Technical Validation

Dell EMC VxRail with Intel Xeon Scalable Processors and Intel Optane SSDs

Business-critical Hyperconverged Workload Performance Testing with Dell EMC VxRail

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ESG Technical Validations

The goal of ESG Technical Validations is to educate IT professionals about information technology solutions for companies of all types and sizes. ESG Technical Validations 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 objectives are to explore some of the more valuable features and functions of IT solutions, show how they can be used to solve real customer problems, and identify any areas needing improvement. The ESG Validation Team'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.

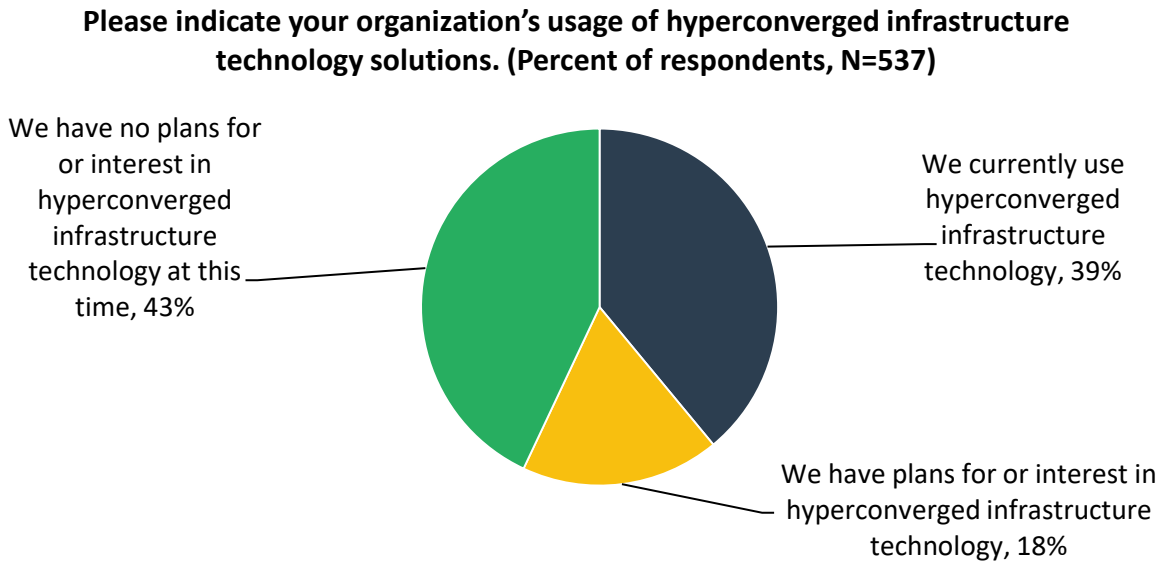
Introduction

This report documents an ESG technical audit and validation of Dell EMC VxRail hyperconverged infrastructure (HCI) performance testing, which focused on comparisons of Dell EMC VxRail all-flash configurations with SAS SSD cache drives with Dell EMC VxRail all-flash configurations with Intel Optane SSD Cache drives servicing business-critical workloads.

Background

Organizations today must be extremely agile and flexible in adding applications and virtual machines (VMs) and deploy business-critical production environments quickly to respond to the needs of the business. As a result, the popularity of hyperconverged infrastructure (HCI) systems has increased considerably. HCI offers a single, centrally managed solution with software-defined compute, network, and storage that is flexible, scalable, and easy to deploy. Adoption of HCI has grown significantly since coming to market, and ESG research continues to confirm the popularity of HCI: In an ESG research study, 57% of respondents reported that they use or plan to use HCI solutions. This is not surprising, given the factors driving them to consider HCI. Deployment drivers most cited by respondents include improved scalability (31%), total cost of ownership (28%), ease of deployment (26%), and simplified systems management (24%).[1]

Figure 1. Hyperconverged Infrastructure Usage Trends



Source: Enterprise Strategy Group

In ESG's annual technology spending intentions survey, 37% of organizations said that they would make the most significant investments deploying hyperconverged and/or converged infrastructure platforms in support of data center modernization, and 55% of organizations indicated that spending on hyperconverged and converged technology would increase in 2019.[2]

Organizations are told to digitally transform, to become more agile, and to respond to the business faster in order to survive in a highly competitive market. One method used by organizations to digitally transform is modernizing their infrastructures, which means shifting from a traditional three-tier architecture to a solution that integrates compute, storage, networking, and virtualization. Such a solution must deliver a more cloud-like experience on-premises, making the eventual transition to the cloud easier while enabling organizations to confidently move cloud-native applications from the

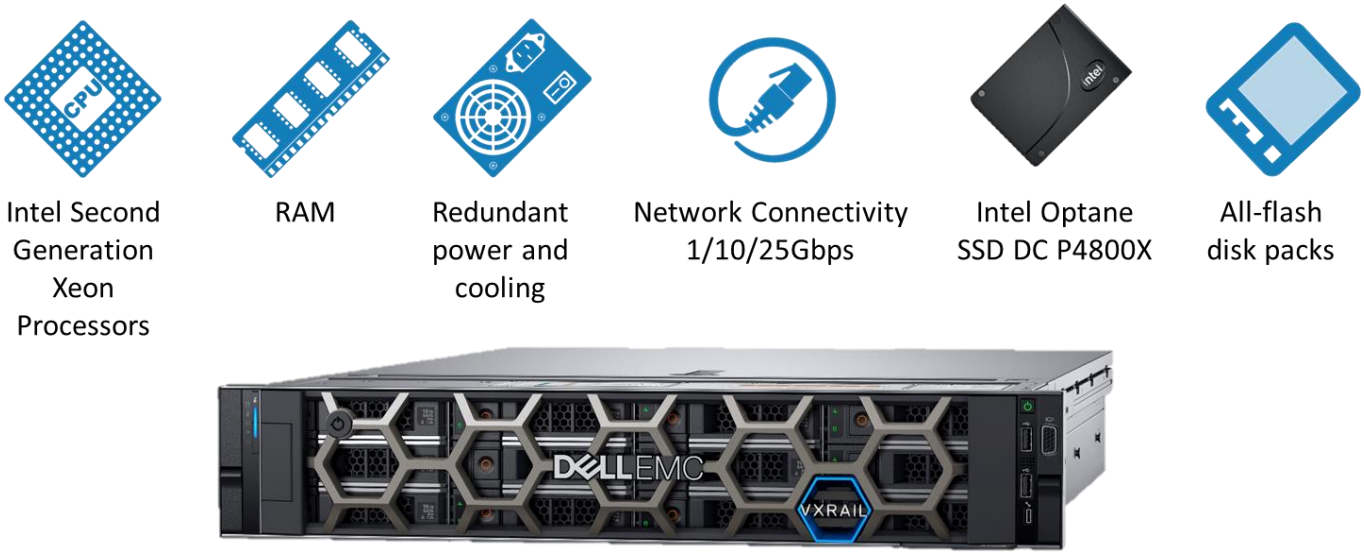
[1] Source: ESG Master Survey Results, *Converged and Hyperconverged Infrastructure Trends*, October 2017.
[2] Source: ESG Master Survey Results, *2019 Technology Spending Intentions Survey*, March 2019.

public cloud back to an on-premises private cloud. According to ESG research, adopters of HCI appreciate the simplicity of deploying and managing a tightly integrated infrastructure anchored in software-defined constructs. Early adopters specifically were keen on leveraging initial deployments to handle what were deemed tier-2 workloads (VDI or email, for example).[3] Organizations looking to move mission-critical workloads traditionally reserved for three-tiered architectures or converged infrastructure (CI) solutions to HCI need to carefully consider the solution they choose. An HCI platform deployed to support tier-1 workloads must provide high IOPS and low read/write latency, *and* do so in a consistent, predictable manner. Predictable performance is critical to maximize end-user productivity across an organization. Finally, the entry-level cost, buying a two- or three-node system, is far more appealing to organizations that are looking to start small and grow over time.

Dell EMC VxRail Hyperconverged Infrastructure

HCI platforms are solutions that deliver compute, software-defined storage, and networking infrastructure services in a cluster of industry-standard servers. VxRail, powered by Dell EMC PowerEdge server platforms, is a turnkey HCI platform that consolidates compute, storage, and virtualization—including Intel Optane SSD NVMe caching drives, SmartFabric services when deployed with the Dell EMC PowerSwitch family, integration across the VMware ecosystem including VMware VSAN, VMware hybrid cloud integration, and automated tools and guides designed to simplify deployment of a secure VxRail infrastructure.

Figure 2. Dell EMC VxRail E, G, and P Series Hyperconverged Infrastructure



Source: Enterprise Strategy Group

Dell EMC, Intel, and VMware work together to quickly bring next-generation technologies to VxRail. Jointly developed with VMware, VxRail leverages proprietary VxRail HCI System Software to automate deployment and deliver complete lifecycle management, speeding time to value in the core data center, in the cloud, and at the edge. Second Generation Intel Xeon Scalable processors and Intel Optane SSDs provide the compute and storage performance to service latency-sensitive business-critical workloads including Oracle, SQL Server, and SAP HANA.

[3] Source: ESG Master Survey Results, *Converged and Hyperconverged Infrastructure Trends*, October 2017.

Second Generation Intel Xeon Processors and Intel Optane SSDs

Intel Optane DC SSDs

Eliminating storage bottlenecks requires solutions that are fast, flexible, and non-volatile. The low latency and high performance Intel Optane SSDs help reduce or eliminate data center storage bottlenecks and allow larger, more economical data sets. Intel Optane technology is not NAND. Built on an architecture that allows memory cells to be individually addressed in a dense, transistor-less, stackable design, Intel Optane SSDs can accelerate applications, reduce transaction costs for latency-sensitive workloads, and improve overall data center TCO.

Benefits of Intel Optane SSDs include:

- High throughput and performance for business-critical workloads.
- Predictably fast servicing of I/O—Lower and more consistent response time than traditional NAND flash. This makes Intel Optane SSD better suited for critical applications with demanding latency requirements.
- Consistent performance scaling—Intel Optane SSD with its bit-level architecture enables consistent performance over longer durations.
- High endurance—Intel Optane SSDs total drive writes per day is many times greater than NAND flash, which gives Intel Optane SSDs a much longer useful life than traditional NAND.
- Economics—A smaller Intel Optane SSD cache can provide comparable performance gains to a much larger NAND flash device. ESG testing in this report used Intel Optane SSD cache with less than half the capacity of the NAND cache we were comparing.

Second Generation Intel Xeon Processors

Intel's latest processor is the second generation processor built on the Purley platform, and provides multiple performance enhancements including:

- Intel Speed Select Technology—Configurable core and/or frequency processor attributes, prioritization of workload performance, and support for platform TCO optimizations.
- Intel Security Libraries—New Intel Threat Detection Technology, Intel Trusted Execution Technology, and Intel Cloud Integrity Technology support a secure platform at the hardware level.
- Encryption and Accelerators—Available with Intel QuickAssist Technology and Integrated Intel Advanced Vector Extensions 512.

Hardware Mitigation of Side Channel Vulnerabilities

L1TF vulnerability is a side-channel attack based on the information about how a system is implemented, where a malicious VM may infer contents of the hypervisor's or another VM's privileged information simultaneously residing in the same core's L1 data cache. Software mitigation imposes a non-trivial performance impact. Second Generation Intel Xeon processors mitigate this vulnerability with negligible CPU utilization and no performance degradation observed during tests.

ESG Technical Validation

ESG performed evaluation and testing of Dell EMC VxRail with Intel Optane SSDs. Testing was designed to validate the predictable and consistent performance of Dell EMC VxRail with Intel Optane SSDs. Other areas of interest include penalty-free security enhancements, automated lifecycle management, scalability, and price-performance.

Business-critical Workload Performance

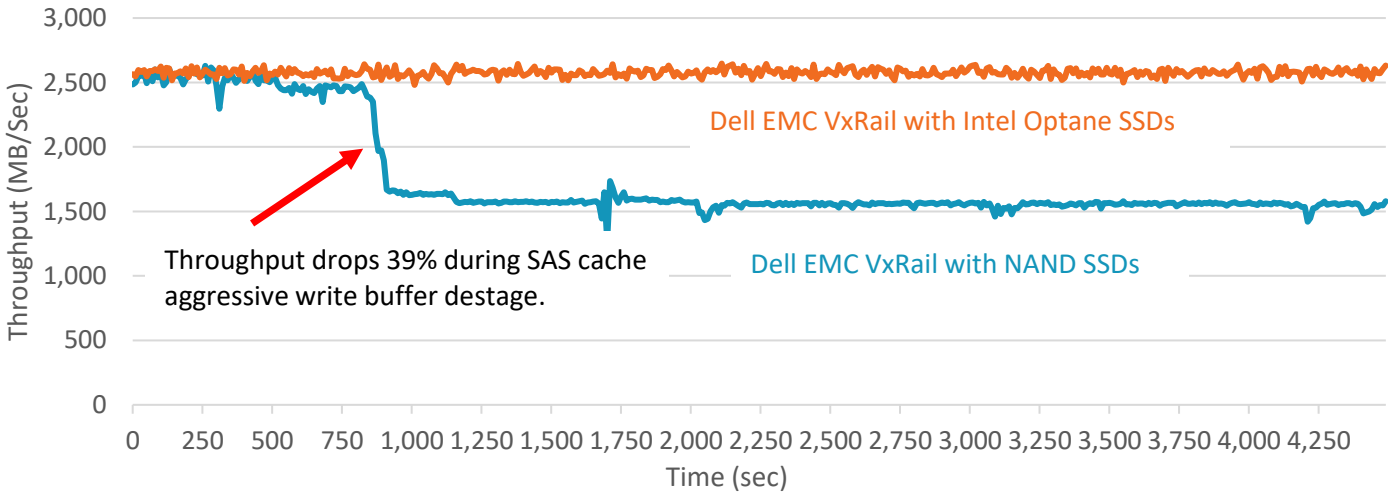
ESG tested using industry-standard tools and methodologies, and we focused on validating VxRail performance using multiple workloads. The goal of testing was to validate that Intel Optane SSDs can not only enhance the performance of business-critical workloads, but also enable Dell EMC VxRail to support multiple, mixed workloads in the same cluster with reduced impact. Workloads we examined include: databases; artificial intelligence (AI)/machine learning (ML) data ingest and transformations; backup; recovery; VM migration using VMotion; and video rendering.

ESG Testing

Tests were conducted on a VxRail cluster with four P570F nodes.[4] Each node contained two Intel Xeon Gold 6254 processors, 384GB RAM, and six 1.9TB capacity SSDs. One cluster used one 800GB SAS SSD per node for cache, and the other cluster used one Intel Dell Express Flash NVMe P4800X, 375GB Intel Optane SSD per node for cache. One of the goals of these tests was to validate the effect of using a smaller cache with the Intel Optane SSD—375GB versus 800GB. Nodes were connected via 25GbE network adapters. First, ESG looked at simulated business workloads using Vdbench. The first test was a sustained sequential write workload, as would be seen in AI/ML data ingest/transformations, video rendering, database logging, or backup applications.

We ran a 100% sequential 64KB workload with a 1.2TB working set per node for 75 minutes. As shown in Figure 3, VxRail with Intel Optane SSDs can sustain heavy write workload throughput—2,500 MB/sec in this test—even during aggressive cache destaging, where SAS SSD performance dropped by 39% and stayed there for the remaining hour of the test.

Figure 3. 100% Sequential 64KB Writes—Throughput

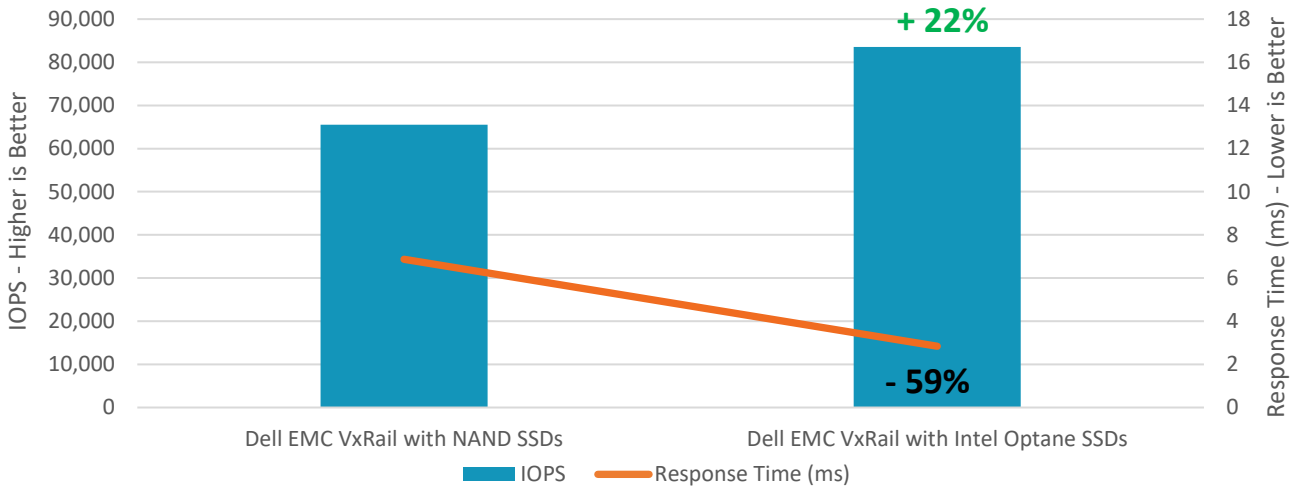


Source: Enterprise Strategy Group

Next, we looked at random writes (see Figure 4)—with enough sequential streams writing to different areas of storage in parallel (multiple ingests and transformations), the workload looks random. Figure 4 shows VxRail with Intel Optane SSDs providing 22% more IOPS and 59% lower latency at 100% utilization.

[4] Configuration details can be found in the Appendix.

Figure 4. 100% Random 32KB Writes—IOPS

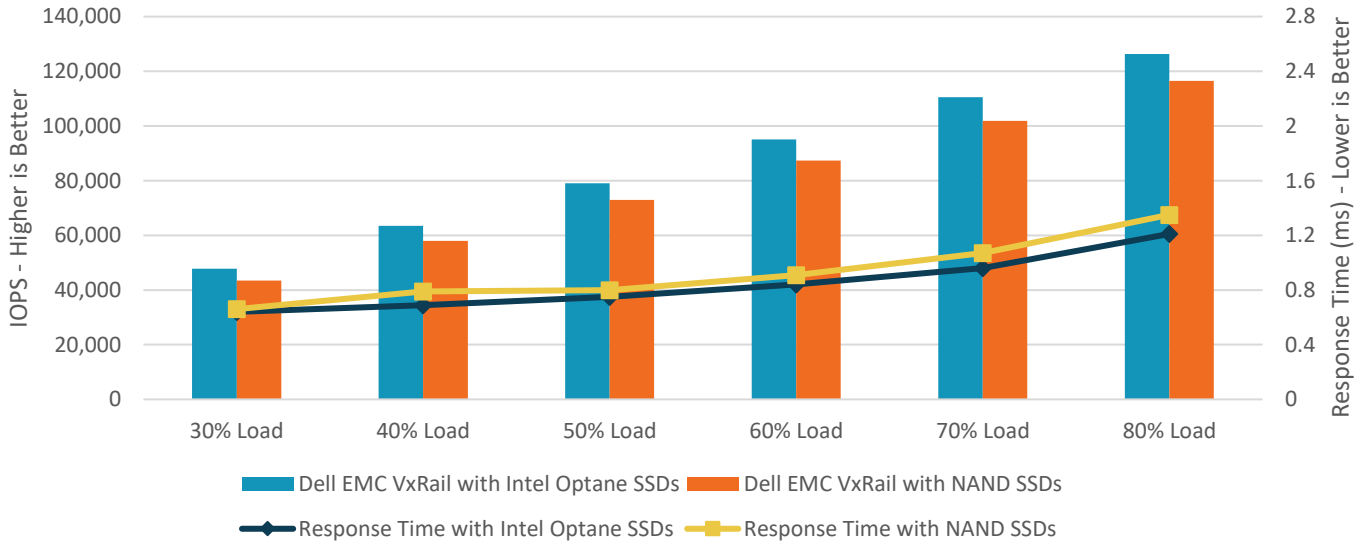


Source: Enterprise Strategy Group

In all synthetic workload tests, we noticed that performance improvements are more pronounced with large I/O sizes. This is because CPU constraints are much less of an issue with larger I/O sizes.

Next, we examined a simulated relational database workload with a 22KB block size, mixing random 8K and sequential 128K I/O, with 60% reads and 40% writes, and a 600GB per node working set. Figure 5 compares the IOPS/response time curves for VxRail with NAND cache and Intel Optane SSD cache. The curve maps the workload from 30% to 80% of maximum load. Throughout this test, VxRail with Intel Optane SSDs consistently supported higher IOPS at lower latency.

Figure 5. Synthetic RDBMS Workload—22KB Block Size—IOPS and Latency



Source: Enterprise Strategy Group

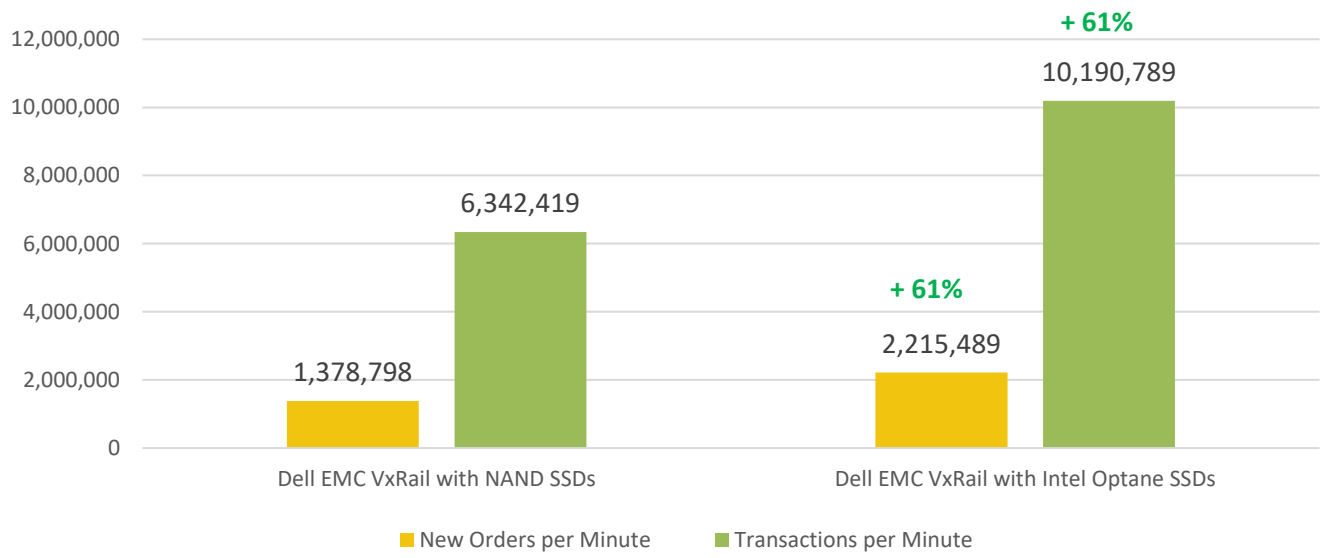
Finally, we wanted to validate these findings using a more real-world workload. It's important to note that when simulating relational database workloads with low-level tools, we observed an improvement in IOPS and latency across the board, but we observed larger performance improvements when running tests with a real database because the latency

improvements provided by Intel Optane SSDs have a positive effect when data consistency is dependent on log write execution.

ESG evaluated Dell EMC VxRail in a typical enterprise OLTP environment 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 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. HammerDB measured the total number of transactions per minute (TPM) and the number of new orders per minute (NOPM) entered into the database.

As Figure 6 shows, testing with HammerDB has revealed a significant improvement in realistic OLTP performance. VxRail with Intel Optane SSDs sustained nearly 61% more transactions per minute (TPM) and new orders per minute (NOPM) than SAS SSDs.

Figure 6. OLTP Workload—HammerDB



Source: Enterprise Strategy Group

What the Numbers Mean

- On tests with a smaller working set size, the latency was about 20% to 30% lower on the system using Intel Optane SSD cache. On tests with a large working set size, the latency was about 15% to 20% lower on the system using Intel Optane SSDs for cache.
- NAND flash performance dropped by 39% once cache began to aggressively destage, while the system running Intel Optane SSD cache sustained consistent service with no drop in performance.
- In every test, the system using Intel Optane SSD cache serviced similar or higher IOPS with consistently lower response time.
- Using a complex OLTP workload, Intel Optane SSDs provided a 61% performance boost to VxRail over traditional NAND flash cache.

Why This Matters

ESG research asked IT managers and executives what benefits their organizations had realized as a result of deploying a hyperconverged infrastructure technology solution, and the top two most-cited reasons were improved scalability and improved total cost of ownership. Executives want IT to purchase new technologies to modernize their infrastructures and meet business requirements without compromising on costs and complexity.

ESG testing validated that Dell EMC VxRail with Intel Optane SSDs delivers a fast, simple path to a seamless and secure VMware experience with higher performance and lower latency than standard all-flash configurations using simulated business-critical workloads. In testing using live SQL Server databases, VxRail with Intel Optane SSD cache serviced 61% more transactions per minute *and* new orders per minute than VxRail with NAND flash cache. This translates directly to improved agility and scalability, as well as lower upfront and ongoing costs because a given workload can potentially be serviced by a smaller number of VxRail nodes.

The Bigger Truth

IT organizations are mandated to digitally transform, to become more agile, and to respond to the business faster in order to survive in a highly competitive market. This is driving organizations to modernize their infrastructures. ESG research reveals that 57% of organizations reported that they use or plan to use HCI solutions, with common drivers including improved scalability, total cost of ownership, ease of deployment, and simplified systems management.[5]

An HCI platform deployed to support tier-1 workloads needs to provide high IOPS and low read/write latency in a consistent, predictable manner. Predictable performance is critical to maximize end-user productivity across an organization.

Dell EMC VxRail provides the expected benefits of HCI—it is simple to deploy and manage, cost-effective, and lets organizations start small and scale. ESG testing validated that Dell EMC VxRail with Intel Optane SSDs provides the high performance and low latency that business-critical, virtualized workloads demand. The consistency of performance over time was particularly notable. Simple management and independent resource scalability provide organizations with the agility to adapt quickly to changing requirements, as modern environments demand.

The test results presented in this report are based on applications and benchmarks 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. Readers are well advised to always explore the details behind any vendor testing to understand the relevance to your environment.

ESG validation has shown how Dell EMC—in partnership with VMware and Intel—delivers an HCI solution that provides simplicity and cost-efficiency with consistent high performance and the security that customers need for business-critical workloads.

[5] Source: ESG Master Survey Results, *Converged and Hyperconverged Infrastructure Trends*, October 2017.

Appendix

Table 1. Dell EMC VxRail Test Configurations

	Dell EMC VxRail with NAND SSDs	Dell EMC VxRail with Intel Optane SSDs
SSD Cache per node	1 x Toshiba PX5SMB080Y, 800 GB	1 x Intel Dell Express Flash NVMe P4800X, 375GB
Data Storage per node	6 x Toshiba PX05SRB192Y 1.92 TB	6 x Toshiba PX05SRB192Y 1.92 TB
vSAN Storage Configuration per node	2 disk groups (3 PX05SRB192Y)	2 disk groups (3 PX05SRB192Y)
CPU	Intel Xeon Gold 6254 * 2 (36 cores per node)	
Memory	384 GB	
Network	25 GbE Mellanox	
Virtualization Configuration	VMware vCenter 6.7.0 VMware ESXi 6.7.0	
Storage Configuration	Deduplication and compression disabled	
Network Configuration	Jumbo frames enabled	
SQL Server VM Configuration		
vCPU	8 vCPUs	
Memory	64 GB RAM	
vNIC	VMXNET3	
OS	Microsoft Windows Server 2016	
Database	Microsoft SQL Server Native Client 11.0	

Source: Enterprise Strategy Group

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