

# SOLUTION BRIEF



Data Center | Hybrid  
Intel® Optane™ SSDs and 3D NAND SSDs  
Intel® Optane™ Persistent Memory

# Get the Right Infrastructure for Hybrid Cloud Workloads

Streamline your hybrid cloud journey, achieve consistently high performance, and increase data center efficiency with VMware Cloud Foundation and Intel® Optane™ technology

## Solution Benefits

Intel® Optane™ SSDs deliver excellent business value to VMware Cloud Foundation:

- **Consistently high performance.** Intel Optane SSDs in the cache tier provide for improved OLTP as well as better database IOPS and throughput performance.
- **Reduced data center footprint.** Intel Optane SSDs as cache increase node density and improve the VM performance per node.
- **Efficient operations management.** Use the performance boost to reduce hardware and software expenses, increase VM support, or a combination of the two.

VMs running on a VMware ESXi server can access Intel® Optane™ persistent memory, to increase the system memory footprint at an affordable cost.

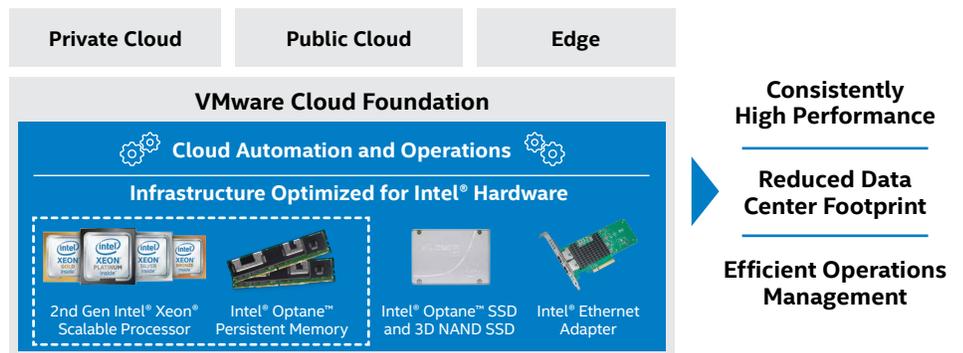


## Executive Summary

More than 50 percent of enterprises state that hybrid cloud and multicloud are their ideal enterprise IT architecture; 93 percent of enterprises that use cloud computing have a multicloud strategy.<sup>1</sup> Organizations are striving to find the right mix of compute, storage, and networking resources that meet their hybrid cloud performance and reliability needs while still keeping a strict eye on IT budgets. To achieve their goals, many organizations are choosing to modernize their data centers with hyperconverged infrastructure (HCI).

But a software-defined HCI environment's performance is determined largely by the hardware being virtualized, and deploying and managing a hybrid cloud environment can be challenging. VMware Cloud Foundation (VCF) solves both issues by providing a high-performance integrated cloud infrastructure, as well as cloud management services to run enterprise applications in both private and public environments.

VCF benefits from using several Intel® technologies to provide consistently high performance, decrease data center footprint through higher VM density, and deliver efficient operations management. Reducing data center footprint can directly translate to cost savings. With VCF running on Intel® architecture, organizations can confidently move to the hybrid cloud without being concerned about performance, density, or cost—freeing them to focus on the business.



**Figure 1.** Adding Intel® hardware, including Intel® Optane™ technology, to your hybrid cloud infrastructure can improve performance and data center efficiency—enabling organizations to move to the hybrid cloud with confidence.

## Business Challenge: Get the Right Hardware for Hybrid Cloud Excellence

In today's data-driven world, businesses often struggle to cost-effectively and adequately handle emerging enterprise workloads like databases and complex analytics applications. Modernizing data centers by moving to a hyperconverged infrastructure (HCI) in the hybrid cloud can provide scale-out, software-defined, and virtualized compute, storage, and networking resources. However, the number of virtual machines (VMs) per server and overall CPU utilization are often less than optimal due to storage bottlenecks and system memory limitations. Organizations need to have the right hardware components in place that meet their requirements for performance, data center optimization through server consolidation, scalability, and efficient operations management.

## Data-Hungry Workloads Need Improved Scalability and More Storage

HCI has matured over the years. It is now deployed in mission-critical data centers because of its ability to offer various storage features on a par with traditional storage arrays, while scaling out storage as needed. No matter how much HCI software is augmented, it needs to have the right hardware configurations to support the software enhancements to optimize performance. When HCI software storage features are enabled, they consume significant compute and storage cycles. Proper consideration must be taken to understand this when choosing the right hardware components to design HCI clusters.

Modern data center workloads such as online transactional processing (OLTP), online analytical processing (OLAP), and other workloads require large-capacity bulk storage and responsive caching to keep up with data growth and latency requirements. These workloads all require infrastructure that provides scalability, performance, security, manageability, and agility to handle these data-hungry usages. As workloads increase in size in a virtualized environment, it's natural to want to run more VMs per server—that is, to scale. Legacy storage architecture limits enterprises' ability to scale cost-effectively. Enterprise IT organizations need a way to modernize and prepare for future storage needs.

## Solution Value: Optimizing Performance with Higher Node Density

Figure 2 shows the various tiers in the VMware vSAN solution architecture in VMware Cloud Foundation (VCF).

### The Right Storage in the Right Place

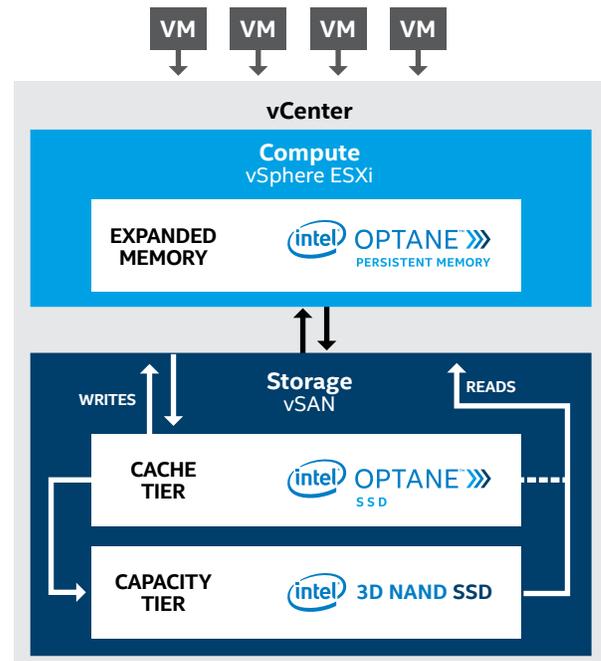
The Intel® Optane™ SSD DC P4800X provides low latency and high endurance, which benefit the cache tier's high-volume, data-intensive, mission-critical workloads. This cache tier absorbs the write pressure, reducing the need to continually

return to the capacity tier until all the writes are completed. All data is de-staged or drained from write cache to the capacity tier over a period of time, enabling more efficient use of the capacity tier. Intel Optane SSDs feature an industry-leading endurance rating of up to 60 DWPD.<sup>2</sup> This enables the capacity tier to use lower endurance-rated SSDs, because the cache tier can accommodate the large volume of write requests.

The 3D NAND SSD capacity tier, at the bottom of Figure 2, focuses on serving all read requests. Read-optimized NVMe-based Intel® 3D NAND SSDs surpass the capacity restrictions that occur in traditional TLC NAND-based SSDs, packing 33 percent more bits/cell than the prior generation of 3D NAND.<sup>3</sup> These SSDs are designed to maximize CPU utilization. With high endurance now available in the caching tier, lower-cost, lower-endurance-rated SSDs are ideal as a cost-effective capacity tier solution.

### Affordable Expanded Memory

VMs running on a VMware ESXi server can access Intel® Optane™ persistent memory (PMem), to increase the system memory footprint at an affordable cost. This enables vSAN to be used in various new emerging use cases that require a larger memory pool. VMware vSphere supports Intel Optane PMem in both App Direct Mode and Memory Mode—customers can choose which mode to enable based on their workload requirements. For more information about using Intel Optane PMem with vSphere, read [VMware's Knowledge Base article](#).



**Figure 2.** Intel® technology helps optimize and modernize data centers through improved performance, density, and efficiency.

## Solution Value: Consistent High Performance for vSAN

Many enterprise use cases need a high degree of storage responsiveness. These use cases include operational databases, storage caches, log files, and similar high-performance or mission-critical usage models. Intel® hardware coupled with VCF—which includes VMware vSAN and VMware vSphere along with the vRealize Management Suite—is a great option. A configuration that combines Intel Optane SSDs with Intel 3D NAND SSDs delivers both scalability and performance.

### Quick Caching with Intel Optane SSDs

Intel Optane SSDs help provide the level of accelerated performance, low latency, and high endurance needed for the most demanding cache applications and services. These gains in performance enable companies to do more per server, break storage bottlenecks, and lower transaction costs of latency-sensitive workloads.

Figure 3 shows the results of several tests of the Intel Optane SSD-based caching solution, compared to 3D NAND caching solution. Using a complex OLTP workload, Intel Optane SSDs provide a 61 percent performance boost over traditional NVMe NAND flash cache—both for new orders per minute and for transactions per minute.<sup>4</sup> For database processing, Intel Optane SSDs enable more data to be transferred and more IOPS to be processed to help you serve more customers and provide a better user experience.<sup>5</sup>

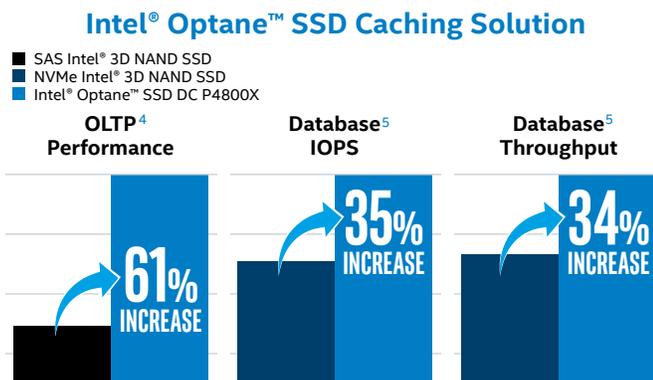


Figure 3. Achieve consistently high performance for mission-critical workloads with vSAN, powered by Intel® Optane™ SSDs.

## Solution Value: Decreased Data Center Footprint

In today's increasingly competitive world, reducing data center footprint is one way to save money and increase profitability. Using Intel Optane SSDs as cache devices delivers greatly improved per-node VM performance. As mentioned earlier, the vSAN cache tier absorbs all writes. Intel Optane SSDs' low latency benefits the cache tier's transactional workloads and allows the capacity tier to use lower-endurance 3D NAND SSDs.

Intel solutions architects compared an 84 TB cache tier using Intel® SSD DC P4610 across six nodes to an 80 TB cache tier

using Intel Optane SSD DC P4800X across four nodes. As shown in Figure 4, data center architects can rely on up to 60 percent better VM performance from each vSAN storage node when using Intel Optane SSDs in the cache tier. Improved VM performance capability means you can meet service-level agreements (SLAs) with 33 percent fewer nodes.<sup>7</sup> Stated differently, cluster size decreased by two nodes and still achieved better VM performance. That can deliver real savings in server cost, footprint, and ongoing maintenance.

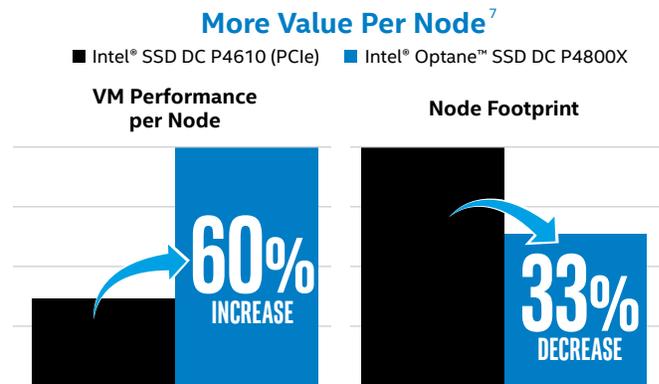
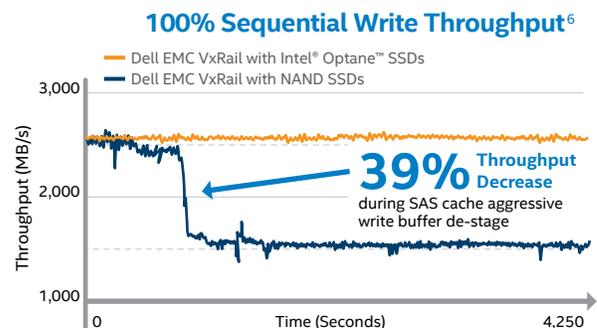


Figure 4. Intel® Optane™ SSDs let you do more per node and decrease data center footprint.

### Spotlight: Intel® Optane™ SSD Performance

Consistent, predictable performance is critical to maximizing productivity across an organization. Consistency is especially critical for vSAN. Traditionally, vSAN customers had to resort to short-stroking disks to improve consistency. Intel Optane SSDs deliver consistent, predictable throughput performance, even under heavy write loads. The consistency and high QoS of Intel Optane SSDs allows for simpler, more efficient, higher performance storage design.

As seen in the figure below, SAS NAND throughput drops by 39 percent once data begins to de-stage from the cache (when the cache initially fills up, it must move data to capacity storage). Bit-addressable Intel Optane SSDs are able to break storage bottlenecks by maintaining consistent throughput throughout the test window.<sup>6</sup>



## Solution Value: Streamlined vSAN Day 2 Operations Management

vSAN operations management tasks are an important task in maintaining efficient IT operations. System administrators use vCenter operations tools to maintain efficient management and maintenance of their IT infrastructure. Operations management tasks include cloning, creating VM snapshots, and moving VM disk files between vSAN datastores and SAN datastores with no downtime. These operations are I/O intensive, and are typically performed outside of normal office hours—especially true for backups. The quicker management operations complete, the sooner focus can return to mission-critical application performance. Additional benefits include maximized server productivity over a server's lifetime and optimized ongoing staff scheduling and utilization.

Of particular interest to organizations seeking to improve operations management are Day 2 operations, a generic term for the management of VMs by an IT administrator. Day 2 operations in general are the greatest cost to IT organizations, measured by total staff hours.<sup>8</sup> The Evaluator Group developed a test to evaluate vSAN management operations efficiency:

- Run steady VM I/O to simulate day-to-day VM workload.
- Simultaneously run storage-centric vCenter operations to evaluate Day 2 vSAN operations performance.

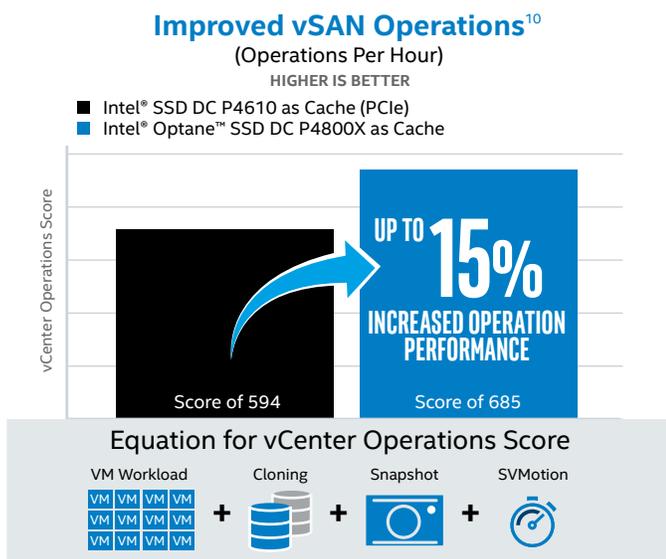
The test measured the total number of vCenter operations completed, running on a cluster of 16 VMs. This test reflects real-world usage scenarios in that normal VM I/O workloads do not shut down during Day 2 operations' management tasks. Instead, VM workloads and Day 2 operations tasks run simultaneously. This places additional stress the vSAN storage solution while running operations tasks such as VM cloning, snapshot operations, and Storage vMotion migration.

Intel Optane SSD endurance, as measured by drive writes per day, is 20 times longer than that of even the best of Intel's 3D NAND SSDs, which are considered mid-endurance.<sup>9</sup> Figure 5 shows that incorporating Intel Optane SSDs into the caching tier delivers significant improvements to vSAN Day 2 operations performance versus mid-endurance 3D NAND SSDs. Less time spent running operations management tasks means the system can focus on normal, mission-critical VM performance. Customers can choose to take advantage of this 15 percent improvement in operations performance to reduce hardware and software expenses, increase VM support, or a combination of the two.<sup>10</sup>

## Conclusion

VCF customers can now obtain consistently high performance for storage- and memory-intensive workloads, decrease data center footprint, and increase operation efficiency. By including Intel Optane technology as part of their platform, VCF customers can satisfy mission-critical SLAs while keeping overall hardware and software costs under control. The VCF solution enables customers to optimize vSAN storage performance using the right combination of Intel Optane SSDs and Intel 3D NAND SSDs. The solution also helps customers increase data center efficiency by improving node density and Day 2 operations management performance.

Find the right solution for your organization. Contact your Intel representative or visit [intel.com/vmware](https://intel.com/vmware).



## Broad Intel® Portfolio for VMware Cloud Foundation

Intel compute, memory, and storage products work together to extend the value of the VMware Cloud Foundation. Together, they can help customers operate more efficiently by affordably increasing node density, improving VM scalability, and improving operations management performance:

- Intel® Optane™ SSDs for improved IOPS performance and very low latency in the cache tier<sup>11</sup>
- Intel® 3D NAND SSDs for increased storage density in the capacity tier
- Intel® Optane™ persistent memory for affordable memory expansion
- 2nd Generation Intel® Xeon® Scalable processors to accelerate demanding VM workloads

**Figure 5.** Improved caching tier performance can improve the efficiency of data center system admin operations.

## Learn More

You may also find the following resources useful:

- [VMware Cloud Foundation](#)
- [VMware vSAN software](#)
- [Intel Optane Technology](#)
- [Intel Optane persistent memory](#)
- [Article: Enhance VMware VMs with Intel® Optane™ Persistent Memory](#)
- [2nd Generation Intel Xeon Scalable processors](#)

## Spotlight on VMware

More than 500,000 customers around the world trust VMware to accelerate their digital transformation through a software-defined approach to business and IT. VMware pioneered virtualization as well as cloud and business mobility. VMware's proven solutions, including VCF, enable their customers to run, manage, connect, and secure applications across clouds and devices in a common operating environment, offering them freedom, control, and low costs.

### Solution Provided By:



<sup>1</sup> Flexera, May 21, 2020, "Cloud Computing Trends: 2020 State of the Cloud Report," [flexera.com/blog/industry-trends/trend-of-cloud-computing-2020](https://flexera.com/blog/industry-trends/trend-of-cloud-computing-2020)

<sup>2</sup> Intel. "Product Brief: Intel Optane SSD DC P4800X Series." [intel.com/content/www/us/en/solid-state-drives/optane-ssd-dc-p4800x-brief.html](https://intel.com/content/www/us/en/solid-state-drives/optane-ssd-dc-p4800x-brief.html). Based on internal Intel testing.

<sup>3</sup> Source: Intel. TLC contains 3 bits per cell and QLC contains 4 bits per cell. Calculated as  $(4-3)/3 = 33\%$  more bits per cell.

<sup>4</sup> Tests commissioned by Dell and performed by Enterprise Strategy Group, test publication date August 26, 2019. Source report with test configurations available at [esg-global.com/validation/esg-technical-validation-dell-emc-vxrail-with-intel-xeon-scalable-processors-and-intel-optane-ssds](https://esg-global.com/validation/esg-technical-validation-dell-emc-vxrail-with-intel-xeon-scalable-processors-and-intel-optane-ssds). Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.

<sup>5</sup> Tests commissioned by HPE and performed by Principled Technologies, test publication date April 2020. Source report with test configurations available at [principledtechnologies.com/HPE/Intel-Optane-HPE-ProLiant-VMware-vSAN-Oracle-workload-testing-0420-v3.pdf](https://principledtechnologies.com/HPE/Intel-Optane-HPE-ProLiant-VMware-vSAN-Oracle-workload-testing-0420-v3.pdf). Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.

<sup>6</sup> See endnote 4.

<sup>7</sup> Performance results are based on Evaluator Group testing as of May 29, 2019 as commissioned by Intel and may not reflect all publicly available security updates. See configuration disclosure below. No product can be absolutely secure. Tested using IOmark-VM. Common configuration: Intel 2U server system, 2x Intel® Xeon® Gold 6254 Processor (18C/36T), ucode version: 0x4000013, BIOS version: SE5C620.86B.02.01.0003.020220190234, HT ON (in BIOS), Turbo ON. Baseline storage configuration: 1x Intel® SSD DC P4610 1.6TB as cache, Intel® SSD DC P4510 3x 4TB + 1x 2TB as capacity; Compare-to storage configuration: 1x intel® Optane™ DC SSD P4800X 375GB as cache, 5x Intel SSD DC P4510 4TB as capacity. SSDs tested were commercially available at time of test. The benchmark results may need to be revised as additional testing is conducted.

<sup>8</sup> VMware Blog, September 2016. "Getting More Out of vRealize Automation: Day 2 Operations," [blogs.vmware.com/management/2016/09/getting-vrealize-automation-day-2-operations.html](https://blogs.vmware.com/management/2016/09/getting-vrealize-automation-day-2-operations.html)

<sup>9</sup> Intel. See product specs in "Product Brief: Intel® Optane™ SSD DC P4800X." [intel.com/content/www/us/en/solid-state-drives/optane-ssd-dc-p4800x-brief.html](https://intel.com/content/www/us/en/solid-state-drives/optane-ssd-dc-p4800x-brief.html).

<sup>10</sup> Tests commissioned by Intel and performed by Evaluator Group as of April 6, 2020. Hardware: Total of 4-node configuration, with each node as follows: CPU: 2x Intel® Xeon® 6154 processor: 72 logical processors (36 cores, 72 threads); DRAM: 192 GB (16 GB x 12 DIMMs); Network: Onboard 2x 10G Base-T, + Mellanox ConnectX 5EN 2x 25 Gb; Storage: vSAN; vSAN Config: 2 disk groups per node; Dedupe + Compression: Enabled; each disk group: Cache Tier: baseline = 1x Intel® SSD DC P4610 1.6 TB, device-under-test = 1x Intel® Optane™ SSD DC P4800X 375 GB; Capacity Tier: 3x Intel® SSD P4510 4 TB; Total vSAN capacity: 87 TB (across 4 nodes). OS Software: VMware ESXi 6.7.0U3 (15160138), VMware vCenter 6.7.0U3. Test Software: IOmark-VM3, vCenter Operations with custom configuration. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors.

<sup>11</sup> See endnote 5.

Intel technologies may require enabled hardware, software or service activation.

No product or component can be absolutely secure.

Your costs and results may vary.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors.

Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit [www.intel.com/benchmarks](https://www.intel.com/benchmarks).

Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details. No product or component can be absolutely secure.

Intel contributes to the development of benchmarks by participating in, sponsoring, and/or contributing technical support to various benchmarking groups, including the BenchmarkXPRT Development Community administered by Principled Technologies.

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