A NEW ARCHITECTURE FOR ENTERPRISE APPLICATION SOFTWARE BASED ON IN-MEMORY DATABASES

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Large enterprise systems
Transaction-maintained aggregates explode in complexity

- ~ 30,000 Functions
- ~ 80,000 Tables
  ~900,000 Columns
- Data Footprint of up to 150TB
- Aggregate Maintenance Development Costs
- Schema Complexity
- Consistency
- Redundancy
- Storage Costs
- Backup
- Disaster Recovery

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Hardware development
Enabler for a new era of business processing

20 YEARS AGO

- MEMORY: 1 GB x 6000
- CPU: 4 x 50 MHz x 1800

TODAY

- MEMORY: 6 TB
- CPU: 120 x 3.0 GHz

NEAR FUTURE

- MEMORY: 48 TB
- CORES: 480 (8X4X15)
Workload analysis

Read-mostly applies to OLTP and OLAP
Simplification and Flexibility

By removing static pre-defined materialized aggregates

Static Pre-Defined Aggregates

Static pre-defined aggregates cannot handle structural changes within the organization

Flexible Aggregation On Demand

Dynamic on-the-fly reporting enables analysis & simulation of organizational changes. Impact analysis is immediately available

Requires Anticipation

Does NOT Require Anticipation

SAP

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2009: A common database approach

For OLTP and OLAP using an in-memory column database

OLTP & OLAP Applications

Data Management Layer

Main Memory Storage

Non-volatile Storage

Source: SIGMOD June 2009
A textbook example

Wire money from account A to account B

Accounts with Transaction-Maintained Balance

Primary Key Select

Update

Raw Account Transactions

Insert

Σ Read (Column Scan)
Example
Posting of a vendor invoice

Vendor Invoice

| Row 1: | ~~~~~ |
| Tax:   | ~~~~~ |
| Total: | ~~~~~ |

Header

Account Vendor

119 Credit

Cost

100 Debit

G/L Account

Tax

19 Debit

G/L Account
SAP Financials – Invoice Posting
Before simplification

- Index on Primary Key
- Other Indices
- Application managed materialized aggregates

Customer
- KNA1
- KNC1

Vendor
- LFA1
- LFC1

General Ledger
- SKA1
- GLTD

Cost Center
- CSKS

- Accounting Document Header
  - BKPF
  - BSEG

- Split Accounting Line Items
  - FAGLFLExA

- Controlling Object Document Header
  - COBK

- Controlling Object Line Items
  - COEP

- Tax Documents
  - BSET
  - BSAT

- Vendors
  - BSAR
  - BSAD
  - BSAS

- Customers
  - BSIK
  - BSD
  - BSIS

- G/L Accounts
  - SKA1

- Application managed materialized views

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SAP Financials – Invoice Posting

Simplification

Customer
- KNA1
- KNC1

Vendor
- LFA1
- LFC1

General Ledger
- SKA1
- GLTO

Cost Center
- CSKS
- COSP

Accounting Document Header
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Customers
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G/L Accounts
- BSAS
SAP Financials – Invoice Posting

After simplification with database views

Views with on-the-fly Aggregations

Views with Projection and Selection
Why column-stores are better than row stores for transaction processing - theoretically...

Insert duration with and w/o transaction-maintained aggregates
...and experimentally with respect to workload and runtime

**SAP Financials Workload Analysis**

<table>
<thead>
<tr>
<th>Workload</th>
<th>Classic SAP Financials</th>
<th>Simplified SAP Financials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Modification</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Insert</td>
<td>80%</td>
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<tr>
<td>Read</td>
<td>70%</td>
<td>70%</td>
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<td></td>
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<tr>
<td>20%</td>
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<tr>
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</tr>
<tr>
<td>0%</td>
<td></td>
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</tr>
</tbody>
</table>

**SAP Financials Runtime Analysis**

Document posting measured on customer data

**SUM of CPU time (ms)**

- Suite on HANA: 20,000 ms
- S/4HANA Finance: 15,000 ms

**SUM of DB reg. time (ms)**

- Suite on HANA: 10,000 ms
- S/4HANA Finance: 5,000 ms

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Universal Journey Entries establish a single source of truth and enable a variety of new analyses.
Compatibility views enable a non-disruptive adoption by redundant tables
Simplified Logistics
No aggregates: on-the-fly aggregation of inventories

Classical Logistics Data Model

- MKPF
- MSEG
- MSTQ
- MSTE
- MSSQ
- MSSA
- MSPR
- MSLB
- MSKU
- MSKA
- MKOL
- MCHB
- MARD
- MARC
- MSTQH
- MSTHE
- MSTBH
- MSSQH
- MSKUH
- MSKAH
- MKOLH
- MCHBH
- MSSAH
- MCHBA
- MARDH
- MARCH

Simplified Logistics Data Model

- MATDOC
- MSSQ
- MSSA
- MCH1
- MCHA
- MSKU
- MSKA
- MAKT
- MARM
- MARD
- MARC
- MARA

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Simplified Logistics

Example case with real data from large automotive company

Throughput items/sec

Classical Data Model

Simplified Data Model

Backflush real-time, large automotive company

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Database footprint reduction
With SAP HANA

<table>
<thead>
<tr>
<th>ERP on any DB</th>
<th>ERP on HANA</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Indices</td>
<td>7.1 TB</td>
</tr>
<tr>
<td>No Aggregates</td>
<td>1.8 TB</td>
</tr>
<tr>
<td>No Redundancy</td>
<td></td>
</tr>
</tbody>
</table>

<sERP> on HANA [estimate]

3:1

Hot = Actuals, status at beginning of current year + all transactions during current year to conduct business and fulfill statutory reporting

Cold = Historical, up to 10 years

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Transparent aggregate cache
Database-maintained aggregates on read-only main partition
Read-Only Replication

Leveraging business workload characteristics

- Executives
- Sales Managers
- Accountants

OLAP, Search, and Read-only Applications on Transactional Schema

Mixed Workload Processing

- OLTP
- Operational Reporting & New Applications
- Data Entry

Read-only Replicas

Asynchronous, Transactionally Consistent Replication

Master Node

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Boardroom Redefined

TRENDS

Review the state of the business at any time, examining data in real-time

Prioritize where we spend time reviewing

Apply analytics to identify solutions

Higher speed leads to more intelligence
Thank you.
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