KRONSYS INC

HIGH-PERFORMING HYPERCONVERGED INFRASTRUCTURE WITH VMWARE VSAN ON LENOVO THINKAGILE VX

17x
HIGHER IOPS[1]

10x
LOWER LATENCY[2]

12x
BETTER PRICE PERFORMANCE[3]

1. IOPs comparison of hybrid to Intel Optane SSD based configuration in most common 70% read, 30% write workload profile.
2. Latency comparison of All-Flash to Intel Optane SSD based configuration in most common 70% read, 30% write workload profile.
3. Price performance comparison of hybrid to Intel Optane SSD based configuration in most common 70% read, 30% write workload profile.

TOPICS

EXECUTIVE SUMMARY

LENOVO® THINKAGILE VX WITH INTEL® OPTANE™ SSD IMPROVED PERFORMANCE ACROSS IOPS AND LATENCY, AS WELL AS PRICE PERFORMANCE OF THE SOLUTION.

Businesses are placing an increasing demand on evolving IT from a cost center to a service provider. This approach requires IT to be more efficient and agile in deploying and provisioning infrastructure that is tailored to specific workloads. This shift is driving changes in IT infrastructure deployment and management models. Software Defined Infrastructure (SDI) is one such emerging trend. SDI combines traditional data center hardware with software technologies to simplify deployment, management, and offer new advanced capabilities. Hyperconverged Infrastructure (HCI) utilizes SDI technologies to provide a unified compute and storage solution in a single server.

In this report, we evaluated the Lenovo® HCI solution; ThinkAgile VX with Intel® Optane™ SSDs. We used a popular industry benchmark for IO performance called Vdbench. Our findings indicated that the Intel Optane SSDs showed higher performance on IOPs and Latency, as well as better price performance over previous SSD technologies used in HCI implementations. These results make a strong case for customers to leverage new HCI solutions based on Intel Optane SSDs for emerging enterprise workloads such as Analytics, Desktop Virtualization, Databases, and AI applications.

Before we dive into the details, let us look at the market landscape and the future of HCI.

HCI MARKET EVOLUTION

The HCI market has evolved in the last two years. In our view, there are three key factors contributing to the growth of HCI:

1. Accelerating growth of Cloud computing
2. Need for alignment of IT and business objectives
3. Continuous growth of enterprise data

At the same time, one of the limiting factors for faster adoption of HCI has been limited scalability Today most HCI deployments are limited to smaller cluster sizes of between four and sixteen nodes typically for VDI, server consolidation, development and test uses. However, as the technology matures across the board, we will see these limitations resolved for HCI to become the platform of choice for tier-1 applications. Other key trends that will shape the future of HCI is the evolution of Cloud computing, Edge Computing, IoT and Artificial Intelligence.

Because the benefits increasingly outweigh the adoption inertia, we believe HCI will be one the fastest growing segments within IT for the next three to four years. We are also seeing most tier-1 data center providers embracing HCI as part of their solution offerings such as the Lenovo ThinkAgile VX, which offers high performance with Intel® Optane™ SSDs and is part of the Intel® Select Solutions. More on the benefits of these technologies is detailed in the next section.

SOFTWARE DEFINED INFRASTRUCTURE MARKET SIZE WILL EXCEED US $84 BILLION BY 2022[1]

1. "Software Defined Infrastructure Market Size will Exceed US $84 Billion by 2022", Market Watch, May 31, 2018,

TECHNOLOGY INTRODUCTION

LENOVO THINKAGILE VX PORTFOLIO

In contrast to traditional storage, HCI offers a simple way to deploy compute and storage resources in relatively small increments. In addition, HCI also offers simple resource-based management that hides the complexity of infrastructure management by virtualizing compute and storage.

VMware vSAN is one of the leading HCI solutions in the market today. Lenovo has partnered with VMware to offer several turn-key solutions for clients whether they are looking for extreme flexibility or a simple appliance experience. The Lenovo portfolio ranges from predefined vSAN ReadyNodes, to Certified Nodes, or factory-integrated ThinkAgile VX appliances.

The Lenovo ThinkAgile VX offers a fast deployment of an HCI solution. Starting with as little as three nodes and scaling as you grow, this is a pre-engineered, tested and scalable infrastructure solution to meet growing performance and capacity needs. VMware vSAN provides a key building block of SDI with VM-specific storage policies. The combination of Lenovo servers and VMware software makes this a leading edge, cost-effective storage solution.

Other Lenovo HCI solutions include ThinkSystem based VMware vSAN ReadyNodes, and Table 1 below shows the characteristics of each.

Features	VMware vSAN ReadyNode on Lenovo ThinkSystem	Lenovo ThinkAgile VX Certified Node	ThinkAgile VX Appliance	Benefits
Verified Cluster Firmware	✗	✓	✓	Ensures customer firmware configuration is valid
Verified Cluster Interoperability	✗	✓	✓	Ensures customer hardware configuration is valid
ThinkAgile VX Installer Support	✗	✓	✓	Easy installation of vSAN at customer site
ThinkAgile Support	Optional Premier	✓	✓	Single point of contact with an expert support team
VMware ESXi pre-installed	Optional	✓	✓	Ensures cluster is optimized, validated and certified
Software Licenses	Optional	Optional	✓	VX Appliance is an all-inclusive solution for vSAN
PS Deployment	Custom SOW	Optional	✓	Delivers an operational solution at a fixed price.

Table 1: Comparison of Lenovo HCI solutions

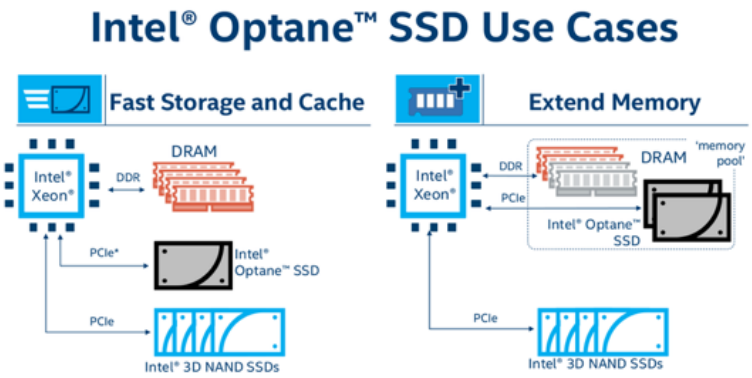
INTEL OPTANE SSDS

As we see immense generational performance improvements in CPU technology, the growth of data shifts the performance bottleneck to storage devices. This requires memory technology that is fast, dense and non-volatile. DRAM memory addresses only a part of this challenge; Speed. Whereas NAND memory, which is underlying design for SSDs, is dense and non-volatile but it is still slower than DRAM. Intel Optane technology brings the best of both by combining the 3D XPoint Memory architecture with other software enhancements to bring a dense design combined with low latency resulting in breakthrough performance.

INTEL OPTANE BRINGS THE BEST OF DRAM AND NAND TECHNOLOGIES WITH THE NEW 3D XPOINT, WHICH CAN BE USED AS FAST STORAGE OR AS AN EXTENSION TO SYSTEM MEMORY.

At the heart of the storage architecture is the ability to pack memory cells with an innovative and dense three-dimensional column structure. The cells are connected to each other directly, eliminating the need for expensive transistors and hence resulting in reduced cost. This structure enables higher density as well as lower cost than previous generations. Lastly, Intel Optane SSDs can be used as fast storage and cache, as well as extend system memory. The transition between these use cases is done by installing the required device drivers, which are available by Intel for popular Operating Systems.

Transition to software-defined solutions is an evolution and clients are looking for easy migration path that does not require complete overhaul of their existing investments. Lenovo SDI portfolio offers complete flexibility to clients as they transition to Software Defined solutions.



Picture 1: Intel Optane SSD use cases as fast storage and cache, or as extension of system memory. (credit: Intel)

INTEL SELECT SOLUTIONS

Intel Select is a portfolio of workload-optimized solutions that accelerate infrastructure deployments by providing a pre-tested set of hardware configurations optimized to deliver the best performance at the lowest price. Lenovo and Intel have collaborated on benchmarking the VMware vSAN solutions to meet Intel Select requirements, which removes the risk and complexity of choosing the right hardware and allows clients to focus on their real business challenges. Intel Select solutions bring years of datacenter experience between the two companies understanding the client requirements and their workload needs. Key benefits of Intel Select Solutions for vSAN include:

1. **Simplified evaluation**: As clients look to transition new workloads to software defined infrastructure, this program makes that transition simple and risk-free by providing optimized solutions based on best hardware and software configuration - taking the guess work out of decision making process.
2. **Fast and easy deployment**: Since these solutions are pre-tested with specific set of HW and SW configurations, it enables faster time-to-value and operational delivery.
3. **Workload optimized performance**: All Intel Select solutions are designed on the latest Intel architecture with the highest level of performance requirements. Clients are assured to get the best possible performance at lowest cost for their workloads.

In order to qualify for this program, Lenovo has worked with Intel to run the VMmark 3.0 benchmark, which simulates a variety of real-world workloads such as Web/e-commerce, transactional and analytics database, and migration operations of virtual machines and storage on a VMware vSAN cluster with Lenovo hardware. The Intel Select program requires the solution vendor to demonstrate a minimum VMmark 3.0 score obtained by executing the workload tiles on the cluster to meet the performance expectation. Lenovo vSAN solution exceeded the base requirement of 7.0 on the VMmark 3.0 score.

PERFORMANCE TESTING

OUR GOAL

We evaluated the performance improvement for the Lenovo vSAN solution using the latest Intel Optane SSD DC Series devices relative to other configurations based on HDDs and SAS SSDs.

While there are multiple measures for performance evaluation, our methodology focused on understanding the raw performance improvement in IOPs and latency at the storage layer and comparing the price/performance across different vSAN configurations to highlight the benefits of the Intel Optane SSD technology.

1

IOPS

A measure of the number of IO operations (reads or writes) per second to a storage device

2

LATENCY

The amount of time an application has to wait for the IO transaction to complete

3

PRICE PERFORMANCE

A measure of the cost to achieve the performance

BENCHMARK AND METHODOLOGY

We collaborated with Lenovo to conduct the performance testing in their labs.

We chose HCIBench benchmark to measure the storage performance of the virtual machines running on the VMware vSAN test configurations. HCIBench is a tool developed by VMware as a wrapper to the Oracle Vdbench storage benchmark. It offers a simple and consistent mechanism for storage administrators to understand the raw performance of a Hyperconverged Infrastructure (HCI) solution such as vSAN. HCIBench allows you to configure a variety of test variables such as the number of test VMs per server, number of virtual disks per VM, threads per disk, IO block size (such as 4K, 8K, 16K and so on), working set size, IO access patterns (random or sequential), IO mix (combination of read and write percentage), and duration of the test run. This degree of variance in the parameters allows us to thoroughly evaluate the underlying storage subsystem and be able to do a realistic comparison of the performance across different vSAN hardware configurations.

In our HCIBench test environment, we implemented a vSAN cluster of four servers. The following three configurations were tested:

1. **Hybrid vSAN Cluster:** Combination of SSDs for cache tier and HDDs for capacity tier
2. **All-flash vSAN Cluster:** SAS SSDs for cache and SAS SSDs for capacity
3. **Optane vSAN Cluster:** Intel Optane DC 4800X SSDs for cache and Intel DC P4500 NVMe SSDs

TEST CONFIGURATIONS

We ran the HCIBench benchmark across three configurations of Lenovo ThinkAgile VX described previously. Each configuration had a set of common elements such as Servers, CPU, Memory, Networking, and Software. Each configuration varied slightly due to hardware requirements such as storage controllers, disk capacity, quantity, etc., however we ensured that these differences did not have measurable impact on performance so as to be able to normalize the results across these configurations

Table 2 provides a quick summary of the three hardware configurations. More detailed hardware information is in Appendix A.

TYPE	QUANTITY AND DETAIL		
Servers	4 x ThinkSystem vSAN ReadyNodes with Intel® Xeon® Scalable processors		
Network	2 x Lenovo RackSwitch™ G8272 (data), 2 x Lenovo RackSwitch™ G8052 (mgmt)		
Software	VMware vSphere and VMware vSAN 6.6		
Storage	Configuration 1 Hybrid	Configuration 2 All Flash	Configuration 3 Intel Optane SSD
Cache-tier	2 x Performance SSDs	2 x Performance SSDs	2 x Intel® Optane™ SSD DC P4800X Series
Capacity-tier	4 x Capacity HDDs	6 x Capacity SSDs	6 x Intel® SSD DC S4500 Series

Table 2: Common elements of two test configurations

TARGET WORKLOADS

Hyperconverged infrastructure (HCI) supports a variety of workloads that range from business-critical applications such as transactional and analytics databases (Oracle, MySQL, SQL Server, SAP), Virtual Desktop Infrastructure (VDI) to emerging AI and machine learning use cases. Different workloads have different IO access patterns. Hence, it's important to optimize the HCI infrastructure to deliver the best performance.

In addition to the IO access patterns, applications are sensitive to the storage latency and throughput. For example, virtual desktop infrastructure (VDI) applications are latency sensitive because this application performs many small block random IO operations. The latency of the IO operations affects the desktop user's experience. The higher the storage latency, the slower the user desktop experience. On the other hand, data warehouse application requires high throughput because of bulk data updates and large block IOs.

Since HCI provides a generic virtualization platform, it is also common to see customers run a mix of workloads on the same cluster. In such cases, the cluster cannot be performance-tuned for any particular workload, however can be configured with optimal hardware configuration to deliver a baseline performance to all workloads on the cluster.

Our testing simulated three specific workloads that are discussed below in Table 3.

TRANSACTIONAL DATABASE AND VDI WORKLOADS	ARTIFICIAL INTELLIGENCE (AI) WORKLOADS	MIXED WORKLOAD CLUSTER
The typical IO characteristic of these workloads is random access. For transactional databases, the system is performing read, insert, update, and delete operations where every write operation is accompanied by two read operations. For virtual desktop, VMs accessing the virtual disks are conducting mostly read operations. Hence, we focus on random small block IO latency for 70/30 read/write mixture for these workloads.	AI is one of the fastest growing technologies with benefits touching almost every field and industry. One of the most performance intensive elements of AI is training a neural network, which requires a system to read large amounts of unstructured data such as images or text. Hence, this is a read-intensive workload, mostly sequential IO with large block sizes. We focus on random small block IO latency for 100% read profile for this workload.	Popular mixed workloads include Web servers, load-balancers, user test and dev applications, backup, disaster recovery. This environment tends to be "bursty" with storage demand peaking at times, causing applications to throttle on latency or throughput. Hence, it's important to have an HCI infrastructure that can handle high variance We focus on random 70/30 read/write latency, throughput for the mixed workload scenario.

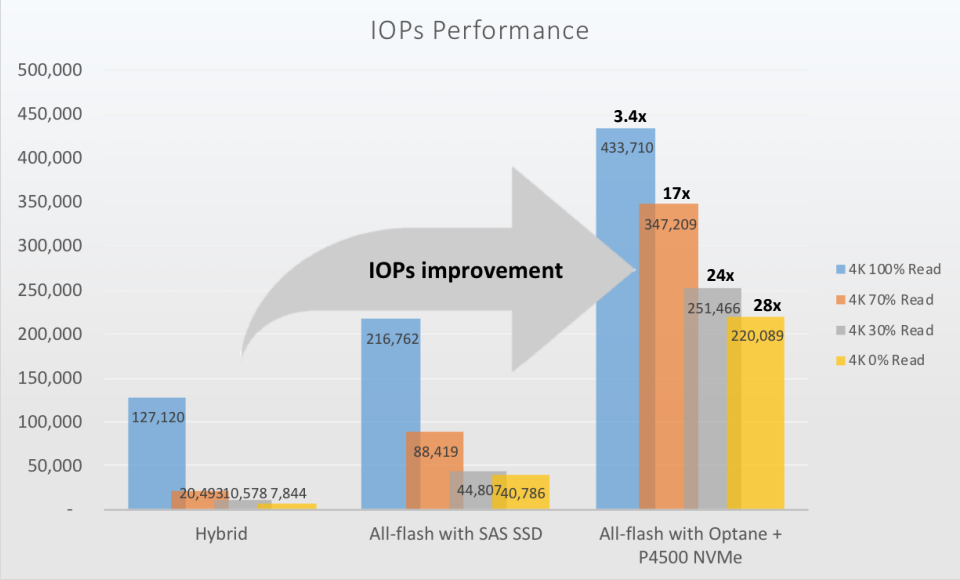
Table 3: Workloads targeted in performance testing

PERFORMANCE TEST METHODOLOGY RESULTS

We evaluated performance across three vSAN configurations described previously – hybrid, all-flash with SAS disks, and all-flash with Intel Optane NVMe disks. In order to get a good understanding of the performance profile for the spectrum of the workloads we described previously, we varied the HCIBench test configuration on multiple dimensions – sequential and random IO, block sizes from 4K to 256K, and concurrency via number of threads per disk (16 to 128). We executed each of the three configurations for 300 iterations each and averaged the test results for an accurate comparison. As you will see below, we saw consistent improvement in performance (IOPs, Latency, and Throughput) as we went from hybrid vSAN to all-flash with SAS SSDs, to all-flash with Optane NVMe drives.

IOPS COMPARISON

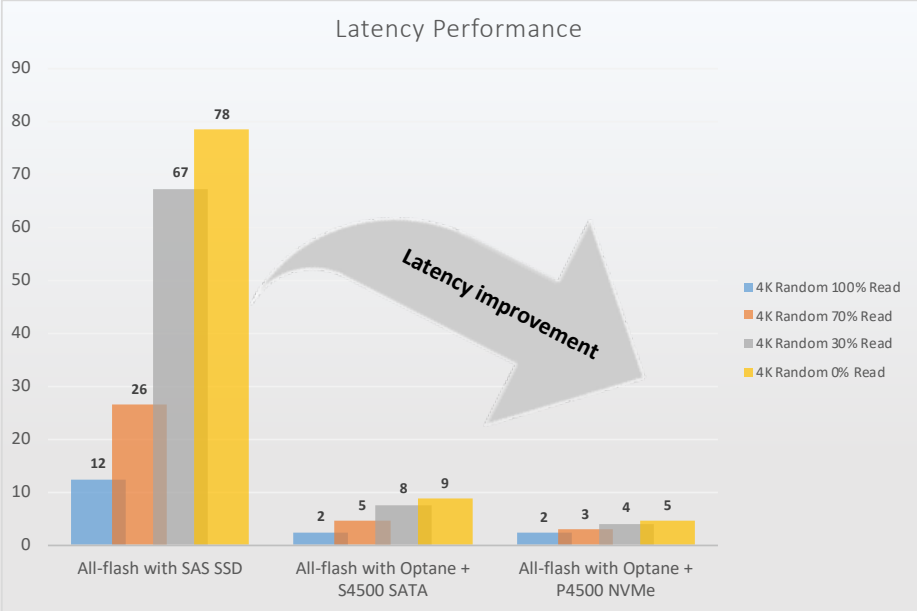
Comparing raw IOPs performance, the configuration with the Intel® Optane™ P4800X SSDs outperformed all others. The largest benefit was observed in write-intensive workloads while the smallest benefit was observed for read-intensive workloads. This is due to the fact that all vSAN configurations use the SSD cache-tier for read operations, hence resulting in high performance even with the hybrid configurations. On the other hand, the SSD cache is used as write-cache for all vSAN configurations, all-flash and hybrid. Since the Intel Optane NVMe drives exhibit ultra-low latency, the performance benefit for write intensive applications will be much higher than as seen in the hybrid configuration. In addition, on the all-NVMe configuration, the Intel P4500 drives also deliver a much higher performance in terms of latency and throughput over HDDs and SAS SSDs, which is demonstrated by the test results. Hence, the Intel Optane and P4500 SSDs win over hybrid and SAS SSD vSAN configurations.



Graph 1: IOPs performance indicating IOPs improvement across simulated workloads (higher is better)

LATENCY

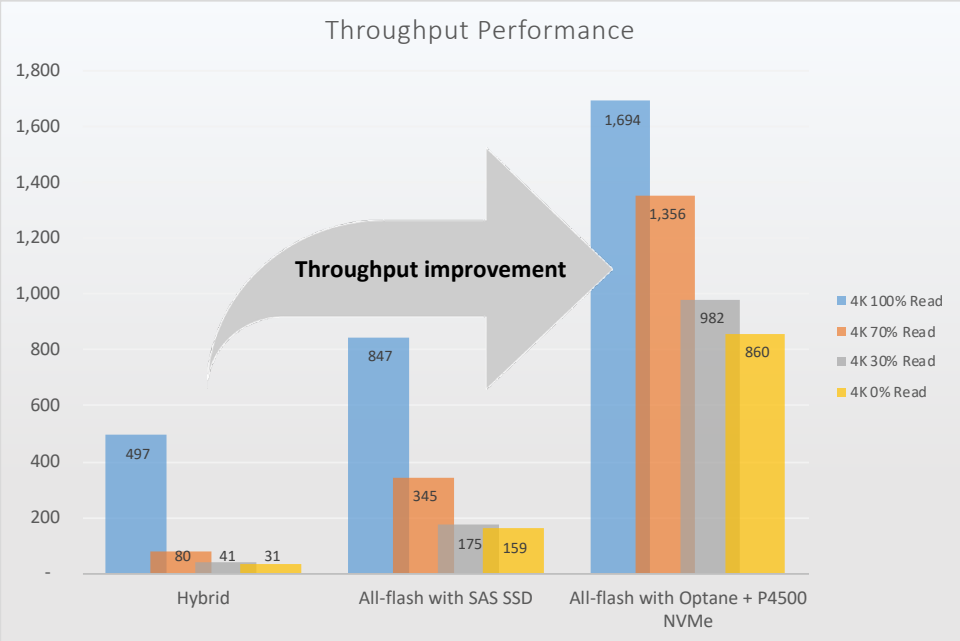
Latency determines how long an application needs to wait until its IO operation completes. Keep in mind that latency is determined by various factors – storage protocol overhead, controller overhead, data caching, how data is staged (write-through or write-back). Because NVMe drives eliminate the need for a controller by plugging directly into the PCIe bus, there is less overhead than controller-based storage access. Our performance results show decrease in latency anywhere from 2x to 12x for the Intel Optane NVMe based configuration over the hybrid and All-Flash vSAN configuration.



Graph 2: Latency performance improvement across simulated workloads (lower is better)

THROUGHPUT

As we described previously, applications such as a data warehouse will rely on the storage to deliver high bandwidth as they tend to be IO intensive at times, reading and writing large amounts of data. Also, applications such as DR/backup of virtual machine data will require high throughput storage to complete backup or restore operations fast. Architecturally, NVMe drives are designed for high throughput because they support direct IO from the operating system to the flash devices via the PCIe bus. In addition, they use 4 PCIe lanes per disk, which translates to 32Gb/sec peak transfer speed, compared to 12Gbps for SAS SSDs. Our performance results show increase in throughput anywhere from 3.4x to 28x with the Intel Optane NVMe based vSAN configuration over the hybrid vSAN configuration.



Graph 3: Throughput performance improvement across simulated workloads (higher is better)

PRICE PERFORMANCE RATIO

A typical observed trend is; as storage technology adoption increases, the cost will decrease. The pace of this trend is increasing as it relates to Flash storage technology. While there are many reasons for this acceleration, the primary driver is the fast pace of growth of data and analytics, which in-turn is accelerating migration from traditional storage to newer technologies such as Intel Optane SSDs.

In this section, we compared the price performance ratio across the three configurations we tested to gain an understanding of the cost of performance for Intel Optane SSDs. Our findings are detailed in Table 4.

As you will notice, there is a 12x improvement in price performance ratio of the Intel Optane based vSAN configuration over the hybrid configuration. Our conclusion is that with a marginally low increase in cost of the solution, you will see a significant improvement in performance with the Intel Optane technology.

		Configuration 1 Hybrid	Configuration 2 All Flash	Configuration 3 Intel Optane SSD
Storage Tier				
Cache	Performance SSD 800GB	2	2	
	Intel® Optane™ SSD P4800X 375GB			2
Capacity	Capacity HDD 1.8TB	4		
	Capacity SSD 3.84TB		6	
	Intel® SSD DC S4500 Series 1.96TB			
	Intel® SSD DC P4500 Series 4TB			6
Pricing				
	Services Total	$7,521	$7,521	$7,521
	Networking Total	$29,504	$29,504	$29,504
	SW Total	$69,611	$69,611	$69,611
	Storage (Cache & Capacity disks)	$31,680	$131,020	$100,660
	Server (CPU, Memory, System) Total	$61,418	$51,276	$71,940
	Total	**$199,733**	**$288,932**	**$279,236**
Performance in IOPs (higher is better)				
	100% Read 4K Random	127,120	216,762	433,710
	70% Read 4K Random	20,493	88,419	347,209
	30% Read 4K Random	10,578	44,807	251,466
Price per Performance (lower is better)				
	100% Read 4K Random	$1.57	$1.33	$0.64
	70% Read 4K Random	$9.75	$3.27	$0.80
	30% Read 4K Random	$18.88	$6.45	$1.11

Table 4: Price Performance Ratio comparison

CONCLUSION

There is exponential growth in data and hence increasingly crucial for customers to leverage this data to understand their market and drive competitiveness. The current deployment models in datacenter need to evolve to match their business needs. Clients are looking for simple and agile deployment models that can allow them to deploy workloads / applications with right amount if resources on demand. Simplification of deployment and management should not have to come at the expense of performance. Intel Optane drives paired with Lenovo ThinkAgile VX combines the simplified usability with performance – offering clients a new way to deploy HCI clusters.

APPENDIX A

NETWORK SWITCH CONFIGURATION

Part No.	Description	Quantity
7159HCW	Switch: Lenovo RackSwitch G8272 (Rear to Front)	2
ASRD	Lenovo RackSwitch G8272 (Rear to Front)	2
6201	1.5m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4
00WW776	Essential Service - 3Yr 24x7 4Hr Response	2
7159HC1	Switch: Lenovo RackSwitch G8052 (Rear to Front)	2
ASY2	Lenovo RackSwitch G8052 (Rear to Front)	2
6201	1.5m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4
00WW816	Essential Service - 3Yr 24x7 4Hr Response	2

HYBRID CONFIGURATION

Part No.	Description	Quantity
7X02CTO1WW	Hybrid 8TB : ThinkSystem SR630 - 3yr Warranty	4
AUW1	ThinkSystem SR630 2.5" Chassis with 10 Bays	4
AWEE	Intel Xeon Silver 4110 8C 85W 2.1GHz Processor	8
AUND	ThinkSystem 32GB TruDDR4 2666 MHz (2Rx4 1.2V) RDIMM	48
AUW9	ThinkSystem SR630/SR570 2.5" AnyBay 10-Bay Backplane	4
5977	Select Storage devices - no configured RAID required	4
AUNM	ThinkSystem 430-16i SAS/SATA 12Gb HBA	4
AUMH	ThinkSystem 2.5" HUSMM32 800GB Performance SAS 12Gb SSD	8
AUM2	ThinkSystem 2.5" 1.8TB 10K SAS 12Gb Hot Swap 512e HDD	16
AUMV	ThinkSystem M.2 with Mirroring Enablement Kit	4
AUUV	ThinkSystem M.2 CV3 128GB SATA 6Gbps Non-Hot Swap SSD	8
AXFT	VMware ESXi 6.5 U1 (factory installed)	4
AUWA	ThinkSystem SR530/SR570/SR630 x16 PCIe LP Riser 2 Kit	4
AUWC	ThinkSystem SR530/SR570/SR630 x8/x16 PCIe LP+LP Riser 1 Kit	4
AUWQ	Lenovo ThinkSystem 1U LP+LP BF Riser Bracket	4
AUKK	ThinkSystem 10Gb 4-port SFP+ LOM	4
AVWB	ThinkSystem 1100W (230V/115V) Platinum Hot-Swap Power Supply	8
AUW7	ThinkSystem SR630 4056 Fan Module	8
5PS7A06895	Premier Essential - 3Yr 24x7 4Hr Response + YourDrive YourData	1
5AS7A02045	Hardware Installation Server (Business Hours)	1
7S06CTO5WW	VMware Storage SW with Support	1
B2CM	VMware HCI Kit Advanced (Per CPU) w/3Yr Support	2

ALL FLASH WITH SAS SSD CONFIGURATION

Part No.	Description	Quantity
7X06CTO1WW	Server : ThinkSystem SR650 - 3yr Warranty	4
AUVX	ThinkSystem SR650 2.5" Chassis with 8 or 16 bays	4
AWEN	Intel Xeon Gold 6130 16C 125W 2.1GHz Processor	8
AUNC	ThinkSystem 16GB TruDDR4 2666 MHz (2Rx8 1.2V) RDIMM	48
AURA	ThinkSystem 2U/Twr 2.5" SATA/SAS 8-Bay Backplane	8
5977	Select Storage devices - no configured RAID required	4
AUNM	ThinkSystem 430-16i SAS/SATA 12Gb HBA	4
AUMH	ThinkSystem 2.5" HUSMM32 800GB Performance SAS 12Gb SSD	4
AUMK	ThinkSystem 2.5" PM1633a 3.84TB Capacity SAS 12Gb Hot Swap SSD	20
AUMV	ThinkSystem M.2 with Mirroring Enablement Kit	4
AUUV	ThinkSystem M.2 CV3 128GB SATA 6Gbps Non-Hot Swap SSD	8
AXFT	VMware ESXi 6.5 U1 (factory installed)	4
AUR3	ThinkSystem SR550/SR590/SR650 x16/x8 PCIe FH Riser 1 Kit	4
AURC	ThinkSystem SR550/SR590/SR650 (x16/x8)/(x16/x16) PCIe Riser 2 Kit	4
AUKK	ThinkSystem 10Gb 4-port SFP+ LOM	4
AVWF	ThinkSystem 1100W (230V/115V) Platinum Hot-Swap Power Supply	8
5PS7A06897	Premier Essential - 3Yr 24x7 4Hr Response + YourDrive YourData	4
7S06CTO5WW	VMware Storage SW with Support	4
B2CM	VMware HCI Kit Advanced (Per CPU) w/3Yr Support	8
7X06CTO1WW	Server : ThinkSystem SR650 - 3yr Warranty	4
AUVX	ThinkSystem SR650 2.5" Chassis with 8 or 16 bays	4
AWEN	Intel Xeon Gold 6130 16C 125W 2.1GHz Processor	8

ALL FLASH WITH SAS SSD CONFIGURATION

Part No.	Description	Quantity
7X06CTO1WW	Server : ThinkSystem SR650 - 3yr Warranty	4
AUVX	ThinkSystem SR650 2.5" Chassis with 8 or 16 bays	4
AWEN	Intel Xeon Gold 6130 16C 125W 2.1GHz Processor	8
AUND	ThinkSystem 32GB TruDDR4 2666 MHz (2Rx4 1.2V) RDIMM	48
AUR5	ThinkSystem 2U/Twr 2.5" AnyBay 8-Bay Backplane	8
5977	Select Storage devices - no configured RAID required	4
AUNM	ThinkSystem 430-16i SAS/SATA 12Gb HBA	4
AUV2	ThinkSystem 1610-4P NVMe Switch Adapter	4
AUMJ	ThinkSystem U.2 Intel P4800X 375GB Perf. NVMe PCIe 3.0 x4 SSD	8
B11D	ThinkSystem U.2 Intel P4500 2.0TB Entry NVMe PCIe3.0 x4 SSD	24
AUMV	ThinkSystem M.2 with Mirroring Enablement Kit	4
AUUV	ThinkSystem M.2 CV3 128GB SATA 6Gbps Non-Hot Swap SSD	8
AXFT	VMware ESXi 6.5 U1 (factory installed)	4
AUR3	ThinkSystem SR550/SR590/SR650 x16/x8 PCIe FH Riser 1 Kit	4
AURC	ThinkSystem SR550/SR590/SR650 (x16/x8)/(x16/x16) PCIe Riser 2 Kit	4
AUKK	ThinkSystem 10Gb 4-port SFP+ LOM	4
AVWF	ThinkSystem 1100W (230V/115V) Platinum Hot-Swap Power Supply	8
AUSG	ThinkSystem SR650 6038 Fan module	4
5PS7A06897	Premier Essential - 3Yr 24x7 4Hr Response + YourDrive YourData	4
7S06CTO5WW	VMware Storage SW with Support	4
B2CM	VMware HCI Kit Advanced (Per CPU) w/3Yr Support	8
7X06CTO1WW	Server : ThinkSystem SR650 - 3yr Warranty	4

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At Kronsys Inc, we always put your needs and requirements first and transform our client's businesses with IT

Kronsys specializes in bringing together technology and marketing for clients of all sizes. With expertise across IT Consulting, Technology Marketing, Mobile Apps and Custom Software development, we can help ensure a successful outcome for your projects.