Optimize VMware Virtual SAN 6 with SanDisk SSDs

SSD Solutions to Power Business-critical Applications and Databases

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments.
Introduction

ESG Lab evaluated SanDisk flash solutions for VMware Virtual SAN 6 hyper-converged infrastructure for business-critical applications and databases, with a focus on assessing the performance and value of flash for infrastructure-wide storage virtualization and hyper-converged solutions in the data center.

Background

The data center of today is transforming to become increasingly virtualized, and next-generation data centers will incorporate more public, private, and hybrid cloud-based applications. Virtualization and cloud bring server consolidation, workload mobility, self-provisioning, management, multi-tenancy, and the ability to rapidly scale up and out. Traditional data center storage solutions, customarily designed for static workloads tied to physical servers, are challenged to provide agility, security, data protection, and performance without costly and proprietary hardware.

ESG recently conducted a survey of 373 IT professionals and respondents were asked to identify what they would consider their biggest challenges with respect to their storage environment. As shown in Figure 1, IT organizations are significantly focused on data growth (26%), data protection (26%), and data migration (23%). Cost, too, is clearly a key consideration for IT organizations, with more than half (68%) citing capital (i.e., hardware, 27%) and/or operational expenses (41%)—including both staff and power and cooling costs—as a storage challenge. Additionally, 19% of organizations cited cost as their primary challenge, whether related to CapEx (7%) or OpEx (12%).

Figure 1. Top Ten Storage Environment Challenges

1 Source: ESG Research Report, 2015 Data Storage Market Trends, October 2015
What’s driving these spending trends? After hardware costs, the rapid growth of data and the subsequent requirements to protect that data were the most commonly cited storage challenges. This makes sense in light of the fact that managing data growth and improving backup and recovery—both with obvious storage implications—were among the top five most-cited overall IT priorities in ESG’s 2016 IT Spending Intentions Survey.²

**VMware Virtual SAN 6**

VMware Virtual SAN 6 is a software-based storage solution for VMware hyper-converged solutions. Embedded in the hypervisor and leveraging industry standard x86 components, Virtual SAN delivers flash-optimized, high-performance compute and storage for hyper-converged infrastructures.³ Virtual SAN provides easy scalability and seamless integration with the entire VMware stack, including VMware vSphere, making it a simple storage platform for virtual machines and ideal for business-critical applications, virtual desktops, IT operations, or remote IT applications. The solution scales from two to 64 nodes, and aggregates locally attached flash and magnetic disks into virtual data stores available to any VM in the hyper-converged cluster (Figure 2).

**Figure 2. SanDisk Flash Solutions for VMware Virtual SAN 6**

In a hybrid configuration, VMware Virtual SAN combines one flash disk and up to seven magnetic disks into a disk group. The flash disks serve as read-and-write cache for the virtual data store and the magnetic disks provide the data store capacity. In an all-flash configuration, one flash disk in a disk group is used for write caching, while the remaining flash disks provide data store capacity. As read performance from the capacity flash devices is more than sufficient, no additional read caching is provided.

VMware Virtual San 6.2 includes thin provisioning, compression, and deduplication, which significantly increase usable capacity with minimal performance impact to the cluster. Organizations implementing Virtual SAN benefit from:

- **All-flash architecture**—Delivers up to 100,000 IOPS per host with consistent low latency through flash-based caching and SSD data persistence.
- **Quality of service (QoS)**—Automatically limits and monitors IOPS consumption, eliminating noisy neighbor issues.

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³ A hyper-converged infrastructure is largely software-defined, with tightly integrated compute, storage, networking, and virtualization resources.
• **Self-tuning**—Automatically rebuilds and rebalances storage to align with QoS limits.

• **Data reduction, deduplication, and compression**—Optimizes storage capacity with as much as 10x data reduction while having minimal impact on server CPU and memory resources.

• **Management**—Simplicity of management through the vSphere Web Client for storage, compute, and networking in a single, tightly integrated interface.

### SanDisk Optimus Ascend and Optimus MAX SSDs

ESG Lab tested VMware Virtual SAN solutions with SanDisk SSDs in two configurations: hybrid and all-flash. The hybrid solution employs SanDisk Optimus Ascend SAS SSDs for the read and write cache, and industry-standard magnetic drives for storage capacity, while the all-flash solution employs SanDisk Optimus Ascend SAS SSDs for the write cache and SanDisk Optimus MAX SAS SSDs for storage capacity.¹

**Figure 3. SanDisk Optimus Ascend and Optimus MAX SSDs**

The SanDisk Optimus SSD family features a native SAS 6Gb/s interface and a comprehensive set of high-end features making them ideal to integrate with existing infrastructures. SanDisk Optimus Ascend SSDs offer performance, endurance, reliability, and affordability in a single package using enterprise Multi-Level Cell (eMLC) flash. SanDisk optimized the Ascend for mixed-use application workloads such as databases and online transaction processing (OLTP), email, virtual desktop, and collaboration where performance and high availability are required. Optimus Ascend SSDs provide 95,000 IOPS random read and 40,000 IOPS random write performance, with 550MB/s read and 540MB/s write speeds. Available in capacities of 200 GB-1.6 TB, the SSDs include support for wide-port SAS, providing up to 1GB/s sequential read performance. Optimus Ascend SSDs provide enterprise-class endurance, with 10 drive writes per day for five years.

The SanDisk Optimus MAX 4TB SAS SSD was designed to deliver SAS SSD performance at SATA-like prices for enterprise, cloud, and virtualized data centers. This 4TB SSD was optimized for read-intensive application workloads and alleviates I/O bottlenecks by providing high-density storage for efficient data throughput to deliver high performance, superior reliability, and enhanced endurance for maximum application scalability. The Optimus MAX 4TB SAS SSD provides up to 500MB/s

¹ Both the SanDisk Optimus Ascend and SanDisk Optimus MAX SSDs used in these solutions are certified for VMware Virtual SAN 6 and listed on the VMware HCL.
read and write speeds as well as 85,000 random read IOPS and 11,000 random write IOPS. This SSD offers 0.5 drive writes per day endurance.

**ESG Lab Validation**

ESG Lab performed hands-on evaluation and testing of a SanDisk SSD-based VMware Virtual SAN at SanDisk’s facilities in San Jose, California. Testing was designed to demonstrate performance and cost-efficiency using industry standard tools and methodologies. Results were analyzed and compared between the hybrid and all-flash Virtual SAN configurations.\(^4\)

**Performance**

Figure 4 illustrates the test bed used by ESG Lab for this validation report. The test bed represents a common configuration for VMware Virtual SAN, and includes four industry-standard x86 servers, each running VMware Virtual SAN 6, which aggregated all storage resources into a single virtual data store.\(^5\)

**Figure 4. The ESG Lab Test Bed**

For the hybrid configuration, each physical server was configured with 16 drives, split into two disk groups of eight drives each. Each disk group was composed of seven industry-standard 1.2TB 10K RPM magnetic SAS drives for storage capacity, and one 800GB SanDisk Optimus Ascend SSD for the read and write cache.

For the all-flash configuration, each physical server was configured with six drives, split into two disk groups of three drives each. Each disk group was composed of two SanDisk Optimus Max 4TB SSDs for storage capacity, and one 800GB SanDisk Optimus Ascend SSD for write acceleration.

Eight virtual machines, two per physical server, were running Microsoft Windows Server 2012 R2 and Microsoft SQL Server 2014. Each VM was configured to have 16 virtual CPUs and 96 GB of RAM.

ESG simulated a typical OLTP workload using HammerDB, an industry-standard, open source database load testing and benchmarking tool. HammerDB was designed as a load testing tool to compare the relative performance of OLTP

\(^5\) Detailed configuration information is provided in the Appendix.
databases. The implementation is intentionally non-optimized, focusing on producing reliable, scalable, accurate, repeatable, and consistent results.

The workload itself emulated the database activity of users in a typical online brokerage firm as they generated trades, performed account inquiries, and executed market research. The workload was composed of ten transaction types with a defined ratio of execution. Four of the transactions performed database updates, and the rest were read only.

Each of the eight VMs was configured for 5,000 HammerDB warehouses. Eight separate HammerDB instances, outside the Virtual SAN cluster, acted as workload generators, and each instance was configured with 256 users, for 2,048 total users. ESG Lab started the test with a five-minute ramp to reach steady state operations. Once steady state was achieved, the test ran for 30 minutes. The performance of the system, measured in the number of new orders per minute entered into the database (NOPM), is shown in Figure 5.

**Figure 5. HammerDB Performance Results**

![HammerDB Performance Results](image)

The hybrid configuration achieved more than 1.7 million new orders per minute, demonstrating the enterprise-class performance achievable with a four-node VMware Virtual SAN cluster using SanDisk Optimus Ascend SSDs for write acceleration.

The all-flash configuration delivered more than 2.5 million new orders per minute, 49% more performance than the hybrid configuration. Using SanDisk SSDs enabled the VMware Virtual SAN cluster to maximize enterprise-class performance.

Next, ESG Lab explored the performance for each individual VM to learn more about how total load was distributed across each node. This is an important aspect of a virtualized infrastructure because having an even distribution of the workload across all of the VMs helps to validate the underlying hardware and software’s capability to properly meet the application’s resource consumption requirements. Along with the aggregate total of new orders per minute, ESG Lab analyzed the results for each node with a goal of seeing a proper workload distribution. The results are shown in Figure 6.
The hybrid configuration showed some variability with a close-to-even workload distribution across SQL servers. The all-flash configuration yielded higher levels of performance with less variability and therefore better workload distribution.

Next, ESG Lab evaluated the price/performance when using SanDisk SSDs in the VMware Virtual SAN cluster. Using street prices for the cost of the servers, software licenses, magnetic disks, and SanDisk SSDs, ESG Lab computed the cost of each solution, and the price/performance, as shown in Figure 7 and Table 1.

**Figure 6. Detailed Performance Results: Hybrid versus All-flash**

**Figure 7. Price/Performance Results**
### Table 1. VMware Virtual SAN with SanDisk Price and Price/Performance

<table>
<thead>
<tr>
<th></th>
<th>Total Price</th>
<th>NOPMs</th>
<th>Price/NOPMs</th>
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<tbody>
<tr>
<td>Hybrid</td>
<td>$332,364</td>
<td>1,702,776</td>
<td>$0.20</td>
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<tr>
<td>All-flash</td>
<td>$365,524</td>
<td>2,542,760</td>
<td>$0.14</td>
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<td>All-flash % Increase</td>
<td>10%</td>
<td>49%</td>
<td>-26%</td>
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</table>

*Source: Enterprise Strategy Group, 2016*

#### What the Numbers Mean

- The all-flash solution was 10% more expensive than the hybrid solution.
- The all-flash solution delivered 49% more NOPMs than the hybrid solution.
- Combing price and performance, the all-flash solution was 26% less for price/NOPM, reflecting the price/performance advantage of a SanDisk-powered all-flash Virtual SAN solution. It would take an additional $164,000 investment in a hybrid solution to achieve the NOPMs of the SanDisk all-flash solution.

#### Why This Matters

Mission-critical database applications serve as the lifeline of many organizations and, therefore, performance is critical. In fact, performance issues remain a key concern preventing organizations from virtualizing mission-critical database applications. This hesitation is due to the perception that virtualization not only adds overhead, but will also prevent performance scalability.

ESG Lab confirmed that a VMware Virtual SAN cluster with SanDisk SSDs easily accommodated the performance requirements of an enterprise-class virtualized OLTP database environment. Performance was excellent for a hybrid configuration, while the all-flash configuration delivered 49% better performance. The number of new orders per minute were evenly split between the VMs, highlighting the solution’s ability to efficiently distribute the OLTP workload across the entire cluster.

In addition, ESG Lab confirmed that the price/performance advantage of SSDs translated directly to the VMware Virtual SAN with SanDisk SSD solution. The all-flash solution, while having a 10% higher price, delivered 49% better performance, resulting in a 26% advantage in price/performance.
ESG Lab Validation Highlights

- SanDisk demonstrated the high levels of predictable performance and sustainability of its Optimus SSDs for VMware Virtual SAN hyper-converged solutions.
- Using the HammerDB performance testing tool, the hybrid solution delivered 1,702,776 new orders per minute from a four-node Virtual SAN cluster.
- The all-flash configuration of the four-node VMware Virtual SAN cluster delivered 2,542,760 new orders per minute, a 49% improvement over the hybrid solution.
- While the all-flash solution was priced 10% more than the hybrid solution, the price/performance advantages of SSDs translated into 26% price/performance advantage for the all-flash solution.
- With the performance benefits demonstrated by the all-flash solution, less server hardware is needed to meet the business requirements, leading to additional savings on power, cooling, and application software licensing.

Issues to Consider

- The test results presented in this report are based on a test bed deployed in a controlled environment with industry-standard testing tools. Due to the many variables in each production data center environment, capacity planning and testing in your own environment are recommended.
The Bigger Truth

Traditional IT infrastructures with various hardware and management silos limit the ability of IT organizations to quickly and easily adjust to business needs and demands. This is especially true in virtualized infrastructures, which have proven to be effective in consolidating application workloads for potential CapEx savings, yet complexities around management and IT administration quickly drive OpEx costs through the roof. The quest for realistic and affordable options to deal with the challenges inherent in IT virtualization and consolidation is daunting. In massive, virtualized environments made up of heterogeneous hardware and software, these management complexities can grow exponentially. Storage management in a modern IT environment has to be simple and practical as well as functional because users will eventually be compelled to virtualize everything.

The VMware Virtual SAN 6 solution with SanDisk SSDs enables IT organizations to simplify all aspects of their operations. All the physical resources are aggregated into a cluster of standard x86 servers. Each server becomes a simple building block to easily scale up and scale out with the business. The distributed-everything architecture leverages a software-defined approach that aggregates all storage resources across the cluster and offers all the storage services that have come to be expected in enterprise infrastructure environments. And for enhanced performance, SanDisk Optimus Ascend SSDs deliver write acceleration while SanDisk Optimus Max SSDs add storage capacity.

Performance testing showed the advantages of SSDs in a real-world, virtualized OLTP database workload. The hybrid solution delivered 1,702,776 new orders per minute from a four-node VMware Virtual SAN cluster, while the all-flash solution delivered 2,542,760 new orders per minute, a 49% improvement. Both configurations demonstrated an even distribution of the workload across each of the VMs. And with cost being a major driver behind the adoption of hyper-converged technologies, ESG Lab was impressed with the potential reduction in TCO that the VMware Virtual SAN with SanDisk SSDs can bring to organizations. While the all-flash configuration price was 10% more than the hybrid solution, the 49% performance increase resulted in a 26% price/performance advantage.

VMware Virtual SAN with SanDisk SSDs proved to be robust, flexible, and responsive, delivering major value in terms of performance, economics, improved response times, high availability (HA), and easy administration. ESG Lab firmly believes that it would benefit any organization considering or implementing an IT virtualization project to take a long look at VMware Virtual SAN with SanDisk SSDs.
## Appendix

### TABLE 2. ESG Lab Test Bed

<table>
<thead>
<tr>
<th>Data Infrastructure Software</th>
<th>Version</th>
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<tbody>
<tr>
<td>VMware Virtual SAN</td>
<td>6.0 U1</td>
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<table>
<thead>
<tr>
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<th>OS and Hypervisor</th>
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<td>Microsoft SQL Server 2014 Standard without SA</td>
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<tr>
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<td>Microsoft Server 2012R2</td>
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<tr>
<td>256 GB RAM</td>
<td>VMware vSphere 6 Enterprise Plus</td>
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<table>
<thead>
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<th>Workload Generation</th>
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