The information in this presentation is confidential and proprietary to SAP and may not be disclosed without the permission of SAP. Except for your obligation to protect confidential information, this presentation is not subject to your license agreement or any other service or subscription agreement with SAP. SAP has no obligation to pursue any course of business outlined in this presentation or any related document, or to develop or release any functionality mentioned therein.

This presentation, or any related document and SAP’s strategy and possible future developments, products and or platforms directions and functionality are all subject to change and may be changed by SAP at any time for any reason without notice. The information in this presentation is not a commitment, promise or legal obligation to deliver any material, code or functionality. This presentation is provided without a warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose, or non-infringement. This presentation is for informational purposes and may not be incorporated into a contract. SAP assumes no responsibility for errors or omissions in this presentation, except if such damages were caused by SAP’s intentional or gross negligence.

All forward-looking statements are subject to various risks and uncertainties that could cause actual results to differ materially from expectations. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of their dates, and they should not be relied upon in making purchasing decisions.
SAP HANA in Data Centers:
Agenda

Introduction & Overview

Design & Setup

Persistence

Backup & Recovery (System Copy)

High Availability

Disaster Recovery

Monitoring & Administration

Security & Auditing
SAP HANA in Data Centers:
Agenda

Introduction & Overview

- Design & Setup
- Persistence
- Backup & Recovery (System Copy)
- High Availability
- Disaster Recovery
- Monitoring & Administration
- Security & Auditing
SAP HANA Platform – Difference to being only a classical database
The data management and application platform for all applications

---

All Devices
---

SAP, ISV and Custom Applications

**SAP HANA PLATFORM**

<table>
<thead>
<tr>
<th>APPLICATION SERVICES</th>
<th>PROCESSING SERVICES</th>
<th>INTEGRATION &amp; QUALITY SERVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Server</td>
<td>Spatial</td>
<td>Data Virtualization</td>
</tr>
<tr>
<td>JavaScript</td>
<td>Text Analytics</td>
<td>ETL &amp; Replication</td>
</tr>
<tr>
<td>Fiori UX</td>
<td>Graph*</td>
<td></td>
</tr>
<tr>
<td>Graphic Modeler</td>
<td>Streaming Analytics</td>
<td></td>
</tr>
<tr>
<td>Application Lifecycle Management</td>
<td>Series Data</td>
<td>Hadoop &amp; Spark Integration</td>
</tr>
<tr>
<td></td>
<td>Business Functions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Search</td>
<td></td>
</tr>
</tbody>
</table>

**DATABASE SERVICES**

- Columnar OLTP+OLAP
- Multi-Core & Parallelization
- Advanced Compression
- Multi-tenancy
- Multi-Tier Storage
- Data Modeling
- Openness
- Admin & Security
- High Availability & Disaster Recovery

**ONE Open Platform**

**OLTP + OLAP**

**ONE Copy of the Data**

* Graph is in controlled availability
SAP HANA Platform: Database services
Breakthrough innovations

• Turns data into real-time information
• No database tuning required for complex and ad hoc queries
• Run Transactions and Analytics together on one system and one copy of data
• Ready for Cloud, Hybrid, or On-premise deployment
• Not limited by the size of memory
SAP HANA Platform: Processing services
Comprehensive advanced data processing and analytics

- Run applications with dramatically different datatype characteristics in the same system
- Optimize graph, planning, and rules applications on the same data
- Empower your business via built-in predictive analytics, business functions, and data quality
SAP HANA Platform: Application services
Web server and database in one system reducing data movements

**SAP HANA PLATFORM**

<table>
<thead>
<tr>
<th>APPLICATION SERVICES</th>
<th>PROCESSING SERVICES</th>
<th>INTEGRATION &amp; QUALITY SERVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Server</td>
<td>ALM</td>
<td></td>
</tr>
<tr>
<td>JavaScript</td>
<td>Graphic Modeler</td>
<td></td>
</tr>
<tr>
<td>Fiori UX</td>
<td>Application Lifecycle Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DATABASE SERVICES**

- Deliver consumer-grade User Experiences for any device, automatically
- Support standards and languages that developers already know how to use
  - Java, JavaScript, C++, Node.JS, SQL, JSON, ADO.NET, JDBC, ODBC, OData, HTML5, MDX, XML/A
- Built-in tools to develop, version-control, bundle, transport, and install applications
SAP HANA Platform: Integration services
Data from any source for a complete view of the business

- Access information stored in data silos while keeping the data in place
- Replicate and move any type of data in real-time to the cloud and on-premise when necessary
- Capture and analysis live data streams and route to appropriate storage or dashboard
- Synchronize data between HANA and thousands of remote databases (SQL Anywhere, UltraLite)
- Multiple access points from HANA to Hadoop data: thru Spark, Hive, HDFS and MapReduce
SAP HANA: Choice of deployment
Cloud, On Premise and Hybrid

Cloud
Run all applications in the cloud

On Premise
Run all applications on premise

Hybrid
Leverage right deployment option that meets business priorities
SAP HANA Continuous Availability
Customer Expectation: Planned & Unplanned

Planned downtime
- SAP HANA Revisions & SPSs
- Patches for Data Services and SLT
- Maintenance Events for OS & Hardware
- Custom development & enhancements
- Planned outages
- ........

Continuous availability

Unplanned downtime

Data Center Readiness
- Hardware failure / Malfunction including Networks
- Software Malfunction / security threat / update
- Natural / Man-made disasters
- Failure of compliance & operation
- Unplanned outages

Extended SAP backend deployments

HANA consumption
SAP HANA Data Center Readiness
Quick Overview

SAP HANA

Data Center Readiness

Backup & Recovery
- Data & Log Backup
  - Point-In-Time Recovery
- 3rd-party backup tool support
  - Netbackup, Tivoli, Simpana, DataProtector, Networker, Sesam...
- Storage Snapshots
  - Point-In-Time Recovery

High Availability
- In case of hardware or system failure the standby system takes over in the same data center
- Several options:
  - storage-based
  - shadow databases
  - Internal or external cluster manager
  - SAP Landscape Management (LaMa)

Disaster Recovery
- Failover to a different HANA instance in another, even far distant data center
- Automatic and manual procedures possible
- Several options:
  - storage-based
  - shadow databases
  - External cluster manager
  - SAP Landscape Management (LaMa)

Design & Setup
- Several deployment options
  - Multi-Tenant Database Container
  - NetWeaver Central instance on HANA server
- Virtualization for production usage
- Tailored Data Center Integration
- Dynamic Tiering

Security & Auditing
- Comprehensive security framework
- Fine-granular authorizations
- Encryption
- Compliance (SoD, audit logging, ...)
- Secure hardware / software setup
- IDM and GRC integration
- 3rd party via standard / documented interfaces

Continuous Improvement of Simplification & Flexibility

Starting Page: Features of SAP HANA: Data Center - Enterprise Readiness and HA/DR
SAP HANA in Data Centers:
Agenda

- Introduction & Overview

**Design & Setup**

- Persistence
- Backup & Recovery (System Copy)
- High Availability
- Disaster Recovery
- Monitoring & Administration
- Security & Auditing
SAP HANA – Started as an Appliance

**Classic software delivery on-premise solutions**
- SAP ships only the software
- Customer is responsible for entire product lifecycle

**Appliance delivery kind of “SaaS on-site customer”**
- SAP defines the solution together with its partners
- SAP & partners control product lifecycle

---

**Diagram:**
- SAP Development
- Software and Licenses
- Setup/Consulting
- Support (Software, Maintenance and Infrastructure)
- Operation
- Infrastructure

- SAP Development
- Software and Licenses
- Setup/Consulting
- Support (Software, Maintenance and Infrastructure)
- Operation
- HW- and Technology Partners
- Infrastructure

Customer’s responsibility  | SAP responsibility  | Partners’ responsibility

* Might be outsourced or owned by customer
SAP HANA Platform

SAP HANA Technology Partners

SAP HANA Hardware Partners

Linux on IBM Power Systems

1300+ certified appliance solutions (September 2015)
SAP HANA Scalability
Scales from very small servers to very large clusters

12 PetaByte Data Warehouse with SAP HANA ➔ Guinness world record

Single Server
• 2 CPU 128GB to 8 CPU 8TB
  (Special layout for Suite on HANA or S/4HANA with up to 20TB+ per host)
• Single SAP HANA deployments for data marts or accelerators with performance demands (Socket to Memory ratio)
• Support for high availability and disaster recovery

Scale Out Cluster
• 2 to n servers per cluster
• Each server is either 4 CPU/2TB or 8 CPU/4TB
• Largest certified configuration: 112 servers
• Largest tested configuration: 250+ servers
• Support for high availability and disaster recovery

Cloud Deployment
• SAP HANA instances can be deployed to AWS, Huawei, etc.
• Limited to developer license
• SAP HANA Enterprise Cloud
• SAP HANA Cloud Platform
• Integration option in on-premise operation (IaaS) e.g. disaster recovery
# Certified Intel IvyBridge/Haswell+/Broadwell*-EX Hardware

June 2016* (available now)

<table>
<thead>
<tr>
<th>Memory Sizes</th>
<th>CPUs</th>
<th>Sockets</th>
<th>BW or Datamart</th>
<th>Suite</th>
<th>Lenovo Standard</th>
<th>Hitachi</th>
<th>HP-SCI</th>
<th>Dell</th>
<th>Fujitsu</th>
<th>NEC</th>
<th>VCE</th>
<th>Bull</th>
<th>Intel</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1TB</td>
<td>4</td>
<td>4-8</td>
<td>X/X*/X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>1TB</td>
<td>4</td>
<td>4-8</td>
<td>X/X*/X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>1.5TB</td>
<td>4</td>
<td>4-8</td>
<td>X°/X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>2TB</td>
<td>4</td>
<td>4-8</td>
<td>X°/X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>3TB</td>
<td>4</td>
<td>4-8</td>
<td>X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>4TB</td>
<td>4</td>
<td>4-8</td>
<td>X°</td>
<td>X</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>&lt;2TB</td>
<td>8</td>
<td>X°/X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>2TB</td>
<td>8</td>
<td>X°/X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>3TB</td>
<td>8</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>4TB</td>
<td>8</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>6TB</td>
<td>8</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>8TB</td>
<td>8</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>8-16TB</td>
<td>12-16</td>
<td>X°/X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>10-20TB</td>
<td>20</td>
<td>X°/X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
<tr>
<td>24-32TB</td>
<td>32</td>
<td>X°/X°</td>
<td>X°</td>
<td>X°</td>
<td>X° X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
<td>X°</td>
</tr>
</tbody>
</table>

* For most up to date list please go to the Certified SAP HANA Hardware

【**Still subject to change**】

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
## Certified Intel IvyBridge/Haswell+/Broadwell*-EX Hardware

**June 2016** (available now)

<table>
<thead>
<tr>
<th>Memory Sizes</th>
<th>CPUs</th>
<th>Sockets</th>
<th>BW or Datamar</th>
<th>Suite</th>
<th>Scale-Out</th>
<th>Scale-Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>½TB</td>
<td>2</td>
<td>2-4</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1TB</td>
<td>4</td>
<td>4-8</td>
<td>X/X+/X*</td>
<td>X/X°</td>
<td>X+</td>
<td>X/X*</td>
</tr>
<tr>
<td>1.5TB</td>
<td>4</td>
<td>4-8</td>
<td>X/X+/X*</td>
<td>X/X°</td>
<td>X/ X+</td>
<td>X</td>
</tr>
<tr>
<td>2TB</td>
<td>4</td>
<td>4-8</td>
<td>X+/X*</td>
<td>X+/X°</td>
<td>X+</td>
<td>X+X/</td>
</tr>
<tr>
<td>1TB</td>
<td>8</td>
<td>8</td>
<td>X/X+/X*</td>
<td>X</td>
<td>X+/X°</td>
<td>X+X/</td>
</tr>
<tr>
<td>2TB</td>
<td>8</td>
<td>8</td>
<td>X/X+/X*</td>
<td>X/X°</td>
<td>X/X/</td>
<td>X</td>
</tr>
<tr>
<td>3TB</td>
<td>8</td>
<td>8</td>
<td>X+/X*</td>
<td>X/X°</td>
<td>X/ X+</td>
<td>X</td>
</tr>
<tr>
<td>4TB</td>
<td>8</td>
<td>8</td>
<td>X+/X*</td>
<td>X/X°</td>
<td>X/ X+</td>
<td>X</td>
</tr>
<tr>
<td>6TB</td>
<td>8</td>
<td>8</td>
<td>Not planned</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| HA – Host Auto-Failover | X | X | X | X | X | X | X | X |
| DR – Storage Repl.: Sync | ¥ | X | ¥ | X | X | X | X | X |
| DR – Storage Repl.: Async | ¥ | X | ¥ | X | X | ¥ | X | ¥ |

‡ Partner recommends (also) SAP HANA System Replication

* For most up to date list please go to the [Certified SAP HANA Hardware](#)
Relaxed HW Specifications for Non-Production

**Notes:**

- Hardware preferred from ICC certified list
  - **Certified SAP HANA Hardware**
- Non-prod: Sizing flexible
  - Instances can be combined
  - SoH layouts can be used for BW or analytical workloads
- SAP note **2271345**
  - Any Enterprise ready hardware with Intel E5 or E7 or released IBM Power8 CPUs

### Processor

- **Intel Xeon E7 Westmere Ex** (E7-x8xx v1)
- or **IvyBridge EX** (E7-x8xx V2) or **Haswell EX** (E7-x8xx v3)
- or **Broadwell EX** (E7-x8xx v4)

### Memory

- **Intel Xeon E5** - (E5-26xx v2/v3/v4, min. 8 cores);
- 2 socket, up to 1.5TB; scale-up only
- 128 GB of RAM to Maximum memory supported on the box

### Storage

- Size: 2x Memory - Any local storage or shared storage w/ standard disk on proven file systems
  - **GPFS** (Lenovo only),
  - **NFS or XFS w/ Raid1 and above**

### Network

- **Standard networking components**

### Operating System

- **SUSE SLES Linux 11.x, 12.x or Red Hat RHEL 6.5 - 6.7, 7.2**

**Virtualized or Bare Metal**

**Note:** Performance related support will only be provided on Production grade hardware (Certified hardware)

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
SAP HANA Platform Hardware
OS Certifications for Intel hardware platform

Suse SLES
Certifications
- SLES 11 SP4 done ⇒ Certification of HW partners setups with new OS pending*
- SLES 12 SP0 done ⇒ Certification of HW partners setups with new OS pending*
- SLES 12 SP1 planned for 2016

Further information
- SAP Note 1310037, SAP Note 1824819, SAP Note 2369981

RedHat RHEL
Certifications
- RHEL 6.7 done ⇒ Certification of HW partners setups with new OS pending*
- RHEL 7.2+ planned for 2016

Further Information
- SAP Note 2136965 (RHEL 6.6), SAP Note 2013638 (RHEL6.5)

* Please check Certified SAP HANA Hardware filter for released OS versions per hardware setup

SAP strongly recommends to use the corresponding Linux distributions “… for SAP applications”

Benefit:
- Longer maintenance support per OS SP or version and many other technical and logistical advantages
Changes for CPU:Memory relations released with SAP HANA SPS11 and analytical workloads like SAP Business Warehouse or Datamarts:

8 CPUs (sockets), 4 TB with Intel Haswell EX or Broadwell EX CPUs
4 CPUs (sockets), 2 TB with Intel Haswell EX or Broadwell EX CPUs

Before, with SAP HANA SPS10 allowed max. sizings were as following:

8 CPUs (sockets), 3 TB with Intel Haswell EX or Broadwell EX CPUs
4 CPUs (sockets), 1.5 TB with Intel Haswell EX or Broadwell EX CPUs

If Intel IvyBridge EX CPUs are still planned to be used, the relations would be like this:

8 CPUs (sockets), 2 TB with Intel IvyBridge EX CPUs
4 CPUs (sockets), 1 TB with Intel IvyBridge EX CPUs

- These relationships will not change with SAP HANA SPS11/12 for Intel IvyBridge EX.
- SAP HANA got major optimizations with Intel Haswell in comparison to Intel IvyBridge EX.
Changes for socket memory relations released with SAP HANA SPS11 and non-analytical workloads like SAP Business Suite or SAP S/4HANA:

1 TB per CPUs (sockets), Intel Haswell EX/EP or Broadwell EX/EP CPUs

Before, with SAP HANA SPS10 allowed max. sizing were as following:

768 GB per CPUs (sockets), Intel Haswell EX/EP or Broadwell EX/EP CPUs

If Intel IvyBridge CPUs are still planned to be used, the relations would be like this:

768 GB per CPUs (sockets), Intel IvyBridge EX/EP CPUs

• These relationships will not change with SAP HANA SPS11/12 for IvyBridge EX.
• SAP HANA got major optimizations with Intel Haswell EX/EP in comparison to Intel IvyBridge EX.
SAP HANA Scale-Out “Extension”
Heterogeneous Landscapes

Supported with the following constraints:

- Certified SAP HANA scale-out hardware from the same hardware partner
- Same memory size on each node (e.g. 2 TB per node)
- Distributed tables: Slowest part of a cluster will define the overall performance
- Mixtures of CPU generations per cluster are supported with following considerations:
  - It’s recommended to use only two consecutive hardware generations of CPUs in one cluster (n & n-1)
  - At a certain point it makes no sense to keep a too heterogeneous environment
    - If such combinations are useful depend on use cases and scalability demands
    - HW partner or HW solutions may introduce additional limitations not allowing these kind of combinations (e.g. incompatibilities)

Aim is to increase the size of the database, not primarily the performance
IBM and SAP reach new milestones with SAP HANA SPS11 ([Link](http://example.com))

### LPAR Restrictions:

- **As of SAP HANA SPS11** LPARs on E870 and E880 running SAP Business Warehouse, powered by SAP HANA may have at most 4800 GB RAM and a core to memory ratio of at most 50 GB per core.
- **For SAP HANA SPS09 and SPS10** LPARs on E870 and E880 running SAP Business Warehouse, powered by SAP HANA may have at most 3TB RAM and a core to memory ratio of at most 32 GB per core.
- LPARs on other models running SAP Business Warehouse, powered by SAP HANA may have at most 1 TB RAM and a core to memory ratio of at most 32 GB per core.
- LPARs running SAP Business Suite, powered by SAP HANA may have at most 9 TB RAM and a core to memory ratio of at most 96 GB per core.

*See SAP Note [2188482](http://example.com) - SAP HANA on IBM Power Systems: Allowed Hardware or [Supported IBM Power Systems](http://example.com)*

---

<table>
<thead>
<tr>
<th>POWER 8 Model</th>
<th>Minimal cores per LPAR</th>
<th>Maximal cores per LPAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S822</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>S822L</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>S824</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>S824L</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>E850</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>E870</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>E880</td>
<td>8</td>
<td>96</td>
</tr>
</tbody>
</table>
SUSE Linux Enterprise Server 11 SP4 for IBM Power
(plus additional Packages)

- SAP Note 2240716 - SAP HANA DB: Recommended OS settings for SLES 11 / SLES for SAP Applications 11 SP4

- SAP Note 2055470 - HANA on POWER Planning and Installation Specifics - Central Note

For general information, see SUSE Linux Enterprise Server 11.x for SAP Applications Configuration Guide for SAP HANA attached to SAP Note 1944799 - SAP HANA on IBM Power Systems: Allowed Hardware

SAP strongly recommends to use the corresponding Linux distributions “... for SAP applications”

Benefit:
- Longer Maintenance duration per SP and many other technical and logistical advantages
SAP HANA on IBM Power – Supported Applications
Minimum Releases

SAP Business Warehouse, powered by SAP HANA
- SAP EHP1 for SAP NetWeaver Business Warehouse 7.3
- SAP Business Warehouse 7.4

SAP Business Suite, powered by SAP HANA
- SAP ERP 6.0 EHP7 and Addons
- SAP SRM 7.0 EHP3
- SAP CRM 7.0 EHP3
- SAP SCM 7.0 EHP4

SAP BusinessObjects Business Intelligence platform 4.1 SP03
SAP Business Planning and Consolidation 10.1 (in controlled availability)
SAP Global Trade Services 11
SAP Master Data Governance 7.0
SAP Landscape Transformation Replication Server 2.0 DMIS 2011 SP 07
SAP Solution Manager 7.2
SAP Transportation Resource Planning 1.0

See [SAP Note 2218464](https://support.sap.com) currently supported applications with HANA on Power
Changes for CPU:Memory relations released with SAP HANA SPS11 and analytical workloads like SAP Business Warehouse or Datamarts:

8 CPUs, 96 Cores, 4.8 TB with Power8 CPUs
4 CPUs, 48 Cores, 2.4 TB with Power8 CPUs

Before, with SAP HANA SPS10 max. allowed sizings were as following:

8 CPUs, 96 Cores, 3 TB with Power CPUs
4 CPUs, 48 Cores, 1.5 TB with Power CPUs

Different concept of deploying SAP HANA hardware to customers by IBM

- Fully stuffed servers
- On demand hardware
- Pay per use concept

Please contact IBM directly for details
# SAP HANA Platform Hardware Roadmap

<table>
<thead>
<tr>
<th>CPU Architecture</th>
<th>CPU Architecture</th>
<th>CPU Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Today</strong></td>
<td><strong>Planned Innovations</strong></td>
<td><strong>Future Direction</strong></td>
</tr>
<tr>
<td><strong>CPU Architecture</strong></td>
<td><strong>CPU Architecture</strong></td>
<td><strong>CPU Architecture</strong></td>
</tr>
<tr>
<td>• Intel x86_64</td>
<td>• Intel x86_64</td>
<td>• Intel x86_64</td>
</tr>
<tr>
<td>• IBM Power</td>
<td>• IBM Power</td>
<td>• IBM Power</td>
</tr>
<tr>
<td>o Intel Broadwell (14nm - TOCK)</td>
<td>o Intel Power8</td>
<td>o Intel Skylake (14 nm - TICK)</td>
</tr>
<tr>
<td>o 24 Cores/CPU, up to 60 MB L3cache, up to 24 TB DDR4 (3DS), up to 165 W TDP</td>
<td>o Change of Endian type (big E. ⇒ little E.) together with the move to SUSE SLES12</td>
<td>o Cores/CPU: Announced by Intel</td>
</tr>
<tr>
<td>o Base freq, up to 2.2 GHz, 2.6-3.2 GHz Turbo mode, 1.8-3.4 GHz AVX2-Turbo</td>
<td>o After Little Endian migration, easier moves between architectures might be possible</td>
<td>o 3D Xpoint</td>
</tr>
<tr>
<td>o Brickland platform (chipset)</td>
<td></td>
<td>o Purley platform (chipset)</td>
</tr>
<tr>
<td>• SUSE SLES</td>
<td>• SUSE SLES</td>
<td>• SUSE SLES</td>
</tr>
<tr>
<td>o Certification SLES 12 SP1</td>
<td>o Certification SLES 12 SP2</td>
<td>o Certification SLES 12 SPx</td>
</tr>
<tr>
<td>• Redhat RHEL</td>
<td>• Redhat RHEL</td>
<td>• Redhat RHEL</td>
</tr>
<tr>
<td>o Certification RHEL 7.2</td>
<td>o Certification RHEL 7.x</td>
<td>o Certification RHEL 7.x</td>
</tr>
</tbody>
</table>

**SAP HANA SPS12**

This is the current state of planning and may be changed by SAP at any time.
Tailored DataCenter Integration
SAP HANA tailored data center integration is an additional option to the existing appliance model

- Limited flexibility in server/storage combinations (well defined packages)
- Established IT operation processes have to be adapted slightly
- Well defined HW and performance KPIs

- Reduce hardware and operation cost at installed based customers
- Mitigate risk and optimize time to value by taking more responsibility
- Gain additional flexibility in hardware vendor selection *

* Please contact for joining pilot phase: SAP_HANA_tailored_data_center_integration@sap.com
SAP HANA Tailored Data Center Integration
A continuous journey towards openness

SAP HANA Appliance GEN 1
Intel Xenon EX
Nehalem & Westmere (E7 v1)

SAP HANA Appliance GEN 2
Intel Xenon EX
IvyBridge (E7 v2)

SAP HANA Appliance GEN 3
Intel Xenon EX
Haswell (E7 v3)

SAP HANA Appliance GEN 4
Intel Xenon EX
Broadwell (E7 v4)

SAP HANA TDI
Phase 1: Shared Enterprise Storage

SAP HANA TDI
Phase 2: Shared Enterprise Networking
Phase 3: Entry-level SAP HANA E5 servers

SAP HANA TDI
Phase 4: SAP HANA on Linux for IBM Power CPUs

Today:
Hundreds of certified SAP HANA configurations available for nearly every customer budget and use case

2011-2012
Oct. 2013
Feb. 2014
Nov. 2014
Mid. 2015
Mid. 2016
SAP HANA tailored data center integration is an additional option to the existing appliance delivery model.
SAP HANA Tailored Data Center Integration
What's in it for you?

Reduce hardware and operation cost by reusing existing hardware components and operation processes

Mitigate risk and optimize time to value by enabling existing IT Management processes for SAP HANA implementation

Gain additional flexibility in hardware vendor selection by Leveraging the existing ecosystem
SAP HANA Tailored Data Center Integration
Differentiating Capabilities

<table>
<thead>
<tr>
<th>SAP HANA appliance delivery</th>
<th>SAP HANA tailored data center integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Implementation</td>
<td>More Flexibility and Responsibility</td>
</tr>
<tr>
<td>Support fully provided by SAP</td>
<td>Save IT budget and existing investment</td>
</tr>
</tbody>
</table>

- Solution validation done by SAP and partner
- Preconfigured hardware set-up
- Preinstalled software

- Installation and validation needs to be done by customer
- Customer aligns with the hardware partner on individual support model
SAP HANA Tailored Data Center Integration
Prerequisites for Enterprise Storage

Requirements:

**Server** - Only servers listed in [Certified SAP HANA Hardware](#) are supported.

Configuration adjustments like:
- **No local disks, no flash cards required**
- Additional FibreChannel adapters for SAN boot are allowed

**Storage** – All storages successfully passed the SAP HANA Hardware Certification.
- For more information, see [Certified Enterprise Storage for SAP HANA](#) or contact HWC@sap.com

**SAP HANA Installation** – Needs a certified expert (internal or external) to be executed
- The exam “SAP Certified Technology Specialist (Edition 2015) – SAP HANA Installation” ([E_HANAINS151](#)) needs to be passed successfully to perform SAP HANA installations at customer side. You get prepared for this exam with SAP training [HA200](#).
- For more information, see [SAP Training and Certification Shop](#) (Requirements)
### SAP HANA Tailored Data Center Integration
Certified Partner Enterprise Storage Solutions (April 2016*)

**Storage Partners & certified storage solutions**: [Certified Enterprise Storage for SAP HANA](#)

<table>
<thead>
<tr>
<th>Datecore</th>
<th>Dell</th>
<th>EMC</th>
<th>Fujitsu</th>
<th>Fusion-IO</th>
<th>Hitachi</th>
<th>HP</th>
<th>Huawei</th>
</tr>
</thead>
<tbody>
<tr>
<td>SANsymphony-V 10.0</td>
<td>Compellent SC8000</td>
<td>Symmetrix VMAX VMAX 10K-40K</td>
<td>ETERNUS DX DX200-DX600 S3 (2 contr.)</td>
<td>ION-Accelerator based on several designs</td>
<td>Enterprise Storage VSP VSP G1000 HUS-VM</td>
<td>3PAR StoreServ 7200-10800</td>
<td>OceanStor Storage S5500T-S6800T 18000F-18800</td>
</tr>
<tr>
<td>SC Series Storage Solutions SC4020 SC9000</td>
<td>VNX Unified Storage Systems VNX 5400 -VNX 8000</td>
<td>FUJITSU ETERNUS with FalconStor NSS</td>
<td></td>
<td></td>
<td></td>
<td>3PAR StoreServ 20450-20850</td>
<td>OceanStor Storage 5500 V3-18800 V3</td>
</tr>
<tr>
<td>VMAX3 Family VMAX3 100K-400K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3PAR StoreServ 8200-8450</td>
<td>OceanStor Storage 18500 V3 (FCoE)</td>
</tr>
<tr>
<td>XtremIO Storage Array XtremIO 3.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>XP Storage XP7 XP P9500</td>
<td></td>
</tr>
<tr>
<td>EMC VPLEX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For most up to date list please go to [Certified Enterprise Storage for SAP HANA](#)  
Request white-paper or best practice document from vendor
# SAP HANA Tailored Data Center Integration

Certified Partner Enterprise Storage Solutions (April 2016*)

## Storage Partners & certified storage solutions*

### Certified Enterprise Storage for SAP HANA

<table>
<thead>
<tr>
<th>Infinidat</th>
<th>IBM (link)</th>
<th>NEC</th>
<th>NetApp</th>
<th>Nimble Storage</th>
<th>Pure Storage</th>
<th>Violin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storwize V3700 V5000 V7000 (SVC)</td>
<td></td>
<td></td>
<td>FAS &amp; All Flash FAS systems AFF/FAS 8020-8080</td>
<td></td>
<td></td>
<td>FA //m Series FlashArray //m20-//-m70</td>
</tr>
<tr>
<td>Elastic Storage Server GS2-GL6</td>
<td></td>
<td></td>
<td>FAS Series FAS 3250-80#0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS8070, DS8000 Family</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XIV Storage 2810-2812</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For most up to date list please go to [Certified Enterprise Storage for SAP HANA](#)  
  
Request white-paper or best practice document from vendor
# Data Throughput and Latency KPIs for Production SAP HANA Systems

<table>
<thead>
<tr>
<th>Volume</th>
<th>Block Sizes</th>
<th>Test File Size</th>
<th>KPIs</th>
<th>Latency (µs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Initial Write (MB/s*)</td>
<td></td>
</tr>
<tr>
<td>Log</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>n.a.</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>n.a.</td>
<td>250</td>
</tr>
<tr>
<td>Data</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>64K</td>
<td>16G</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>16M</td>
<td>16G</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>64M</td>
<td>16G</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Overwrite (MB/s*)</td>
<td></td>
</tr>
<tr>
<td>Log</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>n.a.</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>n.a.</td>
<td>250</td>
</tr>
<tr>
<td>Data</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>64K</td>
<td>16G</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>16M</td>
<td>16G</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>64M</td>
<td>16G</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Read (MB/s*)</td>
<td></td>
</tr>
<tr>
<td>Log</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>40</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>150</td>
<td>n.a.</td>
</tr>
<tr>
<td>Data</td>
<td>4K</td>
<td>5G</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>16K</td>
<td>16G</td>
<td>40</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>64K</td>
<td>16G</td>
<td>100</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>1M</td>
<td>16G</td>
<td>150</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>16M</td>
<td>16G</td>
<td>200</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>64M</td>
<td>16G</td>
<td>200</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Source: SAP Note [1943937 - Hardware Configuration Check Tool - Central Note](http://scn.sap.com/docs/DOC-62595) ⇒ Watch out for the Attachment there!

*MB/s == MByte/s

SAP HANA Tailored Data Center Integration
Hardware Configuration Check Tool (HWCCT)

SAP HANA HW Config Check Tool (HWCCT)
- Command-line tool, generally available since SAP HANA SPS07
- Used by storage vendors, SAP Support, and customers
- Measures the data throughput and latency times between the SAP HANA servers and the Enterprise Storage system
  - Does not require SAP HANA SW being installed beforehand
  - Uses the same libraries for file system access and the same IO patterns as SAP HANA does
- Download it from SAP Service Marketplace
- Documented in the SAP HANA Administration Guide
  - Contains the latest KPIs
  - For latest docu changes, see PDF attachment of SAP Note 1943937
- SAP Note 1652078 – SAP HANA database: Hardware check
- HWCCT Troubleshooting Guide at SAP Note 2212741 for setup problems (missed performance KPIs)

Important: There is no Self-Certification, but an optional Self-Assessment
SAP HANA Storage Layout
Disk sizing with class. HANA appliance vs. HANA TDI

Classical SAP HANA Appliance

“0.5:3:1” Disk layout

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 x RAM</td>
<td>Log</td>
</tr>
<tr>
<td>512 GB</td>
<td>0.5 x RAM</td>
</tr>
<tr>
<td>3 x RAM</td>
<td>Data</td>
</tr>
<tr>
<td>1 x RAM</td>
<td>Shared/Trace</td>
</tr>
</tbody>
</table>

Reason for comfortable sizing:
- Appliance can not always be changed on short notice (add more disks) depending on the general design, etc. for the HW partner offering of choice.
- Source: SAP HANA Administration Guide (to be updated to latest changes)

* Minimum value for every size above 512 GB - more might be necessary depending on very high workload situations (transactional load)

SAP HANA Tailored Datacenter Integration

“0.5:1:1” Disk layout

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 x RAM</td>
<td>Log</td>
</tr>
<tr>
<td>512 GB</td>
<td>0.5 x RAM</td>
</tr>
<tr>
<td></td>
<td>(&lt; 512 GB RAM)</td>
</tr>
<tr>
<td>1 x RAM</td>
<td>Data</td>
</tr>
<tr>
<td></td>
<td>(≥ 512 GB RAM)</td>
</tr>
<tr>
<td>1 x RAM</td>
<td>Shared/Trace</td>
</tr>
</tbody>
</table>

Reason for reduced sizing:
- Customers can change disk layout (extensions of disk areas) on short notice because they are responsible for the complete HANA Stack
- Source: SAP HANA Storage Requirements Whitepaper (SAP note 1900823 or SCN)

* Minimum value for every size above 512 GB - more might be necessary depending on very high workload situations (transactional load)
SAP HANA Tailored Data Center Integration

Enterprise Network

Data Center 1

1. Application Server (ABAP, XS)
2. HANA Client (BI client, HANA Studio, ...)
3. Data Sources
4. SAP HANA Server Node 1
5. SAP HANA Server Node 2
6. SAP HANA Server Node 3
7. SAP HANA Server Node 4

Data Center 2

1. Application Server (ABAP, XS)
2. HANA Client (BI client, HANA Studio, ...)
3. Data Sources
4. SAP HANA Server Node 1
5. SAP HANA Server Node 2
6. SAP HANA Server Node 3
7. SAP HANA Server Node 4

Client zone: 1 Application Server Network 2 Client Network 3 Data Source Network
Internal zone: 4 Internode Network 5 System Replication Network
Storage zone: 6 Enterprise Storage Network 7 Backup Network

More details available in SAP HANA documentation:
SAP HANA Master Guide, chapter 2 "The SAP HANA Network"
Network Requirement Paper with further details
Recommendations:
All recommendations mentioned refer to the usage in productive environments

Network Segmentation – All networks need to be properly segmented and may be connected to the same core/ backbone switch.

Note: Network security and segmentation is a function of the network switch vendor and must be configured according to the specifications of the switch vendor.

For more details on network security see the SAP HANA Security Guide, chapter 4.

Bandwidth
≥ 10 GbE for Internode and Backup Network
≥ 10 GbE (Ethernet) or ≥ 8 GbF (FibreChannel) for Enterprise Storage Network

Redundancy – It depends on the customer’s high-availability requirements if and how to apply redundancy for the different SAP HANA network segments.
SAP strongly recommends to make the following networks redundant:
- Internal zone (Internode and System Replication networks)
- Storage zone (Enterprise Storage and Backup Storage networks)
Fully redundant switches and routers are recommended.
General Availability – Server options:
More CPU flavors are introduced:
  • Intel Xeon E5 for non-production and production
    ▪ Scope
      o Single Box, only Scale-Up
      o Intel Xeon 2 socket E5 26xx up to 1,5 TB (no 4 socket solutions)
      o Sizing process with NEW SAP HANA Quick Sizer
      o Lists with HW solutions with SCN as “Supported Entry Level Systems”
  • SAP HANA on Linux for IBM Power8
    ▪ Only IBM Power 8; previous IBM Power architectures only for non-prod operation with SAP HANA
    ▪ SAP Note: 2133369 - SAP HANA on IBM Power Systems: Central Release Note
    ▪ SAP HANA on IBM Power SP09 and SPS10: SAP Notes 2133369
    ▪ SAP HANA Platform SPS11: SAP Note 2227464  Power related: SAP Note 2218464

Hardware partitioning
  • Current status presented in SAP Note 1788665
    o Hitachi LPAR (SAP Note 2063057)
    o HP nPartitions CS900 „HANA Hawk“ (SAP Note 2103848)
    o Fujitsu pPAR (SAP Note 2111714)
    o Huawei FusionSphere 3.1, FusionSphere 5.1 (SAP Note 2186187)
    o Lenovo FlexNode partitions (SAP Note 2232700)
Going Live with SAP HANA TDI
High-level Process

1) Determine the size of your future SAP HANA system
   • SAP Quick Sizer tool is a quick and easy way for customers to determine the CPU, memory, and SAPS requirements for running their workloads on SAP HANA.
   • Consider involving SAP Active Global Support for IT landscape planning

2) Check the offerings of SAP’s HANA Hardware Partners
   • See the Certified SAP HANA Hardware Directory site

3) Order your SAP HANA server hardware
   • If you decided to follow the TDI approach, please note:
     o You do not need to order the local disks/integrated storage - these are only required for appliances
     o If you want your SAP HANA system to boot from SAN, additional Fibre Channel adapters are allowed

4) Check the offerings of certified storage vendors
   • Select one from the list of certified storage families
   • If your preferred storage is not yet on the list, contact the vendor on their plans to get certified

5) Set up your SAP HANA hardware infrastructure
   • Make yourself familiar with SAP HANA’s IO patterns and the impact of SAP’s data throughput KPIs during daily SAP HANA operation
   • Configure the storage system following the vendor’s directions and recommendations
     o Ask your storage vendor for a copy of their Configuration Guide for SAP HANA
   • Optional: Check the data throughput and the latency times using HWCCT
     o SAP’s KPIs are listed in the tool documentation
   • Contact your storage vendor if the KPIs are not met

6) Install SAP HANA software
   • Make sure that only certified personal do the SAP HANA installation
   • See SAP’s installation guides and related SAP notes at help.sap.com

7) Go Live
   • Consider involving SAP Active Global Support to perform a HANA Go-Live Check prior to going productive
Operation in Data Centers
In the SAP HANA Master Guide, chapter 5, SAP offers all kinds of topics about operating SAP HANA as an appliance (http://help.sap.com/hana_platform).

This manual should be taken as input for further adaptations of the operation of SAP HANA in customers’ Data Centers.

The needed regular duties around the operation of SAP HANA can be derived from this document.

Usually HANA needs lesser administration than other databases, typical duties are:

- Regular backups (Database, Bare-Metal software and configuration backup)
- Patches; usually on demand in case of problems or known issues (DB, OS)
- Monitoring (automated or manual)

### Table: Cited from SAP HANA Master Guide

<table>
<thead>
<tr>
<th>Task</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation of Hardware</td>
<td>Hardware Partner</td>
</tr>
<tr>
<td>Installation of Operating System</td>
<td>Hardware Partner</td>
</tr>
<tr>
<td>Installation of SAP HANA Platform</td>
<td>Hardware Partner</td>
</tr>
<tr>
<td>OS updates</td>
<td>Customer</td>
</tr>
<tr>
<td>SAP HANA updates</td>
<td>Customer</td>
</tr>
<tr>
<td>Data source connectivity</td>
<td>Customer</td>
</tr>
<tr>
<td>BI Client installation</td>
<td>Customer</td>
</tr>
<tr>
<td>SAP HANA software support</td>
<td>SAP</td>
</tr>
</tbody>
</table>
Fulfilling IT compliance (IT policies) for Data Centers

Data Center compliances usually define specific topics to
- Managing, Monitoring and Backup & Restore tools
- Central user management with IDM tools
- Anti Virus software usage mandates
- OS security patches, firewalls
- Etc.

Additional 3rd party tools required to complete these compliances are tolerated with following restrictions
- Neither SAP nor hardware vendor offers support for tools which are not official part of the SAP HANA BOM.
- The hardware vendor is tolerating the installation and operation of this compliance-related software.
- Customers might be asked to stop these tools in case of a support issue and to enable reproduction of the problem
- No closed source driver are allowed with these compliance tools without further support agreement of the vendor with SAP for these
Project Cost Analysis (TCO) by Forrester
Cost Savings Enabled By Transitioning to the SAP HANA platform

Further documentation available on:
www.sap.com/innovation-and-me

Unlock business value and deliver breakthrough innovation while simplifying IT
• Executive Summary
• Full paper (with free registration)
Housekeeping in SAP HANA

SAP HANACleaner for house keeping in SAP HANA

SAP Note 2399996 ("How-To: Configuring automatic SAP HANA Cleanup with SAP HANACleaner")

Provides and describes the SAP HANACleaner tool
It can be used for configurable automatic SAP HANA cleanup tasks like
- deleting old backup catalog entries
- deleting old trace files
- compressing large backup.log and backint.log files

Performance & Troubleshooting Guide

Link: SAP_HANA_Troubleshooting_and_Performance_Analysis_Guide_en.pdf
Part of the standard documentation of SAP HANA with http://help.sap.com/hana_platform
Ongoing extension of guide with “Troubleshooting HSR Log Retention” in progress
Additional system replication sections will be integrated on the following topics
- System replication appears to slow down transaction processing – add new example about performance KPIs
- Setup and initial configuration problems
- Intermittent connectivity problems
Automation on a broad scale
SAP Landscape Management (SAP LaMa)
Making SAP landscape management easier

SAP Landscape Management is an automation and orchestration solution to **simplify** • **automate** • **centralize** the management of your SAP landscapes

**Simplify** landscape management and standardize SAP operations

**Automate** repetitive, time consuming tasks and orchestrate to your needs

**Centralize** landscape operations and gain landscape-wide visibility

---

**SAP Applications**
- S/4HANA
- CRM
- ERP
- BW
- SCM

**Operating System and Database**
- RHEL
- SLES
- HANA

**IT Infrastructure**
- Virtualization
- Storage
- Network
- Server

---

**DEV**
**QAS**
**PRD**

---

**non-SAP Apps**

---

**3rd Party Tools**

---

**On-Premise**
**Cloud**
**Hybrid**
SAP Landscape Management
Addressing your landscape management needs

Centralize Landscape Management
Centralized landscape operations with built-in support for system dependencies and landscape-wide visibility

Capabilities: Dashboards, landscape visualization, mass-operations, scheduling engine, RKS**

Manage SAP HANA Landscapes
Management, provisioning and orchestration of SAP system and landscapes powered by SAP HANA

Capabilities: (Automated) system copy/refresh, takeover/failback, nZDM* maintenance for SAP HANA

Automate SAP System Provisioning
End-to-end automation for SAP system provisioning tasks including post copy/refresh automation (PCA)

Capabilities: (Automated) system clone, copy, refresh, app. server installation, standalone PCA

Extensibility and Orchestration
Tailor to your specific needs, integrate your own procedures and orchestrate your own processes

Capabilities: (Custom) operations, hooks, instances, and automation studio for creating custom processes

* Near Zero Downtime (nZDM)
** Rolling Kernel Switch (RKS)
## Tools for Managing SAP HANA Systems and Landscapes

Which tool to use, for what…

<table>
<thead>
<tr>
<th>Tool</th>
<th>Use it for</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP Solution Manager</td>
<td>End-to-end root cause analysis and unified alert inbox for entire landscape and for business process reporting</td>
</tr>
<tr>
<td></td>
<td>• Central alerting and monitoring infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Runs on SAP NetWeaver AS for ABAP</td>
</tr>
<tr>
<td>SAP Landscape Management</td>
<td>Automation and orchestration of SAP HANA advanced operations, accelerating migration projects and centralizing landscape operations</td>
</tr>
<tr>
<td></td>
<td>• Central landscape management solution</td>
</tr>
<tr>
<td></td>
<td>• Runs on SAP NetWeaver AS for Java</td>
</tr>
</tbody>
</table>

### Native Tools for SAP HANA Database Administration

<table>
<thead>
<tr>
<th>Tool</th>
<th>Use it for</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP HANA Cockpit</td>
<td>Core administration and detailed monitoring of a single SAP HANA database</td>
</tr>
<tr>
<td></td>
<td>• Web-based SAP Fiori launchpad</td>
</tr>
<tr>
<td></td>
<td>• Runs on SAP HANA XS Classic</td>
</tr>
<tr>
<td>SAP DB Control Center</td>
<td>Administration and monitoring of the entire SAP HANA database landscape</td>
</tr>
<tr>
<td></td>
<td>• Web-based SAP Fiori launchpad</td>
</tr>
<tr>
<td></td>
<td>• Runs on SAP HANA XS Classic</td>
</tr>
<tr>
<td>SAP HANA Studio</td>
<td>SAP HANA basic administration tasks and development including modeled views</td>
</tr>
<tr>
<td></td>
<td>• Eclipse-based IDE</td>
</tr>
<tr>
<td></td>
<td>• No longer in feature development</td>
</tr>
</tbody>
</table>
SAP Landscape Management 3.0
What’s new (key capabilities)

<table>
<thead>
<tr>
<th>Landscape Management and Operations</th>
<th>SAP HANA Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enhanced user experience based on SAP UI5</td>
<td>• Simplified provisioning and management of SAP HANA Multi-Tenant Database Container (MDC) setups</td>
</tr>
<tr>
<td>• Enhanced Dashboards, Pods and Landscape Visualization</td>
<td>• Fully automated System Refresh procedure for SAP HANA using backup and restore</td>
</tr>
<tr>
<td>• Simplified operations including templates based execution for operations</td>
<td>• Fully automated procedure to setup and monitor SAP HANA System Replication</td>
</tr>
<tr>
<td>• New scheduling engine to plan and execute landscape tasks</td>
<td>• Fully automated procedure for SAP HANA Failback and nZDM Takeover</td>
</tr>
<tr>
<td>• Automatic sync between two SAP LaMa systems for high availability setups</td>
<td>• Near Zero Downtime (nZDM) maintenance for SAP HANA (e.g. OS updates, SAP HANA upgrades, Hardware maintenance)</td>
</tr>
<tr>
<td>• New Automation Studio for defining and executing custom processes (combination of standard and custom operations)</td>
<td></td>
</tr>
</tbody>
</table>

This is the current state of planning and may be changed by SAP at any time.
### Centralized SAP Landscape Management and Control
- Landscape-wide visibility with advance dashboards and landscape visualization
- Mass-operations on landscape with built-in support for system dependencies
- Visualize disaster recovery relationships for SAP HANA
- Scheduling engine and template based execution for operations
- Integration with native tools like SAP HANA Cockpit and DB Control Center

### Automation for Advanced System Operations
- End-to-end automation for system clone, copy, rename and refresh operations including post-copy automation
- Accelerate SAP BW to SAP HANA migration projects via special task lists
- Manage and provision SAP HANA systems deployed in the cloud (AWS and OpenStack cloud environments)
- Manage and provision multi-tenant database container (MDC) systems

### nZDM* Maintenance and System Replication Support
- End-to-end automation for SAP HANA system replication setup
- End-to-end automation for SAP HANA takeover and failback procedures
- Near zero downtime takeover procedure for planned downtime scenarios
- Near zero downtime maintenance for SAP HANA primary and secondary sites (SAP HANA upgrades, OS upgrades or Hardware maintenance)

* Near Zero Downtime (nZDM)
Check out the different orchestration options in detail in the administration chapter...

**System Copy** is used to create new DEV/QAS systems that are copies of your PRD system.

**System Refresh** is used to update your existing DEV/QAS systems with the latest PRD data.

**System Replication** is used to configure a secondary system as an exact replica of the active primary system.

**Failback** is used to switch back to the original setup once the former primary site comes online.

**Takeover** makes the secondary system function as the new primary (used for a disaster or a planned downtime).

**nZDM Takeover** is used to minimize "planned" business downtime during a takeover to secondary system.

**nZDM maintenance** procedure can be used to minimize the business downtime during HANA/OS/Hardware upgrades for both primary and secondary sites.

**System Copy**
- PRD: SAP ERP, SAP HANA
- DEV: SAP ERP, SAP HANA
- QAS: SAP ERP, SAP HANA

**System Refresh**
- PRD: SAP ERP, SAP HANA
- QAS: Up-to-date, Outdated

**System Replication**
- Before: SAP ERP, Primary HANA
- After: SAP ERP, NEW Primary HANA

**Failback**
- Before: SAP ERP, Primary HANA
- After: SAP ERP, Secondary HANA

**Takeover**
- Before: SAP ERP, Primary SPS11
- After: SAP ERP, Secondary SPS12

**nZDM Takeover**
- Before: SAP ERP, Primary SPS11
- After: SAP ERP, Secondary SPS12

**nZDM maintenance**
- Before: SAP ERP, Primary SPS11
- After: SAP ERP, Secondary SPS12
Sizing
SAP HANA Memory Sizing & Memory Management

Memory sizing
- Is the process of estimating the amount of memory that will be required to run a certain workload on SAP HANA
- It depends on a lot of factors as well as the kind of application running on SAP HANA

There is no relationship between the amount of table data and used memory
- What is the size of data tables
- What is the expected compression ratio
- How much extra working memory will be required

SAP HANA prefers allocating “fresh” memory

Not all “on SAP HANA” products have a license cost based on memory consumption

Starting in SPS09, SAP HANA system measures “Used Memory” for SAP HANA license audit, rather than “Allocated Memory” (SAP Note 1704499)
Sizing Process with SAP HANA

Requirements
- Performance
- Business SLAs
- Business figures

Hardware Vendor
- Scalable HW offering
- Practical sizing Experience
- Different configurations
- Different technology partners

Sizing Recommendation
- CPU (SAPS)
- Memory (GB)
- Disk Space (GB)
- Component performance

Final Sizing
HW partner responsible
Sizing with SAP HANA installations

<table>
<thead>
<tr>
<th>Sizing Scenarios</th>
<th>Available Tools/Resources</th>
</tr>
</thead>
</table>
| Sizing New Applications “Initial Sizing”| 1. SAP QuickSizer tool  
2. SAP Note 1793345                                                                          |
| Migrating to SAP HANA Applications “Productive Sizing” | 1. Stand-alone HANA: SAP Note 1514966  
2. SAP Business Suite or Industry Solutions Powered by SAP HANA: SAP Note 1872170  
3. SAP NetWeaver BW Powered by SAP HANA: SAP Note 1736976 |
| Sidecar Scenarios Sizing               | 1. SAP HANA Enterprise Search: SAP Note 1872170  
2. CO-PA Accelerator: HANA Sizing for CO-PA Accelerator  
3. SAP Applications on HANA: SAP QuickSizer Tool |

1. Please check [SAP HANA Sizing Overview](#) for latest updates.
2. Consider [Sizing paper for SAP HANA](#)
3. General statement: “Prefer a scale-up before starting to scale-out to multiple boxes” ([SAP HANA Scalability document](#) ⇒ Chapter 4.5)
4. Special requirements for BW and Scale-Out: SAP note 1736976 ⇒ check attachments
Deployment Options
Supported Deployment Options for SAP HANA Virtualized

- Single VM: General Support for single SAP HANA virtual machine on a dedicated SAP HANA certified server in production.

- 1x HANA + other: General Support for single SAP HANA virtual machine on a dedicated SAP HANA certified server in production.

- Multi VM: General Support for multiple SAP HANA virtual machines on a single SAP HANA certified server in production.

- MCOS: General Support for multiple SAP HANA database installations on one System / OS in production.

- Scale-out: General Support for SAP HANA scale-out configurations in virtualized environment, either production or non-production.

- MCOS: General Support for multiple SAP HANA database installations on one System / OS in production.

* Windows guest OS currently not supported with Hitachi LPAR for SAP workloads.
** Access to SAP Note is restricted to participants of Controlled Availability.

SAP Note 1995460
SAP Note 2063057 **
SAP Note 2024433 **
SAP Note 1681092
SAP Note 1995460
SAP Note 2063057 **
SAP Note 2024433 **
SAP Note 1681092
SAP HANA and SAP NetWeaver AS ABAP deployed on one server is a multi-component, resource and cost optimized deployment approach.
SAP HANA and SAP NetWeaver AS ABAP deployed on one system is available since December 2013.

**Availability**
For all productive and non-productive SAP HANA SPS07 single node installations. All products based on SAP NetWeaver AS ABAP 7.4 or newer are supported.

**Requirements**
- Additive sizing: Additional memory resources for the SAP NetWeaver AS ABAP system needs to be available on the SAP HANA server. For more information, see memory sizing based on SAP Note 1953429 – SAP HANA and SAP NetWeaver AS ABAP on one Server
- Separate SID’s for both systems required

**SAP HANA software installation**
The exam “SAP Certified Technology Specialist – SAP HANA Installation” (E_HANAINS1xx) needs to be successfully passed for a person to perform SAP HANA software installations. For more information, see SAP Training and Certification Shop

**SAP NetWeaver JAVA Application Server**
SAP Note 2043509 – SAP HANA and SAP NetWeaver Java on a Single Host
Joined SAP HANA and SAP NetWeaver
High Availability setup based on System Replication
Currently, the only SAP supported virtualization solutions for running SAP HANA virtualized are

- VMware vSphere 5.1 and SAP HANA SPS 05 (or later releases) for non-production use cases.
- VMware vSphere 5.5 and SAP HANA SPS 07 (or later releases) for production and non-production use cases.
  - Support by SAP HANA for production use cases released for single VMs, MultiVMs and Scale-Out with VMs.
- VMware vSphere 6.0 and SAP HANA SPS 09 (or later releases) for use cases.
  - Support by SAP HANA for production use cases released for single VMs (MultiVMs and Scale-Out with VMs planned to follow).
- VMware vSphere 6.5 and SAP HANA SPS 12 (or later releases) for use cases.
  - Support by SAP HANA for production use cases released for single VMs (MultiVMs and Scale-Out with VMs planned to follow).
- Non-Production use cases: XEN with SAP HANA SPS 09 (or later releases)
- Non-Production use cases: KVM with SAP HANA SPS 09 (or later releases)

The following general conditions & constraints for running SAP HANA virtualized:

- Limited to 2 and 4 socket certified SAP HANA appliance hardware (large 8-socket appliances are not yet supported)
- CPU & memory overprovisioning must not be used
- SAP HANA installation was either done by an SAP HANA certified engineer on SAP HANA certified hardware and successfully verified with the SAP HANA hardware configuration check tool (SAP HANA Tailored Datacenter Integration option), or system had been delivered pre-configured as certified SAP HANA appliance, with hypervisor installed by SAP HANA hardware partner.

See SAP Note 1788665 – SAP HANA Support for Virtualized Environments
SAP has released SAP HANA on VMware vSphere 5.5 for general availability, allowing to go live with SAP HANA on VMware vSphere 5.5, provided the following conditions have been met:

- Single SAP HANA virtual machine on a dedicated 2 or 4-socket SAP HANA certified server (SAP Note 1995460)
- Multiple SAP HANA virtual machines on a single physical server (SAP Note 2024433)
  - Multiple VMs with HANA on one hardware is in general availability
  - SAP HANA multi-node / scale-out deployment configurations in general availability
  - No 8-socket hardware configurations
- SAP Business Warehouse (BW), powered by SAP HANA in a virtualized scale-out environment (SAP Note 2157587)
- Both, SAP HANA appliance and SAP HANA Tailored Datacenter Integration (TDI) delivery methods are supported for SAP HANA on VMware vSphere.
  - The maximum size of a virtual SAP HANA instance is limited by the maximum size of a virtual machine on VMware vSphere 5.5 release, which is 64 vCPUs and 1 TB of memory (limited by VMware, not SAP HANA).
  - No CPU and/or Memory overcommitting
  - VMware Vmotion (hot move) or VMware-HA are supported

See SAP HANA Guideline for Being Virtualized with VMware vSphere
http://www.saphana.com/docs/DOC-4192
SAP HANA Virtualized
Current Status Supported Hypervisors (overview SAP Note 1788665)

SAP HANA Platform
Supported Hypervisors

VMware 5.5 / 6.0 / 6.5
vSphere & ESXi

- Scale-out
  ✓/ -/ -
  General Availability
  for multiple SAP HANA
  virtual machines on
  multiple certified SAP
  HANA host server in
  production.
  SAP Note 2157587

- Single VM
  ✓/✓/✓
  General Availability
  for single SAP HANA
  virtual machine on a
  single certified SAP
  HANA host server in
  production.
  SAP Note 1995460
  SAP Note 2315348
  SAP Note 2393917

- Multi VM
  ✓/ -/ -
  General Availability
  for multiple SAP HANA
  virtual machines on a
  single certified SAP
  HANA host server in
  production.
  SAP Note 2024433

Hitachi LPAR

- Single/Multi VM
  ✓
  Controlled Availability
  for single or multiple
  SAP HANA virtual machines
  on a single certified
  SAP HANA host server in
  production.
  SAP Note 2063057
  SAP Note 2186187
  SAP Note 2230704

 Huawei FusionSphere

 IBM PowerVM

- Single/Multi VM
  Only Supported for Non-Prod
  Prospects are
  open source hypervisors
  like XEN and KVM.
  SAP Note 2284516

Other Hypervisors
SAP HANA virtualized
Technology Roadmap (from 2013 to 2016+)

- **Today**
  - **General Availability** for all use cases for SAP HANA on VMware vSphere 5.5 in production and non-production
  - **General Availability** for single node deployments of SAP HANA on VMware vSphere 6.0 and 6.5 in production and non-production
  - **Controlled Availability** for all use cases for SAP HANA on Huawei FusionSphere 5.1 in production and non-production
  - **Controlled Availability** for Hitachi LPAR (single and multiple partitions) in production and Huawei FusionSphere 3.1

- **On Roadmap**
  - Support for further scenarios
  - Support of further Hypervisors

This is the current state of planning and may be changed by SAP at any time.

(CA) Controlled Availability - (GA) General Availability - (BWoH) SAP business Warehouse, powered by SAP HANA
What use cases are a good fit for SAP HANA virtualized:

- During performance analysis the majority of tests stayed within 12% performance degradation compared to bare metal.
- However, there are around 100 low-level performance tests in the test suite exercising various HANA kernel components that exhibit a performance degradation of more than 12%.
- This indicates that there are particular scenarios which might not be suited for HANA on VMware.

Use Cases:
- **Mission Critical / High-Performance Scenarios**
  - Absolute Performance Testing (E2E elapse time)
  - Scale-out / HANA Host Auto-Failover
  - SAP Central System (Business Suite)

Use Cases:
- **Sandbox / Trial Systems / Development and Test Systems**
  - Relative Performance Tests (old vs. new version on VM)
  - High-Available / Disaster Recovery Tolerant System Setup

**Performance**

- **Performance Critical**
- **Users** > ~500 named users (Business Suite)
- **Technical** > 64 vCPU* > 1 TB memory*

**Financial**

- **VMs > 512 GB RAM*”**
- **Users** > ~500 named users (Business Suite)
- **Technical** > 64 vCPU* > 1 TB memory*

**Performance**

- **Non-Performance Critical**
- **Users** 1:1 (server : user)
- **Technical** ≤ 64 vCPU* ≤ 1 TB memory*

**Financial**

- **VMs ≤ 512 GB RAM*”**
- **Users** ≤ ~500 named users (Business Suite)
- **Technical** ≤ 64 vCPU* ≤ 1 TB memory*

* Relates to VMware vSphere 5.5 release
The VMware vSphere 5.5 support for SAP HANA in production also covers the following VMware vSphere products / capabilities:

- Use of VMware HA to protect operating system or vSphere host hardware failures
- SAP HANA System Replication or Storage based replication plus VMware SRM to provide disaster protection
- The use of VMware vMotion in conjunction with DRS rules
- The use of additional non-SAP HANA VMs on SAP HANA server
- Use of snapshots and cloning capabilities
SAP HANA Virtualization & Multi-tenancy Options
Horizontal View

One Schema per DB
One or more SAP HANA Databases

Multiple Schemas
One SAP HANA Database
(whitelisted scenarios)

Multiple SAP HANA instances on one SAP HANA virtualized HW appliance
(e.g., VMware)

Multiple tenant databases One HANA Instance

See Notes 1661202
See SAP Note 1788665

SAP Note 1681092 for MCOS approval with HANA SPS09

See SAP Note 2096000

SAP Note 1681092

See Notes 1661202
+ 1826100
SAP HANA Multitenant Database Containers
Overview

System Database
- System-wide parameter settings
- Complete backup of all databases
- Static resource management across all databases (CPU, memory, disk for specific database)

Tenant Database
- Multiple strictly separated database tenants on one HANA system
- Tenant specific life cycle management including backup/restore
- Clear separation of application data and user management
- Local user management within each tenant-DB
- Session and transaction management per tenant-DB
- Move/copy of tenant-DBs to other systems/hosts
SAP HANA Multitenant Database Containers

Overview

SAP HANA multi-tenant database containers (MDC)
Support for multiple tenant containers within a single system database

Initial focus on the following scenarios:
- SAP HANA Cloud Platform
- SAP HANA Enterprise Cloud
- Replace most MCOS deployments (Multiple Components One System)
- Address common MCOD scenarios (e.g. ERP-CRM-BW, QA/DEV, Data Marts)
- Cross scenario support: Fast federation between tenant databases (read only with SPS09)
- Typically scenarios with a database with ‘relatively’ small number of tenants
  - i.e. Typically for ~10s of tenants vs. 1000s of tenant databases
A SAP HANA multitenant database containers system has one SID and one HANA software version

- Shared installation of database system software
- Tenant databases are identified by name or port
- Additive sizing for all tenant database

Strong isolation features, each tenant database has its own:

- Database admin and end users, database catalog, repository, persistence, backups, traces and logs
- Tenant database related parameter settings
- Tenants memory sizing and CPU consumption can be configured independently
- Clear separation of application data and user management
- One HA/DR setting for a SAP HANA system: all tenants are included in a HA/DR scenario

Integration with SAP HANA data center operation procedures, housekeeping, backups, etc.

SAP Note 2096000 for further information (released with SPS09)
Multitenant Database Containers vs. Virtualization

Multitenant Database Containers
- Lower TCO, single software stack
- Central configuration & administration (database level)
- Direct database resource management
- Optimized federation (performance benefits)
- Performance advantages (no virtualization overhead)
- Licensed via SAP HANA

Virtualization
- Strong isolation
- Separate SAP HANA revisions option
- Standard federation (SDA)
- Additional virtualization license (e.g. VMWARE)
Tenant databases can spread over multiple nodes (hosts) in scale-out systems.

**Example:**
If host 2 goes down, the standby host becomes active. The tenant DBs normally running on host 2 will become active on the standby host.
Preparation

SAP HANA version providing the MDC features (>=SPS09).

Remove or migrate the statistics server according to documentation

Shutdown the system: `HDB stop`

Conversion

Command: `hdbnsutil -convertToMultiDB` results in:
- Setting the "multidb mode" flag in configurations
- Creating the System DB
- Converting the original single DB to a tenant DB with name `<SID>`
- Updates the Secure Store

With initial `HDB start`, only the SystemDB will start up.

Connect to the SystemDB either with `hdbsql -d SystemDB` (recommended) or via SQL Port 3xx13

Start the new tenant database:

```
ALTER SYSTEM START DATABASE <SID>
```

Traces and configurations for any tenant DB are now stored in a respective subfolder DB_<dbname>.

**Note:** Recovery into Multi-tenant Database Containers (MDC) systems is only possible with a backup of a tenant out of another MDC. If the source of the backup is not yet an MDC system, follow the migration steps described in this slide first.

With HANA SPS12 it is planned that hdb1cvm can support you in the process.
SAP HANA Multitenant Database Containers
Roadmap – Detailed

Today

Continuous Improvement
- Ensure maximum robustness
- Further application adoption
- Cloud operations
- Easy/fast copy and move of tenant databases (command line version)
- Tenant awareness in hdbuserstore

GUI support for MDC
- Continuous extension of SAP HANA Cockpit

Cross-database access
- Auditing for cross-database queries
- Workload class mapping for cross-database queries

Planned Innovations

Backup & Recovery
- Recover single db (class. setup) backup to tenant database
- BACKINT support for tenant copy

Migration Support/Rolling Upgrade
- Convert an active single db HSR setup into an MDC setup

Administration/UI Support
- Tenant backup via system db with HANA Cockpit
- Tenant recovery via system db with HANA Cockpit
- Optimized copy/move for trusted environments (no need for certificates)

Miscellaneous
- SQL commands for kill/restart tenant

Future Direction

Multi-Tenant Database Containers to become default setting for new installations
Manage landscapes/Cloud operations
- GUI support copy and move of tenant databases
- Flexible tenant provisioning, renaming
- Leverage single db to tenant moves (B&R, HSR)
- Enhanced operations for configuration, alerts, AFLs
- Tenant isolation down the stack: OS, I/O, encryption
- BACKINT support for tenant copy
- HA/DR: Option for tenant wise system replication

Cross-database access
- Extend functionality and supportability (RPC, ...)

Resource Management
- Advanced functionality for dynamic workload management at tenant DB level
- Easier, comprehensive administration

Extend admin UI support
- SAP HANA Cockpit, SAP DBCC

License management
- Individual tenant licenses

Lean tenant DB
- Reduce memory footprint as much as possible

SAP HANA SPS12

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

This is the current state of planning and may be changed by SAP at any time.
Manage your system landscape efficiently and respond flexibly to changing resource requirements

- Uses SAP HANA system replication mechanisms
- Copy and moved securely and conveniently with near-zero downtime

1. The tenant database **is copied** with all of its data to a newly created tenant database.
What’s New in SAP HANA SPS12: Multitenant Database Containers
Copying and Moving Tenant Databases Between Systems

Manage your system landscape efficiently and respond flexibly to changing resource requirements
- Uses SAP HANA system replication mechanisms
- Copy and moved securely and conveniently with near-zero downtime

1. First the tenant database is copied with all of its data to a newly created tenant database in a target system.
2. Once all data has been successfully transferred, the new tenant database is started as a separate, independent database.
What’s New in SAP HANA SPS12: Multitenant Database Containers
Copying and Moving Tenant Databases Between Systems

Manage your system landscape efficiently and respond flexibly to changing resource requirements

• Uses SAP HANA system replication mechanisms
• Copy and moved securely and conveniently with near-zero downtime

1. First the tenant database is copied with all of its data to a newly created tenant database in a target system.

2. Once all data has been successfully transferred, the new tenant database is started as a separate, independent database.

3. Moving a tenant to another system, the original tenant is deleted after takeover completion.
Influence dynamic resource consumption at the session or statement level

- It is possible to classify workloads based on user and application context information.
- Workload classes also work in a multiple container system and need to be defined for each tenant database.
- The cross-database query is executed based on the workload management settings of the tenant database.
- The workload classes from the remote database limits the cross-database query in the remote tenant database.
- If multiple remote tenant databases are involved in the query execution, then different limitations may apply.

SELECT * FROM SAPR3.TRANSACTIONS

ALTER USER ERP_user ADD REMOTE IDENTITY BW_user AT DATABASE BW;

GRANT SELECT ON SAPR3.TRANSACTIONS TO ERP_user

Workload Class of ERP_user applies
What’s New in SAP HANA SPS12: Usability enhancements for MDC

Convert single container to multiple database containers (I)

Converting a single container system to an MDC system has been available since SPS 09, but it required several manual steps and wasn’t available from a UI. Now, the steps have been integrated in HDBLCM, in all three of the user interfaces:

- Command-line interface (hdblcm)
- Graphical user interface (hdblcmgui)
- Web UI
During the conversion process, the system database and one tenant database are created. The tenant database contains all the data of the original system, including users, system configuration, and connection properties (port configuration). However, it does not contain the backup history and the system license.

After conversion, you can create and configure further tenant databases as needed.
SAP Cloud Powered by SAP HANA
SAP Cloud powered by SAP HANA
Complementary offerings

“I want to run my enterprise applications in the cloud to…”

SAP HANA
Enterprise Cloud
SAP Business Suite powered by SAP HANA
SAP BW

“I want to build or extend an application without procuring separate tools or infrastructure…”

SAP HANA
Cloud Platform
Developer Tools & Services
UX
Analytics & Social
Integration
HANA DB & Infrastructure

“I want to leverage <3rd Party IaaS> global and mature IaaS for SAP and 3rd-Party products…”

SAP HANA on 3rd Party IaaS
IaaS for everything
∞ scalability
100% coverage
Openness
Best-in-class self-service

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
SAP HANA in public 3rdparty IaaS Cloud
New cloud providers, new options

SAP HANA in certified 3rd Party Cloud

- SAP HANA BYOL on public IaaS
  - Huawei: Single node + Scale-out up to 7 nodes, OLAP only
  - AWS: OLTP and OLAP, Single node + Scale-out up to 17 nodes if sizing permits, see SAP note 1964437
  - Subscription to 3rd party infrastructure, Bring-Your-Own-License (BYOL) for SAP HANA (+ BW, Suite…)

- SAP HANA Developer Edition
  - For product evaluations, trials, students, data exploration projects, etc.
  - Software is free, Community supported through http://saphana.com/cloud

- SAP HANA One
  - Subscription to infrastructure and HANA license
  - Non-production and production usage, up to 244 GB
  - With community support according SAP Note 1798212

* SAP HANA IaaS Certification: mandatory business-case driven process with global reach
Enterprise-class cloud offering for

- mission critical
- global 24 x 7 operation
- cloud elasticity
  - Global Availability (4 data centers in US and Europe, 2 more planned in APJ)
  - Custom data center arrangements for compliance
  - Advanced business continuity and support

- Standards based cloud operation
- Monthly External Penetration Tests

Open for any data footprint

- Any valid SAP HANA T-shirt size

Full SAP support through OSS
SAP HANA Cloud Platform
Value Add

The power of SAP HANA

The flexibility of the CLOUD

= The platform you need to build, extend, and run next-generation applications today
SAP HANA Cloud Platform
Capabilities and Services

### SAP HANA Cloud Platform (PaaS)

#### App Center

<table>
<thead>
<tr>
<th>Business Services</th>
<th>Platform Services</th>
<th>Data &amp; Storage Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commerce(^1)</td>
<td>Integration</td>
<td>ASE</td>
</tr>
<tr>
<td>Loyalty Mgmt(^2)</td>
<td>IoT</td>
<td>Redis(^2)</td>
</tr>
<tr>
<td>Billing(^2)</td>
<td>Security</td>
<td>Big Data Services:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HANA / Vora(^2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hadoop(^2)</td>
</tr>
</tbody>
</table>

#### IaaS

- OpenStack\(^2\)
- SAP Data Centers & Virtual Machines
- Partner Data Centers\(^2\)
- Customer Data Centers\(^2\)

#### On-Premise / Managed Cloud

- SAP S/4 HANA
- SAP Business Suite
- SAP Business Warehouse

#### SaaS

- SAP S/4 HANA
- SuccessFactors
- C4C
- Ariba
- Concur
- Business One
- Fieldglass
- SAP ByDesign

---

1) beta functionality, 2) planned innovations / future direction
Best Practice - Use Cases:

- ideal if you have existing data or process integration tools available yet
  - use existing know-how and infrastructure, connect to cloud systems similar as to On-Premise
  - no additional license required
- Remark: might be sensitive to network conditions
SAP HANA Cloud Platform
Overview integration options

integration with HCP

- point-to-point integration (Cloud Connector)
- process integration
  - On Premise SAP Process Integration
  - Cloud Service: HANA Cloud Integration (Process Integration)
- data integration
  - File Upload (csv)
  - On Premise Data Integration tools
  - Cloud Service: HANA Cloud Integration (Data Services)
    - Data Synchronization (IoT)
      - Trigger-based
      - ETL, Batch
      - Event Streams
## SAP HANA Deployment Options
### Roadmap

<table>
<thead>
<tr>
<th>Today</th>
<th>Planned Innovations</th>
<th>Future Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td><strong>General</strong></td>
<td><strong>General</strong></td>
</tr>
<tr>
<td><strong>Multi-tenant Database Containers</strong></td>
<td><strong>Multi-tenant Database Containers</strong></td>
<td><strong>Multi-tenant Database Containers</strong></td>
</tr>
<tr>
<td>• Copy/Move tenants with SAP HANA System Replication like technology</td>
<td>• Recover single database backup to tenant database</td>
<td>• More management function for crowds of tenants</td>
</tr>
<tr>
<td>• Improved Resource Management</td>
<td>• Ability to recover non-MDC backups into tenant systems</td>
<td>• Backint support for tenant copies/clones</td>
</tr>
<tr>
<td><strong>Virtualization</strong></td>
<td><strong>Virtualization</strong></td>
<td><strong>Virtualization</strong></td>
</tr>
<tr>
<td>• vSphere 6.0 for SAP HANA production</td>
<td>• vSphere 6.0 &amp; 6.5 for SAP HANA production</td>
<td>• KVM, Xen, etc. for SAP HANA production use</td>
</tr>
<tr>
<td>o SingleVM Support</td>
<td>o MultiVM, Scale-Out Support</td>
<td>• 8-socket HW solutions</td>
</tr>
<tr>
<td><strong>Cloud</strong></td>
<td><strong>Cloud</strong></td>
<td><strong>Cloud</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• SAP Vora/Hadoop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cloud Foundry (Open Stack)</td>
</tr>
</tbody>
</table>

*This is the current state of planning and may be changed by SAP at any time.*
Migrations to SAP HANA
The Path to BW powered by HANA

1. Start: BW with any DB
2. Preparation: Fulfill HANA-DB Prerequisites
   - SAP BW Release Upgrade: min. Release BW 7.30 SP5
   - Release Upgrade for additional components (e.g. SEM-BCS)?
   - Single Stack Separation: Separate ABAP and JAVA
   - Check Modifications
   - Convert Unicode
   - JAVA Upgrade
   - Migrate Authorizations to 7.x-Concept
   - Link BW-Cookbook
3. Proposed: Consider Additional Aspects
4. Target: BW powered by HANA
   a) Sizing of required HANA DB incl. HW/ SW investment
   b) Definition of future System Landscape (incl. DR/ HA – Single Node/ Scale Out)
   c) Housekeeping: Reduction of to be migrated data volume
   d) Data Aging Concept
   e) Optimize Data Models & Check Native HANA Data Models
   f) Check New Frontends (incl. UI5, Fiori, Design Studio, Analysis Office, Mobility)
   g) Complete HANA Strategy (BW = EDW, Operational Reporting, Suite on HANA, HANA Live, Fiori, UI5, …)
5. Future: Potentials from BW p.b. HANA using

SAP BW 3.x/7.x

any DB

BWA

HANA

SAP BW 7.40 SP6+
The Path to ERP powered by HANA

1. Start: ERP with any DB
   
   SAP ERP 6.x
   
   any DB

2. Preparation: Fulfill HANA-DB Prerequisites
   
   - Sizing (SAP Note 1872170)
   - Data Center: Architecture
   - Archiving: Evaluate potential of data archiving
   - Stack Separation: Separate ABAP and JAVA Stack
   - Unicode: Unicode Conversion required
   - Add-Ons: Verify add-on compatibility (SAP Notes 1760306, 1855666)
   - Released Scenarios: Verify released scenarios (SAP Note 1768031)
   - Functional Correctness (SAP Note 1935918)

3. Proposed: Consider Additional Aspects
   
   - Improved Business Processes: Evaluate usage of improved standard transaction (SAP Note 1761546) as well as Industry specific improvements
   - Operational Reporting: Leverage SAP HANA Live Content as the basis for real-time operational reporting
   - Custom Code Optimization: Monitor your system using SQLM / User Procedure Logging or Individual Traces
   - Fiori: Improve End-User Experience by implementing SAP Fiori
   - Simplify: Reduce complexity & interfaces by eliminating existing apps and dbs by moving them to SAP HANA
   - Search: Evaluate usage of Google-Like Search Capabilities

4. Target: ERP powered by HANA
   
   SAP ERP 6.7
   
   HANA

5. Future: Potentials from ERP p.b. HANA using
   
   - Business Re-Engineering: Redefine existing business processes
   - New Business Models: Establish new business models using ERP on HANA
SAP S/4HANA
The 3 transition scenarios

- **Example**: New or existing SAP customer implementing a new SAP S/4HANA system with initial data load

- **Example**: Complete conversion of an existing SAP Business Suite system to SAP S/4HANA

- **Example**: Consolidation of current regional SAP Business Suite landscape into one global SAP S/4HANA system or selective data migration
SAP S/4HANA System Conversion

Scenario description
Customers who want to change their current system into a SAP S/4HANA system. Database, SAP NetWeaver and application transition in one step.

Benefits
+ Migration without reimplementation
+ No disruption for existing business processes
+ Re-evaluation of customization and existing process flows

What | How
---|---
Installation and migration | Rapid Database Migration of SAP Business Suite to SAP S/4HANA (all one step migration, including SAP S/4HANA Finance and SAP S/4HANA Logistics conversion) using SUM with DMO
The road to SAP S/4HANA

- SAP S/4HANA Finance, on-premise edition is the first offering under the SAP S/4HANA product family
- The decision to go for SAP S/4HANA Finance, on-premise edition should be based on the **business benefits** but is not a mandatory **prerequisite** for any system conversion

Start Release

- SAP ERP (lower releases or non-unicode)
- AnyDB or SAP HANA

Start Release

- SAP ERP 6.0, EHP 0-8
- SAP NetWeaver 7.0x
- AnyDB or SAP HANA

SAP S/4HANA Finance, on-premise edition

SAP ERP 6.0, EHP7/8

SAP HANA

SAP S/4HANA, on-premise edition 1511

SAP S/4HANA Enterprise Management

SAP HANA

⇒ S/4HANA SCN Blog:
http://scn.sap.com/docs/DOC-68976
SAP HANA Release Strategy
SAP HANA Release Strategy
Retrieve incremental, but non-disruptive SAP HANA innovation

Updates shipped for SAP HANA are **strictly downward compatible**. Incompatible changes may be considered due to legal or security reasons, but follow a strict exception approval process (*Time-less Software*).

These Updates are shipped with **SAP HANA Support Package Stacks** (SPS), delivered from within one delivery stream and without additional ramp-up. SPS are planned to be released twice per year.

The SAP HANA product **stays in mainstream maintenance** as long as application releases that are built on top SAP HANA are in mainstream maintenance, extended maintenance, or priority-one support (e.g. Release note 74.xx [1935871]).

---

![Diagram showing SPS updates](image)

**Updates are cumulative and strictly downward compatible**
SAP HANA Release Strategy
Understand the Differences in SAP HANA Revisions

SAP HANA Support Package (SP) Revisions
Represents the individual software corrections and updates available for SAP HANA. Revisions are cumulative and strictly downward compatible.

SAP HANA Maintenance Revisions
Contain only major bug fixes found in key SAP HANA scenarios. The provisioning of new maintenance revisions ends with availability of SAP HANA production system verified revision, approx. 3 months after release of a successor SPS. From this date, customers must adopt the regular SP revisions to receive further fixes (see SAP Note 1948334).
SAP HANA Release Strategy
Adapt new SAP HANA releases at your own speed

Customers may choose to maintain their SAP HANA system either with the latest SAP HANA SP revision or to stay temporarily on the SAP HANA Maintenance revisions stream.

**SAP HANA Datacenter Service Point**
Outlines certain revisions which have been running in production enterprise applications at SAP before they are released to customers. Those revisions are planned approx. 3 months after release of the latest SPS and are intended to allow better planning of maintenance windows for production environments running on SAP HANA.

For all other customers, early birds and pilots who do not run SAP HANA in productive usage, SAP propose an immediate switch to a new SPS by implementing the regular **SAP HANA SP Revisions** as soon as they are released. This will allow to benefit from incremental, but non-disruptive innovation, provided by the latest SAP HANA features and fixes.

---

**Recommended path for production systems bug fixing, using SAP HANA Maintenance Revisions**

SAP HANA Revisions 96-97

<table>
<thead>
<tr>
<th>SPS 10</th>
<th>100</th>
<th>101</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.xx</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPS 11</th>
<th>110</th>
<th>111</th>
<th>112</th>
</tr>
</thead>
<tbody>
<tr>
<td>102.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102.xx</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Datacenter Service Point (DSP)
SAP HANA Release Strategy
Expect stability and predictability for your SAP HANA maintenance

The newly introduced SAP HANA Datacenter Service Point (DSP) provides SAP HANA customers with more guidance when and based on which SAP HANA Revision to plan their SAP HANA maintenance stack on.

As most customers have to plan their maintenance window between their quarterly end closings, the DC service point had been defined to be between the SAP HANA SPS, at the end of March and at the end of September.

As prove of SAP’s commitment in its own software quality, the Revisions referenced by such DC service point will also be running in production enterprise applications at SAP for at least one week before they are finally released, assuring customers even more stability and predictability.

Recommended path for production systems planned maintenance, leveraging the SAP HANA Datacenter Service Points
New capabilities are introduced twice a year, every time a new SAP HANA Support Package Stack (SPS) is released.

- This happens normally in December and June
- Datacenter Service Point is declared about 3 month after RTC, normally in March and September
- Previous SPS are running out of maintenance once the DSP of the next SPS is declared
- Critical bug fixes and security patches are provided as SAP HANA revisions for all HANA SPS that are still in maintenance

We recommend that maintenance timelines and project go live dates are adjusted to this release schedule

See SAP Note 2021789 for further details. FAQ document
Customers running mission critical systems demand a longer provisioning of Maintenance Revisions

For SAP HANA SPS12:

- SAP will provide Maintenance Revisions for a period of 3 years after SPS12 RTC
- There will be regular upgrade paths from SPS12 to any newer SPS

See SAP Note 2021789 for further details.
# SAP HANA Revision and Maintenance Strategy

## Summary

<table>
<thead>
<tr>
<th>Revision Type</th>
<th>Schedule</th>
<th>Comprises of</th>
<th>Recommended to</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTC Revision</td>
<td>Every 6 months</td>
<td>New features and fixes</td>
<td>Early adopters and Non-production systems</td>
</tr>
<tr>
<td>(e.g. Rev. 100, 110,…)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Revision</td>
<td>On demand</td>
<td>Incremental fixes, based on latest SPS feature set</td>
<td>Early adopters and Non-production systems</td>
</tr>
<tr>
<td>(e.g. Rev. 101,111,…)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSP Revision</td>
<td>Every 6 months, after having run in SAP production system</td>
<td>Incremental fixes, based on latest SPS feature set</td>
<td>Production systems (targeting planned maintenance)</td>
</tr>
<tr>
<td>(e.g. Rev. 102, 112,…)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Revision</td>
<td>On demand, As of SPS10: provided after DSP for the current SPS</td>
<td>Incremental critical fixes only</td>
<td>Production systems, (targeting planned and unplanned maintenance)</td>
</tr>
<tr>
<td>(e.g. 102.05,112.01,…)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SAP HANA Revisions:**

- 110
- 111
- 112
- 120
- 121 ...

**Datacenter Service Point (DSP):**

- 112.01
- 112.02
- 112.xx

**Zero Downtime Maintenance**

**SAP HANA Revision Update**

**RTC:** Release for Customer | **DSP:** Datacenter Service Point | **SPS:** Support Package Stack
SAP HANA Capture & Replay

Project “Doppelgänger”
What is SAP HANA Capture & Replay?
Current Features & Product Benefits

Features
- Capture real system workload in productive environments
- Pre-process & replay captured workload on target systems
- Analyze runtimes and compare performance between system setups

Benefits
- Provides competitive replay, analysis and tuning capabilities for SAP HANA Database
- Helps ensure that landscape changes do not degrade system performance
- Enables real simulation of workload without the use of other 3rd party tools
- Reduces manual effort for testing changes in customer deployments
When should SAP HANA Capture & Replay be used?

Common Scenarios

Use Case

- Stability Checks
- Hardware Changes
- Software Updates
- .ini File Changes
- Performance Checks
- Table Distribution Changes
- Index Changes
- Partitioning Changes
### When should SAP HANA Capture & Replay be used?

#### Common Scenarios

<table>
<thead>
<tr>
<th><strong>Hardware / Software / .ini File</strong></th>
<th><strong>Distribution / Partition / Index</strong></th>
<th><strong>Stability / Performance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Include downtime of systems for upgrade, installation or restart</td>
<td>➢ Might require longer periods of time when re-distributing tables or re-partitioning of large tables</td>
<td>➢ Mandatory process for many customers</td>
</tr>
<tr>
<td>➢ Can be more or less complex depending on customer landscape</td>
<td>➢ Load generated on productive system can be quite large</td>
<td>➢ Can have substantial effects on migration/upgrade strategy</td>
</tr>
<tr>
<td>➢ Can have side effects in specific scenarios that might require further analysis</td>
<td>➢ Testing of different configurations might require high manual effort</td>
<td>➢ Beneficial for different areas such as operations, administration and development</td>
</tr>
</tbody>
</table>
How does **SAP HANA Capture & Replay** work?
How does SAP HANA Capture & Replay work?
Current Pain Points for Customers

Current Pain Points:
- Inaccurate simulation
- High manual effort for customer
- High cost for 3rd party software

Capture Files
- Capture of all incoming SQL statements

Initialization of test system

Replay Files
- Reformatting & reordering of all SQL statements

Connection via SQLDBC
- Workload is replayed in almost same execution order, with identical concurrency and load distribution

SAP HANA
Revision XXX

Clients

App Servers

SAP HANA
Revision YYY

Test System

Production System

Current Simulation Tools

Replay Service

App Servers
How does SAP HANA Capture & Replay work?
What do we capture?

Limitations
- liveCache, XSEngine Classic (http calls going to the Indexserver via TrexNet) and Native For All Entries operations are not captured.
- Internal operations (EmbeddedStatServer, MergeDog, etc.) are not captured.
How does SAP HANA Capture & Replay work?
Why do we need pre-processing?

- Capture Files
  - Optimized to reduce overhead when capturing, especially in regard to file size
  - Star-schema-like data representation
  - Multi-level in-memory compression added to files
  - Collected for each service process running on HANA database

- Pre-processing
  - Reformat data representation to optimize for Replay Service's incremental loading of workload
  - Examine logical session boundaries in scale-out environments (i.e. statement routing)
  - Reorder workloads on session-base
  - Gather information on size, context and timing for Replay Service

- Replay Files
  - Session-based directory structure
  - Ordered by execution timestamp of statements
  - Flat file format, no compression added, can become quite large depending on amount of captured data
What features does SAP HANA Capture & Replay currently offer?
What features does SAP HANA Capture & Replay currently offer?

Full Integration with HANA Cockpit

- Project "Doppelgänger" is fully integrated with HANA Cockpit
- The tile set includes one tile for capturing workload and one tile for pre-processing and replaying workload on a target system
- Tiles provide overall status information
What features does SAP HANA Capture & Replay currently offer?

Capturing Workload

- New captures can be configured via the Fiori-based UI
- Captures can be defined for full system or based on several filters such as Database User, Statement Types, Application Name, Application User Name or Schema Name
- Detailed information is provided for each capture during the process
- Capturing process can be monitored via UI
What features does SAP HANA Capture & Replay currently offer?

**Pre-Processing Workload**

- Pre-processing can be triggered via the Fiori-based UI
- All Capture Files from one system can be selected for pre-processing
- Detailed information is provided for each pre-processed capture after completion
- Replay can be triggered from details
What features does SAP HANA Capture & Replay currently offer?

Replaying Workload

- Replay can be triggered from pre-processing details or Replay List
- Replay Service information and Target Instance information need to be provided
- Detailed report for runtime analysis is available after replay
- Replay can be monitored from UI
What is the current roadmap for SAP HANA Capture & Replay?

Current & Future Innovations

**Basic functionality**
- Capturing, preprocessing, and replaying of workload
- Filtering and scheduling
- Replay rate control
- Per-query execution time comparison

**HANA Cockpit integration**
- Fiori-based UI
- Separate Delivery Unit deployment

**Advanced features**
- Overhead minimization in capture, preprocess, and replay
- Sophisticated workload manipulation
- Additional reporting information (i.e. lock/wait times)
- Improved monitoring capabilities for capture and replay

**Integration with SAP HANA performance management tools**
- Integration with Workload Analyzer
- Integration with SQL Plan Analyzer

**Advanced features**
- Fully Transaction-consistent replay
- Per-query result comparison and validation
- Flexible comparison of captured workloads

**Stress testing**
- Workload generation (i.e. additional users)
- 3rd party tool integration (i.e. script language support)

**Integration with SAP HANA performance management tools**
- Workload tuning suggestions
- SQL plan tuning suggestions

This is the current state of planning and may be changed by SAP at any time.
Data Temperature
Archiving
Application manages movement of data into some kind of archive (Suite ILM, BW NLS, …)

But: do you really want to archive, or is it just a strategy for cost-evasion?

Memory Eviction
Unload “not so important” data from main memory
- Active/non-active data (BW)
- Page-loadable columns (Suite)

Process requires loading data into RAM
- Caching etc. lead to reduced but non-negligible memory footprint

Tiered Data Storage
Offer data stores of different “priorities”
- E.g. dynamic tiering
- Future: also Hadoop?

Beginning of a journey
- Enterprise readiness
- Concept for data distribution, management, retrieval
SAP HANA Platform
Data Temperature current concepts

Tier 0 (Memory)
- S/4HANA Suite on HANA

Tier 1 (SAN, NAS)
- Tier 1 (SAN, NAS)

Tier 2 (Tape, Hadoop, …)
- Tier 2 (Tape, Hadoop, …)

Applications
- S/4HANA
- BWoH
- Datamart

Storage Tier (Costs and Performance)

1. Data Archiving
   - Fulfill legal requirements

2. Data Aging
   - Unload data from memory which is accessed less frequently; controlled by the application

3. Near-Line Storage (NLS)
   - Move BW data (Cubes, DSOs) to Near-line Storage

4. Dynamic Tiering (DT)
   - Move data to Extended Storage
   - Use Data Lifecycle Manager (DLM) to automate and schedule data movement between data stores

5. Hadoop (Spark)
   - Move data to Hadoop using DLM
Introducing SAP HANA Dynamic Tiering for SAP BW

- **Hot**: HANA column store
  - In DB
  - In memory
  - No restrictions, all features available

- **Warm**: Non-Active Data Concept / Disk store of dynamic tiering
  - In DB
  - On disk
  - No restrictions, all features available

- **Cold (NLS)**: Near-line Storage
  - External to DB
  - Near-line Storage
  - Read access, no updates

- **Archive**: Traditional Archive
  - External to DB
  - Archive storage
  - No read access or updates

Performance and Price

Priority and Data Volume

This is the current state of planning and may be changed by SAP at any time.
Introducing SAP HANA Dynamic Tiering

- Ability to manage data according to its value - not all data needs to be accessed in true real time
- SAP HANA database now comprised of a memory-based hot store and a disk-based warm store
- Two table definition types: HANA table (hot data) and HANA extended table (warm data)
- Push down query processing
- SQL and Calculation View support
- Use Cases:
  - Maintain current, more frequently accessed data in hot store, and historical data in warm store
  - Handle Big Data use cases where data volume prohibits an all in-memory solution
  - Also supported with BW 7.4 SP8
- Initially not supported natively by SAP Business Suite
- Does not replace BW NLS and SoH ILM archiving (cold)

This is the current state of planning and may be changed by SAP at any time.
**SAP HANA Platform**

Dynamic Tiering – Map data priorities to data management

---

**BW on HANA**

Data for dynamic tiering stores

- **Hot Store**
  - All tables with no specific location

- **Warm Store**
  - PSA tables
  - wo-DSO tables
  - Available starting HANA SPS 09 and BW 7.40 SP8

---

© 2016 SAP SE or an SAP affiliate company. All rights reserved.

This is the current state of planning and may be changed by SAP at any time.
Object Classification in BW
Data Sources and write-optimized DSOs can have the property “Extended Table”
• Generated Tables are of type “Extended”
• All BW standard operations supported – no changes
• Only minor temporary RAM required in HANA InfoCubes and Regular or Advanced DSOs
• Generate standard column table
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

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.

This is the current state of planning and may be changed by SAP at any time.
SAP HANA Platform
Possible HW layout for Dynamic Tiering with SAP BW

Failover Group default

SAP HANA

Failover Group extended_storage

Node 1  Node 2  Node 3  Node 4

Hot data (Loaded)

Dynamic Tiering (Extended Storage)

Node 5  Node 6

Warm data (Cashed)

Warm Data

Data for persistence & recovery

data& log  data& log  data& log

data_es & log_es
SAP HANA Platform
Roadmap SAP HANA dynamic tiering

**Today**

**Technical integration**
- Common Installation and Administration Tooling
- Support for phased updates

**Enterprise DB features**
- Consistent file-based database backup
- Point-in-time recovery
- Supporting Intel and IBM Power platforms

**Planned Innovations**

**Enterprise DB features**
- Co-Deployment of HANA+DT on single host

**Future Direction**

**Technical integration**
- Extended support for MDC setups

**Enterprise DB features**
- Delta Backups for dynamic tiering
- Basic HANA system replication for dynamic tiering
- Data volume encryption for dynamic tiering
- Support for storage snapshots
- Improved 3rd party backup tool support
- Extended support in dynamic tiering for capabilities of HANA System Replication
- Further encryption features for dynamic tiering

SAP HANA SPS12

This is the current state of planning and may be changed by SAP at any time.
SAP HANA Platform
Future Direction: Multi-Store Tables

1. Single HANA table that spans hot and warm stores
2. Hot partitions in HANA memory; remaining partitions in warm store
3. Automatic, rules-based, asynchronous data movement between hot and warm stores

Diagram:
- Hybrid Extended Table
  - Current: Hot data in HANA tier
  - Historical: Warm data in warm tier
  - Regulatory audit
  - Aging
SAP HANA in Data Centers:
Agenda

- Introduction & Overview
- Design & Setup
- Persistence
  - Backup & Recovery (System Copy)
  - High Availability
  - Disaster Recovery
  - Monitoring & Administration
- Security & Auditing
SAP HANA Persistence:
In-Memory Data Is RegularlySaved to Disk

Data:
- SQL data and undo log information
- Additional HANA information, such as modeling data
- Kept in-memory to ensure maximum performance
- Write process is asynchronously

Log:
- Information about data changes (redo log)
- Directly saved to persistent storage when transaction is committed (synchronous)
- Cyclical overwrite (only after backup)

Savepoint:
- Changed data and undo log is written from memory to persistent storage
- Automatic
- At least every 5 minutes (customizable)
Distributed HANA database even on a single host with shared nothing concept
In-memory computing is secure

The SAP in-memory database holds the bulk of its data in memory for maximum performance, but still uses persistent storage to provide a fallback in case of failure. The log is capturing all changes by database transactions (redo logs).

Data and undo log information (part of data) are automatically saved to disk at regular savepoints.

The log is also saved to disk continuously and synchronously after each COMMIT of a database transaction (waiting for end of disk write operation).

After a power failure, the database can be restarted like a disk-based database:

- System is normally restarted („lazy“ reloading of tables to keep the restart time short)
- System returns to its last consistent state (by replaying the redo log since the last savepoint)
1. **Open Persistence files (Data Volume, Log Volume)**
   - This and following steps are executed per HANA service individually
   - Converter is loaded from the last successful Savepoint

2. **Load RowStore**
   - Execution time depends a lot on size. Creation of secondary indexes happens decoupled after Restart (after 5.)
   - For HANA persistence RowStore is similar to a BLOB and finally opened logically on engine level

3. **Initialize Hybrid LOBs (can be millions especially with SoH)**
   - LOBs bigger than 1 Kbyte are usually extracted to HANA data volumes and organized via pointers as soon as this database was created since SPS07. Every ABAP text data type "string" is translated into a LOB on the database level. This produces effort to initialize this huge number of small LOBs during startup. With native applications you could try of utilize more data types next to LOB-like structures (varchar).

4. **Get open transactions to follow up on (Data Volumes)**
   - Rollback information is located on Data Volumes, not Log Volumes (allows a consistent database recovery only with the help of a HANA data backup)
   - Roll forward information (redo-log) is located on the online Log Volume

5. **Roll forward Log for Row and Columnar store**
   - First loads of columnar structures are executed as they are accessed to actually roll forward the log on them
   - Next to roll forward also roll back operations can happen in this step if open transactions could not be finished before the database stopped. This is usually very fast, but in rare occasions we saw long running executions depending on the nature of these unfinished transactions.
   - At the end of this redo-log operation the database is technically available – **log-on possible**

6. **Start loading columns marked with the preload flag**
   - Allows to load columns used by important business processes before the next step, if they are not already loaded by the roll-forward in the step before

7. **Start loading tables from the list of lately used tables**
   - During the normal operation before the restart HANA tracks a list of tables which are currently loaded (once per day)
   - This list is now the basis of loading the necessary tables into main memory
Appendix to step 7:

Show info about list of tables to be preloaded (not the preload flag related columns):

`hdbcons „tablepreload i“`
- i: info – how many tables etc.

Show full content (list of tables):

`hdbcons „tablepreload c -f“`
- c: content
- -f: full

Write additional preload info to virtual file inside data volumes:

`hdbcons „tablepreload w -s“`
- w: write
- -s: synchronous

Full list of help:

`hdbcons help tablepreload`
RowStores should be in a size range of about 50 to 150 GB
- Smaller sizes are better
- Huge RowStores have an impact on a lot of operational tasks (start-up, restart, take-over, etc.)
- RowStore has to be loaded before the database has the chance going online and clients can login
- The enclosed SAP HANA system tables are vital for the operation of SAP HANA to know about the content like tables, views, meta-data etc.

Check for your scenario available possibilities to move data from RowStore into ColumnarStore
- General Housekeeping strongly recommended (e.g. BW: 1829728)
- Sizing reports give figures which are the largest tables and where are they located
- SAP BW optimized the use of RowStore during the last revisions and SPs (SAP note 1600929)
  o SAP Note 1750965, 1659383 for BW 7.3x ⇨ requesting to operate SP5 about 4000 tables in RowStore
  o SAP Note 1850112, 2151363 for BW 7.40 ⇨ reduced the number of tables in RowStore with newest SP down to about 800 tables
  o With the installation of newer support packages since BW 7.40, tables are migrated to the new desired place in columnar store automatically. The information where to place a table is stored in DDIC. Anyway a clean-up is often necessary: SAP note 1813245. For older support packages check SAP note 1815547.

Fig.: Number of tables on Row Store per release and service pack of BW on HANA.
## SAP HANA Persistence

### IO pattern per operation

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Write Transaction</th>
<th>Savepoint, Snapshot, Delta merge</th>
<th>DB Restart, Fail-over, Take-over</th>
<th>ColumnStore table load</th>
<th>Data Backup</th>
<th>Log Backup</th>
<th>Database Recovery</th>
<th>Queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Volume</td>
<td>Write 4kB-64MB async. parallel I/O orders (amount of data depends on data load)</td>
<td>Read 4kB-64MB async. parallel I/O orders</td>
<td>Read 4kB-64MB async. parallel I/O orders</td>
<td>Read 4kB-64MB async. parallel I/O orders copied into Buffers of 512 MB</td>
<td>Write 4kB-64MB async. parallel I/O orders</td>
<td>Read possible ⇒ See Column Store load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redo Log Volume</td>
<td>Write OLTP: mostly 4KB seq. I/O orders OLAP: larger I/O order sizes up to 1MB</td>
<td>Read 256kB async. I/O orders</td>
<td></td>
<td></td>
<td>Read 4kB-128MB async. parallel I/O orders copied into buffers of 128 MB</td>
<td>Read 256kB async. I/O orders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backup storage</td>
<td></td>
<td></td>
<td></td>
<td>Write 512MB seq. I/O orders (configurable)</td>
<td>Write 4kB-128MB seq. I/O orders</td>
<td>Read Data Backup: 512MB I/O orders copied into buffers of 512MB Log Backup: 128MB I/O orders copied into buffers of 128MB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MB=MByte
SAP HANA Persistence
Existence check for vital files

Check for existence of Data and Log Volume structures
With every SAP HANA Savepoint execution since SAP HANA SPS10 also a check of vital database files is executed

Checked objects:
• Data Volumes directory
• Data Volumes files
• Log Volume directory
• Log Volume segment files

The check is looking for the file/object existence to offer alerts early enough to start activities to ease the impact of the accidental file deletion

Recommended activities:
As long as the database is still functional admins can still create backups and use them for recovery after restart
• With the restart of the SAP HANA finally the locks on the file bodies are stopped and the file bodies (block chains on disk) are not existing anymore.
• Before that only the file meta data was deleted in directory structures.

With this alert we want to inform HANA admins early enough to take action!
Improved Start-up performance

Optimization in RowStore (RS) handling during start-ups

- Since HANA SPS10 the rebuild of the secondary indexes during activation of the RowStore now can be done in a decoupled way
- No necessity to wait for finishing the creation process
- Is done asynchronously in background
- Short-time missing secondary indexes can be coped with primary key accesses to involved tables until they are created
SAP HANA Smart Data Access
Data virtualization for on-premise and hybrid cloud environments

Benefits
- Remote real-time query processing
- Smart continuously self-tuning system
- Secure access to heterogeneous data sources

Heterogeneous data sources
- SAP HANA to Hadoop (Hive), Spark
- Teradata
- SAP Sybase ASE
- SAP Sybase IQ, ESP
- Oracle 12c
- MS SQL-Server
- SAP MaxDB
SAP HANA Smart data access
Differentiation

The intelligence of knowing when to delegate query processing or pull the data into SAP HANA for query processing, based on the performance windows

- Dynamic query recommendation

To return query results extremely fast. Capabilities supporting fast processing leveraging in-memory acceleration

- Cost-based query optimization
- Data pre-caching
- In-flight transformation

Converged data processing
SAP HANA Smart Data Access
Data modeling in SAP HANA studio

Transactions + Analytics Applications

- Enables users to develop applications on SAP HANA,
- Allows remote data to be accessed seamlessly
- Heterogeneous data sources accessed in SQL statements through a virtual table
SAP HANA in Data Centers:
Agenda

Introduction & Overview

Design & Setup

Persistence

Backup & Recovery (System Copy)

High Availability

Disaster Recovery

Monitoring & Administration

Security & Auditing
SAP HANA Backup & Recovery

Overview of options

**B&R to file system**

Point in Time recovery
- Check of physical consistency with header/trailer check sums

- Early option often with local or remote disk pools
- Follow-up work necessary to transport backup files to save location

**B&R to 3rd party backup tool**

Point in Time recovery
- Check of physical consistency with header/trailer check sums

- Most comfortable solution
- SAP HANA has full control about B&R management

**B&R using storage snapshots**

Point in Time recovery
- No check of physical consistency with header/trailer check sums

- Very useful to create fast and ad-hoc backups in seconds to minutes
- Better combined with the other options to get check data for free
Data backups
- Contain the current payload of the data volumes
- Any pages that are changed during the data backup written to different locations in the data volumes (shadow page concept)
- Manual (SAP HANA studio, SQL commands), or scheduled (DBA Cockpit)

Log backups
- Contain the content of closed log segments
- Automatic (asynchronous) whenever a log segment is full or the timeout for log backup has elapsed
SAP HANA Backup and Recovery

Terminology

Data
- Data area = all data volumes
- 1 data volume per service with persisted data (per node)
- Data volume files can grow (and shrink)

Redo log
- Log area = all log volumes
- 1 log volume per service with persisted data (per node)

- Log volume contains log segments
  - Number of pre-formatted log segments is configurable
  - Log segments are closed when they are full, or the log backup timeout has elapsed
  - After a log segment has been successfully backed up, it is released for overwriting
Backup
SAP HANA Backup and Recovery
Advantages for Backups with HANA Kernel involvement

Structural knowledge of data in database kernel
• Mini-verify of every page with relevant information during simple data and log backup
• Verification of data page checksums (kept in headers of every page) ensures valid data in pages
• Hardware problems get soon recognized and can be treated early enough w/o further implications to general data consistency
• OS-related or external tools don’t offer this structural knowledge into HANA data types

Performance
• Only occupied space is backed up
• Throughput of up to 0.5 or 1 TB per hour and per host (scale-out case) reported in an optimal situation (There are a lot of ways like bad network throughput, slow NFS storage perf., no hardware separation etc. to ruin such a good B&R performance)

Check Backup
• General possibility to check also backups with data knowledge in kernel available (please check SAP note 1869119 and 1873247 for further information)
SAP HANA Backup and Recovery
Data backup: Only payload is backed up

SAP HANA Server
- Backup Savepoint
- Data

Name Server
- Backup Savepoint
- Data

Index Server
- Backup Savepoint
- Data

Statistics Server
- Backup Savepoint
- Data

Shared Backup Directory (staging area)
- DATA_BACKUP_0000
- DATA_BACKUP_0001
- DATA_BACKUP_0002
- DATA_BACKUP_0003
SAP HANA automatically handles the synchronization of backups for all nodes
⇒ no special user interaction required

- All services that persist data are backed up
  - e.g. index servers, master name server
- Global data backup savepoint for all these services
  - Synchronized across all nodes and services
  - Transactions are paused very briefly
  - Savepoint is kept until the backup is finished for all services. If a page is changed during the backup, it’s written to a different location (shadow page concept)
- Data marked in the savepoint is read from data volumes and written to backup files
  - One backup file per service
  - Parallelization
**SAP HANA Backup and Recovery**

**Destinations for backups (I)**

---

**Backups to the file system**

Data backups can be triggered using
- SAP HANA Cockpit
- SAP HANA Studio
- SQL commands

Scheduled with
- DBA Cockpit
- Standard scheduling tools
  - starting SQL commands to initiate operations

**Log backups**

- written automatically
- Triggered every 15 Minutes or by finished Log segment

**More information:**
- File systems that are not supported: [SAP Note 1820529](#)
- Scheduling using the XS scheduler: [SCN blog](#)
SAP HANA Backup and Recovery
Destinations for backups (II)

Backups to 3rd party backup server
• For both data and log backups
• SAP HANA provides an API “Backint for SAP HANA” via which 3rd party backup tools can be connected
• Provides functions for backup, recovery, query, delete
• 3rd party backup agent runs on the SAP HANA server, communicating with 3rd party backup server
• Backups are transferred via pipe

Direct integration with SAP HANA:
• Data backups to Backint can be triggered/scheduled using SAP HANA studio, SQL commands, or DBA Cockpit
• Log backups are automatically written to Backint (if configured)
Certification is an installation prerequisite for tools using the “Backint for SAP HANA” API
- SAP Note 1730932 (“Using backup tools with Backint”)

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Backup tool</th>
<th>Intel Arch.</th>
<th>Power Arch.</th>
<th>Support process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen Systems</td>
<td>ASG-Time Navigator 4.4</td>
<td>✔</td>
<td></td>
<td>2212571</td>
</tr>
<tr>
<td>Commvault</td>
<td>Simpana 10.0, Hitachi Data Protection Suite 10 (via Simpana Backint interface)</td>
<td>✔</td>
<td></td>
<td>1957450</td>
</tr>
<tr>
<td>EMC</td>
<td>Networker 8.2</td>
<td>✔</td>
<td></td>
<td>1999166</td>
</tr>
<tr>
<td></td>
<td>Interface for Data Domain Boost 1.0</td>
<td>✔</td>
<td></td>
<td>1970559</td>
</tr>
<tr>
<td>HP</td>
<td>Data Protector 7.0, 8.1, 9.0; StoreOnce Plug-in for SAP HANA 1.0</td>
<td>✔</td>
<td></td>
<td>1970558</td>
</tr>
<tr>
<td>IBM</td>
<td>Tivoli Storage Manager for Enterprise 6.4</td>
<td>✔</td>
<td></td>
<td>1913500</td>
</tr>
<tr>
<td></td>
<td>Spectrum Protect for Enterprise Resource Planning 7.1</td>
<td>✔</td>
<td></td>
<td>1913500</td>
</tr>
<tr>
<td>Libelle</td>
<td>BusinessShadow 6.0.6</td>
<td>✔</td>
<td></td>
<td>2212575</td>
</tr>
<tr>
<td>Mindtree</td>
<td>NBU CONNECTOR for SAP HANA</td>
<td>✔</td>
<td></td>
<td>2330945</td>
</tr>
<tr>
<td>SEP</td>
<td>Sesam 4.4</td>
<td>✔</td>
<td>✔</td>
<td>2024234</td>
</tr>
<tr>
<td>Veritas (Symantec)</td>
<td>NetBackup 7.7</td>
<td>✔</td>
<td></td>
<td>1913568</td>
</tr>
</tbody>
</table>

Online listing of certified tools: Application Development Partner Directory
- Enter the search term HANA-BRINT and click on a partner name ⇒ ”SAP Certified Solutions” for further details
You can also use SAP HANA Studio to create data backups
SAP HANA Backup and Recovery
Delta backups (incremental and differential)

**Full data backup**
- all data

**A full data backups contains all current data**

**Note:**
- Old data that is no longer valid but might still be physically present in the data volumes is not part of the data backup

**Incremental backup**
- changed data since the last data backup (full or delta)

**Delta backups contain data that was changed since an earlier data backup**

Two types of delta backups: Incremental and differential

**Notes:**
- Delta backups are data backups – they contain actual data. In contrast, log backups contain redo log entries (=sequence of changes)
- Delta backups cannot be used together with a snapshot for recovery

**Differential backup**
- changed data since the last full backup
Comparison of incremental and differential backups

Incremental backups...
- ...are usually small  
  → faster backup
- ...are restored one after the other during a recovery  
  → longer recovery times

Differential backups...
- ...increase the amount of data saved with each backup  
  → longer backup times
- ...reduce the number of data backups during recovery  
  → faster recovery

You can also mix incremental and differential backups
To create delta backups, you can use SAP HANA Studio or SQL commands

Creating a delta backup

1. In the Systems view in SAP HANA Studio, right-click on the system and choose Backup and Recovery → Backup System...

2. Choose the backup type, for a delta backup: either Differential Data Backup or Incremental Data Backup, and specify further settings

3. Start the backup

Note: The creation of delta backups is available in SAP HANA Cockpit since SPS11.
For improved performance Backint can now use multiple parallel streams for data backups
If parallel streams have been configured, the individual service backups are distributed across all available streams. Note that the different services always use dedicated backup streams. Backups will only be distributed if they are bigger than 128 GB. Both full and delta backups are supported.

To configure the number of parallel streams, use the `parallel_data_backup_backint_channels` ini file parameter (default: 1, max: 32).

During recovery, the number of streams used is the same as during backup (independent of the current setting of the parameter).

Note: It is recommended to adapt the configuration of the 3rd party backup tool accordingly.
In the example below, 3 parallel streams have been configured.

- The index server backup is distributed across 3 streams.
- Because both name server and XS engine backups are smaller than 128 GB, they are not distributed across several streams.
Storage snapshots as backups
SAP HANA also supports the creation of storage snapshots, which can later be used for recovery

1. Using SAP HANA studio, prepare the database for the storage snapshot. Technically, this creates an internal data snapshot
2. Using the storage tool, create a storage snapshot of the SAP HANA data area
3. In SAP HANA studio, confirm the storage snapshot as successful. An entry including the external backup ID is written to the backup catalog
Creating a snapshot

To create snapshots, you can use SAP HANA Studio or SQL commands

Some storage tools can also trigger snapshots in SAP HANA directly

Creating a snapshot

1. In the Systems view in SAP HANA Studio, right-click on the system and choose Storage Snapshot... → Prepare. Alternatively, you can use the SQL command: `BACKUP DATA CREATE SNAPSHOT COMMENT 'My Snapshot Test'

2. Using the storage tool, create a snapshot of the SAP HANA data area

3. In SAP HANA Studio, confirm the successful snapshot and enter the external snapshot ID. Alternatively, you can use the SQL command: `BACKUP DATA CLOSE SNAPSHOT BACKUP_ID 3456789 SUCCESSFUL 'storage_id_12345`

Storage snapshots are listed in the backup catalog. You can either display the backup catalog in SAP HANA studio, or query it using SQL (system view M_BACKUP_CATALOG).
# SAP HANA Backup and Recovery

## Options for backup: Comparison

<table>
<thead>
<tr>
<th></th>
<th>File system</th>
<th>Backint</th>
<th>Storage snapshot</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>• Consistency checks on block level</td>
<td>• Consistency checks on block level</td>
<td>• Fast (usually seconds to minutes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ease of use – no explicit backup files management,</td>
<td>• Negligible network load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>integrated into Studio</td>
<td>• First storage partners offer integration in their tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Data center integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Additional features, e.g. encryption or de-duplication</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• After completion, backups immediately available for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>recovery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fast (usually seconds to minutes)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Negligible network load</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• First storage partners offer integration in their tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Data center integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Additional features, e.g. encryption or de-duplication</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• After completion, backups immediately available for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>recovery</td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Additional storage required</td>
<td>• Network load</td>
<td>• No consistency checks on block level</td>
</tr>
<tr>
<td></td>
<td>• File system fill level needs to be monitored</td>
<td>• 3rd party backup tool necessary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Additional time needed to make backups available for recovery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Network load</td>
<td>• In case of recoveries, backup files must be returned to staging area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In case of recoveries, backup files must be returned to staging area</td>
<td>• No consistency checks on block level</td>
<td></td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>• Payload only: Current data (backup size) usually smaller than the data area</td>
<td>• Payload only: Current data (backup size) usually smaller than the data area</td>
<td>• ~ Size data area, but usually compressed/de-duplicated by storage</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>• IO-bound (reading from data volume, writing to target)</td>
<td>• IO-bound (reading from data volume)</td>
<td>• Usually negligible (logical pointers are replicated)</td>
</tr>
<tr>
<td></td>
<td>• Network-bound (writing to file system)</td>
<td>• Network-bound (writing to backup server)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Usually negligible (logical pointers are replicated)</td>
<td></td>
</tr>
</tbody>
</table>
Support for backup operations has been extended in SAP HANA Cockpit

The Data Backup tile shows the state of the current backup. Clicking on the tile takes you to the backup catalog.
The current filter settings are displayed in the blue filter bar at the top of the backup catalog.

To change the settings, you can either click on the filter bar or the filter button.
Creating a data backup in SAP HANA Cockpit

Using SAP HANA Cockpit, you can create data backups to the file system or to Backint. Both full and delta backups are supported.

Creating a data backup
1. In SAP HANA Cockpit, click on the Data Backup tile
2. On the Backup Catalog page, choose Start New Backup
3. Specify your backup settings
4. Start the backup by choosing Back Up
5. The progress is displayed on the Data Backup tile
   To view the progress details, click the tile
To change the backup configuration, use SAP HANA Studio

- **Backint**
  - If a 3rd party backup tool is installed, it is displayed automatically. You can optionally specify vendor-specific parameter files

- **Data backup**
  - Default settings for data backups to the file system (destination, maximum file size).
  - Note: You specify the destination type (file or Backint) when executing the data backup

- **Log backup**
  - Default settings for log backups (destination type – file or Backint), destination, backup interval). Log backups are carried out automatically unless disabled

Note: This is not yet available in SAP HANA Cockpit
You can use SAP HANA Studio or SQL commands to delete old backups

Deleting old backups may be required in order to manage your backup storage space or to fulfill regulatory deletion requirements.

You can delete old backups

- From the backup catalog (logical view)
- Physically (from disk and/or from a 3rd party backup server via the Backint API)

You can enable an audit event to create an entry in the audit trail whenever a backup is deleted using this function.

Note: Not yet available in SAP HANA Cockpit
Recovery
SAP HANA Backup and Recovery
Resulting backups during normal operation of the database including delta backups

1. Last full backup
2. Incremental backup
3. Differential backup
4. Log backup
5. Most recent entries from log area

Time

Now
(A) To the most recent state
- Full data backup or snapshot
  + last differential backup (Note: not supported if a snapshot is used as basis)
  + subsequent incremental backups (Note: not supported if a snapshot is used as basis)
  + subsequent log backups
  + redo log entries that are still available in the log area (if it was not destroyed by the failure)

(B) To a point in time in the past
- Same as above; redo log entries from the log area might not be required

(C) To a specified full data backup or snapshot
- Full data backup or snapshot, but no log replay (“clear log”)
Recovery includes delta backups automatically

SAP HANA automatically determines the best recovery strategy based on all available backups, including delta backups.

If you do not want SAP HANA to use delta backups for the recovery, de-select *Use Delta Backups* when specifying your recovery settings.
A recovery typically consists of the following phases:

1. Data recovery (full backup + delta backups, if applicable)
2. Log replay (log backups + log entries from the log area, if applicable)
3. Restart
If a recovery fails during log replay, SAP HANA can now resume the recovery after the data recovery, thus shortening the outage significantly.

Data recovery usually takes up most of the time of a recovery.

A typical example that could cause a failure during log replay would be a temporary outage of the backup network.
If a recovery failed during log replay, SAP HANA Studio will display the successful data recovery part as RESUME option in the recovery wizard.
The backup catalog provides detailed information on data backups, log backups and storage snapshots, for example start/end time, duration, size, and throughput.

The backup catalog is stored within the SAP HANA database, and also backed up as part of the log backup (even in log mode OVERWRITE). This allows for offline access to the backup catalog during recovery.
You can use SAP HANA Studio or SQL commands to execute a recovery

Caution: For a recovery, SAP HANA will be shut down

In the Systems view in SAP HANA Studio, choose Backup and Recovery → Recover System... from the context menu of the database and enter the credentials of the SAP HANA operating system user <sid>adm

Caution: For a recovery, SAP HANA databases will be shut down

Note: Recovery is not yet available in SAP HANA Cockpit
You can use either a data backup (from the file system or Backint), or a snapshot as the basis for the recovery.
You can use either a data backup (from the file system or Backint), or a snapshot as the basis for the recovery.
SAP HANA Backup and Recovery

Recovery using a specified data backup or snapshot (option C)

You can use either a data backup (from the file system or Backint), or a snapshot as the basis for the recovery. Note that you do not need the backup catalog for this recovery option but can also directly specify a backup.
Recovery includes delta backups automatically
SAP HANA automatically determines the best recovery strategy based on all available backups, including delta backups.
If you do not want SAP HANA to use delta backups for the recovery, de-select Use Delta Backups when specifying your recovery settings
You can display the SQL statement for a specific recovery in SAP HANA Studio

After you have specified your recovery settings, a summary screen is displayed.

You can display the SQL statement equivalent to these recovery settings by clicking the relevant button.
SAP HANA Backup and Recovery
Recovery phases

After the initial collection of system information required for the recovery, there are the following recovery phases:

**Phase 1: Data recovery**
- Using data backups or snapshot plus delta backups if available

**Phase 2: Log recovery**
- Redo log entries are replayed
  - from the log backups
  - and/or
  - from the log area (if still available/required)

**Phase 3: Restart**
- SAP HANA is restarted
SAP HANA Backup and Recovery
Backup information in SAP HANA Studio

You open the backup overview tab by double-clicking *Backup* in the *Systems* view in SAP HANA studio

- Progress information on currently running data backup, with information on the services included in the backup
- Last successful data backup
  - Start/end time, duration, size, and throughput
  - To display more detailed information on this data backup, click More Information
- Information on open snapshot

Buttons for

- Canceling running data backup
- Starting backup
- Displaying backup.log file
SAP HANA Backup and Recovery
Recovery steps when using a storage snapshot

1. Using the storage tool, transfer the storage snapshot to the data area of the SAP HANA database

2. Using SAP HANA studio, recover the database using the storage snapshot as basis (available in the recovery wizard)

Note: All recovery options are available, including point-in-time recovery using log backups/log from the log area

Note: All recovery options are available, including point-in-time recovery using log backups/log from the log area
Support for Multitenant Database Containers
MDC systems follow the same backup/recovery principles as single-container systems

The system database plays a central role for MDC backup and recovery

- It can initiate both backups of the system database itself and of individual tenants databases. A tenant database can also carry out its own backups unless this feature has been disabled for this tenant database.
- Note that the backup location in the file system is specified system-wide and tenant databases always back up to sub-directories of this location.
- Recoveries are always initiated from the system database.
- The system privilege DATABASE ADMIN authorizes the administration of tenant databases from the system database.

To recover a complete MDC system, first the system database and then all tenants need to be recovered individually.

Note: Snapshots are currently not supported in multi-tenant database container systems.
The current Backint API specification also covers MDC systems

There are a few points that you need to be aware of when using a 3rd party backup tool

Isolation level “high”
With SPS10, a new option “isolation level” was introduced for MDC systems. If the isolation level is set to high, all tenant databases run under individual operating system users.
In high isolation scenarios, Backint is supported from the SAP HANA side but you need to check with your 3rd party tool vendor whether any tool-specific restrictions apply.

Tenant copy
Tenant copy using Backint is currently not supported. Use file system backups for tenant copy instead.
You can use SAP HANA Cockpit to create data backups of the system database and of individual tenant databases.

Log on to the relevant database and click on the *Data Backup* tile.

Create data backups and view backup information in the same way as for single-container databases.

**Note:** You can also use SAP HANA Studio to create data backups. Backup lifecycle management is currently not available in SAP HANA Cockpit.
You regularly need to create data backups of the system database

The system database contains information about the system as a whole and all tenant databases and is used for central system administration.

Creating a data backup of the system database

1. In the Systems view in SAP HANA Studio, right-click on the system database and choose Backup and Recovery → Backup Up System Database...

2. Specify your backup settings and start the backup
You regularly need to create data backups of the tenant databases

The tenant databases contain the business data. They have their own index servers.

**Note:** Depending on the system configuration, it may also be possible to initiate a data backup directly from a tenant database

Creating a data backup of a tenant database

1. In the **Systems** view in SAP HANA Studio, right-click on the system database and choose **Backup and Recovery** → **Backup Up Tenant Database**...
2. Select the tenant database to be backed up
3. Specify your backup settings and start the backup
SAP HANA Backup and Recovery
Multitenant database containers: Viewing backup information

Backup information is contained in the backup catalog

Viewing information for all databases
1. In the Systems view of the system database in SAP HANA Studio, expand the system database and double-click on Backup
2. Open the Backup Catalog tab and select the database for which you want to view the information

Viewing information for a tenant database
1. In the Systems view in SAP HANA Studio, expand the tenant database and double-click on Backup
2. Open the Backup Catalog tab
You can delete backups that are not needed any longer

Deleting old backups
1. In the Systems view of the system database in SAP HANA Studio, expand the system database and double-click on Backup
2. Open the Backup Catalog tab and select the database for which you want to delete backups
3. From the context menu, choose which backups you want to delete. Specify whether the backups should be deleted from the backup catalog only, or also from the file system/3rd party backup tool
Use SAP HANA Studio or SQL commands to recover the system database

**Caution:** The whole system will be shut down, including all tenant databases

- You need the `<sid>adm` operating system user credentials for recovering the system database
- The system database can only be recovered to the latest state
- Only the system database will be recovered, the content of the tenant databases is not affected

**Note:** Recovery is currently not available in SAP HANA Cockpit
Use SAP HANA Studio or SQL commands to recover an individual tenant database

- Tenant databases can be recovered to the latest state, a point in time, or to a specific backup
- The system database and all other tenant databases are not affected by the recovery of an individual tenant database
- Recovery of a tenant database can only be initiated from the system database. Note that the system database needs to be online for this.

Note: Recovery is currently not available in SAP HANA Cockpit
You can now configure on which hosts of your system a scale-out tenant database is to be recovered

Until now, you could not influence the distribution of the tenant database across target hosts.

Before you start the recovery, create a new tenant database on one of the hosts (this will be the host that the master index server runs on).

Using *Add Service*, specify the target hosts for further services of your tenant database (e.g. additional index servers).

Services contained in the backup for which you have not specified a target host will be distributed automatically by SAP HANA to suitable target hosts.
Database Copy
You can copy a database using SAP HANA’s standard backup/recovery functions

A typical use case would be to copy your production system to a smaller QA system.

Note that if the target system has less resources, e.g. less CPU and RAM, performance cannot be expected to be the same as in the source system.

As a **basis for a database copy**, you can use a full backup: data backup to the file system/Backint or a snapshot. You can choose to also use delta backups/log backups.

The number of hosts can differ between source and target system.

The following scenarios are possible:

n \(\rightarrow\) n hosts

n \(\rightarrow\) n+x hosts (not supported for snapshots)

n \(\rightarrow\) n-x hosts (not supported for snapshots)
You can carry out database copies using SAP HANA’s standard backup/recovery functions

A typical use case would be to create a copy of your production system for tests on a smaller QA system. **Note:** If the target system has less resources, e.g. less CPU and RAM, performance cannot be expected to be the same as in the source system.

Both file system backups, backups via a 3rd party backup tool, and storage snapshots can be used for database copies.

**Options for database copy**

- **Using data backup or storage snapshot + log backups of the source database**
  - This allows you to restore the database to a point in time after the data backup or storage snapshot

- **Using only data backup or storage snapshot of the source database**
  - This restores the content exactly as of the point in time of the data backup or storage snapshot

Copying from a larger (m nodes) to a smaller system with fewer hosts (n nodes) is supported for database copies using data backups (but not when using storage snapshots). You will need to configure (m-n) additional index servers in the target database.
SAP HANA Backup and Recovery
Database copy from $n \rightarrow n$

**Source and target system have the same number of hosts**

Source database with **n hosts** (e.g. PROD)

Data backup or snapshot + log backups

Target database with **n hosts** (e.g. DEV)

Check detailed scenarios & descriptions in SAP HANA Admin Guide
SAP HANA Backup and Recovery

Database copy from $n \rightarrow n+x$

First copy to a system with the same number of hosts ($n \rightarrow n$), then add more hosts ($+x$)

Source database with $n$ hosts (e.g. PROD)

Data backup + log backups

Target database with $n$ hosts (e.g. PROD_NEW)

Add host and distribute data

Target database with $n+1$ hosts (e.g. PROD_NEW)
Before you copy the database, configure x additional index servers in the target system.
Integration with Dynamic Tiering
The Backint API for connecting 3rd party backup tools has been implemented for dynamic tiering

Add-on certification process planned
• Backup tools will need to be certified for HANA+DT systems
• Included in regular „Backint for HANA“ certification

Note: Snapshots are currently not supported with Dynamic Tiering
SAP HANA Backup and Recovery
Dynamic tiering – backup/recovery

Backup
- Backup paths for the warm store are the same as for the hot store
- Data backups are carried out as usual for SAP HANA either using SAP HANA Studio, SAP HANA Cockpit, or SQL commands. They will automatically include the warm store
- Log backups are carried out automatically (unless disabled)
- The SAP HANA backup catalog also contains information about backups of the warm store

Recovery
- Both data and log backups for the hot and the warm store are required for a recovery. You cannot recover one without the other
- The number and type of services must be identical in both the source and target system
- Recovery can be carried out in SAP HANA Studio or using SQL commands
SAP HANA Backup and Recovery
News with SAP HANA SPS12 and Beyond

Today

Backup
- Data backup scheduling capability in the SAP HANA cockpit
- Show the approximate size of backup
- Customize the backup overview page concerning the backup prefix
- SAP HANA Backup Scheduler

Recovery
- Resume an interrupted recovery - second step
  o Continue a failed recovery with milestones, set during log recovery process before

Supportability
- Reconstruct the SAP HANA backup catalog using file-based delta data backups
- Single DB copy using Backint-based data backup without accessing the backup catalog
- Recovery with storage snapshots and delta backups

Planned Innovations

Backup
- Optimized workload of Backint-based log backups (strong customer demand)

Recovery
- Recover single db (class. setup) backup to tenant database
- Recovery capability in the SAP HANA cockpit

Supportability – MDC Systems
- Option to write the backup catalog to a separate location
- Tenant backup via the system DB in the SAP HANA cockpit
- Tenant recovery via the system DB in the SAP HANA cockpit

Future Direction

Backup & Recovery
- Storage snapshot backups for tenant databases
- 3rd party backup tools: tenant copy via Backint (for MDC systems)
- Additional Backup options – e.g.
  o Support for backup operations on secondary system in system replication scenarios
- Backint 2.0 API and certification
  o extended scope e.g. snapshot automation
- Additional Recovery Options
  o Partial recovery (service oriented)
- Additional options for backup lifecycle management in discussion e.g.
  o Integrity check for the backup catalog
  o Backup staging using 3rd party backup tools
  o Option for manual log backup
  o Configuration file backup
  o Backup compression

This is the current state of planning and may be changed by SAP at any time.
You can now schedule data backups in the SAP HANA cockpit.

To open the backup scheduling page, from within the Data Backup application, select Create Schedule at the bottom of the backup catalog. To view existing data backup schedules, select Go to Schedules.

You can schedule complete, incremental, or differential backups, as well as backups to file or third-party (Backint) tools.

Before scheduling backups, enable the XSC base scheduler, and assign the additional scheduler role to the database user:
sap.hana.backup.roles::Scheduler
Specify the schedule data settings.

At the top of the Schedule Settings page, select the general data backup settings:

- **Backup Type**: Complete, incremental or differential data backup
  
  *Note*: Currently snapshots cannot be scheduled.

- **Destination Type**: File-based or Backint-based

- **Backup Prefix**: Date/time place holder that is replaced at backup execution

- **Backup Destination**: For file-based data backup, it’s the target location in the file system, otherwise it’s the unchangeable identifier of the named pipe used by Backint
Specify the schedule data settings.

On middle of the Schedule Settings page, specify the proper schedule data settings:

- **Schedule Name**: an unique identifier
- **Start of Schedule**: Date and time when the schedule shall become active, specified in UTC

**Note**: Next resp. first execution time will be calculated dependent of the recurrence pattern.

- **Recurrence** pattern:
  - **Weekly**: one or more days in a week including recurrence all n weeks (max 4)
  - **Monthly**: first, second, third, forth or last of a weekday including recurrence all n month (max 12)
- **Create Backup at**: Execution time of the scheduled backup, specified in UTC
Data backup scheduling in the SAP HANA cockpit (IV)

Get an overview of scheduled data backups.

From the Backup Schedules page, you can view existing schedules.

You can activate or pause schedules from the schedule menu, drill down into individual schedule details, or delete a schedule permanently.

You can also execute these operations on the Schedule Settings details page using the toolbar buttons.

Note: You cannot modify a schedule.
The estimated backup size is now displayed in the backup page.

The estimated backup size could be used to check if there is sufficient disk space for file-based backups, or to check if a full data backup would be a better choice than a delta data backup.

**Note:** Currently there is not a disk space check in the SAP HANA cockpit.

By toggling between the backup types, you can easily compare the estimated backup sizes of complete, incremental and differential backups.
You can view the backup prefix in the *Backup Overview* page.

Based on a customer feature request submitted over the new SAP HANA feedback platform, [SAP Idea Place](https://idea.sap.com), it’s now possible to view data backup prefixes in the *Backup Overview* page.

The *Prefix* column is not displayed by default, but can be configured by selecting the gear icon.
SAP HANA can now resume database recovery if outages occur during delta data backup recovery, or after successfully replayed logs, thus further reducing potential outages in comparison to SPS 11.

In SPS 11, all successfully recovered data backups were kept implicitly as internal database snapshot (aka fallback point) in the data area.

In SPS 12, a data recovery can be resumed from the last successfully recovered full backup, or from the successfully recovered delta backups relying on an additional fallback point set between full backups and delta backups during recovery.

In SPS 12, failures during log replay can benefit from preserved changes at frequent savepoint intervals, so that only the most recent set of logs after the savepoint must be replayed.
Resume database recovery after a failure during delta data backup recovery.

- Accelerate subsequent recovery using successful recovered full data backups, differential and incremental data backups and log backups.
- Successful recovered data backups are kept implicitly as internal database snapshot (aka fallback point) in the data area.
- If a recovery failure occurs during delta data backup recovery, the full backup recovery is preserved, and only the delta data backups and the log backups are reprocessed.

Note: As a byproduct, differential and incremental data backups can be created based on an SAP HANA data snapshot.
Resume database recovery after a failure during log recovery.

- Data changes caused by replaying log backups during a database recovery are periodically stored in the log area with savepoints.
- The frequency of savepoints can be set using the configuration parameter: 
  `log_recovery_resume_point_interval` (default: 1.800 sec; max: 18.000 sec, 0 = disabled)
- Once the interval expires, the next savepoint log entry will be replayed.
- If a recovery failure occurs after a savepoint, only the log backups after most recent savepoint must be reprocessed.
If a recovery failed during log replay, SAP HANA Studio will display the successful data recovery part as RESUME option in the recovery wizard.
Reconstruct the SAP HANA backup catalog using file-based delta data backups
If for some reason the HANA backup catalog is unusable file-based delta data backups are recognized in addition to full file-based and log backups. Both incremental and differential file-based backups are considered during reconstruction of the backup catalog.

A database recovery using delta data backups is executed from the reconstructed catalog.

Copy a single DB using a Backint-based data backup without accessing the backup catalog
By specifying the backup destination, prefix, and SID it is possible to identify a specific data backup for copying using Backint in the case that the backup catalog is not available.

Recovery with storage snapshots and delta data backups
It is now possible to recover an SAP HANA database using a combination of a storage snapshot and delta data backups (incremental and differential backups).
SAP HANA Backup and Recovery

More information

Documentation
- SAP HANA Administration Guide,
  SAP HANA Technical Operations Manual

Overview presentation
- Backup/recovery overview presentation

Best practices
- 2091951: Best practice: SAP HANA Backup and Restore

Important SAP Notes
- 1642148: FAQ: SAP HANA database backup and recovery
- 1730932: Using backup tools with Backint
- 1869119: Check backup integrity
- For further notes on backup/recovery, see HAN-DB-BAC

Backint for SAP HANA certification
- Certification announcement and description
SAP HANA in Data Centers:

Agenda

- Introduction & Overview
- Design & Setup
- Persistence
- Backup & Recovery (System Copy)

High Availability
- Disaster Recovery
- Monitoring & Administration
- Security & Auditing
High Availability – Disaster Recovery

Business Continuity

High Availability per Data Center

- SAP HANA Host Auto-Failover (Scale-Out with Standby)
- SAP HANA System Replication
  - Performance Optimized
  - Cost Optimized

Disaster recovery between Data Centers

- SAP HANA Storage Replication
- SAP HANA System Replication
  - Performance Optimized
  - Cost Optimized
Availability – What does 5*9 mean?

What is the desired availability level?
- Which agreements exist with Business?
- What are the SLAs?
- Must it always be 5*9 (99.999%)

What is the maximum planned and unplanned downtime?
- Are there other systems which can be used in the meantime?
  Can the users work with a slower system for a certain time?
- What are the cost considerations?
- What is already implemented?

<table>
<thead>
<tr>
<th>Availability</th>
<th>Downtime/Year [min]</th>
<th>Downtime/Year [translated]</th>
</tr>
</thead>
<tbody>
<tr>
<td>95%</td>
<td>26280.0</td>
<td>18.25 days</td>
</tr>
<tr>
<td>99%</td>
<td>5256.0</td>
<td>3.65 days</td>
</tr>
<tr>
<td>99.9%</td>
<td>525.6</td>
<td>526 minutes</td>
</tr>
<tr>
<td>99.99%</td>
<td>52.6</td>
<td>52.6 minutes</td>
</tr>
<tr>
<td>99.999%</td>
<td>5.3</td>
<td>5.3 minutes</td>
</tr>
</tbody>
</table>

Basis: 365 days per year

Success Stories
SAP IT achieves 99.99% availability with SUSE (Link)
Hidrovias do Brasil, 99.5% availability SLA for whole prod. system including SAP HANA (Link)

Cisco Data Center Case Study: Bluelock, 99,99% uptime SLAs with HANA (Link)
More to come…
Ways to setup High Availability and Disaster Recovery

**Host Auto-Failover**

Cluster-like solution

- One data pool
- Includes internal cluster manager for micro cosmos Auto-Failover
- Uses Storage Connector APIs for communication with environment

Covers HW problems with additional host(s)
Single DataCenter(fire hall) solution

**System Replication**

Similar to classical shadow database solutions

- Ambivalent solution for HA & DR
- Automation possible with external cluster manager (macro cosmos)

Covers HW and data integrity problems with an additional set of individually driven data pools

**Storage Replication**

Often already used by several customers

- Usually used for DR
- Automation possible with external cluster manager (macro cosmos)

Covers HW (data center) failures on a broader scale
HA & DR Concepts in general

KPIs:
- Recovery Point Objective (RPO) = worst-case data-loss
- Recovery Time Objective (RTO) = time to recover from outage

<table>
<thead>
<tr>
<th>Solution</th>
<th>Used for</th>
<th>Cost</th>
<th>RPO</th>
<th>RTO</th>
<th>Perf. ramp</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP HANA-native Backup &amp; Recovery</td>
<td>HA &amp; DR</td>
<td>$</td>
<td>&lt;=0 (high risk)</td>
<td>high</td>
<td>med</td>
</tr>
<tr>
<td>SAP HANA Host Auto-Failover</td>
<td>HA</td>
<td>$</td>
<td>0</td>
<td>med</td>
<td>long</td>
</tr>
<tr>
<td>SAP HANA Storage Replication w/ QA, Dev.</td>
<td>DR</td>
<td>$$$</td>
<td>0*</td>
<td>med</td>
<td>long</td>
</tr>
<tr>
<td>SAP HANA System Replication</td>
<td>HA &amp; DR</td>
<td>$$$</td>
<td>0*</td>
<td>low</td>
<td>short</td>
</tr>
<tr>
<td>SAP HANA System Replication w/ QA, Dev.</td>
<td>HA &amp; DR</td>
<td>$**/$$</td>
<td>0*</td>
<td>med</td>
<td>long</td>
</tr>
</tbody>
</table>

** single host installations  *synchronous solution
SAP HANA Host Auto-Failover
SAP HANA High Availability
Scale-Out with Host Auto-Failover

Scale-out clusters address two problems
- Scale to a setups, bigger than one host
- Online addition and removal of hosts possible without restart
- Offer an easy HA option by putting one or more hosts as spare/standby

Host Auto-Failover is offered by the Name Service (Paper on SCN)
- The resulting cluster is managed by this name service inside of HANA.
- He regularly checks on the cluster members to be still active.
- In case of problems he initiates a fully automated take-over to the standby hardware.
- Together with the switch of mounts/disks also the identity (data/log content) of the failing cluster member is moved to the standby hardware. But local instance parameters are not moved to a different host.

Starting with shared storage, HANA Scale-Out today can use SAN storage with FibreChannel adapters
- Storage Connector API ensures the possibility of remounting necessary file systems to standby hosts
- More details with: SAP Note 1900823 - Storage Connector API ⇒ Please check its attachments for white papers etc.
SAP HANA High Availability
Storage for persistent data

**Fibre Channel Storage using SAN**
Non-shared SAN storage attached via Fibre Channel for HANA data and log volumes and shared NFS/NAS storage for HANA binaries


**Network attached storage using NFS**
Network Attached Storage attached via NFS

More details available in SAP HANA Storage Requirements whitepaper and Fibre Channel Storage Connector Admin Guide: SAP Note 1900823

Shared-nothing architecture with Cluster File Systems
Shared Storage Infrastructure using Cluster File System with local disks

More details available in SAP HANA Storage Requirements whitepaper and Fibre Channel Storage Connector Admin Guide: SAP Note 1900823
SAP HANA High Availability
Host Auto-Failover – Internal Cluster Manager

**Failover decision** *(Paper on SCN)*
- Heartbeat
  - TCP communication based heartbeats
    - Ping Nameserver and Daemon (internal communication protocol)
  - Storage based heartbeats (*nameserver.lck*)
    - In shared storage for HANA binaries (e.g. /usr/sap/MB1/SYS/global/hdb)

**Fencing to prevent data corruption**
- NFS4 or GPFS
- File locking
- NFS3
  - Disable built-in file locking (no automatic lock release)
  - HANA Storage Connector using STONITH (shoot the other node in the head)
- Block storage via fibre channel (SAN)
  - HANA Storage Connector using SCSI-3 persistent reservations

**Split Brain**
- Master Nameserver is the only entity to make a failover decision
- Network errors between master candidates and master nameserver can cause split brain situations
- As long as the randomly written string in file *nameserver.lck* is changing, master is still alive

![Diagram](image-url)
SAP HANA Architecture

- **SAP HANA Database**
  - Name Server
  - Index Server
  - Preprocessor
  - XS engine
- **SAP HANA Studio Repository**
- **SAP Host Agent**

**Single host configuration**

**Multi-node cluster configuration**

- **Maintains landscape information**
- **Holds data and executes all operations**
- **Text analysis pre-processor**
- **XS engine**
- **Repository for HANA Studio updates**
- **Enables remote start/stop**

Storage for fail-over and recovery
Distributed HANA database even on a single host with shared nothing concept

Standby without own persistence
HANA High Availability
Host Auto-Failover (standby)

Different implementation of High Availability by HW partners

Using storage solution inside

Using internal disk
Minimal setup for a Host Auto-Failover (Scale-Out):

2 Servers including one Standby

External storage or similar technology necessary which ensures the data provisioning to second node via external data location

This setup aims for High Availability not performance scaling or size.

Note:
Some use cases (e.g. SAP BW powered by HANA) might have different requirements or recommendations for minimal setups (e.g. BW has a defined setup for SAP HANA Scale-Out – SAP note 1736976 ⇒ attached PDF).
Clients:
- During installation the clients get initial information about how to contact to HANA database – often only one host is offered
- To prevent single point of failure, more host should be offered in case of Scale-Out
- The list is only necessary to establish a first connect to HANA cluster – afterwards the client gets the full topology from the database Name Server anyway
- The complete list of hostnames including the standby host should be stored

User store:
- Contains the list of host names like “hana1;hana2;hana3” etc. next to user and encrypted password information
- All tools based on this database interface named sqldbc (SAP Appl. Server, hdbsql, ODBC, python, etc.) can use this user store.

Algorithm:
- Round robin process is used to find this first contact point
**SAP HANA Disaster Recovery**

**HA/DR Provider Framework – Functionality**

HA/DR Provider Framework now offers an active “communication” channel

- Possibility to inform external entities about activities inside of SAP HANA Scale-Out
- E.g. during move of master service to a different host inside Scale-Out a virtual IP/hostname can be moved accordingly to represent the actual master host
- Documented in SAP HANA Admin Guide with detailed examples (Chapter 7.2 ff. Example HA/DR Provider Implementation)
  - vIPMover HA/DR Provider
  - mySTONITH HA/DR Provider
- A Python script provides hooks that can be called in response to events during Host Auto-Failover and System Replication takeover process (see table)
- Parameter section in global.ini:

```ini
[ha_dr_provider_<classname>]
```
  - provider = : The class name
  - path = : Location of the script
  - execution_order = : The ordering of the HA/DR Provider if there is more than one; this is a number between 1 and 99

<table>
<thead>
<tr>
<th>Name</th>
<th>Trigger</th>
<th>Caller</th>
<th>Landscape</th>
<th>Error behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>startup()</td>
<td>beginning of nameserver’s startup phase</td>
<td>starting nameserver</td>
<td>each host individually</td>
<td>nameserver aborts, startup is cancelled</td>
</tr>
<tr>
<td>shutdown()</td>
<td>just before the nameserver exists</td>
<td>stopping nameserver</td>
<td>each host individually</td>
<td>error trace is written</td>
</tr>
<tr>
<td>failover() [Host Auto-Failover]</td>
<td>as soon as the nameserver made the decision about the new role</td>
<td>host that takes over the role</td>
<td>each host that gets a new role</td>
<td>nameserver aborts, failover is cancelled</td>
</tr>
<tr>
<td>stonith() [Host Auto-Failover]</td>
<td>as soon as the nameserver made the decision about the new role</td>
<td>master nameserver</td>
<td>for each failed host</td>
<td>nameserver aborts, failover is cancelled</td>
</tr>
<tr>
<td>preTakeover() [System Replication]</td>
<td>as soon as the hdbnsutil - sr_takeover command is issued</td>
<td>master nameserver</td>
<td>called only once on the master</td>
<td>takeover is aborted</td>
</tr>
<tr>
<td>postTakeover() [System Replication]</td>
<td>as soon as all services with a volume return from their assign-call (open SQL port)</td>
<td>master nameserver</td>
<td>called only once on the master</td>
<td>error trace is written</td>
</tr>
</tbody>
</table>
Operational security:
For new members of a Scale-Out cluster a check for local time settings during integration of this new host(s) is performed
Standard is to prevent an integration of new Scale-Out members with bigger time differences
Alternatively the installation tools (hdbaddhost) got manual overwrite options for the graphical and console tool versions
  - hdbaddhost --ignore=check_timediff
Additionally there exists an alert which checks regularly on time differences in Scale-Out clusters
  - Time difference on a host/member to initiate alert: 1,2,3 minute differences equal to Low, Med, High priority warning
  - Frequency: every hour
  - Alert number: 76 – Discrepancy between host server times
SAP HANA High Availability
News with SAP HANA SPS12 and beyond

<table>
<thead>
<tr>
<th>Today</th>
<th>Planned Innovations</th>
<th>Future Direction</th>
</tr>
</thead>
</table>

**Scale-Out**
- SAP HANA Cockpit: Add, remove host role to manage services during operation, e.g. Smart Data Streaming
- System Availability Trace

**Scale-Out**
- Asymmetric setups for certain business scenarios
  - Extension Node for SAP BW with bigger-sized hosts and data over-commitment (More details with blog)
  - Same sized extension nodes are already supported with SAP BW

**Scale-Out**
- Extension of Integration with SAP HANA family
  - Dynamic Tiering and Smart Data Streaming
- Asymmetric setups for certain business scenarios
Add, remove host role to manage services during operation, e.g. Smart Data Streaming

SAP HANA hosts in production environments are required to only have one host role so that components are not competing for resources.

- An exception for this rule is the XS advanced component. If the XS advanced runtime is installed, the SAP HANA hosts have a worker or standby role, as well as the XS advanced worker or standby role (respectively).
- A component must have been installed on the system before an additional host role can be assigned.
Availability tracing for SAP HANA

- Parameter nameserver.ini/[halog]/writeLog=true is per default set
- Trace file is created as halog_<hostname>.csv
- Still focusing on Scale-Out, planned to be extended to SAP HANA System Replication in future
- View M_SYSTEM_AVAILABILITY output:

```
EVENT_TIME GUID IS_ORIGIN TRACE_HOST EVENT_NAME EVENT_DETAIL ERROR_MESSAGE SYSTEM_ACTIVE SYSTEM_STATUS HOST HOST_ACTIVE HOST_Status
1 23.03.2016 14:36:49.698451 56fdad62-6db4-74c... TRUE ld2131 SERVICE_STARTING
2 23.03.2016 14:36:49.722118 56fdad63-6db4-74c... TRUE ld2131 SERVICE_STARTED
3 23.03.2016 14:36:52.84965 56fdad64-6db4-74c... TRUE ld2131 SERVICE_STARTED
4 23.03.2016 14:36:54.60625 56fdad65-6db4-74c... TRUE ld2131 SERVICE_STARTED
5 23.03.2016 14:36:54.92876 56fdad66-6db4-74c... TRUE ld2131 SERVICE_STARTED
6 23.03.2016 14:37:00.243352 56fdad67-6db4-74c... TRUE ld2131 SERVICE_STARTED
7 23.03.2016 14:37:00.473377 56fdad68-6db4-74c... TRUE ld2131 SERVICE_STARTED
8 23.03.2016 14:38:00.654397 56fdad69-6db4-74c... TRUE ld2131 SERVICE_STARTED
9 23.03.2016 14:38:07.501344 56fdad6a-6db4-74c... TRUE ld2131 SERVICE_STARTED
10 23.03.2016 14:38:08.96127 56fdad6b-6db4-74c... TRUE ld2131 SERVICE_STARTED
11 23.03.2016 14:39:33.322048 56fdad6c-6db4-74c... TRUE ld2131 SERVICE_STARTED
12 23.03.2016 14:39:35.759019 56fdad6d-6db4-74c... TRUE ld2131 SERVICE_STARTED
13 23.03.2016 14:39:45.292909 56fdad6e-6db4-74c... FALSE ld2131 SERVICE_STARTED
```
SAP HANA in Data Centers:
Agenda

- Introduction & Overview
- Design & Setup
- Persistence
- Backup & Recovery (System Copy)
- High Availability
- Disaster Recovery
- Monitoring & Administration
- Security & Auditing
SAP HANA Disaster Recovery
Different ideas of solutions

1. **SAP HANA Storage Replication** of SAP HANA disk areas controlled by storage technology
   - First synchronous implementation (available, SAP note 1755396)
   - Afterwards asynchronous implementation planned and in preparation with HW partners

2. **SAP HANA System Replication** (initial solution):
   DATA and LOG content is continuously transferred to secondary site under control of SAP HANA database
   - Fast switch-over times because secondary site can preload DATA
   - First synchronous implementation available since SAP HANA SPS05
   - Asynchronous implementation offered with SAP HANA SPS06

3. **SAP HANA System Replication** (extended solution):
   DATA content is only initially transferred to secondary site, afterwards continuous LOG transfer and LOG replay on secondary site
   - LOG is provided to secondary site on transactional basis (COMMIT) controlled by SAP HANA database (including initial DATA transfer)
   - Fastest switch-over times, sec. site preloaded and rolled forward on COMMIT basis
   - Synchronous and asynchronous implementation offered with SAP HANA SPS11
SAP HANA Disaster Recovery: Storage Replication
Cluster across Data Centers

OS: Mounts

Primary

Name Server
Index server

Name Server
Index server

Name Server
Index server

Data Center 1

Secondary (inactive)

Name Server
Index server

Name Server
Index server

Name Server
Index server

Data Center 2

Storage Mirroring

HA Solution Partner

Clients

Application Servers

OS: DNS, hostnames

Data
Volumes
Log Volume

Data
Volumes
Log Volume

Data
Volumes
Log Volume

Data
Volumes
Log Volume
SAP HANA Disaster Recovery: Storage Replication
Cluster across Data Centers with QA & Dev. on 2nd site

Data Center 1
OS: DNS, hostnames

Primary
- Name Server
- Name Server
- Name Server
- Index server
- Index server

OS: Mounts
- Data Volumes
- Log Volume

Data Center 2
OS: Mounts
- Data Volumes
- Log Volume

Secondary
- Prod. (inactive), QA&DEV (active)
- Name Server
- Name Server
- Name Server
- Index server
- Index server

HA Solution Partner
- Storage Mirroring
- Clients
- Application Servers
SAP HANA Disaster Recovery: System Replication
Cluster across Data Centers with DB controlled transfer
SAP HANA Disaster Recovery: System Replication
Cluster across Data Centers with QA & Dev on 2nd site

Data Center 1
- OS: DNS, hostnames, virt. IPs
- HA Solution Partner
- Primary (active)
  - Name Server
  - Name Server
  - Index Server

Data Center 2
- HA Solution Partner
- Secondary
  - Name Server
  - Index Server
  - Server
  - HANA database kernel
  - Transfer by
  - PRD shadow operation

Clients
- Application Servers
  - QA/DEV running
  - QA/DEV running
  - PRD running
  - PRD running

OS Mounts
- Data Volumes
- Log Volumes
- Data Volumes
- Log Volumes
SAP HANA High Availability: System Replication
Minimal setup in one Data Center for fast takeovers

Data Center 1

OS: DNS, hostnames, virt. IPs

Primary (active)
- Name Server
- Index server
- Internal Disks
- Data Disks
- Log Disks

Secondary (active, data pre-loaded)
- Name Server
- Index server
- Internal Disks
- Data Disks
- Log Disks

Transfer by HANA database kernel

HA Solution Partner

Clients

Application Servers

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
SAP HANA in Data Centers
Video about SAP HANA System Replication

Videos about SAP HANA by the SAP HANA Academy on YouTube:

SAP HANA System Replication

1. Concepts
2. Setup Replication
3. Full-SYNC
4. Configuration Parameter
5. Disable Replication
6. Take-over
7. Near Zero Downtime upgrade
8. Fail-back
9. Multi-Tier
10. Online addhost

Corresponding Blog
SAP HANA in Data Centers:
Availability of solutions and detail papers

High Availability per Data Center

**Host Auto-Failover** (Scale-Out with Standby)

**System Replication**
Paper with detail documentation on SCN: [https://scn.sap.com/docs/DOC-47702](https://scn.sap.com/docs/DOC-47702)

High Availability across Data Centers – Disaster Recovery

**Storage Replication**: Existing validations documented in SAP note [1755396](https://scn.sap.com/docs/DOC-1755396)
Mirroring solutions depend on partner technologies
Further detailed information about the solutions offered by partners directly.
No certification necessary and hardware/software partners responsible for the implementation and correctness

**System Replication**: since HANA SPS5, (End 2012)
Rarely partner related, probably external cluster management for take-over or switch-back automation


Further HA documentation: [SAP Note 2407186](https://scn.sap.com/docs/DOC-2407186)
SAP HANA in Data Centers
Cluster Manager with direct SAP HANA Support

**HP Service Guard**
- Directly available from HP and HP drives the implementation process
- Link for further information:
  - User Guide: Managing HP ServiceGuard Extensions for SAP for Linux, December 2013

**SUSE HAE – RedHat HAA**
- Included with “SUSE SLES for SAP Applications” and “RedHat RHEL for SAP Applications”
- Blog: Fail-Safe Operation of SAP HANA®: SUSE Extends Its High-Availability Solution
- Setup Guide: SAP HANA System Replication on SLES for SAP Applications
- Video: https://www.youtube.com/watch?v=yXH7ZkWN-qM
- RedHat: Automated SAP HANA System Replication with Pacemaker on RHEL – Setup Guide

**SAP Landscape Virtualization Manager (SAP LVM)**
- Since Release 2.1 integrated, earlier releases need consulting package (Infrastructure Kit)
- Adaptation to local environment or resources (virtual IP addresses) necessary
SAP HANA in Data Centers
Cluster Manager with direct SAP HANA Support

Veritas ApplicationHA
- General Info: https://www.veritas.com/product/business-continuity/applicationha#sap-hana
- Solution Brief: Virtualizing SAP HANA with confidence using Veritas ApplicationHA
- Video: Virtualizing SAP HANA with confidence using Symantec ApplicationHA
- Solution Guide: http://www.veritas.com/docs/000023431

Veritas InfoScale Availability / Cluster Server:
- Solution Brief: (coming soon)
- Agent information
  - including installation and configuration guides available at http://sort.veritas.com/agents
  - located under "Application Agents" → "SAP HANA Platform 1.0 (SPS08, SPS09, SPS10, SPS11, SPS12 expected with corresponding DSP)"

Note: No solution certification is offered for cluster managers. Support is handled by solution partner directly.
SAP HANA in Data Centers
Cluster Manager with direct SAP HANA Support

NEC EXPRESSCLUSTER X

- Blog  
- Global site  
- Press Release  
  NEC launches solution to improve availability of SAP HANA (r) run on AWS

Other cluster managers

- In pipeline or can be adapted with individual consulting packages

Note:
No solution certification is offered for cluster managers. Support is handled by solution partner directly
SAP HANA in Data Centers
Cluster Manager with direct SAP HANA Support

IBM – System Automation for Multi platforms (Tivoli)
SAP HANA System Replication High Availability Policy

Links:
- Product download: TSA 4.1.0.2 fix pack
- Documentation: SAP HANA System Replication high availability policy
  http://www.ibm.com/support/knowledgecenter/SSRM2X_4.1.0.2/com.ibm.samp.doc_4.1.0.2/sampicpart4sapha_HANA.html
- IBM Product Support:
  http://www-03.ibm.com/software/products/de/tivosystautoformult
Downtime optimized take-over Setups
Client setup with virtual hostnames
Zero Downtime maintenance
Featured by SAP NetWeaver ABAP stack

As an evolution of “Near Zero Downtime Maintenance”, since SPS07 HANA offers

**Zero Downtime Maintenance**

- Based on **connectivity suspend** feature of the SAP NetWeaver ABAP stack (SAP note 1913302)
  - DBSL of the database interface decouples transaction management between ABAP and HANA database
  - This keeps transaction on ABAP layer alive and allows to change components (software versions) on the layers below on secondary (shadow) HANA instance
- Hardware mix (SAP note 1984882 - Using HANA System Replication for Hardware Exchange with minimum Downtime)
- Working between single host to single host or scale-out to scale-out setup
Zero Downtime Maintenance for SAP HANA
Revision Update

1. **SAP NetWeaver ABAP Server**
   - **DBSL**
   - **SAP HANA Version**
   - **Walldorf**
     - Primary
     - Secondary
     - Transport incremental data
     - Sync/Async mirrored redo log writing

2. **SAP NetWeaver ABAP Server**
   - **DBSL**
   - **SAP HANA Version +1**
   - **Walldorf**
     - Primary
     - Secondary
     - Transport incremental data
     - Sync/Async mirrored redo log writing
   - **Cluster Manager (e.g. SUSE Cluster)**
   - **Connectivity Suspend**
   - **Take-over**

3. **SAP NetWeaver ABAP Server**
   - **DBSL**
   - **SAP HANA Version +1**
   - **Walldorf**
     - Primary
     - Secondary
     - Transport incremental data
     - Sync/Async mirrored redo log writing
   - **Cluster Manager (e.g. SUSE Cluster)**
   - **3. Re-initiate**

---

**HANA Planned Downtime**

1. **Update**
2. **Reconfigure**
3. **Re-initiate**

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
SAP HANA High Availability: Takeover Procedure
In case of outage

1. Rebuild
2. Reconfigure
3. Re-initiate

DNS - virtual Hostname

SAP NetWeaver ABAP Server
DBSL

Sync/Async mirrored redo log writing
Transport incremental data

Walldorf
Primary
SAP HANA Data Log
Secondary
SAP HANA Data Log

Cluster Manager (e.g. SUSE Cluster)

virtual IP

DNS - virtual Hostname

SAP NetWeaver ABAP Server
DBSL

Sync/Async mirrored redo log writing
Transport incremental data

Walldorf
Primary
SAP HANA Data Log
Secondary
SAP HANA Data Log

Cluster Manager (e.g. SUSE Cluster)

virtual IP

SAP NetWeaver ABAP Server
DBSL

Sync/Async mirrored redo log writing
Transport incremental data

Walldorf
Primary
SAP HANA Data Log
Secondary
SAP HANA Data Log

Cluster Manager (e.g. SUSE Cluster)

virtual IP

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
1. Initial situation
- SAP NetWeaver is connecting to SAP HANA via the DBSL (Database Shared Library)
- Usually a virtual hostname (virt. IP address) is used to access the database host and the database instance on that host. Usually the Domain Names Service (DNS) translates virtual hostnames into corresponding virt. IP addresses which can move between network adapter ports.
- SAP HANA System Replication is working and secondary is in a synchronous or asynchronous state with primary SAP HANA instance
- System Replication always tries to get in some kind of synchronous state (not guaranteed) although configured as ASYNC
- Of course with SYNC setup the primary waits for secondary to confirm operation of COMMITs

2. Incident happens, Take-over executed
- A cluster manager is checking on operational state of the setup and takes action if a failure is happening
- In case of this failure the cluster manager would isolate the box (drag virt. IPs away, even send a STONITH command) to prevent any further usage of primary host
- The orchestrator "cluster manager" also initiates the take-over, waits for the secondary to prompt the full operational state and finally moves the virtual IP address to the secondary host network port.
- With the move of the virtual IP address finally there is a living system again behind this interface and SAP NetWeaver sessions with work-processes can be reconnected to the secondary database instance

3. Follow-up and re-initiate SAP HANA System Replication in reverse direction
- Every committed transaction and related changes are available again on the take-over system.
- Afterwards the recreation of the HA or DR has to happen with the rebuild of the hardware, maybe reinstall a blank installation or revive of SAP HANA and reconfigure it to be a secondary System Replication host.
- Initiate the resynchronization between new secondary and primary instance. The resync will probably take some time.
- Here SAP HANA automatically choses the optimal way to fulfill this task of execution (delta-transfer).
- Only after this resync a takeover back to the initial situation (failback) can be started.
Worldwide Data Center Setups
Multi Tier System Replication – Cascading Systems

Tier 1
Production

Tier 2
Local shadow with data preload

Tier 3
Remote system/shadow with or without preload (mixed usage together with non-prod. operation)

Data Center
Sync

Tier 1  2
Tier 2  3

SYNCMEM
SYNC

ASYNC
ASYNC

SAP Note 2303243 – SAP HANA Multitier System Replication – supported replication modes between sites with SPS11: ASYNC&ASYNC, SYNCMEM&SYNC
(Of course, distance (latency) will rule the use of replication mode options!)
SAP HANA System Replication
Log Replication Modes: Improved Asynchronous – ASYNC Buffer

SAP HANA offers the shown log replication modes

Improvement for ASYNC

- With SPS 07 the ASYNC mode has been changed in a way that additionally to the buffering capabilities of the Operating System, an additional memory buffer inside HANA was added and operated with signaling semaphores. This introduces another decoupling with possibly limited resources (short term) on OS or HW side when it comes to ASYNC operation.

The size of the intermediate buffer can be changed with the following parameter (here with default size):

- \([\text{system replication}] / \text{logshipping\_async\_buffer\_size} = 67108864\]

It is sufficient to set the parameter only for services with high log generation (e.g. in \text{indexserver.ini}) to save memory with other services. It is not necessary to set it globally.

Using the following parameter, the behavior in case of buffer full can be change (with default setting):

- Transactions and their log transfer are waiting for free space in the buffer, if it’s full \([\text{global.ini} / \text{system replication}] / \text{logshipping\_async\_wait\_on\_buffer\_full} = \text{true}\]

<table>
<thead>
<tr>
<th>Log replication modes</th>
<th>Since</th>
<th>Short name in system table SR_REGISTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous</td>
<td>SPS 05</td>
<td>SYNC</td>
</tr>
<tr>
<td>Synchronous in Memory</td>
<td>SPS 05</td>
<td>SYNCMEM</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>SPS 06</td>
<td>ASYNC</td>
</tr>
<tr>
<td>“Full SYNC option”</td>
<td>SPS 08</td>
<td>SYNC</td>
</tr>
</tbody>
</table>

**ASYNC operation:**

Primary

- Transaction

Secondary

- Buffer

Data

Log

Data

Log
SAP HANA System Replication
Synchronous Log Replication with Full SYNC option

Log Replication “Synchronous with Full Sync Option”

Available since
• SPS 08

Viewed in system table SR_REGISTER as
• SYNC (Full Sync is configured via configuration parameter)

Description
• Log write is successful, when the log buffer has been written to the log volume of the primary and the secondary instance. In addition, when the secondary system is getting disconnected (e.g. because of network failures), the primary systems suspends transaction processing until the connection to the secondary system is re-established. No data loss occurs in this scenario.

Implementation
• The replication mode Synchronous can be configured with the full sync option by setting the following configuration parameter on the primary site:
  * global.ini/[system_replication]/enable_full_sync = true.
  * hdbnsutil -sr_fullsync [--enable|--disable]

Replication mode most interesting for financial institutes
Network design options for System Replication

System Replication over separate network

Site 1
- Host s1h1
- Host s1h2
- Host s1h3
- Internal Network 192.168.*

Site 2
- Host s2h1
- Host s2h2
- Host s2h3
- Internal Network 192.168.*

Client Applications
- Public Network 10.0.*
- Separate Replication Network 10.5.*
- 10.0.1.*
- 10.5.1.*
- 10.0.2.*
- 10.5.2.*

Host Configuration:

**global.ini**

[communication]

`listeninterface=internal`

[internal_host_resolution]
- 192.168.1.1=s1h1
- 192.168.1.2=s1h2
- 192.168.1.3=s1h3

[System_replication_communication]

`listeninterface=glocal` (not for Multi-Tier allowed)

[system_replication_hostname_resolution]
- 10.5.2.1=s2h1
- 10.5.2.2=s2h2
- 10.5.2.3=s2h3

Optionally configurable with global.ini:

[public_hostname_resolution]
**SAP HANA in Data Centers**

**Bandwidth considerations for System Replication**

**SAP How-To Guide:**

Network requirements for System Replication ([Link](#))

1. “Throughput”: Out of practical reason it must be possible to transport the size of the persistently stored data within one day from the primary to the secondary.

2. “Latency”: In case of SYNC operation:
   The redo log shipping wait time for 4 KB log buffers must be less than a millisecond or in a low single-digit millisecond range – depending on the application requirements (relevant for synchronous replication only).

- More info with [SAP HANA Network Requirement Paper](#) or [SAP note 1969700](#) contains among others an SQL statement (in zip archive attached) to estimate the average (per day) bandwidth required for SAP HANA System Replication depending on the data and log amount per day

- Example for a bandwidth calculation:
  Given: 4.3 TB of persistently stored data (sum of data backup file sizes).
  Throughput: 4.3 TB per day ⇒ ~ 50 MByte/s
  ⇒ ~0.5 GBit/s minimum connection required
SAP HANA System Replication
SAP HANA Multitenant Database Containers

SAP HANA Multitenant Database Containers
- SAP HANA System Replication can be used to replicate the whole system
- The replication process treats the complete collection of tenant containers as one
- HA&DR is the intention of this first support
- Replication of a single tenants to an individual location not possible

Further information with SAP Note 2092793
Optimized Delta-Data transfer

In Multi-Tier environment – Tier 3 rebuild is now using a delta process if possible

Possibility of part-time extraction and operative usage of Multitier members

- Temporarily extract a Tier with a take-over command into online mode
  - Alternatively the desired Tier can also be shut down to offline
- Don’t disable replication or unregister Tier
  - This will delete the HANA-internal snapshot necessary for the delta sync
- Following Parameter in `global.ini` controls the retention time for HANA-internal snapshots (default: two hours)
  - `[system_replication] datashipping_snapshot_max_retention_time = 120`
  - After this time the HANA-internal snapshot – necessary for a delta sync – is deleted
  - With extending this parameter, snapshots are kept longer
  - The longer a snapshot is kept the more delta-data shipment is necessary for reconnection
  - Extending the parameter to one or more days will anyway result effectively in a full transfer with the regular data changes happening on Primary
- No further administration necessary
  - Snapshot are created with last delta-data transfer automatically and dropped if not necessary any more

Use cases

- Test a take-over with System Replication and re-couple after execution again
- Rearrange Tiers: E.g. coupling of Tier3 with Tier1 because Tier2 is failing
SAP HANA System Replication
Log & Data Transfer Compression

Log & Data Transfer Compression (lossless algorithm LZ4) with SAP HANA System Replication

Compression can be used to reduce traffic on data exchange between sites especially over long distance

Can be used …
- For initial data transfers
- For sub sequential delta-data transfers
- For continuous redo-log transfers

Configuration parameter in global.ini
- [system_replication]
  enable_log_compression = true (default = false)
  enable_data_compression = true (default = false)
- By default content compression is turned off
- Log Buffer tail compression (default = true) and Log Buffer content compression can be combined

As an alternative, also zlib can be offered

History of transfer compression in SAP HANA System Replication
- Log
  - Log Buffer tail compression (SPS 07)
  - Log Buffer content compression (SPS 09)
- Data
  - Data page compression (SPS 09)
Online AddHost & RemoveHost in Secondary

- On Primary and Secondary
  - As of SPS 09 system replication need not be turned off when adding or removing a host
  - Operation can be done with hdblcmm or preferably hdblcmmgui
- Process for AddHost
  - Start on Secondary (1) with addition process and then move to Primary (2)
  - Add a host to the secondary site and start it – starts as a standby and the coordination process to primary side begins (this can take a little)
  - Add a host to the primary site and start it – as soon as this one is active the Secondary can find its counterpart
  - Replication begins automatically
  - With this order of adding the hosts the primary does not operate with a missing secondary
- Process for RemoveHost
  - To remove a host, first remove it from the primary site and then remove the host from the secondary site (reverse execution compared to AddHost)
Explicit alerts for SAP HANA System Replication

- Existing Alerts made more prominent and show themselves not as “Internal Events” any more
- Own event or alert names
  - System Replication Connection Closed (Alert ID 78)
  - System Replication Configuration Parameter Mismatch (Alert ID 79)
- Alerts only visible with an embedded Statistics Server (ESS)
- Backwards compatible
  - Old style alerts are still generated in order not to invalidate any reporting infrastructure after upgrade
  - Old alerting can be disabled by setting the following configuration parameter in global.ini:
    [system_replication]
    keep_old_style_alert = false (default=true)

Tile on the main screen

- Type of landscape
  (2 tier or 3 tier)
- Sums up the status info underneath
- Presents synchronization mode for the first replication in chain

The following states can be shown:

- Not configured (meaning system replication is not configured)
- Active and in sync (green square)
- All services are active but not yet in sync yet (yellow triangle)
- Errors in Replication (red circle)
Behind the main screen tile

Lists involved systems in order of their relationships
The upper part sums up the chain of systems in case of Multi Tier system replication

- The mentioned avg. write times are related to log writing
  - Values on ASYNC connects usually are smaller because of OS buffering
- Avg. Log Buffer Size is the Log info which is ...
- SY stands for SYNC
- AS stands for ASYNC
Continuous log replay
(Pure log-based transfer)
• Redo Log is processed immediately on secondary (Commit based)
• No more delta-data transfer necessary
• Reduced take-over times
• Network traffic significantly reduced
• Automatic initial data transfer still supported
• Compatible to the current set of operation commands – optimization under the hood
• Operations mode delta data shipment still supported

Build the foundation for active/active operations (planned beyond)
SAP HANA System Replication
Re-sync Optimization (for reconnect and failback) – Data vs. Log Retention

**Data Retention** (delta data shipping)

- After reconnect or failback the primary sends incremental data, if last snapshot is still available.
- How long the last snapshot that was sent to the secondary is kept depends on the parameter value of `datashipping_snapshot_max_retention_time` (default: 120 minutes).
- Otherwise a full set of data is shipped.

**Log Retention** (log replay)

- After reconnect or failback the primary sends incremental log, if the parameter `enable_log_retention` is on.
- `logshipping_max_retention_size` defines the maximum amount of log segments that are kept on primary side for syncing a secondary system, i.e. that are not re-used (default 1 TB).
- Log segments will not be freed, while the secondary is disconnected.
- Full & delta backups can be used from Primary to recover Secondary.
- After take-over no delta backups are allowed before a new backup history is started on Sec. with a full backup first.
# SAP HANA System Replication

## Re-sync Optimization (for reconnect and failback) – RetainedFree

<table>
<thead>
<tr>
<th>Service/Volume</th>
<th>Service</th>
<th>Total Volume Size (MB)</th>
<th>Log Volume Size (MB)</th>
<th>Path</th>
<th>Storage Device ID</th>
<th>Total Disk Size (MB)</th>
<th>Used Disk Size (MB)</th>
<th>Free Disk Size (MB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>id2131:31901</td>
<td>nameserver</td>
<td>1,729</td>
<td>320</td>
<td>/disk1/meck/M19/data/mnt00001/hdb00003</td>
<td>346627</td>
<td>1,407,904</td>
<td>929,796</td>
<td></td>
</tr>
<tr>
<td>id2131:31903</td>
<td>indexserver</td>
<td>51,889</td>
<td>29,359</td>
<td>/disk1/meck/M19/data/mnt00001/hdb00003</td>
<td>346627</td>
<td>1,407,904</td>
<td>929,796</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td></td>
<td>29,359</td>
<td>29,359</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003</td>
<td>346627</td>
<td>1,407,904</td>
<td>929,796</td>
<td></td>
</tr>
<tr>
<td>Log</td>
<td></td>
<td>22,529</td>
<td>22,529</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003</td>
<td>346627</td>
<td>1,407,904</td>
<td>929,796</td>
<td></td>
</tr>
</tbody>
</table>

### Details for Log Volumes of Service: 'indexserver' (id2131:31903)

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Total Size (MB)</th>
<th>Used Size (MB)</th>
<th>Used/Total Size (%)</th>
<th>State</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>logsegment_000_0000000.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000001.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000002.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000003.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000004.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>Writing</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000005.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000006.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000007.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000008.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000009.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000010.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000011.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
<tr>
<td>logsegment_000_0000012.dat</td>
<td>LOG</td>
<td>1.024</td>
<td>1.024</td>
<td>100</td>
<td>RetainedFree</td>
<td>/disk1/meck/M19/log/mnt00001/hdb00003/</td>
</tr>
</tbody>
</table>

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
Comparison between delta_datashipping and logreplay with regards to network traffic showing the expected

- (measurements done with itop Linux tool capturing network traffic every 5 minutes):
  - Delta data shipping: peaks roughly every 10 minutes (when delta data shipping is triggered)
  - Logreplay: no peaks – continuously shipped log buffers
  - No LOG compression used in this example
Dual purpose use – running non-PROD on Secondary
Worst case memory requirement for shadow PROD operation: Persistent data – LOB data
• „Persistent data“ is all relevant content from data volumes loaded in memory
• „LOB data“ are large (binary/character) objects which are usually kept on disk (hybrid LOBs)
• Presumably half of Secondary occupied with shadow PROD operation

First sizing formula to evaluate situation from live systems:
Size of loaded column tables (in-memory)
  + RowStore size
  + 50 GB (for log replay operation)

Size of loaded column tables:
• select round(sum(memory_size_in_total)/1024/1024/1024) size_GB from m_cs_tables;

RowStore size:
• select host, round(sum(page_size * USED_BLOCK_COUNT)/1024/1024/1024,2) as "RowStore Size GB"
  from m_data_volume_page_statistics
  where page_sizeclass = '16k-RowStore'
  group by host;
Dual purpose use – running non-PROD on Secondary

Worst case memory requirement for shadow PROD operation:

- Depends on the size of the RowStore
- Shadow operation is only active to take streams (data & log) for local storage
- Preload is deactivated because resources are blocked by the non-PROD operation

Sizing formula to predict resource demands for PROD shadow operation:

Size of RowStore

+ 20 GB or 20% of RowStore size (take the bigger one) for shadow operation

RowStore size:

- `select host, round(sum(page_size * USED_BLOCK_COUNT)/1024/1024/1024,2) as "RowStore Size GB" from m_data_volume_page_statistics where page_sizeclass = '16k-RowStore' group by host;`
ProxyViews

For easier monitoring and reporting of the secondary site statistics, like

- detailed memory consumption,
- I/O-load and more

remote access via SQL is introduced on the primary site.

This feature is realized by providing proxy schemas and views on the primary site, which extract the corresponding information from the monitoring views on the secondary site.

A new schema is available on the primary site named

SYS_SR_SITE_<siteName>

where <siteName> is equivalent to the case-sensitive name used to register the secondary site.

Note:

- Views can have an additional "<viewname>_RESET" view, e.g., "M_HEAP_MEMORY_RESET"
- Allows to reset the counters for a monitoring session on the selected view

Limitations

- Monitoring view access only possible, if primary and secondary run with exactly the same software version
HA/DR Provider Framework now offers an active “communication” channel

- Possibility to inform external entities about activities inside of SAP HANA operations
- **New:** Communication with an external cluster manager to inform about trouble on the connection to Secondary
- Detailed documented in [SAP HANA Admin Guide](#) with detailed code examples
- A Python script provides hooks that can be called in response to events during System Replication process or state change (see table)
- Parameter section in `global.ini`:
  
  `[ha_dr_provider_<classname>]`
  
  - `provider =` : The class name
  - `path =` : Location of the script
  - `execution_order =` : The ordering of the HA/DR Provider if there is more than one; this is a number between 1 and 99

<table>
<thead>
<tr>
<th>Name</th>
<th>Trigger</th>
<th>Caller</th>
<th>Landscape</th>
<th>Error behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>startup()</td>
<td>Beginning of nameserver’s startup phase</td>
<td>Starting nameserver</td>
<td>Each host individually</td>
<td>Nameserver aborts, startup is cancelled</td>
</tr>
<tr>
<td>shutdown()</td>
<td>Just before the nameserver exists</td>
<td>Stopping nameserver</td>
<td>Each host individually</td>
<td>Error trace is written</td>
</tr>
<tr>
<td>preTakeover()</td>
<td>As soon as the hdbnsutil -sr_takeover command is issued</td>
<td>Master nameserver</td>
<td>Called only once on the master</td>
<td>Takeover is aborted</td>
</tr>
<tr>
<td>postTakeover()</td>
<td>As soon as all services with a volume return from their assign-call (open SQL port)</td>
<td>Master nameserver</td>
<td>Called only once on the master</td>
<td>Error trace is written</td>
</tr>
<tr>
<td>srConnectionChanged()</td>
<td>HA/DR Provider hook for system replication connectivity changes: As soon as one of the replicating services loses or (re-)establishes the system replication connection</td>
<td>Master nameserver</td>
<td>Called only once on the master</td>
<td>Error trace is written</td>
</tr>
</tbody>
</table>
Existing storage replication solution certifications for all SAP HANA appliances continue their validity

Solutions reported in SAP note 1755396

All newer solutions are supported directly by corresponding vendors (hardware and/or storage partners)

No further certification of these storage replication solutions by SAP for use with SAP HANA

With the huge pool of certified technologies by SAP ICC for SAP HANA tailored data center integration (TDI), SAP HANA can use a lot of option of these hardware and technology vendors
**SAP HANA Disaster Recovery**

**News with SAP HANA SPS12 and Beyond**

---

### System Replication extension

- **Today**
  - Start developing Active/Active Operation (r/e reporting on Sec.)
    - Delivery not before End of 2016
  - Improved SAP HANA Cockpit
    - Support for HotStandby in Cockpit
    - Integration of Offline Cockpit in Secondary Management
  - Improved monitoring and alerting of secondary site
  - MDC tenant take-over optimizations for System Rep.
  - Multi-tier System Replication network optimizations (ASYNC&ASYNC)
  - Using Storage Snapshots for initial load operations to secondary
  - Automatic Parameter transfer to Tiers

- **Planned Innovations**
  - Delivering first release of Active/Active operation
    - Read-enabled (r/e) access to Secondary
    - Different access methods from application site
    - Always consistent view on Secondary
    - New operation mode
      - logreplay_readaccess
    - Load Balancing based on different criteria
    - Scale-Out Support
    - Dynamic Tiering supporting System Replication

- **Future Direction**
  - Extension of Active/Active
    - Multi-Tier System Replication
    - Dynamic Tiering support
  - Multi target system replication from one Primary (star-like configurations)
  - Multi-streaming for initial data transfer
  - Time delay option between sites
  - Time travel via internal snapshots on secondary system to handle logical errors
  - Backup on secondary system
  - Create Secondary out of native DB backup

---

**SAP HANA SPS12**

---

*This is the current state of planning and may be changed by SAP at any time.*
In a multitier system replication scenarios additional replication mode combinations are now supported

Depending on the latency between two sites only certain combinations could be useful

- Latencies above a “small one digit number of milliseconds” will still need to be operated with ASYNC (usually distances more than 50-100 km).
- SAP Note 2303243 (SAP HANA Multitier System Replication – supported replication modes between sites) releases already some combinations backported to SPS 11

Idea is to offer greater flexibility and allow simpler update operations

- With updates of such chains a Tier 1 could be moved virtually behind Tier 3 as a secondary while Tier 2 takes the lead (gets primary role)
Snapshot data backups for setting up SAP HANA System Replication initialization

If the primary connection between datacenters is to weak for an initial data load (usually TBs) then this option comes handy:

Execution steps

1. Create a IO consistent binary storage copy from the primary system for the data persistence of all services. You can use snapshot technologies to capture an IO consistent data persistence state.
   - Info: If you cannot use the method above, create a consistent OS copy of data persistence while the primary site is stopped.
2. Create a full copy of the data persistence using these captured snapshots on a media of choice and transport it to the secondary site.
3. Use the tools of the storage vendor (or OS) to replace the data persistence on the secondary system by the IO consistent storage copy from primary when secondary instance is shut down.
4. Register the secondary system without [--force_full_replica].
5. Start the secondary system
   - During start-up SAP HANA System Replication will evaluate the relationship with primary site and request a resync.
   - Afterwards a small last delta-data shipping will probably take place to fill the gap (faster than log redo).
   - In parallel also log is already transferred.

![Diagram of HA & DR - What's New in SPS 12?](image)
HA & DR – What’s New in SPS 12?
Automatic transfer of database parameter and SSFS root key changes

Automated transfer of parameter / key changes to secondary instances to minimize manual changes and risk of human errors.

Monitoring INI File Parameter Changes and Replication
- The configuration parameter checker reports on any differences between primary, secondary, and tier 3 secondary systems
- It is possible to replicate the .ini file parameters based on alerts.
- The parameter replication can be enabled to all sites.

SSFS encryption root key: Replication of key changes to secondary instances
Up to SPS 11 encryption root keys had to be changed in the Secure Store File System (SSFS) on every instance in System Replication chains manually.
With SPS12 also these root keys are automatically replicated to tier 2 and tier 3 secondary systems
With SPS12 and Multi-Tier System Replication alerts can be displayed on Primary

Alert Management on tier 2 or tier 3 can create local alerts transferred to global Primary alerts

- With SPS12 six important operation alerts can be created on Secondaries using local alert management and stored in local M_EVENTS
- Monitoring data from other tiers is presented in ProxyViews on Primary
- HANA Cockpit can combine the different sources of alerts from local and remote
- Next to the six secondary alerts, Primary can create alerts using ProxyViews from Secondary datasources

Primary (Tier 1) also has its own Alerting writing to his local M(EVENTS

- Alerts are jointly presented on Primary
Primary-based Alert generation

In a system replication scenario, alerts issued by secondary system hosts can be monitored with the Alerting Host & Port information in the Alerts app of the SAP HANA cockpit.

This allows you to ensure availability of secondary systems by addressing issues before an actual failover.

**Alerts shown in SAP HANA System Replication Application in HANA Cockpit**

"DiskFull" Alert from proxy version of M_EVENTS by Tier-3.
(The DB Admin should know, that the shown host ld2133 belongs to Tier-3)

<table>
<thead>
<tr>
<th>ID</th>
<th>Alerts locally created on Tier-2 and Tier-3 reported on Primary</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Savepoint duration</td>
</tr>
<tr>
<td>72</td>
<td>Number of Log Segments</td>
</tr>
<tr>
<td>21</td>
<td>Internal Event</td>
</tr>
<tr>
<td>30</td>
<td>Check internal disk full event</td>
</tr>
<tr>
<td>78</td>
<td>Connection between systems in System Replication setup</td>
</tr>
<tr>
<td>89</td>
<td>Missing Volume File</td>
</tr>
</tbody>
</table>
New Alert: 94 – Log replay backlog for system replication secondary

If the redo log replay shows a delay in processing, an alert is created to show this problem with the roll forward of the redo log.

This situation doesn’t relate to SYNC state:
- Replay of log is always decoupled from the replication process.
- Redo log is still synchronously replicated and stored persistent in Log Volumes.
HA & DR – What’s New in SPS 12?

New consolidated view M_SYSTEM_REPLICATION for System Replication

System View M_SYSTEM_REPLICATION now offers a consolidated view on System Replication

Also Multi-tier System Replication relationships are better visible with its properties

```
select * from M_SYSTEM_REPLICATION
```

<table>
<thead>
<tr>
<th>SITE_ID</th>
<th>SITE_NAME</th>
<th>SECONDARY_SITE_ID</th>
<th>SECONDARY_SITE_NAME</th>
<th>REPLICATION_MODE</th>
<th>REPLICATION_STATUS</th>
<th>OPERATION_MODE</th>
<th>TIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SiteA</td>
<td>2</td>
<td>SiteB</td>
<td>SYNC</td>
<td>ACTIVE</td>
<td>logreplay</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>SiteB</td>
<td>3</td>
<td>SiteC</td>
<td>ASYNC</td>
<td>ACTIVE</td>
<td>logreplay</td>
<td>2</td>
</tr>
</tbody>
</table>
System View M_SERVICE_REPLICATION got 2 new columns for Continuous Log Replay

Better visibility into replication process:

- **REPLAY_LOG_POSITION**
  - Latest log position rolled forward on Secondary
- **REPLAY_LOG_POSITION_TIME**
  - Time stamp of the last log information rolled forward on Secondary
SAP HANA in Data Centers:
Agenda

Introduction & Overview
Design & Setup
Persistence
Backup & Recovery (System Copy)
High Availability
Disaster Recovery

Monitoring & Administration
Security & Auditing
Tools for Managing SAP HANA Systems and Landscapes
Which tool to use, for what…

Native Tools for SAP HANA Database Administration

SAP HANA Cockpit
Use it for: Core administration and detailed monitoring of a single SAP HANA database
- Web-based SAP Fiori launchpad
- Runs on SAP HANA XS Classic

SAP DB Control Center
Use it for: Administration and monitoring of the entire SAP HANA database landscape
- Web-based SAP Fiori launchpad
- Runs on SAP HANA XS Classic

SAP HANA Studio
Use it for: SAP HANA basic administration tasks and development including modeled views
- Eclipse-based IDE
- No longer in feature development

SAP Solution Manager
Use it for: End-to-end root cause analysis and unified alert inbox for entire landscape and for business process reporting
- Central alerting and monitoring infrastructure
- Runs on SAP NetWeaver AS for ABAP

SAP Landscape Management
Use it for: Automating advance SAP HANA operations and avoiding business downtime during maintenance activities
- Central landscape management solution
- Runs on SAP NetWeaver AS for Java

SAP IT Operations Analytics
Use it for: Obtaining a holistic view of the entire data center in real-time with additional insights to predict critical events
- Collect and analyze log and master data
- Runs on SAP HANA XS Classic
Tools for Managing SAP HANA Systems and Landscapes
Which tool to use, for what…

Native Tools for SAP HANA Database Administration

SAP HANA Cockpit

Use it for: Core administration and detailed monitoring of SAP HANA databases at both individual and landscape levels

- Web-based HTML5 user interface
- Runs on SAP HANA XS Advanced

Future Direction

SAP Landscape Management

Use it for: Automating advanced SAP HANA operations and avoiding business downtime during maintenance activities

- Central landscape management solution
- Runs on SAP NetWeaver AS for Java

SAP Solution Manager

Use it for: End-to-end root cause analysis and unified alert inbox for entire landscape and for business process reporting

- Central alerting and monitoring infrastructure
- Runs on SAP NetWeaver AS for ABAP

SAP IT Operations Analytics

Use it for: Obtaining a holistic view of the entire data center in real-time with additional insights to predict critical events

- Collect and analyze log and master data
- Runs on SAP HANA XS Classic
SAP HANA Administration and Monitoring
SAP DB Control Center and SAP HANA Cockpit

Overview

• SAP DB Control Center
  o Web-based tool for administration and monitoring of your landscape of SAP databases
  o Theme for SPS09: Support thousands of SAP Databases in Data Center or Cloud

• SAP HANA cockpit
  o Web-based tool for administration and monitoring of a single SAP HANA database
SAP HANA Administration and Monitoring
SAP DB Control Center

SAP DB Control Center
Built following the SAP Fiori design principles
- Enables monitoring on mobile devices
- Focus on usability

Landscape management for SAP databases
- Applications designed to monitor the overall health of systems located within a data center or across your enterprise
- Start and stop systems
- SAP HANA, SAP Sybase ASE, SAP Sybase IQ, ...

URL of SAP DB control center
- http://<host>[:<port>]/sap/hana/dbcc
SAP HANA Administration and Monitoring
SAP HANA Cockpit

SAP HANA Cockpit
Built following the SAP Fiori design principles
- Enables monitoring on mobile devices
- Focus on usability

Persona-oriented design principle
- Launchpad offers wide range of applications
- Applications designed to offer solutions for typical DBA tasks

Web-application installed as HANA auto-content
- Applications can be integrated in other tools via URL redirect
- Ready for cloud deployments

URL of SAP HANA cockpit
- http://<host>:<port>/sap/hana/admin/cockpit
SAP HANA Administration and Monitoring
SAP HANA Studio – Native Administration & Monitoring Console
SAP Solution Manager
SAP HANA as Part of the Customer Solution

Provide a holistic operations concept

SAP Solution Manager integrates SAP HANA and SAP HANA Studio
SAP HANA Administration and Monitoring

****Screenshots****

**SAP HANA Studio**

**DBA Cockpit in SAP Solution Manager**
Monitoring of the complete scenario
Example: BI Monitoring in SAP Solution Manager

Watch the entire application process: from data load to data presentation

- Monitoring of Technical Systems (ABAP and Java, Application Server, Scale-out Database, Servers)
- Monitoring of BI Objects (process chains, queries and templates in SAP BW system; jobs in BO system)
- SYSTEMS – grouped by BI component type (BW, HANA, SLT, Data Services, Business Objects Explorer, BO Web Applications)

Watch the entire stack: from frontend to server
The Monitoring and Alerting Infrastructure Supports SAP HANA

1. Utilize established SAP Solution Manager functions

2. Knowledge Articles explain how to handle exceptions

3. Notifications lead to Guided Procedures that document the individual steps
   - Daily/weekly/monthly HANA Database Administration tasks
   - Handling of HANA Database Alerts

4. … and provide access to required activities

Training on the Job while operating SAP HANA
End-To-End Workload Analysis
• Analyze workload across components

End-To-End Change Analysis
• Ensure compliance with standard configuration

End-To-End Exception Analysis
• Get central access to all log information

End-To-End Trace Analysis
• Investigate performance across the full stack

System, Host & Database Analysis
• Analyze capacity needs and trends per technical component

Accelerate time for problem analysis and resolution
Using Standard CTS
for SAP Business Suite on HANA

How it works?

- Develop in ABAP workbench (ABAP) or in HANA Studio (HANA Studio)
- Export HANA developments (views, stored procedures) into transport container
- Assign transport container to a transport request in ABAP Transport Organizer
- Use standard Change and Transport System (CTS) to transport and deploy changes
- For HANA systems without ABAP stack, use enhanced Change and Transport System (CTS+)

Result

- Utilize full transport system and change control of SAP Solution Manager for SAP HANA

Use well-proven technology for transport of changes
SAP Landscape Management
Tools for Managing SAP HANA Systems and Landscapes
Which tool to use, for what…

SAP Solution Manager

**Use it for:** End-to-end root cause analysis and unified alert inbox for entire landscape and for business process reporting

- Central alerting and monitoring infrastructure
- Runs on SAP NetWeaver AS for ABAP

SAP Landscape Management

**Use it for:** Automation and orchestration of SAP HANA advanced operations, accelerating migration projects and centralizing landscape operations

- Central landscape management solution
- Runs on SAP NetWeaver AS for Java

Native Tools for SAP HANA Database Administration

SAP HANA Cockpit

**Use it for:** Core administration and detailed monitoring of a single SAP HANA database

- Web-based SAP Fiori launchpad
- Runs on SAP HANA XS Classic

SAP DB Control Center

**Use it for:** Administration and monitoring of the entire SAP HANA database landscape

- Web-based SAP Fiori launchpad
- Runs on SAP HANA XS Classic

SAP HANA Studio

**Use it for:** SAP HANA basic administration tasks and development including modeled views

- Eclipse-based IDE
- No longer in feature development
**System Copy** is used to create new DEV/QAS systems that are copies of your PRD system.

**System Refresh** is used to update your existing DEV/QAS systems with the latest PRD data.

---

**Standard Procedure**

- Can take up to 7-8 business days (per) copy/refresh activity
- Time consuming post-copy/refresh processing steps; have to be performed manually
- Quality of copied/refreshed system varies with each cycle
- Incomplete coverage due to time constraints

---

**SAP LaMa Procedure**

- End-to-end automation for system copy/refresh activities (down from days to hours)
- Including post-copy/refresh automation for both ABAP and Java applications
- High service quality with built-in best practices and BDLS optimizations; offers complete coverage
- Available for SAP HANA systems deployed in AWS cloud as well (via EC2 adapter)
System Replication is used to configure a secondary system as an exact replica of the active primary system

Before

Primary HANA

SAP ERP

After

Secondary HANA

Sync / Async logreplay

Local / Remote

SAP LaMa Procedure

# Fully automated procedure

# All the prerequisite steps are automated together with built-in best practices

# Faster system setup using the storage snapshot procedure

# System Replication can be setup, monitored and disabled centrally

Standard Procedure

# Manual procedure

# 10 prerequisites steps to be performed including secondary system installation, .ini file configuration etc.

# All the steps should be performed correctly and in the right sequence for proper setup

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
SAP Landscape Management 3.0
SAP HANA Takeover

**Takeover** makes the secondary system function as the new primary (used for a disaster or a planned downtime)

**Before**

- SAP ERP
- Primary HANA
  - Sync / Async
  - Log replay
- Secondary HANA
  - Local / Remote

**After**

- SAP ERP
- NEW Primary
  - Local / Remote
- Primary HANA
  - Crossed out

### Standard Procedure

**# Manual procedure**

- # Does not perform IP-switch for SAP applications; does not stop the primary in case of a planned downtime
- # All the steps should be performed in the right sequence to ensure a successful takeover

### SAP LaMa Procedure

**# Fully automated procedure**

- # Includes IP-switch and stop of primary (checks and confirms stop of primary site in case of a unplanned downtime as well)
- # Faster response to unplanned downtimes and disasters
nZDM Takeover is used to minimize “planned” business downtime during a takeover to secondary system.

**Standard Procedure**

- # Manual procedure
- # Does not perform IP-switch for applications; does not stop the primary
- # All the steps should be performed in the right sequence to ensure a successful takeover

**SAP LaMa Procedure**

- # Fully automated procedure including “pre-loading of data” in-memory (before takeover) to speed-up takeover procedure
- # Applications are automatically quiesced/unquiesced (before and after a takeover) to ensure consistency and quick activation
- # Includes IP-switch and stop of primary system
- # Support for non-productive systems on secondary server
Failback is used to switch back to the original setup once the former primary site comes online.

**Standard Procedure**

- # Manual procedure
- # Does not perform IP-switch for applications; does not stop the secondary/primary
- # All the steps should be performed in the right sequence to ensure a successful failback

**SAP LaMa Procedure**

- # Fully automated procedure including “pre-loading of data” in-memory (before failback) to speed-up failback procedure
- # Applications are automatically quiesced/unquiesced (before and after a failback) to ensure consistency and quick activation
- # Includes IP-switch and stop/start of primary and secondary systems as required

---

**Diagram:**

- **Before:**
  - SAP ERP
  - Primary HANA
  - NEW Primary
  - Local / Remote

- **After:**
  - SAP ERP
  - Primary HANA
  - Secondary HANA
  - Local / Remote
  - Sync / Async logreplay
nZDM maintenance procedure can be used to minimize the business downtime during HANA/OS/Hardware upgrades for both primary and secondary sites.

### Standard Procedure

- **# Manual procedure**
- **# Does not perform IP-switch for applications; does not stop the secondary/primary servers**
- **# All the steps should be performed in the right sequence**

### SAP LaMa Procedure

- **# Automated procedure; does not include HANA/OS/Hardware upgrades (LaMa waits for user input until upgrade is finished)**
- **# Custom operations can be created to trigger and automate SAP HANA or OS upgrades via SAP LaMa centrally**
- **# Includes IP-switch and stop/start of primary/secondary**
- **# Includes “pre-loading of data” in-memory plus, applications are automatically quiesced/unquiesced (same as...**
SAP HANA Monitoring, Alerting, Scheduling

External monitoring tools

Use SAP Solution Manager as relay station for monitoring information for external monitoring tools.

- A lot of these tools offer SAP Solution Manager as a counterpart in these communications.

Alternatively possible by direct SQL connect to SAP HANA

- Monitoring via direct connection to SAP HANA Statistics Server
- Scheduling via SQL administration commands send directly to SAP HANA by tool
## SAP HANA Monitoring, Alerting, Scheduling

### External monitoring tools

#### List of possible monitoring tools and their support status for SAP HANA (collection in Q1/2015)

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Tool</th>
<th>Support for SAP HANA</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centerity</td>
<td>BSM, SP</td>
<td>Yes (see link, Technical Suitability Review by SAP ICC)</td>
<td>Link</td>
</tr>
<tr>
<td>Blue Medora</td>
<td>Ops MP for SAP HANA</td>
<td>Yes (see link, Technical Suitability Review by SAP ICC planned)</td>
<td>Link</td>
</tr>
<tr>
<td>DataVard</td>
<td>Canary Code</td>
<td>Yes (see link)</td>
<td>Link</td>
</tr>
<tr>
<td>syslink</td>
<td>Xandria</td>
<td>Yes (see link, confirmed by customer)</td>
<td>Link</td>
</tr>
<tr>
<td>Bradmark</td>
<td>Surveillance DB</td>
<td>Yes (see link)</td>
<td>Link</td>
</tr>
<tr>
<td>Axibase</td>
<td>AER for SAP HANA</td>
<td>Yes (see link)</td>
<td>Link</td>
</tr>
<tr>
<td>Ozsoft</td>
<td>HANA Management Pack</td>
<td>Yes (see link), add-on package for Microsoft System Center Operations Manager</td>
<td>Link</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>FlexFrame Orchestrator</td>
<td>Yes (see link)</td>
<td>Link</td>
</tr>
<tr>
<td>IBM</td>
<td>Tivoli</td>
<td>Prototype maybe available, please contact IBM directly</td>
<td>Link</td>
</tr>
<tr>
<td>BMC</td>
<td>Patrol</td>
<td>Native (planned, see link) or via SAP Solution Manager</td>
<td>Link</td>
</tr>
<tr>
<td>HP</td>
<td>Openview</td>
<td>No native support, only via SAP Solution Manager possible</td>
<td>Link</td>
</tr>
<tr>
<td>HP</td>
<td>Oneview</td>
<td>Planned (on HP’s roadmap)</td>
<td>Link</td>
</tr>
<tr>
<td>Realtech</td>
<td>The Guard</td>
<td>(tbd – in contact with Realtech product management)</td>
<td>Link</td>
</tr>
</tbody>
</table>

- If you don’t find your long-term monitoring tool of choice, please contact your tool vendor directly!
- There is no certification in place for monitoring tools. The support is managed directly by tool vendor.
SAP HANA Platform Livecycle Management – hdblcm
SAP HANA – Platform Lifecycle Management

Overview

Installation & Upgrade

- Single or Multiple Hosts
- Single or Multiple Software Components
- Multitenancy Support
- SAP HANA Options
  - SAP HANA Dynamic Tiering
  - SAP HANA Smart Data Streaming
  - SAP HANA Accelerator for SAP ASE
  - SAP HANA Remote Data Sync
- XS Advanced Runtime

Configuration

- System Scale Up/Down
- System Scale Out (Add Hosts)
- Remove Hosts
- System Copy
- System Rename
- System Landscape Directory Registration
- Convert to Multitenancy

Video for Lifecycle Management for HANA: SAP HANA Academy - Installation and Update: HDBLCM [SPS 12]
SAP HANA Platform Lifecycle Management
History of Tool Portfolio

SAP HANA SPS07
- hdblcm
  - Cmd-Line UI
  - Graphical UI
- SAP HANA lifecycle manager (HLM)

SAP HANA SPS08
- hdblcm
  - Cmd-Line UI
  - Graphical UI
- SAP HANA lifecycle manager (HLM)

SAP HANA SPS09+
- hdblcm
  - (SAP HANA database lifecycle manager)
  - Command-Line UI
  - Graphical UI
  - Web UI

Installation
Update
Configuration
SAP HANA Database Lifecycle Manager (HDBLCM)

Wrapper Tool

- **hdblcm**
  - Wrapper tool for installation, update, and configuration
  - Called during installation of server, client & studio
  - Called during update
  - Called during administration tasks

If your SAP HANA server is SPS 08 or later, and has been installed with HDBLCM, using the underlying tools instead of HDBLCM could result in an incorrectly installed SAP HANA landscape due to a missing lm_structure file required for identifying components for SAP Solution Manager. HDBLCM also offers better user interfaces as well as streamlined actions for multiple-host and multiple-component systems.
# HDBLCM and Resident HDBLCM

<table>
<thead>
<tr>
<th>Tool</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDBLCM</td>
<td><code>&lt;installation_medium&gt;/DATA_UNITS/HDB_LCM_LINUX_X86_64</code></td>
</tr>
<tr>
<td>Resident HDBLCM</td>
<td><code>&lt;sapmnt&gt;/&lt;SID&gt;/hdblcm</code> e.g. <code>/hana/shared/&lt;SID&gt;/hdblcm</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installation</th>
<th>Update</th>
<th>Uninstallation</th>
<th>Add Host</th>
<th>Remove Host</th>
<th>Configure Internal Network</th>
<th>Configure Connection to SLD</th>
<th>System Rename</th>
<th>System Registration and Unregistration</th>
<th>Install or Update Additional Components</th>
<th>Convert to MDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPS 8+</td>
<td>HDBLCM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HDBLCM (resident)
SAP HANA Database Lifecycle Manager (HDBLCM) Interfaces

- Command-line user interface (hdblcm)
- Graphical user interface (hdblcmgui)
- Web user interface – accessible from:
  - Standalone Web browser
  - SAP HANA studio
  - SAP HANA cockpit (SPS 10)
SAP HANA Database Lifecycle Manager (HDBLCM)

Usage

• HDBLCM is a back-end tool with three interfaces a number of interaction mode and parameter entry combinations.

• HDBLCM has been designed to user-friendly enough for someone who rarely uses the tool and needs flexible means of access or someone who regularly uses the tool and wants to automate their processes.
Advanced interactive mode for HDBLCM means supplying parameter values through call options and/or a configuration file, and then running interactive mode as usual.

An example use case would be for a test environment, where several SAP HANA systems run side-by-side. So, the same configuration file could be called, and only the SID and instance number would need to be unique.

Note: If parameters are specified as command-line options, they override the corresponding parameters in the configuration file. Parameters in the configuration file override default settings.
Batch mode is enabled with the call option --batch (or -b).

If all required parameters are provided, any non-specified parameters accept their default values and HDBLCM requires no additional interaction.

./hdblcm --configfile=/home/root/HANA_install.cfg -b

HANA_install.cfg

# SAP HANA System ID
sid=P01
# Instance Number (Default: 00)
number=01...
# ID of User Group 'sapuser'
Groupid=110
# SAP Host Agent (sapadm) Password
sapadm_password=Agent1234
# System Administrator Password
password=Admin1234....
# Database User (SYSTEM) Password
system_user_password=Sys1234
User Experience
The SAP HANA cockpit home page can be configured to include platform lifecycle management tiles for the actions available in the HDBLCM Web UI.

Selecting one of the platform LCM tiles in the SAP HANA cockpit redirects to a separate Web browser tab in which the corresponding action of the HDBLCM Web UI is opened.
**User Experience**

Host Addition and Host Removal Available in the Web UI

Add one or multiple SAP HANA database hosts or SAP HANA option hosts at a time using the HDBLCM Web UI.

After marking hosts for removal in the SAP HANA studio, remove one or multiple hosts using the HDBLCM Web UI.
Component installation and update in the SAP HANA database lifecycle manager (HDBLCM) Web UI now has all of the same parameter configuration options as in the command-line or graphical user interfaces.

The advanced parameters available are non-interactive parameters and the same parameters listed when you call the pass-through help in the command-line interface:

For example:

```
./hdblcm --action=install --pass_through_help -h
```

Pass-through parameters access the parameters of the underlying hdbinst and hdbupd programs.
Since SAP HANA SPS12 you can use your SAP HANA database lifecycle manager (HDBLCM) Web user interface to check for available software component updates and download them from SAP Support Portal to your local machine or a shared space with your SAP HANA host.
User Experience
Convert single container to multiple database containers (I)

Converting a single container system to an MDC system has been available since SPS 09, but it required several manual steps and wasn’t available from a UI. Now, since SPS12 the steps have been integrated in HDBLCM, in all three of the user interfaces:

• Command-line interface (hdblcm)
• Graphical user interface (hdblcmsgui)
• Web UI
During the conversion process, the system database and one tenant database are created. The tenant database contains all the data of the original system, including users, system configuration, and connection properties (port configuration).

In the Web user interface, select the gear to configure advanced parameters.

Note: These parameters are only available as call options for the command-line and graphical user interfaces.
Add and remove host roles

SAP HANA hosts are assigned host roles as part of host auto-failover between primary (worker) and standby hosts.

Since SPS 10, it has been possible to add more than one host role to an SAP HANA host. With SPS 12, it’s possible to perform the configuration from the HDBLCM Web UI.

A component must have been installed on the system before its respective host role can be assigned to the host. Likewise, the role (or the host itself) must be removed before the component can be uninstalled.
Enhancements
Update Performance Enhancements
Phased System Update for Reduced Downtime – SAP HANA Server

With a standard SAP HANA system update, the system is offline from the time the update is triggered, including the preliminary checks, and actual software switch.

The phased system update is performed in two steps:

1. Running the LCM update action with the “prepare update” flag set. This phase is performed while the system is online.
2. Running the LCM update action a second time as usual, which resumes the updates, and takes the system offline for the software switch.
SAP HANA SPS 11: Update Performance Enhancements

Optimized update for reduced downtime – SAP HANA server and SAP HANA options

HDBLCM executes…

1. Prepare
   - SAP HANA Database Server 1.1
   - Stop System 2.1

2. Finalize
   - SAP HANA Accelerator for SAP ASE 1.2
   - Check and validate, extract new binaries 1.3
   - Switch to new binaries, deploy autocontent or delivery units, restart 2.2
   - SAP HANA Smart Data Streaming 2.3
   - SAP HANA Remote Data Sync 2.4
XS Advanced support in hdblcm
SAP HANA SPS 11: XS Advanced
Installation and update of the XS advanced runtime

- SAP HANA SPS 11 includes an additional, new runtime environment for application development: SAP HANA extended application services (XS), advanced model. For more information about the XS advanced model, see the SAP HANA Developer Guide for SAP HANA XS Advanced Model.

- The XS advanced runtime is handled by the SAP HANA platform lifecycle management tools with the existing host role concept. The XS_WORKER role is by default assigned to all SAP HANA database worker hosts, and the XS_STANDBY role is by default assigned to all SAP HANA database standby hosts.

- In addition to setting host roles, the HDBLCM tool also configures the following:
  - XS advanced administrator user
  - Customer organization name
  - Customer space name
SAP HANA SPS 12: XS Advanced
Extended support

With SPS 12, the platform LCM tools have extended their functionality to support XS advanced in the following scenarios:

- System rename – SID, instance number, host name
- SAP HANA host register/unregister – In copy or move scenarios
- Add and remove host role
- Uninstallation
- XS advanced parameters:
  - Space OS user isolation
  - Routing mode
  - Domain name
  - SAP HANA Web IDE
Further Documentation

Dokumentation: SAP Help Portal
- SAP HANA Installation and Update Guide
- SAP HANA Administration Guide – Chapter 3: Lifecycle Management
- SAP HANA Smart Data Streaming – Installation Guide
- SAP HANA Dynamic Tiering – Installation Guide
- SAP HANA Accelerator for SAP ASE – Installation Guide
- SAP HANA Remote Data Sync – Installation Guide

Schulung: HA200: SAP HANA - Operations & Administration

Zertifikation: SAP Training and Certification Shop
- C_HANATEC_11 – SAP HANA (Edition 2016)
- E_HANAINS151 SAP Certified Technology Specialist (Edition 2015) – SAP HANA Installation

<table>
<thead>
<tr>
<th>SAP Hinweis</th>
<th>Titel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2078425</td>
<td>Fehlerbehebung für SAP HANA Platform Lifecycle Management Tool hdblcmm</td>
</tr>
<tr>
<td>2082466</td>
<td>SAP HANA hdblcmm: Fehlerbehebung</td>
</tr>
</tbody>
</table>

Weitere SAP Hinweise sind für folgende LCM-Komponenten verfügbar: HAN-DB-PLT, HAN-LM-INS, and HAN-LM-UPG
SAP HANA LiveCycle Management
Roadmap

Today

**Usability**
- Convert single container to multiple database containers
- Download SAP HANA component updates from the HDBLCM Web UI
- Add and remove host roles

**Supportability**
- System verification tool
- Further support for XS advanced, including:
  - Register and rename of systems with an XS advanced runtime
  - Add/remove XS advanced runtime host roles
  - Uninstallation of systems with an XS advanced runtime
  - Installation and update of the Web IDE
- Download, installation and update of SAP Address Directories and Reference Data

Planned Innovations

**Usability**
- Integrated download, extract and update process in HDBLCM Web UI

**Supportability**
- Define worker group during installation
- Uninstall component with existing component-specific hosts/roles in one step

Future Direction

**Usability**
- Enhanced capabilities to resume/restart failed actions
- Enhanced system information

**Supportability**
- Create the first tenant during installation of an MDC system
- Enhanced system verification tool
- Installation, update and reconfiguration support for additional software components within the SAP HANA system landscape
- Further support for the XS advanced runtime and applications
- Improved support for very large system landscapes (cloud scenarios)

SAP HANA SPS12

This is the current state of planning and may be changed by SAP at any time.
SAP HANA in Data Centers: Agenda

- Introduction & Overview
- Design & Setup
- Persistence
- Backup & Recovery (System Copy)
- High Availability
- Disaster Tolerance
- Monitoring & Administration
- Security & Auditing
Manage secure data access and keep your systems protected

**SAP HANA provides a comprehensive security framework**

- Securely run SAP HANA in a **variety of environments**
- Meet increasing **regulatory and compliance requirements**
- Easily **configure, manage and monitor security**
- Keep up to date with relevant **security updates**
SAP HANA – Security
Overview

SAP HANA provides a comprehensive security framework with standard/documentated interfaces that allow integration of SAP HANA into existing security infrastructures

Secure information access

• Comprehensive role and privilege framework
• Authentication and single sign-on: password-based logon inclined password policy, Kerberos/SPNego, SAML, X.509, SAP Logon and Assertion Tickets
• User and identity management, adapters for SAP Identity Management and SAP Access Control
• Audit logging of critical security and configuration changes and data access

Secure system setup, administration and operation

• Tools for security administration, configuration and monitoring
• Secure network communication
• Data encryption
• Security infrastructure integration

Secure software and patching

• SAP secure development lifecycle
• Security patches and updates
SAP HANA’s unified security architecture

- SAP HANA Studio
- Client
- Application Server
- JDBC/ODBC
- Database
- Authentication/SSO
- Authorization
- Users/Roles
- Design Time Repository
- Cockpit
- Application
- XS Classic
- Encryption
- Audit Logging
- HTTP(S)
- Browser
- Client
- XS Advanced
- SAP HANA

© 2016 SAP SE or an SAP affiliate company. All rights reserved.
# SAP HANA – overview of security functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authentication</td>
<td>• <strong>JDBC/ODBC access:</strong> User name and password (incl. password policy), Kerberos, SAML, SAP logon and assertion tickets</td>
</tr>
<tr>
<td></td>
<td>• <strong>HTTP access (SAP HANA XS):</strong> User name and password (incl. password policy), SPNEGO, SAML, SAP logon and assertion tickets, X.509</td>
</tr>
<tr>
<td>Users and roles</td>
<td>• User and role concept, separation of duties, transport mechanism (development -&gt; production system), SAP Identity Management and GRC Access control support</td>
</tr>
<tr>
<td>Authorization</td>
<td>• Privilege concept based on standard SQL privileges + extensions for business applications</td>
</tr>
<tr>
<td>Encryption</td>
<td>• Communication encryption (SSL), data volume encryption (on disk), backup encryption via certified 3rd party backup tools</td>
</tr>
<tr>
<td>Audit logging</td>
<td>• Audit logging framework for logging critical events, e.g. user ROLE or configuration changes, data access logging, firefighter mode; audit trail written to Linux syslog or to SAP HANA database table</td>
</tr>
<tr>
<td>Security administration</td>
<td>• SAP HANA Studio, SAP HANA XS administration tool, additionally SQL interface for user/role management and other administration tasks (command line tool hdbsql available)</td>
</tr>
</tbody>
</table>
Security Scenarios
Traditional security architecture

- **Client**
- **Application Server**
  - **Application**
    - Application end users
  - Application server administrators
- **Database**
  - Technical account
  - Database administrators
SAP HANA scenarios – three-tier and data mart

SAP solutions e.g. Suite, BW

Client → Application Server → SAP HANA

ABAP application permissions

Data mart (3-tier or 2-tier)

Client → BI Server → SAP HANA

BI application permissions

Source → SAP HANA

Replication

Database permissions
SAP HANA scenarios – SAP HANA native applications

XS Classic – integrated

XS Advanced – decoupled
Database migration to SAP HANA

→ no change to the security model

- End users in the application server layer
  - Security functions of the application server apply
  - No change to authentication/authorization management
- Application server connects with technical account to SAP HANA
- SAP HANA security functions are used to manage administrative access to SAP HANA
- Examples: Business Warehouse on SAP HANA, Business Suite on SAP HANA
**S4HANA On Premise**

**Same security model as traditional ABAP applications**

- **End users in S/4HANA AppServer (NetWeaver)**
  - NetWeaver security functions apply, e.g. for authentication and authorization
- **Frontend/client security**
  - Input validation, encrypted communication
- **Application server connects with technical account to SAP HANA**
- **SAP HANA security functions are used to manage administrative access to SAP HANA**
Fiori delivers state-of-the-art UX with security benefits

- Fiori delivers state-of-the-art HTML5 technology
- SAP adheres to a safe and proven HTML5 subset only
- Standard ODATA protocol used for data transport

Fiori role/authorization handling

- Fiori Launchpad provides a role-specific and individualized subset of the available apps
- Privileges are assigned to the end user via PFCG roles
Integrated scenario – Reporting on ERP data in SAP HANA

Direct user access to SAP HANA
→ modified security model

SAP HANA Live for SAP Business Suite supports direct access to ERP data in SAP HANA

- ERP data is exposed via SAP HANA views
  - Read only
  - Authorization checks using SAP HANA privileges

- End users both in application server layer and in SAP HANA
  - Tool support for generation of SAP HANA privileges from ABAP PFCG roles

- SAP HANA security functions are used to manage administrative access to SAP HANA
**Integrated scenario – Reporting on BW data in SAP HANA**

**Direct user access to SAP HANA**

→ modified security model

SAP Business Warehouse supports direct access to BW data in SAP HANA

- BW data is exposed via SAP HANA views
  - Read only
  - Authorization checks using SAP HANA privileges

- End users both in application server layer and in SAP HANA
  - Automatic generation of SAP HANA views, privileges and roles based on BW privileges, automatic role assignment

- SAP HANA security functions are used to manage administrative access to SAP HANA
Integrated scenarios – user generation from ABAP

**SAP HANA users can be generated from ABAP users**

**Since NW 7.40 SPS 3**
- User management transaction SU01

**Since NW 7.40 SPS 6**
- Report for mass synchronization: RSUSR_DBMS_USERS
- User copy supported in SU01
Data mart – Customer-specific analytic reporting on SAP HANA

Direct user access to SAP HANA
→ based on SAP HANA native security model

Custom reports and dashboards support direct access to data in SAP HANA using BI tools

- Data is exposed via SAP HANA analytic views
  - Read only
  - Often on replicated/aggregated data
  - Authorization checks using SAP HANA privileges

- End users in SAP HANA
  → SAP HANA privileges need to be modelled for the individual project

- SAP HANA security functions are used to manage administrative access to SAP HANA
Applications built on SAP HANA XS classic model

Direct user access to SAP HANA ➔ integrated security model

SAP HANA supports direct access to data via web-based native applications based on XS classic

- **End users in SAP HANA**
  - Security functions of SAP HANA apply: Authorization, authentication/SSO, encryption, audit logging
  - Additional security functions for XS classic applications:
    - Application-specific authorization checks ➔ need to be modelled for the individual XS classic application
    - Protection against XSRF, SQL injection, XSS
    - For outgoing connections:OAuth client support
- **SAP HANA security functions are used to manage administrative access to SAP HANA**
Applications built on SAP HANA XS advanced model (*)

New scalable, flexible application runtime option

Security aspects

- Support for **decoupling application layer and data layer**
  - Separate deployment (e.g. network zones) and scaling of application layer

- **Isolation for applications**
  - data layer: separate containers per application based on the SAP HANA Deployment Infrastructure (HDI)
  - application layer: separate OS users per application configurable

- **New user and role management for business users**
  - business users managed via **identity provider** (external SAML2 compliant identity provider or HANA as native identity provider)
  - business user authorized based on **scopes** for functional authorizations (e.g. view cost center data) and **attributes** for instance based authorizations (e.g. cost center “XYZ“)
Multitenant database containers – a new way to separate access

Run multiple applications on one HANA system

- 1 system database and multiple tenant databases, shared software installation

**Strong isolation features**

- Users, database catalog, repository, persistence, backups, traces and diagnosis files → per database
- Overall system administration from system database. **But:** No access to tenant schemas from the system database
- Security-relevant features configurable per database

**Additional security options**

- Isolation level “high”: dedicated OS user/group per tenant
- Configuration change blacklist: prevent changes of critical configuration parameters by tenant administrators
- Restricted features: prevent usage of critical features in tenant databases
Secure System Setup and Operation
Security administration, configuration and monitoring using SAP HANA Cockpit

SAP HANA Cockpit is installed with SAP HANA as automated content

➤ **Role-based access to tiles**  
applies on top of the usual SAP HANA privileges

➤ **Default homepage of tiles is customizable**
The security dashboard in SAP HANA Cockpit provides an overview of important security KPIs

➤ Get alerts about security issues

➤ View information about **important security settings**
  - Network communication channels, TLS/SSL
  - Encryption and keys
  - Authentication methods and password policy
  - Audit logging policies

➤ **Drill-down to related tasks** and further information
When to use which tool?

**SAP HANA Cockpit**

- Detailed information on SAP HANA systems
  - Security monitoring
  - Security alerting
  - Security configuration and administration

**Solution Manager**

- Overview information on SAP system landscape
  - Security monitoring
  - Security alerting
  - Security configuration and administration

Leverage the same system information ➔ consistent view regardless of tool
Secure system setup

SAP HANA is designed to run securely in different environments

Incorrectly configured security settings are one of the most common causes of security problems

➔ SAP offers tools and information to help you to run SAP HANA securely

- SAP HANA Security Checklists and Recommendations accompany the detailed SAP HANA Security Guide
  - See also SAP Note 1969700 for SQL commands
- SAP HANA is part of the SAP Security Baseline template
- DSAG Prüfleitfaden ERP 6.0

Monitoring tools leverage SAP HANA alerts

- SAP HANA Studio/Cockpit, SAP Solution Manager/SAP Early Watch Alert/Configuration Validation
**Secure communication**

**SAP HANA supports TLS/SSL connection encryption for network communication channels**

- Documented network communication channels, recommendations on the use of firewalls and network zones
- Encryption of client-server communication (external channels) can be enforced
- Automatic setup of key management infrastructure (PKI) for internal communication channels

---

**External channels**

Client - server

**Internal channels**

Scale-out system

System replication

+ SAP HANA option

---

**System replication**

- **Host1**
- **Host2**
- **Primary System**
- **Secondary System**
- **Data Center 1**
- **Data Center 2**

**SAP HANA options**

- **Hot store**
- **Warm store**
Data encryption

Authorization is the primary means for fine-granular access control. Encryption addresses potential authorization bypass on lower architecture layers or by highly privileged users.

Data at rest encryption (data volume encryption)
- Encryption of SAP HANA’s data files
- Page content is encrypted using the AES-256-CBC algorithm
- Encryption does not increase the data size

Application encryption
- Encryption APIs are available for applications based on SAP HANA extended application services (XS) for storing values in encrypted form

Backup encryption
- Backup encryption is provided by a wide variety of 3rd party backup tool vendors who are certified for SAP HANA’s Backint interface

SAP HANA supports SAP’s standard cryptographic library, which is FIPS-certified
**Security infrastructure integration**

**SAP HANA** supports industry standards and documented interfaces to enable integration with the customers’ security network and datacenter infrastructures.

**Identity management**
- Connector for SAP Identity Management, SQL interface for integration with other identity management solutions.

**Compliance**
- Connector for SAP Access Control.

**Single Sign-On**
- E.g. for Microsoft Active Directory.

**Logging**
- Standard logging infrastructures (Linux syslog).

**Threat detection**
- SAP Enterprise Threat Detection support.

**Antivirus**
- XS antivirus interface.
Secure software and patching
SAP secure software development lifecycle

At the core of SAP’s development processes is a comprehensive security strategy based on three pillars: **Prevent – Detect – React**

Secure software development lifecycle (secure SDL)

- Ensures that security is an integral component of the architecture, design, and implementation of SAP solutions
- **Risk-based** approach, uses threat-modeling and security risk assessment methods
- **Comprehensive security testing** with automated and manual tests
- See [SAP Security @ http://www.sap.com/security](http://www.sap.com/security)
Security patches

Keep up to date by installing the latest security patches and monitoring SAP security notes

Security improvements/corrections ship with SAP HANA revisions
- Installed using SAP HANA's lifecycle management tools
- See also SAP Note 2021789 – SAP HANA revision und maintenance strategy

SAP security notes contain further information
- Affected SAP HANA application areas and specific measures that protect against the exploitation of potential weaknesses
- Released as part of the monthly SAP Security Patch Day
- See also http://support.sap.com/securitynotes and SAP Security Notes – Frequently asked questions

Operating system patches
- Provided by the respective vendors SuSE/Redhat
What is preventing you from upgrading your systems?

SAP HANA offers features that support you in making upgrades as painless as possible

- Reduced testing effort
  - Capture and replay
- No/reduced downtime
  - Zero downtime maintenance (based on system replication)
  - Upgrade by moving tenants (based on multi-tenant database container scenario)
Security services by SAP

SAP offers a wide range of security tools and services to ensure the smooth operation of your SAP solution by taking action proactively, before security issues occur.

More information

- SAP Support Portal - EarlyWatch Alert
- SAP Security Optimization Services
More information

- **Documentation on SAP Help Portal:**
- **Secure configuration guidelines:**
  - SAP HANA Security Checklists and Recommendations accompany the Security Guide
  - SAP Security Baseline Template
  - DSAG Prüfleitfaden ERP 6.0
- **Whitepaper:** SAP HANA Security Whitepaper
- **Best practices:** How to Define Standard Roles
- **SAP Notes**
  - [2159014](https://support.sap.com/2159014) FAQ: SAP HANA Security
  - [1730928](https://support.sap.com/1730928) Using external software in a HANA appliance
  - [1730929](https://support.sap.com/1730929) Using external tools in an SAP HANA appliance
  - [1730930](https://support.sap.com/1730930) Using antivirus software in an SAP HANA appliance
  - [784391](https://support.sap.com/784391) SAP support terms and 3rd-party Linux kernel drivers
  - [1730999](https://support.sap.com/1730999) Configuration changes in HANA appliance
  - [863362](https://support.sap.com/863362) Security checks with SAP EarlyWatch Alert
  - [2021789](https://support.sap.com/2021789) SAP HANA revision and maintenance strategy
- **Training:** [HA 240](https://support.sap.com/HA 240)
SAP HANA in Data Centers:
Summary

Introduction & Overview
Platform & Appliance methodology (Installation & Update)
Persistence
Backup & Recovery (System Copy)
High Availability
Disaster Tolerance
Monitoring & Administration
Security & Auditing
SAP HANA Timeline
The journey so far

SAP HANA Data Marts

- **SPS2**
  - 27. June 2011

- **SPS3**
  - 7. Nov. 2011

Round-Off Release

- **SPS4**
  - 11. May 2012

- **SPS5**

Real Time Data Platform

- **SPS6**
  - Mid 2013

- **SPS7**
  - End. 2013

---

**SAP BW powered by SAP HANA**

**SAP Suite powered by SAP HANA**

**Core Topics Innovations**
SAP HANA Timeline

More journey

One Platform, Enabling New Business

- **SPS08**
  - 2. June 2014

- **SPS09**

- **SPS10**

Delta Backup

- **SPS11**
  - 25. Nov. 2015

System Replication for other HANA platform family members

- **SPS12**
  - Mid 2016

Tenant move for MDC

- **SPS13**
  - End. 2016

Dynamic Tiering, Multitenant Database Containers

- **SPS08**
  - 2. June 2014

- **SPS09**

- **SPS10**

- **SPS11**
  - 25. Nov. 2015

Optimized System Replication (HotStandby)

- **SPS08**
  - 2. June 2014

- **SPS09**

- **SPS10**

- **SPS11**
  - 25. Nov. 2015

This is the current state of planning and may be changed by SAP at any time.
More Information
More Information

**SAP HANA documentation**


- SAP HANA Administration Guide, several chapters e.g. “High Availability for SAP HANA” covering also Disaster Recovery topic
- SAP HANA Technical Operations Manual (TOM)

**FAQ for SAP HANA Operations:**

SAP HANA Operation Expert Summit FAQ Document


**SAP Notes**

- SAP HANA Platform Release Notes: SPS 09 [2075266](http://help.sap.com/hana_platform); SPS 10, [2165826](http://help.sap.com/hana_platform); SPS 11, [2227464](http://help.sap.com/hana_platform); SPS 12, [2298750](http://help.sap.com/hana_platform)
- [1755396](http://help.sap.com/hana_platform): Released DT solutions for SAP HANA with disk replication
- [1876398](http://help.sap.com/hana_platform): Network configuration for SAP HANA System Replication
- [1834153](http://help.sap.com/hana_platform): HANA high availability disaster recovery config
Customer statements about SAP HANA

Interesting presentation sessions by SAP HANA customers and users


More than 15 recordings of customer statement about SAP HANA

Global HANA iFG VIP Customer Community: [http://ifg.saphana.com](http://ifg.saphana.com)

Individual Customer Feedbacks

Germany: Schukat electronic –

The first SME on SAP HANA / SAP HANA trotz Mittelstand (german)

"Molson Coors talks SAP BW on HANA"


(including a 5 min video with global BI specialist)

Newsletter

MaxAttention Newsletter with portait of HANA usage at Bayer

SAP’s own Data Center Management: [SAP Data Center](http://www.sap.com/datacenter)
SAP HANA Operation Expert Summits

2014
Gain insights, share experiences: SAP HANA Operation Expert Summit
• Customer feedback: SAP HANA operation expert summit
• Now Available: Frequently Asked Questions Dokument - SAP HANA Operations

2015
SAP HANA Operation Expert Summit 2015 – Keep Making Progress happen!
• Get all presentations shared during the two days at the SAP HANA Operation Expert Summit.
• We updated the Frequently Asked Questions - Document on SAP HANA Operations based on the attendees questions and feedback during the event

2016
Thank You!

Contact information:

Dr. Ralf Czekalla
Product Management TIP In-Memory Platform
Ralf.Czekalla@sap.com