SAP HANA
Data Tiering Options

SAP HANA Product Management, SAP
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The Data Growth Challenge

Trend:
Organizations collect increasingly more and more information about their business to control their daily operations in real-time

Problem:
- manage a continuous data growth in the HANA in-memory database
- dependency between database growth and storage costs
- data growth impacts system performance

Solution:
- decouple data location from fixed storage layer
- storage layers differ in the costs and performance
- scale and store data with the best cost/performance ratio
Agenda

Technology Overview

Data Tiering Options in SAP HANA
- Hot Store
- Warm Store
- Cold Store

Application View on SAP HANA Data Tiering

Data Lifecycle Management
- SAP HANA DWF/DLM 2.0 SP04 + SP05
SAP HANA Data Tiering

Solution: Decouple data location from a fixed storage layer.

| Hot Store | Hot Data | • Mission-critical data  
|          |          | • For real-time processing and real-time analytics.  
|          |          | • Data is retained in-memory of the SAP HANA database.  |

| Warm Store | Warm Data | • Data with reduced performance SLAs, which is less frequently accessed.  
|           |          | • Stored on a lower cost storage tier, managed as a unified part of the SAP HANA database.  |

| Cold Store | Cold Data | • Voluminous data for sporadic or very limited access.  
|           |          | • Stored on low cost storage tiers, like disk or Hadoop, managed separately from the SAP HANA database, but still accessible at any time.  |
## SAP HANA Data Tiering
### Technology Overview

### Hot Store
- **Persistent Memory** extends the in-memory storage capacity for hot data in SAP HANA.

### Warm Store
- **Native Storage Extension (NSE)** is an intelligent, built-in disk extension for the SAP HANA in-memory database. It is the primary warm store option for HANA on-premise and HANA Service.
- Extension node and dynamic tiering will continue to be offered.

### Cold Store
- SAP HANA cold data tiering provides persistence capabilities for HANA cold data in external data stores, like HDFS, Azure Data Lake and SAP Big Data Services.

### SAP HANA Data Tiering Components

<table>
<thead>
<tr>
<th>DRAM</th>
<th>Persistent Memory</th>
<th>Native Storage Extension</th>
<th>Nearline Storage (SAP BW)</th>
<th>Spark Controller</th>
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<td>Extension Node</td>
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### SAP HANA Data Tiering Technologies
- **Dynamic Tiering**
- **Extension Node**
Hot Store
Persistent Memory
SAP HANA Native Support for Persistent Memory
Officially Supported in SAP HANA 2.3 (April 2018)

**Benefit**

- Process more data in real-time at a lower TCO with improved business continuity

**Feature**

- Persistent Memory (non-volatile)
- Data Reliability (faster starts)
- Higher Capacity than DRAM
- Transforming the memory hierarchy

**Key Benefits**

- Larger memory capacity with high performance (vs. DRAM & lower tier storage)
- Lower TCO data storage hierarchy
- Faster start time delivers less downtime
- Co-innovation with Intel® leads to first fully optimized major DBMS platform
- Early Adoption Program with key partners/customers ongoing

**First major DBMS vendor to officially support Intel Optane DC persistent memory!**

[sap.com/persistent-memory](http://sap.com/persistent-memory)

*Internal Benchmark measured with a 6TB dataset in SAP HANA*
Operating Modes
Intel® Optane™ DC Persistent Memory

**Memory Mode**
- **Volatile** – Data will not survive a restart.
- Pool of volatile memory, combining DRAM and Persistent Memory.
- Transparent to applications – no changes necessary.

**App Direct Mode**
- **Non-volatile** – Data is retained across a restart.
- DAX filesystem maps persistent memory to memory volumes.
- Applications must be adapted & optimized.
SAP HANA Persistent Memory
Memory Distribution

SAP HANA controls what is placed in Persistent Memory and what remains in DRAM.

- **Volatile data structures remain in DRAM.**
  - Column Store Main moves to Persistent Memory
    - More than 95% of data in most HANA systems.
    - Loading tables at startup becomes obsolete.
    - Lower TCO, larger capacity.

- **No changes to the persistence.**
Memory Configuration

Example: 2 sockets, largest DRAM and largest PMEM configurations

Actual configuration and ratios between DRAM, PMEM and CPU depend on application sizing.
Use Cases for Persistent Memory
Capacity & Data Volume Management

Lower TCO, higher capacity
PMEM replaces DRAM for data storage.

DRAM, PMEM and CPU requirements must be carefully evaluated!

Extension Node
Extension nodes allow to overload a node by factor 4.
- No performance impact for warm data stored on extension node.
- Less I/O on persistence.

Data Tiering
Hot and warm data are stored on persistent memory.
- Keep more data in HOT.
- Dedicated warm data store becomes obsolete.
Warm Store
Native Storage Extension
Native Storage Extension (NSE) value proposition and use cases

- **Value proposition:**
  - Increase HANA data capacity at low TCO
  - Deeply integrated warm data tier, with full HANA functionality
  - Will support all HANA data types and data models
  - Simple system landscape
  - Scalable with good performance
  - Supported for both HANA on-premise and HANA-as-a-Service (HaaS)
  - Available for any HANA application
  - Complements, without replacing, other warm data tiering solutions (extension nodes, dynamic tiering)

- **Use cases:**
  - Any customer built or SAP built HANA application that is challenged by growing data volumes
  - S/4HANA data aging (NSE is an evolution of “paged attributes”)  
  - BW team currently uses extension nodes, but may evaluate NSE in the future
NSE allows the user to specify that certain data is “page loadable”

**Hot “column loadable” data:**
- HANA is an in-memory database and loads all data into memory for fast processing.
- Data is “column loadable” and resides completely in memory.

**Warm “page loadable” data:**
- Less frequently accessed data may be specified as “page loadable”.
- “Page loadable” data is loaded into memory in granular units of pages as required for query processing.
- NSE will reduce memory footprint for “page loadable” data. Data is partly in memory, and partly on disk.
- Query performance on warm data may be reduced compared to hot data.
- Data may be converted between “column loadable” and “page loadable”.
Native Storage Extension
Specifying data as “page loadable”

• Data may be specified as “page loadable” at table, partition, and column level.

• Data may be converted between “page loadable” and “column loadable”.

• NSE supports range, range-range partitioning.

Example DDL

Table:

```
CREATE COLUMN TABLE T (C1 INT, C2 VARCHAR(10))
    PAGE LOADABLE;
```

Partition:

```
CREATE COLUMN TABLE T (C1 INT)
    PARTITION BY RANGE (C1)
    (PARTITION 0 <= VALUES < 10 PAGE LOADABLE,
     PARTITION OTHERS COLUMN LOADABLE);
```

Column:

```
CREATE COLUMN TABLE T (C1 INT, C2 VARCHAR(10))
    PAGE LOADABLE;
```

Convert table to page loadable:

```
ALTER TABLE T PAGE LOADABLE IMMEDIATE CASCADE;
```
Native Storage Extension
Native warm data tier of the SAP HANA database

NSE manages “page loadable” warm data in the HANA database with expanded disk capacity and an intelligent buffer cache to transfer pages of data between memory and disk.
Native Storage Extension
Sizing and Limitations (on-premise)

Limitations with SPS04:

• Only scale-up landscapes are supported.
• Maximum data volume:
  • 4 x data volume in memory, or
  • 10 TB

\[
\text{size}(\text{buffer cache}) = \frac{\text{size} (\text{warm data})}{8}
\]
Native Storage Extension
Tooling

SAP HANA Cockpit

- Configure buffer cache size (on-premise only; HaaS will configure this for the user)
- Configure tables, columns, and partitions as “page loadable”
- Monitor buffer cache usage and capacity
- Report on resident memory status for page loadable data
- Includes rule-based “recommendation engine” to monitor user data access patterns.
- Based on statistics, the engine will advise user on which tables, columns, or partitions would benefit from being converted to “page loadable”

Data Lifecycle Manager (planned Q4/2019):

- DLM will allow user to convert tables, columns, and table partitions between “column loadable” and “page loadable”

SQL Analyzer (DB Explorer)

- Visualized query plan will display when warm data is accessed from NSE in order to satisfy the query
Warm Store

Extension Node, Dynamic Tiering
What’s New in SPS 04?
SAP HANA Extension Node

Feature description
- HANA node in the scale-out landscape is reserved for warm-data storage and processing
- Supports all HANA operations and data management features
- Allows larger data footprint of up to 200% of the node DRAM size
- HANA persistent memory is supported

New Features:
- Benefits from new partitioning and scale-out features in SPS04:
  - range-hash partitioning scheme
  - “pinning” tables on fixed HANA nodes
  - partition grouping
What’s New in SPS 04?
SAP HANA Dynamic Tiering

Feature description

• Addition of TIMESTAMP data type for multistore tables
• Asynchronous table replicas of slowly changing dimension tables maintained consistently across the HANA and dynamic tiering servers

Benefits

• 7-digit TIMESTAMP support for multistore tables rounds out basic data type support in SAP HANA dynamic tiering
• Asynchronous table replicas improves cross-store query performance by allowing SQL JOIN operations to be executed close to the data
Customers should start with the built-in Native Storage Extension for warm data. Depending on SLAs, customers may choose extension node (performance) or dynamic tiering (data volume) as alternative options. We don’t recommend to mix multiple warm store options in one landscape, due to complexity reasons.
Cold Store
Spark Controller / Hadoop
What’s New in SPS 04?
HANA Spark Controller

New Features in SPS04:
- For DLM scenarios, you can now install SAP HANA spark controller on Amazon Elastic MapReduce (EMR)
- Support of newer Apache Spark versions: 2.3.x and 2.4.0
- Support of newer Hadoop Distributions: CDH 6.1.0, MapR 6.1, HDP 2.6 and HDP 3.0
Application View

Data Tiering
Which Data Tier Should I Use?

Native HANA
- In-Memory
- Extension Node
- Native Storage Extension
- Extended Store
- Internal Store

BW on HANA BW/4HANA
- In-Memory
- Extension Node
- Native Storage Extension
- Extended Store
- Data Aging (via NSE)

Suite on HANA S/4HANA
- In-Memory
- Extension Node
- Native Storage Extension
- Extended Store
- Data Aging (via NSE)

External Store
- Near-Line Storage, SAP IQ
- HDFS, ADLS
- DWF/DLM with Spark Controller
- BW NLS, BW/4 DTO w/ IQ
- ILM Store w/ IQ
- ILM/Archiving
Data Lifecycle Management
SAP HANA DWF/DLM 2.0 SP04 + SP05
What’s New?
SAP HANA DWF/DLM 2.0 SP04 + SP05

- SAP data warehousing foundation is a separate software release, but with the same shipment date as HANA 2.0 SPS04

- SAP DWF includes the Data Lifecycle Management tool (DLM)

- SAP DWF 2.0 SPS05 release is based on the XSA software stack and supports:
  - Dynamic tiering multistore tables
  - Generating groups of tables that are common in their data sets (same columns) and move them together to another storage location
  - Defining “nominal key” to enable the relocation of data for tables without a primary key, which is mandatory to relocate data
Thank you

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