



Financial and Operational Impact of VMware vSAN ESA vs. External Fibre Channel Storage

AUTHOR

Jonathan Fellows

Performance Validation Engineer | Signal65

IN PARTNERSHIP WITH



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Executive Summary

A 5 year cost of ownership analysis between VMware vSAN ESA and external Fibre Channel SAN storage in VMware Cloud Foundation 9.0 environments

Signal65 was asked to compare two storage approaches commonly deployed in VMware environments, VMware vSAN ESA and an external Fibre Channel SAN. Both were evaluated in the same test infrastructure across two environment sizes, measuring administrative time for common tasks and modeling five-year capital cost at list pricing. The two environments are intentionally different sizes, chosen to represent realistic mid-market and large enterprise deployments respectively. The Standard environment models a single site with 12 hosts in 3 clusters, 600 virtual machines, and 150 TB of raw storage, while the Expanded environment models two sites with 64 hosts in 8 clusters, 6,400 virtual machines, and 2,148 TB of raw storage.

Combined five-year cost of ownership, capital and operational:

- **vSAN costs 13.5% and 39.5% less over five years** vSAN lowers the five-year total by 13.5% in the Standard environment (\$2,398,369 against \$2,772,410) and by 39.5% in the Expanded environment (\$18,745,389 against \$30,965,048).
- **Capital cost:** vSAN carried the lower five-year capital cost in both environments, 13.5% lower in the Standard environment and 39.5% lower in the Expanded environment, at list pricing and equal raw capacity. Sourcing vSAN hosts through build-to-order channels, an option with no equivalent for an external array, widens that to 37.6% and 61.8%.
- **Operational cost:** vSAN required less administrative time in both environments and did not require a separately designated storage administrator for the modeled tasks, lowering operational cost by 13% in the Standard environment and 36% in the Expanded environment over five years.

The sections that follow present the capital analysis first, since it carries the larger financial weight, then the operational analysis, and finally the two combined. Detailed methodology, per-task timings, and the full cost model are in the Appendix.

Hyperconverged in the Enterprise

HCI Trends

Signal65 works with IT organizations across many countries and industries and conducts primary research into emerging trends and technologies to help IT leaders shape their strategies. Cloud computing and hyperconverged infrastructure remain two of the most influential forces shaping infrastructure decisions, and their appeal is closely linked.

One reason cloud and HCI gain traction together is their inherent synergy. Hyperconverged designs let organizations grow by adding standard units in a scale out fashion that is straightforward to operate, and disaggregated capabilities now let HCI mimic the independent scaling of compute and storage that traditional architectures provided. HCI also spans on premises and public cloud deployments, letting organizations standardize infrastructure regardless of where it runs.

VMware vSAN

VMware vSAN is a foundational component of many organizations' hyperconverged architectures, providing the storage layer for HCI. It allows administrators to manage compute, networking, and storage through a single familiar tool, VMware vCenter. Using vSAN does not preclude external network storage, but external storage typically requires additional tools, training, and, in larger organizations, additional personnel.

The current generation of vSAN, delivered as part of VMware Cloud Foundation 9.0, is built on the Express Storage Architecture (ESA). ESA is designed for modern, all-NVMe hardware and represents a significant simplification over the earlier Original Storage Architecture (OSA). Rather than pairing cache and capacity devices inside disk groups, ESA places all devices on a host into a single storage pool, which streamlines both capacity expansion and device replacement. ESA also introduces a new native snapshot implementation with minimal performance impact, and it supports high performance erasure coding so that space efficiency no longer trades off against performance. Note that the VMware operations suite, formerly known as VMware vRealize and then VMware Aria Operations, is now branded VMware Cloud Foundation Operations (VCF Operations), and the remote datastore capability formerly called HCI Mesh is now provided through vSAN storage clusters; this report uses the current names throughout.



Capital Expense Considerations

Operational cost is a major focus of this study, but capital expense also differs between the two approaches. To quantify it we built a five-year capital cost model covering the same Standard and Expanded environments used in the operational analysis. The model prices server hardware, NVMe capacity media, Fibre Channel arrays and their capacity, SAN fabric, software licensing, five-years of hardware support, and annual capacity growth of 10%.

Two scope decisions shape every figure that follows. First, all prices are vendor list or MSRP, drawn from published cooperative purchasing schedules and dated public procurement records. No negotiated discount is applied to either platform, so the comparison does not depend on assumptions about what discount a given buyer might obtain. Second, both platforms are costed to deliver the same raw capacity, 150 TB in the Standard environment and 2,148 TB in the Expanded environment. This is a deliberate simplification as it compares the cost of purchasing raw capacity and makes no adjustment for the differing amounts of usable or effective capacity each architecture returns from that raw total, a point we return to under Assumptions and Limitations.

Cost Analysis

Table 1 presents the five-year capital cost of each platform at list pricing in the reference case, with server hardware, NVMe media, and support sourced from tier-one OEM vendors.

Environment	FC SAN	vSAN	vSAN Advantage
Standard	\$2,658,054	\$2,298,860	13.5%
Expanded	\$30,720,914	\$18,588,562	39.5%

Table 1: Five Year Capital Cost, Reference Case, List Pricing, OEM Sourcing (source: Signal65)

vSAN has the lower five-year capital cost in both environments:

- **vSAN costs 13.5% less** than FC SAN in the Standard environment ($((\$2,658,054 - \$2,298,860) / \$2,658,054 = 13.5\%)$)
- **vSAN costs 39.5% less** than FC SAN in the Expanded environment ($((\$30,720,914 - \$18,588,562) / \$30,720,914 = 39.5\%)$)

The Standard environment is the narrower margin since that is where vSAN carries its largest licensing premium, \$672,000 or about a quarter of the FC SAN total, and because the FC platform licenses at vSphere Standard there while vSAN carries VCF. The vSAN advantage widens considerably at the Expanded scale, where array and fabric costs grow faster than vSAN media does. vSAN has the lower capital cost in every licensing case modeled, in both environments; the full set of results appears in the Appendix.

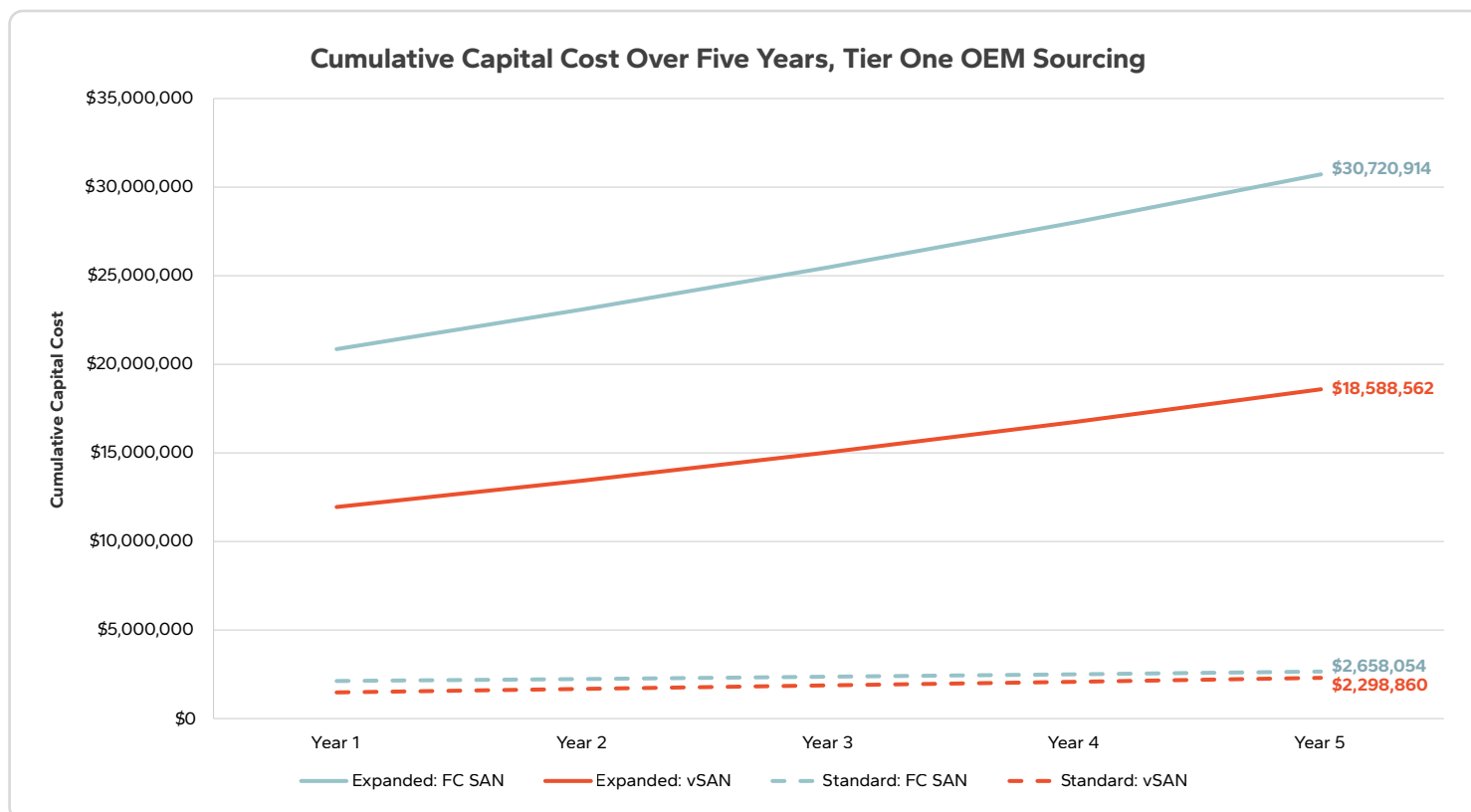


Figure 1: Cumulative Capital Cost Over Five Years, Tier One OEM Sourcing (source: Signal65)

Figure 1 shows how capital cost accumulates. Hardware, fabric, and the array itself are acquired in Year 1, which is why both platforms start high and the Year 1 gap is already most of the five-year gap. Licensing accrues evenly across the term, and incremental capacity is added in Years 2 through 5 as the environment grows at 10% annually. The lines therefore rise steadily rather than stepping, and the separation between them widens slightly each year because the FC platform pays more for each increment of added capacity.

Major Differentiating Factors

Table 2 breaks the reference case totals into their major components. Compute hosts are identical on both platforms, because both buy the same servers, so the entire difference lies in storage hardware, licensing, capacity growth, and fabric.

Component	Standard: FC SAN	Standard: vSAN	Expanded: FC SAN	Expanded: vSAN
Compute hosts	\$871,171	\$871,171	\$4,664,693	\$4,664,693
Storage hardware	\$1,128,494	\$450,360	\$15,053,265	\$6,456,204
Licensing and vSAN capacity add-on	\$96,000	\$768,000	\$4,096,000	\$4,470,072
Capacity growth	\$463,534	\$209,329	\$6,600,818	\$2,997,592
FC SAN fabric	\$98,856	\$0	\$306,138	\$0
Total	\$2,658,054	\$2,298,860	\$30,720,914	\$18,588,562

Table 2: Reference Case Five Year Cost Composition, List Pricing (source: Signal65)

In the Standard environment, licensing runs against vSAN. The FC platform licenses at vSphere Standard while vSAN carries VCF, so vSAN pays \$672,000 more for software, about a quarter of the FC total. vSAN still finishes ahead because its storage hardware costs \$678,134 less and it carries no fabric cost. Controllers, array software, and array support are all priced into the FC storage figure, whereas vSAN storage is NVMe media installed in servers the organization is buying regardless.

In the Expanded environment the picture is different. Both platforms are on VCF, so licensing is close to parity; vSAN pays \$374,072 more, which is entirely the capacity add on and just over 1% of the FC total. The gap is therefore almost entirely storage hardware, \$8,597,061, together with the capacity growth that follows from it. Storage hardware alone accounts for roughly 70% of the \$12.1 million difference.

Both platforms license the same 2,048 cores of VCF in the Expanded environment, \$4,096,000 on each side. The \$374,072 difference is entirely the vSAN capacity add-on. VCF entitles one tebibyte of vSAN capacity per licensed core, so 2,048 cores cover 2,048 TiB, while 2,148 TB of raw capacity grown at 10% annually exceeds that entitlement by an average of 356 TiB per year across the term, charged at \$17.50 per TiB per month. In the Standard environment the 384 TiB entitlement comfortably covers 150 TB of raw capacity, so no add-on applies and the entire licensing difference is the gap between VCF and vSphere Standard.

The fabric row covers Fibre Channel infrastructure only: host bus adapters, FC switches, port activation licenses, and SAN management software. It is zero for vSAN because vSAN has no separate storage fabric, not because networking is excluded from the model. Both platforms carry a 25GbE network adapter in every host, priced within the compute host figure, and the Ethernet switching that serves the cluster is required by both architectures equally and so does not differentiate them.

Build-to-Order (Original Design Manufacturer) Hardware

Because vSAN supplies the storage software layer, the underlying server hardware is interchangeable. Broadcom supports discrete component builds as emulated ReadyNodes provided they meet the published profile minimums, and a number of large organizations source vSAN hosts from build-to-order (ODM) channels rather than from tier-one OEMs¹. There is no equivalent on the FC SAN side. The array operating environment is inseparable from the vendor's own controller hardware and cannot be licensed onto a commodity chassis. This asymmetry is a structural difference between the two approaches rather than a pricing artifact.

Table 3 shows the reference case result when vSAN hosts, NVMe media, and server support are all sourced from a build-to-order (ODM) channel rather than from tier-one OEMs, against the same FC SAN pricing used throughout this section. The tier-one blend prices hardware from two leading server OEMs; the build-to-order (ODM) figures are drawn from one representative integrator and are indicative of that channel rather than a survey of it. Because the FC platform buys the same compute hosts, its total moves slightly as well.

Environment	vSAN Host Sourcing	FC SAN	vSAN	vSAN Advantage
Standard	Tier-one OEM	\$2,658,054	\$2,298,860	13.5%
Standard	Build-to-order (ODM)	\$2,276,892	\$1,420,698	37.6%
Expanded	Tier-one OEM	\$30,720,914	\$18,588,562	39.5%
Expanded	Build-to-order (ODM)	\$31,166,354	\$11,915,938	61.8%

Table 3: Reference Case, Tier One OEM versus Build-to-Order (ODM) Hardware Sourcing, List Pricing (source: Signal65)

The larger advantage comes principally from NVMe media, which is priced at \$714 per raw TB through the build-to-order (ODM) channel against \$2,466 per TB from tier-one OEMs, and from the lower support rate. In the Expanded environment the build-to-order (ODM) host is in fact more expensive than the OEM blend, owing to the cost of its 1 TB memory configuration, which is why the FC total rises slightly. The vSAN advantage in that environment comes from media and support, not from cheaper servers.

¹ Broadcom stated to Signal65 that a significant number of large organizations source vSAN hosts through build-to-order or ODM channels rather than from tier-one OEM vendors.

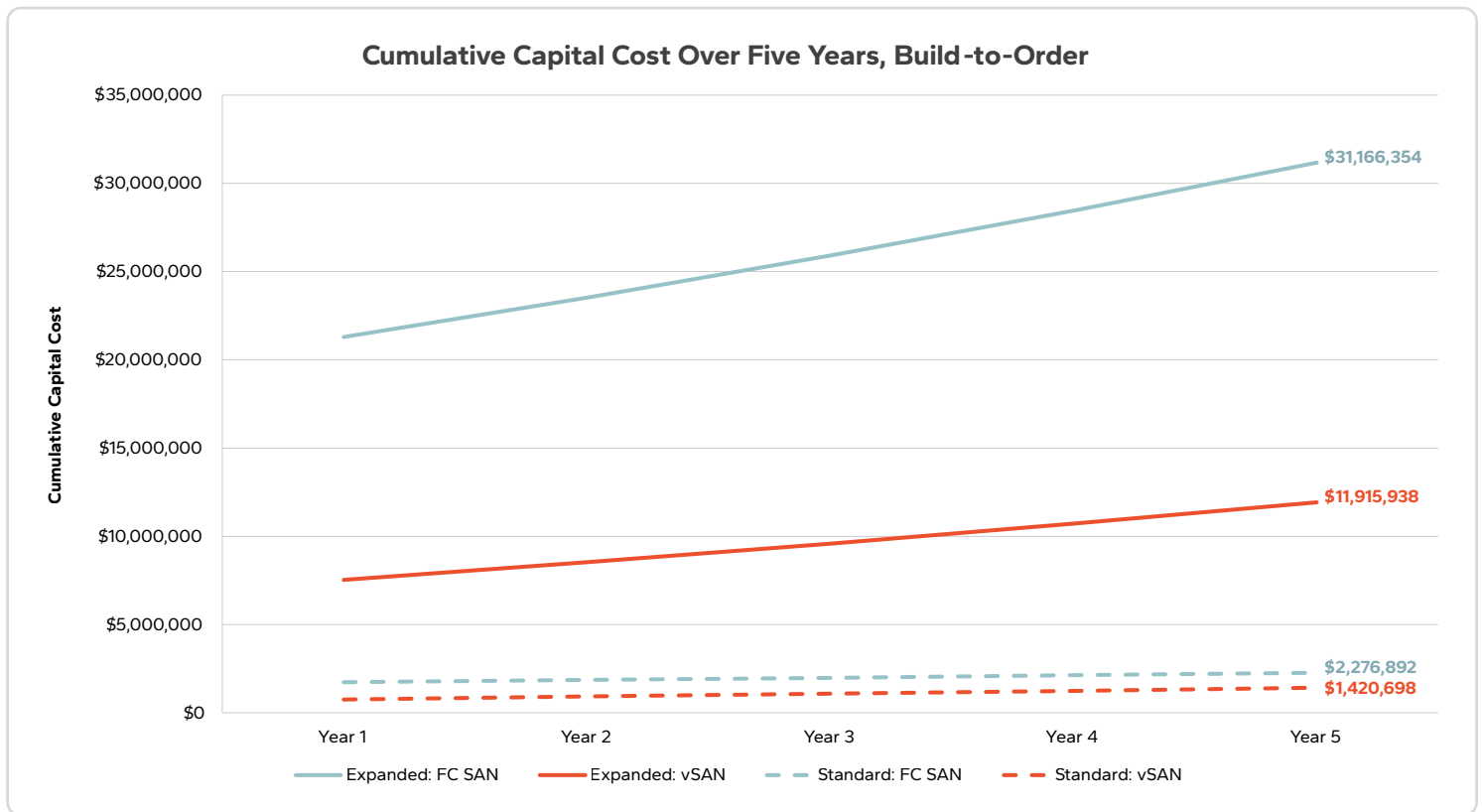


Figure 2: Cumulative Capital Cost Over Five Years, Build-to-Order (ODM) Hardware (source: Signal65)

The support difference between the two platforms is significant in this scenario. Tier-one OEM support in this model is four-hour onsite response at 4.39% of hardware cost per year. The build-to-order (ODM) channel provides five-year advanced parts replacement with onsite labor at 0.81% per year, but no response-time commitment. Failed hardware is still replaced under warranty, so no separate failure cost is added, but the operational risk of a longer outage, and the cost of any spares inventory an organization holds to offset it, fall on the customer and are not modeled here. Whether parts coverage extends to capacity media purchased separately from the server should also be confirmed with the supplier. The build-to-order (ODM) sourcing figures are favorable to that option on these counts, and it is best understood as a legitimate sourcing choice with an operational cost attached rather than a like-for-like saving.

Operational Efficiency

Signal65 evaluated VMware vSAN ESA against an external Fibre Channel SAN presented to vSphere hosts, using the same test infrastructure for both. Common administrative tasks were performed and timed, then scaled to two modeled environments. Full methodology, per-task timings, and the cost calculation are in the Appendix.

The measured results for administrative time in each category appear in the Appendix, and the resulting operational costs are summarized below. Operational cost is calculated as the administrative time required multiplied by the fully loaded cost of the appropriate IT administrator.

Standard environment (5 year cumulative):

- **vSAN costs 13% less** than FC SAN over 5 years ($((\$114,355 - \$99,509) / \$114,355 = 13\%)$)

Expanded environment (5 year cumulative):

- **vSAN costs 36% less** than FC SAN over 5 years ($((\$244,134 - \$156,827) / \$244,134 = 36\%)$)

These operational costs recur annually and accumulate over the life of the environment, as shown in the table and figure below. Out of Box Initialization and Storage Network Setup are one time, Day 1 activities and are counted only in Year 1. All other categories, including the small recurring share of setup work tied to adding hosts or storage systems over time, accrue every year. As a result, the projection is linear for recurring costs but not for the total, since the one-time setup cost is not repeated in Years 2 through 5.

Environment	Year 1	Year 2	Year 3	Year 4	Year 5
Standard: vSAN	\$19,957	\$39,845	\$59,733	\$79,621	\$99,509
Standard: FC SAN	\$22,981	\$45,824	\$68,668	\$91,512	\$114,355
Expanded: vSAN	\$31,572	\$62,886	\$94,200	\$125,513	\$156,827
Expanded: FC SAN	\$49,091	\$97,852	\$146,612	\$195,373	\$244,134

Table 4: Operational Costs over Time (source: Signal65)

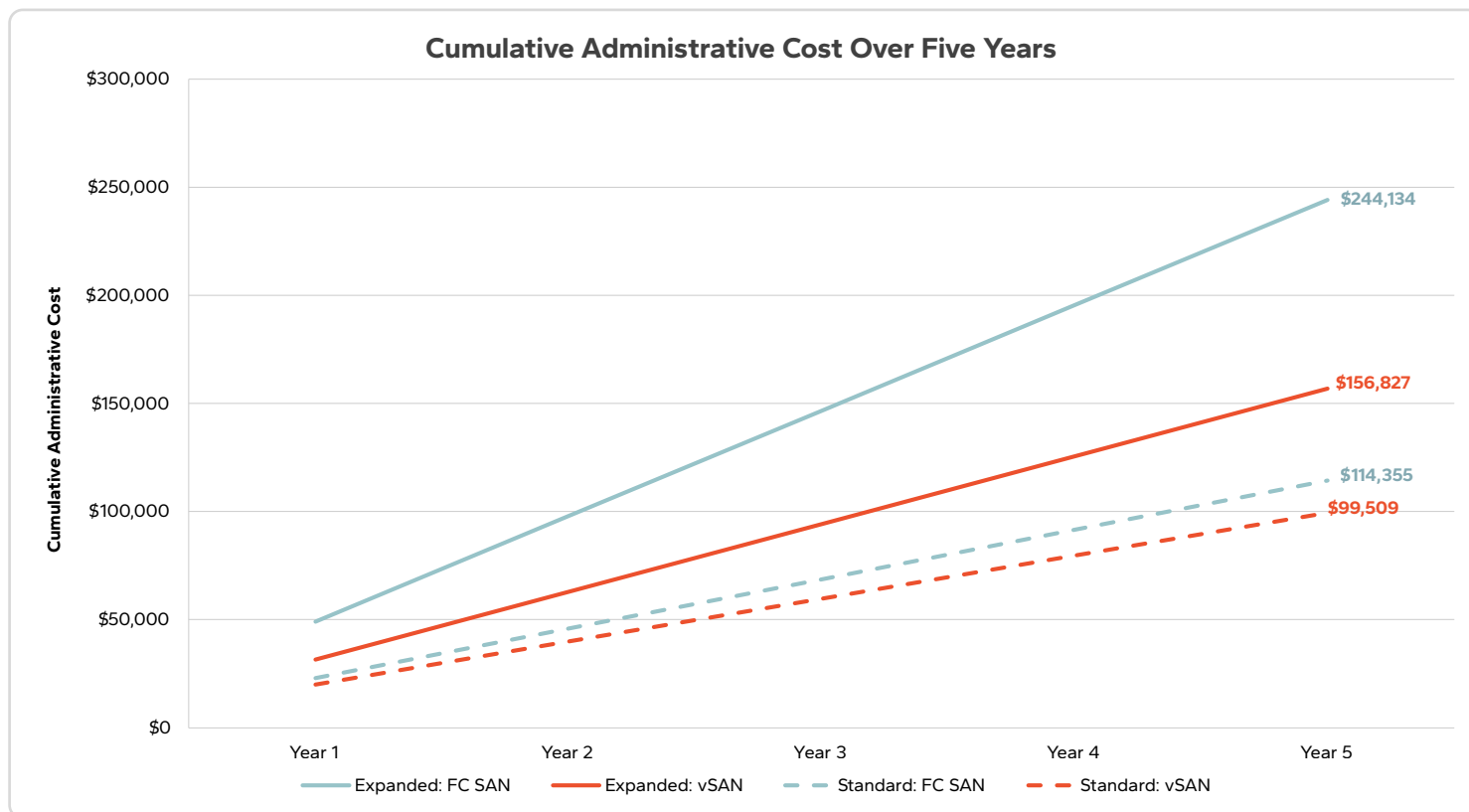


Figure 3: Cumulative Administrative Cost Over Five Years (source: Signal65)

The primary drivers of operational cost for both approaches come from Storage Planning and Remediation, which spans both capacity and performance management. In both areas vSAN required less administrative time and, importantly, did not require a designated storage administrator for the modeled tasks. The principal reasons vSAN required less time:

vSAN presents fewer items to manage:

- A single vSAN datastore has no artificial per datastore VM limits, whereas VMFS on FC SAN is commonly divided into more datastores
- vSAN provides per VM snapshot granularity, while a VMFS array snapshot captures sometimes many VMs on a single datastore
- As a result, an FC SAN on VMFS environment maintains many more datastores than the equivalent vSAN environment

A single tool workflow reduces coordination:

- A vSAN environment is administered end to end from vCenter by a VM administrator. On FC SAN, modern vendor plugins bring provisioning and monitoring into vCenter as well, but array side configuration and root cause work still touch the vendor's management console
- Where cross role coordination between VM and storage administrators does occur, it adds elapsed time beyond the modeled per task minutes

The relative savings is considerably larger in the Expanded environment (36%) than in the Standard environment (13%). This is expected, the operational benefits of a single management plane compound as the number of datastores, VMs, and administrative events grows. In a smaller environment, where a leading modern array is already simple to operate and a dedicated storage specialist may not even be on staff, there is a more modest (though still positive) difference. Organizations should weigh the Standard result as indicative of smaller deployments and the Expanded result as indicative of larger ones.

Note: In addition to the time to perform tasks, further inefficiency can arise when coordinating actions between VM and storage administrators. Because this factor varies widely between organizations, we chose not to include it, which makes our comparison on the conservative side with respect to FC SAN.

Operational Task Evaluation

The table below summarizes how vSAN ESA and an external Fibre Channel array meet the requirement for reduced administration in hyperconverged environments, based on their features and their administrative cost and complexity.

Requirement	VMware vSAN	External FC SAN	vSAN Advantage
Ease of Deployment and Expansion	Very Good: Installation and expansion in minutes by a VMware administrator alone.	Good: Modern arrays automate much of their own setup and deploy quickly. Additional steps remain for array configuration and for zoning and provisioning the Fibre Channel fabric.	30 to 42% less time: Lower complexity with no separate storage skill set.
Storage Provisioning and Maintenance	Very Good: All management from vCenter by a VMware administrator.	Good: Plugin brings provisioning into vCenter, but array side settings remain.	36 to 37% less time: Single tool reduces complexity and cost.
Capacity Analysis and Remediation	Very Good: Pooled capacity is clearly visible and needs remediation less often.	Very Good: Volume capacity is clearly visible; expansion is non disruptive.	Minimal time difference: Similar time, but vSAN tasks need only a VM admin.
Performance Analysis and Remediation	Very Good: Per VM data; remediation is applying a policy.	Good: Per-volume data, with per-VM visibility available through vCenter plugins. Remediation is applied through QoS limits or by rebalancing volumes across resources.	2 to 17% less time: Fewer items and better per VM visibility.
Recovery and Availability	Very Good: Features managed for the VM admin from a single tool.	Good: Capable features. Protection is applied per volume, so per-VM granularity depends on volume layout and can be approached by dedicating volumes to individual VMs, at the cost of managing more volumes. Recovery workflows involve more steps.	75 to 80% less time: Establishing basic DR is simpler with vSAN.

Table 5: Comparison of Storage Requirements (source: Signal65)

Annual administrative cost by task category for each environment is charted in Figures 4 and 5 in the Appendix. In both environments, vSAN required less administrative time and did not require a separately designated storage administrator for the modeled tasks.

Combined Five-Year Cost

Here we present the combined capital and operational five-year costs. The two are additive and independent, the capital model prices hardware, fabric, licensing, support, and capacity growth, while the operational model prices administrative labor. Neither includes any element of the other. Table 6 combines them for the reference case.

Environment	Sourcing	FC SAN	vSAN	vSAN Advantage
Standard	Tier-one OEM	\$2,772,410	\$2,398,369	13.5%
Standard	Build-to-order (ODM)	\$2,391,247	\$1,520,207	36.4%
Expanded	Tier-one OEM	\$30,965,048	\$18,745,389	39.5%
Expanded	Build-to-order (ODM)	\$31,410,488	\$12,072,765	61.6%

Table 6: Combined Five-Year Capital and Operational Cost, List Pricing (source: Signal65)

The combined result is almost identical to the capital result alone, 13.5% in the Standard environment and 39.5% in the Expanded environment on both measures. The reason is scale since administrative cost is 4.1% of the five-year total in the Standard environment and 0.8% in the Expanded environment. Operational efficiency is the more interesting finding of this study because it reflects how the two architectures are actually run day-to-day, but in a five-year cost model priced at list, capital expense dominates the equation.

An organization evaluating these platforms on cost alone will find the decision driven largely by acquisition cost, and the operational difference, while real and consistently in vSAN's favor, will not change the ranking. Also, the operational advantage compounds in ways this model does not capture. Administrative time returned to a team is redeployed rather than banked, and the coordination overhead between virtualization and storage teams, which we deliberately excluded, falls entirely on the FC SAN side.

We describe this as a combined five-year cost rather than a total cost of ownership, because several elements a full TCO would include are outside the scope of what was measured. The most significant are facilities costs, principally power, cooling, and rack space, where an external array consumes both power and floor space that a vSAN deployment does not add on top of its servers. Also excluded are one-time migration and deployment services, staff training, the cost of any downtime attributable to either architecture, and end-of-life decommissioning.

Final Thoughts

This study set out to compare two established ways of providing storage to a VMware environment, an internal vSAN ESA datastore and an external Fibre Channel array, using the same infrastructure, the same workloads, and the same raw capacity for both. The two differ in how they are bought and in how they are run, so we measured both the five-year capital cost at list pricing, and the administrative time that storage consumes once the equipment is in place. Both measures favored vSAN, which could lead to large savings for organizations.

Capital expense is where the larger difference lies. At list pricing and equal raw capacity, the vSAN configuration carried a lower five-year capital cost in both environments and in every licensing case modeled, 13.5% lower in the Standard environment and 39.5% lower in the Expanded environment in the reference case. That advantage came from storage hardware and the absence of a Fibre Channel fabric rather than from software licensing, which in the Standard environment ran against vSAN. It widens with scale, because array and fabric costs grow faster than the NVMe media a vSAN cluster adds.

There is also the option to use a build-to-order (ODM) hardware approach with vSAN, as it supplies the storage software layer, the server hardware beneath it is interchangeable, and organizations willing to buy through build-to-order (ODM) channels saw the advantage widen to 37.6% and 61.8%. No equivalent option exists for an external array, whose operating environment is inseparable from its own controller hardware. That route carries support and operational tradeoffs that should be weighed alongside the capital saving, and it is best understood as a legitimate procurement choice rather than a like-for-like discount.

Operational efficiency points the same way, for a different reason. As environments grow, reducing complexity is essential to managing IT staffing expense. HCI with vSAN lets organizations use administrators with a common set of skills and tools for the majority of required tasks, including storage administration, without adding separate groups or specialized skills for array management and Fibre Channel zoning. Needing only one platform and one administrative role also removes operational friction between teams, a real cost that this study, by excluding coordination overhead, does not capture.

That operational advantage is consistent and grows with the scale and complexity of the deployment. It is worth noting that it is driven less by any weakness of contemporary all-flash arrays, which have matured considerably in setup, replication, and snapshot administration, than by the durable value of a single management plane and a single administrative skill set. As environments scale and administrative events multiply, that single tool, single role model is where the savings compound.

Overall, we found that VMware vSAN ESA enabled both small and large VMware environments to reduce the time required for storage administration while also lowering capital cost, with little or no incremental storage software expense under current VCF licensing. For many organizations, hyperconverged infrastructure built on vSAN can meet enterprise availability requirements at lower five-year cost and with lower operational overhead.

Appendix

Test Environment Details

The evaluation used a single test infrastructure containing both vSAN ESA and external Fibre Channel storage, with the environment held identical except for the storage under test. The software baseline was VMware Cloud Foundation 9.0 (ESXi on hosts, with vCenter Server), with vSAN configured to use the Express Storage Architecture. Multiple VMs were configured to validate configuration and administration.

A note on vendor naming. The external Fibre Channel array used in this evaluation is an all-flash platform from a leading enterprise storage provider referred to throughout this report as "Competitor A."

vSAN Storage Configuration

- vSAN ESA on the hyperconverged clusters, with vSAN storage clusters used to mount remote vSAN datastores on clusters that consume storage remotely
- Standard model: 3 clusters; approximately 75% of clusters provide local vSAN storage, with remaining clusters mounting remote datastores
- Expanded model: 8 clusters following the same topology assumption

FC SAN Storage Configuration

- Standard environment: 2 storage systems, used for local DR and capacity requirements, 150 TB raw combined
- Expanded environment: 4 storage systems, 2 per site, 2,148 TB raw combined
- The array was presented to vSphere as VMFS datastores; the array vendor's vSphere plugin was used for in vCenter provisioning and snapshot administration

A note on total storage capacity. The 150 TB and 2,148 TB raw capacity figures were chosen to represent realistic mid-market and large enterprise footprints and are held constant between the two storage approaches so the administrative task counts derived from them remain directly comparable. This is a conservative choice with respect to the array hardware: a current four controller deployment of a leading all-flash FC array sized for an environment of this scale is typically capable of holding substantially more raw capacity than 2,148 TB, so the modeled environment does not assume array capacity is a constraint for either platform. Both vSAN ESA and modern all-flash arrays also apply inline data reduction; effective capacity on both sides is therefore larger than the raw figures used, though achieved ratios vary by workload and by platform.

Evaluation Methodology

Signal65 evaluated VMware vSAN ESA storage against an external Fibre Channel SAN presented to vSphere as VMFS datastores. Testing used a current environment built on VMware Cloud Foundation 9.0, with vSAN ESA on the HCI clusters and Competitor A's all-flash array providing the external storage.

The primary objective was to fairly evaluate the operational efficiency of the two storage approaches supporting application servers on a common VMware hypervisor infrastructure. Analysis focused on time required to perform each administrative task and also reports qualitative aspects such as integration and relative ease of use that are not easily reduced to a single number.

Using the same test environment, we performed typical administrative tasks and recorded the time required for each. To translate those measurements into cost, we applied them to two hypothetical environments, each with a defined number of hosts, VMs, storage capacity, and other components. The two environments are referred to throughout as "Standard" and "Expanded":

- **Standard:** 1 site, 12 hosts in 3 clusters, 600 total VMs, and 150 TB of raw storage
- **Expanded:** 2 sites, 64 hosts in 8 clusters, 6,400 total VMs, and 2,148 TB of raw storage

The Standard and Expanded environments are intentionally different sizes, chosen to represent realistic mid-market and large enterprise deployments respectively. Within each of the two environments, however, the underlying VMware infrastructure, including host counts, cluster layout, and VM counts, is identical regardless of which storage platform is being modeled; only the storage layer changes. This means differences in the results reflect the storage technology and its administration rather than a difference in the environment itself. Full configuration details appear in the Appendix.

A note on methodology. Task times were captured directly where possible in the current lab environment. A subset of tasks that are difficult to reproduce in a single lab pass, notably out of box initialization and business continuity / disaster recovery configuration, were carried forward from the earlier study and adjusted with reference to current vendor documentation and technical guides describing modern all-flash and stretched cluster configurations.

Operational Efficiency Areas

Operational efficiency was assessed by performing common administrative tasks, measuring the time required, and noting the relative complexity of each. Tests covered the deployment and setup of storage as well as the ongoing tasks common to most application environments. The operational areas considered were:

1. Initialization and Setup (Day 1 operations)
2. Ongoing Operations, including provisioning, capacity management, and performance management (Day 2 operations)
3. Recovery and Availability, including snapshots, business continuity and disaster recovery, and device failure

Standard Environment: Annual Administrative Cost by Category

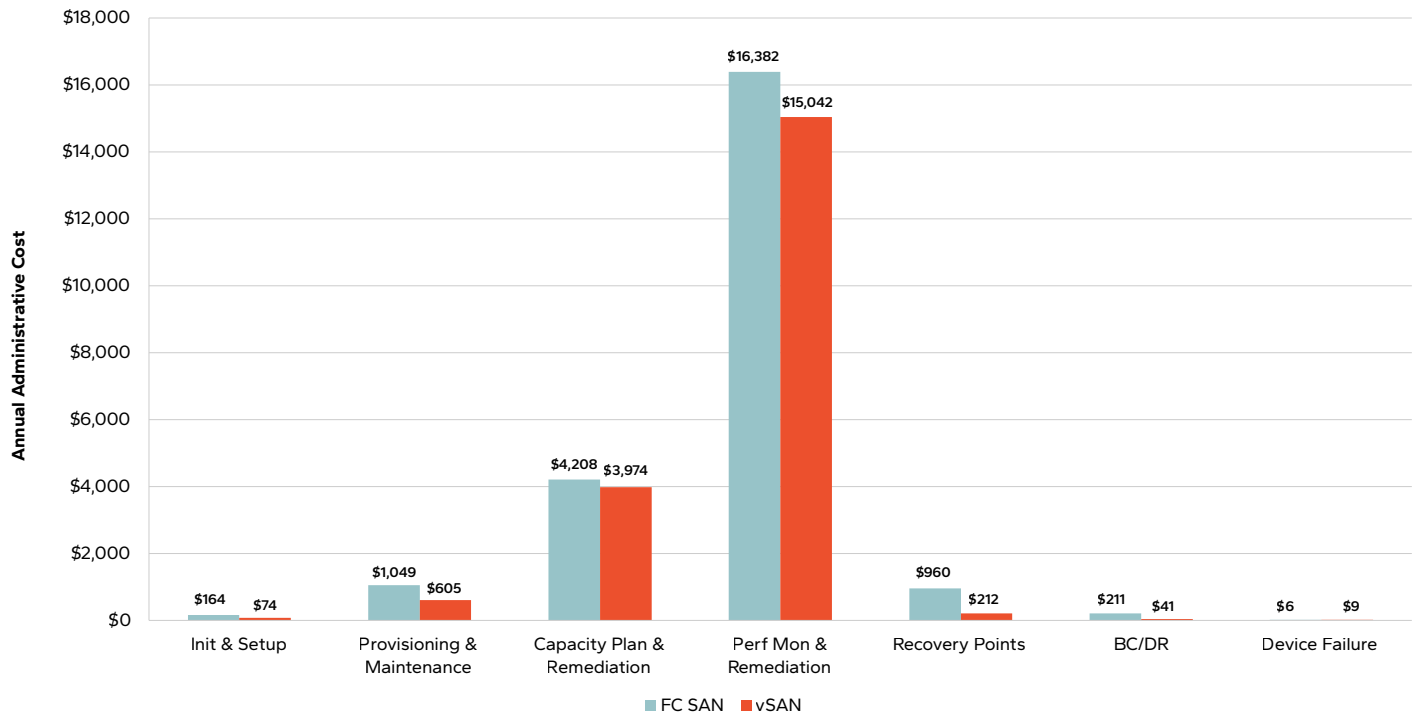


Figure 4: Standard Configuration Administrative Costs (source: Signal65)

Expanded Environment: Annual Administrative Cost by Category

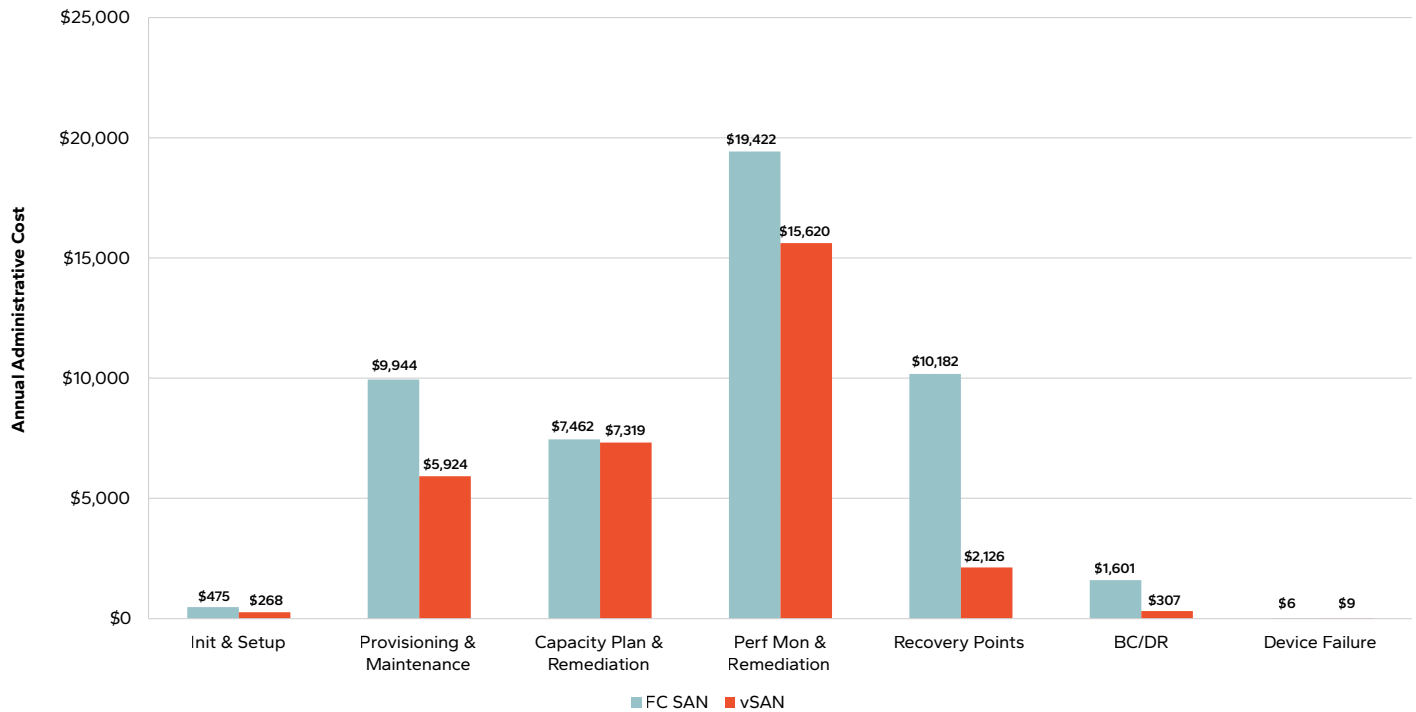


Figure 5: Expanded Configuration Administrative Costs (source: Signal65)

Operational Cost Calculations

Operational cost is driven by three factors: the time each operation takes, the number of times per year it is performed, and the fully loaded cost of the people performing it.

- **Task time.** The per event minutes required to complete each administrative task, measured in the lab environment or, for tasks not directly reproduced, taken from the earlier study and adjusted using current vendor documentation.
- **Event frequency.** How often the task recurs across a year, scaled to the modeled environment size. Frequency assumptions are held constant between the two storage approaches for each task, so differences in the totals reflect per event effort and role allocation rather than a difference in how many events each platform generates.
- **Personnel cost.** Tasks are apportioned between a VM administrator and a storage administrator based on which role actually performs the work. FC SAN uses both roles; vSAN uses primarily the VM administrator for the modeled tasks. Salary assumptions reflect current 2026 market compensation, as described in the Appendix.

One consequence of the current compensation landscape is that the fully loaded cost of a dedicated storage administrator is only modestly higher than that of a VM administrator today. In other words, an hour of storage admin time saved is worth roughly 20% more than an hour of VM admin time saved, rather than the larger premium used in earlier reports. This compresses the modeled advantage of vSAN and makes the comparison conservative.

Operational Time Details

The following sections present the time aspect of administration, independent of cost. Times were captured per event in minutes in the underlying model and are aggregated to annual hours in the summary tables below for readability. All figures are also provided in the Appendix.

Initialization and Setup

Initialization and setup are infrequent but important "Day 1" operations. For complex products, initial setup can take days or longer to integrate and configure all components including server configuration, storage networking, and the installation and configuration of the storage itself, and large SAN systems have historically required on-site service. In essence, this measures the time to place the asset into service.

These figures reflect administrator configuration time after the physical hardware is already racked, powered, and cabled, work that storage vendors commonly perform as part of deployment services for enterprise arrays. What is timed here is the remaining logical setup: connecting the array to vCenter, creating host groups and initial volumes, and applying starting policies.

Both approaches are relatively simple to bring into service. Setup for a modern all-flash SAN is largely wizard driven, with vendor documentation and published product guides for leading platforms indicating initialization on the order of tens of minutes per system rather than the multi hour setups typical of earlier generation arrays. Modern ESXi releases handle path selection for supported enterprise arrays through the native multipathing layer, so per host multipathing software installation is generally not required. On the vSAN side, ESA setup is straightforward, with the practical consideration that current ReadyNode profiles assume higher speed networking.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	2.4 hours annually	1.4 hours annually	42% lower
Expanded	7.0 hours annually	4.9 hours annually	30% lower

Table 7: Initialization and Setup, Annual Administrative Time (source: Signal65)

Ongoing Operations

Daily, or "Day 2," operations are performed most frequently over the life of a product and therefore have the largest impact on total administrative time. The number of times a task is performed matters as much as its per instance duration. At the scale of the Expanded environment, continuously monitoring and tuning performance is unrealistic without an operations tool that provides alerting; the current environment uses VCF Operations for this purpose. At a high level, ongoing operations include provisioning storage for new applications, capacity monitoring and remediation, and performance monitoring and remediation.

Note: Under VCF licensing, the operations suite (VCF Operations) is included in the platform, so its use carries no separate acquisition cost. VCF Operations was not modeled for the Standard environment, reflecting that smaller shops often operate without a dedicated operations tool, while the Expanded environment assumes it is deployed and used for the modeled tasks.

Storage Provisioning and Maintenance

This subcategory covers provisioning storage for applications, including creating storage policies and, on the array side, volumes with the appropriate settings. For vSAN this means creating storage policies applied to VMs or virtual disks. For an FC SAN, the vendor's vSphere plugin (available for most leading all-flash arrays today) can create the volume, connect it to the hosts, and format the VMFS datastore from a single wizard within vCenter. Volume differentiation is applied through array side policies such as QoS limits and protection group membership rather than RAID or tiering choices, which modern all-flash arrays generally do not expose.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	16.0 hours annually	10.1 hours annually	37% lower
Expanded	166.2 hours annually	106.8 hours annually	36% lower

Table 8: Storage Provisioning and Maintenance, Annual Administrative Time (source: Signal65)

Storage Capacity Planning and Remediation

This subcategory is typically the second largest driver of administrative time after performance monitoring. vSAN required less total time and used only a VM administrator, without a separate storage administrator. Capacity work benefited from the operations tooling in the larger environment. On the vSAN side, ESA's single storage pool made adding capacity devices simpler than the OSA disk group model. On the Competitor A side, volume expansion is near instant, with the remaining time spent in the vCenter rescan and grow workflow. One exception: in the Expanded environment, FC's capacity planning time is exceeded by both its recovery points and provisioning categories, reflecting the larger number of FC datastores in that environment.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	76.2 hours annually	72.3 hours annually	5% lower
Expanded	133.6 hours annually	133.1 hours annually	Approximately the same

Table 9: Storage Capacity Planning and Remediation, Annual Administrative Time (source: Signal65)

Storage Performance Monitoring and Remediation

This subcategory consumed the most administrative time for both approaches. vSAN again required less total time and used primarily a VM administrator. The character of performance remediation is different on a modern all-flash platform: with an all-flash array there are no performance tiers or tuned LUN templates, so remediation is a matter of adjusting per volume QoS limits or rebalancing VMs across datastores rather than migrating workloads to a faster tier. Much routine contention is also handled automatically by the array's built in workload management. On vSAN, remediation is applying or adjusting a storage policy per VM or virtual disk.

Both platforms surface performance data directly in vCenter: the array vendor's vSphere plugin now brings per datastore latency, IOPS, and bandwidth into vCenter alongside vSAN's native views, so the administrator no longer needs to switch between two consoles for routine analysis. Storage Policy-Based Management (SPBM) policies can likewise be authored in vCenter and assigned to VMs or virtual disks on either platform, using tag-based rules that reference the underlying datastores. vSAN's remaining advantage in this subcategory is narrower than in earlier eras and more specific: standard VM level CPU, memory, and disk activity is visible in vCenter for any VM regardless of backing storage, but vSAN's per VM storage objects let its native telemetry attribute storage layer latency and IOPS directly to a single VM, while an array plugin reports storage layer metrics at the volume level, since multiple VMs typically share one VMFS datastore, requiring the administrator to correlate a datastore level reading back to the VMs it hosts.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	291.0 hours annually	285.5 hours annually	2% lower
Expanded	342.7 hours annually	284.0 hours annually	17% lower

Table 10: Storage Performance Monitoring and Remediation, Annual Administrative Time (source: Signal65)

Recovery and Availability

These tasks are performed less often than the repetitive capacity and performance tasks, but managing data protection is an important part of storage administration. This area covers three subcategories: establishing and managing snapshot recovery points, administering business continuity and disaster recovery, and recovering from device and node failures.

Manage Recovery Points

Snapshot administration is policy driven on both platforms. Recurring snapshots are scheduled by policy, array side protection groups on the FC SAN, and vSAN data protection on the hyperconverged side. This means recurring manual work collapses into one time schedule configuration, leaving only ad hoc snapshots as manual events.

vSAN offers per VM granularity natively in vCenter, while an FC array snapshot typically captures the entire volume on the FC SAN array, which usually includes multiple VMs. Single VM recovery is available on the FC side through the standard VMFS mount and re-signature workflow surfaced by the array vendor's plugin. vSAN ESA's native snapshot implementation carries no meaningful performance penalty, similar to FC SAN snapshots.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	15.8 hours annually	3.9 hours annually	75% lower
Expanded	166.9 hours annually	38.6 hours annually	77% lower

Table 11: Manage Recovery Points, Annual Administrative Time (source: Signal65)

Managing BC/DR Features

Establishing basic disaster recovery capability is simpler with vSAN, which applies stretched cluster protection per VM through storage policy. The gap is not as large as it might once have been however, because synchronous replication on a modern all-flash SAN is itself straightforward to configure: connecting the arrays, creating a stretched configuration, and connecting hosts, with a witness component provided at a third location. On the array approach, protection is applied at the volume or datastore level, so VMs must be co-located onto stretched datastores.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	3.5 hours annually	0.8 hours annually	77% lower
Expanded	27.7 hours annually	5.6 hours annually	80% lower

Table 12: Managing BC/DR Features, Annual Administrative Time (source: Signal65)

Managing Device Failures

Both approaches handle device failure with minimal administrative time. On the vSAN side, ESA supports replacing a failed drive without placing the host in maintenance mode, on ReadyNodes whose drive models support hot plug, and the elimination of disk groups means a device failure affects only that device with faster resynchronization. An array drive swap remains a low touch, largely mechanical event. In practice the two are very similar in process, and both consume well under an hour annually in the modeled environments.

Environment	FC SAN	VMware vSAN	vSAN Time Savings
Standard	< 1 hour annually	< 1 hour annually	Approximately the same
Expanded	< 1 hour annually	< 1 hour annually	Approximately the same

Table 13: Managing Device Failures, Annual Administrative Time (source: Signal65)

Licensing Cases

The vSAN platform is licensed under VMware Cloud Foundation in every scenario, since VCF is the licensing vehicle that includes vSAN and the one under which the tested environment was built. The FC SAN platform has more latitude, because an external array does not require VCF. The reference case used throughout this section licenses the FC platform under vSphere Standard in the Standard environment and under VCF in the Expanded environment², while vSAN carries VCF in both. This is the more demanding test for vSAN since in the Standard environment the FC platform pays \$50 per core for licensing while vSAN pays \$400. It is also consistent with the assumption made throughout the operational analysis that VCF Operations is in use at the Expanded scale and not at the Standard scale. Two alternative licensing cases, one with both platforms on VCF throughout and one with the FC platform on VMware vSphere Foundation in the Expanded environment, are presented in the Appendix for reference.

Rates applied are \$400 per core per year for VCF, \$190 for VMware vSphere Foundation, and \$50 for vSphere Standard, with 32 cores licensed per host. VCF entitles one tebibyte of vSAN capacity per licensed core and capacity above that entitlement is charged at \$17.50 per TiB per month.

Cost Model and Assumptions

Total administrative time was determined from two inputs: how long each operation takes, and how many times per year it is performed. Time was captured separately for the VM administrator and the storage administrator. Operational cost was then computed by multiplying time by the fully loaded cost per hour of the appropriate administrator.

Salary assumptions are based on current 2026 market data. The model uses \$110,000 per year for a VM administrator and \$135,000 per year for a storage administrator, against a 2,000-hour work year. These figures are drawn from current compensation surveys for VMware/virtualization administrators and storage administrators, including ZipRecruiter's Virtualization Administrator average (\$110,278 as of May 2026) and Glassdoor's Storage Systems Administrator average (\$138,799 as of May 2026). The premium for storage administrators over VM administrators is modest (roughly 1.2 times), and because storage administrator time is precisely what vSAN reduces, this narrow premium limits vSAN's modeled advantage and makes the comparison conservative.

² Broadcom stated to Signal65 that the majority of its large FC SAN customers license those environments under VMware Cloud Foundation. That is the basis for licensing the FC platform under VCF in the Expanded environment of the reference case.

Theoretical Operating Characteristics	Standard	Expanded
Sites	1	2
Total Hosts	12	64
Hosts / Cluster	4	8
Total Clusters	3	8
vSAN Datastores (≈ 75% of total clusters)	2	6
Total Raw Storage (TB)	150	2,148
FC Storage Systems	2	4
VMs / Host (average)	50	100
Total VMs	600	6,400
Assumed FC VMFS Datastore Size	32 TB	32 TB
FC Datastores	5	67
VCF Operations in use	No	Yes

Table 14: Environment Sizes Modeled (source: Signal65)

Note: VCF Operations is not used in the Standard environment and is fully deployed in the Expanded environment, as shown above. This binary assumption affects the time required to monitor storage capacity and performance: manual monitoring is practical at the Standard environment's scale without a dedicated tool, while the Expanded environment relies on VCF Operations because continuous manual monitoring at that scale would be impractical.

Capital Cost Model and Sources

The reference case presented in the body of this report is one of three licensing cases modeled. Table 15 defines all three. The vSAN platform is licensed under VCF in every case; the cases differ only in how the FC SAN platform is licensed.

	vSAN	FC SAN, Standard	FC SAN, Expanded
Case A	VCF	VCF	VCF
Case B (reference)	VCF	vSphere Standard	VCF
Case C	VCF	vSphere Standard	VVF

Table 15: Licensing Cases Modeled (source: Signal65)

Table 16 presents the five-year capital cost at list pricing for all three cases and both environments, with tier-one OEM sourcing. vSAN has the lower cost in every case. Case A, with both platforms on VCF, is the like-for-like comparison; Cases B and C are the more demanding tests for vSAN, since the FC platform drops to less expensive licensing while vSAN continues to carry VCF.

Case	Environment	FC SAN	vSAN	vSAN Advantage
Case A	Standard	\$3,330,054	\$2,298,860	31.0%
Case B	Standard	\$2,658,054	\$2,298,860	13.5%
Case C	Standard	\$2,658,054	\$2,298,860	13.5%
Case A	Expanded	\$30,720,914	\$18,588,562	39.5%
Case B	Expanded	\$30,720,914	\$18,588,562	39.5%
Case C	Expanded	\$28,570,514	\$18,588,562	34.9%

Table 16: Five Year Capital Cost by Licensing Case, List Pricing, OEM Sourcing (source: Signal65)

The capital cost model prices both platforms at vendor list or MSRP. Where a vendor publishes a cooperative purchasing schedule, the list column of that schedule is used; where it does not, list pricing is taken from dated public procurement records that show list and transacted prices side by side, or from published catalog data corroborated against such records. The principal inputs are summarized in Table 17. Full source references, including document links, are maintained in the accompanying cost model workbook.

Input	Value	Basis
FC array chassis, Standard	\$53,074	Average of NetApp ASA A20, Dell PowerStore 3200T, and HPE Alletra 6030, list
FC array chassis, Expanded	\$169,891	Average of NetApp ASA A50, Dell PowerStore 5200T, Pure FlashArray X50R4, and HPE Alletra 6050, list
FC capacity, per raw TB	\$5,449 / \$5,419	Average of Dell, NetApp, HPE, and Pure Storage capacity media at list, Standard / Expanded drive sizes
vSAN NVMe media, per raw TB	\$2,466	Average of Dell and Lenovo, list
vSAN NVMe media, build-to-order(ODM)	\$714	Supermicro based build-to-order (ODM) channel
Array support	4.44% per year	Published NetApp and Pure Storage rates, four hour onsite
Server support, tier-one OEM	4.39% per year	Dell and Lenovo, four hour onsite
Server support, build-to-order (ODM)	0.81% per year	Advanced parts replacement, no response-time commitment
Licensing	\$400 / \$190 / \$50 per core per year	VCF / VVF / vSphere Standard, 32 cores per host
vSAN capacity add on	\$17.50 per TiB per month	Applied above the VCF entitlement of 1 TiB per licensed core
Annual capacity growth	10%	Applied identically to both platforms over Years 2 through 5

Table 17: Capital Cost Model Inputs, List Basis (source: Signal65)

Two sourcing notes bear on how the figures should be read. NetApp and Pure Storage inputs are taken from their May 2026 cooperative purchasing schedules, and Dell PowerStore capacity media from an October 2024 public procurement record that states MSRP against transacted price for the same part number. Pure Storage capacity is entered as the average of two published schedules, from January 2025 and May 2026, because the identical part number rose by a factor of 2.79 between them; neither endpoint alone is representative, and the average sits within the period spanned by the other inputs.

A note on vendor coverage. The FC SAN side of the model blends four array vendors, while the server side blends two tier-one vendors, Dell and Lenovo. Because the server figures apply to both platforms and to the vSAN result in particular, the level was checked against a third vendor priced from an independent document. A June 2025 public procurement quote to the City of Green River, Wyoming states HPE list and transacted prices side by side for every line; building a comparable 32 core, 512GB host from its list column gives \$60,129 before support, which falls between the two vendors used here and within about 1% of the blended figure. That build is not used as an input, because the quote prices a SimpliVity chassis rather than a plain ProLiant, carries a 10GbE adapter where this model uses 25GbE, and prices neither the 64GB memory modules needed for the Expanded configuration nor five-year support. It serves only to corroborate that the two vendor blend sits at a representative level.

CapEx Assumptions and Limitations

Several simplifications in the model were made and each of them understates the cost of the FC SAN platform. The comparison as presented is therefore conservative with respect to the vSAN result.

- Array controller memory is excluded on all four array vendors modeled. One vendor source prices appliance memory as a separate mandatory line item while the others bundle it into the controller, so it could not be applied consistently and is therefore omitted throughout.
- The FC host bus adapter, switch, and port activation figures are not tied to published part numbers and are likely conservative. Secondary sources place a production configured switch with optics at roughly twice the figure used here, but no switch price could be verified against a published schedule or procurement record. Substituting an unverified figure would have raised FC SAN cost, and therefore the measured vSAN advantage, on sourcing rejected as insufficient elsewhere in the model. The lower figure is retained and disclosed instead.
- One OEM compute host figure reflects a 48 core build while the model licenses 32 cores per host, which overstates that vendor's share of the blended host cost on both platforms.
- Capacity is compared on a raw TB basis. The two architectures return different amounts of usable capacity from the same raw total, because vSAN applies failures to tolerate through mirroring or erasure coding while an array applies parity, and both then recover capacity through data reduction. Modern FC arrays provide inline deduplication and compression, and vSAN ESA introduced cluster-wide global deduplication alongside compression in VCF 9.0, generally available in VCF 9.1, so both platforms now apply data reduction across their full capacity. The achieved ratios depend on the workload and on the resilience policy chosen, and the model does not attempt to estimate them for either platform.

Important Information About this Report

CONTRIBUTORS

Jonathan Fellows

Performance Validation Engineer | Signal65

PUBLISHER

Ryan Shrout

President and GM | Signal65

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