In-Memory Computing and the Future of Business Software

Dr. Stefan Sigg, SAP AG
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Technology

Basic Facts About In-Memory Computing
New Computing Power for Better Business Results

“Imagine you feel hungry. But instead of just opening the fridge (imagine you don’t have one) to get hold of, say, some butter and cheese, you would have to leave the house for the nearest dairy farm. Each time you feel hungry. This is what we do today with most company data: We keep them far away from where we process them…” *

Prof. Norbert Walter

(former Chief Economist of Deutsche Bank AG)

* Quote about the new book “In-Memory Data Management” by H. Plattner and A. Zeier
A Shift of Frontiers in Computer Science
Freely Adapted from Jim Gray, Turing Award Winner 1998

- Tape is Dead
- Disk is Tape
- Main Memory is Disk
- CPU Cache is Main Memory
Orders of Magnitudes
Programming Against a New Scarce Resource…

<table>
<thead>
<tr>
<th>Type of Memory</th>
<th>Size</th>
<th>Latency (~)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 CPU Cache</td>
<td>64K</td>
<td>1 ns</td>
</tr>
<tr>
<td>L2 CPU Cache</td>
<td>256K</td>
<td>5 ns</td>
</tr>
<tr>
<td>L3 CPU Cache</td>
<td>8M</td>
<td>20 ns</td>
</tr>
<tr>
<td>Main Memory</td>
<td>GBs up to TBs</td>
<td>100ns</td>
</tr>
<tr>
<td>Disk</td>
<td>TBs</td>
<td>&gt;1.000.000 ns</td>
</tr>
</tbody>
</table>

… requires cache-conscious data-structures and algorithms.
In-Memory Computing vs. Caching

Traditional Caching

- Use Disk structures and put them into Main Memory (Cache) for speed
- Runtime structures come from disk, not optimized for RAM

True In-Memory Computing

- Always use Main Memory structures and store them on disk for backup purposes only
- Runtime structures optimized / compressed for RAM
Two Other Major Qualities
… Besides In-Memory Processing

1. Massively Parallel Processing

2. Columnar Storage
Massively Parallel Processing (MPP)
Scalability Counts

Data Distribution

- **RAM locality** – data gets spread out to all available cores
- **MPP execution** – blades share nothing when crunching large data sets
- **Failover** - Individual blades may fail without causing problems
Columnar Storage
Do More With Less (Space)

- Compression (by factors)
- Read relevant data only
- Main Memory Structures
- Super-Efficient Algorithms
- Insert Only Works Fine
- Adding fields is easy
A Common Database Approach for OLTP and OLAP Using an In-Memory Column Database

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Categories and Subject Descriptors
H.2.0 [Information Systems]: DATABASE MANAGEMENT—General

General Terms
Design, Performance

1. INTRODUCTION
Relational database systems have been the backbone of business applications for more than 20 years. We promised to provide companies with a management information system that covers the core applications, including financials, sales, order fulfillment, manufacturing, as well as human resources, which run from planning through business processes. After the conversion of attributes into integers, processing becomes faster. More recently, the use of column store databases for analytics has become quite popular. Dictionary compression on the database level and reading only those columns necessary to process a query speed up query processing significantly in the column store case.

I always believed the introduction of so-called data warehouses was a compromise. The flexibility and speed we gained had to be paid for with the additional management of extracting, and loading data, as well as controlling the redundancy. For many years, the discussion seemed to be closed and enterprise data was split into OLTP and OLAP [9]. OLTP is the necessary prerequisite for OLAP, however only with OLAP companies are able to understand their business and come to conclusions about how to steer and change course. When planned data and actual data are
Introducing the In-Memory Computing Engine

Transactional and analytic data acceleration and management in a single environment:

- a high performance in-memory computing engine
- a powerful and flexible data calculation engine
- supports SQL & MDX
- a unified information modeling design environment
- a data repository to persist views of business information
SAP In-Memory Strategy
Product Strategy

In-Memory Analytics

- **Capabilities**
  - HANA 1.0 Real-time operational analytics with HANA 1.0

- **Next generation apps**
  - SAP BW fully running on HANA 1.5
  - New applications tailored for in-memory, e.g. Strategic Workforce Planning

- **Benefits**
  - Flexible real time analysis of operations at non-aggregated level
  - Real-Time operational planning, simulation and forecasting: link to execution
  - Reduced landscape complexity
  - Value chain transformation

Q4 2010 “Renovation” HANA 1.0

2011-12 “Innovation” HANA 1.5 → 2.0

2012+ “Transformation” HANA 2+
Business

Better Results for IT and Business
IT and Business – A Sensitive Equilibrium

Finding the right trade-off is difficult

- Agility
  Uncontrolled “Laissez Faire”

- TCO
  Central “Dictatorship”

- IT
  LoB
Self-Service BI
How Fast Can IT React on Change? – Empower Business People

How can In-Memory help?
- No aggregates
- No MOLAP cubes
- External hierarchies
- No re-alignment runs
- Virtual structures only
- Stable performance

traditional change management process
How can In-Memory help?

- Closer to real-time
- Work on entire data set
- Create local views
- Do not duplicate
- Use online forecasting algorithms
- Give design-time to LoB
- More, faster iterations
- Share master data, hierarchies, authorizations,…

Corporate planning processes
Demand / Stock Optimization
Analyze and Predict Demand – Optimize Inventory

Based on a real-life PoC project with a major CPG company

Shipment → Demand Forecast → Profitability → Promotions → Point-of-Sales

… – Replenishment – Assortment Planning – Demand Signal Analysis – …
“...The benefit for Hilti applying SAP’s in-memory technology is not only seen in a dramatic improvement of reporting execution speed - for example, we were able to speed up a reporting batch job from 3 hours to seconds – but even more in the opportunity to bring the way we work with information and ultimately how we service our customers on a new level.”

Dr. Martin Petry

(CIO, Hilti AG)

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Applications

Opportunities for a New Breed of Business Software
New and Optimized Applications

In-Memory Computing

- Solve Problems or Remove Pain Points
  - Trade Promotion Mgmt
  - Availability-to-Promise
  - Dunning / Cash Mgmt
  - Customer Segmentation

- Create New Value with New Applications
  - Planning & Simulation
  - Pricing
  - Prediction
  - Risk Management
Next Generation Business Applications

Today

- App Server
- App
- DB

Tight Coupling

- With large data volumes, reading information becomes a bottleneck
- Next generation applications will delegate data intense operations
- The runtime environment executes complex processes in memory
- In memory computing returns results by pointing apps to a location in shared memory

Tomorrow

- App Server
- Next Generation Apps
- Procedure code
- Program code
- Fast data transfer
- Compile & deploy
- Runtime
- Data in memory
- In-Memory Engine
“...This change in the way data is stored is having, and will continue to have a significant impact on enterprise applications and ultimately on the way businesses are run. Having real-time information available at the speed of thought provides decision makers in an organization with insights that have, until now, not existed.”

Prof. Dr. h.c. Hasso Plattner

Co-Founder of SAP AG
Chairman of the Supervisory Board of SAP AG
Founder of the Hasso-Plattner-Institute, Potsdam

to appear soon in Springer Verlag
Thank You!

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