

BEST PRACTICES

SAP HANA on vSphere

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1. Executive Summary

SAP helps customers migrate from traditional relational databases to their in-memory SAP HANA database to gain more agility in their business processes. Many SAP customers are searching for ways to deploy SAP HANA in an efficient, simple way that minimizes risk and preserves the benefits of an agile platform. Nutanix provides such an option.

This document outlines mandatory steps and best practices for deploying SAP HANA on the Nutanix Cloud Platform to help you achieve the best possible performance and obtain production support from SAP for your SAP HANA database VMs.

This SAP HANA on Nutanix best practices guide describes all the relevant technical settings and considerations you need to get the most out of your SAP HANA scale-up and scale-out environments running on Nutanix AOS with VMware ESXi. Nutanix, in collaboration with SAP Engineering, developed the requirements and recommendations presented in this document by extensively testing SAP HANA on the Nutanix Cloud Platform. These settings ensure that you're running a fully supported production SAP HANA system.

Compared to traditional three-tier virtualization implementations, deploying SAP HANA on Nutanix lets you realize several key benefits, including dramatic reductions in complexity, significant risk avoidance, gains in flexibility, and a shorter time to market.

2. Introduction

Audience

This best practice guide is part of the Nutanix Solutions Library. We wrote it for customers, partners, and internal employees responsible for working on any SAP HANA project. Readers of this document should already be familiar with Nutanix AOS, VMware ESXi, and SAP HANA. You need credentials for the SAP Knowledge Base to access some of the SAP notes mentioned in this guide.

Purpose

We cover all necessary guidelines and prerequisites for successfully deploying SAP HANA in production on Nutanix AOS using VMware ESXi as the hypervisor.

If you're deploying SAP HANA on Nutanix AOS using Nutanix AHV as the hypervisor, refer to the [SAP HANA on AHV best practice guide](#).

Document Version History

Version Number	Published	Notes
1.0	January 2021	Original publication.
1.1	April 2022	Updated the Prerequisites, Hardware and Hypervisor, and VM and Application sections for new AOS version.
1.2	September 2022	Updated the Hardware and Hypervisor section.

3. Hyperconverged Infrastructure (HCI) for SAP HANA Certification

The HCI certification for SAP recognizes the potential of HCI to reduce the TCO, risk, and complexity of traditional implementation methods for SAP HANA.

The certification has two primary segments. As the first step, a platform vendor (Nutanix, in this case) must validate their platform, which consists of a hypervisor and an HCI component. Nutanix has validated the combination of VMware ESXi and Nutanix AOS to fulfil all requirements of SAP for systems using VMware ESXi as the hypervisor. In a second step, the hardware original equipment manufacturer (OEM) must certify a suggested configuration through some additional HCI-related tests.

When both parts of the validation are complete, the solution is certified and listed in the [HCI for SAP HANA category](#) on the [SAP website](#). The hardware OEM is then responsible for selling and supporting the certified solution for the customer. Nutanix frequently supports these sales efforts with SAP presales specialists.

4. SAP HANA Deployment Requirements

To ensure that you're running your SAP HANA VMs in a way that allows for maximum performance while assuring full production support, work through the following lists to verify your settings and complete any modifications. These requirements and recommendations are the direct results of intensive testing and validation exercises run by Nutanix with guidance from SAP HANA Engineering.

Note: Unless otherwise noted, these requirements are mandatory to achieve full support for the implementation from SAP and Nutanix.

To make it easier for you to confirm that everything is covered, we have grouped our best practices in four main categories:

- Prerequisites
- Design considerations and caveats
- Hardware and hypervisor
- VM and application

Prerequisites

Before you install a system, verify that it meets the following prerequisites. For production landscapes these prerequisites are mandatory; for nonproduction landscapes we strongly recommend adhering to the same prerequisites.

- Ensure that you're using a supported OS for your VM, per the [SAP Product Availability Matrix \(PAM\)](#) (SAP account required).
- Ensure that your version of VMware ESXi is 6.7 U3 or later and supported by the compatible AOS versions listed in the next bullet point. Consult [SAP note 2686722: SAP HANA virtualized on Nutanix AOS](#) (SAP account required) for updates regarding support for newer versions of VMware ESXi.

- Ensure that your version of Nutanix AOS is 5.15.nn or 5.20.nn. These versions are Long Term Support (LTS) releases that ensure long support cycles. Nutanix only qualifies AOS LTS releases for SAP HANA. Review our [Support Policies and FAQs](#) for more detailed information about Nutanix product releases and support cycles. Nutanix strongly recommends updating to the newest available AOS LTS release validated for SAP HANA as soon as possible.
- Ensure that you're using a supported version of SAP HANA; both SAP HANA 1 and 2 are supported.
- SAP HANA on HCI is only supported on Intel® Xeon® Scalable Processors of the Intel Cascade Lake microarchitectures.
- Check the [SAP HANA HCI Hardware directory](#) for supported and certified solutions from Nutanix OEMs.

Review the appendix of this document for guidance on how to verify your current version.

Design Considerations and Caveats

When you design your environment, keep the following caveats in mind for production SAP HANA database systems:

- The maximum memory size of a single production SAP HANA VM is 4.5 TB.
- The maximum number of virtual CPUs for a single production SAP HANA VM is 168 vCPU. This maximum assumes the VM has hyperthreading enabled.
- Don't place the SAP HANA production database on the same socket as the CVM.
- Resource sharing between production SAP HANA VMs and any other VMs isn't allowed.
- You can live-migrate an SAP HANA VM on VMware ESXi with Nutanix AOS.
- For production SAP HANA database VMs, ensure that you adhere to the resource combinations outlined in the following table.

Table: Resource Combinations for Production SAP HANA Database VMs

Platform	VMs	CPU / Memory Sockets per VM	Notes
Dual Socket	1	1	Example: 56 vCPU and 768 GB of RAM on an Intel® Xeon® Platinum 8280 Processor
Quad Socket	3	1	3 VMs with 1 socket's worth of CPU and memory
Quad Socket	2	1 / 2	1 VM with 1 socket's worth of CPU and memory; 1 VM with 2 sockets' worth of CPU and memory
Quad Socket	1	3	Example: 168 vCPU and 4.5 TB of RAM on an Intel® Xeon® Platinum 8280 Processor

Memory configuration for SAP HANA production VMs must follow these rules:

- You must assign each SAP HANA production VM the full memory amount of its assigned sockets.
- Reserve some memory for hypervisor overhead. The amount of memory depends on several different configuration specifics, such as the number of vCPUs, the number of disk devices, and so on, but plan for approximately 3-6 percent of the available memory.

We support nonproduction SAP HANA database systems as follows:

- For nonproduction databases, we support the listed production VM configurations, as well as database VMs that consume half a socket's worth of CPU and memory resources.

- For nonproduction databases, we support running the database VM in parallel with other nonproduction VMs, including the CVM.
- For nonproduction databases, you don't need to follow the strict memory and NUMA configuration rules described earlier in this section.

For your Nutanix cluster design, consider the following points:

- Always plan for failover capacity in the form of $n + 1$. Your Nutanix cluster should always be able to sustain a complete node loss without any manual intervention.
- If possible, Nutanix recommends starting with a four-node cluster. A four-node cluster allows you to complete maintenance operations without worrying about free space or timing.
- When you size usable storage on the cluster, ensure the following:
 - For production VMs, assume three times the SAP HANA database memory footprint per VM, available locally on the node where the VM is running.
 - For nonproduction VMs, assume twice the SAP HANA database memory footprint, available locally on the node where the VM is running.
- Don't configure storage-saving functionalities such as compression, deduplication, or erasure coding (EC-X) on a storage container that holds production database files. Because of how the SAP HANA Persistence Engine stores data, these features deliver no benefits. Nutanix SAP Engineering has tested compression with SAP HANA workloads; the tests indicate no noticeable performance impact but also show no reduction in the space the SAP HANA workload consumes.

Hardware and Hypervisor

SAP maintains the list of supported systems available from different OEMs on its [Certified HCI Solutions page](#). We recommend that you check this page regularly for newly certified systems and OEMs. For your SAP HANA on Nutanix deployment to be supported, you must select a system listed on the [SAP HANA HCI Hardware directory](#).

When you choose and set up your hardware, follow the SAP HANA networking recommendations described in [SAP HANA Network Requirements](#) to ensure the availability of enough physical and virtual network interfaces.

Note: It's mandatory to separate HANA network traffic (for example, database access and HANA replication) from all other types of traffic.

Nutanix recommends different configurations for your storage subsystem depending on the use case. For production systems with low latency requirements and workloads that are generally transactional, we recommend using SSDs with NVMe. Data warehouse workloads and systems with less strict latency requirements can use all-flash (SSD only) configurations. Hybrid disk (SSD and HDD) configurations aren't supported for SAP HANA.

Note: All-flash configurations must have a minimum of four SSD devices.

Verify the best way to set the hardware-specific BIOS settings to the equivalent of "Maximum performance" with your specific hardware vendor. These hardware settings can have a significant impact on latency performance for the overall solution.

VM and Application

Note the following sizing limitations when creating your SAP HANA production VMs:

- On dual-socket hardware:
 - › An SAP HANA production VM can't have more than 56 vCPU. This maximum assumes the VM has hyperthreading enabled.
 - › A VM can't have more than 1.5 TB of RAM.
- On quad-socket hardware:
 - › A VM can't have more than 168 vCPU. This maximum assumes the VM has hyperthreading enabled.
 - › A VM can't have more than 4.5 TB of RAM. There is some memory overhead, which varies depending on the hardware platform configuration.

The overhead is specific to the system and VM configuration; it varies across setups.

In addition to these sizing limitations, there are several guidelines for creating your VMs:

- Stay within NUMA boundaries for each VM's vCPU and memory configurations. To find out more about NUMA, refer to [SAP note 2393917: SAP HANA on VMware vSphere 6.5 and 6.7 in production](#) or [SAP note 2937606: SAP HANA on VMware vSphere 7.0 in production](#) (SAP account required).
- Apply OS settings for SAP HANA inside the VM as recommended in the relevant SAP notes.
- Use four PVSCSI adapters inside the VM.
- Use a minimum of four virtual hard disks for the database log and four virtual hard disks for the database data volume.
- Follow the advice in the [VMware Knowledge Base article 2053145](#) regarding queue depth settings in the GuestOS.
- Use a supported file system as described in [SAP note 2972496: SAP HANA Filesystem Types](#) (SAP account required).
- SAP fully supports the use of the Linux Logical Volume Manager (LVM), as described in [SAP note 597415: Logical volume manager \(LVM\) on Linux](#) (SAP account required). Keep the disks for the data volume and the disk for the log volume in separate LVM volume groups. When you create the logical volume, create a striped logical volume using all the physical volumes in the volume group.
- Check the [SAP HANA Master Guide](#) for disk space requirements for SAP HANA log, data, and shared volumes.

To create the respective file systems, follow these steps:

- Create log and data volume groups for SAP HANA (note that the following code block is an example; replace the sample letters with those from your setup):

```
$ vgcreate hanalog /dev/sd{b,c,d,e}
$ vgcreate hanadata /dev/sd{f,g,h,i}
$ vgcreate hanashared /dev/sdj
```

- Create logical volumes for log and data striped across four virtual hard disks with 64 K stripe size and readahead=none. Use all logical extents of a volume group for the logical volumes:

```
$ lvcreate -i <# of virtual disks for log> -I 64K -l 100%VG -r none -n vol_hanalog
$ lvcreate -i <# of virtual disks for data> -I 64K -l 100%VG -r none -n vol_hanadata
$ lvcreate -l 100%VG -r none -n vol_hanashared
```

- Create XFS file systems on the log and data volumes:

```
$ mkfs.xfs /dev/mapper/hanalog-vol
$ mkfs.xfs /dev/mapper/hanadata-vol
$ mkfs.xfs /dev/mapper/hanashared-vol
```

- Create mount points /hana/log, /hana/data, and /hana/shared:

```
$ mkdir -p /hana/{log,data,shared}
```

- When using XFS, add the following mount parameters to the relevant entries in /etc/fstab:

```
$ noatime,nobarrier,inode64,largeio,swalloc 1 2
```

- Mount the volumes accordingly.

Creating SAP HANA VMs

When you create SAP HANA VMs, verify the following configuration changes.

Pin production SAP HANA VMs to one or more specific NUMA nodes. The Nutanix CVM already occupies one NUMA node; you can use the remaining NUMA nodes.

The following examples are based on a physical CPU with 20 cores (40 threads) and a Nutanix CVM running on NUMA node 0.

It's important to note that the cores per socket distribution must align with the physical layout of the VMware ESXi host in use. You must configure a VM spanning two physical CPUs with two sockets, and so on. Additionally, adjust NUMA node affinity to the correct NUMA node on the physical layout.

- Example 1: The following two figures show the settings for an SAP HANA VM with three CPU sockets. Each vCPU has 40 cores (hyperthreads included).

These settings result in a VM with three virtual sockets, three NUMA nodes, and a total of 120 vCPU.



Figure 1: Example 1 Core Configuration



Figure 2: Example 1 NUMA Affinity

- Example 2: The following two figures show the settings for an SAP HANA VM with two CPU sockets. Each vCPU has 40 cores (hyperthreads included). These settings result in a VM with two virtual sockets, two NUMA nodes, and a total of 80 vCPU.



Figure 3: Example 2 Core Configuration



Figure 4: Example 2 NUMA Affinity

- Example 3: The following two figures show the settings for an SAP HANA VM with three CPU sockets. Each vCPU has 40 cores (hyperthreads included). These settings result in a VM with one virtual socket, one NUMA node, and a total of 40 vCPU.



Figure 5: Example 3 Core Configuration



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Figure 6: Example 3 NUMA Affinity

Enable the VM metrics host daemon as described in [SAP note 2266266: Key Monitoring Metrics for SAP on VMware vSphere \(version 5.5 u3 and higher\)](#) (SAP account required).

SAP HANA Specifics

- Review the [SAP HANA Master Guide](#) and the [SAP HANA Server Installation and Update Guide](#).
- Always check the relevant SAP notes for updates before you install any SAP HANA-specific software.
- SAP HANA System Replication is supported on Nutanix to ensure application availability.
- Set the max_parallel_io_requests to 256. To set this parameter, navigate to Configuration and Monitoring in SAP HANA Studio. Click Open Administration and select global.ini, then fileio. For max_parallel_io_requests, change the setting to 256.
 - › Alternatively, you can set this parameter with the following hdbsql command:

```
$ <sidadm>@<hostname>:/usr/sap/<SID>/HDB00> hdbsql -n 1v9906 -i 00 -user SYSTEM -
password manager
$ Welcome to the SAP HANA Database interactive terminal
$ Type: \h for help with commands
$   \q to quit
$ hdbsql 001=> ALTER SYSTEM ALTER CONFIGURATION ('global.ini', 'SYSTEM') SET
('fileio','max_parallel_io_requests') = '256' WITH RECONFIGURE;
$ 0 rows affected (overall time 379.908 msec; server time 378.079 msec)
```

5. Conclusion

When you choose Nutanix for your SAP HANA implementation, you benefit from reduced complexity and improved agility. Following the recommendations provided in this document can help ensure successful implementation and operation of SAP HANA on Nutanix.

If you have questions regarding this document, visit the [Nutanix SAP solution page](#).

6. Appendix

References

For SAP support information and verification, see [SAP note 2686722: SAP HANA virtualized on Nutanix AOS](#) (SAP account required).

Version Information

To view the Nutanix version running in the cluster, click the user icon in the main menu, then select About Nutanix from the dropdown list. The About Nutanix window that appears displays the AOS and Nutanix cluster check (NCC) version numbers. It also includes a link to Nutanix patent information.

About Nutanix

Nutanix is a global leader in cloud software and a pioneer in hyperconverged infrastructure solutions, making clouds invisible and freeing customers to focus on their business outcomes. Organizations around the world use Nutanix software to leverage a single platform to manage any app at any location for their hybrid multicloud environments. Learn more at www.nutanix.com or follow us on Twitter [@nutanix](https://twitter.com/nutanix).

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