What is HCI?

modernizing legacy infrastructure. It also helps simplify data management and smooth the path to hybrid cloud. With HCI, data is distributed across clusters of servers, while virtualizing and centralizing compute, storage, and networking. Modular scalability can help optimize capital expenditure (CapEx), while ease of deployment and management can decrease operational expenditure (OpEx). Although modern analytics and artificial intelligence (AI) often drive the deployment of HCI,

Hyperconverged infrastructure (HCI) is an increasingly popular approach to cost effectively

it can be a good fit for a wide range of workloads. These include: real-time collaboration, databases, testing and development, enterprise resource planning (ERP), virtual desktop infrastructure (VDI), and multi-workload clusters.

Typically, workloads running on HCI are highly data intensive. They are also often latency

Why is Choice of Storage Solution Important?

in order to derive insight. This means the right data must be held in the right place at the right time, with hot data as close to the CPU as possible—all while managing costs. Organizations planning to run HCI workloads face three common challenges in achieving this delicate balancing act:

sensitive—like AI and analytics—needing fast, reliable, and scalable access to complex datasets

Scaling effectively as data

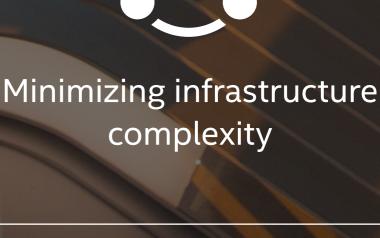
volumes continue to grow

Meeting the demanding performance requirements

of mission-critical workloads Intel® Optane™ technology helps address these needs across the storage/memory continuum.

enable more HCI workloads per server while helping to reduce costs. When you're upgrading

your VMware vSAN cluster from the prior generation, be sure to add 2nd Gen Intel® Xeon®



HCI Challenges

1. Modular Scalability Intel® Optane™ SSDs and Intel® 3D NAND SSDs help extend storage performance and capacity, consolidate storage resources, and boost VM density. This lets you retain performance and

Intel® Optane™ Technology Helps Address Common

processors and Intel® Optane™ SSDs in the caching tier. Meanwhile, Intel® Optane™ persistent memory increases capacity¹ for memory-intensive workloads and offers native persistence to support greater resilience and productivity.

Moving the caching tier in your VMware vSAN cluster from 3D NAND to Intel® Optane™ SSDs can yield:

Intel® Select Solution for VMware Horizon VDI on vSAN

from 384 GB to 1 TB. Intel® Optane™ persistent memory helps achieve³:

estimated cost² On a cluster using 2nd Gen Intel® Xeon® Scalable processors with Intel® Optane™ SSDs, scaling

Up to 25% lower

J-16% Up to 87% increase in number of VDI 16% reduction in costs

up the number of virtual desktop infrastructure (VDI) users by increasing the amount of memory

2. Consistently High Performance

Up to

users from 160 to 300 sessions

Intel® Optane™ SSDs increases performance and lower latency to support the most demanding

\$/VDI

Using Intel® Optane™ SSDs helps deliver significant performance and responsiveness advantages over 3D NAND SSD alone⁴:

Up to **3** 60 X Up to © 63x 6x faster throughput⁵ better quality of service faster response time⁷

 $(QoS)^6$

Using Intel® Optane™ SSDs to support multiple mixed workloads on a VMware VxRail

Flash without Intel® Optane™ SSDs9

HPE ProLiant servers with Intel® Optane™ SSDs running Oracle benchmark (SLOB) on a

HCI workloads, across multiple common platforms and environments. They deliver high

endurance, low latency, and high quality of service (QoS) for the cache/metadata tier.

processing (OLTP) workload

cluster enables:

59% lower latency than NAND SSDs alone8

Cisco HyperFlex All NVMe with Intel® Optane™ SSDs running SQL Server online transaction

Provided up to 34% faster throughput than a solution with only NAND SSDs¹⁰

Intel collaborates with leading HCI solution providers to deliver Intel® Select Solutions – proven

solutions for HCI and hybrid cloud, available from a wide variety of server vendors. These pre-

validated, workload-optimized solutions can help reduce the time required to evaluate, select,

and purchase the necessary hardware and software components, and minimize the time required

Using Intel® Optane™ persistent memory to increase memory by 33 percent over DRAM alone,

Delivers up to 57% increase in IOPS compared to HyperFlex All

3. Simplified Solutions

to deploy new infrastructure.

helps achieve:

VMware vSAN cluster:

Intel® Select Solution for Azure Stack HCI

Intel® Select Solution for VMware vSAN Using Intel® Optane™ persistent memory with Intel® Optane™ SSDs

35%

Up to 35% more VMs per node

delivers up to 60% higher VM density per server compared to the base configuration¹²

126%

Up to 26% lower estimated hardware

costs than DRAM alone¹¹

Explore how storage and memory innovation can drive HCI and digital transformation for your organization: • Webpage: Intel® Select Solutions for Hybrid Cloud

Learn More

• Cloud customer story: IONOS: Extending the cloud to SMBs • ESG report: Mission-critical Hyperconverged Workload Performance Testing on Cisco HyperFlex All-NVMe with Intel® Optane™ DC SSD

• Solution brief: Virtual Desktop Infrastructure: How to Scale and Optimize for Today's Realities

• Infographic: Get more VMware vSAN database performance with Intel® Optane™ SSDs and HPE

• Partner solution brief: Intel® Optane™ Technology Boosts Dell EMC VxRail HCI Performance

• Business brief: HCI: A critical component for the modern enterprise

• HCI customer story: Global Mobility Leader Hyper-Accelerates its ERP

- Optane™ SSD pricing. ³ In the Principled Technologies white paper (https://www.principledtechnologies.com/VMware/VMwareHCI-Intel-Optane-VDI-0420.pdf), the 200 user proof point was obtained by using 512 GB Intel® Optane™ PMem + 96 GB DRAM, using 8 GB DIMMs. Principled Technologies also tested 16 GB DIMMs and this data reference is located in the report supplement here: https://www.principledtechnologies. com/VMware/VMware-HCI-Intel-Optane-VDI-science-0520-v2.pdf. We chose to highlight the configuration using the 16 GB DIMMs in this solution brief as 8 GB DIMMs are becoming difficult to find and 16 GB DIMMs are coming down in price. Three-year TCO estimates as of April 2020, include hardware, hardware support, software licensing and support includes VMware Horizon 7 Advanced production concurrent user licensing at https://store-us.vmware.com/vmware-horizonadvanced-298798300.html and VMware vSphere Enterprise Plus production concurrent user
- 300 User Configuration: Intel® Xeon® Gold 6258R Processor 1024 GB DCPMM: 4 Node, 2x Intel® Xeon® Gold 6258R Processor, 1x Intel® Server Board S2600WFT, Total Memory: 1,024 GB Intel® Optane™ DC persistent memory, 8 slots/128 GB/2666 MT/s and 192 GB DDR4, 12 slots/16 GB/2666 MT/s, Hyperthreading: Enabled, Turbo: Enabled, Intel® VMD: Enabled, Storage (boot): 1x 960 GB Intel® SSD 3520 Series SATA, Storage (cache): 2x 375 GB Intel® Optane™ DC SSD P4800X Series, Storage (capacity): 6x 2 TB Intel® SSD DC P4510 Series PCIe NVMe, Network devices: 1x Intel® Ethernet CNA XXV710-DA2 at 25 GbE, Network speed: 25 GbE, OS/Software: VMware 6.7.0 U1 and VMware Horizon 7. Testing by Principled Technologies. Tested between Feb 2-28, 2020. 4 Source: Breakthrough Performance Expands Datasets, Eliminates Bottlenecks https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/optane-ssd-dc-p4800x-p4801x-brief.pdf ⁵ Source: Intel-tested: 4K 7030 RW performance at low queue depth. Measured using FIO 3.1. Common configuration: Intel® 2U Server System, OS: CentOS 7.5, Kernal 4.17.6-1.el7.x86 64, CPU 2x Intel® Xeon®
- Gold 6154 @ 3.0 GHz (18 cores), RAM 256 GB DDR4 @ 2666 MHz. Intel Microcode: 0x2000043; System BIOS: 00.01.0013; Intel® ME firmware: 04.00.04.294; BMC Firmware: 1.43.91f76955; FRUSDR: 1.43. Configuration: Intel® Optane™ DC SSD P4800X 375 GB compared to Intel® SSD DC P4600 1.6 TB. Performance results based on testing as of November 30, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure. 6 Source: Intel-tested: Measured 99 percent QoS under 4K 70-30 workload at Qd1. See configuration in footnote (3) above. Performance results are based on testing as of July 24, 2018 and may not reflect all publicly available security updates. ⁷ Source: Intel-tested: Response time refers to average read latency measured at gueue depth 1 during 4K random write workload. See configuration in footnote (3) above. Performance results are based on testing as of July 24, 2018 and may not reflect all publicly available security updates. 8 Source: ESG. "Dell EMC VxRail with Intel® Xeon® Scalable Processors and Intel® Optane™ SSDs." Commissioned by Dell Technologies. August 2019. www.esg-global.com/hubfs/images/LabReports/Dell-EMC-VxRail-with-Intel-Optane-Aug19/ESG-Technical-Validation-Dell-EMC-VxRail-with-Intel-Optane-Aug-2019.pdf. 9 https://www.cisco.com/c/dam/en/us/products/collateral/hyperconverged-infrastructure/hyperflex-hx-series/dc-ssd-esg.pdf 10 Testing performed by Principled Technologies on June 4, 2019. Workload: SLOB 2.4.2.1; Server platform: HPE ProLiant DL380 Gen10; BIOS: U30 v1.46; BIOS settings: Performance; OS: VMware ESXi 6.7
- NVMe. vSAN capacity tier storage (second configuration): Number of drives: 6; Drive model and vendor: Intel® SSD DC P4500 Series (SSDPE2KX020T7P); Drive size: 2000 GB; Drive information: NAND NVMe. vSAN cache tier storage (first configuration): Number of drives: 2; Drive vendor and model: Intel® SSD DC P4500 Series (SSDPE2KX020T7P); Drive size: 2000 GB; Drive information: NAND NVMe. vSAN cache tier storage (second configuration): Number of drives: 2; Drive vendor and model: Intel® Optane™ DC SSD P4800X Series (SSDPE21KE75GAP); Drive size: 375 GB; Drive information: Intel® Optane™ NVMe. Network adapter: 2x 25 GbE Intel® Ethernet Network Adapter XXV710. Cooling fans: 6x Delta PFM0612XHE. Power supplies: 2x 800W HPE 865414-B21. 11 Benchmark details: Benchmark Setup: VMFleet Test: Each VM with 1 Core, 8 GB Memory, 40 GB VHDX. Test setup: Threads = 2, Buffer Size = 4 KiB, Pattern: Random, Duration = 300 Seconds, Queue Depth = 16, 30% write, OS: Windows Server 2019 Standard (Desktop) with updated patch. Performance results are based on testing by Intel as of February 8, 2019 and may not reflect all publicly available security updates. See configuration disclosures for details. No product or component can be absolutely secure. For more complete information visit http://www.intel.com/benchmarks. Intel® system configuration costs (4 systems): Baseline configuration: CPU: 2 - 6230 (CLX, Gold, 20 cores) \$3,788; Memory Subsystem: Total Cap: 384 GB (192 GB/Socket) 24x16 GB \$3,384; Storage: HDD/ SSDs \$6,823; RBOM: Chassis; PSUs; Boot drive etc. \$969; SW costs: SW Cost (per core or per system) \$15,415. Total system cost: \$30,379 x 4 systems = \$121,516. VMs per node: 41.5, \$732 per VM. ISO Cost 512 GB AEP: CPU: 2 - 6230 (CLX, Gold, 20 cores) \$3,788; Memory Subsystem: Total Cap: 512 GB (256 GB/Socket) 12x16 GB \$1,692, 4x128 GB AEP \$1,508; Storage: HDD/SSDs \$6,823; RBOM: Chassis; PSUs; Boot drive etc. \$969; SW costs: SW Cost (per core or per system) \$15,415. Total system cost: \$30,195 x 4 systems = \$120,780. VMs per node: 56, \$539 per VM. Estimated pricing as of Feb. 1, 2020.
- ¹² Plus System: CPU: 2x Intel® Xeon® Gold 6252 Processor, Memory: 512 GB Intel® Optane™ DC Persistent Memory in Memory Mode and 128 GB 2666 MHz DDR4 DRAM Memory, Network: 2x 25 GbE Intel® Ethernet Network Adapter X710, Storage: 2x Intel® Optane™ DC P4800X + 6x Intel® P4510 vs Base system: CPU: 2x Intel® Xeon® Gold 6230 Processor, Memory: 384 GB DDR4 2666 MHz DRAM Memory, Network: 4x 10 GbE Intel® Ethernet Network Adapter X722, Storage: 2x Intel® Optane™ DC P4800X + 4x Intel® Optane™ DC persistent memory pricing & DRAM pricing referenced in TCO calculations is provided for guidance and planning purposes only and does not constitute a final offer. Pricing guidance is subject to change and may revise up or down based on market dynamics. Please contact your OEM/distributor for actual pricing. For more complete information about performance and benchmark results, visit www.intel.com/benchmarks. VMware VMmark is a product of VMware, Inc. 95 VMs on the base configuration and 152 VMs on the Plus configuration. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performances 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
- Intel technologies may require enabled hardware, software or service activation.

final offer. Pricing guidance is subject to change and may revise up or down based on market dynamics. Please contact your OEM/distributor for actual pricing. Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy. Community administered by Principled Technologies.

343956-001EN

number of VMs vs. 4-Node Intel® Optane™ SSD Configuration. Intel® Optane™ SSD-based solution: \$218,133.39. Estimated pricing as of Feb 3, 2020, see newegg.com for all flash Intel® SSD and Intel® licensing at https://store-us.vmware.com/vmware-vsphere-enterprise-plus-284281000.html. Performance results may not reflect all publicly available security updates. TCO \$/VDI user calculated by dividing the 3-year TCO estimate by the average VDI users per given configuration. VDI users / TCO \$ calculated by dividing the average VDI users by the three-year TCO estimate per given configuration. For all tested configurations, each test was run three times and the average number of VDI users was used. 160 User Configuration: Intel® Xeon® Gold 6258R Processor – 384 GB RAM: 4 Node, 2x Intel® Xeon® Gold 6258R Processor, 1x Intel® Server Board S2600WFT, Total memory: 384 GB DDR4, 12 slots/32 GB/2666 MT/s, Hyperthreading: Enabled, Turbo: Enabled, Intel® VMD: Enabled, Storage (boot): 1x 960 GB Intel® SSD 3520 Series SATA, Storage (cache): 2x 375 GB Intel® Optane™ DC SSD P4800X Series, Storage (capacity): 6x 2 TB Intel® SSD DC P4510 Series PCIe NVMe, Network devices: 1x Intel® Ethernet CNA XXV710-DA2 at 25 GbE, Network speed: 25 GbE, OS/Software: VMware 6.7.0 U1 and VMware

ProLiant DL380 servers

intel

absolutely secure.

with vSAN 6.7; Date of last OS patch/update: January 4, 2019; Power management policy: Static high performance mode. Processor: 2x Intel® Xeon® Gold 6154; Core count: 18; Core frequency: 3.0 GHz; Stepping: H0; Hyperthreading: Yes; Turbo: Yes. Memory modules: Total memory in system: 384 GB; Number of memory modules: 24; Vendor and model: Samsung M393A4K40BB2-CTD6Q; Size: 32 GB; Type: PC4-2666V; Speed: 2,666 MHz; Speed running in the server: 2,666 MHz; NVMe memory present: No; Total memory: 384. Local storage: Number of drives: 1; Drive vendor and model: HP Boot SD Card; Drive size: 32 GB; vSAN capacity tier storage (first configuration): Number of drives: 6; Drive model and vendor: Intel® SSD DC P4500 Series (SSDPE2KX020T7P); Drive size: 2000 GB; Drive information: NAND

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.

1020/LD/CAT/PDF

1 Source – "The Challenge of Keeping Up with Data" https://www.intel.com/content/www/us/en/products/memory-storage/optane-dc-persistent-memory.html ² Source – The Evaluator Group. Estimated HW, SW, MEDIA, MAINT costs Current General all Flash solution: \$303,739.13; Based on 6-node 3D NAND-based cluster needed to support the approximate same Horizon 7. Testing by Principled Technologies. Tested between February 2-28, 2020, using VMware View Planner 4.3: 160 high memory users (2 vCPUs, 16 GB Memory, 50 GB Disk space).

Software Cost follows Microsoft Licensing Models https://download.microsoft.com/download/7/C/E/7CED6910-C7B2-4196-8C55-208EE0B427E2/Windows Server 2019 licensing datasheet EN US.pdf

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 Your costs and results may vary. Intel® Optane™ persistent memory pricing and DRAM pricing referenced in TCO calculations is provided for guidance and planning purposes only and does not constitute a Intel contributes to the development of benchmarks by participating in, sponsoring, and/or contributing technical support to various benchmarking groups, including the BenchmarkXPRT Development

© Intel Corporation. Intel, the Intel logo, and other Intel marks are trademarks of Intel Corporation or its subsidiaries. Other names and brands may be claimed as the property of others.