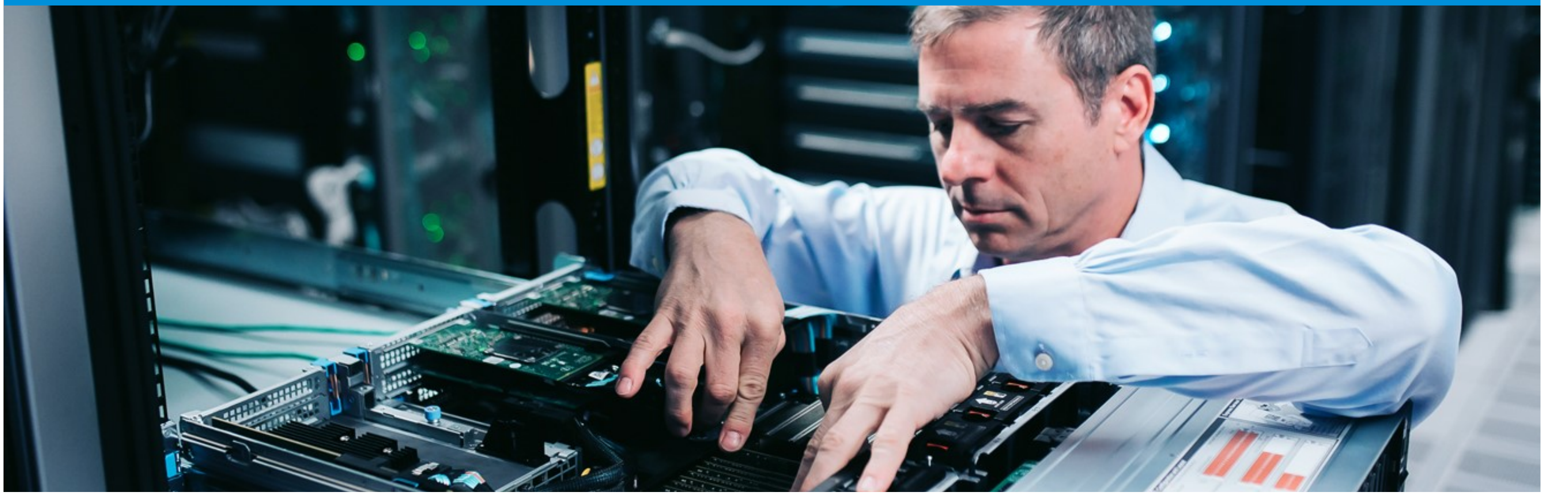
Micron® Storage and Memory Selection Guide for VMware vSAN™ Deployments



Select the right Micron SSDs and memory for all-flash vSAN deployments

VMware vSAN, a leading hyper-converged infrastructure (HCI) solution, provides the flexibility to respond to changing business demands by using a modular storage design. However, selecting the right storage and memory technology and planning the configuration is crucial in order to optimize cost and performance.

VMware provides a set of server design recommendations for vSAN called a VMware vSAN ReadyNode™. Each ReadyNode defines minimum requirements for CPU, memory and storage designed to meet different scales of virtual infrastructure performance and capacity. Table 1 provides a summary of these recommendations for storage and memory.

Micron offers a broad suite of memory and storage options fully certified for use with vSAN. Which memory and SSDs should you choose for your HCI deployment? By combining the vSAN ReadyNode definitions and years of Micron lab testing, this guide can help you select the right memory and SSD for each ReadyNode configuration.

vSAN Architecture Overview

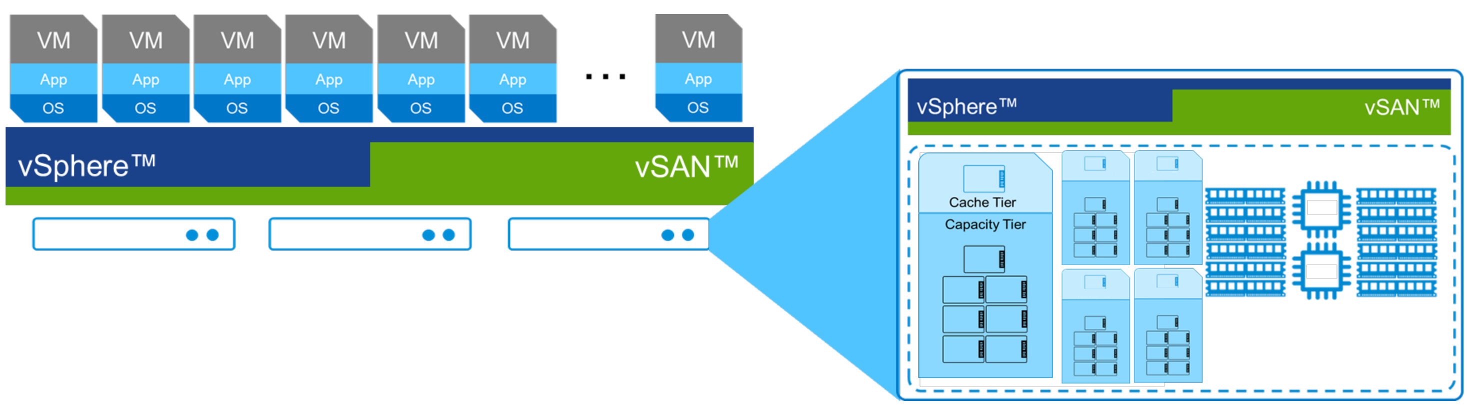


Figure 1— vSAN architecture overview

vSAN is an add-on component of the VMware vSphere virtual server platform that adds a virtualized storage component to the virtual server and networking components in vSphere. Using vSAN, we can combine the storage hosted in individual server nodes into a single pool of storage that can host virtual servers and their application data. A vSAN cluster can scale from as few as two nodes—with no data protection—to as many as 64 nodes (Figure 1).

The storage resources within each node are organized into one or more disk groups. Each cluster node can have between one and five storage disk groups. Each disk group is configured into two segments: a cache tier consisting of a single flash-based SSD and a capacity tier that can consist of between one and seven spinning-media or flash-media storage devices. The former is considered a “hybrid” disk group and the latter an “all-flash” disk group. In this paper we focus on all-flash configurations which are becoming more common and offers enhanced data management and protection features.

		AF-4 Series	AF-6 Series	AF-8 Series
Target Node Performance: (IOPS)		20K+	50K+	80K+
Recommended Memory: (GB)		128+	256+	384+
Raw Storage Capacity: (TB)*		4+	8+	12+
Storage Groups (Minimum):		1	2	2
Capacity Tier	**Devices per Storage Group:**	3-7		
	Endurance: (5 years total terabytes written)	365+		
	Write Performance: (IO ops per second)	10K+		
Caching Tier	**Cache Capacity: (gigabytes)**	200+	200+	400+
	Endurance: (5 years total terabytes written)	3650+	3650+	7300+
	Write Performance: (IO ops per second)	10K+	20K+	30K+

Table 1 — vSAN all-flash ReadyNode recommendations

vSAN Data Protection

vSAN offers multiple options to define your storage policy. While vSAN storage policies can encompass a variety of features and functions, this guide will focus on those that address data protection and storage capacity management.

vSAN has two primary data protection features that can be independently configured focusing on fault tolerance and data integrity.

Fault tolerance defines the method(s) used to ensure that data is always available in the event of a storage device or cluster node failure. vSAN uses the concept of FTT (Failures to Tolerate) that defines the number of devices (SSDs or servers) that can fail without losing access to stored data. Erasure coding is more efficient, but requires more CPU performance; while mirroring offers the best storage performance, but requires significantly more raw capacity. Table 2 provides a summary of the different failure mitigation settings.

Fault Tolerance Mode	FTT	RAID Level	Raw : Usable Capacity	Cluster Nodes Required
None	0	RAID-0	1:1	1
Mirroring	1	RAID-1	2:1	3
	2	RAID-1	3:1	5
	3	RAID-1	4:1	7
Erasure Coding	1	RAID-5	1.33:1	4
	2	RAID-6	1.5:1	6

Table 2 — vSAN data protection options

Data integrity ensures that the data stored is the data read without any modification. vSAN calculates a standards-based checksum for every data block stored within the cluster. When that data is later read, the same checksum is calculated again and compared against the checksum stored when the data block was written. This ensures the data has not been altered at any point since it was last written. Micron and VMware recommend that checksum be enabled on all production vSAN clusters.

vSAN Data Capacity Management

All-flash vSAN offers two additional methods of improving storage efficiency: deduplication and compression. To ensure that these processes do not impact overall cluster performance, these features are implemented as a “near-line” process. Within an all-flash vSAN storage group, all data is initially written to the cache device. This data is then destaged to the capacity tier as available processing resources allow. It is during this destaging process that deduplication and compression are implemented.

Deduplication ensures that all data blocks that are identical are stored only once within the storage group. As multiple “owners” of an identical block are identified, vSAN tracks the number of owners within the vSAN metadata store.

* Raw capacity does not take into account additional capacity for de-duplication, compression, or erasure coding. Cache tier device capacity do not count toward capacity targets.

Compression looks for repeating bit patterns within a single block and replaces those blocks with shorter bit sequences that represent the longer bit pattern. The net result — depending on the data — can be a significant reduction in the amount of data stored. Compression is highly dependent on the data characteristics and the actual benefit from compression will vary.

Data deduplication happens before compression if both are enabled (Figure 2).

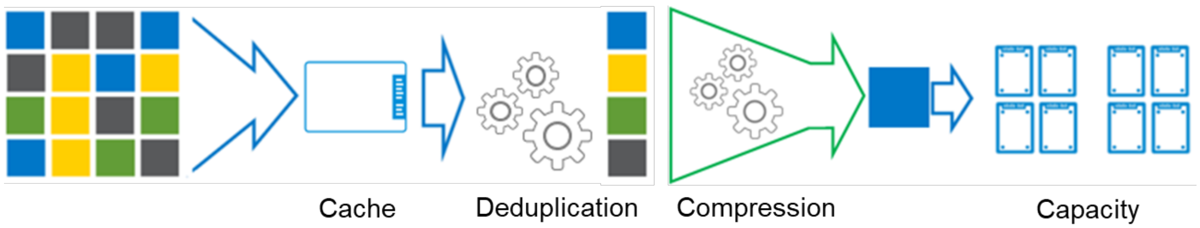


Figure 2 — vSAN data management features in action

Balancing Performance and Data Protection

Micron reference architectures and technical briefs define four combinations of vSAN data protection and data efficiency features that offer a variety of options with different balances of performance and data protection for production vSAN clusters. Micron and VMware recommend that all production clusters have some form of fault tolerance enabled and have checksum always enabled. For test and development environments, all features can be disabled though Micron recommends always having fault tolerance enabled. Table 3 provides an overview of each configuration along with its focus on performance vs density.

	Baseline/Test/Dev	Performance	Balanced	Dense
Fault Tolerance	Mirroring	Mirroring	Erasure Coding	Erasure Coding
FTT	1	1	1 (RAID-5)	1 (RAID-5)
Checksum	No	Yes	Yes	Yes
Deduplication	No	No	No	Yes
Compression	No	No	No	Yes

Table 3 — Storage settings enable a broad set of options between performance and density focused deployments

Cache Sizing for All-Flash vSAN

vSAN cache size can significantly impact overall vSAN performance as all writes go first to the cache device. vSAN 6.x uses a maximum of 600GB of device capacity while vSAN 7.x can use a maximum of 2.4TB of device capacity per storage group. Any excess capacity of the SSD is used by vSAN to enhance the lifetime of the SSD by distributing writes across the entire device.

Workload Type	Read/Write Ratio	AF-8	AF-6	AF-4
Read Intensive	0-30% Random Write	800 GB	400 GB	200 GB
Mixed	>30% Random Write	1.2 TB	800 GB	400 GB
Write Intensive	100% Sequential Write	1.6 TB	1.2 TB	600 GB

Table 4 — vSAN cache sizing recommendations

Identifying the amount of cache required for a vSAN node is determined by the read-to-write ratio of the combined IO of the hosted virtual machines. Table 4 provides a general set of guidance based on three broad workload types. Recommendations are based on VMware target endurance of 10 drive-writes per day over five years and a 4KB block size. Where the capacity listed in Table 4 is larger than the maximum usable capacity (600GB if deploying vSAN 6.x) indicates that additional storage groups will need to be deployed. vSAN 7.x deployments could meet recommended cache requirements with a single storage group. In this case, storage group designs should be based on capacity needs.

Micron vSAN Storage Recommendations

vSAN all-flash ReadyNodes configure storage into a set of one to five storage groups. Each storage group consists of a single, high-performance "cache" SSD and one to seven "capacity" SSDs.

Micron SSDs use either SATA or NVM Express™ (NVMe™) technology to offer differing ratios of performance and cost that match well with VMware ReadyNode categories. The following recommendations are based on vSAN recommended IOPS performance and endurance guidance:

- AF-4 is focused on smaller, cost-sensitive deployments such as remote offices. Micron SATA SSDs provide cost-effective performance for AF-4.
- AF-6 offers balanced performance . Micron recommends higher performance NVMe for cache while continuing to use SATA for capacity.
- AF-8 ReadyNodes focus on maximum performance and scalability. AF-8 targets 80,000+ IOPS per node. Micron NVMe SSDs for both storage group roles is indicated.

ReadyNode Class		Cache Tier	Capacity Tier
AF-4	Good	Micron 5400 MAX	Micron 5400 PRO
	Better	Micron 5400 MAX	Micron 5400 MAX
AF-6	Good	Micron 5400 MAX	Micron 5400 PRO
	Better	Micron 7450 MAX	Micron 5400 PRO
	Best	Micron 7450 MAX	Micron 5400 MAX
AF-8	Good	Micron 7450 MAX	Micron 7450 PRO
	Better	Micron 9300 MAX	Micron 7450 PRO
	Best	Micron 9300 MAX	Micron 9300 PRO

Table 5 — Micron SSD recommendations for vSAN ReadyNodes definitions

Table 5 provides specific SSD recommendations for each ReadyNode category. vSAN scales faster with more disk groups vs adding more capacity drives to existing storage groups. Specific SSD quantity and capacity for the capacity tier of each storage group will be based on specific performance and solution storage requirements.

Micron vSAN Memory Recommendations

vSAN ReadyNodes recommendations indicate a minimum memory capacity per node for each configuration.

Current generation processors from Intel® (3rd Generation Xeon® Scalable) and AMD™ (EPYC™ 7002/7003) can host eight memory channels per socket. Each channel hosts two memory modules that share the channel data path to the CPU.

Memory deployment assumes a balanced DIMM population per the vendor's recommendations (Intel and AMD). Therefore, the recommendations in Table 6 attempt to maximize the number of memory channels used for the given capacity recommendation provided by VMware for each AF configuration. Table 7 provides the Micron part numbers for each capacity of DRAM recommended.

To maximize system performance, Micron recommends:

- Distributing memory across as many channels as possible for each target capacity.
- Balance channel use across all CPU sockets.
- Use one DIMM per channel until all channels have been used, then add additional DIMMs to each channel until target capacity has been reached.

Capacity	Recommended Configuration	Ready-Node Class
128GB	16x 8GB	AF–4
256GB	16x 16GB	AF–4, AF–6
384GB	24x 16GB	AF–4, AF–6, AF–8
512GB	16x 32GB	AF–6, AF–8
1024GB	16x 64GB	AF–8

Table 6 — Micron memory configuration recommendations for vSAN

Micron Part	Part Number
8GB-3200MT/s RDIMM	MTA9ASF1G72PZ-3G2R1
16GB-3200MT/s RDIMM	MTA18ASF2G72PZ-3G2R1
32GB-3200MT/s RDIMM	MTA36ASF4G72PZ-3G2R1
64GB-3200MT/s RDIMM	MTA36ASF8G72PZ-3G2E1

Table 7 — Recommended Micron Memory

micron.com