IBM Analytics Platform Group

The Science and Engineering Behind Super Fast Load-and-Go In-memory Analytics

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BLU Acceleration

1. Next generation in-memory SQL data warehousing
   - Super Fast (query performance)
   - Super Simple (load-and-go)
   - Super Small (RAM and storage savings)

2. Seamlessly integrated
   - Built seamlessly into both dashDB (cloud) and DB2 (software)
   - Consistent SQL, language interfaces, administration
   - Dramatic simplification

3. Hardware optimized
   - Memory optimized
   - CPU-optimized
   - I/O optimized
35x-73x faster

...than traditional row-organized relational database technology, on average.
“Compared to our current production system, DB2 10.5 with BLU Acceleration is running **106x** faster for our Admissions and Enrollment workloads. We had one query that we would often cancel if it didn’t finish in 30 minutes. Now it runs in 56 seconds every time. **32x** faster, predictable response time, no tuning…what more could we ask for?”
- Brenda Boshoff, Sr. DBA

“Wow…unbelievable speedup in query run times! We saw a **speedup of 273x** in our Vehicle Tracking report, taking a query from **10 minutes** to **2.2 seconds**. That adds value to our business; our end users are going to be ecstatic!”
- Ruel Gonzalez - Information Services
"My largest row-organized, adaptive compressed table gave me 3.2x storage savings. However, converting this row-organized uncompressed table to a column-organized table in DB2 10.5 delivered a massive 15.4x savings!"

- Iqbal Goralwalla, Head of DB2 Managed Services, Triton
Super simple

CREATE. LOAD. GO!
Risk system injects 1/2 TB per night from **25 different** source systems. “Impressive Load times.”

Some queries achieved an almost 100x speed up with literally no tuning.

6 hours.
Installing BLU to query results.

One of the world’s most profitable and secure rated banks.
Load-and-go simplicity

• LOAD and then... run queries

Simple.

• No indexes
• No storage reclaim (it’s automated)
• No memory configuration (it’s automated)
• No process model configuration (it’s automated)
• No statistics collection (it’s automated)
• No MDC or MQTs
• No Statistical views
• No optimizer profiles/guidelines

“The BLU Acceleration technology has some obvious benefits: … But it’s when I think about all the things I don’t have to do with BLU, it made me appreciate the technology even more: no tuning, no partitioning, no indexes, no aggregates.”

-Andrew Juarez, Lead SAP Basis and DBA
In-memory speeds with tiny RAM requirements

• Rule of thumb: RAM requirements are just 5% of source data size.

• Example:
  • 10 Terabytes of raw user data
  • 500 GB of RAM
Magic: How did they do that?
BLU Acceleration

BLU Acceleration includes over 30 new patents and patents pending from IBM Research & Development Laboratories.
Incredibly inexpensive drives (& processors) have made it possible to collect, store, and analyze huge quantities of data.

Over the last 30 years:
- **Capacity**: 80MB → 800GB (10,000x increase)
- **Transfer Rates**: 1.2MB/sec → 80MB/sec (65x increase)

But, consider the metric: **transfer bandwidth/byte**

- **1980**: 1.2 MB/sec / 80 MB = 0.015
- **2009**: 80 MB/sec / 800,000 MB = 0.0001

When relative capacities are factored in, drives are **150X slower** today!!!
We’ve been snookered!

Historical Cost of Computer Memory and Storage

Source: http://www.jcmit.com/mem2013.htm
Big Idea: RAM is Too Slow

CPU cache optimized

• RAM is at the bottom of the memory hierarchy. It is the slowest non-persistent memory in a server.
• CPU cache is many times faster than RAM.
• Extreme re-engineering of database algorithms to be CPU cache optimized
• BLU algorithms adapt automatically to hardware cache size.

![Speed-up versus RAM chart]

Big Idea: RAM is Too Slow

15x
41x
173x
1x

0 20 40 60 80 100 120 140 160 180 200

RAM L3 L2 L1

Speed-up versus RAM

Speed-up versus RAM chart
More Evil Than Ever

1. Human intervention
2. Voluminous I/O
3. Random I/O
4. Memory stalls
5. Single core processing
6. The cost of RAM
Load-and-go simplicity: System resources

1. Auto-detect and adapt to available RAM
2. Auto detect and adapt to core number and type
3. Auto detect and adapt to CPU cache size
Load-and-go simplicity: Automatic Workload Management

- Built-in and automated query resource consumption control
- Many queries can be submitted, but effective concurrency, per query RAM, and CPU are automatically and dynamically controlled

Applications and Users
Up to tens of thousands of SQL queries at once

BLU Runtime
Moderate number of queries consume resources
Load-and-go simplicity: Automatic Space Reclaim

- Automatic space reclamation
  - Frees extents with no active values
  - The storage can be subsequently reused by any table in the table space

- No need for costly DBA space management and REORG utility

- Space is freed online while work continues

- Regular space management can result in increased performance of RUNSTATS and some queries

DELETE * FROM MyTable WHERE Year = 2012

These extents hold only deleted data
Super Compress

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

HONEY, I SHRUNK THE DATA

Query on Compressed Data

- No CPU for decompression
- Data flows through memory and CPU at compressed size
- “Actionable Compression”
**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”

**Rethink Memory**

- Cache intelligently for analytics
- Predictive I/O with “Dynamic List Prefetching”
- Massive I/O reduction
• Use modern SIMD instructions to do multiple operations with a single instruction.
• Use 1 instruction instead of 8.
• Massive CPU acceleration
• Store data as vectors
• “Parallel Vector Processing”

• 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.
The System: 32 cores, 1TB memory, 10TB table with 100 columns and 10 years of data

The Query: How many “sales” did we have in 2010?
   - SELECT COUNT(*) from MYTABLE where YEAR = ‘2010’

The Result: In seconds or less as each CPU core examines the equivalent of just 8MB of data
• 1GB RAM required to cache all data for query over 10TB of data.
• 10,000 times reduction in memory requirements to achieve in-memory speeds
IBM dashDB – Data Warehousing as a Service

Terabytes of data ready to analyze within minutes

• **Fast querying**
  • In-memory
  • Columnar
  • SIMD hardware acceleration
  • Actionable compression

• **Advanced analytics**
  • Support for OLAP SQL extensions
  • In-database analytics & R for predictive modeling
  • Spatial analytics

• **Easy to integrate**
  • Connect common 3rd party BI tools

*keeps data warehouse infrastructure out of your way*
IBM dashDB – a fully managed data warehousing service in the cloud.

Gain instant access to critical business insights without the hefty upfront infrastructure investment. Load, analyze, and visualize your data in minutes.

What is dashDB?
Download the Data Sheet
The dashDB Cocktail: Three Parts IBM, Shaken…

Focus on the business, not the business of data warehousing!
Partnership with IBM Cloudant and dashDB

- **Cloudant** is a **fully managed** distributed NoSQL **Database as a Service** (DBaaS)
  - Multi-tenant and single (dedicated) tenants
  - Managed 24x7 by Cloudant expert engineers
  - Service Level Agreement
  - Operational data store

- **dashDB**’s partnership with Cloudant presents two opportunities:
  1. A **launching point** for new NoSQL customers looking for low-risk, low-cost avenues for getting started with data warehousing & analytics in a multi-tenant environment on the cloud
  2. A **new point of entry** for existing Cloudant developers to access industry-leading INZA analytics and BLU warehousing
  3. Automatic schema discovery from the JSON data. One button push to create warehouse.
dashDB MPP  
~elastic growth

1. 4TB building blocks (subject to change)
2. Min 3 servers.
3. Elastic growth without re-hashing all row data
4. Webscale clustering
The what & the wow

1. Fast: Superior Performance 35-73X
2. Small RAM requirements: Typically just 5% of the original uncompressed user data.
3. Small: Superior Compression
5. Introducing dashDB for cloud
   - Fully managed service on IBM BlueMix
   - JSON NoSQL integration, Cloudant.com
   - R and Spatial analytics
6. SAP BW certified
7. Oracle compatibility @98% +

“We cut report runtimes by up to 98% thanks to IBM DB2 with BLU Acceleration technology – without changing operations processes or investing in new hardware or software. We were impressed how easy boosting database performance can be.”

-Bernhard Herzog, Team Manager Information Technology SAP, Balluff
Where to find more information:

• dashDB.com
• ibmbluhub.com
• Sam Lightstone’s BLOG: SoftwareTradecraft.com
• Sam Lightstone’s papers on DBLP:
  • http://dblp.uni-trier.de/pers/hd/l/Lightstone:Sam