KIOXIA

Performance Brief

Showcasing Next-Generation PCIe® 5.0 Server Performance with New AMD EPYC™ 9004 Series Processors and New KIOXIA CM7 Series NVMe® SSDs

Data centers collect an overwhelming amount of data from many different sources, located both on-premises and at the network edge. The addition of compute-intensive, algorithmic technologies such as artificial intelligence, machine learning, deep learning and data analytics means that IT administrators are tasked to deliver fast storage device performance to end-users to support a wide array of applications and workloads. This need is driving the widespread transition to NVMe SSDs because of their very fast read/write capabilities.

NVMe SSDs connect to a host and move data through the data center via the PCIe interface, which in turn complies with NVMe specifications as defined by NVM Express, Inc. The newly available PCIe 5.0 specification, defined by PCI-SIG®, delivers double the performance of the previous PCIe 4.0 revision and increases data transfer speed up to 32 gigatransfers per second (GT/s). The PCIe 5.0 interface delivers approximately 4 gigabytes per second (GB/s) bandwidth per lane. This increased interface speed allows SSDs, GPUs, NICs and other devices to deliver faster I/O performance than previous PCIe revisions (Table 1).

PCIe Revision	Introduced	Maximum Transfer Rate	Maximum Per Lane Bandwidth
4.0	2017	16 GT/s	2 GB/s
5.0	2019	32 GT/s	4 GB/s

Table 1: PCIe 4.0/5.0 performance capabilities

This performance showcases the potential increased sequential performance from servers equipped with both PCIe 5.0 CPUs and SSDs. KIOXIA America, Inc. validated this increase in PCIe 5.0 performance by conducting tests in a lab environment using the newly launched AMD EPYC 9354 processor and a KIOXIA CM7 Series PCIe 5.0 NVMe SSD. The results of these tests were compared to the results of the same tests that ran on a KIOXIA CM6 Series PCIe 4.0 NVMe SSD. This comparison indicates that IT administrators can nearly double storage device sequential read performance using PCIe 5.0 SSDs instead of PCIe 4.0 devices. The following sections describe the test configuration, results and analysis.

PCIe 5.0 Tested Products

The PCIe 5.0 CPUs and SSDs tested for this comparison includes:

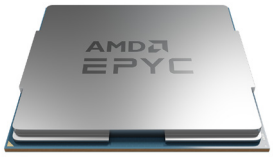


Image reproduced with permission from AMD[6]

32-core AMD EPYC 9354 processor:

AMD recently launched 4th Generation AMD EPYC processors based on the new Zen 4 core architecture with up to 96 cores and PCIe 5.0 support. Please visit https://www.amd.com/en/data-center-blogs/delivering-the-modern-data-center for more information.

KIOXIA CM7 Series PCIe 5.0 NVMe SSDs:

KIOXIA recently launched its latest generation CM7 Series SSDs that support EDSFF E3.S and 2.5-inch[1] (15mm, z-height) form factors and are designed to the NVMe 2.0 and PCIe 5.0 specifications. These SSDs are available in two configurations: Read-intensive 1 DWPD[2] with capacities up to 30.72 terabytes[3] (TB), and mixed-use 3 DWPD with capacities up to 12.80 TB. Additional features include a dual-port design for High Availability (HA) applications, flash die failure protection to maintain reliability in case of a die failure, and a Self-Encrypting Drive[4] (SED) supporting TCG Opal and TCG Ruby, and an SED option of FIPS 140-3[5]. The CM7 Series is currently in pre-production and all specifications and test results are subject to change.

KIOXIA CM7 Series SSD[6]

KIOXIA CM6 Series PCIe 4.0 NVMe SSDs:

The CM6 Series of CM Series SSDs is compliant with the NVMe 1.4 and PCIe 4.0 specifications. These SSDs include dual-port capabilities, flash die failure protection to maintain reliability in case of a die failure, and a host of security options. CM6 drives continue to deliver superb enterprise-class PCIe 4.0 SSD performance[7].

Further CM Series information: https://americas.kioxia.com/en-us/business/ssd/enterprise-ssd.html.

KIOXIA CM6 Series[6]

Test Configuration

The hardware and software equipment used in this environment to run the tests described in this brief includes:

Server Information	
Model	4th Gen AMD EPYC reference system
CPUs	2x AMD EPYC 9354
No. of CPU Cores	32 per processor
CPU Frequency	3.80 GHz
Total Memory	64 GB DDR-5 DRAM
Memory Frequency	4,800 megatransfers/sec (MT/s)

Operating System Information	
Model	Ubuntu®
Version	22.04 LTS
Kernel	5.150-50-generic

SSD Information		
Model	KIOXIA CM7 Series	KIOXIA CM6 Series
Form Factor	2.5-inch	2.5-inch
Interface	PCIe 5.0 (single 32 GT/s x4, dual 32 GT/s x2)	PCIe 4.0 (single 16 GT/s x4, dual 16 GT/s x2)
Capacity	3.84 TB	3.84 TB
Flash Memory	BiCS FLASH™ 3D flash memory	BiCS FLASH™ 3D flash memory
Drive Write(s) per Day	1 (5 years)	1 (5 years)
Active Power	25 W (preliminary)	19 W

Test Software Information	
Model	Flexible I/O[8] (FIO)
Version	3.28

Test Set-up & Procedures

Set-up: The 4th Gen AMD EPYC reference system was configured using the hardware and software outlined above.

Procedures: The AMD EPYC reference system described above was configured with a 3.84 TB capacity CM7 Series SSD that performed a sequential read and a sequential write workload test that included a 128 kibibyte[9] (KiB) block size, a queue depth of 32, and 1 CPU thread, and these results were recorded.

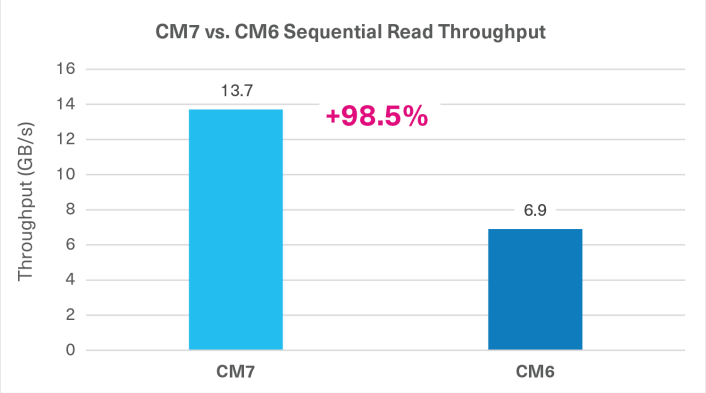
The same AMD EPYC reference system was then equipped with a 3.84 TB capacity CM6 Series SSD that performed a sequential read and a sequential write workload test that included a 128 KiB block size, a queue depth of 32, and 1 CPU thread. No other system changes were made other than changing the SSDs as described here.

Both sets of test results were compared to determine the performance differences between the PCIe 5.0 CM7 Series and the PCIe 4.0 CM6 Series.

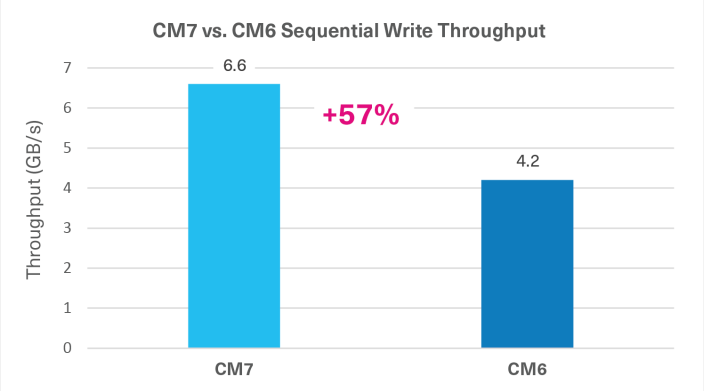
Test Results

The FIO test results are as follows:

Sequential Read: This FIO test reads data of a specific size that is ordered one after the other from a Logical Block Address (LBA) perspective. Sequential read performance is regarded as data throughput and typically specified in either megabytes per second (MB/s) or gigabytes per second (GB/s). Higher values indicate better results.



Sequential Write: This FIO test writes data of a specific size that is ordered one after the other from an LBA perspective. Sequential write performance is also regarded as data throughput and typically specified in either MB/s or GB/s. Higher values indicate better results.



Test Analysis

The AMD EPYC reference system powered by dual 32-core AMD EPYC 9354 processors and equipped with a PCIe 5.0 KIOXIA CM7 Series SSD demonstrated significant sequential performance gains when tested against the same AMD EPYC reference system equipped with a PCIe 4.0 SSD.

FIO Workload *Block size=128K; QD = 32; Threads=1*	**CM7 Series** (PCIe 5.0)	**CM6 Series** (PCIe 4.0)	**CM7 Series Advantage**
Sequential Read *(higher is better)*	13.7 GB/s	6.9 GB/s	+98.5%
Sequential Write *(higher is better)*	6.6 GB/s	4.2 GB/s	+57%

Summary

These test results show that 4th Gen AMD EPYC processors equipped with PCIe 5.0 KIOXIA CM7 Series SSDs can deliver significant generational performance uplifts compared to PCIe 4.0 SSDs. Compute and storage intensive workloads can most certainly benefit from PCIe 5.0 technology that allows CPUs and SSDs to process workloads and run applications at faster speeds to meet today's and tomorrow's advanced business needs.

KIOXIA CM Series Snapshot:

CM7 Series SSDs[6]

Compliant with the PCIe 5.0 and designed to NVMe 2.0 Specifications

Preliminary Performance (subject to change)
SeqRead = up to 14,000 MB/s
RanRead = up to 2.5M IOPS
SeqWrite = up to 7,000 MB/s
RanWrite = up to 550K IOPS

Endurance and Capacities
1 and 3 DWPD options
800 GB to 30,720 GB capacities

CM6 Series SSDs[6]

Designed to the PCIe 4.0 and NVMe 1.4 Specifications

High-Performance
SeqRead = up to 6,900 MB/s
RanRead = up to 1.4M IOPS
SeqWrite = up to 4,200 MB/s
RanWrite = up to 350K IOPS

Endurance and Capacities
1 and 3 DWPD options
800 GB to 30,720 GB capacities

Notes:

[1] 2.5-inch indicates the form factor of the SSD and not the drive's physical size.

[2] Drive Write(s) per Day: One full drive write per day means the drive can be written and re-written to full capacity once a day, every day, under the specified workload for the specified lifetime. Actual results may vary due to system configuration, usage, and other factors.

[3] Definition of capacity - KIOXIA Corporation defines a kilobyte (KB) as 1,000 bytes, 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.

[4] SED supports TCG Opal and Ruby SSCs. It has a few unsupported TCG Opal features. For more details, please make inquiries through "Contact us" in each region's website, https://business.kioxia.com/.

[5] KIOXIA CM7 Series Federal Information Processing Standard (FIPS) drives utilize a security module designed to comply with FIPS 140-3 Level 2, which define security requirements for cryptographic module by NIST (National Institute of Standards and Technology). For the latest validation status of each model, please contact us in each region's website, https://business.kioxia.com/.

[6] Product image may represent a design model.

[7] Based on publicly available information as of this publication.

[8] Flexible I/O (FIO) is a free and open source disk I/O tool used both for benchmark and stress/hardware verification. The software displays a variety of I/O performance results, including complete I/O latencies and percentiles.

[9] A kibibyte (KiB) is a unit of information equal to 1024 bytes (or 2^10 bytes).