Introduction

Abstract

This guide is the 2024 July edition of the best practices and recommendations for SAP HANA on VMware Cloud Foundation, focusing on VMware vSphere. It describes the best practices and recommendations for configuring, deploying, and optimizing SAP HANA scaled-up and scaled-out deployments, with a focus on vSphere 8.0 running on 3rd- and 4th-generation Intel Xeon Scalable processors, such as Cascade Lake, Cooper Lake, Ice Lake, and Sapphire Rapids systems.

Note: Scale-up SAP HANA vSphere deployments use a larger host and, therefore, larger VMs to scale from 2-socket up to 8-socket large VMs on a single 8-socket ESXi host. Scale-out means adding more hosts/VMs to a single SAP HANA, typically for a business warehouse instance.

Most of the guidance provided here results from ongoing joint testing by VMware and SAP to characterize the performance of SAP HANA running on vSphere.

vSphere 7.0 and vSphere 7.0 update versions on second and third-generation Intel Xeon Scalable processors, such as Broadwell, Skylake, Cascade Lake, Cooper Lake, and Ice Lake ESXi hosts are still supported and are covered in this document as well.

We also provide information on Intel Optane Persistent Memory (PMem) 100 series technology, which is only supported with Cascade Lake and vSphere 7.0 virtualized SAP systems. SAP HANA does not support later CPU generations with PMem, and Intel has announced it is discontinuing this technology.

Audience

This guide is intended for SAP and VMware hardware partners, cloud services providers, system integrators, architects, and administrators responsible for configuring, deploying, and operating the SAP HANA platform in a VMware virtualization environment.

It assumes you have a basic knowledge of VMware Cloud Foundation concepts and features, SAP HANA, and related SAP products and technologies.

Solution overview

SAP HANA on VMware vSphere

Per SAP, 80% of their German and over 51% of their US customers run SAP on-premises or in a private cloud. According to an IDC study in the same SAP article, up to 68% of SAP workloads will stay on-premises in the United States, especially for large customers. SAP has supported vSphere for production use cases for 10 years, and most of the on-premises customers (over 70%) use VMware solutions as their private cloud (SDDC) solution for SAP applications like SAP HANA.

By continuing to validate SAP HANA on the latest Intel CPU generations and latest vSphere and Cloud Foundation (VCF) versions, these customers can continue to seamlessly integrate their IT and SAP operations by leveraging their existing IT processes, know-how, and customer-tailored infrastructure. This allows full control of their data and the overall SAP HANA solution.

SAP HANA on VMware vSphere supports scaling database sizes up to 12TB (16TB is planned with 8-socket Sapphire Rapids systems) and scaling out with up to 16 nodes (plus high-availability nodes) with up to 48TB (depending on the host configuration).

The SAP HANA platform with VMware virtualized infrastructure provides an optimal environment for achieving a unique, secure, cost-effective solution. It also offers benefits that physical deployments of SAP HANA do not include, such as:

- On-premises security and control
- Locality for consistent and predictable performance
- Regulatory demand for cloud neutrality
- Sovereignty over data and business transactions
- Increased security (using VMware NSX as a zero-trust platform)
- Higher service-level agreements (SLAs) by leveraging vSphere vMotion to migrate live SAP HANA instances to other ESXi host systems before hardware maintenance or host resource constraints
- Integrated lifecycle management provided by VMware Cloud Foundation SDDC Manager
- Standardized high availability solution based on vSphere HA
- Built-in multitenancy support via SAP HANA system encapsulation in a VM
- Easier hardware upgrades or migrations due to the abstraction of the hardware layer
- Higher hardware utilization rates
- Automation, standardization, and streamlining of IT operations, processes, and tasks
- Public cloud operating model and cloud readiness due to software-defined data center (SDDC) SAP HANA deployments

These and other advanced features found almost exclusively in virtualization lower the total cost of ownership and ensure the best operational performance and availability. As mentioned in SAP Notes 2937606, 3102813, and 3372365, and SAP KB 2101244, this environment fully supports SAP HANA and related software in production environments, as well as SAP HANA features such as multi-tenant database containers (MDC) and system replication (HSR).

Note: Refer to SAP Note 2104291 "FAQ - SAP HANA multi-tenant database containers," page 2.

Solution components

An SAP HANA system based on VMware technologies is a fully virtualized and cloud-ready infrastructure solution running on VMware vSphere and supporting technologies, such as VMware vCenter. All local server host resources—such as CPU, memory, local storage, and networking components—are presented to a VM virtually, abstracting the underlying hardware resources.

The solution consists of the following components:

- VMware-certified server systems as listed in the VMware hardware compatibility list (HCL)
- SAP HANA-supported server systems, as listed in the SAP HANA HCL
- SAP HANA-certified hyperconverged infrastructure (HCI) solutions, as listed in the SAP HANA HCI HCL
- VMware Cloud Foundation or vSphere Foundation with VMware products like:
  - vSphere and vSAN version 7.0 U2 and later, Sapphire Rapids-based systems, vSphere 8.0 and vSAN U2 and later
  - vCenter 7.0 and later, vCenter 8.0 with vSphere 8.0
  - Optional: NSX Networking and Security (out of scope for this document)
  - Optional: Aria Suite for management (out of scope for this document)
- A VMware-specific and SAP-integrated support process

What's new in vSphere 8.0?

From Introducing vSphere 8: The Enterprise Workload Platform, VMware vSphere 8, the enterprise workload platform, brings the benefits of the cloud to on-premises workloads, supercharges performance through DPUs and GPUs, and accelerates innovation with an enterprise-ready integrated Kubernetes runtime. Additionally, there are significant operational benefits, like VMware Live Recovery add-on services, Unified Cloud Management, a unified multi-cloud management solution that provides capacity planning and optimization for your infrastructure with the right size to fit the current and future needs of your SAP workloads, host different GPU workloads on a single GPU, and perform pre-staged ESXi upgrades, to name some. Visit the VMware by Broadcom specific product webpages for details and up-to-date information.

Benefits of SAP HANA on VMware vSphere 8.0

The latest advancements in vSphere 8.0 bring significant benefits to SAP customers, facilitating the creation of robust, cost-efficient, manageable, and high-performing SAP HANA environments. A notable enhancement for SAP users in vSphere 8.0 is the revamped approach to presenting the physical system/processor topology to virtual machines (VMs).

Previously, vSphere administrators had to manually configure SAP HANA VMs to align with the underlying host hardware, including non-uniform memory access (NUMA) alignment. This alignment is crucial for optimizing SAP HANA performance. To achieve optimal performance before vSphere 8.0, admins had to configure the advanced parameters for each VM.

The introduction of the enhanced virtual topology feature in vSphere 8.0 marks a significant improvement. This feature automatically determines optimal coresPerSocket values and virtual L3 cache sizes for VMs, simplifying configuration and enhancing performance.

vSphere 8.0 also incorporates intelligent, adaptive NUMA scheduling and memory placement policies, eliminating the need for manual VM balancing across nodes. Admins can still use manual controls to override the default behaviors and configure the NUMA placement for performance-critical SAP HANA VMs.

To learn more about optimizing performance, refer to the Performance Best Practices for VMware vSphere 8.0 paper. For detailed configuration steps, consult the VMware vSphere 8.0 Virtual Topology paper.

In addition, vSphere 8 Update 1 marks the first release supporting up to 960 logical CPUs per physical host, further expanding scalability.

vSphere 8 Enterprise is available as part of VMware Cloud Foundation and VMware vSphere Foundation, as well as standalone editions such as vSphere 8 Standard and Essentials.

Software and hardware support for SAP HANA on vSphere

SAP HANA production support for vSphere and VMware Cloud Foundation

In November 2012, SAP announced initial support for scaling up SAP HANA systems on vSphere 5.1 for non-production environments. Since then, SAP has extended its production-level support for scale-up and scale-out SAP HANA deployment options and multi-VM and half-socket support. vSphere versions 5.x and 6.x are no longer supported, and vSphere 7.0 will be unsupported in April 2025. Therefore, you should plan to upgrade to vSphere versions 7.0 or 8.0. The following table lists relevant SAP HANA on vSphere support notes as of March 2024.

Table 1. Relevant SAP notes

Key notes for virtual environments	1492000: General support statement for virtual environments 1380654: SAP support in cloud environments 2161991: VMware vSphere configuration guidelines
SAP HANA on vSphere	3102813: SAP HANA on VMware vSphere 8 3102813: SAP HANA on VMware vSphere 7.0 U2 with up to 12 TB 448 vCPUs VM sizes 2937606: SAP HANA on VMware vSphere 7.0 (incl. U1 and U2) in production 2393917: SAP HANA on VMware vSphere 6.5 and 6.7 in production 2779240: Workload-based sizing for virtualized environments 2718982: SAP HANA on VMware vSphere and vSAN 6.x / 7.x 2718982: SAP HANA on VMware vSphere and vSAN 8.x 2913410: SAP HANA on VMware vSphere with Persistent Memory 2020657: SAP Business One, version for SAP HANA on VMware vSphere in production

vSphere version support for Intel CPU platforms

The following table provides an overview, as of March 2024, of the vSphere 7/8 versions and CPU platforms supported by the SAP HANA on vSphere solution.

Table 2. Supported vSphere versions and CPU platforms as of March 2024

vSphere version	Broadwell	Skylake	Cascade Lake	Cooper Lake	Ice Lake	Sapphire Rapids
vSphere 7.0 U2 and later up to 8-socket wide VM	✓	✓	✓	✓	✓	
PMem Series 100 (vSphere 7)			✓			
vSphere 8.0 U2 and later up to 2-socket wide VM			✓	✓	✓	✓
vSphere 8.0 U2 and later up to 4-socket wide VM			✓	✓		✓
vSphere 8.0 U2 and later up to 8-socket wide VM			✓	✓		

vSphere maximums

The following table summarizes the critical maximums of the different vSphere versions supported for SAP HANA.

Table 3. vSphere memory and CPU SAP HANA relevant maximums per CPU generation as defined by SAP

vSphere version	SAP HANA maximum virtual memory	Maximum CPUs for SAP HANA deployments	CPU sockets for SAP HANA
vSphere 7 U2 and later	< 12TB with Cascade and Cooper Lake	<= 448 vCPUs	0.5-, 1-, 2-, 3-, 4-, 5-, 6-, 7-, and 8-socket wide VMs
vSphere 8 U2 and later	< 4TB for Ice Lake and Sapphire Rapids 2-socket systems	<= 240 vCPUs	0.5-, 1- and 2-socket wide VMs. SPR 2-socket hosts require SNC for half-socket VMs
vSphere 8 U2 and later	< 8TB for Sapphire Rapids	<= 480 vCPUs	0.5-, 1-, 2-, 3-, and 4-socket wide VMs
vSphere 8 U2 and later	< 12TB with Cascade and Cooper Lake	<= 448 vCPUs	0.5-, 1-, 2-, 3-, 4-, 5-, 6-, 7-, and 8-socket wide VMs

Note: These configurations may vary if smaller core count CPUs or different memory configurations are used and require an SAP HANA TDI/workload-based sizing. >8 socket Sapphire Rapids systems are in SAP HANA vSphere validation.

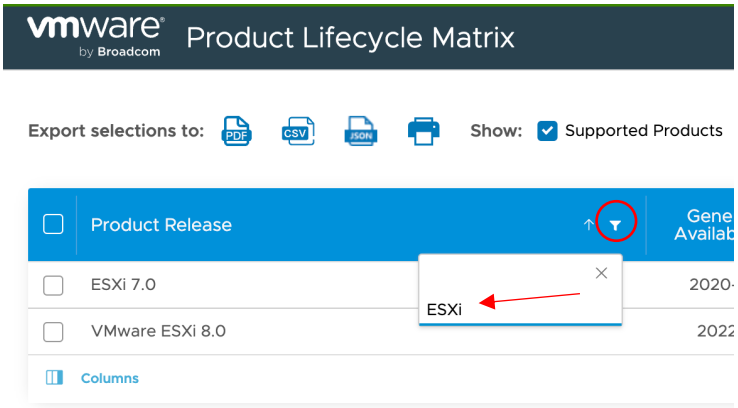
Release strategy

VMware's SAP HANA certification and support strategies for vSphere are to support a single CPU generation or chipset with two versions of the hypervisor and to have a single hypervisor version span two CPU generations/chipsets.

VMware does its best to balance supporting new customers on the latest hardware and those on an older platform. You may still use vSphere 7 since this version is supported until April 2025. vSphere 8.0 Update 3 is the most recent available version, and we recommend using this version for all new SAP HANA deployments on vSphere. The end of general support for this version is April 2027.

To directly show the ESXi versions: Set a filter for `ESXi` at the **Product Release** table heading, as shown in the following figure.

Figure 1. Select the filter icon next to Product Release and type `ESXi`



Supported vSphere and VMware Cloud Foundation offerings

SAP HANA on vSphere is supported only with the following editions:

- VMware Cloud Foundation
- vSphere Foundation

vSphere Standard can also be used for smaller SAP application deployments. vSphere Essentials Plus supports Business One solutions. Make sure you are familiar with the feature, CPU, and host limitations of these products.

Notes:

- We highly recommend VMware Cloud Foundation with bundled Select Support for strategic enterprise customers.
- Per SAP Note 2652670: SAP HANA VM on VMware vSphere, usually all update and maintenance versions of vSphere hypervisors are automatically validated within the same boundary conditions.
- This architecture reference guide and the involved test environment use only vSphere dvPortGroups to connect the SAP HANA nodes and non-SAP HANA DB / VM workloads. An upcoming version of this guide will include NSX-based vLANs or overlay segments.
- For the latest SAP-released support information, refer to the SAP notes related to VMware.

Scalability and VM sizes

SAP HANA on vSphere is supported on the smallest SAP HANA system, which is a half-socket CPU configuration with a minimum of 8 physical CPU cores and 128 GB of RAM, up to 8-socket large SAP HANA VMs with up to 12 TB of RAM. The CPU power and RAM required for SAP workloads on HANA must be sized appropriately. VMs larger than 4 sockets require an 8-socket host. 8-socket servers are an optimal consolidation platform and could, for instance, host two large 4-socket VMs, each with up to 6TB of memory, 16 half-socket VMs with up to 750GB memory, or one large 12TB SAP HANA VM.

SAP supports VMware virtualized OLTP workloads up to 8TB for a 4-socket large SAP HANA VM and 12TB for an 8-socket large VM as standard sizes when selecting top-bin Intel CPUs. This standard sizing supports 50 % of the memory defined for OLTP-type workloads (for example, 3TB for 4-socket OLAP VMs or 6TB for 8-socket VMs). If additional memory is needed, you must do a workload-based SAP expert sizing.

For more details, review SAP Note 2779240: Workload-based sizing for virtualized environments. Table 4 shows the current vSphere maximums per physical ESXi host.

Table 4. vSphere physical host maximums (extract)

Relevant Maximums	ESXi 7.0 U2 and later	ESXi 8.0 U1 and later
Logical CPUs per host	896	960
VMs per host	1,024	
Virtual CPUs per host	4,096	
Virtual CPUs per core	32	
RAM per host	24TB	
NUMA nodes/CPU sockets per host	16 (**SAP HANA only 8-CPU socket hosts / HW partitions**)	

Note: ESXi hosts with up to 8 physical CPUs are supported. If larger 8-socket systems are required, contact your SAP or VMware account team and discuss deployment alternatives, such as scale-out or memory-tier solutions. Also note the support limitations when using 8-socket or larger hosts with node controllers (also known as *glued-architecture systems* or *partially QPI meshed systems*).

The following table shows the maximum size of a vSphere VM and some other relevant parameters, such as virtual disk size and the number of virtual NICs per VM. These VM limits are higher than the SAP HANA–supported configurations.

Table 5. vSphere guest VM maximums (extract)

Maximums	ESXi 7.0 U2 and later	ESXi 8.0 U1 and later
Virtual VM hardware version [1]	19	21
Virtual CPUs per VM	Up to 768	
RAM per VM	Up to 24TB	
CPU sockets per SAP HANA VM	<= 8	
RAM per SAP HANA VM	<= 12TB	
Virtual SCSI adapters per VM	4	
Virtual NVMe adapters per VM	4	
Virtual disk size	62TB	
Virtual NICs per VM	10	
Persistent Memory per SAP HANA VM	<= 12TB	Not supported

* [1] Review the Hardware Features Available with Virtual Machine Compatibility Settings web page for a detailed list of the guest hardware capacities. You must use hardware version 21 for VMs on (or migrated to) Sapphire Rapids hosts.

Deployment options and considerations

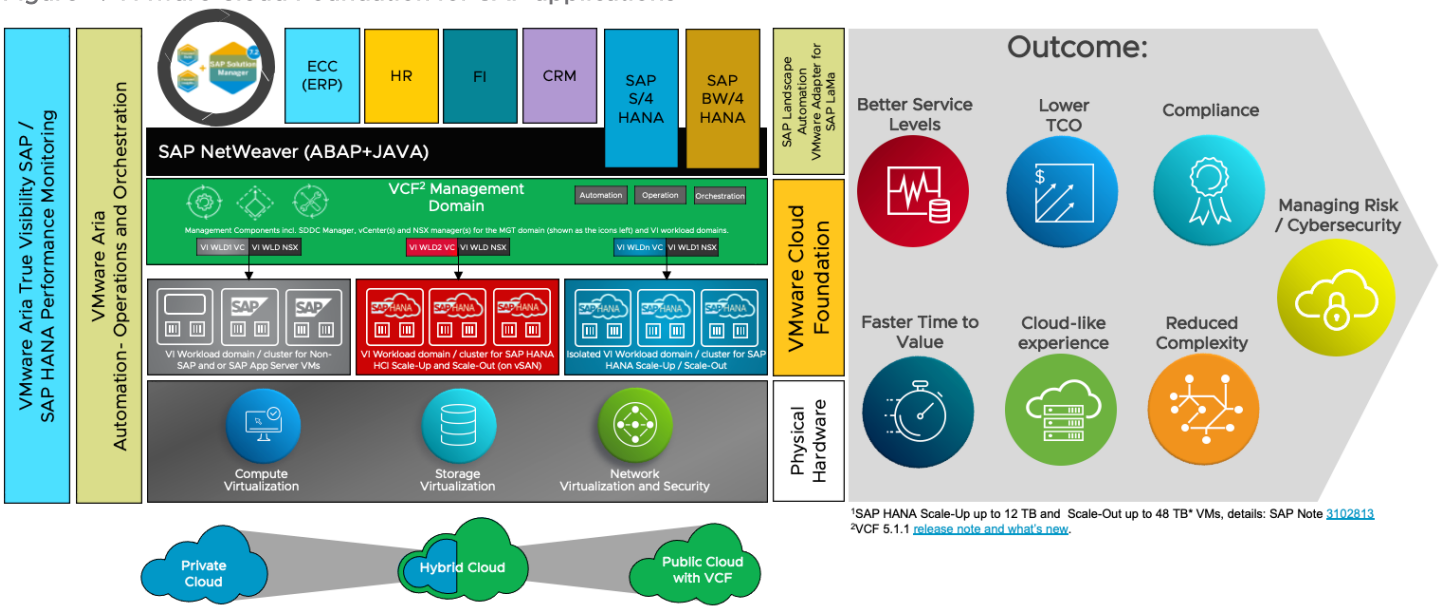
Reference architecture diagram

The following figure shows an overview of a typical VMware software-defined data center (SDDC) for SAP applications. At the center of a VMware SDDC is VMware Cloud Foundation, which includes vSphere, vSAN, and NSX. VCF has VI Workload Domains—each Workload Domain is a logical unit of application-ready infrastructure that groups ESXi hosts managed by a vCenter Server instance with specific characteristics according to VMware recommended practices.

The figure shows the preferred VCF design for non-SAP HANA database VMs and SAP HANA with separate VCF VI Workload Domains. (You can include an optional, isolated VI Workload Domain.) Each VI Workload Domain has a dedicated NSX Manager cluster to provide the benefits of flexible lifecycle management, which includes the option to run different VCF software stack versions across the different VI Workload Domains. A VI Workload Domain can consist of one or more vSphere clusters provisioned by the SDDC Manager.

The red and blue VI Workload Domains are examples of SAP HANA Workload Domains with different storage types. The grey VI Workload Domain is an example of mixed SAP and non-SAP application Workload Domains with different SLAs/requirements, like ESXi hosts that are not SAP HANA-certified.

Figure 2. VMware Cloud Foundation for SAP applications



The next table provides an overview of the different Workload Domain types (WLDs) and how best to leverage these for SAP and non-SAP VMs/applications.

A VI Workload Domain (VI WLD) shares a vCenter single sign-on domain and the identity provider configuration with the Management Domain. You can manage all VI WLDs through a single pane of glass.

A VI WLD can share an NSX Manager instance with other VI WLDs. We recommend a dedicated NSX Manager per VI WLD for easier and more flexible lifecycle management.

Small and medium SAP deployments could consolidate SAP HANA and non-SAP HANA database VM workloads into a single VCF VI WLD with one or more vSphere cluster configurations to reduce the required hardware footprint, but this would lose the lifecycle management flexibility between different SAP workloads.

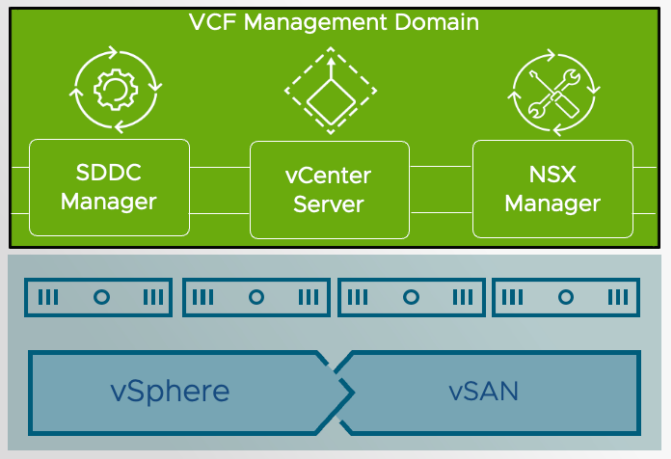
Larger deployments with SAP HANA systems with different operation, hardware, and SLA requirements should not share a VI WLD/cluster with non-SAP HANA VMs. Running these VMs in a dedicated SAP HANA VI WLD/cluster eases lifecycle management and ensures the correct cluster-wide settings for features like HA, DRS, and EVC.

An isolated VI WLD is another option for a distinct vCenter single sign-on domain; this requires an identity provider configuration. VI WLDs of this type cannot yet share an NSX Manager instance with other VI WLDs and, therefore, need a dedicated NSX Manager instance. This allows the independent lifecycle management of isolated VI WLDs and is recommended when strict isolation of user and business data is required.

Small SAP deployments could leverage the consolidated VCF architecture model, which consolidates the VCF Management components (vCenter, NSX Manager, and SDDC Manager) and all SAP workloads (non-SAP HANA database VMs and SAP HANA) with the lowest possible hardware footprint, but this loses the lifecycle management flexibility between the VCF Management Domain and the VI WLD running the different SAP workloads. If you want to deploy SAP HANA production-level VMs in a consolidated WLD, you must ensure these SAP HANA VMs run on SAP HANA TDI-supported systems and do not share a NUMA node with a non-SAP HANA VM. We advise configuring dedicated vSphere clusters to manage VCF VMs and workload VMs. For a consolidated WLD, we recommend separate cluster-wide settings for management and SAP NetWeaver/SAP HANA hosts.

Note: Every vSphere cluster requires at least 2 embedded vCLS VMs or 3 external vCLS VMs. A cluster allows different cluster-wide settings; however, we recommend you add non-SAP HANA hosts to an SAP HANA cluster to offload the vCLS VMs.

Table 6. VMware Cloud Foundation Management and VI Workload Domain types and use cases

VCF Management Domain	
First domain deployed, runs on dedicated ESXi hosts (min. 4) Contains the following management appliances for all Workload Domains: • vCenter Server • NSX Manager • SDDC Manager • Optional: VMware Aria Suite components, Management Domain NSX Edge nodes The VI WLD vCenter and NSX Manager VMs are installed on the Management Domain hosts. Depending on the Workload Domain type, you can scale from 14 to 24 VI WLDs. A total of 1000 ESXi hosts are supported per VCF instance following the VCF standard architecture, where a single VI WLD can scale up to 800 ESXi hosts and up to 4000 registered VMs. A single VCF instance can have multiple availability zones (a stretched deployment).	

Consolidated VCF SAP Domain

Represents a Management Domain that also runs customer workloads. It's limited to 100 hosts per consolidated VI WLD.

Uses resource pools to ensure sufficient resources for management components.

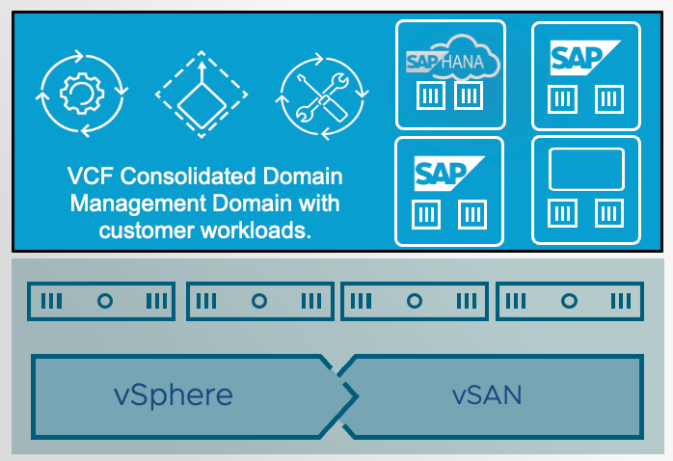
Considers the minimum possible initial hardware and management component footprint (min. 4 hosts). Only with vSAN and SAP HANA HCI certified hosts and the listed configurations for CPU, memory, and storage.

Can be scaled to a standard architecture model.

Management components and customer workloads are not isolated.

SAP HANA production-level workloads must not run on the hosts that run the management components or non-SAP HANA VMs.

This is an option for small deployments or test and dev environments. **Add HANA dedicated hosts as required if you want to deploy production-level SAP HANA VMs.**



SAP/SAP HANA VI Workload Domain

Represents an additional Workload Domain for running customer workloads. Can scale up to 14 VI Workload Domains per VCF instance.

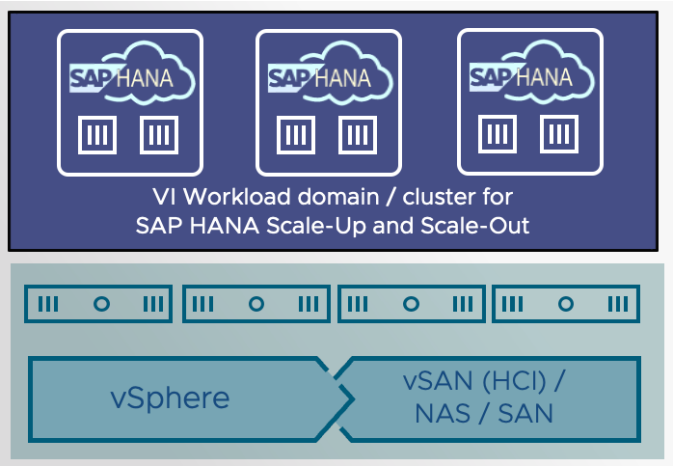
Shares a vCenter single sign-on domain and the identity provider configuration with the Management Domain. All Workload Domains can be managed through a single pane of glass. Can share an NSX Manager instance with other VI Workload Domains. A dedicated NSX Manager per VI WLD is recommended for easier lifecycle management.

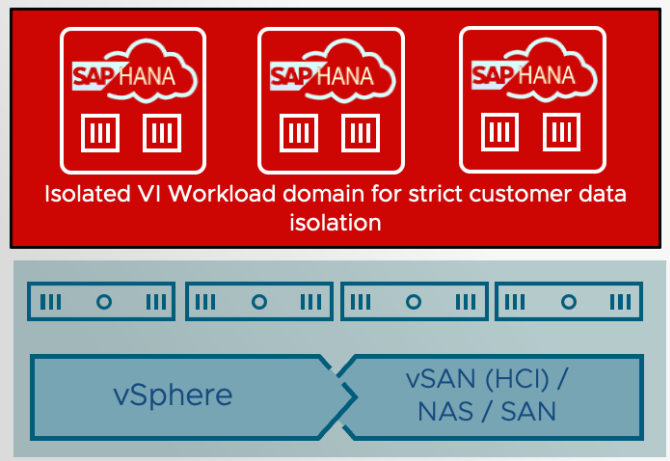
Allows for independent life cycle management of the different VI WLDs.

This Workload Domain type cannot provide distinct vCenter single sign-on domains for customer workloads. For this, an isolated VI WLD is required.

If SAP applications are deployed, only SAP-supported hosts can be used. SAP HANA hosts must also be SAP HANA TDI-supported systems and are limited to 2-, 4-, or 8-socket ESXi hosts with validated Intel CPUs.

This Workload Domain type cannot provide distinct vCenter single sign-on domains for customer workloads. For this, an isolated VI WLD is required.



If SAP applications are deployed, then only SAP-supported hosts can be used. SAP HANA hosts must also be SAP HANA TDI supported systems and are limited to 2-, 4- and 8-socket ESXi hosts with validated Intel CPUs. VM maximum host size: ≤ 12TB and 480 vCPUs per single SAP HANA scale-up VM. The smallest size is 0.5 socket with 128GB RAM. Scale-out deployment: VM must be ≥ 4 sockets, maximum 8 sockets, VM vRAM up to 6TB per VM depending on the use. Maximum 8 hosts + HA for a total size of 48TB. For shared ESXi or VM connected SAN or NAS storage w/o vVOLs, the storage must meet HANA KPIs. HCI certified hosts are required when vSAN is used. SAN or NAS deployments require min. 2 hosts; vSAN systems require min. 3 hosts. SAP NetWeaver and SAP HANA hosts can run consolidated in a VI WLD if the same SLAs and lifecycle management requirements exist. If not, then use dedicated VI WLDs for SAP HANA and NetWeaver or AnyApp.	
SAP/SAP HANA Isolated VI WLD	
Represents an additional Workload Domain for running customer workloads. Can scale up to 24 VI Workload Domains per VCF instance **Has a distinct vCenter single sign-on domain and identity provider configuration. Workload domain vCenter Server instances are managed through different panes of glass**. Can provide distinct vCenter single sign-on domains for customer workloads. **Workload domains of this type cannot share an NSX Manager instance with other VI Workload Domains.** Allows for independent life cycle management of the isolated VI WLDs and is the **recommended option when a strict isolation of user and business data is required.** **If SAP applications are deployed, then only SAP-supported hosts can be used.** SAP HANA hosts must also be SAP HANA TDI supported systems and are limited to 2-, 4-, and 8-socket ESXi hosts with validated Intel CPUs. VM maximum host size: ≤ 12TB and 480 vCPUs per single SAP HANA scale-up VM. Smallest size is 0.5 socket with 128GB RAM. Scale-out deployment: VM must be ≥ 4 sockets, maximum 8 sockets, VM vRAM up to 6TB per VM depending on the use. Maximum 8 hosts + HA for a total size of 48TB.	

For shared ESXi or VM-connected SAN or NAS storage w/o vVOLs, the storage must meet HANA KPIs. HCI certified hosts are required when vSAN is used. SAP NetWeaver and SAP HANA hosts can run consolidated in a VI WLD if the same SLAs and lifecycle management requitements exist. If not, then use dedicated VI WLDs for SAP HANA and NetWeaver or AnyApp.	

Depending on the Workload Domain type, you can scale from 14 (ELM) to 24 (isolated) VI WLDs. Refer to Maximums and Configuration Limitations, VCF Deployment Options (for example, deployments in multiple availability zones), and vSphere Design for VMware Cloud Foundation.

In total, 1000 ESXi hosts are supported per VCF instance following the VCF standard architecture, where a single VI WLD can scale up to 800 ESXi hosts and up to 4000 registered VMs.

As shown in the figure and table above, the VI WLD vCenter and the NSX Manager VMs are installed in the VCF Management Domain among the vCenter and the NSX Manager VMs to manage the VCF Management Domain.

Review the Maximums and configuration limitations and VCF Deployment Options (for example, deployments in multiple availability zones for configuration details).

As previously explained, virtualized SAP HANA systems are currently supported on VMware vSphere with up to 448 vCPUs and 12 TB RAM per VM on Intel Cascade / Cooper Lake and with up to 480 vCPUs and 8 TB on Intel Sapphire Rapids systems; the vSphere 7.0 U2 and vSphere 8.0 U1 VM guest limits are 768 vCPUs and 24 TB per VM. Only the ESXi host systems shown in table 2 are validated on SAP HANA.

Note: The following may limit the maximum number of vCPUs and vRAM available for a VM:

- The selected CPU type
- The virtualized SAP HANA workload type (OLTP or OLAP)
- An SAP HANA use case of network-heavy OLTP workloads with thousands of concurrent users, which may be required to reserve CPU threads to handle such an intensive network load.
- The implemented design options in VCF, like vSAN or NSX networking and security features, will reduce the available memory per SAP HANA VM.

Larger SAP HANA systems can leverage SAP HANA extension nodes or be deployed as SAP HANA scale-out configurations. In a scale-out configuration, up to 16 nodes (more upon SAP approval) work together to provide larger memory configurations. A scale-out SAP HANA node's memory size depends on the selected CPU generation, and 4- or 8-socket systems with memory sizes per host and up to 6TB can be chosen. Refer to the relevant SAP Notes (3102813 and 3372365) for detailed information on supported host configurations. In addition, the SAP HANA on vSphere SAP Help Portal page provides an overview of supported configurations and is a good starting point.

An SAP HANA system deployed on a VMware SDDC based on VMware Cloud Foundation can be easily automated and operated by leveraging VMware Aria products. SAP HANA or hardware-specific management packs allow a top-to-bottom view of a virtualized SAP HANA environment, where an AI-based algorithm allows the operation of SAP HANA in a nearly automated approach, optimizing performance and availability. A tight integration with SAP Landscape Management Automation Manager via the VMware Adapter for SAP Landscape Management helps to cut down operation costs even further by automating work-intensive SAP management and operation tasks.

An SAP HANA system deployed in VMware Cloud Foundation allows you to adopt cloud-like virtual networking with NSX overlay segments, and it protects your business-critical SAP workloads with the NSX Distributed Firewall (DFW).

Note: This reference guide does not include the adoption of NSX vLAN, overlay segments, and NSX Distributed Firewall (DFW). These NSX deployment options require additional consideration and are currently out of the scope of this document.

In addition to SAP HANA, most SAP applications and databases can be virtualized and are fully supported for production workloads. Each SAP workload can run on its own ESXi host, or multiple SAP workloads/VMs can be consolidated on a single ESXi host.

Virtualizing all aspects of an SAP data center is the best way to plan for quick growth and easily move to a cloud-based infrastructure. SAP applications can also run in a true hybrid mode, where the most important SAP systems still run in the local data center and less critical systems run in the cloud.

SAP HANA on VCF deployment options and sizes

You can install SAP HANA on SAP-supported vSphere versions and validated CPU generations as scale-up and scale-out deployments on a single large VM or on multiple SAP HANA VMs on a single ESXi host. You may use only 2-, 4-, and 8-CPU socket VMware and SAP-supported or certified systems for SAP HANA production-level systems.

SAP HANA tenant databases (MDC) can run inside a VMware VM (see SAP Note 2104291, FAQ doc, page 2). Running SAP HANA VMs next to non-SAP HANA VMs, such as vSphere management VMs or SAP application servers, is also supported when these VMs run on different CPU sockets or when an SAP HANA and SAP NetWeaver AS (ABAP or Java) run in one VM (see SAP Notes 1953429 and 2043509).

The following table shows the supported host configurations for SAP HANA on vSphere and the deployment options for both single-tenant and multi-tenant SAP HANA instances on vSphere. It also gives guidelines for the standard memory sizes that SAP and VMware support based on the current SAP-defined memory limits for the top-bin Intel CPUs listed as certified appliance configurations.

The examples show the SAP-selected, top-bin CPUs with the maximum core count and memory support available for SAP HANA workloads. Refer to the SAP HANA Certified and Supported SAP HANA Hardware directory for details. Lower-bin CPUs or other CPU families may have different SAP HANA-supported memory configurations. As mentioned, deviating from these memory configurations is possible when an SAP HANA expert workload-based sizing is performed.

Note: The maximum available memory for a virtualized SAP HANA system is limited to the maximum memory tested with vSphere, which is currently 12TB per single scale-up VM or 48TB with scale-out deployments.

Legend:

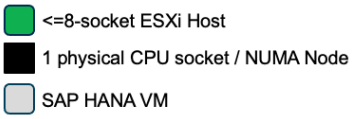
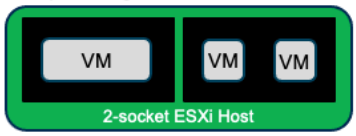
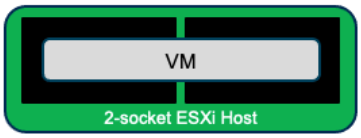
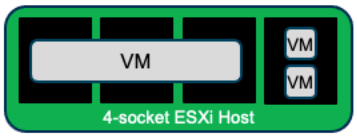


Table 7. Overview of SAP HANA on vSphere deployment options and possible VM sizes

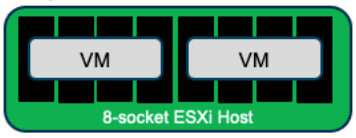
2-socket host examples Example 1: Single and Half-Socket HANA VMs  Example 2: 2-Socket Wide HANA VM  	vSphere 7.0 supported CPU generations: • Broadwell • Skylake, Cascade Lake, and Cooper Lake • Ice Lake vSphere 8.0 supported CPU generations: • Cascade Lake and Cooper Lake • Ice Lake • Sapphire Rapids (half-socket support only with SNC) VM sizes: 0.5, 1, 2-socket wide VMs on 2-socket hosts with a minimum of 8 vCPUs and 128 GB vRAM and up to 240 vCPUs and >4 TB (SAP HANA standard memory size) with Ice Lake and Sapphire Rapids, 3 TB (standard) or larger memory sized based on a workload-based sizing possible with Cascade or Cooper Lake. Recommended network configuration per host (dual-NIC port configuration): • 1GbE IPMI, 1 GbE ESXi Management network • >= 10GbE vMotion / HA • >= 10GbE HANA to App Server network • Plus optional networks like those for backup or replication
4-socket host example Example 3: Wide and Half-Socket HANA VM on one host  	vSphere 7.0 supported CPU generations: • Broadwell • Skylake, Cascade Lake, and Cooper Lake vSphere 8.0 supported CPU generations: • Cascade Lake and Cooper Lake • Sapphire Rapids VM sizes: 0.5, 1, 2, 3 and 4-socket wide VMs on 4-socket hosts with minimal 8 vCPUs and 128 GB vRAM and up to 224 vCPUs and >6 TB (SAP HANA standard

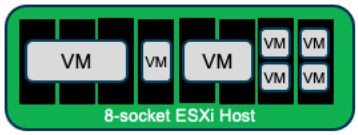
<table>
<tr><td></td><td>memory size) with Cascade and Cooper Lake. Larger memory sizes based on a workload-based sizing is possible.

Recommended network configuration per host (dual-NIC port configuration):

• 1GbE IPMI, 1GbE ESXi Management network
• >= 25GbE vMotion / HA
• >= 10GbE HANA to App Server network
• Plus optional networks like those for backup or replication</td></tr>
<tr><td>8-socket host examples

Example 4: 1 HANA VM across 8 NUMA nodes
 

Example 5: 2 HANA VM across 4 NUMA nodes
 

Example 6: Wide VMs, single and half-socket VMs on one host
 
</td><td>vSphere 7.0 supported CPU generations:

• Broadwell
• Skylake, Cascade Lake, and Cooper Lake

vSphere 8.0 supported CPU generations:

• Cascade Lake and Cooper Lake
• Sapphire Rapids is not currently available on 8-socket hosts, but is undergoing the validation process

VM sizes:

0.5, 1, 2, 3, 4, 5, 6, 7 and 8-socket wide VMs on 8-socket hosts with minimal 8 vCPUs and 128 GB vRAM and up to 448 vCPUs and >12 TB (SAP HANA standard memory size) with Cascade and Cooper Lake.

Note: 6-socket ESXi host configurations are supported as well.

Recommended network configuration per host (dual-NIC port configuration):

• 1GbE IPMI, 1GbE ESXi management network
• >= 25GbE vMotion / HA
• >= 10GbE HANA to App Server network
• Plus optional networks like those for backup or replication</td></tr>
</table>

SAP HANA half-socket VM support on 2-socket Sapphire Raids hosts requires Intel sub-NUMA Clustering (SNC-2) due to higher measured deviations while running two SAP VMs on 2-socket Sapphire Rapids hosts.

However, 4-socket Sapphire Rapids systems support half-socket SAP HANA VMs without requiring SNC-2. You can deploy two SAP HANA VMs, as in previous CPU generations.

SAP HANA half-socket VM support on non-SNC 2-socket Sapphire Rapids hosts or >2-socket Sapphire Rapids systems are not yet supported.

NUMA node/CPU sharing half-socket VMs are supported up to Ice Lake CPUs with vSphere 7 and, where applicable, with vSphere 8.

Intel sub-NUMA clustering (SNC-2) support and deployment options

Support for SNC-2

Support for SNC-2 in SAP HANA considers the increasing density of processors, memory controllers, processor interconnects, and supporting infrastructure within a single chip as the CPU size decreases. Increasing the number of CPU cores and, consequently, CPU performance is advantageous for users. However, this increased density is associated with a longer data transfer time between different parts of the CPU chip.

The process of accessing the memory within a CPU is facilitated by a uniform memory access (UMA) domain, which offers a unified and contiguous address space that is interleaved among all the memory controllers. UMA lacks a mechanism for optimizing data flow from the closest available resources. Processor affinity is typically employed to specify the processor(s) that a particular software thread utilizes. Consequently, in a Uniform Memory Access (UMA) system, all cores have equal access to the last level cache and memory. In this scenario, a processor might access a memory controller or a portion of the last level cache located on the opposite side of the CPU chip compared to the nearest.

Accessing and moving data within a CPU chip takes longer, and the memory subsystem is used more than before. This is clear when you compare the latest Sapphire Rapids CPUs to Cascade Lake CPUs. In this case, the number of CPU cores and memory controllers doubled (from 2 to 4 memory controllers) or slightly more than doubled (from 28 to 60 cores), but the number of memory channels only went up by 33.33%. The Sapphire Rapids platform has a faster memory bandwidth (MT/s), but this means that more CPU threads need to share a memory channel. DDR5 memory modules also have a longer CAS latency than DDR4 modules. CAS latency is a timing parameter that measures the delay between a memory controller sending a request for data and the memory module responding with the requested data. A longer CAS latency leads to bigger differences when memory-sensitive applications are used, for example, when two SAP HANA VMs share a NUMA node or CPU socket. A Sapphire Rapids CPU performs much better than a Cascade Lake CPU. This includes half-socket deployments.

However, there are more fluctuations when running several SAP HANA VMs on a socket. Because of these fluctuations, SAP does not support half-socket deployments for Sapphire Rapids CPUs. The following table shows this. It also shows a Sapphire Rapids CPU's theoretical available memory channels per CPU core.

The table doesn't reflect the change in increased memory speed. It only shows that the available memory channels are more utilized because of the increased CPU core count per chip and the higher CAS latencies when first accessing data stored in memory.

Table 8. Overview of CPU memory channels and CAS latency of selected SAP HANA-relevant CPUs

CPU	Cores	# of memory controllers	Max # of memory channels	Core/channel ratio	DDR type	Percentage change	Typical CAS latency [1]	Percentage change
Intel Xeon Platinum 8280 Processor "Cascade Lake"	28	2	6	4,667	4	0%	21	0%
Intel Xeon Platinum 8380 Processor "Ice Lake"	40	4	8	5,000	4	7%	22	5%
Intel Xeon Platinum 8490H Processor "Sapphire Rapids"	60	4	8	7,500	5	61%	40	90%

∗ [1] For more information, refer to this article: The difference between RAM speed and CAS latency.

The number of memory channels refers to the bandwidth operation for the real-world application. (After following the hyperlink, click on **(?)** at **Max # of Memory Channels**.)

Intel introduced sub-NUMA clusters (SNC) to decrease the latency of data movements across the CPU. Sapphire Rapids CPUs support SNC-2 and SNC-4, **but SAP HANA vSphere VMs support only SNC-2 on 2-socket host configurations.**

Two localization domains exist within a processor in a two-cluster SNC (SNC-2). Each domain has addresses mapped from the local memory controller and local Last Level Cache (LLC) slices. Processors in the local domain will use the local memory controller and local LLC slices. This means that LLC and memory accesses in the local domain will have lower latency than accesses to locations outside the same SNC domain.

SNC has a unique location for every address in the LLC, and it is never duplicated within the LLC banks. Localization of addresses within the LLC for each SNC domain applies only to addresses mapped to the memory controllers in the same socket. All addresses mapped to memory on remote sockets are uniformly distributed across all LLC banks independent of the SNC mode. Therefore, even in the SNC mode, the entire LLC capacity on the socket is available to each core, and the LLC capacity reported through the CPUID is not affected by the SNC mode.

Refer to figure 2 – "Block Diagram Representing Domains Of sub-NUMA With Two Clusters" and figure 3 "– Block Diagram Representing Domains Of sub-NUMA With Four Clusters" on the Intel product webpage, which shows the block diagrams of a sub-NUMA node enabled CPU. Figure 2 represents a two-cluster configuration. This is the SAP-supported SAP HANA on vSphere configuration consisting of SNC Domains 0 and 1 and their associated cores, LLCs, and memory controllers. Each SNC-2 domain contains half of the processors on the socket, half of the LLC banks, and half of the memory controllers with its associated DDR channels, limiting a VM to these resources.

According to Intel, the affinity of cores, LLC, and memory within a domain are expressed via software using the NUMA affinity parameters in the operating system.

Note: SNC is enabled at the BIOS level and requires that the memory be symmetrically populated.

When SNC-2 is used for SAP vSphere VMs on 2-socket Sapphire Rapids, then we advise that either all hosts in a Sapphire Rapids vSphere cluster are SNC-2 enabled or that a VM host rule is applied to ensure that the SNC-2-enabled VMs do not get migrated or started on non-SNC-enabled hosts.

SNC-2 supported deployment examples

SAP HANA and SAP Application servers are supported by SAP and VMware with SNC-2 only on 2-socket Sapphire Rapids servers with vSphere 8 and can be leveraged as described in the table below.

Important: SAP and VMware don't support any other configurations for SAP HANA and SAP application deployments. They only support non-SNC-2 configurations as full-socket VM configurations.

The SAP HANA reference architecture for 2-socket Intel Xeon Platinum 8490H Processor Sapphire Rapids–based systems defines a 60-core Sapphire Rapids CPU to support up to 2TB of memory (4TB in total per 2-socket Sapphire Rapids host) according to SAP HANA appliance sizing. Different memory sizes and lower core count CPUs, like a 32- or 48-core Sapphire Rapids CPU, can also be used, but they require SAP application/workload sizing.

Note: The following configuration options for running SAP HANA on vSphere are not supported on bare metal servers enabled for SNC. Sapphire Rapids 4-socket hosts support half-socket deployments without SNC-2. Therefore, the following table isn't relevant for >2-socket Sapphire Rapids hosts. It only applies to 2-socket Sapphire Rapid hosts.

Legend:

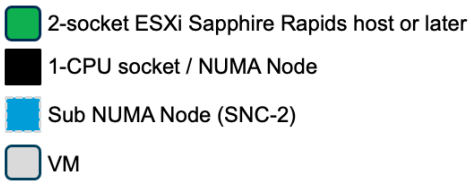
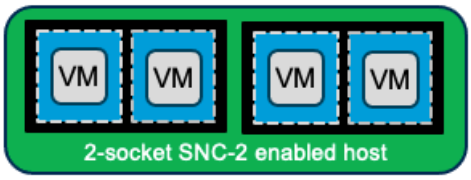
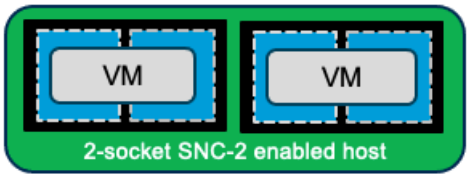
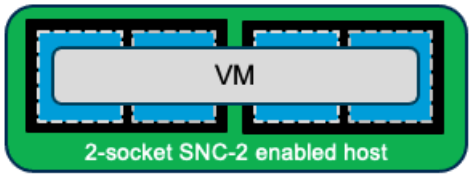
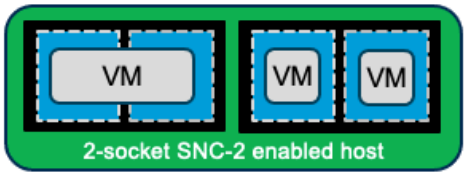
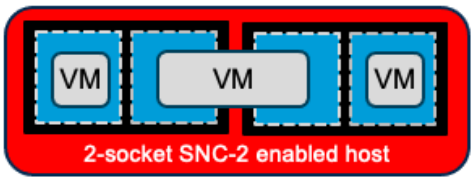
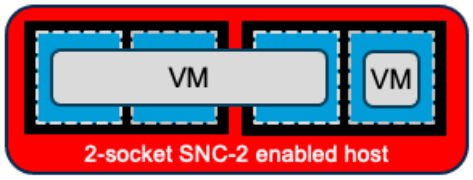


Table 9. SAP HANA–supported SNC-2 configurations

Option 1: 2 VMs per NUMA node, 4 VMs in total per ESXi host VM size is based on the SAP HANA reference configuration for 2-socket Sapphire Rapids systems: • 4 VMs with <=60 vCPUs, <1 TB vRAM, and 1 vSocket 	Option 1 shows 4 SAP HANA VMs running on an SNC-2 enabled host. Each VM operates on a sub-NUMA node that is fully isolated, providing exclusive access to all available CPU resources. This configuration replaces the NUMA node sharing half-socket configuration seen in older CPU generations running SAP HANA VMs shared on a CPU. The benefit lies in the dedicated CPU resources separated by SNC, eliminating resource sharing between VMs as seen without SNC. This full isolation and shorter distance from a CPU thread to memory offer the best possible performance per VM when 4 VMs run on a host. Additionally, SAP supports, with SNC, the deployment of non-SAP HANA VMs on another sub-NUMA node on the same physical CPU socket. This was not supported in the past, allowing VMs for infrastructure management (such as vCLS VMs) or SAP application servers to be co-deployed with SAP HANA VMs on the same CPU socket. **Attention:** The drawback of an SNC-divided CPU is that VMs sharing a CPU socket, as in the past, cannot utilize idle resources not used by a co-deployed VM. This may result in lower peak performance due to the split of CPU resources compared to a non-SNC configuration. However, in an SAP environment with its strict sizing rules, this drawback is not significant, and the benefits of lower latencies and more predictable performance outweigh it.
Option 2: 1 VM per NUMA node, 2 VMs in total per ESXi host VM size is based on the SAP HANA reference configuration for 2-socket Sapphire Rapids systems: • 2 VMs with <=120 vCPUs, <2 TB vRAM and 2 vSockets 	Option 2 shows 2 SAP HANA VMs running on an SNC-2 enabled host. SAP supports expanding an SAP HANA VM across two sub-NUMA nodes to utilize a full CPU socket. This is analogous to when a single CPU socket VM spans two CPU sockets on an older CPU generation. SAP HANA is NUMA-aware and optimizes memory access based on memory latencies. This allows a user to scale up an SAP HANA "half-socket" VM to occupy a full physical CPU socket, without the need to migrate a VM to a non-SNC host, which remains an option and may be the preferred solution due to the SNC-based CPU limitations. **Attention:** Be aware that leveraging two SNC-2 NUMA nodes to allocate more memory or CPU resources to this VM may result in lower performance compared to a single CPU socket VM running on a non-SNC-2 enabled host. If you observe this performance, then this VM must be migrated to a non-SNC configured host, because SAP (not VMware) can address this issue in their software. In approximately 3% of all tested cases, we observed a negative impact related to SNC-2 on a 2-sub-NUMA Node-wide VM compared to a 1-NUMA Node SAP HANA VM (without SNC-2) when transactions had to leverage more CPU threads or memory that crossed the sub-NUMA node boundary. The impact we measured ranged between 5% and 23% for runtime or throughput. The positive impact, when a task stayed inside the sub-NUMA node, was not measured.

Option 3: 1 VM across two NUMA nodes/physical CPU sockets VM size is based on the SAP HANA reference configuration for 2-socket Sapphire Rapids systems: • 1 VM with <=240 vCPUs, <4 TB vRAM and 4 vSockets 	Option 3 shows a 4-SNC 2-node wide single SAP HANA VM running on an SNC-2 enabled host. On an SNC-2 enabled 2-socket SAP HANA host, SAP supports spanning an SAP HANA VM across 4-SNC 2 nodes. In this configuration, SAP HANA detects a '4 NUMA node' server and attempts to optimize memory latency based on NUMA locality. This capability allows a user to scale up an SAP HANA VM to the maximum size of a 2-socket Sapphire Rapids server, as specified in the SAP HANA reference architecture, which can accommodate up to 240 logical CPUs with <4 TB of memory per host. When an SAP HANA VM requires all CPU resources of a host, we recommend you migrate this VM to a non-SNC host. **Attention:** Be aware that leveraging four SNC-2 sub-NUMA nodes may result in lower performance compared to a two NUMA node wide VM running on a non-SNC-2 enabled host. If you observe this performance degradation, then this VM must be migrated to a non-SNC configured host, because SAP (not VMware) can address this issue in their software. In approximately 4% of all tested cases, we observed a negative impact related to SNC-2 on a 4 sub-NUMA node wide VM compared to a 2 NUMA node wide SAP HANA VM (without SNC-2) when transactions had to leverage more CPU threads or memory that crossed the sub-NUMA node boundary. The impact we measured ranged between 5% and 14% for runtime or throughput. The positive impact, when a task stayed inside the sub-NUMA node, was not measured.
Option 4: 1 VM across two NUMA nodes/ physical CPU sockets VM size is based on the SAP HANA reference configuration for 2-socket SPR systems: • 1 VM with <=120 vCPUs, <2 TB vRAM and 2 vSockets • 2 VM with <=60 vCPUs, <1 TB vRAM and 1 vSocket 	Option 4 shows a supported configuration with 3 SAP HANA VMs, two single SNC-2 wide VMs and one VM spanning two SNC nodes. This option is the last supported configuration. **Attention:** Be aware that leveraging four SNC-2 sub-NUMA nodes may result in lower performance compared to a two NUMA node wide VM running on a non-SNC-2 enabled host. If you observe this performance degradation, then this VM must be migrated to a non-SNC configured host, because SAP (not VMware) can address this issue in their software.

Option 5: No support for NUMA node / sockets crossing SNC-2 VMs 	Not supported for SAP HANA VM deployments.
Option 6: No support for NUMA node / sockets crossing SNC-2 VMs 	Not supported for SAP HANA VM deployments.

Important: Due to the lower memory bandwidth associated with an SNC-NUMA node, we recommend primarily using SNC-2 for half-socket VMs. If SAP HANA VMs running on SNC-2-enabled hosts experience performance issues, they should be migrated to a non-SNC-enabled host. All VMs that leverage SNC-2 require the VMX advanced parameter `sched.nodeX.affinity="Y"` to prevent unwanted NUMA node migrations.

If an SAP HANA VM running on an SNC-2-enabled host shows performance issues, migrate the VM to a whole socket non-SNC-enabled host as part of the troubleshooting.

Recommended: Build a vSphere cluster based on the same CPU model and generation. This allows for easy VM migration.

When you deploy SNC-2-enabled Sapphire Rapids systems, you must build a dedicated 2-socket SNC-2-enabled Sapphire Rapids cluster to ensure seamless VM migration. We don't recommend adding non-SNC-enabled hosts to this cluster.

Review the "SNC-2 management and operation" section to learn how to best build and operate a vSphere SAP HANA cluster with SNC-2-enabled hosts and VMs, along with non-SNC-2 hosts and VMs.

Scale-up and scale-out deployment architecture

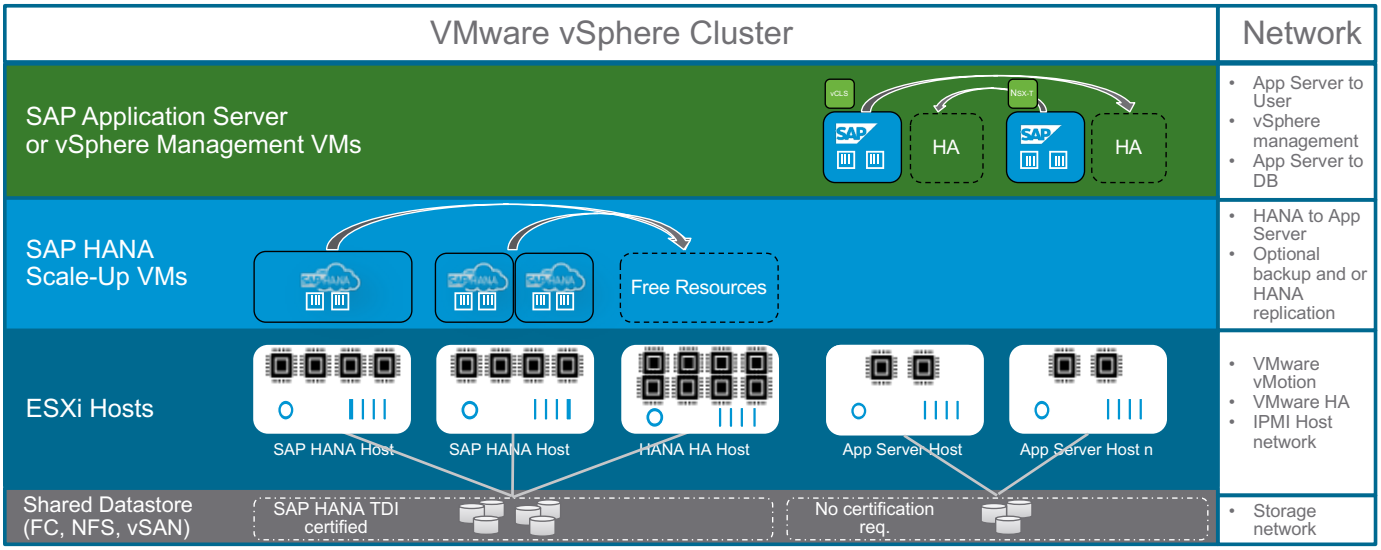
The following 2 figures describe typical scale-up and scale-out SAP HANA on vSphere architectures.

The storage must be SAP HANA certified. In the case of vSAN, the complete solution (server hardware and vSAN software) must be SAP HANA HCI certified.

The network column highlights the network needed for an SAP HANA environment. Bandwidth requirements should be defined regarding the SAP HANA size; for example, vMotioning a 2TB SAP HANA VM or a 12TB SAP HANA VM will take significantly more time to be migrated or will need a higher bandwidth network to minimize the migration time. Latency should be as low as possible to support the transactions of heavy or sensitive workloads and use cases. For SAP applications, the average response time for dialog transactions (online transactions) should be below one second.

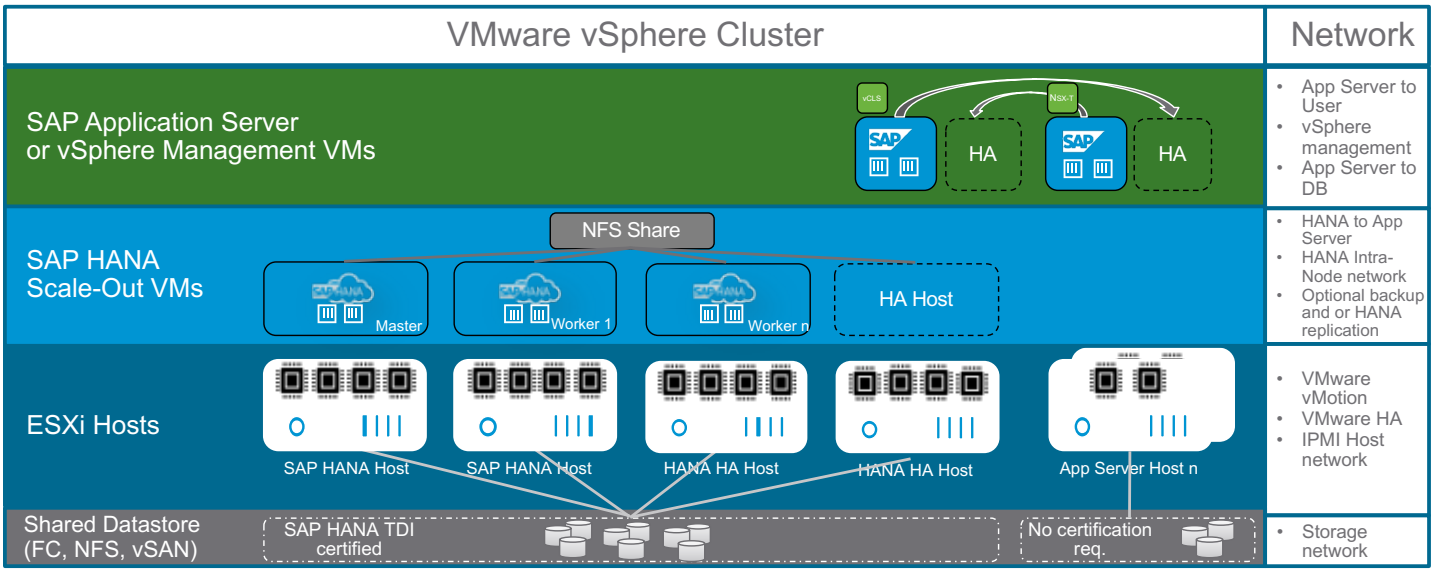
The following figure shows scale-up SAP HANA systems (single SAP HANA VMs).

Figure 3. High-level architecture of a scale-up SAP HANA deployment on vSphere



The next figure shows a scale-out example where several SAP HANA VMs work together to build one large SAP HANA database instance.

Figure 4. High-level architecture of a scale-out SAP HANA deployment on ESXi 4- or 8-socket host systems



Configuration and sizing guidelines

You must select the correct components and configuration to achieve the performance and reliability requirements for SAP HANA. The server configuration (RAM and CPU), network configuration, and storage configuration determine which and how many SAP HANA VMs can be supported.

Note: It is possible to consolidate a certain number of SAP HANA VMs on an ESXi host with a given RAM and CPU configuration; however, the network and storage configurations must have the capacity to support these SAP HANA VMs. Otherwise, a network or storage bottleneck could impact the performance of all running SAP HANA VMs on the host.

Sizing compute and memory

It is possible (since SAP HANA TDI Phase 5) to perform a workload-based sizing (SAP Note 2779240) and not depend on appliance configurations with fixed CPU-to-memory ratios.

You perform VMware virtual SAP HANA sizing in much the same way as you do for physically deployed SAP HANA systems. The significant difference is that an SAP HANA workload must fit into the compute and RAM maximums of a VM. You also need to consider the costs of virtualization (RAM and CPU of the ESXi host) when planning an SAP HANA deployment.

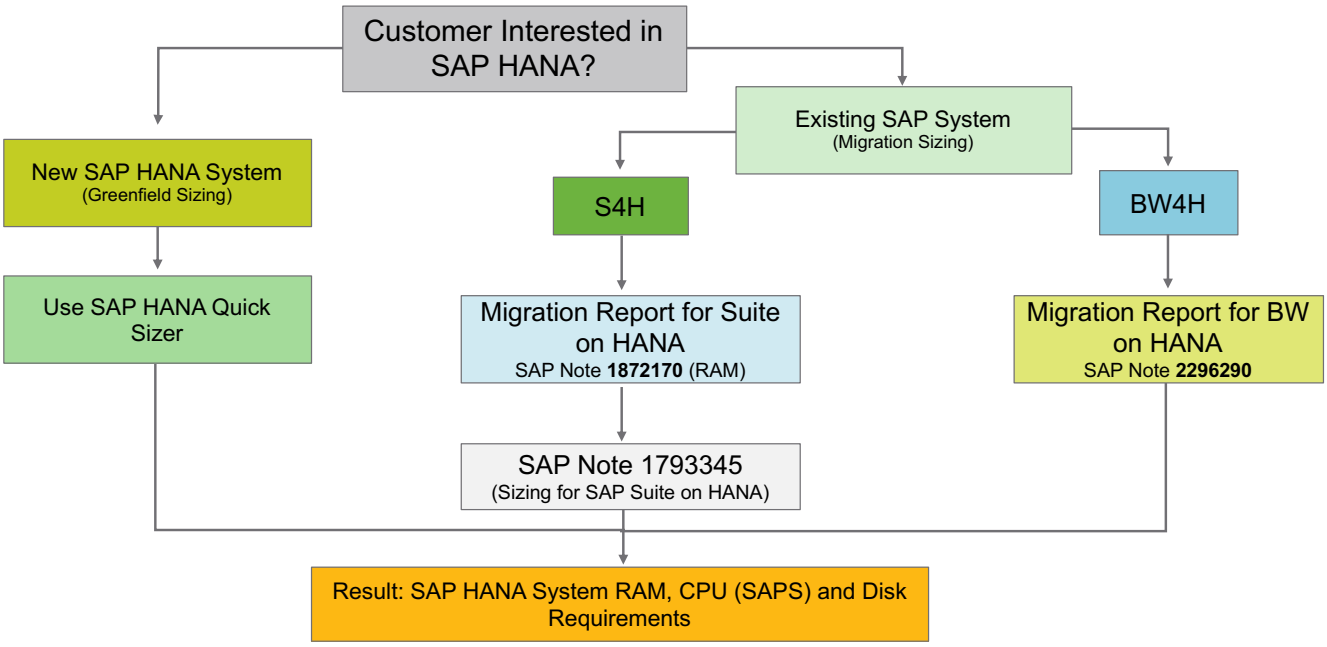
If an SAP HANA system exceeds the available resources for virtual deployments, the VM can be moved to a new host with more memory or higher-performing CPUs. After this migration to the new host, the VM must be shut down, and the VM configuration must be changed to reflect these changes (more vCPU and/or virtual memory). If a single host cannot satisfy the resource requirements of an SAP HANA VM, then you can use scale-out deployments or SAP HANA extension nodes.

Note: The current VMware SAP HANA VM maximums are 448 vCPUs and 12 TB of RAM with Intel Cascade and Cooper Lake 8-socket systems and 480 vCPUs and 8 TB of RAM with Intel Sapphire Rapids 4-socket systems. SAP HANA systems that fit into these maximums can be virtualized as a single scale-up system. You might also be able to deploy larger scale-out systems.

Sizing process

As noted, sizing a virtual SAP HANA system is just like sizing a physical SAP HANA system plus the virtualization costs of CPU and RAM on the ESXi host). The following figure depicts the SAP HANA sizing process.

Figure 5. The SAP HANA sizing process



An SAP HANA sizing results in the following required resources:

- Compute - per the SAP Application Performance Standard (SAPS)
- Memory
- Storage

Note: By now, the SAP Quick Sizer allows you to calculate the needed SAPS for SAP HANA-based applications. Therefore, a manual calculation, as mentioned above in the table, is no longer required.

The SAP sizing tools do not cover network sizing. Network latency is only a general guideline—you must set your own goal. In SAP sales and distribution (SD) benchmarks, a time below 1,000 milliseconds for the average dialog response time must be maintained.

In the "Network configuration and sizing section," we refer to the SAP HANA network requirements white paper when we define the network infrastructure for a virtualized SAP HANA environment. SAP also provides a tool, ABAPMETER, to measure the network performance of a selected configuration to ensure it follows the SAP-defined and recommended parameters. See SAP Note 2879613: ABAPMETER in NetWeaver AS ABAP.

Note: The provided SAPS depend on the SAP workload you use. This workload can have an OLTP, OLAP, or mixed workload profile. From the VM configuration point of view, only the different memory, SAPS, network, and storage requirements are important and not the actual workload profile.

The storage capacity requirements for virtual or physical SAP HANA systems are identical. However, the CPU resource and physical memory requirements of a virtualized SAP HANA system are slightly higher than when deployed on bare metal servers; the virtualized requirements also include the virtual CPU and memory of the VM. We can express the CPU requirements with a fixed factor like 3-10%, but the memory needs are more challenging to determine.