



# Reference Architecture for SAP applications on ThinkAgile VX

Last update: 18 March 2025

Version: 2.2

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Provides a technical overview of  
ThinkAgile VX integrated  
solutions and certified nodes

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Contains SAP HANA best  
practices and sizing  
recommendations

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Shows how SAP applications  
can be used in a hyper-  
converged environment

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Configure your system for best  
use with SAP HANA

Mark Kelly  
Andrei Stanescu  
Patrick Hartman



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# 1 Introduction

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The intended audience for this document is technical IT architects, system administrators, and managers who are interested in executing SAP application workloads on the ThinkAgile VX Integrated Systems and Certified Nodes.

ThinkAgile VX provides a hyper-converged infrastructure. Hyper-converged means incorporating multiple components like compute and storage into a single entity through software. A hyper-converged infrastructure seamlessly pools compute and storage to deliver high performance for the virtual workloads and provides flexibility to combine the local storage using a distributed file system to eliminate shared storage such as SAN or NAS. These factors make the solution cost-effective without compromising performance.

The ThinkAgile VX Integrated Systems can be used for all SAP applications except for the SAP HANA®, along with ThinkAgile VX Certified Nodes. ThinkAgile VX Certified Nodes are available in 2U form factor and utilize the dramatic efficiency and cost savings of industry-leading VMware virtualization technology to handle the high demands of SAP applications such as the SAP HANA database.

Chapter 2 brings a technical overview of ThinkAgile VX and explains why the combination of Lenovo servers with VMware software gives the best system performance and reliability. Chapters 3 and 4 present sizing examples for SAP business applications and the SAP HANA database. Then, best practices using the SAP HANA database are given in chapter 4.

## 1.1 SAP SE solutions overview

SAP Societas Europaea (SE) is a software vendor of mission critical business software. Their comprehensive solutions for business processes across all industries offer the solutions needed to run a company.

SAP SE has over 1600 products and 330 solutions which may run on ThinkAgile VX. Those can be categorized, in general, as follows:

- Enterprise Resource Planning
  - SAP S/4HANA®
  - SAP Business Suite® (ERP, SCM, PLM, CRM, SRM)
- Digital Platform
  - SAP HANA database
  - SAP Sybase ASE® (and other databases, like Oracle®, IBM DB2®, or Microsoft SQL Server®)
  - SAP NetWeaver® platform (Portal, KM, BI, PI, ABAP, JAVA)
- Business Analytics
  - Business Intelligence with SAP BW/4HANA®

## 2 Technical overview of ThinkAgile VX

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This chapter provides an overview of the ThinkAgile VX Certified Nodes (CN) including the associated software, systems management, and networking.

### 2.1 ThinkAgile VX

ThinkAgile VX CN systems are designed to help you simplify the IT infrastructure, reduce costs, and accelerate time to value. These hyper-converged appliances from Lenovo combine industry-leading hyper-convergence software from VMware with Lenovo enterprise platforms. Several common uses are:

- Enterprise workloads, like SAP S/4HANA
- Server virtualization
- Virtual desktop infrastructure (VDI)

Starting with as few as three nodes to keep your acquisition costs down, the ThinkAgile VX systems are capable of immense scalability as your needs grow.

### 2.2 Configurations

ThinkAgile VX CN systems are available in the 2U form factor tailored to your SAP application needs:

- ThinkAgile VX650 V3 2U CN based on Intel Eagle Stream Platform – Intel 4<sup>th</sup> and 5<sup>th</sup> Gen Xeon Processors
- ThinkAgile VX650 V3-DPU 2U CN based on Intel Eagle Stream Platform – Intel 4<sup>th</sup> and 5<sup>th</sup> Gen Xeon Processors
- ThinkAgile VX850 V3 2U CN based on Intel Eagle Stream Platform – Intel 4<sup>th</sup> Gen Xeon Processor

For more information about the system specifications and supported configurations, refer to the [VX650 V3](#) and [VX850 V3](#) product guides or the ThinkAgile VX Series [data sheet](#) ([lenovopress.com/ds0104](http://lenovopress.com/ds0104)).

In addition, the ThinkAgile VX Solution for SAP HANA [data sheet](#) ([lenovopress.com/ds0118](http://lenovopress.com/ds0118)) lists the VX Certified Nodes available for the SAP HANA Platform edition database.

#### 2.2.1 NVIDIA SmartNIC DPUs

ThinkAgile VX650 V3 supports the new VMware vSphere Distributed Services Engine (DSE) using NVIDIA Bluefield-2 SmartNIC DPUs (Data Processing Unit). This solution improves the performance of VMware vSphere by offloading tasks from server CPUs to the DPU thereby making data center applications more efficient.

For more information on DPUs and the vSphere Distributed Services Engine see [Lenovopress](#) and the [VMware documentation](#).

## 2.3 Software components

This section gives an overview of the software components used in the solution.

### 2.3.1 Hypervisor

The ThinkAgile VX models come with VMware ESXi hypervisors preloaded in the factory, which is optionally preloaded in the factory for the ThinkAgile VX server per customer request.

The ThinkAgile VX CN for SAP HANA models, while similar, have special restrictions to the versions of VMware ESXi hypervisors allowed to be used to run SAP HANA dependent on the processor generation of the series chosen.

**Table 1: Versions of VMware vSphere ESXi for SAP HANA usage**

System Type	VMware vSphere ESXi version
ThinkAgile VX650 V3 CN for SAP HANA	VMware ESXi 8.0 U3
ThinkAgile VX850 V3 CN for SAP HANA	VMWare ESXi 8.0 U3

### 2.3.2 Lenovo XClarity Administrator

Lenovo XClarity Administrator is a centralized system management solution that helps administrators deliver infrastructure faster. This solution integrates easily with Lenovo servers and ThinkAgile VX nodes providing automated agent-less discovery, monitoring, firmware updates, and configuration management.

Lenovo XClarity Administrator is provided as a virtual appliance that can be quickly imported into a virtualized environment. XClarity can either be installed on a separate server or a server within a VMware vSAN cluster, providing that the hardware management network with the server xClarity Console (XCC) is routable from the server hosting the XClarity virtual machine.

## 2.4 SAP application landscapes

Logically, an SAP application landscape has 3 tiers: a presentation layer, a business logic or application layer, and a database layer. Scalability is key for a successful implementation of an SAP solution. As a business grows, SAP provides scaling using 2 and 3-tier deployment architectures as follows:

- A 2-tier (also known as vertical scaling) architecture uses a single server for all SAP applications, except the presentation layer. This means that the presentation layer is one tier and the application and database layer is mapped to the second tier.
- A 3-tier (also known as horizontal scaling) architecture means that each of three logical tiers maps to an individual set of one or more physical servers.

A 2-tier architecture has the following key advantages:

- Because the application and database layers are on the same host, this architecture provides the best performance, since there is no overhead for database connections, nor network traffic, and no shadow processes.
- The 2-tier approach makes it easier to administer small installations or installations with performance demands that are not dynamic. Larger installations can also use the extra performance that can be achieved from this type of installation.

A 3-tier architecture offers the following key advantages:

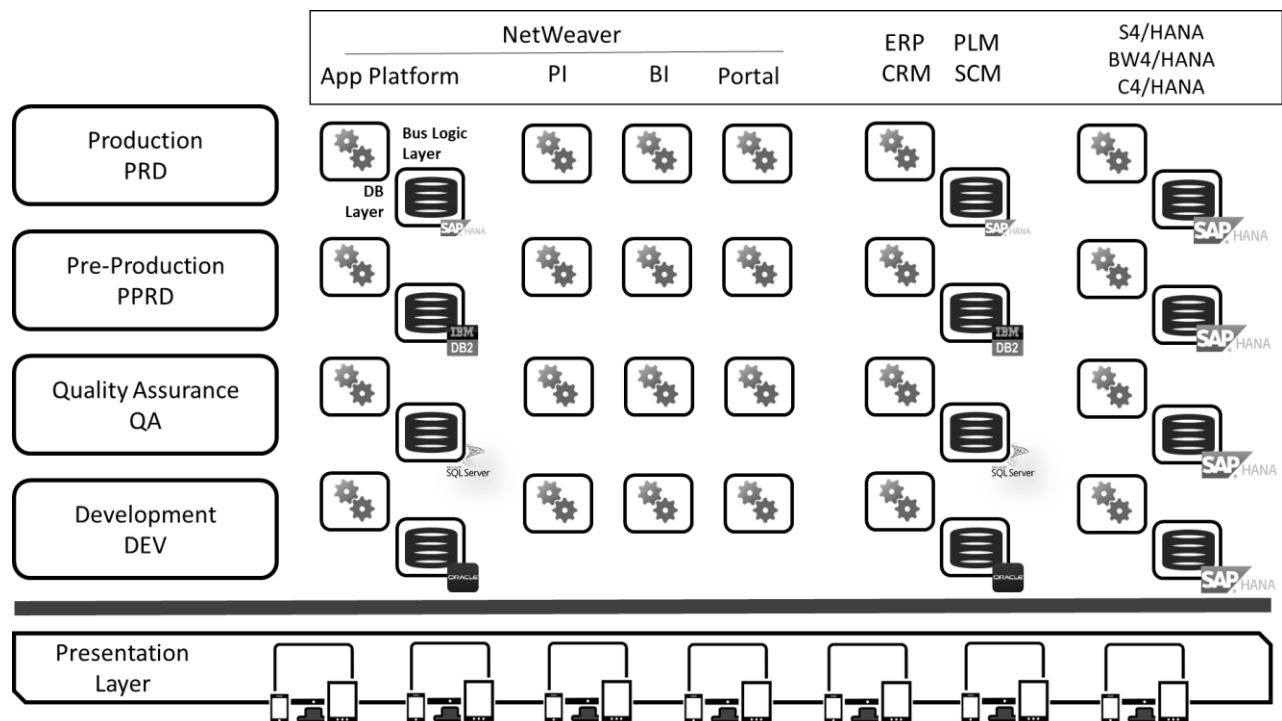
- The application tier can be scaled separately from the database tier to provide both, load sharing and high availability in each tier. Short-time load peaks can be easily managed by temporarily adding more application servers. Larger SAP application implementations typically use a 3-tier or multi-tier architecture to allow easier implementation of high availability for each component or tier.
- Separating the database layer from the application layer gives an organization the flexibility to choose the database of choice, such as Microsoft SQL Server, Oracle, IBM DB2, SAP MaxDB, SAP Sybase ASE or SAP HANA and keep it separate from SAP application servers.

The flexibility of the SAP software enables one to decide the best approach whether that is a two, three or multi-tiered architecture.

An SAP application landscape is a group of two or more SAP systems. An SAP system consists of one or more SAP instances across one or more servers. A traditional SAP landscape may consist of one or more of the following types of SAP instances:

- Development system (DEV)
- Test and Quality Assurance (QA) systems
- Training system (TRN)
- Pre-Production system (Pre-PRD)
- Production system (PRD)

Figure 1 shows an example of a typical landscape for an SAP customer.



**Figure 1: SAP customer landscape**

## Virtualization of SAP landscapes

Traditionally, the SAP application tier is executed on physical servers which can be a wasteful use of physical resources. Virtualization can be applied to consolidate servers and reduce CAPEX and OPEX. Virtualization of the SAP application tiers provide all the standard benefits of virtualization including:

- Flexibility
- Load shifting
- Optimized application availability
- Rapid provisioning

Lenovo and their partners have conducted benchmarks with virtualization enabled to show the performance differences between a virtualized and non-virtualized SAP application system. According to the SAP Notes for VMware ESXi, the performance overhead has been measured to be 10% of the CPU and Memory resources. These overheads should always be included when sizing a new hardware platform. VMware vSAN has its own memory overhead that depends not only on the processing power, but also the storage configurations. This overhead calculation can be determined using a formula in the VMware KB [2113954](#) Understanding vSAN memory consumption in ESXi 7.0 as an example.

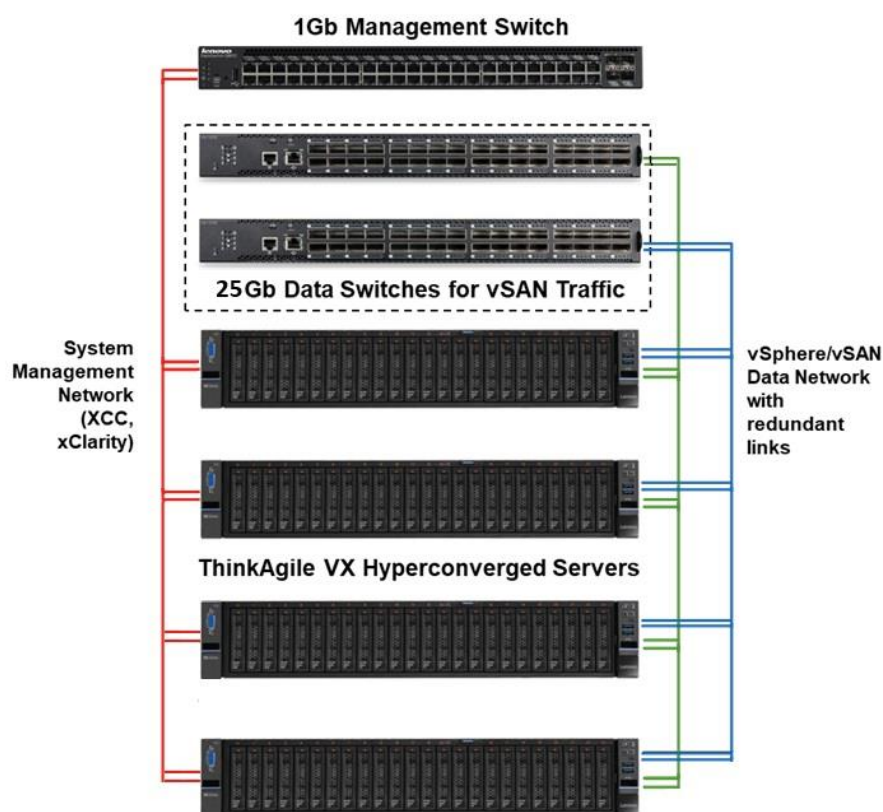
## 2.5 Networking

There are three logical networks defined in this reference architecture:

- **External:** The external network is used for the internet access to the clusters, ingress to the exposed applications (services and routes).
- **Internal:** This is the non-routable network used for vMotion, and vSAN data networks.
- **Out-of-band network:** This is a secured and isolated network used for switch and server hardware management, such as access to the xClarity Controller (XCC) module on the servers and SoL (Serial-over-LAN).

## Network redundancy

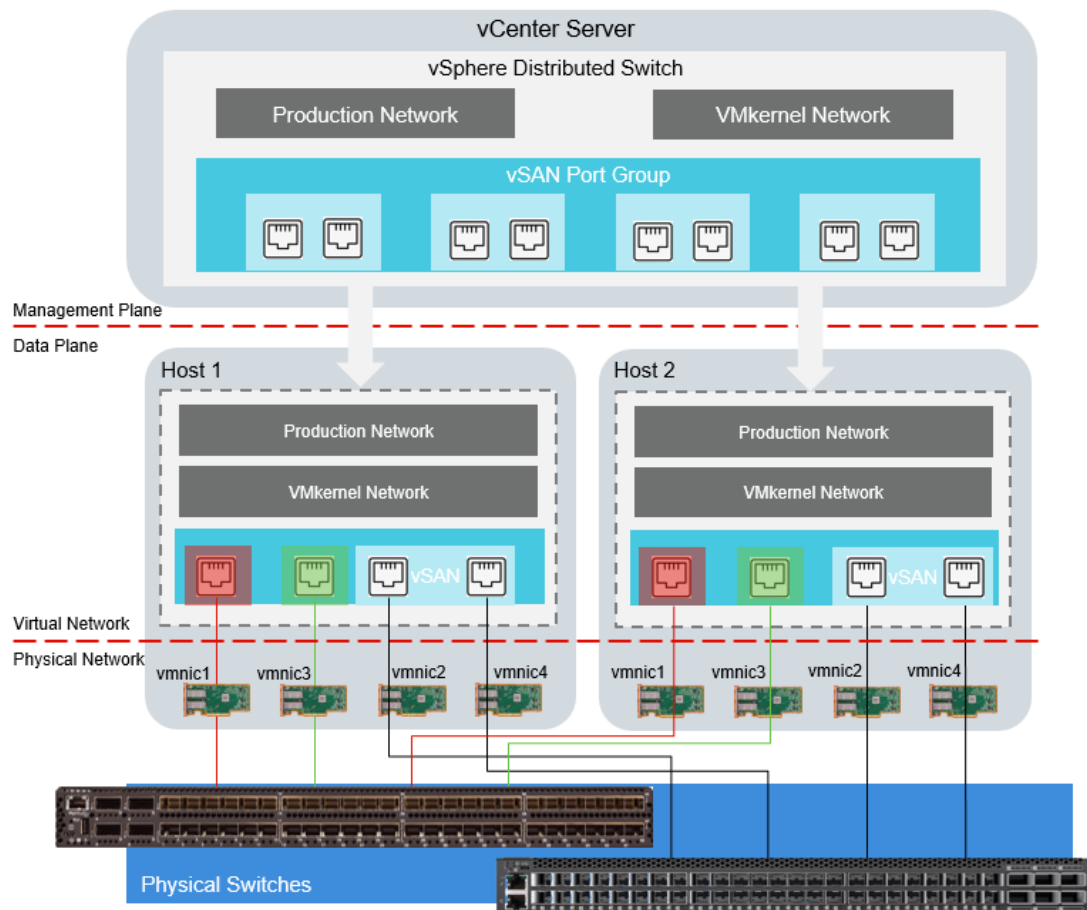
A deployment of SAP applications on the ThinkAgile VX vSAN platform uses 10GbE or higher network as the primary fabric for inter-node communication. This example uses two switches to provide redundant data layer communication and deliver maximum network availability. The typical deployment architecture for this setup is shown in Figure 2.



**Figure 2: ThinkAgile VX network connectivity**

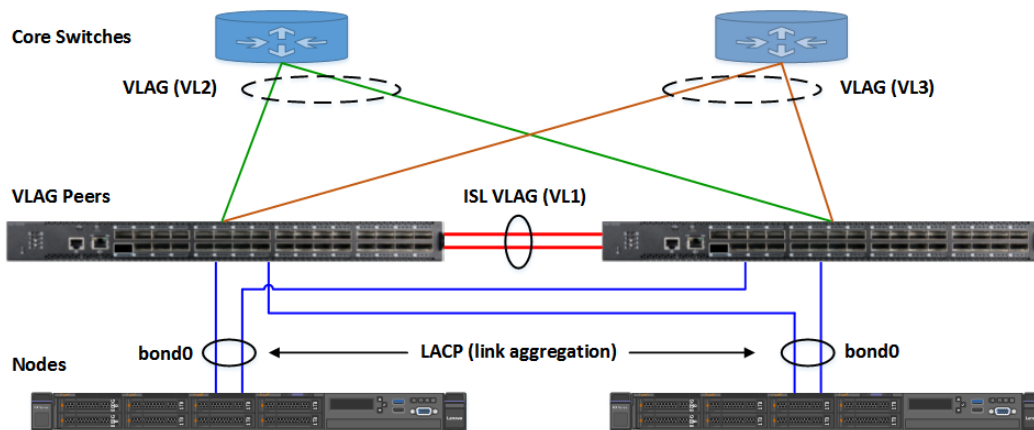
The two primary network fabrics shown in Figure 3 are the systems management network and the internal data/user network. Typically, 1Gbps Ethernet is enough for the systems management network, which provides out-of-band access to the on-board management processors on the servers and network switches. The data/cluster internal fabric is recommended to be 25Gbps Ethernet. This fabric is also recommended to have redundant switches for high availability of the network fabric.





**Figure 3: Networking**

Figure 4 shows the redundant network architecture and the MCLAG configuration.



**Figure 4: Network fabric redundancy and MCLAG**

Multi-Chassis Link Aggregation Group (MCLAG) is a feature of the switch Network Operating System that allows a pair of switches to work as a single virtual switch. Its implementation may vary by vendor; most notably that the protocol between each chassis is proprietary. Each of the cluster nodes has a link to each MCLAG peer switch for redundancy. This provides high availability (HA) for the nodes using the link aggregation control protocol (LACP) for aggregated bandwidth capacity. Connection to the uplink core network is facilitated by the MCLAG peers, which present a logical switch to the uplink network, enabling connectivity with all links active and without a hard requirement for spanning-tree protocol (STP). The link between the two MCLAG peers is an inter-switch link (ISL) and provides excellent support of east-west cluster traffic between the nodes. The MCLAG presents a flexible basis for interconnecting to the uplink/core network, ensures the active usage of all available links, and provides high availability in case of a switch failure or a required maintenance outage needs to be connected to a 1GbE TOR switch.

## 2.6 Reliability and performance features

Reliability and excellent performance are important for any workload but particularly for hyper-converged infrastructures like ThinkAgile VX. These requirements are met through the following design features of VMware vSAN software combined with Lenovo Servers.

### Hardware reliability

A ThinkAgile VX node has redundant hardware components by including two power supplies, multiple chassis fans, two Intel CPUs, multiple memory DIMMs, multiple SSDs, and optionally up to two dual-port network interface cards. Lenovo uses the highest quality hardware components combined with firmware that is thoroughly tested. Consequently, Lenovo servers are consistently rated #1 in [hardware reliability](#).

### Hardware performance

The ThinkAgile VX systems have been carefully designed for performance. In addition to all the usual attributes like processors and memory; for example, when configured for vSAN OSA and SAS/ SATA SSD disk the 32 drive ThinkAgile VX650 V3 CN uses three HBA controllers instead of only one. Therefore, the latency is halved for some workloads that heavily utilize the cold tier. This allows higher throughput and improved transaction rates.

## 3 SAP HANA system sizing

VMware has created an SAP community document entitled "[SAP HANA on VMware vSphere](#)" which describes the best practices and configuration guidance when deploying the VMware vSphere hypervisor for SAP applications. In addition, the following SAP note should be helpful:

- SAP note [3406060](#): SAP HANA on VMware vSphere 8 and vSAN 8

Lenovo provides two ThinkAgile products for use with SAP HANA.

These are the ThinkAgile VX650 V3 CN for SAP HANA and ThinkAgile VX850 V3 CN for SAP HANA based on Intel 4<sup>th</sup> and 5<sup>th</sup> Generation Xeon Processors. These servers have been certified by Lenovo and SAP for use with SAP HANA and VMware vSAN software defined storage.

### 3.1 ThinkAgile VX650 V3 Certified Nodes for SAP HANA

#### 3.1.1 Supported SAP HANA Configurations using 2 Sockets:

<b>Model Name</b>	<b>ThinkAgile VX650 V3 CN</b>	
<b>Machine Type/Model</b>	7D6WCTO3WW	
<b>Processor</b>	2x 4 <sup>th</sup> / 5 <sup>th</sup> * Gen Intel® Xeon® Scalable processors	
<b>System Memory Sizes</b>	Up to 4TiB TruDDR5 Memory	
<b>Virtual</b>	S4/HANA (OLTP)	BW/4HANA (OLAP)
<b>Memory Sizes</b>	128GiB – 4TiB vMemory / VM	128GiB – 4TiB vMemory / VM
<b>Drive Bays</b>	32x 2.5" (HS) NVMe/SAS/SATA	
<b>vSAN Nodes / Cluster</b>	3-64 nodes	
<b>OSA Disk Groups per node*</b>	2 – 4	
<b>OSA Disks allowed*</b>	<b>Cache:</b> Any NVMe/SAS SSD (max 4)	
	<b>Capacity:</b> Any NVME/SAS/SATA (max 28)	
<b>ESA Disks allowed</b>	4 – 24 NVMe	
<b>PCIe Networking</b>	Minimum 10GbE networking required	
	Recommended 4 × 25GbE ports or higher	

\*VMware vSAN OSA is only allowed for SAP HANA on 4<sup>th</sup> Gen Intel Xeon Scalable processors

## 3.2 ThinkAgile VX850 V3 Certified Nodes for SAP HANA

### 3.2.1 Supported SAP HANA Configurations using 4 Sockets:

Model Name	ThinkAgile VX850 V3 CN	
Machine Type/Model	7DDKCTO3WW	
Processor	2x or 4x 4th Gen Intel® Xeon® Scalable processors	
System Memory Sizes	Up to 8TiB TruDDR5 Memory	
Virtual	S4/HANA (OLTP)	BW/4HANA (OLAP)
Memory Sizes	128GiB – 8TiB vMemory / VM	128GiB – 8TiB vMemory / VM
Drive Bays	24x 2.5" (HS) NVMe/SAS/SATA	
vSAN Nodes / Cluster	3-64 nodes	
OSA Disk Groups per node	2 - 4	
OSA Disks allowed	Cache: Any NVMe/SAS SSD (max 4)	
	Capacity: Any NVME/SAS/SATA (max 21)	
ESA Disks allowed	4 – 24 NVMe	
PCIe Networking	Minimum 10GbE networking required	
	Recommended 4 × 25GbE ports or higher	

The **ThinkAgile VX CN for SAP HANA** have special hardware configuration rules that must be considered when configuring a server for use with SAP HANA.

#### Memory Rules:

- Each memory channel must be partially (1 DIMM per Channel) or fully (2 DIMMs per Channel) populated by following the rules from Table 2: ThinkAgile VX V3 DRAM Memory Configurations

#### Networking Rules:

- A minimum of two (2) 10/25GbE Dual-Port Adapters are required
  - A minimum of two (2) 25GbE ports are required for vSAN SDS traffic.
  - A minimum of two (2) 25GbE ports are required for the ESXi hypervisor traffic.
- Other adapters may be added up to maximum supported by the equivalent base model.

#### GPU Rules:

- VX nodes for SAP HANA do not support GPUs.

#### Software Rules:

- For VX650 V3 nodes based on Intel Xeon SP 4<sup>th</sup> or 5th generation processors
  - VMware ESXi 8.0 U3 may be used with SAP HANA applications
- For VX850 V3 nodes based on Intel Xeon SP 4th Generation processors
  - VMware ESXi 8.0 U3 may be used with SAP HANA applications
- All system management software FC and Option part number are allowed
- An additional Professional Service Unit exists for installation and deployment of SAP HANA

## 3.3 SAP HANA vSAN sizing

### 3.3.1 SAP based expert sizing

The size of an SAP HANA VM is the result of estimating the memory, processor, storage, and network components for each instance. Additionally, any non-productive SAP HANA workload and other SAP applications need to be calculated into the total to find the appropriate ThinkAgile VX solution size.

For each additional virtual machine (VM), you will need to add the results together to form a complete picture of the resources necessary to run SAP applications. Typically a customer will require a Production HANA VM (Prod), a High Availability HANA VM (HA), a Quality Assurance HANA VM (QA), a Development HANA VM (Dev) as well as a number of SAP Application instances to reside on the cluster.

SAP Note [3406060](#) and the [SAP Wiki](#) for VMware vSAN are useful reference documents when sizing vSAN systems for SAP HANA.

Some main criteria are:

- SAP HANA VMs can occupy a 1, 2, 3 or 4 sockets
- VMware recommends allowing a hypervisor overhead of 10-15% for vSAN nodes – see the [Best Practice guidelines](#)

### Memory sizing

The ThinkAgile VX650 V3 and VX850 V3 use TruDDR5 memory with eight memory channels per CPU and one or two DIMMs per Channel (DPC) resulting in the following DRAM memory configurations:

**Table 2: ThinkAgile VX V3 DRAM Memory Configurations**

Memory DIMM Type	Capacity (GB) per CPU	VX650 V3	VX850 V3
		2S	4S
16GB DIMM (1 DPC)	128	256	512
48GB DIMM (1 DPC)	384	768	-
16GB DIMM (2 DPC)	256	512	1024
32GB DIMM (1 DPC)	256	512	1024
16/32GB DIMM mix (2 DPC)	384	768	1536
32GB DIMM (2 DPC)	512	1024	2048
64GB DIMM (1 DPC)	512	1024	2048
96GB DIMM (1 DPC)	768	1536	3072
32/64GB DIMM mix (2 DPC)	768	1536	3072
64GB DIMM (2 DPC)	1024	2048	4096
128GB DIMM (1 DPC)	1024	2048	4096
96GB DIMM (2 DPC)	1536	3072	6144
128GB DIMM (2 DPC)	2048	4096	8192

## Processor (CPU) sizing

The best approach to determine the processing power required is to use the *SAPS* value which can be calculated using the outputs of Sizing Reports and Quick Sizer tools provided by SAP. They enable Lenovo experts to translate the sizing results into a Lenovo configuration with the appropriate Intel Xeon processors and memory.

While no other workload may run on the socket running a productive SAP HANA instance according to the SAP documentation, unused sockets may be used for any other type of workload including non-productive instances of SAP HANA. This means that when using both sockets of a 2-socket server for a single SAP HANA VM, there will be no remaining socket to be used for other purposes like SAP application servers, and other non-productive SAP HANA instances. Instead, you can add other nodes into the cluster – for those applications or create a second cluster for explicit use of those applications.

Note that SAP recommends a minimum of eight cores for each processor and also for a minimum of eight cores each SAP HANA VM.

## Storage sizing

The storage of VMware vSAN monitors for any disk to be above an 80% threshold. When this value is reached, VMware vSAN starts moving the data onto other disks. If all disks are above 80%, then VMware vSAN will continuously try to swap data in and out of every drive, reducing thus the storage bandwidth to nothing. The recommendation from VMware is to stay safely aware from that condition. This “slack” space is a comfortable value set around 30% of the whole physical space of the cluster to be left aside. A cluster-wide slack space of 30% additional cluster space must be added with a factor of 1.42 multiplied to the total raw space of the entire cluster. In general, assuming a replication factor value of 2 (or failures to tolerate, FTT, equal to 1), we create a formula for the storage overhead as such:

$$Raw\ Capacity = \sum_{nodes=1}^{\#Nodes} \left( \sum_{VMs=1} (HANA_{shared} + HANA_{data} + HANA_{log} + OS_{FS} + OS_{swap}) \right) \times 2_{FTT=1} \times 1.42_{slack}$$

### Example:

$$Raw\ Capacity = ((2560 + 128 + 32) * 2) * 4) * 1.42 = 15449 \cong \mathbf{16TB\ total\ cluster\ capacity}$$

Using the above requirements, the total cluster capacity can be determined:

- Storage for SAP HANA Shared, Data and Log directories.
    - SAP HANA TDI guidelines require roughly 2.5 \* amount of VM memory
- Example: 3 VMs each with 1024GB = 2.5 \* 1024GB = 2560GB

- Storage for each VM Linux OS = 128GB<sup>1</sup>
- Storage for each VM Linux swap = 32GB

We add all individual SAP HANA VM requirements together for one server and then multiply this by 2 because VMware states to set the failures to tolerate to one (FTT1) which implies the doubling of the storage.

We multiply the number of nodes by 4, then finally using the recommended 1.42 multiplier (30% slack space) we calculate the total disk requirement.

See the [SAP HANA Storage Requirements](#) document for further information on sizing storage for SAP HANA TDI servers. A more simplified rule-of-thumb approach to calculating the capacity disk is to use a ratio of 2.5x, 3x, 3.5x or 4x of SAP HANA node memory, then multiply by the number of nodes.

For example using a ratio of 3x:  $4 \times (3 \times 1TB) = 12TB$

With the capacity disk known, we now need to determine the correct number and size of SSD drives.

This can be done using the [vSAN Quick Sizer calculator](#) on the VMware/Broadcom website.

Further guidance and assistance are available on the [Lenovo LETS website](#)

## vSAN OSA and vSAN ESA

Since 2023 VMware vSAN has been available in two storage architectures: VMware vSAN Original Storage Architecture (OSA) and vSAN Express Storage Architecture (ESA).

VMware vSAN OSA divides the installed disk drives into [Disk Groups \(DG\)](#) with each Disk group comprising at least one cache drive and multiple capacity drives.

The more recently announced VMware vSAN ESA architecture uses all NVMe SSD devices removing the need for a caching layer.

5th Gen (Emerald Rapids) and future systems support the ESA architecture only

4th Gen (Sapphire Rapids) supports both OSA and ESA architectures 3rd Gen (Ice Lake) and older 2<sup>nd</sup> Generation (Cascade Lake), 1<sup>st</sup> Gen (Skylake) systems support the OSA architecture only

With the certification of SAP on vSAN ESA, it is expected that all new deployments will be on the ESA vSAN platform. However, in any scenario where a customer requires to run vSAN 8 OSA on a 4th Gen (Sapphire Rapids) system for a time before migrating to ESA, it is recommended to configure NVMe drives in the server, as these will also be supported for ESA. SATA and SAS SSD drives are not vSAN ESA supported.

For guidance and recommendation on how to proceed with such a migration see "[Migrating to the Express Storage Architecture in vSAN 8](#)"

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<sup>1</sup> SAP [recommends](#) only 50GB for the OS. Lenovo recommends a higher value in hyperconverged scenarios.

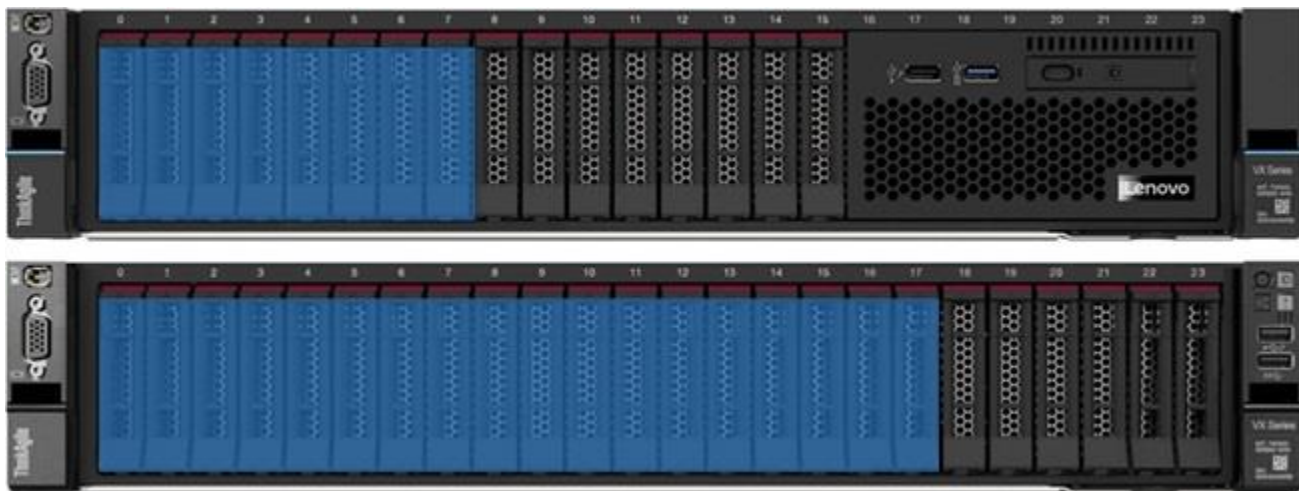


**Table 3: vSAN OSA Disk Group settings**

vSAN OSA	<p>For All Flash storage configurations, ThinkAgile VX Certified Nodes for SAP HANA support from 2 to 28 capacity drives depending on the ThinkAgile VX V3 model and the number of drive groups.</p> <p>For SAP HANA models, the number of drive groups supported are restricted as follows in order to ensure optimal performance:</p> <ul style="list-style-type: none"> <li>• 2-4 drive groups: 1 cache drive and 2 to 7 capacity drives in each drive group.</li> </ul> <p>The quantity of the capacity drives in each drive group must be the same. All cache drives in the node must be of the same model and capacity. All capacity drives in the node must be of the same model and capacity<sup>2</sup>. All nodes in a cluster must have the same storage configuration.</p> <p>For optimal storage performance, VMware and Lenovo recommends using 1 DG per virtual machine running SAP HANA within the cluster of nodes.</p> <p>For SAP HANA Configurations, drive groups of 1 or 5 are not supported.</p>
Disks allowed	<p><b>Cache:</b> Any NVMe SSD or SAS SSD</p> <p><b>Capacity:</b> Any SATA/SAS SSD or NVMe SSD</p>

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<sup>2</sup> For subsequent upgrades when the original drive is no longer available, follow-on drives with the same capacity may be used. Drive technology, speed and brand should be as similar as possible.



**Figure 5: ThinkAgile VX650 V3 node showing 8 vSAN ESA storage tier drives**  
**ThinkAgile VX850 V3 node showing 16 vSAN ESA storage tier drives**



**Figure 6: ThinkAgile VX650 V3 node with 2 OSA disk groups of one cache drive and 4 capacity drives**  
**ThinkAgile VX850 V3 node with 4 OSA disk groups each with one cache drive and 4 capacity drives**

## Network sizing

Running SAP HANA on ESXi requires network cards and switches that support Remote Direct Memory Access (RDMA) technology when using NVMe devices. Any ethernet switch described in Section 2.5 may be used for SAP HANA as they all support the RDMA over Converged Ethernet (RoCE) as standard, but some additional configuration on the switch will be required (e.g. PFC parameters).

Setting up your switch should be done according to the switch vendors best practices guides.

ThinkAgile VX for SAP HANA Certified Nodes require at least two ethernet network cards to achieve a redundant connection. These adapters should be connected to a 10GbE, 25GbE or 100GbE enabled switch, with the recommendation being 25GbE. Adapters such as Mellanox ConnectX-6, Broadcom 57414, 57504, 57508, 57416, 57454, Intel E810-DA2, E810-DA4 support RDMA.

VLAN policies must be created in VMware vCenter and pushed over to the switch CLI according to the switch vendor's instructions.

## NUMA Node sharing – Half-socket VM support

Full-socket VMs are supported on all Generation 4 (Sapphire Rapids) and Generation 5 (Emerald Rapids) vSAN systems for SAP HANA.

Half-socket VMs are supported for SAP HANA with Generation 5 (Emerald Rapids) using NUMA Node sharing

Half-socket VMs are not supported with Generation 4 (Sapphire Rapids)

Sub NUMA Clustering (SNC-2) is not certified by SAP for use with SAP HANA with VMware vSAN.

For more information on this see [SAP Note 3406060](#) / SAP HANA on VMware [vSAN WIKI](#).

## 4 Virtualized SAP HANA Recommendations

This section describes at a high level the installation and configuration of supported Linux operating systems running SAP HANA. For more details on the configuration and operation of VMware vSAN as well as file layouts, please refer to the *Best Practices Guide for SAP HANA solutions using ThinkAgile VX* on [Lenovo.com](http://Lenovo.com).

### 4.1 SAP HANA architecture

In order to deploy an instance of SAP HANA, you need to size and configure VMware ESXi hypervisor, guest, operating system, file system, and SAP HANA itself correctly. The following are the best practices and sizing guidance to create the most efficient use of the ThinkAgile VX system chosen.

#### 4.1.1 ThinkAgile VX system specification

For installations of SAP HANA, certain minimum and maximum values need to be considered before starting to size a VM and the entire landscape.

Table 4 and Table 5 are derived from SAP Notes [2718982](#), [2393917](#) and the [Lenovo certification](#)

**Table 4: ThinkAgile VX650 V3 - SAP HANA limitations on VMware ESXi for vSAN**

Description	Minimum	Maximum
Virtual Memory (vMEM) allowed	128GiB	4TiB
Virtual CPUs (vCPUs) allowed	8	up to 240
Sockets / Production SAP HANA use	1	2
Number of ThinkAgile VX Nodes	3	64

**Table 5: ThinkAgile VX850 V3 - SAP HANA limitations on VMware ESXi for vSAN**

Description	Minimum	Maximum
Virtual Memory (vMEM) allowed	128GiB	8TiB
Virtual CPUs (vCPUs) allowed	8	up to 480
Sockets / Production SAP HANA use	1	4
Number of ThinkAgile VX Nodes	3	64

#### 4.1.2 VMware vSAN Cluster Best Practices

To best handle the nature of software defined infrastructure's inherent need for a cluster of servers, The VMware vSAN servers require a minimum of three servers to run a vSAN cluster, while for SAP HANA, we highly recommend at least four servers to ensure that VMware can handle not only a system fail-over, but also allows for maintenance of the cluster while maintaining resilience to any high availability outages.

If the customer wishes to use workloads other than productive SAP HANA DBs, extra ThinkAgile VX Integrated Systems or Certified Nodes may be used, but VMware vSphere and vSAN must be configured so

that no SAP HANA workload is run on these extra nodes. All nodes within the cluster where SAP HANA would be run, must conform to the storage restrictions of SAP HANA TDI Storage Guidelines:

- For production SAP HANA VMs
  - Do not share resources across any VMs and the productive VM(s)
  - Allow only whole multiples of processor sockets (1,2,3 or 4) per productive VM
- For non-production SAP HANA VMs
  - The same configurations for productive VMs are valid
- For all other VM workloads
  - Any socket not running an instance of a productive SAP HANA VM can run productive or non-productive workloads, such as SAP ERP, BW or NetWeaver.
- Turn off any VMware vSAN features that save storage impacts, such as compression, deduplication or erasure coding (EC-X), on any containers holding the SAP HANA productive data files.
- The storage must remain the same on all nodes, but from the 3rd node onwards, it is allowed to configure a lower cost CPU and/or less RAM. From the 3rd node onwards it is also allowed to configure other VX node types, including non-HANA VX nodes. These might be used for SAP Application workloads for example.

## 4.2 ThinkAgile System Configuration

### 4.2.1 ThinkAgile UEFI Configuration

For better results of your VMware vSphere ESXi installation, see the VMware Guide “*SAP HANA on Hyper-converged Infrastructure (HCI) Solutions based on VMware vSAN [Guide](#)*” for the specific configuration changes necessary for SAP HANA. Those settings recommended by VMware are valid for ThinkAgile VX systems.

### 4.2.2 VMware vSphere Configuration

For better results of your VMware vSphere ESXi installation, see the VMware Guide “*SAP HANA on Hyper-converged Infrastructure (HCI) Solutions based on VMware vSAN [Guide](#)*” for the specific configuration changes necessary for SAP HANA.

### 4.2.3 Operating System Configuration

Both Suse SLES for SAP and Red Hat for SAP are supported operating systems for VMware vSAN. It is recommended to apply operating system settings for SAP HANA inside the VM as recommended in SAP Note [2235581](#) - SAP HANA: Supported Operating Systems.

VMware and SAP have created an SAP HANA on vSAN Health Check vib and Installation script that can be run on the ESXi host which allows during runtime if an SAP HANA instance is running on a vSAN datastore. This script can be downloaded from the [VMware vSAN Skyline Heath Check page](#).

The script, based on Python, runs every five minutes on the ESXi host. It should be installed by the customer or Lenovo partner into the VMware ESXi before the SAP HANA VMs are created. It adds the following information to the VM configuration file.

- "guestinfo.vsan.enabled": True/False,
  - "guestinfo.SDS.solution": esxi\_version, this is equivalent to the vSAN release
  - "guestinfo.vm\_on\_vsan": True/False
- (see the [VMware documentation](#) for more details)

#### Prerequisites:

- Enable SSH on VMware ESXi before installing the script. Deactivate SSH after installation.
- We recommend having identical passwords of the super user across all ESXi hosts. This may be changed afterwards.

### 4.2.4 File System Configuration

Along with the VMware Guide “*SAP HANA on Hyper-converged Infrastructure (HCI) Solutions based on VMware vSAN* [Guide](#)”, we also recommend to read the Lenovo Best Practices for ThinkAgile VX using SAP HANA [paper](#) for the specific configuration changes necessary for SAP HANA. Use the Linux logical volume management (LVM) tools to create your volumes for SAP HANA as described in these guides.

### 4.2.5 SAP HANA configuration

Apply SAP HANA settings inside the VM as recommended in SAP documentation for the version of SAP HANA you are installing. This can be found on [help.sap.com/hana](http://help.sap.com/hana).

### 4.2.6 Check compliance

It is highly recommended to work with the latest version of the system check script. You can find it in SAP Note [2533844](#) – Lenovo Support Tool for SAP HANA Integrated Systems. Verify all hardware requirements and basic operating system requirements using this script.

# Resources

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## VMware Resources

[SAP HANA on Hyperconverged Infrastructure \(HCI\) Solutions Powered by VMware vSAN](#)

[Wiki](#) – SAP HANA based Applications on VMware vSAN (SAP HANA HCI)

[Wiki](#) – SAP HANA based Applications on VMware vSphere

[SAP HANA on vSAN Skyline Health Check Information and Installation Script](#)

[vSAN ESA ReadyNode Hardware Guidance](#)

## SAP Resources

[SAP Certified and Supported](#) SAP HANA Hardware for HCI Solutions

SAP Note [3406060](#) – SAP HANA on VMware vSphere 8 and vSAN 8

SAP Note [3372365](#) – SAP HANA on VMware vSphere 8

SAP Note [2235581](#) – SAP HANA: Supported Operating Systems

SAP Note [2533844](#) – Lenovo Support Tool for SAP HANA Solutions

SAP Note [2161991](#) – VMware vSphere configuration guidelines

SAP Note [1612283](#) – Hardware Configuration Standards and Guidance

[Whitepaper](#) – SAP HANA Storage Requirements

## Lenovo Resources

ThinkAgile VX Series datasheet: [lenovopress.lenovo.com/ds0104](https://lenovopress.lenovo.com/ds0104)

ThinkAgile VX650 V3 Certified Node Product Guide: [lenovopress.lenovo.com/lp1673](https://lenovopress.lenovo.com/lp1673)

ThinkAgile VX850 V3 Certified Node Product Guide: [lenovopress.lenovo.com/lp1792](https://lenovopress.lenovo.com/lp1792)

ThinkAgile VX - [Best Recipes, firmware and driver packages](#)

[Best Practice Guide](#) for SAP HANA solutions using ThinkAgile VX

[Lenovo LETS](#) - Configuration Guidance, VX templates and support

# Document History

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Version 2.2	18 March 2025	Add Express Storage Architecture Add VX650 V3 5th Generation (Emerald Rapids) including ½ Socket
Version 2.1	22 October 2024	Add ThinkAgile VX850 V3 Remove ThinkAgile VX 4U systems based on Intel Xeon 2 <sup>nd</sup> Gen
Version 2.0	1 March 2024	Add Intel Xeon Scalable Processor 4th Generation (Sapphire Rapids) on ThinkAgile VX V3 2-Socket systems Add VMware 8.0 support Remove VMware 6.7 support Remove ThinkAgile VX 2U systems based on Intel Xeon 2 <sup>nd</sup> Gen
Version 1.8	5 May 2021	Update ThinkAgile VX 4U 8-Socket configurations Adding SAP Notes 2718982 & 3102813 regarding VMs larger than 4-Sockets. Included a statement in network sizing of SAP HANA
Version 1.7	5 December 2020	Add ThinkAgile VX 4U 8-Socket configurations
Version 1.6	28 September 2020	Add Intel Optane Persistent Memory App-Direct Mode Clean cache and capacity device SAP HANA recommendations
Version 1.5	14 July 2020	Add Intel Xeon Scalable Processor 2. Generation (Cascade Lake) Add ThinkAgile VX 4U 4-Socket models
Version 1.0	6 February 2019	Initial version

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