White Paper

VMware vSAN for Microsoft SQL Server

Meeting Today's Database Challenges with Hyperconverged Infrastructure

By Mike Leone, ESG Senior Analyst; and Leah Matuson, Research Analyst

March 2019

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Introduction

To meet the constantly changing needs of the business, organizations continue to travel down the digital transformation path—moving from legacy architectures, on-premises systems, and a collection of disparate solutions to embrace the speed, flexibility, and agility of a cloud-operating model that aligns with their unique business requirements.

ESG research shows that while 17% of organizations view themselves as having already implemented and optimized several digital transformation initiatives, nearly two-thirds (60%) of organizations are still on the path, with 19% still in the planning stages.[1]

Whether modernizing infrastructure, adopting cloud technologies, or becoming more data-driven, organizations are looking for a viable means to consolidate IT, to become more operationally efficient and responsive to be able to swiftly respond to the dynamic, real-time needs of the business.

Transformation Starts with the Infrastructure

Digital transformation starts with modernizing infrastructure. Leveraging hyperconverged infrastructure (HCI) technology is one such way an organization can accelerate digital transformation—combining compute, storage, networking, and virtualization into a software-defined, node-based infrastructure.

Organizations are using hyperconverged technology to create private cloud environments that can yield similar benefits to those of the public cloud. In fact, ESG research shows that organizations that have invested in an HCI platform have the highest likelihood to become more cloud-like, with the ability to deliver IT-as-a service (ITaaS).[2] Leveraging an HCI platform also enables organizations to transition to a cloud-operating model on-premises—prior to embracing the public cloud— and serves as a stepping stone to a true hybrid cloud infrastructure.

Mission-critical Databases on HCI

While many vendors market the ability to satisfy mixed workload requirements and handle the demands of mission-critical database requirements, many adopters are still leveraging HCI technology for Tier-2 workloads. With HCI becoming mainstream, the expectation is that an increasing number of organizations will utilize HCI to execute their mission-critical database workloads, such as SQL Server, to reap the benefits of a cloud-like infrastructure, while also fulfilling performance, scalability, reliability, security, and cost requirements.

Database Challenges

Organizations are constantly looking for ways to better align their infrastructures with their database initiatives and requirements. Between disparate components and systems from various vendors on different upgrade cycles, it is close to impossible to fulfill the real-time needs of the business with a database deployment on a traditional three-tier infrastructure. Frustration runs rampant as IT departments suffer through roadblock upon roadblock as they try to scale to meet their organization's performance demands, improve deployment times, simplify system management, and manage remote storage.

What organizations need is a solution that can easily scale to meet the continual growth of data, enable performance that aligns to customer expectations, provide always-on availability, integrate seamlessly with a public cloud environment, reduce costs, and allow for faster, more flexible deployments to meet DevOps requirements—a tall order to be certain. In fact, when it comes to infrastructure used to support databases, ESG research shows that the most important attributes
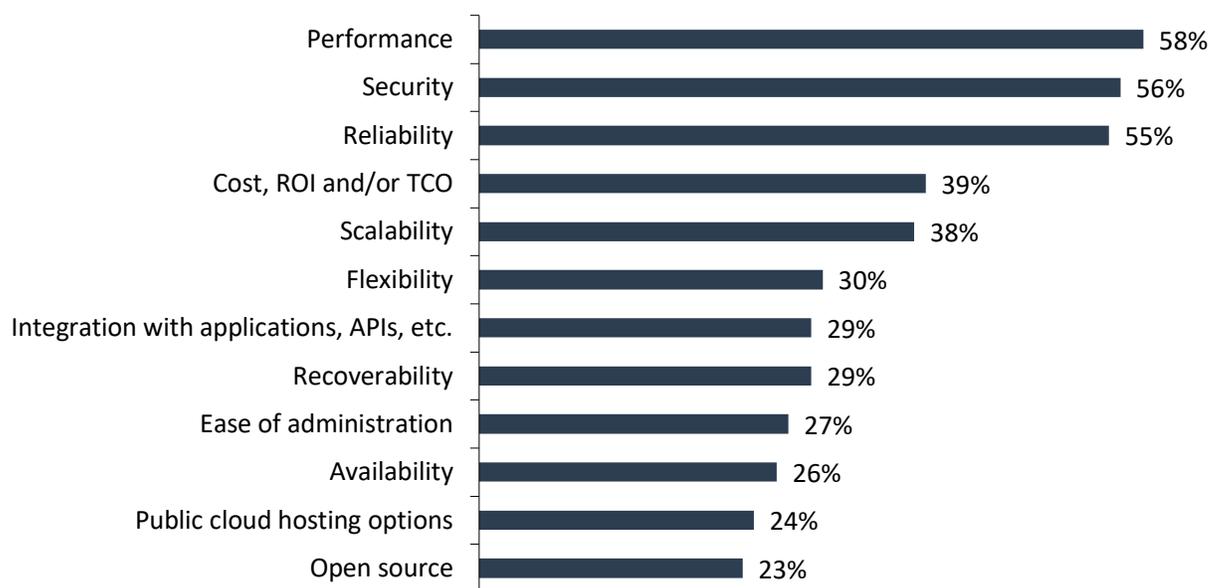
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[1] Source: ESG Research Report, *2019 Technology Spending Intentions Survey,* February 2019.
[2] Source: ESG Master Survey Results, *Converged and Hyperconverged Infrastructure Trends*, October 2017.

are performance, security, reliability, cost (ROI/TCO), scalability, and flexibility (see Figure 1).[3] These attributes align quite well with the benefits organizations are realizing since leveraging HCI technology. By combining and tightly integrating the core components of a database infrastructure (compute, memory, and storage) into a scale-out, x86-based architecture, businesses can easily deploy virtualized database instances faster, from a single vendor, with centralized management, integrated data protection, and next-generation local storage.

Figure 1. Most Important Attributes in an Underlying System and Infrastructure to Support Databases

Which of the following attributes are most important to your organization when considering underlying systems and infrastructure for databases? (Percent of respondents, N=354, multiple responses accepted)

Attribute	Percent
Performance	58%
Security	56%
Reliability	55%
Cost, ROI and/or TCO	39%
Scalability	38%
Flexibility	30%
Integration with applications, APIs, etc.	29%
Recoverability	29%
Ease of administration	27%
Availability	26%
Public cloud hosting options	24%
Open source	23%

Source: Enterprise Strategy Group

SQL Server on HCI

Organizations can greatly benefit by migrating or deploying a net-new SQL Server database instance on HCI. From a storage standpoint, HCI leverages internal storage pools that aid in eliminating storage implementation and management complexities such as deploying separate LUN or RAID groups for each data or log file. Additionally, HCI can accelerate access to those data and log files, as well as improve the performance of tempdb. This is key as tempdb is a shared system database across all databases and connections in SQL Server, handling information associated with user-created temporary objects, internal objects and version stores, as well as features including online re-indexing, or multiple active result sets (MARS).

Traditional storage networking constructs such as fabric switches, zoning, LUN masking, and multi-pathing are likely unnecessary with HCI, as HCI drastically simplifies the networking infrastructure and improves database access speeds—thus improving performance, leveraging high speed interconnects between nodes.

Organizations can reduce their hardware footprints by leveraging the HCI infrastructure to consolidate virtualized instances of SQL Server. This not only helps in lowering database management costs, but also decreases SQL Server licensing costs.

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[3] Source: ESG Brief, *Database Purchase Criteria*, June 2017.

Because the database serves as the lifeline of the business, ensuring data protection and availability is a must. SQL Server offers automatic data protection, AlwaysOn support for failover clustering with availability groups, and log shipping, as well as support for third-party backup tools.

Microsoft SQL Server

SQL Server 2017

Available today, SQL Server 2017 focuses heavily on developer enablement with Microsoft support for SQL Server on Linux—it can be deployed in container platforms such as Docker, Open Shift, and Kubernetes. Microsoft has added adaptive query processing, which introduces new techniques for adapting SQL Server to specific application workload characteristics. Additionally, organizations gain flexibility when deploying the database, and supporting mixed workload environments.

SQL Server 2019

With SQL Server 2019, Microsoft has continued to emphasize flexibility when deploying the database and supporting workloads, further highlighting the advantages organizations can receive by leveraging HCI as the underlying infrastructure to support their mission-critical databases. Organizations obtain a unified view of enterprise data, whether relational data stored in databases or big data stored in HDFS clusters. Apache Spark query capabilities have been added on top of existing SQL, now giving organizations the opportunity to query that data.

When it comes to platform and language, organizations can enjoy freedom of choice. SQL Server 2019 offers support for Windows, Linux, and Containers—aligning to the deployment flexibility that many organizations have already realized from HCI deployments.

SQL Server 2019 offers scalable compute and storage for faster data processing. This aligns quite well with HCI's flexible, scale-out architectures and, depending on the vendor, enables organizations to choose from the most current storage (NVMe) and processing (GPU) technologies to provide predictable, scalable performance.

Organizations are now able to garner benefits from SQL Server 2019's additional security features, such as protection of data at rest and in use—extending SQL Server's already impressive standing as the least vulnerable database in the NIST vulnerabilities database for the past eight years.[4]

VMware vSAN for SQL Server

With more than 500,000 customers worldwide and an extensive partner ecosystem, VMware is a market leader in both the virtualization and HCI spaces. VMware vSAN is an HCI, seamlessly integrated with VMware vSphere (the virtualization layer) to create a distributed shared data store. This tightly coupled combination allows organizations to easily deploy and/or migrate their virtualized SQL Server databases to a cost-effective infrastructure.

Through the use of Storage Policy-Based Management (SPBM), organizations can realize a unified control plane across all storage services, enabling IT administrators to improve productivity while managing SQL Server deployments. By layering VMware NSX on top of their physical networks, organizations can gain logical switching, routing, load balancing, firewall capabilities, and additional security functions through a virtualized network. This provides increased network configuration flexibility—and organizations are now able to leverage automation for faster deployment times; micro-segmentation for an improved security posture; and simplified network management and orchestration.

With VMware vMotion, organizations can non-disruptively consolidate SQL Server databases to ease migrations and reduce licensing costs between clusters, data centers, or clouds. And with NSX Hybrid Connect, layer 2 is encapsulated too.

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[4] See: https://nvd.nist.gov/

Shared-nothing vMotion allows migrations from non-vSAN enabled clusters to vSAN clusters, Cross vCenter vMotion within a single sign-on (SSO) domain allows migrations between non-linked environments, and Long Distance vMotion allows migration across clouds. [5]

Essentially, VMware vSAN enables organizations to meet the ongoing performance, scalability, and reliability requirements of a mission-critical database, while offering deployment flexibility and cost savings.

Performance

In vSAN, storage cluster resources are managed independently of one another, enabling organizations to ensure they are meeting performance requirements for their service level agreements (SLAs). Likewise, organizations leveraging vSAN HCI clusters to consolidate multiple workloads on a single cluster must ensure their mission-critical database always has the resources needed for optimal performance, to avoid resource starvation mode.

The latest version of vSAN answers the performance needs of organizations with its Adaptive Resync feature, ensuring resource utilization fairness across the entire cluster. When there is a change in load on the cluster, and an existing application that must not be impacted, Adaptive Resync guarantees a level of bandwidth for that existing application workload, eliminating resource starvation for a mission-critical application such as the database. It's important to note that while VM I/Os and resync I/Os may not be vying for resources, the intelligence behind Adaptive Resync ensures maximum bandwidth is allocated for optimal resource utilization. This feature supplements existing SPBM policies for IOP limits and cache reservations, which can be used to establish baseline quality of service among regular VM workloads.

VMware Internal Adaptive Resync Benchmark Results

Through VMware internal testing, the vendor has published numerous benchmark results highlighting vSAN's Adaptive Resync capability. One test leverages a four-node VMware vSAN cluster, which compares the number of operations per minute (OPMs) with and without active Adaptive Resync. The goal was to highlight the fact that Adaptive Resync has little to no impact on a mission-critical database workload.

Results also showed that without Adaptive Resync, the SQL Server workload was able to consume 100% bandwidth, and VMware witnessed an operation-per-minute (OPM) value of 181,244. But with Adaptive Resync running and consuming 20% of the bandwidth, VMware witnessed an OPM value of 176,454. This 2.6% degradation is well outside of end-user impact, and highlights the ability of vSAN to manage different types of traffic across I/O queues, ensuring storage SLAs are met cross-cluster for multiple applications. [6]

Scalability and Flexibility

Supporting the latest NVMe storage and processing technologies (i.e., GPUs) helps organizations ensure their infrastructure can adapt to the changing needs of the business and meet the challenging performance requirements of next-generation SQL Server workloads.

With vSAN offering organizations a viable means to scale up or out incrementally (depending on current business demands), organizations can gain peace of mind knowing their supporting database infrastructure can easily adapt to their unique performance and capacity requirements. Further, organizations can select a vSAN deployment model that best aligns to both their organizations' vendor preferences as well as their database requirements. VMware has 20 unique OEM partnerships in the vSAN ReadyNode program, including every major server vendor, and nodes can easily be added to an existing cluster with more compute, higher capacity storage, or faster storage.

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[5] For more information, see: vSAN Migration guide.
[6] For more information, see: SQL Server 2016 Database Performance and Improvements on vSAN 6.7

VMware Internal OLTP SQL Server Database Benchmark Results

VMware has completed numerous internal tests to highlight the ability of vSAN to support scale-up performance of multiple on-line transaction processing (OLTP) SQL Server databases. One such test ran an OLTP workload simultaneously on four virtual SQL Server instances, while increasing the number of vCPUs from 12 to 48. Additionally, hyperthreading was enabled. (Note: When hyperthreading with SQL Server occurs, the public consensus is that performance will degrade). In this case, VMware saw a near-linear increase in performance from 12 vCPUs (85,984 OPMs on average) to 24 vCPUs (157,162 OPMs on average), with a CPU bottleneck at the 48 vCPU test.

Furthermore, when the impact of hyperthreading was measured at the 24 vCPU count, VMware found that as long as CPU cycles were available, hyperthreading was able to increase performance—rising from 133,873 OPMs on average (without hyperthreading) to 157,162 OPMs on average (with hyperthreading).

Reliability

While Day 1 operations—getting a mission-critical SQL Server database up and running—is the first priority of most organizations, ensuring that end-users can rely on that database to be available 24/7 and protected through intelligent operational management, monitoring, and alerting is just as important. Features such as snapshots, cloning, and backup and recovery fall into the Day 2 operations category—and VMware vSAN offers organizations a number of benefits to ensure database availability, accessibility, and business continuity. Through VMware vSphere, snapshot and clone technologies can be applied to standalone databases, as well as those configured with AlwaysOn Availability Groups.[7]

To ensure business continuity, organizations gain backup and recovery capabilities through key VMware partners, such as Veeam. Veeam offers organizations database and application consistency capabilities. Organizations are able to perform a backup of all changes in transaction logs after a point-in-time backup of a VM, ensuring an accurate recovery to a specific point in time. And with vRealize Operations Manager with Management Pack, organizations are able to centrally manage and monitor globally distributed SQL Server clusters, while leveraging Site Recovery Manager to coordinate replication, failover, and DR tasks.

Cost

Relational database sprawl is an issue that many organizations struggle with, and while organizations continue to turn to virtualization to help, the fact of the matter is that there is still a 1:1 relationship between a database instance and supporting infrastructure. VMware vSAN enables organizations to reliably consolidate those SQL Server instances onto a single, shared infrastructure that enables significant CapEx and OpEx savings, without sacrificing performance, scalability, and reliability SLAs.

Through a consolidated infrastructure footprint, organizations reduce upfront hardware costs that in turn reduce power and cooling costs. From a software standpoint, that smaller hardware footprint means a reduction in SQL Server licensing. Multiple databases can run on the same infrastructure and utilize that same underlying hardware. And by utilizing a single infrastructure with centralized management, both IT operations and DBAs can simplify day-to-day tasks and improve productivity. Altogether, organizations gain improved TCO and faster ROI.

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[7] For more information, see: Microsoft SQL Server on VMware vSAN—Day 2 Operations and Management

The Bigger Truth

Many organizations have seen benefits from deploying HCI in their own environments, and the pervasiveness of the technology is giving organizations confidence to reliably support mission-critical applications and workloads, especially databases like Microsoft SQL Server. These applications often serve as the lifeline of the business, with performance, scalability, and reliability being essential to meet strict SLAs that map to the real-time needs of the business.

Organizations are placing their trust in VMware vSAN to support their next-generation applications that utilize SQL Server as the underpinning technology. With vSAN's proven ability to meet and often exceed customer expectations when satisfying even the strictest of SQL Server SLAs, organizations gain peace of mind knowing their platform can support current and, more importantly, future needs. VMware vSAN helps reduce TCO and improve ROI, while ensuring SQL Server remains reliably up and running, optimally performing, and flexibly scaling.

Key Takeaways

- Organizations stake their business on Microsoft SQL Server Database to develop transactions and business analytics applications. These next-generation applications are dictating a new infrastructure to better support the growing needs of the business—enter HCI.

- High performance, scalability, flexibility, reliability, and cost effectiveness serve as key characteristics to consider when evaluating infrastructure solutions to satisfy current and future SQL Server workloads requirements.

- Organizations are relying on VMware vSAN to consolidate workloads, and with Adaptive Resync, optimal performance and resource fairness can be provided to mission-critical applications, such as SQL Server.

- In order to reduce costs and avoid SQL Server sprawl, VMware vSAN provides a means to consolidate SQL Server onto a single, shared infrastructure, shrinking the hardware footprint, minimizing power and cooling requirements, simplifying management, and minimizing SQL Server licensing costs.

- VMware vSAN offers freedom of choice through various consumption models and OEM partnerships, while enabling independent resource scaling and adaptability depending on current workload demands.

- With an emphasis on both Day 1 and Day 2 operations, VMware focuses on deployment and provisioning for Day 1, and high availability and business continuity for Day 2 operations. VMware vSAN provides a complete solution for Day 2 operations from snapshots and clones, with AlwaysOn Availability Groups, to backup and recovery with key VMware partners such as Veeam.

- Through the use of Storage Policy-Based Management (SPBM), organizations can realize a unified control plane across all storage services, enabling IT administrators to improve productivity while managing SQL Server deployments.

- With VMware vMotion, organizations can non-disruptively consolidate SQL Server databases to ease migrations and reduce licensing costs between clusters, data centers, or clouds.

- Benefits of VMware-powered HCI allow simple evolution to full stack, with consistent operations from edge to core to cloud, and intrinsic security for data at rest and in flight, all while using existing virtualization tools and staying native to an organization's hypervisor.

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