Business Analytics in System z: The IBM DB2 Analytics Accelerator

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IBM Software Group
Business challenges and technology trends

- **Change in business requirements**
  - BI/DW is evolving to a “mission critical” system with quality of service requirements similar to those of OLTP systems
    - Reliability, availability, security, workload management, mixed workloads, etc...
    - Faster complex query execution times
    - Predictable and stable query execution times
  - Trend to dynamic DW dynamicos and operational BI
    - Mixed OLTP and OLAP workloads

- **Traditional performance tuning tools of the trade such as indexing, pre-built aggregates and MQTs struggling to keep the pace**
  - Require top DBA expertise and sophisticated tools
    - Even then not good enough due to ad-hoc, unpredictable nature of the workload

- **Technology trends**
  - Very large number of processor sockets and core
  - Specialized query processing engines
  - Appliances
The market has moved to the strengths of System z

**Requirements for operational characteristics**

- *System z is the most available platform you can buy* (99.999%)
- *The security on System z is unsurpassed by any other platform*

**Low Latency of key information**

- *A large portion of today’s operational data resides on the mainframe*

**Workload management for mixed workloads**

- *Manage multiple workload types with priority and work types scheduling*

**Lower costs through reduced complexity**

- Simplified management
- Reduced environmental costs
- Greater flexibility to meet changing needs
IDAA: DB2 Analytics Accelerator for z/OS

Netezza appliance connected to System z only accessible through DB2

Blending System z and Netezza technologies to deliver unparalleled, mixed workload performance for complex analytic business needs.

What is the value?

• Fast, predictable response times for “right-time” analysis
• Accelerate analytic query response times
• Improve price/performance for analytic workloads
• Minimize the need to create data marts for performance
• Highly secure environment for sensitive data analysis
• Transparent to the application
IDAA: Extreme Performance for Complex Analytics

- Data compression
- Zero tuning and Admin
  - No Indices
  - No MQTs
  - No query plans
  - No query rewriting
- Advanced algorithms
  - Zone Maps
  - Wire-speed decompression
  - Row-based storage
- Enhanced compression scheme
  - 4X on avg up to 32x possible

Applications
  - Application Interfaces (standard SQL dialects)

DBA Tools, z/OS Console, ...
  - Operation Interfaces (e.g., DB2 Commands)

Data Manager
Buffer Manager
IRLM
Log Manager
IBM DB2 Analytics Accelerator

DB2

z/OS on System z
  - 10s of processors
  - 100s of GB of memory

Netezza

Superior availability, reliability, security, workload management, OLTP performance...

Industry leading DW performance, ease of use
IDAA: The Netezza AMPP™ Architecture

AMPP = Asymmetric Massively Parallel Processing (SMP+MPP)

- Advanced Analytics
- BI
- Legacy Reporting
- DBA

DB2 for z/OS
- V9
- V10

Netezza 1000

IBM DB2 Analytics Accelerator

IBM DB2 Analytics Accelerator
How Query acceleration is enabled?

- **System parameters:**
  - ACCEL set to AUTO or COMMAND
  - QUERY_ACCELERATION
    - Sets the initial value for the CURRENT QUERY ACCELERATION special register

- **Special reg. CURRENT QUERY ACCELERATION:**
  - **NONE**
  - **ENABLE**
  - **ENABLE WITH FALLBACK**
  - **ELIGIBLE**: skip heuristics & costing in the ENABLE option. Queries that are not eligible for acceleration are executed by DB2
  - **ALL**: All queries to be executed in the Accelerator, error (-4742) for not eligible queries

- The data of all the referenced tables and columns in the query are loaded and reside in the same accelerator.
- The SQL query is among the query types that DB2 for z/OS can route
  - The whole query will either run in DB2 or in the accelerator
  - The associated cursor is not defined as a scrollable or a rowset cursor
  - The query is defined as read-only
    - INSERT FROM SELECT supported
  - The query is a dynamic SELECT statement
    - Plans for STATIC-SQL support
  - **Routing to IDAA is considered more efficient for performance than to execute the query in DB2 mainline**
select DISTRICT, PRODUCTGRP, sum(NRX)
from MTHLY_RX_TERR_DATA
where MONTH = '20091201'
and MARKET = 509123
and SPECIALTY = 'GASTRO'
Loading and Refreshing IDAA Data Contents

- Partitions belonging to the same table can be loaded in parallel
  - User-defined degree of parallelism
  - Updates are done on a per-table or per-partition level
- Implemented as a stored procedure ACCEL_LOAD_TABLES
  - Can be invoked directly or through IDAA Studio
  - A single and uniform interface for:
    - Initial load of a DB2 table into IDAA
    - Refresh of a table or any subset of table's partitions in IDAA
- DB2 can route queries to IDAA while the table's or partition's content is being refreshed

Estimated 1 TB / h for TF-12 –can vary, depending on CPU usage, etc...
The tables need to be defined and deployed to IDAA before data is loaded and queries sent to it for processing.

- Definition: identifying tables for which queries need to be accelerated
- Deployment: making tables known to DB2, i.e. storing table meta data in the DB2 and Netezza catalog.

IBM DB2 Analytics Accelerator Studio guides you through the process of defining and deploying tables, as well as invoking other administrative tasks.

IBM DB2 Analytics Accelerator Stored Procedures implement and execute various administrative operations such as table deployment, load and update, and serve as the primary administrative interface to IDAA from the outside world including IDAA Studio.
Connectivity options

Multiple DB2 systems can connect to a single IDAA

A single DB2 system can connect to multiple IDAAs

Multiple DB2 systems can connect to multiple IDAAs

Full flexibility for DB2 systems:
- residing in the same LPAR
- residing in different LPARs
- residing in different CECs
- being independent (non-data sharing)
- belonging to the same data sharing group
- belonging to different data sharing groups

Better utilization of IDAA resources
Scalability
High availability
DISPLAY ACCELERATOR

-DIS ACC(BLINK1) LIST(ACTIVE) SCOPE(LOCAL) MEMBER(DB1D)

dsnx810i ) dsnx8cmd display accel follows -
dsnx830i ) dsnx8cda
accelerator

<table>
<thead>
<tr>
<th>ACCELERATOR</th>
<th>MEMB</th>
<th>STATUS</th>
<th>REQUESTS</th>
<th>ACTV</th>
<th>QUED</th>
<th>MAXQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLINK1</td>
<td>DB1D</td>
<td>STARTED</td>
<td>9210</td>
<td>7</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

Location=Accelerator1 Healthy

Detail Statistics
Level = AQT02010
Status = ONLINE
Failed Query Requests = 3
Average Queue Wait = 99
Maximum Queue Wait = 400
Total Number Of Processors = 4
Average CPU Utilization On Coordinator Nodes = 45.00%
Average CPU Utilization On Worker Nodes = 40.00%
Number Of Active Worker Nodes = 2
Total Disk Storage Available = 93000 MB
Total Disk Storage In Use = 56100 MB
Disk Storage In Use For Database = 36100 MB
Display Accel Report Complete

Dsn9022i ) Dsnx8cmd '-DISPLAY ACCEL' Normal Completion
Customer example: Immediate Savings with IDAA

- IBM DB2 Analytics Accelerator (Netezza 1000-12)
  ➔ Production ready - 1 person, 2 days
- Table Acceleration Setup … 2 Hours
  - DB2 “Add Accelerator”
  - Choose a Table for “Acceleration”
  - Load the Table (DB2 copy to Netezza)
  - Knowledge Transfer
  - Query Comparisons
- Initial Load Performance …
  ➔ 5.1 GB “Loaded” in 1 Min 25 Seconds
  24 million rows
- Actual Query Acceleration … 139x
  ➔ 1 Minute to 1/2 Second
- CPU Utilization Reduction … over 99%
  ➔ 35% to ~0%
Free Workload Evaluation/Sizing

- **Customer**
  - Collecting information from dynamic statement cache, supported by step-by-step instruction and REXX script (small effort for customer)
  - Uploading compressed file (up to some MB) to IBM FTP server

- **IBM / Center of Excellence**
  - Importing data into local database
  - Quick analysis based on IDAA capabilities

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**Report for a first assessment:**
- Acceleration potential for Queries
- Estimated time
- CP cost

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**IBM Smart Analytics Optimizer -- Workload Evaluation**
Center of Excellence, Database on System z, IBM Research

**Query Summary**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>With potential</th>
<th>Uncertain</th>
<th>With potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queries</td>
<td>23</td>
<td>11 (48%)</td>
<td>5 (22%)</td>
<td>7 (30%)</td>
</tr>
<tr>
<td>Query Blocks</td>
<td>32</td>
<td>13 (41%)</td>
<td>6 (19%)</td>
<td>13 (41%)</td>
</tr>
<tr>
<td>Elapsed Time</td>
<td>144001.47</td>
<td>108016.61</td>
<td>1592.24 (0%)</td>
<td>25929.56 (21%)</td>
</tr>
<tr>
<td>CPU Time</td>
<td>2108.25</td>
<td>11428.12 (54%)</td>
<td>1483.16 (7%)</td>
<td>8329.98 (10%)</td>
</tr>
</tbody>
</table>

**Load Query Blocks**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>With potential</th>
<th>Uncertain</th>
<th>With potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23</td>
<td>13 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>with constant</td>
<td>7</td>
<td>7 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>with large dim.</td>
<td>1</td>
<td>1 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>with quant. pred.</td>
<td>0</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>16 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>with very large dimension</td>
<td>1</td>
<td>1 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

**Start time:** Apr 2, 2010 9:41 AM
**End execution time:** Apr 2, 2010 4:37 PM
**Max mem cached:** Apr 2, 2010 4:44 AM
**Max mem cached:** Apr 2, 2010 4:37 PM
DB2 Analytics Accelerator V3
Lowering the costs of trusted analytics

What’s New?

• High Performance Storage Saver
  • Store a DB2 table or partition of data solely on the Accelerator. Removes the requirement for the data to be replicated on both DB2 and the Accelerator

• Incremental Update
  • Enables tables within the Accelerator to be continually updated throughout the day.

• zEnterprise EC12 Support
  • Version 3 will support the zEnterprise EC12, z196 and z114 System z platforms

• Query Prioritization
  • Brings System z workload management down to the individual query being routed to the Accelerator

• High Capacity
  • Support has been extended to include the entire Netezza 1000 line (1.28 PB)

• UNLOAD Lite
  • Reduces z/OS MIPS consumption, by reducing the workload off System z
Save Over 95% of Host Disk Space for Historical Data

One Quarter = 3.57% of 7 years of data
One Month = 1.12% of 7 years of data
One month = 2.78% of 3 years of data
High Performance Storage Saver
Reducing the cost of high speed storage

Store historic data on the Accelerator only

Tables can be resident on:
1. DB2 Only
2. DB2 and Accelerator
3. Accelerator Only

When data no longer requires updating, reclaim the DB2 storage

Special Registers control behavior
- CURRENT QUERY ACCELERATION
- CURRENT GET_ACCEL_ARCHIVE

Managed by zParms
Incremental Update

- An alternative to a full table load or table partition load. Refreshes only the records of the table that have been recently modified in the data warehouse.
  - This capability keeps the data on the IDAA in sync with the data in the DB2 Analytic System.
  - Used for low volume highly critical information. Some delay is present.
  - This is a fully integrated function that provides incremental update to tables and partitions.

Synchronizing data to lower data latency from days to minutes/seconds
Other V3 enhancements

• Query prioritization
  – DB2 sends the importance level to IBM DB2 Analytics Accelerator with each query.
  – IDAA maps the importance level to a Netezza priority and alters the session prior to query execution, using the corresponding priority.
  – Netezza supports only 4 different priority levels, therefore multiple WLM importance levels have to be mapped against the same Netezza priority.

• Data staleness detection
  – Accelerator data can be refreshed from DB2 at table or partition granularity
  – Admin must know explicitly which data needs to be refreshed
  – New feature: find out if DB2 data for a table or partition has changed since last load on accelerator
    • Avoid refreshing data that is already up-to-date without requiring explicit knowledge about data changes
    • Based on DB2 real-time statistics about data updates
Now expandable to 960 cores and 1.28 petabytes

<table>
<thead>
<tr>
<th>Cabinets</th>
<th>1/4</th>
<th>1/2</th>
<th>1</th>
<th>1 1/2</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-Blades</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>18</td>
<td>24</td>
<td>36</td>
<td>48</td>
<td>72</td>
<td>96</td>
<td>120</td>
</tr>
<tr>
<td>Processing Units</td>
<td>24</td>
<td>48</td>
<td>96</td>
<td>144</td>
<td>192</td>
<td>288</td>
<td>384</td>
<td>576</td>
<td>768</td>
<td>960</td>
</tr>
<tr>
<td>Capacity (TB)</td>
<td>8</td>
<td>16</td>
<td>32</td>
<td>48</td>
<td>64</td>
<td>96</td>
<td>128</td>
<td>192</td>
<td>256</td>
<td>320</td>
</tr>
<tr>
<td>Effective Capacity</td>
<td>32</td>
<td>64</td>
<td>128</td>
<td>192</td>
<td>256</td>
<td>384</td>
<td>512</td>
<td>768</td>
<td>1024</td>
<td>1280</td>
</tr>
</tbody>
</table>

*Capacity = User Data space
Effective Capacity = User Data Space with compression
*: 4X compression assumed

Predictable, Linear Scalability throughout entire family

Low Latency, High Capacity Update
### IDAA: Extreme Performance for Complex Analytics

Queries run faster
- Save CPU resources
- People time
- Business opportunities

**Actual customer results, October 2011**

<table>
<thead>
<tr>
<th>Query</th>
<th>Total Rows Reviewed</th>
<th>Total Rows Returned</th>
<th>DB2 Only</th>
<th>DB2 with IDAA</th>
<th>Times Faster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours</td>
<td>Sec(s)</td>
<td>Hours</td>
<td>Sec(s)</td>
<td></td>
</tr>
<tr>
<td>Query 1</td>
<td>2,813,571</td>
<td>2:39</td>
<td>9,540</td>
<td>0.0</td>
<td>5</td>
</tr>
<tr>
<td>Query 2</td>
<td>2,813,571</td>
<td>2:16</td>
<td>8,220</td>
<td>0.0</td>
<td>5</td>
</tr>
<tr>
<td>Query 3</td>
<td>8,260,214</td>
<td>1:16</td>
<td>4,560</td>
<td>0.0</td>
<td>6</td>
</tr>
<tr>
<td>Query 4</td>
<td>2,813,571</td>
<td>1:08</td>
<td>3,480</td>
<td>0.0</td>
<td>5</td>
</tr>
<tr>
<td>Query 5</td>
<td>3,422,765</td>
<td>0:57</td>
<td>4,080</td>
<td>0.0</td>
<td>70</td>
</tr>
<tr>
<td>Query 6</td>
<td>4,290,648</td>
<td>0:53</td>
<td>3,180</td>
<td>0.0</td>
<td>6</td>
</tr>
<tr>
<td>Query 7</td>
<td>361,521</td>
<td>0:51</td>
<td>3,120</td>
<td>0.0</td>
<td>4</td>
</tr>
<tr>
<td>Query 8</td>
<td>3,425,293</td>
<td>0:44</td>
<td>2,640</td>
<td>0.0</td>
<td>2</td>
</tr>
<tr>
<td>Query 9</td>
<td>4,130,107</td>
<td>0:42</td>
<td>2,520</td>
<td>0.1</td>
<td>193</td>
</tr>
</tbody>
</table>

**DB2 Analytics Accelerator:** “we had this up and running in days with queries that ran over 1000 times faster”

**DB2 Analytics Accelerator:** “we expect ROI in less than 4 months”

“Back of the Envelope” ROI
- Consider the MIPs of your z196 / z114
- Consider software MLC reduction: z/OS, CICS, DB2...
- Consider hardware value of MIPs redeployed

**Examples of 6 month ROI:**
- Avoiding 400 MIPs is roughly the cost of an IDAA Netezza 1000-3
- Avoiding 800 MIPs is roughly the cost of an IDAA Netezza 1000-6
- Avoiding 1600 MIPs is roughly the cost of an IDAA Netezza 1000-12

Accelerating decisions to the speed of business
New model: PureData System for Analytics N2001

IDAA has now TWO models
- N1001 ("TwinFin") – economical, high performance and scalability
- N2001 ("Striper") – highest performance appliance to-date

Accelerate Performance of Analytic Queries
- 3X faster performance\(^1\)
  for Big Data analytics
- 128 GB/sec effective scan rate per rack\(^2\)
  to tackle Big Data faster

Increase Efficiency of your Data Center
- 50% greater data capacity per rack\(^3\)
  helps optimize data center efficiency
- More capacity and less power per rack
  than both Oracle and Teradata

Simplicity and Ease of Administration
- Improved system management and resilience
  to spend less time managing and more time delivering value
- 70% FEWER service calls
  with more spare drives and faster disk regeneration\(^4\)
What is the value?

✓ High speed analytics where the data is generated

✓ Quickly delivers analytics to operational applications

✓ Enables thought time analysis with high speed complex queries

✓ Substantially reduces operational costs by removing the need for complex query tuning

✓ Creates a highly secure environment for highly sensitive analysis (ELA5)

✓ Speeds batch reporting cycle to meet stricter SLAs

✓ Enables decision makers to perform business analysis they never dared in the past

✓ Enables query acceleration across multiple applications and systems

✓ Capitalizes on DB2 skills and certification removing the need to learn or convert to another SQL environment
Thank You

Merci

Gracias!

Danke

Obrigado

Bedankt

Thank You

Obrigado

Danke

Merci

Gracias!

Thank You

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