Nové možnosti optimalizace ukládání dat v SAP HANA (Dynamic tiering)

Martin Zikmund, Presales – Innovative solutions & Utilities industry
Agenda

Overview of SAP HANA dynamic tiering
- Data temperature management in SAP HANA
- High-level: what is dynamic tiering

Technical implementation choices
- Properties of dynamic tiering in data management, system operations, etc.

System architecture and sizing for dynamic tiering
- A brief overview of the most important sizing metrics

Use cases
- BW on HANA and native projects

Outlook/Roadmap
- Priorities for the upcoming support package stacks
Overview

Options for data volume management in SAP HANA
The data growth challenge

HANA as In-Memory database
Strong coupling between data and hardware
- More data → more RAM → more CPUs
- Impacts on hardware configuration

Growing HANA hardware
- Scale-up ends at 2(BW) or 12(Suite) TB
- Larger systems require scale-out hardware

In very large systems:
- Does all my data justify hardware and license cost?

→ Can we de-couple hardware growth from data growth?
### Ways to Tackle Data Growth

**Offerings in the Context of SAP HANA Systems**

<table>
<thead>
<tr>
<th>Archiving</th>
<th>Memory Displacement</th>
<th>Tiered Data Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manages movement of data into some kind of archive (Suite ILM, BW NLS, …)</td>
<td>Unload “not so important” data from main memory</td>
<td>Offer data stores of different “priorities”</td>
</tr>
<tr>
<td>But: do you really want to archive, or is it just a strategy to minimize cost?</td>
<td>• Active/non-active data (BW)</td>
<td>• E.g. dynamic tiering</td>
</tr>
<tr>
<td></td>
<td>• Page-loadable columns (Suite)</td>
<td>• Future: also Hadoop?</td>
</tr>
<tr>
<td></td>
<td>Process requires loading data into RAM</td>
<td>Beginning of a journey</td>
</tr>
<tr>
<td></td>
<td>• Caching etc. lead to reduced but non-negligible memory footprint</td>
<td>• Enterprise readiness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Concept for data distribution, management, retrieval</td>
</tr>
</tbody>
</table>
Strategies based on RAM displacement
Why and how applications need to help

**Displace “unused” data from RAM**
Column-based displacement
- Evict data if memory is running low
- Load back to RAM on request
- Define “unload priorities” on table level

Page-loadable columns
- Typical request for few records, many fields
- Tailored for OLTP workload

Load displaced data by page
- Each column is a list of pages in data file
- Look up individual pages needed by query

**Based on HANA’s Column Store**
Most HANA capabilities unchanged
SAP HANA dynamic tiering
Key aspects at a glance

Add-on option to SAP HANA
Manage data of different temperatures
- **Hot** data (always in memory) – classical HANA
- **Warm** data (disk-based data store)

Introducing a new type of table:
- **Extended table** – disk-based columnar table
- A table is either 100% in memory or 100% extended (SPS 09)

SPS 9 & 10 focus
Operational integration
- Installation, monitoring, administration, backup, HA
Initial functional scope
- Common transaction management
- Transparent query processing & Optimization
- Use extended table in calculation views and more

SAP HANA Database System

Fast data movement and optimized push down query processing

All data of extended table resides in warm store
**Problems with temperatures**

There are too many options – across system boundaries

<table>
<thead>
<tr>
<th>Hot</th>
<th>Warm</th>
<th>Cold</th>
<th>NLS</th>
<th>Archive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In DB</strong></td>
<td><strong>In memory</strong></td>
<td><strong>No restrictions, all features available</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>In DB</strong></td>
<td><strong>On disk</strong></td>
<td><strong>Full read/write access, some funct. limitations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>External to DB</strong></td>
<td><strong>Near-line Storage</strong></td>
<td><strong>Near-line Storage</strong></td>
<td><strong>Read access, no updates</strong></td>
<td></td>
</tr>
<tr>
<td><strong>External to DB</strong></td>
<td><strong>Traditional Archive</strong></td>
<td><strong>Archive storage</strong></td>
<td><strong>No read access or updates</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Data Volume**

**Performance and Price**

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Implementation Details

What do you have to know about SAP HANA dynamic tiering?
SAP HANA dynamic tiering

One database / one experience for SAP HANA application developers and admins

SAP HANA dynamic tiering
- Reduced TCO
- Single database experience
- Centralized operational control
- Optimized for performance
SAP HANA dynamic tiering
The overall system layout

SAP HANA with dynamic tiering consists of two types of hosts:
- Regular worker hosts (running the classical HANA processes: \texttt{indexserver}, \texttt{nameserver}, \texttt{daemon}, \texttt{xserver},...) 
  - HANA hosts can be single-node or scale-out; appliance or TDI 
- "ES host" (running \texttt{nameserver}, \texttt{daemon}, and \texttt{esserver}) 
  - esserver is the database process of the warm store

- One single SAP HANA database: one SID, one instance number 
- All client communication happens through index server / XS server 
- Non-productive: co-deployment on one host possible

SAP HANA System with dynamic tiering service
Fast data movement and optimized push down query processing

(*) Standby hosts not shown
SAP HANA extended tables
And how they relate to classical memory-based tables in SAP HANA

HANA extended table **schema** is part of HANA database catalog

HANA extended table **data** resides in warm store

HANA extended table is a **first class database object** with full ACID compliance

Database Catalog

- **Table Definition**

  - **Data**
    - **Hot Store** (memory) Classical HANA column/row table

  - **Table Definition**

  - **Data**
    - **Warm Store** (disk) Extended table (warm table)

HANA Database
Loading data into extended tables

Insert from CSV files
- IMPORT FROM CSV FILE ‘bigfile.csv’ INTO t1
Row insert:
- INSERT INTO t1 (col1, col2...) VALUES (val1, val2...)  
Data movement between HANA tables and HANA extended tables:
- INSERT INTO t_extended select c1 FROM t_hana

Concurrent inserts from multiple connections:
- A HANA extended table may be a DELTA enabled table, which allows multiple concurrent writes
- Prerequisite: extended storage must be created with delta

Changing table from HANA table to extended table
- ALTER TABLE t_hana using extended storage
- ALTER TABLE t_extended not using extended storage
Managing and processing data in extended tables

**Data temperature tied to table type (SPS 9/10)**

Applications must manage data temperature explicitly
- Appropriate for object-based classification
- Possible if application has good control over data
- Easiest if cold data is mostly read-only

**Push/Pull query optimization and transformation**

Optimized cross-store execution
- Shift query operations to hot or warm store as appropriate
- Parallel execution of operations in hot and warm store
- Supported in HANA calculation views
Example query plan visualization

Query reading from hot and warm store

Example query computing UNION of hot and warm data

```sql
select SUM (GROSS_AMOUNT) as GROSS_AMOUNT, BUYER_ID from SO_2013_EXT group by BUYER_ID
UNION
select SUM (GROSS_AMOUNT) as GROSS_AMOUNT, BUYER_ID from SO_2014 group by BUYER_ID
```

SO_2013_EXT is an extended table in the warm store

SO_2014 is a native HANA table in the hot store

HANA Plan Visualization gives inside into both store executions
Tool-based management of data lifecycle

- Leverage SAP HANA Dynamic Tiering, Hadoop or SAP Sybase IQ with a tool-based approach to setup an aging strategy
- Optimize memory footprint in SAP HANA native use cases
- Define data slices on SAP HANA tables to be displaced from SAP HANA memory
- Optimize union access between the tables

Automated Data Movement between stores

- Generated Stored Procedures to do data mass movement – in and out
- Schedule data movement using HANA tasks

Pilot Program started June 30, 2015
Host auto failover for dynamic tiering hosts
High availability within database cluster

HANA plus DT is a clustered database
You may want to set up standby hosts
- Standby for either indexserver (standard HANA) or esserver (DT)
- One host cannot be standby for both at the same time

Automatic failover available for dynamic tiering hosts (SPS 10)
- No manual intervention necessary in case the DT host fails
- System automatically activates DT standby
- Database remains available during failover procedure, only DB requests that access DT will fail
Unified backup and restore

- HANA backup manages backup of both hot and warm store
- Point in Time Recovery (PITR) is supported
Backup & recovery affects full DB
We always back up memory + disk store!
• Works the same way as in regular scale-out:
  – All hosts are included in backup
  – All worker processes must be running
New HANA Delta Backup not yet for DT
• Planned for future release

With SPS 10: implementation for Backint API for 3rd party backup solutions
• See next slide for info on Backint for SAP HANA
Backint is a two-party implementation
• HANA-side implementation now also includes DT
  – Backup, recovery, query backup catalog, delete
• Tool vendors implement backup agent
Add-on certification process planned
• Backup tools will need to be certified for the new HANA+DT system
• Not included in regular Backint for HANA certification
• Certification will be offered after first pilot (Q3/Q4)
Disaster recovery
System replication or storage replication

System replication not yet implemented for DT
There is no disaster recovery with RPO=0 for DT in SPS 09
• This applies to the entire HANA system, if DT is enabled
What is RPO = 0?
• Recovery Point Objective, i.e. the expected maximal data loss in a “disaster” situation

SAP HANA has two types of DR setups
SAP HANA System replication
• Software solution; not yet implemented in DT service
• Planned for future release (not yet in SPS 09 or 10)
Storage Replication
• Storage solution – can be offered by hardware vendors
Multitenant Database Containers (MDC)
MDC setups with SAP HANA dynamic tiering

Starting with SPS 10, SAP HANA dynamic tiering is also available for tenant databases

- Each tenant database can be associated with zero or one extended stores
- Each extended store is dedicated to exactly one tenant database
- Each extended store requires a dedicated dynamic tiering host

Important properties of DT and MDC combined

- The following features are not supported in this setup:
  - Backup & Recovery using Backint
  - Cross-tenant access to extended tables
  - Strong tenant isolation
EIM flow graphs with extended tables

SAP HANA Enterprise Information Management
Can now be used with extended tables
• Include extended tables in flow graphs
• As data source or data sink
• Based on tasks or stored procedures

Value Proposition
• Load into extended tables from within HANA system or external data sources
• Model and schedule data movement between in-memory and extended tables
• Data staging in native HANA data warehouses
Admin UIs for DT in the Cockpit

User Tables
- Determine tables that are candidates for conversion to extended tables

Dynamic Tiering Administration
- Create and manage extended storage
- Create and modify DB space files
- Configure dynamic tiering server

SAP-provided administrator roles

Monitoring user (view DT tiles)
- sap.hana.tiering.roles::Monitoring

Administer DT (change configuration etc.)
- sap.hana.tiering.roles::Administration
SAP HANA Cockpit
Table Usage – first step towards supporting decision-making on data aging

Find candidates for extended tables
Combine size and usage information
- Only displaying HANA column tables
- Table size in MB/GB
- Number of read operations on table
- Number of write operations on table

Convert table to extended table
- Select one or multiple tables
- Convert to extended tables
- Control delta creation in conversion
Sizing the DT host

How should you approach DT sizing?
Hardware layout view
SAP HANA system with SAP HANA dynamic tiering

(*) The hosts for SAP HANA dynamic tiering do not need to be based on hardware certified for SAP HANA (you may of course choose HANA-certified hardware)
### DT system sizes based on raw data size

A starting point – adjust cores (and memory) based on workload requirements

<table>
<thead>
<tr>
<th>Raw Data Size</th>
<th>Storage</th>
<th>Cores</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>10TB</td>
<td>5TB</td>
<td>18</td>
<td>288GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>Add 288GB space for RLV transaction log</td>
<td>32 cores:</td>
<td>512GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>6 cores to process 216GB/hour of data</td>
<td>12 cores to process 8 concurrent queries</td>
<td>12 cores to process 16 concurrent queries</td>
</tr>
<tr>
<td></td>
<td>288GB RAM (16GB/core)</td>
<td>8 cores to load 288GB/hour of data</td>
<td></td>
</tr>
<tr>
<td>20TB</td>
<td>10TB</td>
<td>32</td>
<td>512GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>Add 512GB space for RLV transaction log</td>
<td>46 cores:</td>
<td>736GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>24 cores to process 16 concurrent queries</td>
<td>36 cores to process 24 concurrent queries</td>
<td>10 cores to load 360GB/hour of data</td>
</tr>
<tr>
<td></td>
<td>8 cores to load 288GB/hour of data</td>
<td>10 cores to load 360GB/hour of data</td>
<td></td>
</tr>
<tr>
<td>30TB</td>
<td>15TB</td>
<td>46</td>
<td>960GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>Add 736GB space for RLV transaction log</td>
<td>60 cores:</td>
<td>1184GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>36 cores to process 24 concurrent queries</td>
<td>48 cores to process 32 concurrent queries</td>
<td>12 cores to load 432GB/hour of data</td>
</tr>
<tr>
<td></td>
<td>10 cores to load 360GB/hour of data</td>
<td>10 cores to load 360GB/hour of data</td>
<td></td>
</tr>
<tr>
<td>40TB</td>
<td>20TB</td>
<td>60</td>
<td>1184GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>Add 960GB space for RLV transaction log</td>
<td>74 cores:</td>
<td>1184GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>48 cores to process 32 concurrent queries</td>
<td>60 cores to process 40 concurrent queries</td>
<td>14 cores to load 504GB/hour of data</td>
</tr>
<tr>
<td></td>
<td>12 cores to load 432GB/hour of data</td>
<td>14 cores to load 504GB/hour of data</td>
<td></td>
</tr>
<tr>
<td>50TB</td>
<td>25TB</td>
<td>74</td>
<td>1184GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>Add 1184GB of space for RLV transaction log</td>
<td>74 cores:</td>
<td>1184GB RAM (16GB/core)</td>
</tr>
<tr>
<td></td>
<td>60 cores to process 40 concurrent queries</td>
<td>60 cores to process 40 concurrent queries</td>
<td>14 cores to load 504GB/hour of data</td>
</tr>
<tr>
<td></td>
<td>14 cores to load 504GB/hour of data</td>
<td>14 cores to load 504GB/hour of data</td>
<td></td>
</tr>
</tbody>
</table>

### Sizing “Rules of Thumb” for DT Store

<table>
<thead>
<tr>
<th>Component</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>2.5 data compression factor (raw data compressed to 40% of its original size)</td>
</tr>
<tr>
<td></td>
<td>Metadata and versioning space: 5% of compressed data</td>
</tr>
<tr>
<td></td>
<td>Temp store: 20% of compressed data</td>
</tr>
<tr>
<td></td>
<td>For any DT system size, ensure that the storage system can provide 50MB/sec/core of throughput</td>
</tr>
<tr>
<td></td>
<td>Size RLV transaction log at 8GB * 2 * (number of cores)</td>
</tr>
<tr>
<td>Cores</td>
<td>1.5 core/concurrent query</td>
</tr>
<tr>
<td></td>
<td>1 core can load 10MB/sec of raw data</td>
</tr>
<tr>
<td></td>
<td>In the sizing boxes above, round up the number of cores to match a hardware vendor’s most compatible server model</td>
</tr>
<tr>
<td>RAM</td>
<td>16GB/core (assumes use of delta enabled extended tables for concurrent writes)</td>
</tr>
<tr>
<td>Network</td>
<td>10GBit/sec dedicated network between HANA and DT server</td>
</tr>
<tr>
<td></td>
<td>Add networks as needed, so that HANA &lt;-&gt; DT network is completely isolated from storage network</td>
</tr>
</tbody>
</table>
Use cases

Preferred use cases for the SPS 10 release
Uses cases for SAP HANA dynamic tiering in SPS 10

The best and primary use case
SAP NetWeaver Business Warehouse powered by SAP HANA (BW on HANA)
• BW requirements were the driving force behind extended storage – now dynamic tiering
• BW uses dynamic tiering with object-based temperature assignment

The secondary use case – with limited feasibility
SAP HANA native data marts / warehouses or applications
• Add option to manage HANA memory footprint also for native scenarios
• Evaluate use of DLM tool (from SAP Data Warehousing Foundation
• Data provisioning capabilities include SLT and SAP HANA EIM
• Table and data management: responsibility of data mart architect / application developers
• Verify if all your required advanced functionalities are supported with extended tables (e.g. Geospatial, text …)

Not supporting SAP HANA dynamic tiering in its current form
SAP Business Suite powered by SAP HANA and S/4 applications (Simple Finance, …)
HANA Native usage – data modeling
Switch to all-calculation-view modeling approach

Extended tables are not allowed in all kinds of views

Only Calculation Views
- Cannot add extended table to Analytic or Attribute Views
- Changing table in such a view to extended table invalidates the view

Migration to Calculation Views
- Wizard exists to convert existing data models to calculation views

Typically require manual data aging
- Split table into in-memory and extended
- Support by planned DLM tool
- Replace original table with union calc view (Replace with Data Source…)

Classical model: Calculation, Analytic and Attribute views

Wizard-supported mass migration

Split and Union generation via DLM tool

All Calculation Views

Views

T1

All in-memory

Split and Union generation via DLM tool

In-memory and extended

Tables

T1

T1_EXT
Future direction
Summary

- Technical integration
  - Common installer
  - Integrated administration & Monitoring
  - Support for DT in multitenant database containers (MDC)
- Enterprise Readiness
  - Host auto-failover, support for storage connector API
  - Convergence of file-based backup; Implementation of Backint API
- Functional integration
  - Global database catalog
  - Cross-store optimizer
  - Support in Calculation Models
  - Performance optimization for BW data loads
  - Enable use of DLM tool to manage extended tables
  - Enable HANA EIM to use extended tables in data flows

- Extend enterprise readiness
  - Delta backup mechanism
  - Full backup/restore integration
  - Storage Snapshots
  - Integration with system replication
- Focus: Data Volume Management
  - Native data lifecycle management
  - Scale-out for extended store
- Functional integration
  - Support for special functionalities (series data, geospatial, …)
  - Unstructured data, search, …

Today
SAP HANA SPS 10

Future Direction
SPS 11 and beyond (2016/2017)
This is the current state of planning and may be changed by SAP at any time.
Documentation related to SAP HANA dynamic tiering

Public documentation
Available from http://help.sap.com/hana_platform
- Navigate to “SAP HANA Options” • “SAP HANA Dynamic Tiering”
Note that for full system documentation, you will also need the regular HANA documentation
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