Technical Validation

Dell EMC VxRail on 15th Generation PowerEdge Technology

Pushing the Boundaries of Performance and VM Density for Business- and Mission-critical Workloads

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Contents

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 ESG's validation of Dell Technologies' VxRail Hyperconverged Infrastructure (HCI) running on the latest Dell EMC PowerEdge servers with 3rd Gen Intel Xeon Scalable processors and VxRail HCI System Software. ESG's focus was on how VxRail on nex- generation PowerEdge servers enables organizations to bring even more mission-critical, high-performance workloads to VxRail with refined simplicity, increasing organizations' opportunities to leverage VxRail's management, efficiency, and flexibility benefits.

Background

Across all industries, organizations have recognized the benefits of HCI as they modernize data centers. The ability to consolidate multiple virtual workloads on a single platform brings agility and scalability to match the speed of business today. Instead of individually managed silos of infrastructure (compute, storage, and network) that IT must separately evaluate, procure, test, deploy, tune, and manage, HCI solutions like Dell EMC VxRail provide a centrally managed, single solution with software-defined resources that are easy to deploy, scale, and manage. These features also endow HCI solutions with a lower cost of ownership advantage. It is no surprise, then, that ESG research shows a considerable increase in HCI usage over the past few years. While in 2017, 22% of respondents were employing HCI on-premises, the responses to the same question in our follow-up report released in 2020 more than doubled to 46% (see Figure 1).[1] This analyst expects this trend to continue into 2022 and beyond, as it is clear that organizations see HCI as a key contributor to digital transformation and increasingly want it to power business- and mission-critical production applications.

Figure 1. Increase in Use of Hyperconverged Infrastructures

On-premises data center storage technologies currently in use, 2017 vs. 2019.
(Percent of respondents)
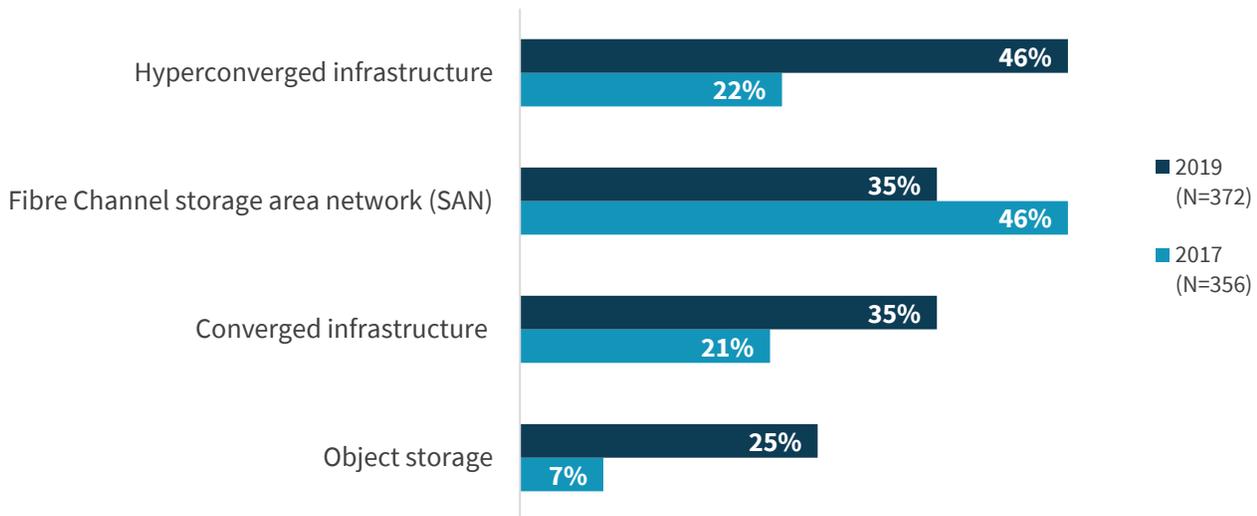
Source: Enterprise Strategy Group

However, when multiple applications compete for resources, an "I/O blender effect" can occur, degrading performance. As a result, organizations have historically avoided placing applications that need consistent high performance, such as real-time analytics, online transaction processing (OLTP), content delivery, and high-performance computing (HPC), on HCI. In

[1] Source: ESG Research Report, *Data Storage Trends in an Increasingly Hybrid Cloud World*, March 2020.

order for these applications to run on HCI, a hyperconverged solution must offer high performance and consistently low latency; this would expand the opportunity to gain from HCI's efficiency, flexibility, and scalability.

Solution: Dell EMC VxRail Hyperconverged Infrastructure on 15th Generation PowerEdge Nodes

Dell EMC VxRail is an HCI solution that is designed at its core to deliver agility, scalability, simplicity, and operational efficiency. Jointly developed by Dell EMC, VMware, and Intel, VxRail offers configurations using Intel Optane persistent memory to increase both performance and memory capacity while maintaining data persistence at a significantly lower cost than DRAM. In the current release of VxRail, a number of hardware and software enhancements have dramatically increased the performance of the platform.

Dell EMC VxRail

VxRail provides turnkey infrastructure for a variety of modern, virtualized applications, including databases, virtual desktop infrastructure (VDI), data analytics, and artificial intelligence (AI) at the core, edge, or cloud. It offers what Dell, VMware, and Intel call the fastest, simplest VMware environment, including management using the familiar vCenter interface.

Figure 2. Dell EMC VxRail Hyperconverged Infrastructure on 15th Generation PowerEdge Servers
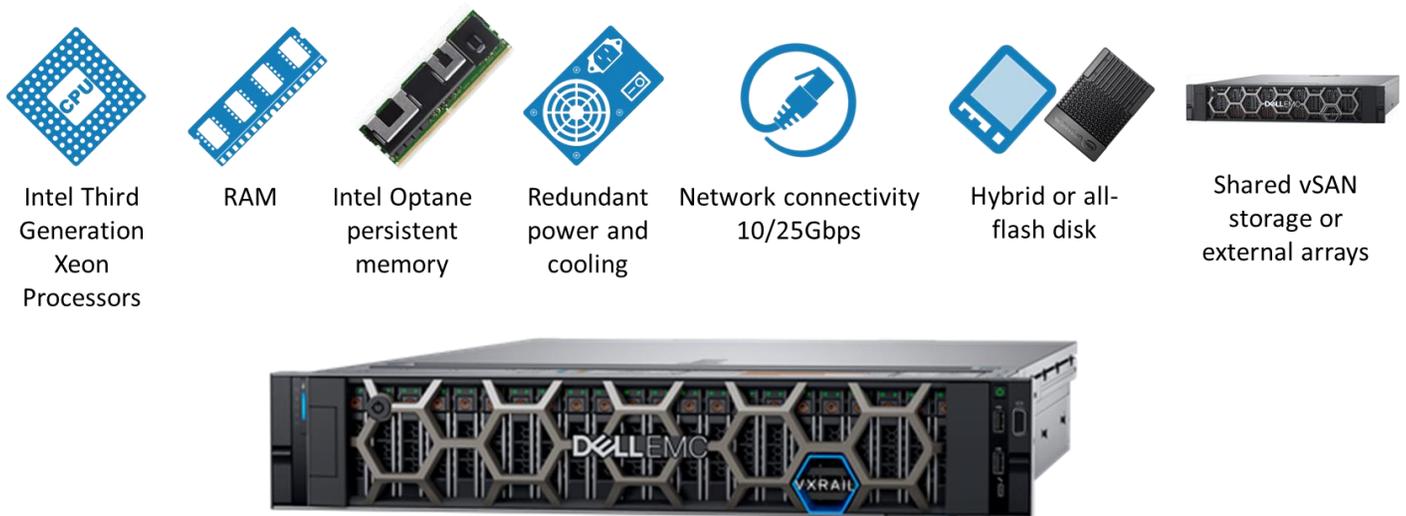
The next-generation VxRail hardware platform is based on the latest 15th generation PowerEdge servers with third-generation Intel Xeon processors. This release includes updated versions of the VxRail E, P, and V Series platforms with increased processor, memory, and PCIe capabilities, as well as increased storage capacity for the P Series. VxRail HCI System Software now includes RDMA (Remote Direct Memory Access) support.

Processing

VxRail leverages Intel 3rd generation Xeon processors with higher performance per core and up to 40 cores per CPU, which enables higher VM density per node. VxRail can also leverage VMware vSAN over RDMA. RDMA is a mature technology that allows direct memory access from the memory of one computer to the memory of another computer without involving the operating system or CPU.[2] RDMA is now being leveraged by VMware to provide vSAN over RDMA. This

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[2] Source: VMware vSAN Virtual Blocks Blog, *vSAN 7 Update 2 RDMA Support*, March 2021.

software enhancement alone reduces both latency and CPU utilization while delivering a significant portion of the performance improvement ESG is examining in this report.

Bandwidth

PCIe Gen4 provides a large internal bandwidth increase that has a significant impact on VxRail performance. ESG analyzed test data isolating PCIe as a single variable and found that this architectural update alone provided a major increase in overall performance capability of the platform. VxRail now supports quad 25 gigabit OCP3 networking, for a 2.5x increase in network bandwidth.

Storage

VxRail integrates next-gen Intel Optane PMem, which provides increased bandwidth and capacity compared to the previous generation. Other storage improvements include NVMe cache for the V Series to support more demanding apps and additional storage density on the P Series—due to four additional cache drive slots on the rear of the chassis—to benefit use cases where very large files are being stored and retrieved like VDI, oil and gas, video, and medical imaging.

Taken together, the gamut of architectural hardware and software enhancements represent much more than a simple, incremental update to server hardware. Next-generation VxRail significantly expands capabilities across multiple dimensions:

- **VxRail is Faster**—42% more cores, PCIe Gen 4, next-gen Intel Optane PMem, and NVMe cache—new for V Series— increase both processing and bandwidth while speeding VM deployment for VDI and AI/ML workloads.

- **VxRail is Bigger**—New GPUs enable support for more AI/ML workloads, while 166% more memory capacity, 20% more capacity disk slots (on P Series), and 50% more PCIe slots (on E Series), provide increased workload flexibility.

- **VxRail is Simpler**—Architectural improvements like standardized OCP3 networking, rear-serviceable BOSS (Boot Optimized Storage Solution) drives, and dual-side PSU wiring simplify networking, maintenance, cabling, airflow, and cooling.

ESG Technical Validation

ESG audited results of performance testing by the VxRail team using VxRail on the latest hardware platform and compared it with performance testing conducted on VxRail systems running on previous generation PowerEdge servers.

VxRail Performance Testing

ESG audited complete and detailed results from performance tests using multiple four-node VxRail clusters—configured as similarly as possible[3]—that used multiple industry-standard tools to demonstrate the raw performance capabilities of the platform, realistic database workloads, and mixed virtualized workloads. All testing in this report used common, standard configurations. The goal was to show performance that any customer could achieve when running these workloads.

The workloads we looked at in this report include:

- IOPs and Throughput Performance — These tests used the fio tool to generate random reads and writes, with a goal of demonstrating IOPS and throughput performance, comparing hardware generations. I/O profiles:

  o   IOPS: 4KB 100% random reads and writes

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[3] Detailed configurations can be found in the Appendix.

o   Throughput: 16KB 100% random reads and writes

- Database Performance —The Vdbench tool was used to generate OLTP-like database workloads requiring both read and write operations, comparing hardware generations.

o   OLTP—100% random 4KB I/O: 70 percent reads and 30 percent writes

o   RDBMS—A mostly random mix of 8 KB and 128 KB I/O: 60 percent reads and 40 percent writes.

- Virtualization Platform Benchmark

o   The VMmark 3.1.1 benchmark tool was used to measure the performance and scalability of VxRail. The VMmark 3 benchmark combines virtualized applications into bundles called tiles. The number of VMmark tiles a virtualization platform can run, combined with the cumulative performance of those tiles and of a number of platform-level workloads, determine the VMmark 3 score.

IOPS

First, we tested the VxRail clusters' IOPS performance, a common assessment of the basic horsepower of the system. While IOPS performance tests are not reflective of real-world workloads, they do offer a general idea of the capabilities of a system. This test—and all subsequent tests—compared results between a four-node E560F (previous generation) cluster to a four-node P670F (current generation) cluster. Both clusters were configured with 12 virtual machines, eight 200GB VMDK disks per VM, and a total working set of 14,400 GB for random reads, and 3,600 GB for random writes.

Figure 3. VxRail Raw IOPS Performance-4KB I/O
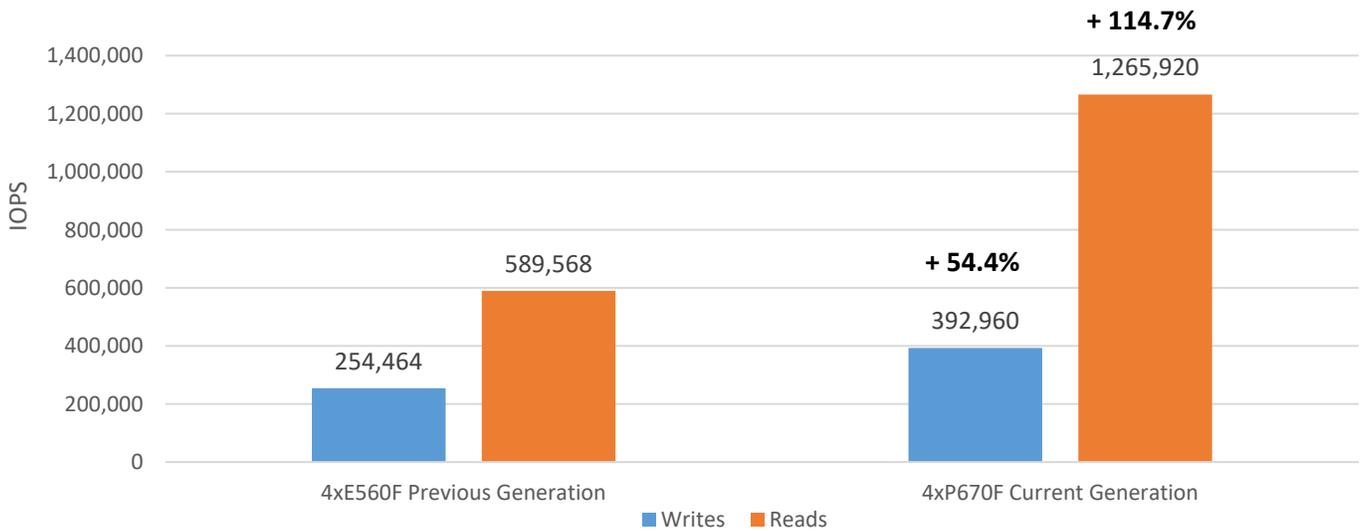
Source: Enterprise Strategy Group

As Figure 3 shows, testing revealed that VxRail IOPS performance increased significantly compared to previous generation hardware, supporting 54.4% more write IOPS and 114.7% more read IOPS. These results were due to a combination of factors: the increased processing power of 3rd Gen Intel Xeon processors, the increased bandwidth of PCIe Gen4, and the use of the RDMA protocol all contributed. Next ESG looked at throughput.

Figure 4. VxRail Raw Throughput Performance—16KB I/O
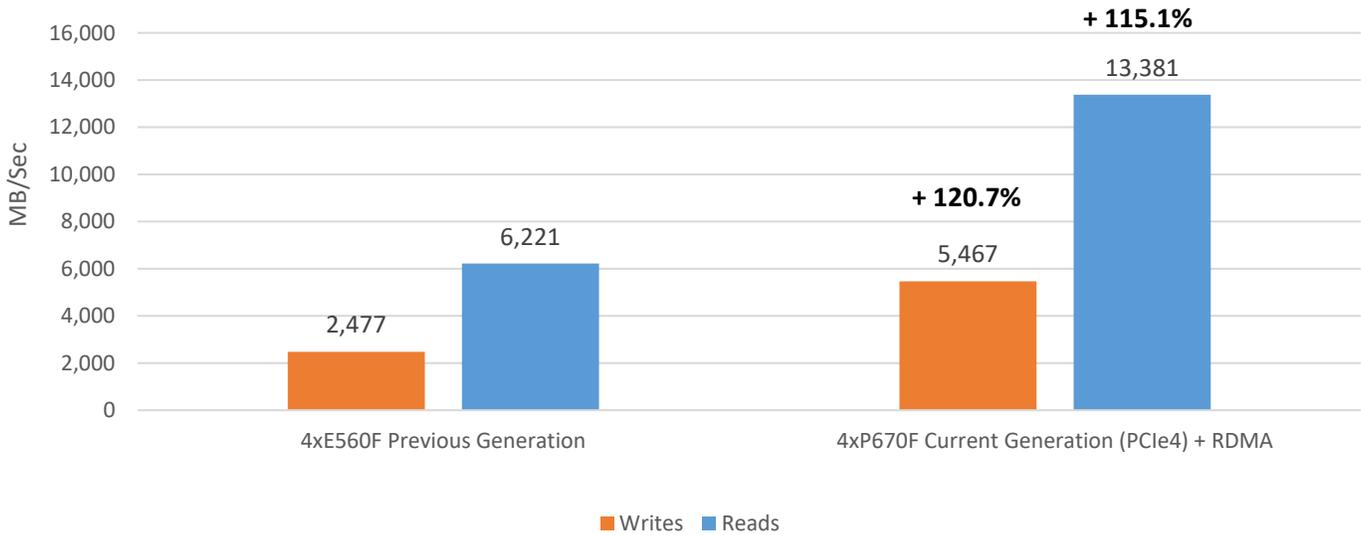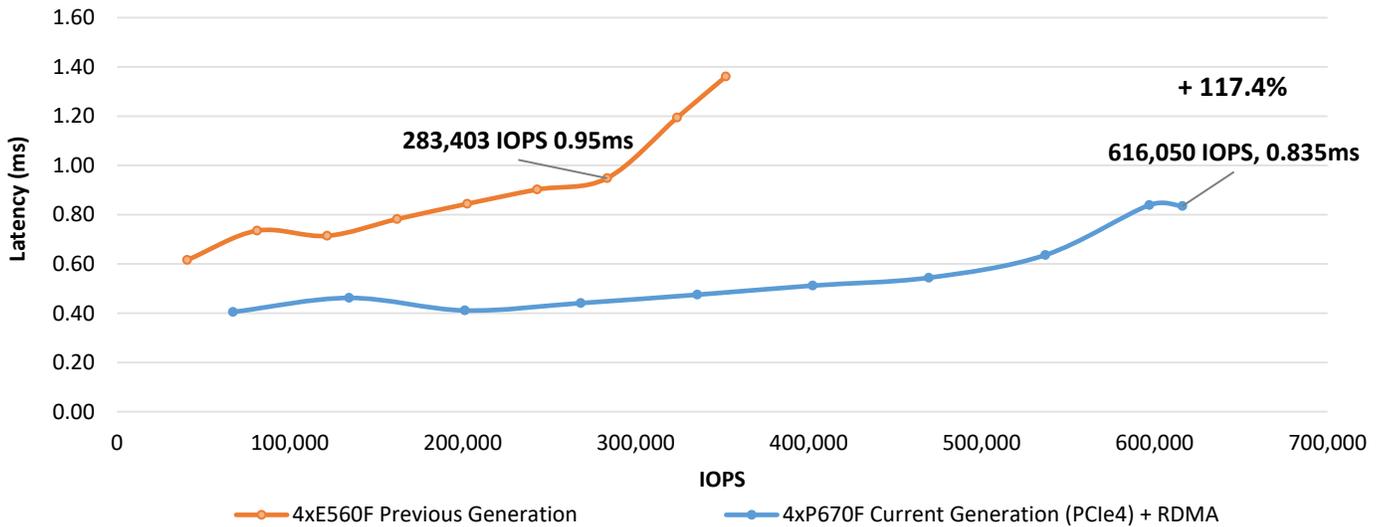

Source: Enterprise Strategy Group

As shown in Figure 4, VxRail read and write throughput performance has also increased significantly compared to previous generation hardware, supporting 120.7% more write bandwidth and 115.1% % more read bandwidth. These results were due to the same combination of factors as the IOPS improvement, but it's important to note that in these tests, the 25GbE network was the limiting factor. When ESG tested at larger block sizes, the ethernet pipe was completely saturated. Organizations requiring higher throughput can aggregate multiple 25GbE networking ports or deploy 100GbE networking to achieve higher throughput.

Database Performance

Next, we examined the VxRail clusters' database performance, simulating the real-world OLTP and RDBMS workloads organizations typically run. In these tests, both clusters were configured with 8 workload VMs that had assigned 8 virtual disks, each with 200GB allocated space for a total of 1.6TB per VM. The workload working set size assigned for Vdbench was 600GB per VM. These tests used a performance framework that used Vdbench and a suite of different parameter files to produce realistic workloads, including both short duration reads and writes with different block sizes to assess front-end performance under optimal conditions as well as longer steady-state random and sequential writes to assess back-end performance. At the start of each test suite, Vdbench was used to write random data fully to the end of each VMDK with sequential 64 KB writes. Each test was run at increasing workloads, and ESG compared the highest performance achieved at response times under 1ms.

It's important to note that not too long ago, performance this high with sub-millisecond response times required a significant investment in specialized storage hardware, which required dedicated, often highly paid administrators, ongoing support contracts, and professional services, all with significant costs.

Figure 5 shows the results of testing of a 4KB OLTP workload with a 70% read, 30% write ratio, comparing a four-node E560F (previous generation) cluster to a four-node P670F (current generation) cluster.

Figure 5. VxRail 4KB OLTP Performance

Source: Enterprise Strategy Group

As Figure 5 shows, VxRail 4KB OLTP performance has increased significantly compared to previous generation hardware. The current generation was able to support more than double (117.4% more) OLTP IOPS than the previous generation at a lower sub-millisecond average response time. Next, ESG looked at an RDBMS workload. It's important to note here that each individual note was servicing more than 154,000 IOPS. When considered alongside the near linear scalability demonstrated by VxRail in previous testing, we can extrapolate an impressive potential for large cluster performance scalability.

Figure 6. VxRail RDBMS Performance
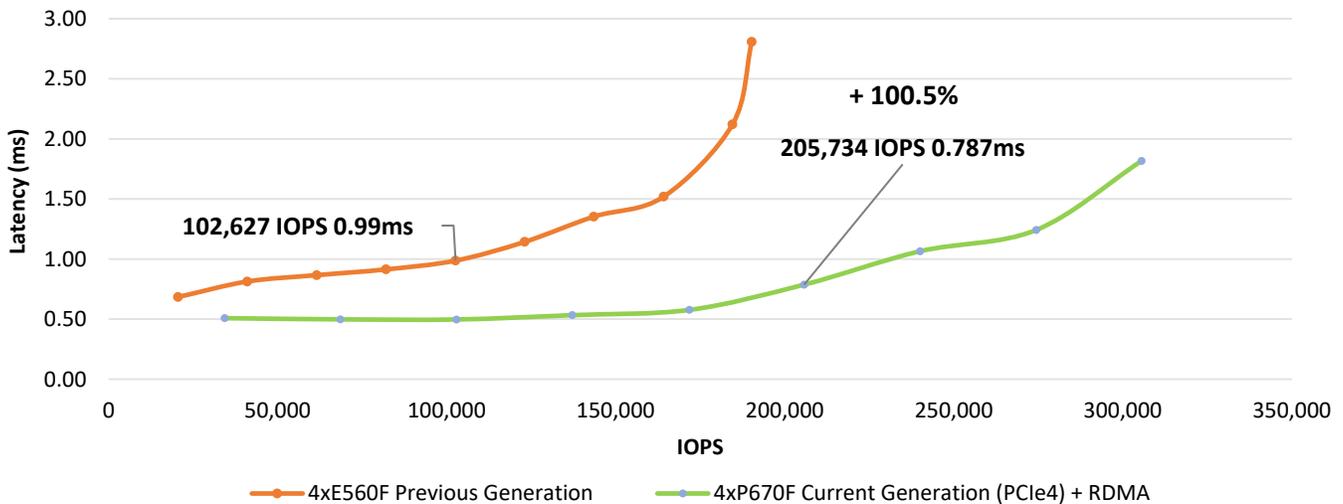
Source: Enterprise Strategy Group

As seen in Figure 6, VxRail RDBMS performance unsurprisingly has also increased significantly compared to previous-generation hardware. The current generation was again able to support more than double (100.5% more) RDBMS IOPS than the previous generation at a lower sub-millisecond average response time.

ℹ️ Why This Matters

Delivering high levels of performance is a requirement for IT environments that rely heavily on mission- and business-critical databases and applications. This is especially important in dynamic environments where data growth is constant and continuous accessibility is a requirement. The ability to meet these performance requirements is essential for anyone evaluating hyperconverged infrastructures.

ESG previously validated that configuring VxRail with a combination of DRAM and Intel Optane PMem in Memory Mode can be cost-effective for many business- and mission-critical workloads. VxRail on 15th generation PowerEdge servers increases compute, bandwidth, and network capacity across the board, and performance of these workloads more than doubled in nearly every metric we measured. Hardware enhancements are only part of the story. vSAN over RDMA enables VxRail to deliver an additional 16.3% of 4KB IOPS by ESG's calculations. Combined with consistently lower latency and 5% lower CPU utilization, VxRail using vSAN over RDMA can support the same workloads with smaller clusters. This can reduce hardware costs, software licensing expenses, and power requirements. While ESG did not calculate TCO or ROI for this report, it's easy to see that there is a potentially significant financial benefit to be had, just by enabling RDMA.

In summary, ESG validated that VxRail on PowerEdge servers with 3rd Gen Intel Xeon processors, PCIe Gen4, and vSAN over RDMA has pushed past the bottlenecks of previous-generation HCI systems, enabling organizations to deploy even more business- and mission-critical workloads on smaller clusters with confidence.

Mixed Workload Virtualized Application Performance

Finally, ESG evaluated VxRail performance in a virtualized, mixed-workload environment using the VMmark 3 virtualization platform benchmark. VMmark is a product of VMware, Inc. VMmark 3 is designed to capture key performance characteristics of virtual systems using realistic, diverse workloads running across multiple hosts in the cluster. VMmark 3 differs from storage performance benchmarks in that it measures the performance of a system holistically, exercising CPU and memory, in addition to storage.

A higher VMmark 3.1.1 score suggests that a virtualization platform can sustain greater performance in a mixed workload cloud environment with data center operations occurring in the background. When a larger number of VMmark 3 tiles are used to generate a benchmark, it usually means that the platform under test supported more virtual machines across its hosts during the benchmark run. Typically, achieving a higher benchmark score requires a higher number of tiles.

A VxRail cluster with four P670F nodes was able to support a substantial mixed workload running on 342 virtual machines, achieving a VMmark 3.1.1 score of 17.41 @ 18 Tiles.[4] Readers can compare and contrast this result with other published results at VMmark 3.x Results.

ⓘ Why This Matters

According to ESG research, more than a third of organizations (34%) are planning to deploy hyperconverged infrastructure in support of data center modernization in 2021.[5] However, performance challenges of consolidated virtualized workloads have historically prevented organizations from placing critical analytics, OLTP, and other applications on HCI.

ESG has been watching Dell Technologies push HCI technology past these challenges for years. Our validation of VxRail in 2020 showed how the addition of Intel Optane Persistent Memory (PMem) could enable organizations to begin to move mission-critical, performance-sensitive applications to HCI.[6] It comes as no surprise that Dell Technologies has moved the goal posts yet again with a powerful combination of hardware and software enhancements to expand the reach of HCI to more applications that are not only critical to the business, but require the highest levels of performance and availability.

ESG validated that a four node VxRail cluster running on 15th Generation Dell PowerEdge nodes supported a substantial mixed workload running on 342 virtual machines, achieving a VMmark 3.1.1 score of 17.41 at 18 tiles.

These results go even further to validate that VxRail on PowerEdge servers with 3rd Gen Intel Xeon processors, PCIe Gen4, and vSAN over RDMA can enable organizations to confidently deploy even more business- and mission-critical workloads on HCI.

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[4] Source: Dell Technologies, *VMmark 3.1.1 Results*, July 2021.
[5] Source: ESG Research Report, *2021 Technology Spending Intentions Survey*, January 2021.
[6] Source: ESG Technical Validation Report, Dell EMC VxRail and Intel Optane Persistent Memory, November 2020.

The Bigger Truth

Organizations continue to focus on digital transformation to make optimal use of digital assets to better understand customer needs, inform their strategies, and improve operations. According to ESG research, some of the most common objectives for digital transformation reported by respondents are to become more operationally efficient (56%) and to provide better and more differentiated customer experience (40%). As many organizations desire to leverage the agility of deployment, scaling, and management that HCI promises, it comes as no surprise that more than a third of organizations in the same survey said they plan to deploy HCI solutions in support of their digital transformation efforts.[7]

To accomplish these goals, IT organizations employ a wide range of applications with varying needs. Many have realized that consolidating diverse applications on HCI can greatly improve efficiency of infrastructure and management, but only if performance demands are met.

The current generation Dell EMC VxRail HCI solution on 15th Generation PowerEdge servers has increased processing power with 3rd Gen Intel Xeon processors, reduced I/O bottlenecks with PCIe Gen 4, higher bandwidth network options, and has further enhanced performance and efficiency with vSAN over RDMA. Intel Optane PMem continues to offer key benefits, including larger capacity than DRAM at a fraction of the cost, high-performance storage, and data persistence after power-off. ESG will be examining Intel Optane PMem on Dell EMC VxRail in more detail later in 2021.

ESG compared the performance of the current generation VxRail against the previous generation VxRail and found significant performance and scalability increases, including:

- IOPS increased by 54.4% for writes and more than doubled for reads.

- Throughput more than doubled for reads *and* writes.

- Small block OLTP performance with sub-millisecond response time increased by 117.4%.

- Medium to large block RDBMS performance with sub-millisecond response time increased by 133.9%.

- Mixed workload virtualized application performance also more than doubled, with current generation VxRail supporting more than twice the number of VMs *and* driving more than twice the application performance across multiple key performance characteristics including processing, networking, and storage.

The results presented in this report are based on testing in a controlled environment. Due to the many variables in each production data center, it is important to perform planning and testing in your own environment to validate the viability and efficacy of any solution.

While individual business applications don't need millions of IOPS and GB/s of throughput individually, when they are consolidated, their aggregate performance demands quickly add up. VxRail can consolidate more applications and gain deployment, management, and cost-efficiency benefits. It also expands the range of VxRail-applicable workloads at the core, edge, and in the cloud. The ability to start with a smaller amount of Intel Optane PMem and grow with scalable performance further improves flexibility, agility, and cost efficiency.

If consolidating applications, supporting more transactions, obtaining faster insights, and making better business decisions while gaining infrastructure and management cost efficiency is important to your organization, ESG recommends a close look at Dell EMC VxRail for enterprise-class performance that once required expensive, siloed infrastructure.

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[7] Source: ESG Research Report, *2021 Technology Spending Intentions Survey*, January 2021.

Appendix

Table 1. Dell EMC VxRail Test Configurations

Previous Generation VxRail	
VxRail Platform	4 * VxRail E560F*, Software v. 7.0.100
CPU	2 * Intel Xeon Gold 6248 2.5GHz – 20 cores
Memory	512GB (16x32GB DDR4 2933 MHz)
Disk Groups	2
Cache Disk	1 * Samsung PM1735 PCIe3 (1GB/sec per lane)
Capacity Disk	3* SAS SSD 3.84TB
Network	Broadcom BCM57414 25GbE

Current Generation VxRail	
VxRail Platform	4 * VxRail P670F, Software v. 7.0.210
CPU	2 * Intel Xeon Platinum 8358 2.6GHz – 32 cores
Memory	1024GB (32x32GB DDR4 3200MHz)
Disk Groups	2
Cache Disk	1 * Samsung PM1735 PCIe4 (2GB/sec per lane)
Capacity Disk	3* SAS SSD 3.84TB
Network	Mellanox CX-5 25GbE

*Note: VxRail positions the P Series above the E Series in terms of performance, as the P Series does have higher potential performance, due to the capacity for twice the number of disk groups. However, as tested, the configurations would have comparable performance if they were of the same PowerEdge generation.

Enterprise Strategy Group is an IT analyst, research, validation, and strategy firm that provides market intelligence and actionable insight to the global IT community.