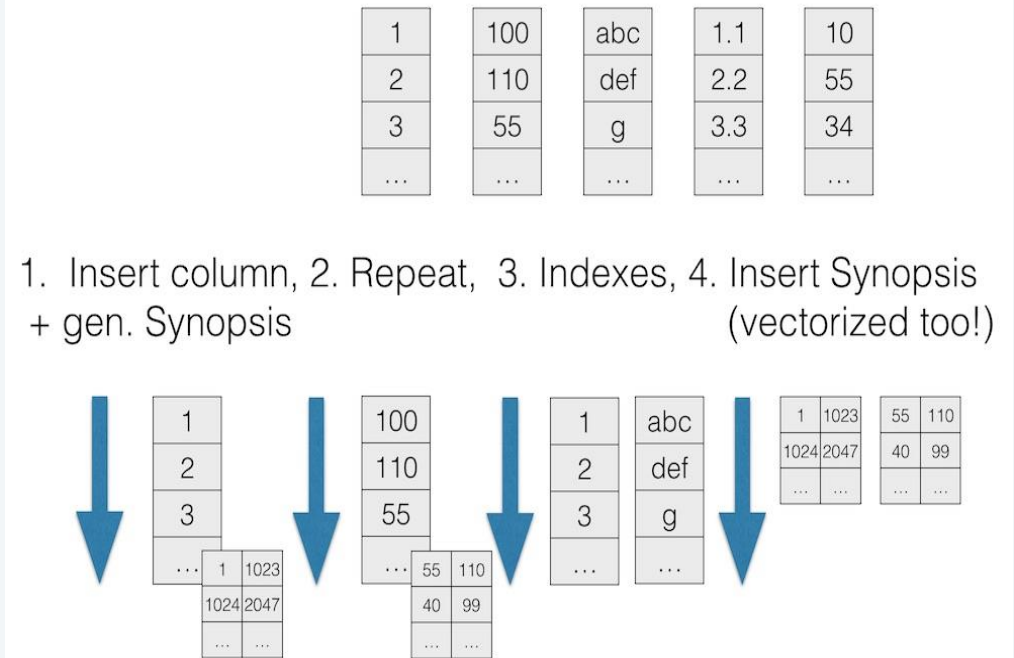
- Db2 11.5 greatly expands core-friendly parallelism for SQL-based IUD operations on columnar tables
 - KIWI: Kill It With Iron (Slide stolen from Chris D! Only fruit acronym I have!)
 - Maximize CPU cache, cache-line efficiency
- Critical to maximize ETL/ELT batch performance
- Many general improvements, but primary focus on bulk operations

Performance - Vectorized Insert/Update

Pre-v11.5 approach



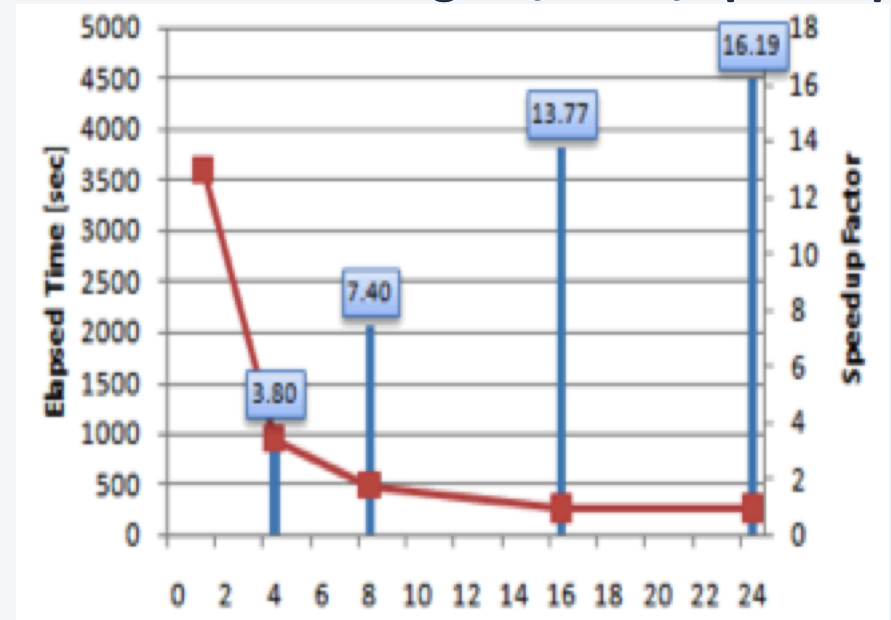
v11.5 approach



Performance - ETL Performance Example

- Data ingest rate
 - 1 TB/hour before enhancements
 - **Now ~5 TB/hour (IIAS)**
- >10 TB data
- Table remains online
- Combined features (in Db2 W today)
 - GA - ET load
 - future - Columnar Reduced Logging
 - GA - Columnar Parallel insert
 - GA - Columnar Vectorized insert
 - GA - Columnar Optimized bulk insert codepath

Parallel Insert Degree/Time/Speedup



Performance- 2x faster pureScale LOAD for range-partitioned tables

LOAD requires the buffer pool to be flushed/purged of the target table data before it starts.

In pureScale v11.1 and earlier, the flush/purges were done individually for each partition X each data part; requiring multiple RPCs to each member.

Improvements:

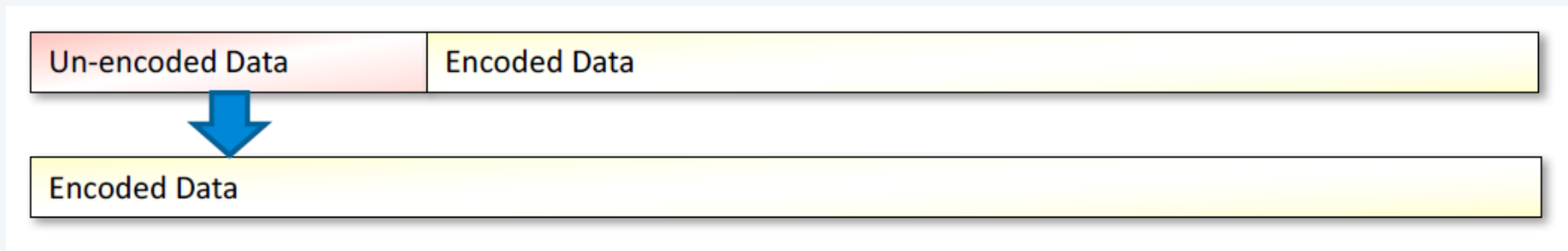
- Grouped flush/purge for partitions, indexes and LOB columns

Storage Reduction - Grooming for columnar tables

When Automatic Dictionary Creation (ADC) or Vectorized-ADC is used, some portion of the data will be inserted before the dictionary is created

- Grooming is focused on these uncompressed first portions of the data
- NOTE: amount of data inserted before creating a dictionary has been increased.

Grooming simply applies the compression dictionary to the first portion of the data that was uncompressed initially



Gap Closing - Large Objects in Columnar Tables

Datatypes supported CLOB, BLOB, DBCLOB, NCLOB

Columnar database engine consumers can now avoid storing Large objects in row store tables

Descriptor and in-lined data placed in Columnar data page

- Larger Objects stored in same buddy space as row tables

Gap Closing - Db2 pureScale Cross-member Currently Committed

1/2

In pureScale environments, the Currently Committed isolation will avoid lock wait when:

- Concurrent access allows a member to use a older (but still valid) version of a page that does not yet show a IUD operation
- The application performing the row read, and the application performing the row UPDATE or DELETE, reside on the same member
- The application performing the row read, and the application performing row INSERTs, reside on any member

Gap Closing - Db2 pureScale Cross-member CC

2/2

In current pureScale environments, the Currently Committed isolation method can still result in a wait if:

- A row-reader finds the row is being updated or deleted (locked) by an application on a different member

This feature brings completeness to Currently Committed behaviour in pureScale environments, by allowing a row-reader to go out to the another member to return the currently committed data from the other members logs.

SQL Compatibility - External Tables

A simple mechanism that lets you access external “files” within an SQL statement just like a table

- Can also be used to load from or unload to external files
- Can be used to define a permanent external table or directly within a SQL statement

Currently supports CSV/delimited files and local/remote sources

Example:

```
create external table ext_orders(order_num INT, order_dt TIMESTAMP)
    USING(dataobject('/tmp/order.tbl') DELIMITER '|');

insert into orders (select * from ext_orders);
```

Example:

```
insert into orders (select * from external '/tmp/orders.txt' using(REMOUTESOURCE
    GZIP delimiter ','));
```

SQL Compatibility - DROP/CREATE TABLE [IF EXISTS]

DROP TABLE IF EXISTS FOO

- IF EXISTS clause can be added to suppress SQL0204N errors
- 0 success returned if table exist or not

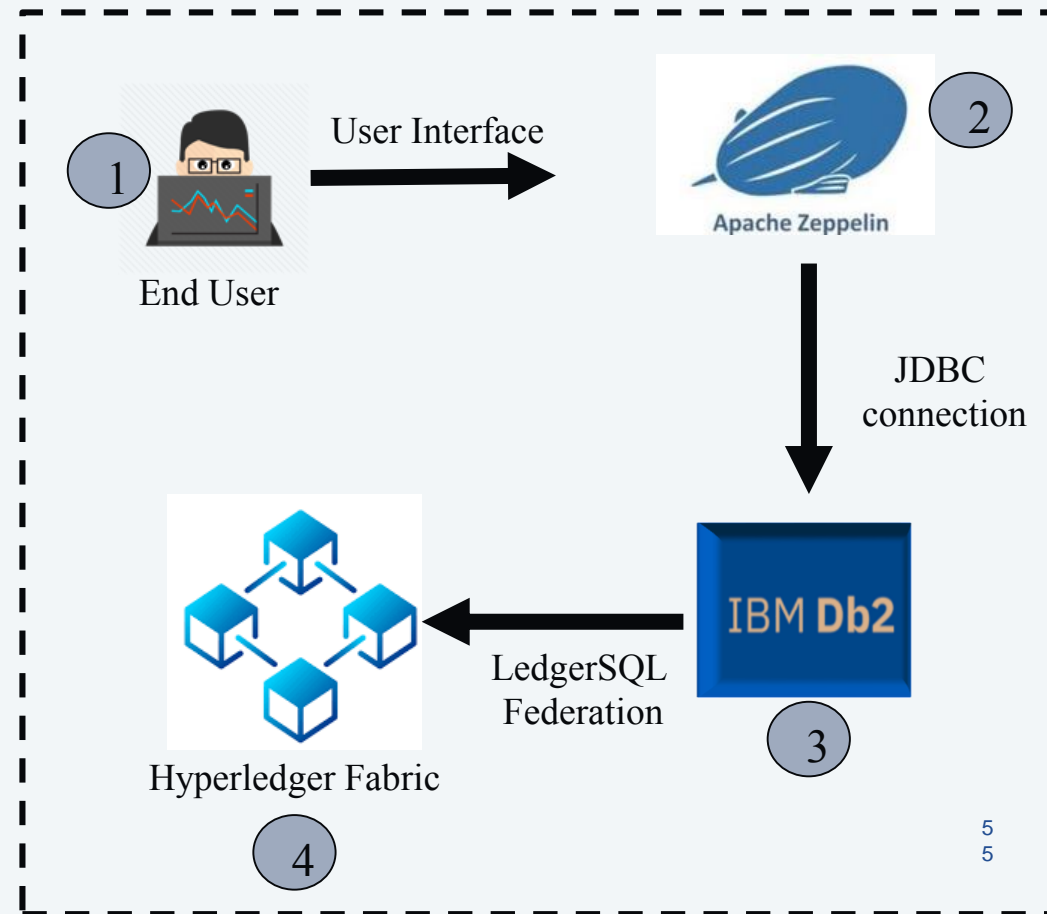
CREATE TABLE FOO (C1 int) IF NOT EXISTS

- IF NOT EXISTS clause add to suppress SQL0601N error
 - Warning “SQL4136W Table or view "SPRINGGA"."FOO" already exists.” returned if table does exist
- No impact if table exists
- Table created as normal if not exists

Developer - Use Db2 SQL to query Blockchain (Tech Preview)

1. A Db2 federation wrapper that provides:
 - Connectivity to Blockchain Transactions via Hyperledger Rest API
 - Rewriting SQL queries into equivalent Hyperledger API calls to query data.
2. Using Zeppelin (can use any JDBC supported tool) as end user tool to connect to Big SQL (Db2).
3. Query Blockchain via Zeppelin using SQL.

Honors the security measures in place at Blockchain level and Db2 level for end users.



AI - Db2, the only database w/ ML Optimizer in addition to Cost-based Optimizer

Tech
Preview

*Machine Learning
Optimizer that
improves from
experience to make
query optimization
simple, reliable and
stable*

- Number of rows flowing through the various operations impacts performance for most common issues and is calculated via cardinality estimates
- Basic tuning to improve cardinality estimation is high impact
- **Phase 1 – Cardinality Estimation**
 - Initial phase – Support equality & range local operators with no expressions
 - Future phases – Cardinality support for expressions, predicates & BLU, support for join enumerations,

AI -



Beta!

*Get to the
insights faster –
Use Natural
Language Query
(NLQ) for data
analysis*

Conversational analytics is the future...

- Data scientists often face the challenge of exploring data sets that are not familiar to them
 - Time consuming, Not sure what to look for
 - Need understanding of what is in the data set
- Need an intuitive data exploration tool
 - Alexa, Google Home, etc. prove trend
 - Natural extension of conversation to data
 - Provide multiple views of the data with minimal touch
- **Augmented Data Explorer** available to download - <https://www.ibm.com/us-en/marketplace/db2-augmented-data-explorer>
 - Currently in Beta
 - Seamlessly plugs and plays with Db2

Availability: Replication of Columnar Tables (tech preview)

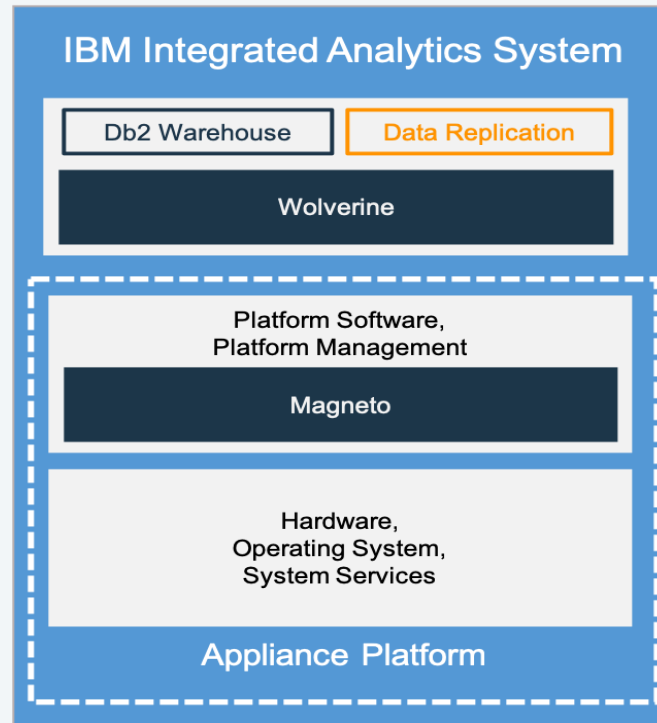
IBM Data Replication for Db2 Continuous Availability Feature (Rep4CA)

Built for Hybrid Cloud

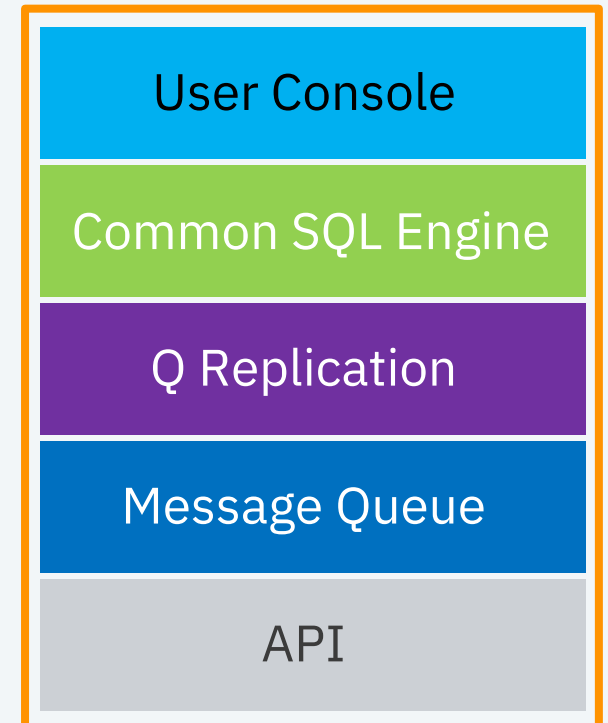
- Deploys with common container
- Designed for on-premises, private and public Cloud
- Docker-based container with REST APIs
- Integrated User console for setup, management and monitoring
- Built-in 90 Day Trial Demo

✓ **Pre-configured & customized for replicating Columnar Analytics workloads**

Simple deployment



Framework



Agenda

Data and AI. Meet The Family

Db2 Strategy And Roadmap

Version 11.5

- Goals: Convergence! Convergence! Convergence!
- Platform Support
- Planned GA Content
- Looking Forward
 - Core Database Capabilities, Resiliency, Security
 - Developer Focus
 - Cognitive Capabilities (aka AI)

Security - Schema level authorization

Database

Administration = DBADM
Security = SECADM, ACCESSCTRL
Access = DATAACCESS
Load = LOAD

Schema

Administration = SCHEMAADM
Security = ACCESSCTRL
Access = DATAACCESS, SELECTIN, INSERTIN, UPDATEIN, DELETEIN
Load = LOAD

Object

Administration = Owner/CONTROL
Security = Owner/CONTROL
Access = SELECT, INSERT, UPDATE, DELETE
Load = LOAD



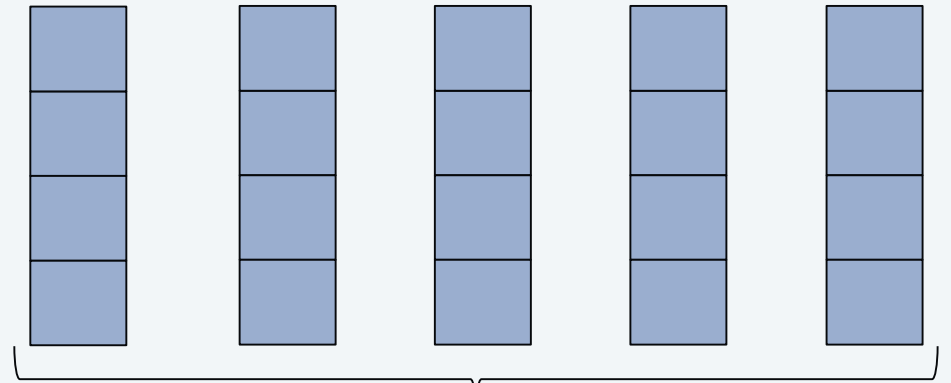
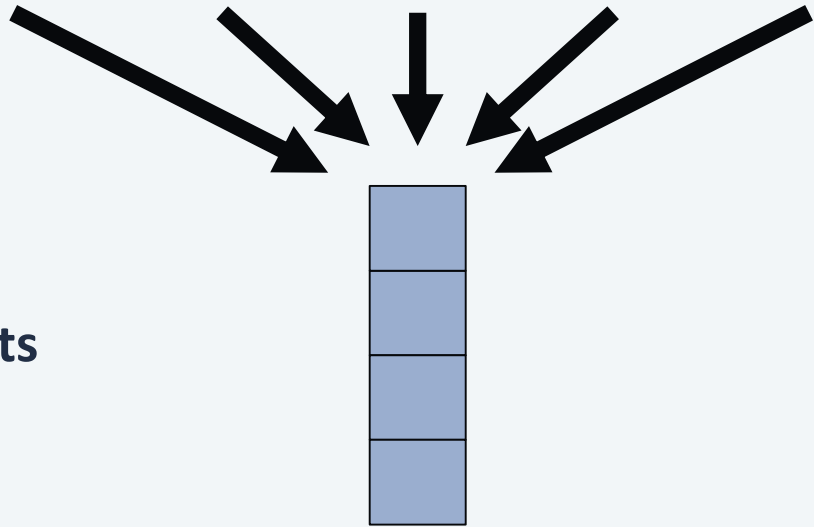
Potential
Future

Performance – (HTAP) Trickle Columnar Insert

1	100	abc	1.1	10
---	-----	-----	-----	----

Post-v11.5 approach

Extents



Potential
Future

Row-like format

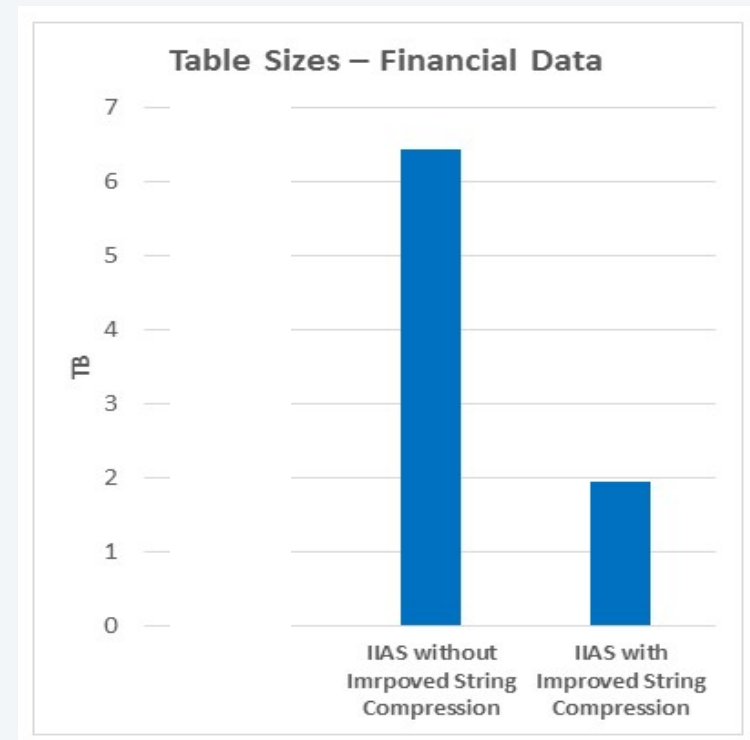
Columnar format

Performance - Improved Compression of String Datatypes

- Frequency-based compression difficult for some string datasets
- String data dominates storage cost
- Add another level of pattern-based page compression



Potential
Future



Performance - Reduced logging for Columnar



- An enhanced version of “Not Logged Initially” (NLI)
 - Table contents will be preserved during rollback, crash recovery, and rollforward recovery to END of online backup
- Very large INSERTs possible without running out of log space
 - Up to 95% less data logged!
- Unlike NLI, reduced logging is not a universal table property. Instead, it is only relevant to operations driving a large amount of insert work against a table
 - E.g. Insert from subselect via External Table, Create Table As, Update statements, INGEST, MERGE, Insert statements, etc
 - Reduced logging takes effect after a certain amount of insert work has already occurred
- This is the default (and only behaviour in Db2 Warehouse on the Cloud (Db2WoC))

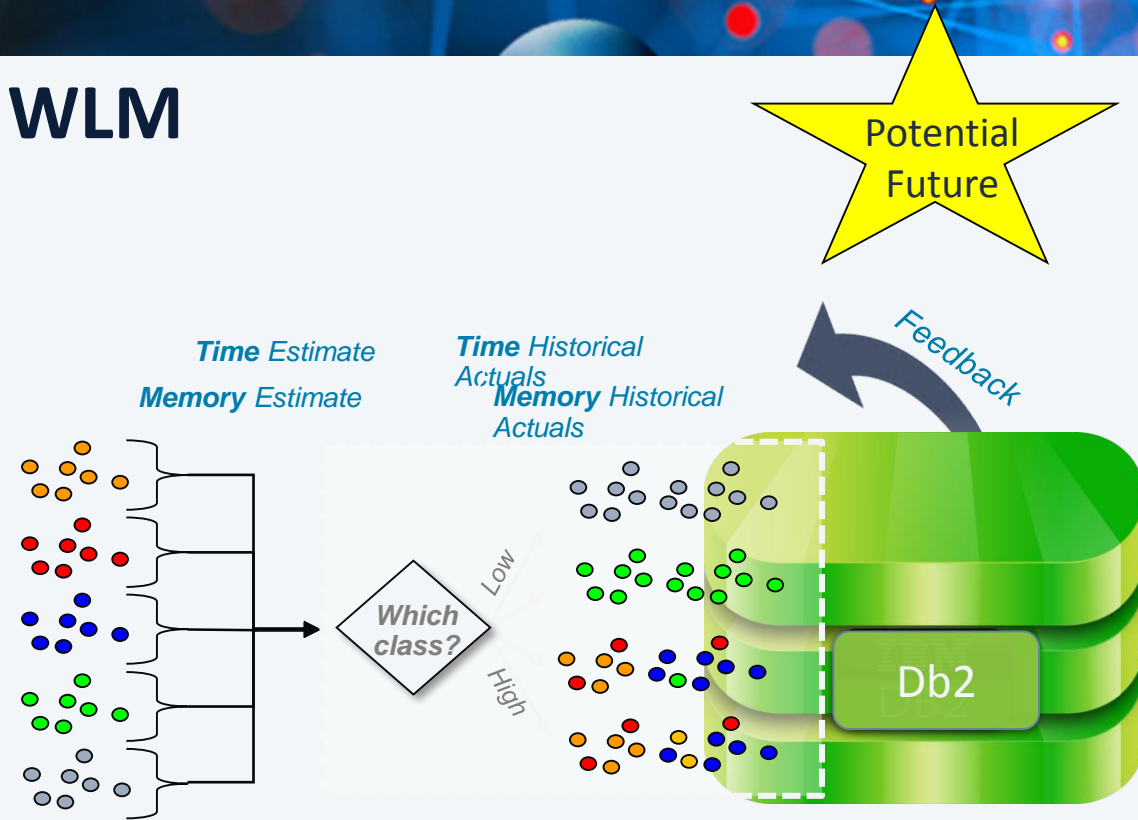
Simplicity - Adaptive WLM



- Objective is to deliver automatic workload management within Db2 that ensures system stability and responsiveness with zero tuning
 - Don't overcommit the system yet ensure it's well utilized
 - Schedule jobs appropriately to ensure fairness and appropriate responsiveness
- Basic premise:
 - Incoming work guided to different "lanes" based on expected resource consumption and duration
 - Each "lane" gets a defined resource allotment to maximize predictability
 - Resources considered: Sort memory & CPU
 - Scheduling of work in each "lane" based on dynamic view of resource availability
 - Admission of new work is on the fit of the work to the available resources in that class and latency
 - Includes historical feedback based on past executions

The introduction of Adaptive WLM

- Currently being used by default in Db2 Warehouse family
 - New default workload configuration
- Will introduce as new, optional behaviour for default configuration in Db2 VNext in an early update
 - Need to validate further with more row-centric workloads
- User defined capabilities to be rolled out in later updates



Bringing AWLM to Db2...



- **AWLM will have a staged delivery to Db2**
 - **Stage 1:** AWLM available for use by analytics (BLU) customers
 - Available to customers who set `DB2_WORKLOAD = ANALYTICS`
 - **Stage 2:** AWLM available for use by all Db2 customers
- **Moving to AWLM will require an outage to allow the implementation of a new default system configuration**
 - A new “opt-in” procedure will be provided

Developer – Additional JSON support



Objective:

Complete implementation of the current set of defined ISO JSON SQL functions.

This includes:

Schema	Name	Comments
SYSIBM	IS JSON	Validates format of JSON
SYSIBM	JSON_ARRAYAGG	Creates JSON array from input key value pairs
SYSIBM	JSON_OBJECTAGG	Creates JSON object from input key value pairs
SYSIBM	JSON_TABLE	Creates relational output from a JSON object (full ISO JSON specification)



IDUG
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Community since 1988

IDUG Db2 Tech Conference
Charlotte, NC | June 2 – 6, 2019

 **#IDUGDb2**



Tech
Preview



Up to 10x better query performance
powered by an ML-Optimizer



Tech
Preview

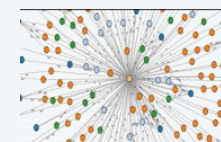
Enriched and faster data exploration
by using NLQ and Db2 ADE



**No data movement &
a single view on all data**
delivered by Data Virtualization

IBM Db2

the AI database



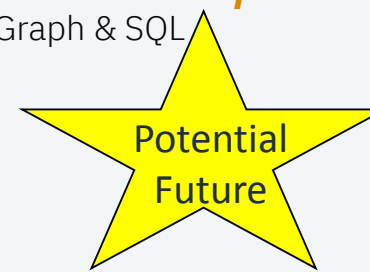
Model Complex Relationships
by using Db2 Graph & SQL



Potential
Future



Confidence-based query results
leveraging ML-SQL



Potential
Future

Build AI based applications
by using Python, GO , JSON and Jupyter notebooks

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Session code: TRIDEX



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*Please fill out your session
evaluation before leaving!*

