SAP HANA on SUSE Linux Enterprise Server
Operating, Maintaining and Optimizing

Uwe Heinz
Product Management (SAP LinuxLab)
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SAP HANA on SLES:
Agenda

- Introduction & Overview (SAP and LINUX)
- SAP HANA on SLES (Platform & Appliance methodology)
- Deployment
- High Availability (SAP and HA certification and outlook)
- Backup & Recovery (System Copy)
- Monitoring & Administration
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Introduction & Overview (SAP and LINUX)

SAP supports only: SLES, RHEL and Oracle Linux

and growing ...

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Introduction & Overview (SAP and LINUX)
Open Standards (support of multiple solutions)

**HA solutions**
- SUSE HA
- RH Cluster
- Veritas
- Steeleye
- HP Service Guard

**Database**
- SAP HANA
- Sybase ASE15 / IQ
- SAP MaxDB
- Oracle RDBMS
- IBM DB2 LUW

**OS/Distributions**
- SUSE Linux Enterprise Server (SLES)
- Red Hat Enterprise Linux (RHEL)
- Oracle Linux (OL)

**Hardware**
- Intel / AMD X86_64
- Linux on IBM Power
- Linux on IBM System z
SAP Solutions on Linux - Trends

Reasons for deploying Linux:

- Cost Reduction
- High availability
- Performance improvement
- Low training efforts (Unix-> Linux)

* Source RAAD
Today Linux is favoured target for SAP OS Migrations

Linux QA and Dev

Linux Appl Server

Linux DB Server

Today > x APP installations on Linux

Today > 15000 DB installations on Linux

Reliability, stability

virtualization

HA and DR


20000 and more

LCM/LVM
Linux Benchmarks

Windows:
12930 SD User
Referenz *2013018

Linux:
12735 SD User
Referenz *2013017

Linux:
23250 SD User
Referenz *2013014

Same HW
4 socket

8 socket
Server
SAP rely on Linux

- Major new SAP development projects like HANA or BWA happen on Linux
- SAP’s own ERP system runs on HANA (SUSE SLES)
- Linux is Reference Platform for SAP software development
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SAP HANA on SLES (Platform & Appliance methodology)
SAP HANA Platform

SAP HANA Technology Partners

SAP HANA Hardware Partners

SAP HANA Product Flavors

- SAP HANA Platform Edition
- SAP HANA Enterprise Edition
  - incl data provisioning (SLT)
- SAP HANA for BW/Suite
  - BW/Suite database only
SAP HANA scalability
Scales from very small servers to very large clusters

**Single Server**
- 2 CPU 128GB to 8 CPU 1TB (Special layout for Suite on HANA for up to 4 TB per host)
- Single SAP HANA deployments for data marts or accelerators
- Support for high availability and disaster recovery

**Scale Out Cluster**
- 2 to n servers per cluster
- Each server is either 4 CPU/512GB or 8 CPU/1TB
- Largest certified configuration: 56 servers
- Largest tested configuration: 100+ servers
- Support for high availability and disaster recovery

**Cloud Deployment**
- SAP HANA instances can be deployed to AWS
- Limited to developer license
- SAP HANA Enterprise Cloud
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Backup & Recovery (System Copy)

Monitoring & Administration
SAP HANA – Variety of deployment options

**In the Cloud**
- HANA developer edition
  *free of charge*
- SAP HANA One / HANA one premium
  *pay per use*
- SAP HANA Enterprise Cloud
  *24/7 mission critical / Enterprise Support*

**In the Data Center**
- Bare metal single Server
  *pre-configured & validated stack*
- Scale-Out / HA & DR cluster
  *scalable from single node to Geo cluster*
- Virtualized with VMware
  *VMware vSphere 5.1 or newer*
SAP HANA - Implications of being 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

* Might be outsourced or owned by customer
# Certified HANA Hardware – June 2013*

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<thead>
<tr>
<th>Specification</th>
<th>IBM</th>
<th>HP</th>
<th>Hitachi</th>
<th>Cisco</th>
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<th>Lenovo</th>
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<tr>
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<td>X</td>
<td></td>
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</tr>
</tbody>
</table>

* For most up to date list please go to the [SAP Product Availability Matrix](#)
SAP HANA Tailored Data Center Integration
Customer Feedback & Challenges and alternative Concept

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 Appliance vs. Tailored Data Center Integration
Differentiating Capabilities

Fast Implementation
- Solution validation done by SAP and Partner
- Preconfigured hardware set-up
- Defined performance & KPIs out of the box
- Preinstalled software

More Flexibility & Responsibility
- Additional efforts through verification test
- Preferred combinations of server and storage possible
- Installation and validation needs to be done by customer
- HANA installation certification necessary
- Customer ensures support for all stack components

Support fully provided by SAP  
Save IT budget and existing investments
SAP HANA SP Stack Update
Process Description

1. Perform *Software Update Manager for SAP HANA* self-update
2. Detect components in the SAP HANA landscape
3. Get latest SP stack information from SAP Service Marketplace (SMP)
4. Download required component updates
5. Update components on the SAP HANA system

*All remote connections are done via secure web services.*
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
SAP offers a technical operational manual (TOM) with all kinds of topics about operating SAP HANA as an appliance (http://help.sap.com/hana_appliance).

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>
<thead>
<tr>
<th>Task</th>
<th>Responsible</th>
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<tr>
<td>SAP HANA appliance installation</td>
<td>Hardware Partner</td>
</tr>
<tr>
<td>Hardware</td>
<td>Hardware Partner</td>
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<tr>
<td>OS installation</td>
<td>Hardware Partner</td>
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<tr>
<td>OS updates</td>
<td>Customer</td>
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<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>
Cloud & Virtualization

SAP HANA in the Cloud
- **SAP HANA Developer Edition**
  - For product evaluations, trials, students, data exploration projects, etc.
  - Software is free, developers pay cloud provider for server usage.
  - Community supported through [http://saphana.com/cloud](http://saphana.com/cloud)
  - Available of choice on 4 public cloud providers
- **SAP HANA One**
  - Non-productive and productive usage
  - Option 1 - with community support according SAP Note 1798212
  - Option 2 - with full SAP support through OSS as part of SAP HANA One premium license
  - Available of choice on 4 public cloud providers

SAP HANA – Virtualization On Premise
- **Non productive usage**
- **Restrictions**
  - Vendors ([Note 1788665](https://service.sap.com/notes/1788665) - SAP HANA running on VMware vSphere VMs)
  - Maximum HANA performance is only reached on “bare metal” (non-virtualized)
  - VMWare Vmotion (hot move) is not supported
## SAP HANA Cloud Offerings Today

<table>
<thead>
<tr>
<th></th>
<th>Private Cloud</th>
<th>Public Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HANA Hosting</td>
<td>Developer Edition</td>
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<td>✓</td>
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<tr>
<td>Savvis</td>
<td>✓</td>
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<tr>
<td>Portugal Telecom</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Telstra</td>
<td>✓</td>
<td></td>
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<tr>
<td>Amazon Web Services</td>
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<td>✓</td>
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<tr>
<td>VirtuStream</td>
<td>✓</td>
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<td>Cloudshare</td>
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<tr>
<td>IBM</td>
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<td></td>
</tr>
<tr>
<td>HP</td>
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</tr>
<tr>
<td>VMware</td>
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</table>
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High Availability (SAP and HA certification and outlook)

Backup & Recovery (System Copy)

Monitoring & Administration
High Availability – Disaster Recovery

High Availability
- Business function fail over between two or more physical frames within the same data center using a single shared storage location.
- Elimination of single points of failure (SPOF's) are a necessary part of HA.
- The goal is to minimize downtime for business functions, not computer systems.
  - This is NOT non-stop computing, downtime will be experienced during fail over.

Disaster Recovery
- Business function recovery between geographically separated data centers using a storage replication system between the data centers.
- The output of disaster recovery planning is a disaster recovery project plan.
- The goal is to minimize downtime for business functions, not systems.
- Business function recovery times and maximum allowable data loss is specified during the business impact analysis.
High Availability – Disaster Recovery

Business Continuity

High Availability per Data Center
- SAP HANA Host Auto-Failover (Scale-Out with Standby)
- SAP HANA System Replication

Disaster recovery between Data Centers
- SAP HANA Storage Replication
- SAP HANA System Replication
SAP HANA Architecture

- SAP HANA Appliance
  - SAP HANA Database
    - Name Server
    - Index Server
    - Statistics Server
    - Preprocessor
    - XS engine
  - SAP HANA Studio Repository
  - SAP Host Agent
  - Software Update Manager

Single host configuration

- Node 2
  - Name Server
  - Index Server
  - Preprocessor
  - XS engine
- Node n
  - Name Server
  - Index Server
  - Preprocessor
  - XS engine

Multi-node cluster configuration

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

Shared storage for fail-over and recovery
Scale Out
High Availability

High Availability configuration
- N active servers in one cluster
- M standby server(s) in one cluster
- Shared file system for all servers

Services
- Name and index server on all nodes
- Statistics server (only on one active server)
- Name server active on Standby

Failover
- Server X fails
- Server N+1 reads indexes from shared storage and connects to logical connection of server X
SAP HANA Database Landscape

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

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HANA High Availability
Video to present functionality of Auto Host Failover

Video: https://www.saphana.com/videos/1417
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 1637145 ⇒ attached PDF).
**SAP HANA High Availability**

**Client Management with Scale-Out**

**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 sqdbc (SAP Appl. Server, hdbsql, ODBC, python, etc.) can use this user store.

**Algorithm:**
- Round robin process is used to find this first contact point
High Availability – Disaster Recovery

[Diagram showing the setup of a primary system with two hosts, a replicated storage system, and a secondary system with two hosts, illustrating the data and logs flow.]
System Replication
Asynchronous Data and Synchronous Redo Log Shipping

Data Center 1

Primary (Online)
Name Server
Name Server
Name Server
Index Server
Index Server
Index Server

Data Volumes
Log Volume
Data Volumes
Log Volume

Data Center 2

Secondary
Name Server
Name Server
Name Server
Index Server
Index Server
Index Server

Data Volumes
Log Volume
Data Volumes
Log Volume

Clients

Synchronous mirrored redo log writing

Incremental data replication based on HANA snapshots

Load and rebuild main indexes as loaded in primary

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HANA System Replication versus Disk Replication

Pro:
- No I/O latency issue for data writing, less data transportation
- Redo-Log write latency only at EOT time, non-EOT log writing is asynchronous
- Faster availability after takeover
  - Load main tables in memory during standby mode
  - Data transported via incremental backup is already in memory
- No dependency on hardware solutions / VMs
- High flexibility
- Lower license costs

Contra:
- Higher hardware costs: servers in secondary data center cannot be used for test/QA-systems when using the table preload feature
- No HANA integrated full automatic failover
- No consistency groups with other related systems (e.g. ERP)
- Doesn’t replicate binaries, config (so far) and trace files
Setup (Example Locations: Walldorf – Rot)
Configuration Steps

Start with two system on different hosts
SID, system-number and host topology are equal
Secondary additionally uses port range (system-number + 1)

- Stop secondary, primary stays online
- Primary: `hdbnsutil -sr_enable --name=WALLDORF`
- Secondary: `hdbnsutil -sr_register --remoteHost=<walldorf_host> --remoteInstance=50 --mode=syncmem --name=ROT`

- Secondary: Start system
Setup
Transport Complete Data Backup and Load Columns into Memory

Walldorf

Primary (Online)

Name Server
Index server

Name Server
Index server

Name Server
Index server

Synchronous mirrored redo log writing

Backup primary data, transport and restore into secondary

Rot

Secondary

Name Server
Index server

Name Server
Index server

Name Server
Index server

Store Info about currently loaded main tables

Load and rebuild main indexes as loaded in primary

Use virtual hostnames, etc.

Clients

Data Volumes
Data Volumes
Data Volumes

Log Volume
Log Volume
Log Volume
Setup
Periodic Transport of Incremental Backup

Walldorf

Primary (Online)

Name Server
Index server

Name Server
Index server

Name Server
Index server

Synchronous mirrored redo log writing

Asynchronous transport of incremental data backup. Check loaded and unloaded main tables

Secondary

Name Server
Index server

Name Server
Index server

Name Server
Index server

Load and rebuild main indexes as loaded in primary

Clients
Check Configuration
HANA Studio

### General Information
- **Operational Status:** All services are started
- **Secondary System Status:** All services are active and in sync
- **Start Time of First Started Service:** 02.10.2012 15:25:14
- **Start Time of Latest Started Service:** 02.10.2012 15:28:23

#### Distributed System
- **Yes (2 hosts)**

#### Hardware
- **Version:** 1.50.00.000000 (HighAvailability)
- **Build Time:** 01.10.2012 11:34:49
- **Platform:** SUSE Linux Enterprise Server 11.1
- **Hardware Manufacturer:** HP

### Services

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<th>Secondary Host</th>
<th>Replication Mode</th>
<th>Replication Status</th>
<th>Replication Status Details</th>
<th>Port</th>
<th>Volume</th>
<th>Site ID</th>
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### Secondary System Status

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<td>02.10.2012 19:37:04</td>
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## Check Configuration

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<td>Volume ID</td>
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<td>Generated site ID</td>
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<td>SECONDARY_HOST</td>
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<td>SECONDARY_SITE_NAME</td>
<td>Secondary logical site name</td>
</tr>
<tr>
<td>SECONDARY_ACTIVE_STATUS</td>
<td>Secondary Active Status</td>
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<tr>
<td>SECONDARY_CONNECT_TIME</td>
<td>Time the connection was established from the secondary</td>
</tr>
<tr>
<td>SECONDARY_RECONNECT_COUNT</td>
<td>Secondary Reconnect Count</td>
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<tr>
<td>SECONDARY_FAILOVER_COUNT</td>
<td>Secondary Failover Count</td>
</tr>
<tr>
<td>REPLICATION_MODE</td>
<td>Replication Mode</td>
</tr>
<tr>
<td>REPLICATION_STATUS</td>
<td>Replication Status</td>
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<tr>
<td>REPLICATION_STATUS_DETAILS</td>
<td>Replication Status Details</td>
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<tr>
<td>LAST_LOGPOSITION</td>
<td>Current Log Pos</td>
</tr>
<tr>
<td>LAST_LOGPOSITION_TIMESTAMP</td>
<td>Current Log Pos Timestamp</td>
</tr>
<tr>
<td>LAST_SAVEPPOINT_VERSION</td>
<td>Current Savepoint Version</td>
</tr>
<tr>
<td>LAST_SAVEPPOINT_LOGPOSITION</td>
<td>Current Savepoint Log Position</td>
</tr>
<tr>
<td>LAST_SAVEPPOINT_START_TIME</td>
<td>Current Savepoint Timestamp</td>
</tr>
<tr>
<td>SHIPPED_LOGPOSITION</td>
<td>Shipped Log Position</td>
</tr>
<tr>
<td>SHIPPED_LOGPOSITION_TIMESTAMP</td>
<td>Shipped Log Position Timestamp</td>
</tr>
<tr>
<td>SHIPPED_LOG_BUFFERS_COUNT</td>
<td>Shipped Log Buffers Count</td>
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<tr>
<td>SHIPPED_LOG_BUFFERS_SIZE</td>
<td>Shipped Log Buffers Size in Bytes</td>
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<tr>
<td>SHIPPED_LOG_BUFFERS DURATION</td>
<td>Shipped Log Buffer Duration in microseconds</td>
</tr>
<tr>
<td>SHIPPED_SAVEPPOINT_VERSION</td>
<td>Shipped Savepoint Version</td>
</tr>
<tr>
<td>SHIPPED_SAVEPPOINT_LOGPOSITION</td>
<td>Shipped Savepoint Log Position</td>
</tr>
<tr>
<td>SHIPPED_SAVEPPOINT_START_TIME</td>
<td>Shipped Savepoint Start Time</td>
</tr>
<tr>
<td>SHIPPED_FULL_REPLICA_COUNT</td>
<td>Shipped Full Replica Count</td>
</tr>
<tr>
<td>SHIPPED_FULL_REPLICA_SIZE</td>
<td>Shipped Full Replica Size in Bytes</td>
</tr>
<tr>
<td>SHIPPED_FULL_REPLICA_DURATION</td>
<td>Shipped Full Replica Duration in microseconds</td>
</tr>
<tr>
<td>SHIPPED_LAST_FULL_REPLICA_SIZE</td>
<td>Shipped Last Full Replica Size in Bytes</td>
</tr>
<tr>
<td>SHIPPED_LAST_FULL_REPLICA_END_TIME</td>
<td>Shipped Last Full Replica End Time</td>
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<tr>
<td>SHIPPED_DELTA_REPLICA_COUNT</td>
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<td>Shipped Delta Replica Size in Bytes</td>
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<tr>
<td>SHIPPED_DELTA_REPLICA_DURATION</td>
<td>Shipped Delta Replica Duration in microseconds</td>
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<td>Shipped Last Delta Replica Size in Bytes</td>
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<tr>
<td>SHIPPED_LAST_DELTA_REPLICA_END_TIME</td>
<td>Shipped Last Delta Replica End Time</td>
</tr>
</tbody>
</table>
Check Configuration Management Console

**hdbcons –e hdbindexserver “replication info”**

walldorf:HA1:haladm /usr/sap/HA1/HDB50 53>hdbcons –e hdbindexserver "replication info"

Executable: hdbindexserver (PID: 17602)

[OK]

--

Dumping replication statistics ...  
Replication Primary Information

===============================
System Replication Primary Configuration

- [system_replication] preload_column_tables = true
- [system_replication] logshipping_timeout = 30

- lastLogPos : 17957627520
- lastLogPosTimestamp : 03.10.2012-12.31.27 (1349267487672283)
- lastSavepointVersion : 2331
- lastSavepointLogPos : 17953754050
- lastSavepointTimestamp : 03.10.2012-12.28.32 (1349267312948713)

1 session registered.

Session index 0
- SiteID : 2
- RemoteAddress : 10.21.68.20/35103_tcp

...
Restart

Restart of Primary
- Secondary reconnects automatically if it was connected after restart

Restart of Secondary
- Secondary reconnects automatically if primary is online

Primary sends incremental data backup
- Redo log history can get lost in secondary!
  (Future releases will ship missing redo log if possible)
Log Shipping Timeout

Primary
- Stops log shipping when waiting longer than logshipping_timeout (default 30 seconds)

Secondary
- Tries to reconnect in intervals defined by reconnect_time_interval (default 30 seconds)

Primary sends incremental data backup after reconnect

Redo log history can get lost in secondary!
(Future releases will ship missing redo log if possible)
Takeover

Send Takeover to secondary

```
hdbsnsutil -sr_takeover
```

Secondary goes online, main columns as used in the primary are loaded
Runtime of takeover mainly depends on the size of the row store
Takeover II

Secondary Takeover steps
- Open data persistence based on last savepoint
- Load Row Store
- Replay Redo Log
- Rebuild Row Store Indexes

Load of Column Store Table when Secondary is Online
- Read delta log from disk
- Replay delta log

Verify System State

ld8454:HDB:ha1adm> python $DIR_INSTANCE/exe/python_support/landscapeHostConfiguration.py

<table>
<thead>
<tr>
<th>Host</th>
<th>Host</th>
<th>Failover</th>
<th>Remove</th>
<th>Storage</th>
<th>Failover</th>
<th>Failover</th>
<th>NameServer</th>
<th>NameServer</th>
<th>IndexServer</th>
<th>IndexServer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>------------</td>
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<td>-----------</td>
</tr>
<tr>
<td>ld8454</td>
<td>yes</td>
<td>ok</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>default</td>
<td>default</td>
<td>master 1</td>
<td>master</td>
</tr>
<tr>
<td>ld8453</td>
<td>yes</td>
<td>ok</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>default</td>
<td>default</td>
<td>master 2</td>
<td>slave</td>
</tr>
</tbody>
</table>

overall host status: ok
Failback

Activate Previous Primary as secondary when DC is back
Register Walldorf as secondary
Walldorf: `hdbnsutil -sr_register --remoteHost=<rot_host> --remoteInstance=50 --mode=synmem --name=WALLDORF`

Primary sends a complete data backup
➢ Redo log history can get lost in secondary !
   (Future releases will ship missing redo log or an incremental backup if both systems were not online in parallel)
Operations
Alerts

Log Shipping Timeouts Generate Alerts
Operations
Mail Notification

Use “Check for internal event” for mail notification
Backup & Recovery

Backup

- Data backups and redo log archives are still needed
- Primary and secondary should access to the same (shared) or replicated backup location ➔ adjust your backup file description or backup parameters
License Validity

- Primary replicates relevant license information to secondary
- No additional license need to be installed if primary and secondary have the same SID
Upgrade
The secondary system can run with a higher version than the primary

Upgrade Procedure
The secondary system can run with a higher version than the primary
- Upgrade secondary system with
  \( hdbupd --import_content=off \)
  As a result the secondary runs in system replication mode.
- Upgrade primary system as usual

Near Zero Downtime Upgrade with upgrading the secondary first, performing a takeover and upgrading the previous primary as secondary is planned for future releases.
SAP HANA on SLES:
Agenda

- Introduction & Overview (SAP and LINUX)
- SAP HANA on SLES (Platform & Appliance methodology)
- Deployment
- High Availability (SAP and HA certification and outlook)
- Backup & Recovery (System Copy)
- Monitoring & Administration
SAP HANA Persistence:
In-Memory Data Is Regularly Saved 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)
SAP HANA Database Landscape

Distributed HANA database even on a single host with shared nothing concept

In-Memory

Persistence Layer
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)
**SAP HANA Backup and Recovery**

Memory ➔ Disk ➔ Backup

---

### 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
Backup and Recovery
Data backups

Data backups save the content of the data area to a different location in the file system. Depending on the usage scenario, this includes the replicated business data from ERP and all the modeling data.

Data backups are carried out manually:
- SAP HANA studio
- DBA Cockpit
- SQL commands (command line)

Scheduling:
- Using scripts (via the SQL interface)
- Planning calendar in DBA Cockpit

Backup frequency
- Regular data backups required, but no general guidelines available (depends on the usage scenario)

Space requirements
- Only occupied space is backed up
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
- Header and Trailer verification of checksums 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
- Further functionality planned
SAP HANA Backup/Recovery
Data backup: Only payload is backed up
Backup and Recovery
Backups during normal operation of the database: Summary

1. Data backups (external backup destination)
2. Log backups (external backup destination)
3. Most recent log entries from log area
4. Crash
Backup
Backup in SAP HANA Studio

Note that the configuration files must be backed up separately. For that purpose also copy the configuration files of each host to an external backup destination.
Recovery

Recovery in SAP HANA Studio
SAP HANA Backup/Recovery
Data backup: Single-node and scale-out systems

SAP HANA automatically handles the synchronization of backups for all nodes ⇒ no special user interaction required

What happens internally:
- All services with a persistence need to be backed up (e.g. index servers, master name server)
- A global, synchronized backup savepoint is written for all these services
  - All transactions are stopped for a brief moment
  - Kept until the backup is finished for all services
- Data marked in the savepoint is written from the data volume to a backup file
  - One backup file per service
  - Written in parallel → read from different disks (depends on appliance configuration)
Backup and Recovery
Support for external backup tools

Available today via Backup Staging Area

- Staging area management will be optimized by backup tool vendor
- SAP note [1651055](#) offers a PDF attachment and scripts about handling the backup staging area

Further integration available with HANA SPS5 and first pilot certification achieved.

Use of operating system pipes to connect directly to external backup tools

New interface standard defined: Backint for HANA

- Backint (in general) is an established standard by SAP and has been continuous extended over time
- Extended for pipes for some years (e.g. Backint for MaxDB/liveCache)
- Further minor extends for the use with SAP HANA
- Description and simulator already available to start adoption process on external tools now

Contacts to major vendors of external backup tools established, first pilot certification available.

For more information please check SAP note [1730932](#).
SAP HANA Backup/Recovery
Backup Cockpit in SAP HANA Studio: Configuration

• Backint Settings:
  – If a Backint agent is configured, it is displayed. Vendor-specific parameter files for Backint (optional).
• Data and Log Backup Settings:
  – Default settings for data backups (file-based only) and log backups
SAP HANA Backup and Recovery
Options for backups

SAP HANA supports
- Backups to the file system
- Backups to 3rd party backup tools (via pipes)

Backups to the file system:
- Use a location that is not on the same disk as the data or log area of the database, e.g. an NFS share
SAP HANA Backup/Recovery
3rd party backup tool support (I)

Backups to 3rd party backup tools:
- “Backint for SAP HANA” is an API that can be implemented by a 3rd party backup agent
- For both data and log backups
- Provides functions for backup, recovery, query, and delete
- 3rd party backup agent runs on HANA server, communicates with 3rd party backup server
- Backups are transferred via pipe
- Full integration with SAP HANA studio (configuration and execution of backups to Backint)
Backup and Recovery
Storage-based offline database copy

1. While the source database is offline, create a filer snapshot of the database and transfer the content of the snapshot to a different location. This leads to two databases with the same name.
2. Restart the source database.
3. Change database name and topology (hostname) using the `hdbrename` utility (located in `/usr/sap/<SID>/SYS/global/hdb/install/bin/`)
4. The target database is automatically started.
Backup and Recovery
Backup-based online database copy

- Available since SAP HANA SPS4
- SID and hostnames are adapted during the recovery process
- Target database is started at the end of the recovery
- No impact on in-memory processing on source; executed on persistence level
Backup and Recovery
Internal Snapshots in SAP HANA

**SAP note:** [1703435](#)

**Limitation: One internal Snapshot only right now**
- Conflicts with Backup Snapshot which is needed during backup execution time.
- If an internal snapshot already exists when backup is started, the backup will not be executed and an error presented.

**Roadmap: multiple named internal Snapshots are planned**
Backup and Recovery
New features for database copies

SAP HANA database copy from PROD to QA or DEV allows now to change the topology in case of a Scale-out setup on PROD side:

- Backups which are produced on scale-out landscapes with n hosts can be recovered to one QA or DEV system.
- Purpose is to offer a possibility for a light system copy without the full performance scope like PROD
- Ability to work on that copy limited by performance and restricted by tables/partition sizes

![Diagram showing database copy topology change](image-url)
SAP HANA Backup & Recovery
News with SAP HANA SPS6 and Beyond

Backup LiveCycle Management & Security extensions
- Option to split large data backups
- Backup Catalog in Studio
- Extended log backup Availability Check
- New system privilege BACKUP OPERATOR
- SecureStoreFileSystem (SSFS)

Recovery Options (n→m)
- Flexible recovery despite different number of hosts – this feature offers new options also to system copies (Prod ⇒ QA)

Direct backup content streaming to 3rd party backup tools

- First official releases; further announcements about possible release dates for several tool partners

Planned with SAP HANA SPS7 (End of 2013)
- Integration of external Storage System snapshots with Redo Log roll forward of HANA
- Keep Backup History with Topology Changes
- More 3rd party backup tools

Planned beyond (2014)
- Incremental or differential Backup
- Named internal Snapshots
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- Monitoring & Administration
**SAP HANA Administration and Monitoring**

**Introduction**

**SAP HANA Administration and Monitoring**

**HANA Studio** is one administration & monitoring tool for managing SAP HANA.

It enables customers to make sure their HANA system runs as expected and provides possibilities to analyze problems.

It also houses the SAP HANA modeler and the user management for the SAP HANA database.

**SAP Solution Manager** can be used for basic administration and holistic monitoring of HANA systems within existing SAP landscapes.

It is used by SAP support for early problem analysis and as backbone for CTS+ transport integration.

SAP HANA also integrates with **SAP Landscape and Virtualization Manager (LVM)** for basic operation of larger/more complex SAP landscapes (start/stop & dependencies, etc.)
SAP HANA Studio
Native Administration & Monitoring Console
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
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
E2E Root Cause Analysis with SAP Solution Manager 7.1

**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
SAP HANA Administration and Monitoring
Feature comparison between Studio <> LVM

SAP HANA Studio

• Administration
  – Starting/Stopping the SAP HANA database
  – Backup and recovery
  – User and role management
  – Configuration changes

• Monitoring
  – Integration of all SAP HANA databases in the landscape possible
  – Detailed views for specific areas (like services, volumes, performance relevant information)

• Alerting
  – Alerts for critical situations are generated by the database automatically
  – Adjustment of alert thresholds to customer needs
  – Configuration of Email notifications

• Tracing
  – Changing trace levels
  – Display of individual trace files
  – View to display merged trace files of the different database services and from all database hosts

SAP NetWeaver Landscape Virtualization Management

• Administration
  – Auto-detection of SAP HANA systems within SAP landscapes by LVM and required configuration parameters (incl. host- and instance-information)
  – Managing hierarchies in starting/stopping the SAP HANA database in context of larger SAP landscapes, respecting their dependencies

• Monitoring
  – Monitoring of SAP HANA system status and process activity
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 Solution Manager as a counterpart in these communications.

Alternatively possible by direct SQL connect to SAP HANA
- Monitoring via direct connection to HANA Statistics Server
- Scheduling via SQL administration commands send directly to SAP HANA by tool

Alerting framework in external tool

Availability in preparation
- First contacts to external tool vendor established
- Availability depends on tool partners and the validation process and subsequent partner solution offerings
SAP HANA Monitoring, Alerting, Scheduling
News with SAP HANA SPS6 and Beyond

Improved Monitoring

Improved SQL Plan Cache

Table and partition redistribution editor with automation option
• Important for Scale-Out setups and how the data is located in an optimal way on different hosts for BW and SoH scenarios
• Prepared schemas of data distribution in place to offer this automation

More support for 3rd party management tools

Planned with SAP HANA SPS7 (End of 2013)
• More 3rd party management tools

Planned beyond (2014)
• Monitoring API
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)
- List of interesting links about the topic
  Data Center Operation:
  http://www.saphana.com/docs/DOC-2935

SAP Notes

- 1848976: SAP HANA Platform SPS 06 Release Note
- 1755396: Released DT solutions for SAP HANA with disk
- 1876398: Network configuration for SAP HANA System Replication
- 1834153: HANA high availability disaster tolerance config
Thank You!

Contact information:

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http://www.saphana.com/
SAP HANA Persistence
News with SAP HANA SPS6 and Beyond

Hybrid LOBs
• Keep LOBs mostly on disk to optimize memory efficiency

Paged Attribute
• Read tables/columns in smaller chunks especially with single record access

IO Optimizations for ROW store
• Do IOs on ROW store in chunks up to 64 MB
• Increases speed of start-up and Backup & Recovery

Support for large Data Volumes on EXT3 file system
• Support bigger Data Volumes possible with Scale-up of SoH which will not be able to be handled by EXT3 (2 TB file size limit of EXT3)

Smart Data Access
• Let external database content look like internal SAP HANA local tables to create content on top with all known features SAP HANA can offer to developers

Planned with SAP HANA SPS7 (End of 2013)
• Persistence development is deeply involved in several projects, like IQ technology integration into SAP HANA

Planned beyond (2014)
• More flexible Data Volume management