DB2 LUW 10.5 for Linux on System z

R Matchett
IBM Information Management
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Agenda

- Linux on Z Systems – quick look
- History of DB2 on Linux on System Z
- Linux on System Z – Enterprise Linux Server
- Use cases for implementing DB2 LUW on Linux on System Z
- Features of DB2 LUW
  - Oracle compatibility
  - Encryption
  - BLU Acceleration
- Some best practices for DB2 LUW
- Summary
Linux on z Systems

- Typically DB2 for z/OS is implemented on a System Z machine

- Typically DB2 for Linux, Unix & Windows is implemented on a distributed server.

- The Z platform has a processor called an IFL – Integrated Facility for Linux

- The Integrated Facility for Linux (IFL) is a processor dedicated to Linux workloads on IBM z Systems. The IFL is supported by z/VM virtualization, IBM Wave for z/VM and the Linux operating system; it cannot run other IBM operating systems

- Linux on z Systems is the synonym for Linux running on any IBM mainframe, including:
  - IBM z13™ (z13) - 141
  - IBM zEnterprise™ EC12 (zEC12) - 101
  - IBM zEnterprise BC12 (zBC12) – 13
  - IBM zEnterprise 196 (z196)
  - IBM zEnterprise 114 (z114)
  - IBM System z10™
  - IBM System z9®
  - IBM eServer™ zSeries™ (z990, z890, z900, z800)
History of DB2 for Linux on System Z

- In 2000, **DB2 7.1 was one of the first software programs** certified for use on "z/Linux" – more appropriately now referred to as .......... *Linux on System Z*
- The IBM DB2 & Linux on System Z teams work together
- Quality, reliability, & performance **proven by many satisfied DB2 on Linux on System Z customers**
- In 2013, IBM delivered **DB2 10.5** which introduced BLU Acceleration
- In August 2014, **DB2 10.5 Fix Pack 4 (Cancun) delivered** – added Shadow tables
- In December 2014, **DB2 with BLU Acceleration became available on Linux on System Z with DB2 10.5 Fix Pack 5**

15 years of Enterprise Linux® on System z® running DB2

A simple idea that changed the world

Why Linux on System Z

The Benefits of IT Simplicity

Infrastructure

- Provide efficiency at scale on a single physical server
- Deliver industry-leading virtualization for effective deployment
- Enable flexible delivery of services
- Allow for fast data access and high utilization efficiency
- Deliver resilience and availability with high qualities of service
- Do more with less while deploying workloads and consolidating

Cost Savings

- Lower maintenance and operational costs
- Lower software and maintenance costs
- Lower footprint and energy costs
- Lower security and business continuity costs
The Enterprise Linux Server

IT simplicity - the real alternative to server sprawl

A full room of servers versus One footprint with the size of a refrigerator

Unmatched total Linux capacity
## IBM Enterprise Linux Server includes

- IBM z Systems server + maintenance
- IBM virtualization and virtualization management + support & subscription

### LPAR
Logical Partition = subset of hardware resources, virtualized as a separate computer; up to 85 LPARs can be configured on IBM z13™ (z13*)

### IFL
Integrated Facility for Linux = Core; up to 141 cores (IFLs) on IBM z13™(z13*)

### Virtual. Mgmt.
Hypervisor providing efficiency at scale and virtualization management for easy administration, provisioning, automation

### Linux Guest
Virtual Linux guests running workloads such as mobile, analytics, databases, Java™ apps, etc. -- in a cloud; up to thousands Linux guests can be hosted on a single z13*

* z13 = IBM z13
Logical Partitioning (LPAR) and z/VM are complementary

- **LPAR**
  - Host a relatively small number of very high-performance virtual servers
  - Very low overhead, hardware-based virtualization through partitioning

- **z/VM**
  - Host large numbers of high-performance virtual servers
  - Low overhead, hardware-based, true virtualization with extreme levels of software augmentation

- **IBM Wave for z/VM**
  - Drives simplicity into managing highly virtualized environments
  - Take the first critical steps toward cloud

Together, LPAR and z/VM technology provide:

- High performance “on the metal” virtual servers for larger, performance-critical workloads
- The ability to provision up to thousands of virtual Linux servers flexible and on demand

Virtualization is a part of the basic componentry of the Enterprise Linux Server
IBM z/VM – Powerful and Versatile Virtualization

- **World class quality, security, reliability**
- **Extreme scalability creates huge cost savings opportunities**
  - Software licensing
  - Hardware maintenance and networking
  - Floor space and Energy
- **Exploitation of advanced technologies, such as:**
  - Shared memory (Linux kernel, executables, communications)
  - Virtual networking (Switches, LANs)
- **Highly granular control over resource pool**
- **Valuable tool for Disaster Recovery and Resiliency plans and processes**
IBM is committed to open standards Linux

DB2 is optimized to run on SuSE and Red Hat Linux distributions

<table>
<thead>
<tr>
<th>Distribution</th>
<th>z13</th>
<th>zEnterprise - zBC12 and zEC12</th>
<th>zEnterprise - z114 and z196</th>
<th>System z10 and System z9</th>
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<tr>
<td>RHEL 7</td>
<td>Y</td>
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<td>RHEL 6</td>
<td>Y</td>
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<td>SLES 12</td>
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<td>SLES 11</td>
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* Check specific kernel level requirements

Minimum Levels
- SLES 11 SP3
- RHEL 6.5
DB2 LUW: One Database Platform for All Business Applications

Advanced Application Functionality

- NoSQL
- Spatial
- Analytics
- HADOOP Extensibility
- MongoDB API
- Industry Standard API's

Advanced Data Functionality

- Oracle Compatibility
- JSON/Graph Store
- Workload Management
- Continual Data Ingest/Access
- Temporal Data
- In Memory BLU Acceleration
- Autonomic Management
- Intelligent Compression
- Pure XML
- Fine grained Security

Enterprise Data Platform for all Business Applications

- Massive scale / 24x7 OLTP Platform
- Multi-tenant Enterprise Platform
- Active / Active 24x7 Massive Data Scale Warehouse

Database Partitioning Feature (DPF)

Deployment Options

- Customer Infrastructure Optimized Deployment
- Available Linux on System Z
What is DB2 for Linux on System Z?

- **DB2 LUW** for Linux is
  - Just **DB2** for LUW
  - 99.9%+ the same code
  - 99.9%+ the same look/feel
  - 99.9%+ the same skills

- **DB2 LUW** is supported on both RHEL and SLES
  - RHEL 7 and SLES11 SP3 preferred

- **DB2 LUW** for Linux on System z has the **same 98%+ Oracle Compatibility**
  - PL/SQL support
  - Datatype support

- **DB2 LUW** is not identical to **DB2** for zOS, but
  - Common client infrastructure
    - JCC/ODBC/CLI
    - Perl/PHP/Python/Ruby ...
  - Optim database tooling (**Data Studio**, OPM, OQWT)
  - Exceptionally similar **DDL/DML/DCL**
DB2 11 SQL – Standard SQL Support

(Not exhaustive, some features may be missing)

DB2 11 for z/OS and DB2 10.5 Linux, Unix, and Windows

z
Multi-row INSERT, FETCH and multi-row cursor UPDATE, Dynamic Scrollable Cursors, GET DIAGNOSTICS, Enhanced UNICODE SQL, join across encoding schemes, IS NOT DISTINCT FROM, VARBINARY, FETCH CONTINUE, SELECT FROM MERGE, MERGE, routine versioning, transparent archive query

Inner and Outer Joins, Table Expressions, Subqueries, GROUP BY, Complex Correlation, Global Temporary Tables, CASE, 100+ Built-in Functions including SQL/XML, Limited Fetch, Insensitive Scroll Cursors, UNION Everywhere, MIN/MAX Single Index, Self Referencing Updates with Subqueries, Sort Avoidance for ORDER BY, and Row Expressions, 2M Statement Length, GROUP BY Expression, Sequences, Scalar fullselect, Materialized Query Tables, Common Table Expressions, Recursive SQL, CURRENT PACKAGE PATH, VOLATILE Tables, Star Join Sparse Index, Qualified Column names, Multiple DISTINCT clauses, ON COMMIT DROP, Transparent ROWID Column, Call from trigger, statement isolation, FOR READ ONLY, KEEP UPDATE LOCKS, SET CURRENT SCHEMA, Client special registers, long SQL object names, SELECT from INSERT, UPDATE or DELETE, INSTEAD OF TRIGGER, SQL PL in routines, BIGINT, file reference variables, XML, FETCH FIRST and ORDER BY in subselect and fullselect, caseless comparisons, INTERSECT, EXCEPT, MERGE not logged tables, OmniFind, spatial, range partitions, data compression, DECFLOAT, optimistic locking, ROLE, TRUNCATE, index and XML compression, created temps, inline LOB, administrative privileges, implicit cast, increased timestamp precision, currently committed, moving sum and average, index include columns, row and column access controls, time travel query, GROUPING SETS, ROLLUP, CUBE, global variables, Text Search functions, accelerated tables, DROP COLUMN, array data type, XML enhancements

Common
Updateable UNION in Views, more Built-in Functions, SET CURRENT ISOLATION, multi-site join, full MERGE, MDC, XQuery, additional data type (row, cursor), even more vendor syntax, temp table compression, MODULEs

LUW
Strong Value Use Cases

- **Consolidation**
  - Bring many small, typically low utilized database environments together into a highly consolidated and virtualized environment under z/VM

- **Migrate Oracle on "zLinux"** (more later)
  - Oracle may be pushing alternative solutions – like Exadata
  - Oracle pricing may be a strong consideration
  - Migration is typically straightforward
    - Especially if
      - Using a packaged application that already supports DB2
      - A home grown application

- **Use DB2 as the persistent data store for other solutions**
  - Websphere Portal Server, WebSphere Application Server
  - Cognos 10 content server
  - ... many more

- **Leverage DB2 BLU for in-memory analytics** (more later)
  - Use both row and columnar tables
**Oracle Compatibility**
- Break free with DB2 LUW
- Reduce the cost & risk associated with migrating Oracle applications to DB2

**Encryption** – securing data natively in DB2  *New in Fix Pack 5*

**Enhanced Tooling**
- Reducing the total cost of ownership with DB2 and make the adoption, management, monitoring and maintenance very simple

**DB2 BLU** – *now supported on Linux on System Z with Fix Pack 5*
- In memory * columnar database analytics
Moving Your Applications to DB2 is Easy

Easily move your applications from Oracle database or data warehouse environments. Integrated, cross-platform tools support both DB2 and Oracle Database. Applications moved to DB2 run quickly with full native execution.

Leverage existing skills and people without re-training. Customers and partners have moved in only days. Available since DB2 9.7 – enhanced in 10.1 & 10.5 releases.
Realistic Migration to DB2 10 with Oracle Compatibility

**Months to years**

1. **Map schema and data types**
   - Different types behavior. *Eg: DATE*
   - Separate DDL for different *RDBMS*

2. **Move data**

3. **Translate PL/SQL code**
   (Triggers/Procedures/Functions)
   - Missing built-in functions & packages
   - Missing functionality: REF CURSORs, %TYPE, ...

4. **Translate SQL in application logic**
   (manual)
   - Untyped expressions (thousands of occurrences)

5. **Debugging**
   - Hard to fix concurrency problems

6. **Test and Tuning**

**Days to weeks**

1. **Map schema and data types**
   - Native support
   - 98% of SQL immediate available
   - 98% procedures immediate
   - 98% PL/SQL immediate

2. **Move data**

3. **Run your shared code**
   - Native support
     - NO EMULATION!!
   - Minor adjustments

4. **Test and Tuning**
| 9.7.1 | SUB STRB, UDF Parameters: INOUT, FORALL/BULK COLLECT, Boolean, Conditional compilation, OCI Support | Increase compatibility |
| 9.7.2 | UDF Parameters: DEFAULT | Increase compatibility |
| 9.7.2 | Obfuscation | Enhancement |
| 9.7.2 | NCHAR, NVARCHAR, NCLOB | Increase compatibility |
| 9.7.3 | NUMBER Performance | Performance |
| 9.7.3 | Runtime "purity level" Enforcement | Increase compatibility |
| 9.7.3 | RATIO_TO_REPORT Function | Increase compatibility |
| 9.7.3 | RAISE_APPLICATION_ERROR | Increase compatibility |
| 9.7.3 | Small LOB Compare | Increase compatibility |
| 9.7.4 | Multi-action Trigger & Update Before Trigger | Increase compatibility |
| 9.7.4 | Autonomous Tx Improvements | Increase compatibility |
| 9.7.4 | LIKE Improvements, LISTAGG | Increase compatibility |
| 9.7.4 | ROW & ARRAY of ROW JDBC Support | Increase compatibility |
| 9.7.5 | Pro*C Support | Increase compatibility |
| 9.7.5 | Nested Complex Objects | Increase compatibility |
| 10 | Local Procedure Definitions | Increase compatibility |
| 10 | Local Type Definitions | Increase compatibility |
| 10 | PL/SQL Performance | Performance |
| 10.1.2 | SUBTYPE, PIPElined functions, ..... | Increase compatibility |
| 10.5 | Rows Beyond 32K | Increase compatibility |
| 10.5 | Index on Expression | Increase compatibility |
| 10.5 | Compatible unique index semantics | Increase compatibility |
| 10.5 | @dblink syntax when referencing remote tables | Increase compatibility |
| 10.5 | INSTRB, INSTR2, INSTR4, LENGTHB, LENGTH2, LENGTH4, and SUBSTR4 functions | Increase compatibility |
We Can Help You Easily Move from Oracle

- **Database Conversion Workbench (DCW)**
  - Plug-in for Data Studio
  - Analyzes PL/SQL and database objects to quickly identify compatibility ratio and any areas that may require manual intervention during conversion
  - Migrates Oracle data, schema & procedural objects to DB2

- **DB2 Conversion Assessment Questionnaire**
  - Used to gather information for accurately sizing the migration effort. Based on our experience performing hundreds of application migrations

- **IBM DB2 Workshop for Oracle Professionals (PoT)**
  - Designed especially for Oracle practitioners, provides hands-on proof of how easy it is to learn and apply their existing skills to DB2

- **Flexible Migration Services to fit your needs**
  - We offer a variety of Service options, from helping your existing staff migrate applications on their own to turnkey migrated solutions

  ➢ And much more!
Keep DB2 Data Assets Safe

NEW native encryption of data stored in DB2

Protect DB2 data assets and meet organizational and regulatory requirements without the expense and complexity of non-native encryption solutions

Industry compliant (meets the requirements of NIST SP 800-131 compliant cryptographic algorithms and utilizes FIPS 140-2 certified cryptographic libraries)

- Included in Advanced Workgroup and Advanced Enterprise Editions
- Available as add-on to Enterprise, Workgroup, and Express Editions
IBM DB2 Encryption Offering – DB2 10.5 FP5

Simple to deploy in cloud, software, or appliance – keyword **ENCRYPT**

**Encrypts online data & backups**
- All table spaces (system defined and user defined)
- All types of data in a table space (LOB, XML, etc.)
- All transaction logs including logs in the archives
- All LOAD COPY data
- All LOAD staging files
- All dump .bin files
- All backup images

**Transparent**

**Built-in secure and transparent key management including key rotation**

**Compliant, e.g.**
- NIST SP 800-131 compliant cryptographic algorithms
- Uses FIPS 140-2 certified encryption

**Runs wherever DB2 runs!**
- All 64-bit platforms: AIX, HP-UX, Linux, pLinux, Linux on Z, Solaris, Windows
- Exploits available HW acceleration (AES encryption only)
- Intel supported
IBM DB2 with BLU Acceleration on Enterprise Linux Server

New

IBM DB2 with BLU Acceleration represents a new generation of data management

Next-generation in-memory computing

Column-based BLU Tables

Actionable Compression

Exploiting CPU Acceleration techniques

Data skipping

BLU Shadow Tables for real time analytic queries

The result:

Reliably faster analytic query processing for a variety of online analytical workloads—without the limitations of in-memory-only systems.

DB2 with BLU Acceleration combines proven in-memory and columnar data store capabilities with advanced compression and hardware exploitation techniques.

DB2 can process both row- and column-based tables in the same system, resulting in significantly improved performance.
1. **Next generation database**
   - Super **fast** (query performance)
   - Super **simple** (load-and-go)
   - Super **small** (storage savings)

2. **Seamlessly integrated**
   - Built **seamlessly** into DB2
   - **Consistent** SQL, language interfaces, administration
   - Dramatic simplification

3. **Hardware optimized**
   - Memory optimized
   - CPU-optimized – exploits **SIMD** capability on **Z13**
   - I/O optimized
What is DB2 10.5 with BLU Acceleration?

- "New" state-of-art technology for analytic queries in DB2 LUW
  - Column-organized database tables
    - Data processed based on column store instead of traditional row store
    - Smaller data and faster processing
  - Dynamic In-Memory Processing
    - Scan, locate, and cache data in memory even if data exceeds memory
  - Parallel Vector Processing
    - Provide multi-core and multiple data parallelism over different processors
  - Actionable Compression
    - Deep compression that is order-preserving
    - Data can be used without decompressing
  - Data Skipping
    - Skip over the irrelevant data to access only necessary information
  - Easy to Use
    - Load and Go – data is ready for query in record time
    - No significant tuning

- db2set DB2_WORKLOAD=ANALYTICS prior to database creation
What is DB2 10.5 with BLU Acceleration?

Super Compress

- 10-20X smaller is common
- Compress as small as 1 bit
- Compress the most frequent data the smallest

Query Compressed Data

- No decompression - save CPU cycles
- Data flows through memory and CPU at compressed size
- Actionable compression

HONEY, I SHRUNK THE DATA
What is DB2 10.5 with BLU Acceleration?

**Columnar Everywhere**

- Reduce I/O
- Increase data density in RAM
- Increase CPU efficiency

**Skip Boring Data**

- Queries skip uninteresting data
- Synopses on every column, automatically
- Data Skipping
What is DB2 10.5 with BLU Acceleration?

Faster Than RAM
- RAM is too slow for BLU!
- Redesign the query engine to operate at CPU cache speeds instead
- CPU cache is 10-75X faster than RAM access

Rethink Memory
- Cache intelligently for analytics
- Predictive I/O with Dynamic List Prefetching
- Massive I/O reduction
DB2 10.5 BLU Shadow Tables

Instant insight into operational data without compromising transaction performance

DB2 creates column-based ‘Shadow Table’ versions of row-based operational data

Analytic queries are seamlessly routed to Shadow Tables to take advantage of BLU Acceleration analytics performance in the transaction processing environment

With BLU Shadow Tables, the performance of analytical queries can improve by 10x or more, with equal or greater transactional performance*. In one instance, the removal of secondary analytic indexes improved transactional performance by 2x**

* - Based on internal IBM testing of sample transactional and analytic workloads by replacing 4 secondary analytical indexes in the transactional environment with BLU Shadow Tables. Performance improvement figures are cumulative of all queries in the workload. Individual results will vary depending on individual workloads, configurations and conditions.
** - Based on internal IBM testing of sample transactional and analytic workloads by replacing 20 secondary analytical indexes in the transactional environment with BLU Shadow Tables. Performance improvement figures are cumulative of all queries in the workload. Individual results will vary depending on individual workloads, configurations and conditions.
(System configuration)

- **Use a modern System z machine**
  - The System z IFL processors have been enhanced in Z13

- **If you want to use z/VM (most do) remember**
  - z/VM is not “free” (resource-wise) – especially regarding memory
    - The more IFLs the more memory you need to reserve for z/VM
  - Ensure you have current maintenance for z/VM

- **If your database does disk I/O (most do) remember**
  - Less concern for storage space
  - More consideration for storage performance (random IOPS, sequential Mb/sec)
    - Use SCSI disks
    - Consider SSD where cost appropriate

- **Use a current Linux version**
  - SLES 11 / 12 or RHEL 6 / 7
Use current DB2 LUW software – 10.5 FP5
- Stay current & leverage new capabilities (BLU)

DB2 10 has been well-received (across platforms)
- Many customers are using DB2 10
- DB2 10.5 FP5 is already GA for 6 months

Don’t overthink the sizing. First order approximations
- Family of processor (Power, Intel, or System z)
  - i.e., an IFL on Linux on System z is treated as equivalent to a core on Power/Intel

Keep It Simple principle
- Resist the urge to over-specify all possible options
- Just because they exist doesn’t mean you have to use them
- Recent sizing guidelines available
Use DB2 automatic storage (required for BLU)
- A modest number of storage paths that map sensibly to the SAN storage

Minimize the use of distinct page sizes
- 8K is a good default (no more than 2 page sizes)
- Specify the smaller one at create database time for the catalog
- 32K required for BLU columnar tables

Minimize the number of bufferpools
- 1 each for data/index, 1 for temp is usually sufficient
- Tune as needed – use tooling

Tablespaces
- Often helpful to split data/index/LOB (esp LOB) into separate tablespaces
- No need to put EACH table in its own tablespace – unlike DB2 for z/OS practice

Use the Autonomics
- Autoconfigure & STMM
  - Give DB2 a budget via `instance_memory` or `database_memory`

Compression
- Turn on compression at create table time – automatically on for BLU
IBM has a strong tools portfolio
- Many are no charge
- Most are included in Advanced Enterprise Server Edition (AESE)

Optim Data Studio
- Database Administration
- Developer tools
- Database Conversion Workbench (DCW) plug-in for Oracle compatibility

Optim Performance Manager (OPM)
- With Extended Insight for application server environments (e.g. WAS)

Optim Query Workload Tuner (OQWT)
- Integration with OPM
- Next generation of “DB2 design advisor”

Optim Capture/Replay
- Realistic Pre-production view of existing environment

Data Server Manager
- Server based browser capable monitoring
DB2 for Linux on System Z - Summary

- **DB2 LUW is a mature, full function product on Linux on System Z**
  - Many years of development/testing/deployment
  - Nearly every capability is available on Linux on System Z

- **DB2 LUW on Linux on System Z is high performance**
  - Regular testing on latest System z hardware (OLTP and BI)

- **DB2 10.5 is production ready and available on Linux on System Z**
  - DB2 10.5 FP5 is available and production ready
    - Including BLU Acceleration

- **DB2 BLU runs extremely well on Linux on System Z z13**
  - Fast, small, simple
  - Demonstrated up to 62x speedup over DB2 10.1 row-store on zEC12

- **Many satisfied customers on DB2 for Linux on System Z already**
  - Growing interest now that DB2 with BLU Acceleration is available
    - **Customer tests with DB2 BLU underway**
DB2 for Linux on System Z – Helpful Links

Integrated Facility for Linux

http://www-03.ibm.com/systems/z/os/linux/solutions/ifl.html

Enterprise Linux Server

http://www-03.ibm.com/systems/z/os/linux/els.html

IBM z/VM

http://www.vm.ibm.com

DB2 for Linux, UNIX and Windows:

http://www-01.ibm.com/software/data/db2/linux-unix-windows/db2-blu-acceleration

BLU Acceleration technology now supported on Windows & Linux:

http://www.ibmbluhub.com/blu-windows
Thank you!