KIOXIA

Performance Brief

Achieving Significant Virtualization Performance Gains with KIOXIA CM7 Series Enterprise NVMe™ SSDs and 16G Dell® PowerEdge™ R760 Servers

Introduction

Data center infrastructures typically fall into three categories: traditional, converged and hyperconverged. Hyperconverged infrastructures enable users to add compute, memory and storage requirements as needed, delivering the flexibility of horizontal and vertical scaling. However, many virtual machine (VM) configurations run in converged infrastructures, and their ability to scale is often difficult when VM clusters require more storage.

VMware®, Inc. enables hyperconverged infrastructures through VMware ESXi™ and VMware vSAN™ platforms. The VMware ESXi platform is a popular enterprise-grade virtualization platform that scales compute and memory as needed and provides simple management of large VM clusters. The VMware vSAN platform enables the infrastructure to transition from converged to hyperconverged, delivering incredibly fast performance since storage is local to the servers themselves. The platforms support a new VMware vSAN Express Storage Architecture™ (ESA) that has gone through a series of optimizations to utilize NVMe SSDs more efficiently than in the past.

With the latest 16G Dell PowerEdge R760 servers utilizing the PCIe® 5.0 interface to connect networking and storage to the CPU, there are great performance increases in data movement over previous PCIe generations. These improvements can be utilized by hyperconverged infrastructures running on these servers.

This performance brief presents a generational SSD/server performance comparison in a virtualized environment. It compares new KIOXIA CM7 Series enterprise NVMe SSDs deployed in new 16G Dell PowerEdge R760 servers with prior generation KIOXIA CM6 Series enterprise NVMe SSDs deployed in 14G Dell PowerEdge R740xd servers, in a VMware cluster.

Six tests were run on each cluster – two performance tests, two latency tests and two power consumption tests. The tests included Input/Output Operations per Second (IOPS), throughput, read latency, write latency, IOPS per watt and throughput per watt. The tests were performed through HyperConverged Infrastructure Benchmark (HCIBench) test software. Up to five workloads were run that included 100% sequential write, 100% random read, random 70% read/30% write, random 50% read/50% write and one that blended varying block sizes and threads.

The test results show that the latest PCIe generation of KIOXIA CM7 Series SSDs and 16G Dell PowerEdge R760 servers in the test configuration delivers faster performance in a virtualized environment when compared with the previous PCIe generation SSD/server configuration.

The results presented include a brief description of each workload test, a graphical depiction of the test results and an analysis. Appendix A covers the hardware/software test configuration. Appendix B covers the configuration set-up/test procedures.

Test Results Snapshot

KIOXIA CM7-R Series SSDs deployed in 16G Dell PowerEdge R760 servers delivered the following results when compared with a previous PCIe SSD/ server configuration:

IOPS
(higher is better)
up to 101% Higher

Throughput
(higher is better)
up to 101% Higher

Read Latency
(lower is better)
up to 50% Lower

Write Latency
(lower is better)
up to 50% Lower

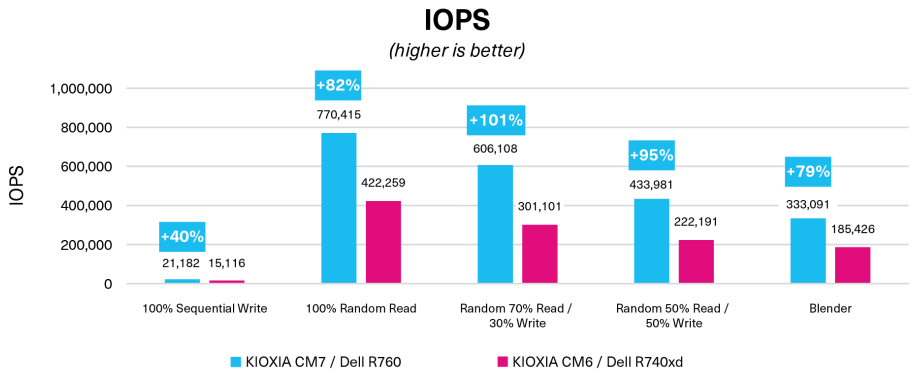
IOPS per Watt
(higher is better)
up to 10% Higher

Throughput per Watt
(higher is better)
up to 9% Higher

Test Results[1]

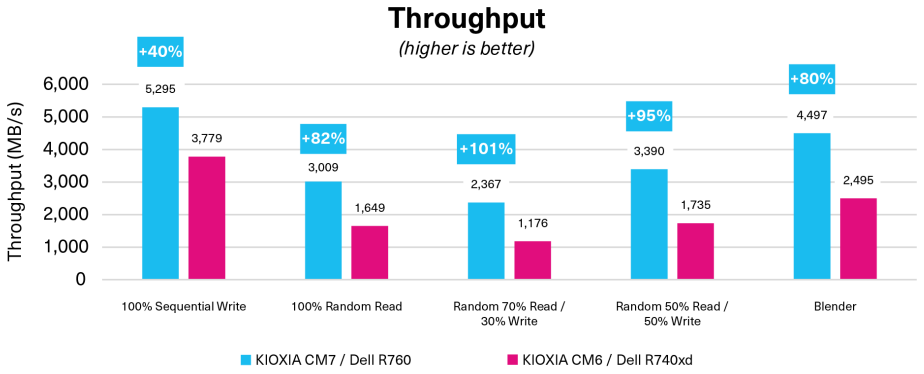
Test 1: IOPS

This test measured the number of IOPS that the SSD/server configuration completed. The results are in IOPS. The higher result for each is better.



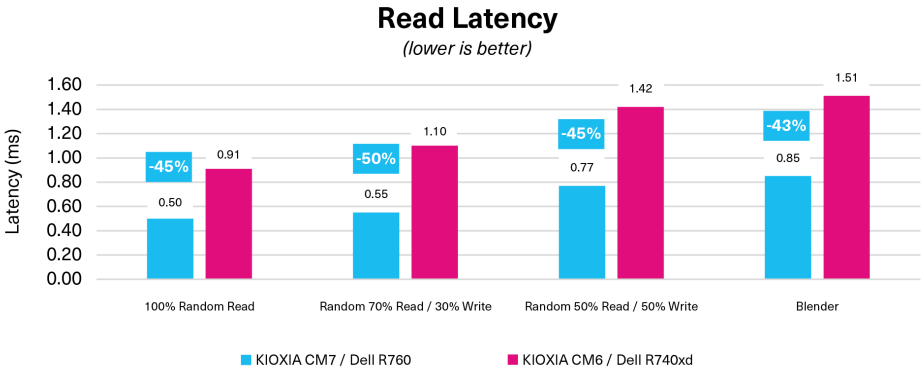
Test 2: Throughput

This test measured the amount of data transferred per second to and from the SSDs. The results are in megabytes per second (MB/s). The higher result for each is better.



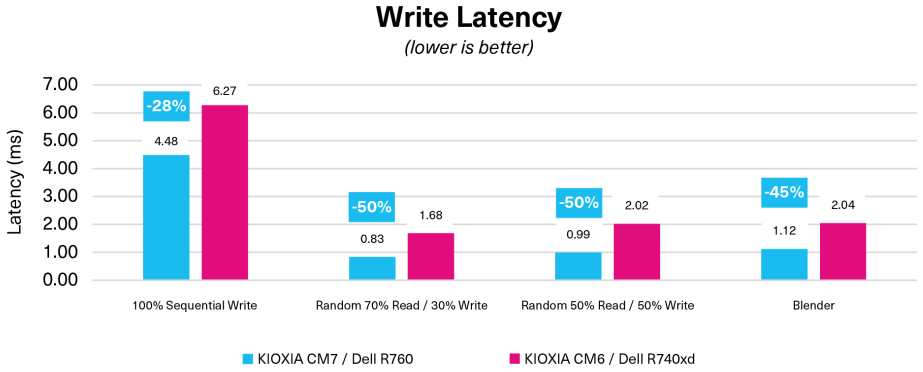
Test 3: Read Latency

This test measured the time it took to perform a read operation. It included the average time it took for the load generator to not only issue the read operation, but also the time it took to complete the operation and receive a 'successfully completed' acknowledgement. The results are in milliseconds (ms). The lower result for each is better. The 100% sequential write workloads for both configurations were not tested as they do not include read operations.



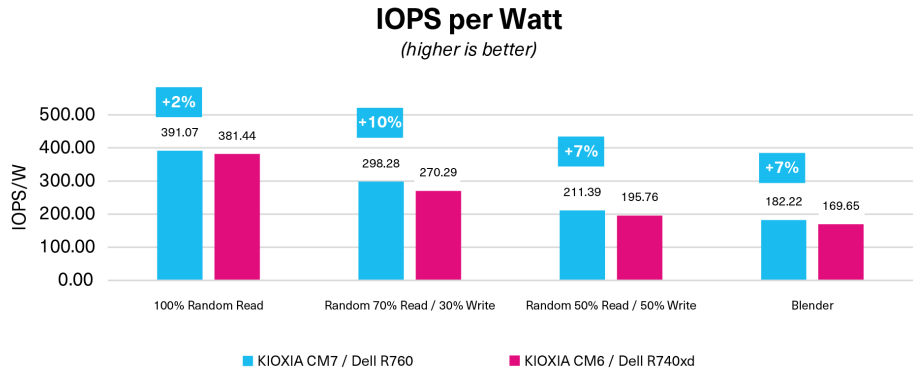
Test 4: Write Latency

This test measured the time it took to perform a write operation. It included the average time it took for the load generator to not only issue the write operation, but also the time it took to complete the operation and receive a 'successfully completed' acknowledgement. The results are in milliseconds. The lower result for each is better. The 100% random read workloads for both configurations were not tested as they do not include write operations.



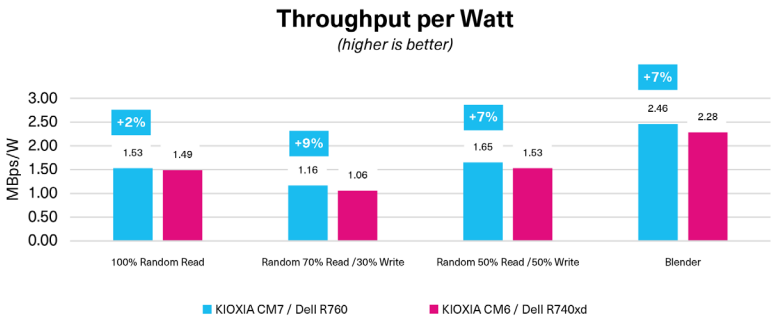
Test 5: IOPS per Watt

This test measured the amount of IOPS performed in conjunction with the power consumed by the cluster. The results are in IOPS per Watt (IOPS/W). The higher result for each is better.



Test 6: Throughput per Watt

This test measured the amount of throughput performed in conjunction with the power consumed by the cluster. The results are in MB/s per Watt (MBps/W). The higher result for each is better.



Analysis

The new KIOXIA CM7 Series enterprise NVMe SSDs deployed in new 16G Dell PowerEdge R760 servers outperformed the prior PCIe generation SSD/server configuration in IOPS, throughput and latency. They also delivered higher performance per watt. With the newer generation of Dell PowerEdge servers, there are notable performance increases associated with hyperconverged infrastructures that directly affect server, CPU, memory and storage performance when compared with prior generations.

Summary

As presented by the test results, the new KIOXIA CM7 Series SSDs deployed in 16G Dell PowerEdge R760 servers deliver faster performance in a virtualized environment when compared with a prior PCIe generation SSD/server configuration.

Products Tested:

KIOXIA CM7 Series SSD Product Info

The latest generation KIOXIA CM7 Series enterprise NVMe SSDs support Enterprise and Datacenter Standard Form Factor (EDSFF) E3.S and 2.5-inch[2] form factors and are compliant with the NVMe 2.0 and PCIe 5.0 specifications. These SSDs are available in two configurations: CM7-R Series for read intensive applications (1 DWPD[3], up to 30.72 TB[4] capacities) and CM7-V Series for higher endurance mixed use applications (3 DWPD, up to 12.80 TB capacities). Additional features include a dual-port design for high availability applications, Flash Die Failure Protection and security options[5]. Additional KIOXIA CM7 Series SSD information is available here.

KIOXIA CM7 Series SSD[6]

Dell PowerEdge 760 Rack Server Product Info

Specifications: https://www.delltechnologies.com/asset/en-us/products/servers/technical-support/poweredge-r760-spec-sheet.pdf.

Dell PowerEdge 760 Rack Server[6]
(used with permission from Dell Inc.)

Appendix A

Hardware/Software Test Configuration

Server Information		
Server Model	Dell PowerEdge R760[7]	Dell PowerEdge R740xd[8]
No. of Servers	3	3
BIOS Version	1.3.2	2.18.1

CPU Information		
CPU Model	Intel® Xeon® Gold 6430	Intel Xeon Silver 4214
No. of Sockets	2	2
No. of Cores	64	24
Frequency (in gigahertz)	2.1 GHz	2.2 GHz

Memory Information		
Memory Type	DDR5	DDR4
Memory Speed (in megatransfers per second)	4,400 MT/s	2,400 MT/s
Memory Size	16 GB[4]	32 GB
No. of DIMMs	16	12
Total Memory	256 GB	384 GB

SSD Information		
SSD Model	KIOXIA CM7-R Series	KIOXIA CM6-R Series
Form Factor	2.5-inch	2.5-inch
Interface	PCIe 5.0 x4	PCIe 4.0 x4
No. of SSDs	12	12
SSD Capacity	3.84 TB	3.84 TB
Drive Writes per Day	1	1
Active Power	25 watts	19 watts

Operating System Information		
Operating System (OS)	VMware ESXi	VMware ESXi
OS Version	8.0.1, 21813344	8.0.1, 21495797
VMware vCenter® Version	8.0.1.00200	8.0.1.00200
Storage Type	vSAN ESA	vSAN ESA

Load Generator Information (Test Software)		
Load Generator	HCIBench	HCIBench
Load Generator Version	2.8.2	2.8.2

Appendix B

Configuration Set-up/Test Procedures

Configuration Set-up

The latest VMware ESXi 8.0 operating system was installed on all hosts.

Two clusters were created in VMware's vCenter management interface with 'High Availability' and 'Distributed Resource Scheduler' disabled for testing.

Each of three Dell PowerEdge R760 servers were added into a cluster - then each of three Dell PowerEdge R740xd servers were added into a separate cluster.

VMkernel adapters were set up to have VMware vMotion™ migration, provisioning, management and the VMware vSAN platform enabled for both test configurations.

In the VMware vSAN configurations, twelve KIOXIA CM7 Series SSDs were added for the Dell PowerEdge R760 cluster (four drives per server), and twelve KIOXIA CM6 Series SSDs were added for the Dell PowerEdge R740xd cluster (four drives per server). The default storage policy was set to 'vSAN ESA Default Policy – RAID 5' for both configurations.

The HCIBench load generator (virtual appliance) was then imported and configured on the network.

Test Procedures

Six tests were performed on each cluster as follows:

- Two performance tests: IOPS and throughput
- Two latency tests: read latency and write latency
- Two power consumption tests: IOPS per watt and throughput per watt

For IOPS and throughput, the following five workloads were run with the test results recorded:

- 100% sequential write (256K block size, 1 thread) and representative of a data logging use case.
- 100% random read (4K block size, 4 threads) and representative of a read cache system.
- Random 70% read/30% write (4K block size, 4 threads) and representative of a common mixed read/write ratio used in commercial database systems.
- Random 50% read/50% write (4K block size, 4 threads) and representative of other common IT use cases such as email.
- Blender (block sizes/threads vary) and representative of a mix of many types of sequential and random workloads at various block sizes and thread counts as VMs request storage against the vSAN storage pool.

For read latency, all of the above workloads were run with the exception of 100% sequential write, with the test results recorded.

For write latency, all of the above workloads were run with the exception of 100% random read, with the test results recorded.

For IOPS per watt and throughput per watt, all of the above workloads were run with the exception of 100% sequential write, with the test results recorded.

NOTES:

[1] Read and write speed may vary depending on the host device, read and write conditions and file size.

[2] 2.5-inch indicates the form factor of the SSD and not the drive's physical size.

[3] DWPD or Drive Write(s) Per Day (DWPD) means the drive can be written and re-written to full capacity once a day, every day, for the specified lifetime. Actual results may vary due to system configuration, usage, and other factors.

[4] Definition of capacity: KIOXIA Corporation defines a megabyte (MB) as 1,000,000 bytes, a gigabyte (GB) as 1,000,000,000 bytes, a terabyte (TB) as 1,000,000,000,000 bytes and a petabyte (PB) as 1,000,000,000,000,000 bytes. A computer operating system, however, reports storage capacity using powers of 2 for the definition of 1Gbit = 2^{30} bits = 1,073,741,824 bits, 1GB = 2^{30} bytes = 1,073,741,824 bytes, 1TB = 2^{40} bytes = 1,099,511,627,776 bytes and 1PB = 2^{40} bytes = 1,125,899,906,842,624 bytes and therefore shows less storage capacity. Available storage capacity (including examples of various media files) will vary based on file size, formatting, settings, software and operating system, and/or pre-installed software applications, or media content. Actual formatted capacity may vary.

[5] Optional security feature compliant drives are not available in all countries due to export and local regulations.

[6] The product image shown is a representation of the design model and not an accurate product depiction.

[7] The Dell PowerEdge R760 server features a PCIe 4.0 backplane.

[8] The Dell PowerEdge R740xd server features a PCIe 3.0 backplane.

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