SAP HANA Guidelines for running virtualized
Guidelines for Partners & Customers

September 2014 v3.0

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1 BACKGROUND

With SAP HANA SPS 05, SAP announced support for running SAP HANA running SAP HANA in a virtualized environment for non-production scenarios, using VMware vSphere 5.1 on Intel E7 Westmere-EX platform. VMware vSphere 5.1 in conjunction with SAP HANA SPS 05 was at that time the first and only hypervisor supported by SAP HANA.

Meanwhile SAP has gathered further experience in running SAP HANA within virtualized environments, allowing us to further extend the support and to include support of SAP HANA on VMware vSphere 5.5 and Hitachi LPAR 2.0 in production.

This document is targeted at SAP partners and customers interested in running SAP HANA in such virtualized environments, as it describes in more detail the existing constraints which need to be met, when running SAP HANA virtualized in production and non-production scenarios.

2 APPROACH

Together with its partners, SAP has worked on this document describing the requirements for virtualizing SAP HANA on VMware vSphere and Hitachi LPAR.

In addition to this document, which focuses on the general conditions under which SAP HANA may be virtualized, additional information and necessary best practices are published by the hypervisor vendors (as of today VMware and Hitachi) on how to configure their corresponding hypervisor, the VMs and the guest operating system, to run SAP HANA in a supportable and performace optimized environment.

SAP HANA hardware and technology partners are allowed to extend the list of guidelines with additional requirements and best practices for their own SAP HANA offerings / configurations, as long they are not in conflict with this document.

This document may be release dependent. A new release of SAP HANA or one of the hypervisors might require an update / a new version of this document to be issued.

3 OUTLOOK

SAP and its partners will explore further use cases and scenarios in the context of virtualizing SAP HANA. Any update and changes on this topic will be communicated through SAP Note **1788665** and the documents it references.

4 SAP HANA GUIDELINE FOR VIRTUALIZATION

To ensure a successful implementation and on-going supportability of SAP HANA within virtualized environments, now and in the future, SAP will continue to limit support within virtualization environments to those use cases / scenarios where SAP and its partners have already gained experience and could identify and resolve potential problems before they occur at a bigger scale on customers sites.

4.1 Supported Use Cases

Currently SAP supports the following hypervisors for running SAP HANA in a virtualized environment:

- 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) production and non-production use cases

  - In General Availability for single-VM scenarios.
    See SAP Note **1995460** for specific information and constraints

  - In Controlled Availability for multi-VM scenarios.
    See SAP Note **2024433** for specific information and constraints.[1]

- Hitachi LPAR 2.0 and SAP HANA SPS 07 (or later releases) production and non-production use cases

  - In Controlled Availability for single- and multi-VM scenarios.
    See SAP Note **2063057** for specific information and constraints.[1]

For further details on the approval process for above mentioned Controlled Availability, see paragraph 4.5.1 SAP HANA Controlled Availability in this document.

4.2 Use Case Limitations

In general, SAP supports SAP HANA running virtualized in production and non-production. The following constraints have to be met, however:

- Support is limited to scale-up scenario only. SAP HANA database scale-out installations are <u>not</u> supported. The maximum size of a virtual SAP HANA instance is hence limited by the maximum size the hypervisor supports per virtual machine and the application specific core-to-memory ratios.

- Each SAP HANA instance / virtual machine needs to be sized according to the existing SAP HANA sizing guidelines and corresponding hypervisor vendor recommendations. CPU & memory overprovisioning must <u>not</u> be used.

- The SAP HANA system setup needs to be done by an SAP HANA certified engineer, on SAP HANA certified hardware, and successfully verified with the SAP HANA hardware

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[1] Access to this SAP Note is restricted to participants of Controlled Availability

configuration check tool (SAP HANA Tailored Datacenter Integration option). Alternatively, the system can be delivered pre-configured with hypervisor and SAP HANA software installed by SAP HANA hardware partner (SAP HANA appliance option).

- Configuration and overall setup complies with current version of the "SAP HANA Guidelines for running virtualized" and the vendor specific best practice document for running SAP HANA virtualized on the corresponding hypervisor.

Further constraints may apply for the various use cases and hypervisors. See above referenced SAP Notes (paragraph 4.1 Supported Use Cases) for more details.

4.3   Supported Software Versions

SAP HANA virtualized with VMware vSphere and vSphere ESXi hypervisor was tested on releases VMware vSphere 5.1 and SAP HANA SPS 05 for non-production, and SAP HANA SPS 07 and VMware vSphere 5.5 for production use cases.

SAP also supports running SAP HANA with single or multiple virtual machines of SAP HANA SPS 07 on Hitachi LPAR 2.0 for production and non-production use cases.

Newer releases may be used, based on backward compatibility of both products. Additional versioning constraints may apply, for example resulting from the support contracts with an SAP HANA appliance vendor.

4.4   Supported Hardware Generations

SAP HANA virtualized with VMware vSphere 5.1 is supported on SAP HANA validated Intel E7 Westmere-EX hardware. SAP further supports SAP HANA virtualized on Intel E7 v2 Ivy Bridge-EX CPU generation when running at least on VMware vSphere 5.5 / Hitachi LPAR 2.0 releases.

Future Intel CPU generations may be supported based on architecture assessments by SAP. Additional constraints may apply for example from support contracts with SAP HANA hardware or technology partners.

4.5   SAP HANA Support

In the case an issue arises with the SAP HANA software, customers are asked to open an SAP OSS support ticket, which then can be processed by SAP or routed to any SAP HANA hardware and technology partner as required.

SAP and its partners will jointly support virtual SAP HANA in production adhering to the SLAs defined in the customer support contract. If a reported problem is a known SAP HANA issue with a validated fix, SAP support will recommend the appropriate fix directly to the customer. For all other performance related issues, the customer will be referred within SAP's OSS system to the hypervisor vendor for support. The partner will take ownership and work with the SAP HANA HW/OS partner, SAP and the customer to identify the root cause. Due to the abstraction of hardware that occurs when using virtualization, some hardware details are not directly available to SAP HANA support. Work is ongoing between SAP and its partners to improve this visibility inside the SAP HANA virtual machine. Until then, SAP support may request that additional details be gathered by the customer or the SAP HANA HW partner to help with troubleshooting issues or the hypervisor vendor to re-produce the issue on SAP HANA running in a native, non-virtualized environment.

Table 1- Simplified Troubleshooting Process Flow
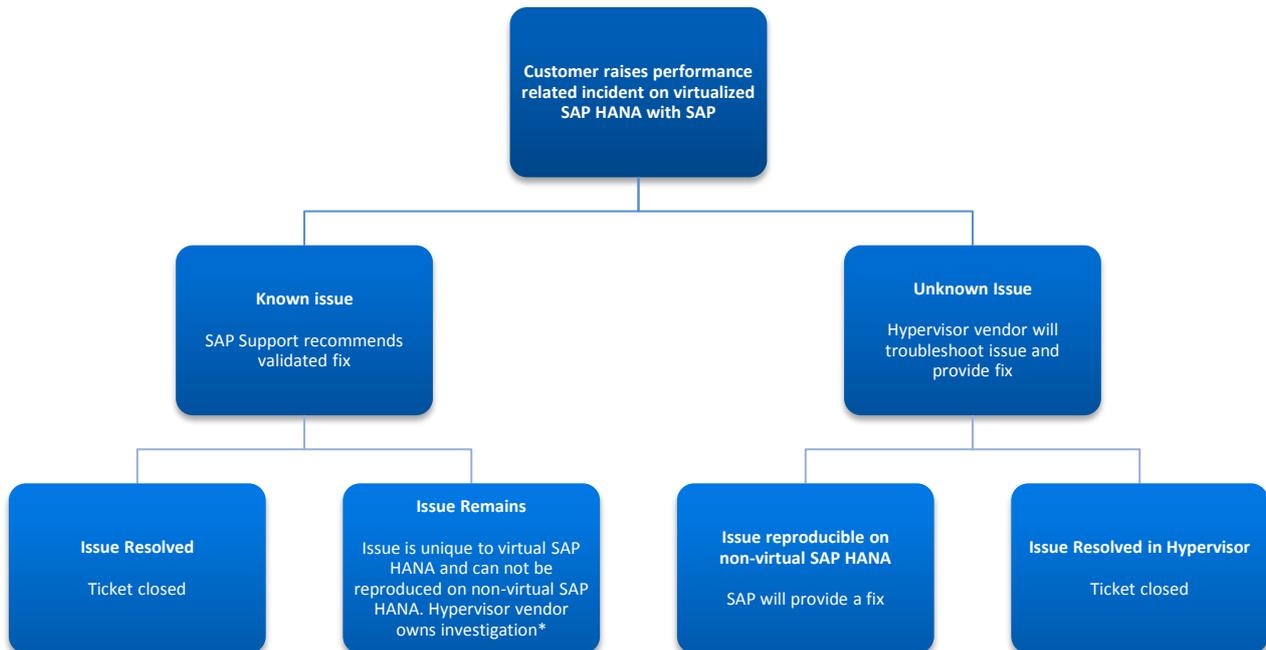
* Investigation may continue to involve SAP. If ultimately SAP HANA is found to be the cause, in agreement with SAP, ticket will be returned to SAP HANA development.

In case of SAP HANA running on top of VMware vSphere, VMware Tools should be installed inside the VM according to SAP Note **1606643** for monitoring and support purposes.

4.5.1 SAP HANA Controlled Availability

Customers interested in running multiple SAP HANA VMs on VMware vSphere 5.5 in production or in general on Hitachi LPAR 2.0 in production need to apply for the Controlled Availability of SAP HANA production support by sending an email to:
sap_hana_tailored_data_center_integration@sap.com

This email should contain:

- High-level scenario description and timeline (e.g. planned Go-live date)

- Expected database size (compressed HANA DB size, number of users)

- Hardware spec (HW vendor, server t-shirt size),

- Planned HA/DR setup (if applicable),

- Contact details (incl. SAP account number) for further communication

All information provided will be kept confidential and is only being used during the selection process. Once accepted, customers will receive the usual SAP HANA support as also provided for non virtualized environments for the presented scenario.

4.6 SAP HANA Platform Requirements

4.6.1 Hardware requirements

SAP only supports virtualization of SAP HANA on validated single-node SAP HANA appliances or through SAP HANA tailored data center integration verified hardware configurations. The Time Stamp Counter (TSC) must be synchronized between all sockets/cores.

4.6.2 Operating System Requirements

SAP HANA virtualized with VMware vSphere has the same operating system (OS) platform availability as non-virtualized SAP HANA deployments. Due to different scope and test coverage during corresponding validation activities, the underlying server must be certified for the corresponding operating system, however.

The latest information on supported OS platforms and corresponding versions is documented as part of the SAP HANA Platform Availability Matrix (PAM), available on http://service.sap.com/pam -> *Database and Technology -> SAP HANA PLATFORM EDIT 1.0.*

SAP permits the installation and operation of external software that is required for IT policy and compliance requirements as determined by the particular on-site operations, provided that the prerequisites stated in SAP Note **1730928** are met.

This also applies to VMware tools which may be installed inside the VM following the documentation available from VMware[2].

See SAP Notes **1944799** (related to SLES), **2009879** (related to RHEL) and the SAP HANA Installation Guide[3] for general guidance on operating system prerequisites.

4.6.2.1 SUSE and Red Hat Licensing and Pricing Policies

SUSE and Red Hat offer a wide range of server OS subscriptions to meet specific needs of their customers, like different support options, different hardware configuration, different term length and different deployment environments (physical and virtual).

For example, one SUSE server subscription for virtual use covers all of the virtual images running on one physical server. You can create as many virtual server images as you want, and get support for them, as long as you have a paid virtual use subscription for the physical server they are running on. Red Hat offers a subscription that you can migrate from physical to virtual environments and another that provides unlimited virtual images for running on a VMware hypervisor.

If your current SUSE Linux Enterprise Server or Red Hat Enterprise Linux subscription (physical) does not yet include such virtual operating environment, but you would like to run SAP HANA on SLES or RHEL on top of hypervisors like VMware, please get in contact with SUSE or Red Hat directly to upgrade your license subscription accordingly. See *SUSE Linux Enterprise Server*

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[2] http://packages.VMware.com/tools/docs/manuals/osp-esxi-51-install-guide.pdf
[3] https://help.sap.com/hana_platform#section2

Licensing and Pricing Policies[4] and the *Red Hat Enterprise Linux Subscription Guide[5]* for more details.

4.6.3   Storage Requirements

The existing SAP HANA storage requirements regarding partitioning, configuration and sizing of data, log and binary volumes remain valid. See the SAP HANA Installation Guide[6] for general guidance, for example in regards to file system recommendations.

In case of multiple VMs running in parallel, the defined KPIs for data throughput and latency for production SAP HANA systems has to be fulfilled for each VM. To measure if the used storage is able to deliver the required I/O capacity, SAP has released the SAP HANA HW Configuration Check Tool as part of SAP HANA Platform. See SAP Note **1943937** for more details.

In case of VMware, SAP further recommend to following the *VMware Best Practices for SAP HANA virtualized with VMware vSphere* with regards to technical storage configuration in VMware. Especially virtual disks created for log volumes of SAP HANA should reside on local SSD or PCI adapter flash devices if present.

Central storage may be used in terms of the SAP HANA tailored data center intergation approach[7].

4.6.4   SAP HANA Installation Requirements

The components of SAP HANA virtualized may only be installed by certified SAP HANA appliance vendors, their partners or SAP certified SAP HANA technology specialists.

In the case of pre-configured, virtualized SAP HANA appliance offerings customers may use provided VM machine base images or subsequent (e.g. patched) versions to clone it as often as desired.

Note that SAP also provides advisory and design services for virtualized SAP HANA configurations like for SAP HANA running on VMware vSphere, providing either architectural guidance in system planning or verification of existing installations in regards to current constraints and best practices.

4.7   Hypervisor Setup

4.7.1   Upgrade from Earlier (non-virtualized) SAP HANA Releases

SAP provides tools to upgrade SAP HANA software from one release to another. SAP HANA hardware and technology partners may offer additional service to do P2V (physical to virtual) conversions. See also chapter 4.7.5 for more information.

4.7.2   Virtual Machine Sizing

In general SAP HANA virtualized is sized the same as non-virtualized SAP HANA deployments. In other words, for sizing the virtual machine (VM) the CPU/memory ratio as used for native, non-virtual sizing is taken into account to ensure locality of memory access on the underlying hardware resources.

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[4] https://www.suse.com/products/server/policy.html
[5] http://www.redhat.com/en/resources/rhel-purchasing-guide
[6] https://help.sap.com/hana_platform#section2
[7] http://www.saphana.com/docs/DOC-3633

An initial system sizing is completed using the SAP QuickSizer or a sizing is based on an existing system. The result is a number that represents the needed performance for the system that is to run the application that was sized. This number is referred to as SAPS, which represents a unit of performance. Using SAPS, the CPU resource needs of an SAP HANA system can be calculated.

Since SAP HANA is an in-memory data platform, the memory needs of an SAP HANA system need to be calculated based on capacity sizing as well. These figures are determined by the customer working in conjunction with SAP or partners. The tools and resources used for this effort are exactly the same for both virtual and native environments. Once these initial sizing numbers are determined, they can be used to define the size of a virtualized SAP HANA virtual machine and the size of the vSphere host.

It is important to note that a vCPU is not exactly equivalent to a full physical core because it is mapped to a logical execution thread. When hyper-threading is enabled, a physical core has two execution threads. This means, two vCPUs are needed in order to use both of them. However, the additional thread created by enabling hyper-threading does not double the performance of the core. It has been determined that enabling hyper-threading usually increases overall SAP HANA system performance by approximately 20 percent.

More information on how to do sizing for SAP HANA Platform can be found on SAP Service Marketplace at https://service.sap.com/sizing, SAP Notes **1514966** (data mart), **1637145** (BW on HANA) and **1793345** (Suite on HANA) and the vendors specific best practice guides for running SAP HANA virtualized on corresponding hypervisors.

To avoid memory overcommitting, the memory resource allocation upon virtual machine startup shall be always enabled. Also keep in mind that the underlying hypervisor also requires some resouces (CPU/memory) to operate, which must not be dedicated to one of the SAP HANA VMs.

4.7.3   Operating Mixed VM Landscapes

Additional non-performance critical, non-SAP HANA VMs may run on the same hypervisor / host as long as the following constraints are met:

- There must be no memory or CPU overprovisioning configured between VMs.
- Resources sized for dedicated use by SAP HANA must not be utilized by other VMs.
- VMs running SAP HANA must be configured with HW resource scheduling priority.

4.7.4   VM Cloning

If a virtual machine is cloned, the SAP HANA license is virtually cloned as well. We encourage customers therefor to install a valid license for each virtual SAP HANA instance after cloning.

As for other SAP solutions SAP HANA license-keys for non-production systems are free of additional charge and can be generated under the terms and conditions of the production SAP HANA license.

4.7.5   P2V & V2P

It is a valid use case to clone for example, an SAP HANA bare-metal system into a virtual machine (P2V) to be then used for quality assurance purposes. In general SAP will not support issues which arise from P2V conversions, however, as in this way SAP cannot guarantee fulfillment of all

requirements that apply for a common SAP HANA system copy on bare metal. It's recommended to use SAP HANA system copy procedures instead.

For a virtual to physical (V2P) conversion either third-party V2P tooling or the standard SAP HANA system copy procedures may be used. SAP recommends to establish such system replication or automated V2P relocation procedure (with a recommended max. duration of 2h) to allow, within very rare support situations, the reproduction of corresponding workloads on bare metal hardware.

4.7.6 Nested Virtualization

SAP does not support SAP HANA virtualized within nested VMs.

4.7.7 Live Migration

SAP supports the use of live migration of the SAP HANA VMs, if explicit listed as tested capabilitiy in the hypervisor specific SAP HANA support Note.

Live migration might depend on the use of the SAP HANA tailored datacenter integration option, as often requiring the use of a central, enterprise storage, whereas most of the certified single-node SAP HANA appliances utilize local attached storage.

Some vendors also support a combined approach of live VM memmory and storage migration. Such enhanced live migration capabilities may be only used, if explicitly stated in the corresponding SAP HANA support Note.

In general, the following constraints apply then using VM live migraton in the context of SAP HANA:

- Virtual TSC must *not* be used.
- Synchronized TSC and identical clock speed must be ensured (on hardware level).
- Requires a 10GBit network interconnect between VMware nodes.
- All nodes within a cluster shall run the same version of hypervisor.
- Not to be used when SAP HANA system replication is configured.

4.7.8 High Availability and Disaster Recovery

As of today, SAP does not support built-in SAP HANA host auto-failover capability to achieve high availability (HA) system configurations, as this feature is considered a scale-out setup which is so far not supported within virtualized landscapes.

Alternatively, hypervisor HA and DR capabilities may be used to achieve highly available (HA) or disaster tolerant (DR) configurations between two or more single-node VMs.

For hypervisor platforms which support automated live migration, an accidental live migration of SAP HANA VMs to non-certified hardware must be prevented. For example, in case of VMware, Automated Distributed Resource Scheduled (DRS) rules shall be used. See the *VMware Best Practices for SAP HANA virtualized with VMware vSphere* for more information.

To prevent race conditions between various tools, automated live migration procedures shall not be used in combination with HA configurations.

Table 2- High Availability Options

High Availability solution	Hypervisor High Availability	Hypervisor HA + In-Guest Cluster (node recovery)	In-Guest cluster only	SAP HANA System Replication * + In-Guest Cluster
Scenario Description	Standard VM HA solution (based on shared file system, no split brain)	Cluster manager handles switch over to secondary site, while VM HA is used to restart/restore availability of primary host, so HA cluster is ready for next fault situation (just in opposite direction).	Standard 3rd party cluster manager, not utilizing VM capabilities. Data replication between primary and secondary site may be done by storage replication (or similar).	Standard 3rd party cluster manager, not utilizing VM capabilities. Data replication between primary and secondary site is done by SAP HANA system replication, however.
Operating system failures	Yes	Yes	Yes	Yes
Hardware failures	Yes	Yes	Yes	Yes
Application failures	No **	Yes	Yes	Yes
IP Redirect / DNS update	Not necessary	Handled by In-Guest Cluster Manager	Handled by In-Guest Cluster Manager	Handled by In-Guest Cluster Manager
RTO	Medium (crash recovery of DB)	Medium (crash recovery of DB)	Medium (crash recovery of DB)	Shortest (IP redirect)
RPO	0	0	0	0 (synchronous) >0 (asynchronous)
Remarks:	Suitable also for disaster tolerant (DT) solution, in conjunction with site failover with VMware Site Recovery Manager and storage replication	Note: 2nd cluster node shall not reside on same physical host Possible cluster manager includes Suse HA; HP Service Guard, SAP LVM, VMware Site Recovery manager	Note: 2nd cluster node shall not reside on same physical host	Alternative to VM HA / DT solution, leveraging SAP HANA system replication to achieve possible lower RTO.

*The SAP HANA host auto-failover is not yet supported, as scale-out supported is currently missing for virtualized environments; ** Future plans to also support application failure detection*

5 REFERENCES

- SAP HANA virtualized overview presentation
  http://www.saphana.com/docs/DOC-3334
- SAP HANA Guidelines for running virtualized (this document)
  http://www.saphana.com/docs/DOC-4192
- SAP HANA Tailored Datacenter Integration
  http://www.saphana.com/docs/DOC-3633
- VMware Best Practices for SAP HANA
  http://scn.sap.com/docs/DOC-27384
- Hitachi Best Practices for SAP HANA
  http://scn.sap.com/docs/DOC-58059

6 RELATED SAP NOTES

1492000   General Support Statement for Virtual Environments

1122388   Linux: VMware vSphere configuration guidelines

1788665   SAP HANA Support for VMware Virtualized Environments

1995460   Single SAP HANA VM on VMware vSphere in production

2024433   Multiple SAP HANA VMs on VMware vSphere in production (controlled availability)

2063057   SAP HANA VMs on Hitachi LPAR in production (controlled availability)

1943937   Hardware Configuration Check Tool - Central Note

7 DOCUMENT CHANGE HISTORY

V1.5   Updated chapters 4.1, 4.3.4, 4.3.6 & 4.3.10
V1.6   Generally revisited to reflect SAP HANA tailored data center integration option
V1.7   Added dependency to synchronized TSC
V1.8   Added chapter on supported hardware / CPU generations
V2.0   Generally revisited for support of non-production and production use cases
V3.0   Added Hitachi LPAR support statement
V3.1   Adapted chapter 4.6.2.1 to include Red Hat licensing terms