

# Why vSAN with VMware Cloud Foundation

Software-Defined Storage  
for the Modern Data Center

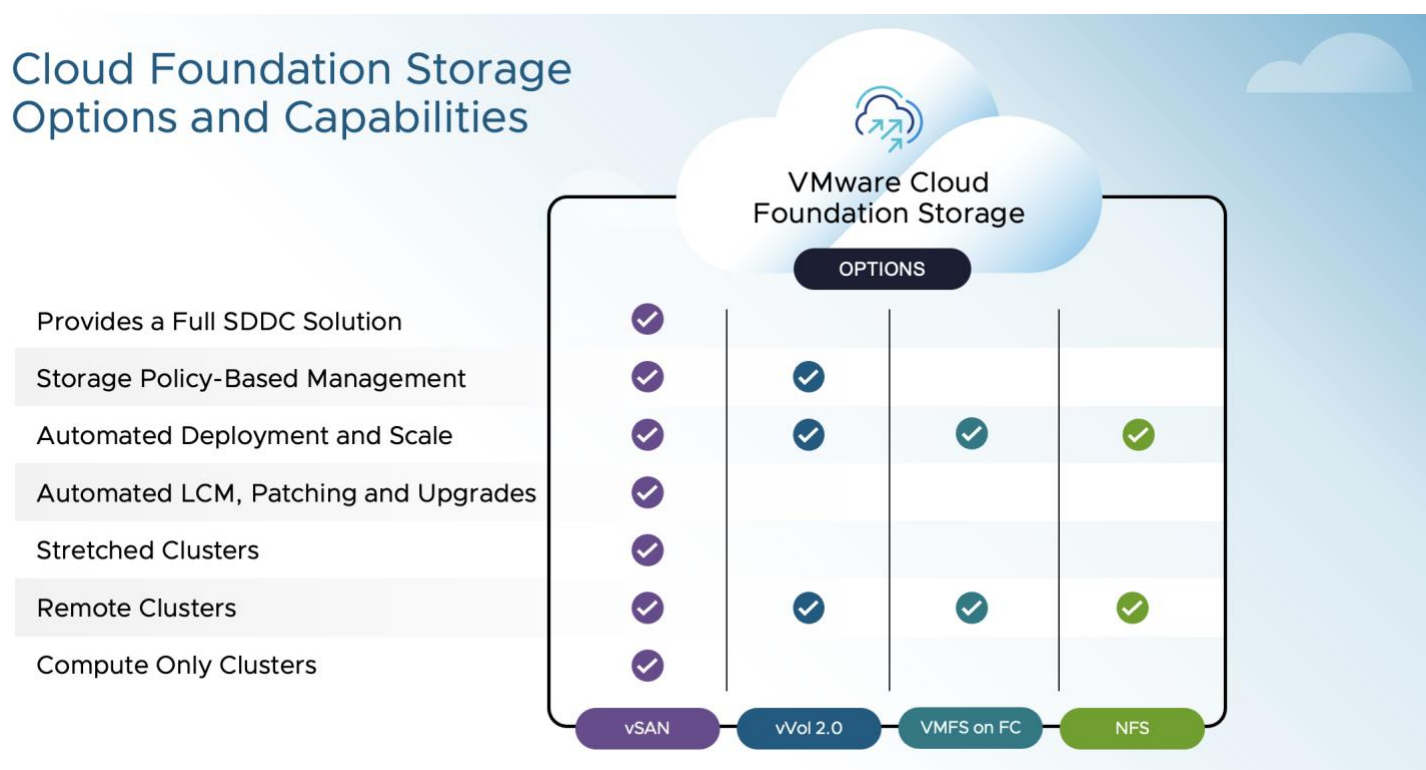
## Table of contents

Executive Summary .....	3
Brief Overview of vSAN .....	3
Why vSAN for VMware Cloud Foundation .....	4
Deep Integration .....	4
Enhanced Performance and Efficiency .....	5
Scalability and Flexibility .....	6
Resilience and Availability .....	6
Simplified Operations .....	7
Streamlined Lifecycle Management .....	8
HCI Economics .....	8
Hardware Freedom of Choice .....	9
Power and Cooling Advantages .....	9
Advanced Storage Capabilities .....	9
Enhanced Data Services .....	10
Ideal Use Cases .....	11
Database Workloads and other Business Critical Applications .....	11
Mainstream Virtualization .....	11
Edge and Remote and Branch Offices (ROBOs) .....	11
Cloud-Native Applications .....	11
Virtual Desktop Infrastructure (VDI) .....	12
vSAN for the Management Domain .....	12
vSAN for the Workload Domain .....	12
Understanding Principal and Supplemental Storage in vSAN .....	13
Conclusion .....	13
Glossary .....	13

## Executive Summary

VMware Cloud Foundation (VCF) is a powerful platform that transforms traditional data centers into agile, software-defined environments. At the core of VCF's success lies vSAN, a high-performance, software-defined storage solution that seamlessly integrates with the broader VCF software stack. This paper will shed light on the critical role that vSAN plays while enabling VCF to deliver a robust, scalable, and efficient infrastructure solution. We will explore how advanced vSAN features contribute to VCF's ability to support demanding workloads and ensure business continuity with simplified management and automation capabilities. We'll also look at a handful of ideal use cases where vSAN shines by reducing operational overhead and accelerating time to market for new applications and services.

## Cloud Foundation Storage Options and Capabilities



## Brief Overview of vSAN

vSAN, introduced in 2014, is a leading software-defined storage solution that leverages local storage resources from multiple ESXi hosts to create a shared, centrally managed storage pool. This eliminates the need for dedicated storage hardware, simplifying management, and reducing costs.

vSAN employs advanced data resilience techniques such as space-efficient erasure coding to ensure data resilience and high availability.

Additionally, it optimizes storage utilization through Storage Policy Based Management and capabilities like deduplication and compression. These features empower organizations to efficiently manage their storage infrastructure and meet the demanding requirements of modern applications.

As a software-based solution integrated directly into the hypervisor, vSAN is a natural fit for VMware Cloud Foundation. It provides a simple, unified platform to manage both compute and storage resources, streamlining operations and reducing complexity. By leveraging vSAN's advanced features and integration with VMware Cloud Foundation, organizations can accelerate their cloud transformation journey and achieve significant benefits, including improved performance, enhanced data protection, and optimized resource utilization.

## Why vSAN for VMware Cloud Foundation

Simply put, vSAN is the best choice for VCF storage due to its seamless integration with vSphere, high performance, and advanced features. vSAN's all-flash optimizations deliver exceptional performance for demanding workloads while data efficiency features enhance capacity utilization. The scale-out architecture allows for effortless expansion of storage resources by simply adding hosts, providing flexibility and cost-effectiveness. Finally, vSAN's distributed nature and integration with VCF's availability features ensure high resilience and business continuity.



Lower Storage  
Costs



Fully  
Integrated  
with VCF



Enterprise-  
Grade Storage  
Without  
Overhead



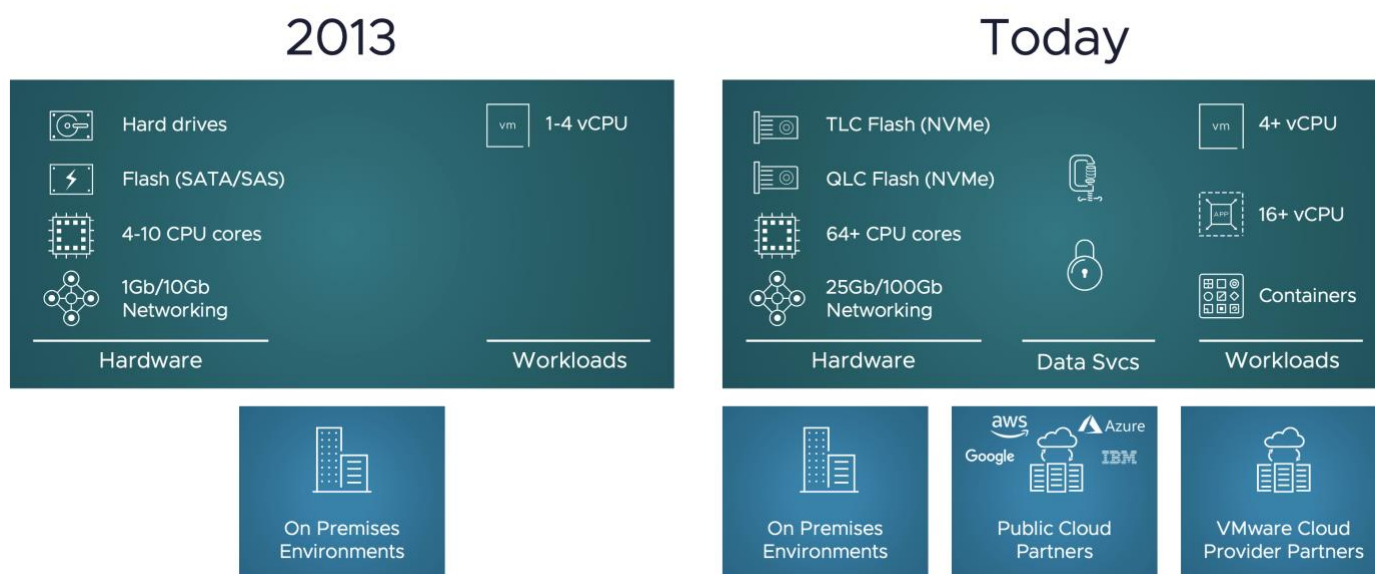
Enterprise  
Tested and  
Approved

### Deep Integration

vSAN's deep integration with vSphere provides a significant advantage, streamlining management and enhancing performance within a VCF environment. Because vSAN is embedded directly into the vSphere hypervisor, it eliminates the need for external storage and the complexities associated with managing separate storage operating systems. This tight coupling allows for unified management of compute and storage resources through the familiar vSphere Client, simplifying operations and reducing the learning curve for administrators. Furthermore, vSAN uses core vSphere features like vMotion, DRS, and HA to ensure seamless workload mobility, resource optimization, and high availability. This streamlined approach significantly reduces administrative overhead and allows for more efficient resource allocation within the VCF stack.

### Enhanced Performance and Efficiency

vSAN's integration with vSphere is architected for optimal performance. By residing within the hypervisor, vSAN minimizes I/O latency compared to traditional storage arrays that require traversing separate storage networks. This proximity to virtual machines allows for faster data access and improved application performance, a critical factor in demanding VCF deployments. vSAN's distributed architecture, pooling local disks from multiple ESXi hosts, further enhances performance by distributing I/O across multiple nodes. This distributed approach, combined with features like caching and intelligent data placement, makes vSAN the ideal storage foundation for the high-performance workloads typically found in a VCF environment.

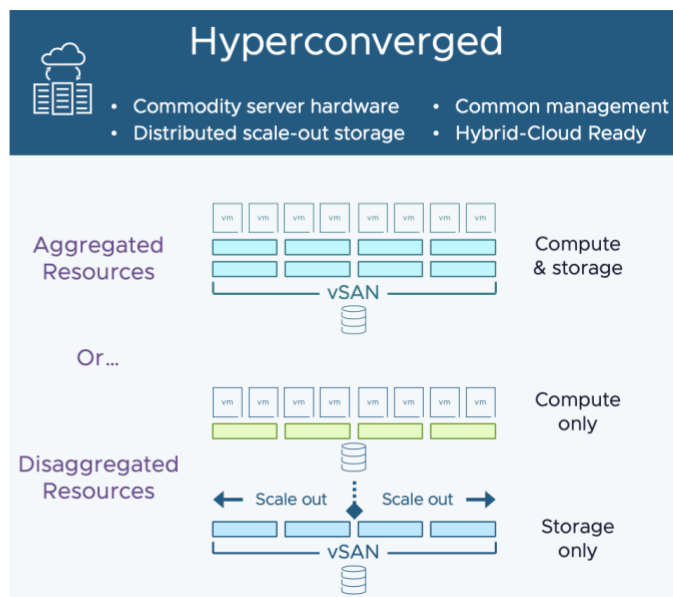
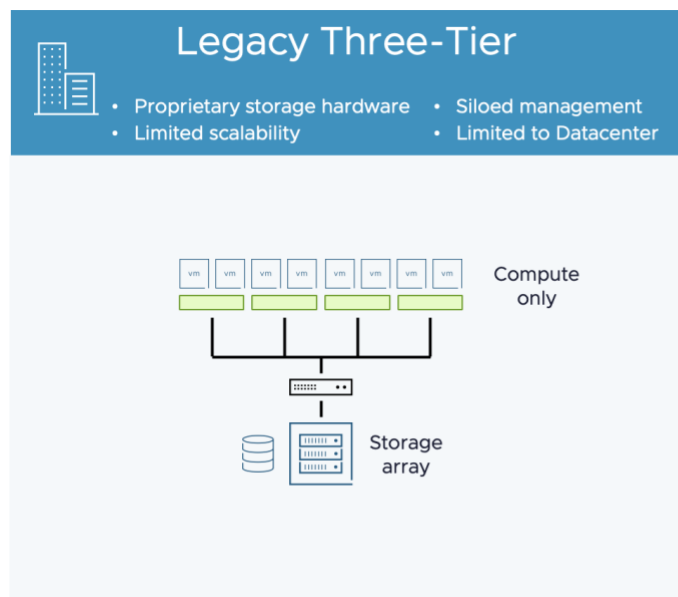


vSAN's ability to adopt the latest technology much faster due to the speed of server hardware development is a significant advantage. Unlike traditional storage arrays that have a longer development cycle, vSAN is software-defined and can use the latest server hardware as soon as it becomes available. This means that vSAN can quickly take advantage of new advancements in CPU, memory, and storage technologies, delivering improved performance and efficiency to your virtualized environment. With vSAN, you can stay at the forefront of technology without being locked into a specific hardware platform or waiting for lengthy hardware refresh cycles.

### Scalability and Flexibility

vSAN's scale-out architecture provides inherent flexibility for VCF deployments. By simply adding more hosts to the VCF environment, you can seamlessly expand both storage capacity and performance. This granular scalability allows you to easily adapt to evolving workload demands and future growth, making it a cost-effective solution for dynamic environments. Moreover, vSAN empowers administrators with granular control over storage resources through the implementation of storage policies. This capability enables precise tailoring of storage performance and availability to meet the unique requirements of individual applications within the VCF environment.

vSAN supports scale-up (adding disks to existing hosts) and scale-out (adding more hosts to the cluster) approaches. This flexibility enables granular scaling based on workload demands, optimizing resource allocation and cost efficiency. For example, a vSAN cluster can start with at least three hosts and scale to 64 hosts, each contributing storage capacity and performance to the cluster. vSAN enables dynamic resource allocation and workload mobility across VCF workload domains. This flexibility allows for efficient resource utilization and responsiveness to changing business needs. Using vMotion, VMs can be migrated between hosts and even across workload domains without downtime, allowing for workload balancing and optimization.



### Resilience and Availability

Resilience is at the core of vSAN's design. Its distributed architecture, where data is replicated across multiple hosts within the VCF environment, provides built-in redundancy and high availability. This ensures that applications remain online even if a host experiences a hardware failure. Furthermore, vSAN seamlessly integrates with VCF's availability features, such as vSphere HA and DRS. This integration further enhances resilience by enabling automated recovery actions and optimizing resource utilization across the cluster, ultimately ensuring business continuity in the face of unexpected disruptions.

vSAN Data Protection provides a comprehensive solution for protecting your virtual machines (VMs). It offers efficient snapshot management, allowing you to easily back up and recover VMs from accidental deletion or ransomware attacks. You can create protection groups to manage and

protect multiple VMs together, with customizable retention policies and immutability settings. Additionally, vSAN Data Protection provides the ability for deep snapshots, enabling you to create numerous snapshots per VM with minimal performance impact. Immutable snapshots, which cannot be modified or deleted, offer an extra layer of security against data tampering.

vSAN simplifies the deployment and management of disaster recovery sites. Its integration with VMware Live Site Recovery enables automated failover and recovery of critical workloads, ensuring business continuity. vSAN stretched clusters provide synchronous replication across geographically dispersed sites, ensuring data protection and high availability in the event of a disaster.

vSAN continuously strives to ensure data maintains its prescribed level of resilience even after host or storage device failures. vSAN will “self-heal” any data not in compliance with its prescribed storage policy, and it also has an advanced Adaptive Resynchronization mechanism to prioritize VM traffic over resynchronization traffic. Critically, this process is adaptive, meaning it dynamically adjusts resource allocation based on real-time workload demands. vSAN prioritizes virtual machine I/O over resynchronization traffic, ensuring minimal performance impact on running VMs. Conversely, when VM I/O demand is low, vSAN intelligently utilizes available bandwidth to accelerate the resynchronization process, minimizing the window of vulnerability and swiftly restoring full data protection. This dynamic balancing act between performance and protection ensures both application availability and rapid recovery, contributing to a highly resilient infrastructure.

### Simplified Operations

vSAN simplifies storage management within VCF through comprehensive automation and centralized control. Firstly, the storage deployment process is fully automated within VCF, significantly reducing the time and effort required to set up and configure storage. The automation of VCF workload domain creation, including storage, ensures consistent and validated vSAN deployments, adhering to VMware best practices and reducing the risk of configuration errors.

As well, ongoing management through this centralized approach streamlines administration and simplifies day-to-day operations. Administrators manage vSAN directly through the vSphere Client, the same interface used for virtual machine management. This eliminates the need for separate storage consoles and specialized training, reducing the learning curve and streamlining workflows. All storage-related tasks, from provisioning and monitoring to configuration and troubleshooting, are performed within the familiar vSphere environment. This unified approach simplifies administration, reduces the potential for errors, and improves overall operational efficiency.

vSAN leverages Storage Policy Based Management (SPBM) to simplify storage provisioning. Instead of manually configuring complex storage parameters, administrators define storage policies that specify requirements for performance, availability, and capacity. These policies are then attached to virtual machines, and vSAN automatically provisions the underlying storage to meet those requirements. SPBM abstracts away the complexities of traditional storage provisioning, allowing administrators to focus on application requirements rather than low-level storage configurations. This policy-driven approach also ensures consistency and compliance, as storage is always provisioned according to defined policies, reducing the risk of misconfigurations and improving overall governance. In fact, vSAN’s Auto-Policy Management capability will automatically configure a cluster-specific storage policy based on the characteristics of the cluster to ensure the highest level of resilience.

vSAN automates many routine storage tasks, further simplifying operations and reducing administrative overhead. Capacity management is automated through space-efficiency features like compression, deduplication, and space reclamation techniques to drive lower storage cost. Performance optimization is achieved through intelligent caching and data placement, ensuring that workloads receive the necessary resources. Data protection is simplified through integrated features like snapshots, clones, and erasure coding without requiring complex manual

configurations. These automated operations minimize manual intervention, reduce the potential for human error, and free up administrators to focus on more strategic initiatives.

Additionally, vSAN's lifecycle management is fully integrated with VCF, allowing for automated patching, upgrades, and maintenance. This integration ensures that vSAN remains up-to-date and secure with minimal manual intervention. We'll get into that in more detail in the next section.

### Streamlined Lifecycle Management

vSAN's lifecycle management is deeply integrated with vSphere, streamlining operations from initial deployment through ongoing maintenance. Automated deployment leverages vSphere's capabilities to simplify cluster creation and configuration. vSAN enablement is typically a few clicks within the vSphere Client, and guided wizards assist with initial setup, minimizing manual configuration and reducing the potential for human error. This automation extends beyond initial setup, with vSAN leveraging vSphere's cluster management services for ongoing configuration and monitoring. This tight integration reduces administrative overhead and accelerates time to production compared to traditional storage arrays requiring separate management planes.

Ongoing maintenance and updates are also significantly simplified via vSphere Lifecycle Manager (vLCM). vLCM integrates with vSAN to provide a unified update and patching mechanism for the entire software stack, including ESXi, vSAN, and even the underlying hardware firmware. This integration ensures compatibility between all components and reduces the risk of introducing instability during updates. vLCM's health checks and proactive alerts provide visibility into the vSAN cluster's health, enabling administrators to address potential issues before they escalate. This proactive approach to maintenance minimizes downtime and improves the overall resilience of the vSAN environment.

Firmware and BIOS management are incorporated into the vSAN lifecycle through vLCM. This allows administrators to manage hardware firmware and BIOS updates directly through the vSphere Client, centralizing hardware maintenance and ensuring consistency across the cluster. By managing firmware and BIOS updates in conjunction with vSAN and ESXi updates, administrators maintain a validated configuration, minimizing compatibility issues and enhancing overall system stability. vLCM allows administrators to define a desired state for the cluster and then automatically remediates any deviations from that state. This includes patching, updates, and configuration changes, all managed through a centralized interface. By maintaining a consistent configuration, vLCM minimizes the risk of configuration drift, which can lead to performance issues, instability, and security vulnerabilities. This proactive approach simplifies compliance and reduces the administrative overhead associated with manually tracking and remediating configuration inconsistencies.

### HCI Economics

Hyperconverged infrastructure (HCI) offers several advantages over traditional external storage arrays, primarily through its integrated and software-defined approach. By converging compute, storage, networking, and virtualization resources into a single system, HCI simplifies management and reduces complexity. This convergence eliminates the need for separate storage arrays, SANs, and associated cabling, lowering capital expenditures and simplifying infrastructure management. Furthermore, HCI's scale-out architecture allows for granular expansion of resources, enabling organizations to easily adapt to changing workload demands. The software-defined nature of HCI enables automated provisioning, simplified management, and centralized control, reducing operational expenses and improving agility compared to traditional storage solutions that often require specialized expertise and complex configurations. Finally, HCI often leverages commodity hardware, further reducing costs and avoiding vendor lock-in associated with proprietary storage arrays.



### Hardware Freedom of Choice

Unlike traditional storage arrays that often require proprietary hardware, vSAN supports a wide range of industry-standard servers and components from various vendors. This gives you the flexibility to choose the hardware that best suits your needs and budget. You can select servers with the specific CPU, memory, and network configurations required for your workloads, and choose from a variety of certified disk drives and storage controllers. This open ecosystem fosters competition and innovation, driving down costs and providing greater choice for customers.

Additionally, vSAN's flexible architecture allows for incremental hardware upgrades without requiring forklift replacements. This approach minimizes disruption and reduces the cost and complexity of hardware refresh cycles. Individual hosts can be upgraded or replaced without affecting the availability of the vSAN datastore.

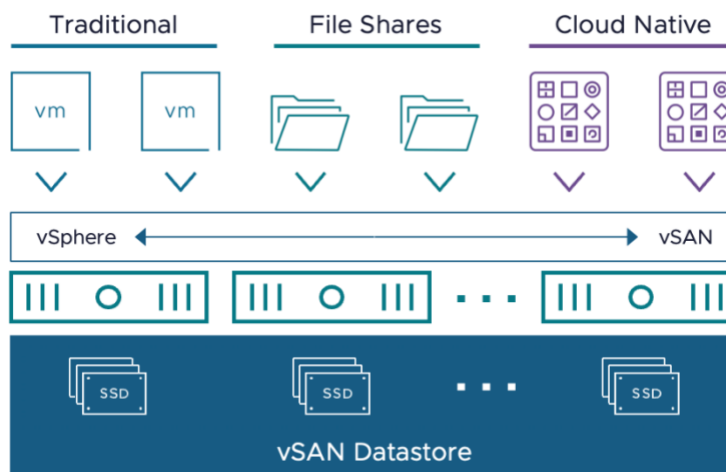
### Power and Cooling Advantages

vSAN contributes to a more sustainable and cost-effective data center by significantly reducing power and cooling demands. Its hyperconverged architecture consolidates compute and storage onto the same servers, eliminating the need for power-hungry dedicated storage arrays and reducing the overall hardware footprint. This consolidation, coupled with efficient data storage techniques like deduplication and compression, minimizes the number of physical disks required, further lowering power consumption.

All-flash hosts with commodity ethernet switching can significantly reduce power and cooling demands. Moreover, vSAN's all-flash specific optimizations and efficient data access patterns decrease the energy required for storage operations. By supporting the latest energy-efficient server hardware, vSAN allows organizations to leverage advancements in low-power processors and high-efficiency power supplies. This translates to lower energy bills and a reduced carbon footprint, making vSAN a compelling choice for organizations committed to environmental responsibility.

### Advanced Storage Capabilities

VMware vSAN abstracts the complexities of traditional storage management through its software-defined architecture, offering a rich set of advanced storage capabilities tightly integrated with vSphere. vSAN automatically discovers and claims local disks attached to ESXi hosts to create a single datastore. Users can then immediately use this datastore to power VM workloads, letting vSAN choose the storage policy for them, or choosing it for themselves. These policies are directly assigned to virtual machines, ensuring each VM receives the appropriate level of storage service without requiring manual configuration of LUNs or volumes. This policy-driven approach simplifies storage provisioning and ensures consistency across the environment.



vSAN's distributed architecture pools the local disks of multiple ESXi hosts to create a shared datastore accessible by all hosts in the cluster. This eliminates the need for dedicated storage arrays and simplifies capacity planning. vSAN automatically distributes data and metadata across the cluster to ensure redundancy and high availability. The distributed nature of the storage pool also contributes to improved performance by distributing I/O across multiple hosts and disks. This architecture eliminates single points of failure and ensures that data remains accessible even in the event of host or disk failures.

Integrated health checks continuously monitor the vSAN cluster's configuration and operational status. vSAN proactively identifies potential issues, such as hardware failures, performance bottlenecks, or configuration inconsistencies, and alerts administrators. With Cluster Health Scoring, diagnostics and remediation capabilities will help identify the type and severity of issues, prioritizing them in the order they should be resolved. This proactive approach allows for early intervention and prevents minor issues from escalating into major problems. vSAN also integrates with VCF Operations, providing detailed telemetry and analytics data for comprehensive monitoring and performance analysis. This integration allows administrators to gain deep insights into storage performance, capacity utilization, and overall health, enabling them to optimize the environment and ensure optimal performance.

Beyond core storage functionality, vSAN offers advanced features that extend its capabilities. Datastore sharing allows multiple vSAN clusters to share capacity, improving resource utilization and simplifying management across multiple environments. vSAN also provides integrated file services, enabling the creation of file shares directly on the vSAN datastore, simplifying file storage management for virtualized workloads.

### Enhanced Data Services

vSAN goes beyond simply providing storage; it offers a rich set of data services designed to enhance data protection, availability, and efficiency. These services are tightly integrated with vSphere, simplifying management and streamlining operations. For data protection, vSAN offers features like snapshots and clones, enabling quick recovery points and simplified development workflows. Now with vSAN ESA, it introduces a new snapshot architecture based on a B-tree lookup table and a log-structured file system. This approach significantly improves snapshot performance, scalability, and space efficiency compared to traditional redo-log-based snapshots. vSAN ESA snapshots are nearly instantaneous and have minimal impact on VM performance, enabling frequent snapshots for data protection and testing.

Advanced data resilience techniques ensure the highest levels of data availability in the event of host or storage device failures. Furthermore, vSAN integrates with VMware Site Recovery Manager (SRM) to provide disaster recovery capabilities, enabling rapid failover and failback in the event of a site outage. These comprehensive data protection features ensure business continuity and minimize downtime.

vSAN provides advanced data services for specific use cases. It offers integration with VCF Operations for comprehensive monitoring and analytics, providing insights into storage performance and capacity utilization. For security-conscious environments, vSAN supports end-to-end encryption which protects data both in transit and at rest, mitigating the risk of unauthorized access even if storage devices are compromised. Immutable snapshots provide a robust defense against ransomware attacks by creating read-only copies of data that cannot be deleted or modified by malicious actors, ensuring recoverability. Furthermore, the integration of secure boot with TPM 2.0 establishes a hardware root of trust, verifying the integrity of the boot process and preventing the loading of unauthorized software, thereby strengthening the overall security posture of the vSAN environment. These advanced features, combined with the core data services, make vSAN a comprehensive and versatile storage solution for a wide range of workloads.

### Ideal Use Cases

vSAN is a highly adaptable storage solution with a wide range of applications. As a key component in VCF, it truly excels in certain areas. Let's explore some of these key use cases.

#### Database Workloads and other Business Critical Applications

vSAN's high performance and low latency make it suitable for database workloads, such as Oracle and SQL Server. vSAN delivers exceptional performance and scalability for demanding database applications like Oracle, SQL Server, and SAP HANA. vSAN Express Storage Architecture ensures consistent high performance and resiliency, even when using efficient RAID 5/6 erasure coding. Additionally, vSAN's independent scaling of storage and compute resources allows IT to accommodate the rapid storage growth often associated with OTLP workloads. By disaggregating storage and compute, organizations can also optimize their licensing costs.

#### Mainstream Virtualization

vSAN provides a reliable and scalable storage platform for virtualized workloads, including virtual machines and containers. Specialized storage arrays needed to support different types of applications and workloads is a thing of the past. vSAN can easily run a mixture of applications within the same cluster, or tailor a cluster that represents the organizational structure of a business, aligning more easily to charge-back or show-back metrics.

For well-established, mission-critical applications that require reliable, cost-effective storage, vSAN is an ideal solution. Its policy-based management simplifies storage operations, while its use of standard servers reduces costs. vSAN also streamlines disaster recovery by enabling data replication across sites without specialized hardware. By virtualizing storage, organizations can deploy only the necessary storage capacity at DR sites, reducing upfront investments. vSAN offers flexible DR options, including stretch clustering for high-sensitivity applications and asynchronous replication for less critical workloads. This approach empowers IT teams to implement cost-effective and efficient disaster recovery strategies, even in resource-constrained environments.

#### Edge and Remote and Branch Offices (ROBOs)

vSAN can simplify IT management in remote offices by providing a centralized storage solution in a simplified form factor. Providing scalability, flexibility, and enhanced performance at the edge at a lower cost and in a smaller footprint is a big win.

vSAN supports 3-node clusters with RAID 5 (2+1) erasure coding, providing a cost-effective solution for small deployments, edge locations, and remote offices. This allows organizations to deploy vSAN in smaller environments without sacrificing data protection.

#### Cloud-Native Applications

vSAN can support the demanding storage requirements of cloud-native applications. It can automate storage provisioning for containerized workloads that allows developers to quickly obtain the storage they need while IT administrators can efficiently manage both container and virtual machine storage on a unified platform. Like Cloud-Native workloads, vSAN's architecture is designed to future-proof your data center by seamlessly accommodating next-generation IT trends. Its ability to handle the intense demands of AI/ML workloads, coupled with support for high-performance NVMe storage, ensures that your infrastructure can keep pace with evolving data processing requirements. This forward-looking design allows vSAN to adapt to emerging technologies and workload demands, maximizing your infrastructure investment and minimizing the need for disruptive upgrades as IT landscapes evolve.

### Virtual Desktop Infrastructure (VDI)

vSAN can handle the demanding I/O requirements of VDI environments, delivering a smooth user experience. As remote work and VDI become increasingly prevalent, high-performance, scalable, and cost-effective storage solutions are essential. vSAN addresses these needs by offering a scale-out architecture, support for high-performance NVMe-based flash storage, and advanced data reduction technologies. This combination ensures optimal performance, efficient storage utilization, and a seamless user experience for VDI deployments.

### vSAN for the Management Domain

vSAN is the default storage supported for running workloads in a Cloud Foundation Management Domain. vSAN provides reliable, fast storage to run nearly any workload including management and monitoring applications. Deployment and lifecycle tasks such as patches and upgrades are automated for the entire stack—compute, network, and storage—when vSAN is used with Cloud Foundation. The vSAN license for the Management Domain is included with Cloud Foundation licenses. This combination of availability, performance, and simplicity helps ensure an excellent user experience for administrators, operators, and application owners from Day-0 bring-up through Day-2 operations.

While workload domains in VCF offer more flexibility with support for vVols, NFS, and VMFS, the management domain requires the consistency and reliability that vSAN provides.

VCF's reliance on automation for streamlined deployment and management necessitates a storage solution that offers predictable performance and behavior. vSAN, with its tight integration into the vSphere hypervisor and SDDC Manager, fulfills this requirement perfectly. By eliminating the need to manage external storage arrays, vSAN simplifies operations and reduces dependencies within the VCF environment. This self-contained approach ensures a consistent and reliable foundation for the management domain, which houses critical VCF components.

Furthermore, vSAN's native integration eliminates the complexities and potential points of failure associated with external storage dependencies. This results in a more robust and easier-to-manage VCF deployment, allowing administrators to focus on delivering business value rather than troubleshooting storage-related issues.

### vSAN for the Workload Domain

Storage used for running virtual machines and containers in a Cloud Foundation Workload Domain must be on the VMware Compatibility Guide for Storage/SAN and it must be one of these storage types:

- vSAN (Express Storage Architecture Recommended)
- NFS v3
- VMFS on fiber channel
- vVols

For all the reasons we've walked through above, vSAN is the recommended choice.

### Understanding Principal and Supplemental Storage in vSAN

In the context of VMware Cloud Foundation (VCF), principal and supplemental storage refer to the types of storage used within a workload domain.

- **Principal Storage:** This is the initial storage type used to deploy a workload domain. It's the foundation upon which the domain is built. vSAN is the preferred choice for principal storage due to its seamless integration with VCF and its ability to provide high performance and reliability.
- **Supplemental Storage:** This is additional storage that can be added to an existing workload domain after its initial deployment. It can be used for various purposes, such as expanding storage capacity, offloading specific workloads, or creating datastores for different purposes. Supplemental storage can be vSAN, or it can be external storage via NFS, iSCSI, or FC storage arrays.

The key difference between the two lies in their timing and role. Principal storage is foundational, while supplemental storage is additional and can be added or removed as needed. Both types of storage can be used to meet the diverse storage needs of modern workloads within a VCF environment.

### Conclusion

Cloud Foundation supports myriad storage types, but vSAN is key for storage modernization and the most optimal experience with VCF. Storage arrays provide a good experience even with the need to perform some tasks manually. vVols-enabled arrays provide a better experience by enabling the use of per-VM storage policies to manage service levels. However, vSAN is the best option and is deployed by default for Management domains. Deployment of vSAN for Workload domains keeps a consistent operational model and enables full lifecycle management for compute, networking, and storage. vSAN is the ideal building block for consistent infrastructure and operations.

### Glossary

SDDC Manager	Cloud Foundation software component that provisions, manages, and monitors the logical and physical resources of a Cloud Foundation system.
Management Domain	vSphere cluster that runs infrastructure management components such as vCenter Server, NSX, SDDC Manager, and Log insight.
Workload Domain	vSphere cluster combined with storage and networking into a single consumable entity. A workload domain can be created, expanded, and deleted as part of the SDDC lifecycle operations.
Principal Storage	Storage supported by vSphere that is used to store and run virtual machines and container volumes in Workload Domains.

### Supplemental Storage

Storage supported by vSphere mainly for data at rest such as virtual machine templates, backup data, ISO images, etc. It is not used for running workloads.

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