



KIOXIA

SOLUTION BRIEF

# HIGH-DENSITY E1.S SERVER/STORAGE SOLUTION: SUPERMICRO® ALL FLASH PETASCALE SERVER WITH KIOXIA XD6 SERIES SSDS

*Optimized for MongoDB® and Other Applications Requiring High Performance at Very Low Latency and Ultra-Dense Storage Servers*

## TABLE OF CONTENTS

Executive Summary .....	1
E1.S Form Factor SSD .....	1
NoSQL4 Mongo Database .....	2
Performance Benefits of E1.S Form Factors .....	3
Summary and Appendix .....	5



*Supermicro SSG-1029P-NES32R*

## Executive Summary

Datacenter applications generate large quantities of data that have increased storage requirements and, in turn, require increased speed to access this data. IT administrators are tasked with delivering fast processing and storage performance to support the many applications and workloads that users demand. This has created a need for denser storage solutions. As a result, the amount of data generated within a data center has become very large to manage, space-limited to store, and more challenging to access. With the recent availability of E1.S Enterprise and Datacenter Standard Form Factor<sup>1</sup> (EDSFF) servers and SSDs, the data center objective of higher performance and increased storage density has become more attainable.

## E1.S Form Factor SSD

The PCIe® interface and NVMe® protocol drive E1.S form factor servers and SSDs – proven to deliver strong throughput, input/output operations per second (IOPS), and latency performance compared to legacy hard drive interfaces and protocols.

## SUPERMICRO

Supermicro (Nasdaq: SMCI) is the leading innovator in high-performance, high-efficiency server and storage technologies and a premier worldwide provider of advanced server Building Block Solutions® for Enterprise Data Center, Cloud Computing, Artificial Intelligence, and Edge Computing Systems. Supermicro is committed to protecting the environment through its “We Keep IT Green®” initiative by providing customers with the most energy-efficient, environmentally friendly solutions available on the market.

Though many server and storage vendors are developing E1.S form factor platforms, there are very few solutions available per the date of this publication.

One innovative server solution available in the E1.S form factor is the Supermicro SSG-1029P-NES32R, a Petascale storage server. It enables very dense storage installations with potentially greater density<sup>2</sup> versus media deployed with 2.5-inch or 3.5-inch<sup>3</sup> drives and features KIOXIA XD6 Series PCIe 4.0 data center NVMe SSDs. These E1.S form factor SSDs take advantage of PCIe Gen4 speeds and are designed to the Open Compute Project (OCP) NVMe Cloud SSD Specification. The Supermicro SSG-1029P-NES32R Storage Server coupled together with Kioxia XD6 Series E1.S SSDs is now available under the Supermicro Petascale Product Family. The combination of solid read performance and a rich feature set help position this as the leading E1.S storage solution in the market.

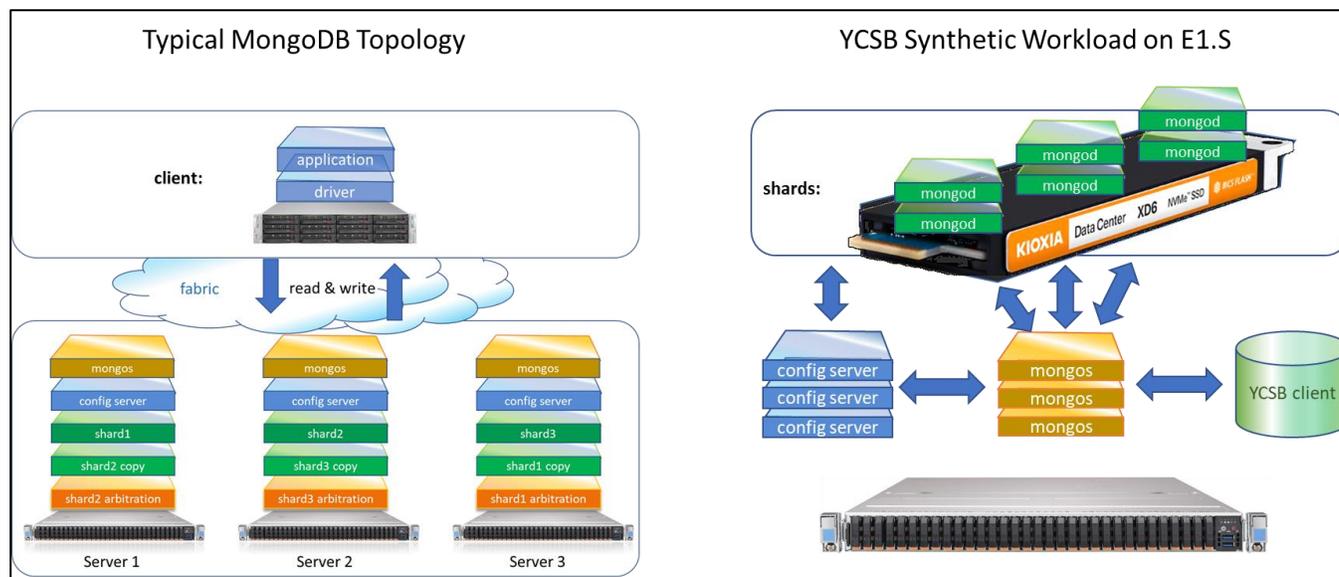
### KIOXIA XD6 Series E1.S driven by synthetic tests

This solution brief presents E1.S server/storage performance relating to latency and throughput and delivers this high performance without relying solely on system memory. Although many applications can benefit from this powerful E1.S solution, these results demonstrate how the system can perform running a NoSQL<sup>4</sup> MongoDB database driven by synthetic tests.



### NoSQL MongoDB Database

In a large-scale MongoDB database, the data is sharded across many storage devices and storage nodes, and database transactions traverse networking infrastructure, impacting latency. Every component in the architecture can act as a benefit or detriment to the overall performance. Recognizing that most of the key infrastructure has been removed for this drive during the internal system test, the raw performance of the individual drive remains the most critical metric to overall database performance at scale.



## Performance Benefits of E1.S Form Factors

To demonstrate the performance of XD6 Series SSDs in a Supermicro SSG-1029P-NES32R server, the system was tested with synthetic benchmarks in KIOXIA's lab environment. A test database was created on the MongoDB application consisting of three hundred million records and synthetic tests run through Yahoo! Cloud Serving Benchmark (YCSB) software.

One database test was conducted where a workload of two billion operations (50% reads and 50% updates) was run against the NoSQL MongoDB database. A 50% read/50% update workload is reasonably standard for database applications. This test measured four metrics: Run Time, Average Read, Latency, Average Update Latency, and Operations Throughput. The Supermicro Petascale storage server CPUs are PCIe 3.1-capable, so the XD6 Series SSD was tested at PCIe Gen3 speed. The results of the synthetic tests yielded the following results:

### **Run Time**

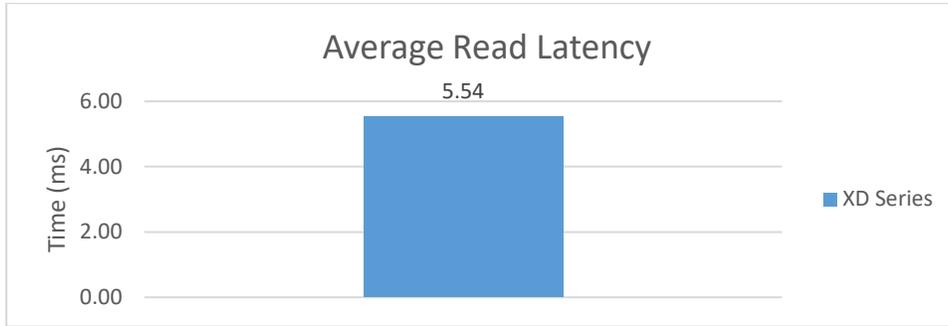
This metric represents the total time required in hours to complete the workload consisting of two billion read and update operations against the MongoDB database. This measurement is heavily dependent on factors such as database size. As databases become larger, the amount of time it takes to perform a read operation successfully can increase as the system has to query the database and find all of the data it needs through the vast records stored in the database.

For update operations, the system needs to traverse the entire database of records until it finds the record that needs to be updated and then performs the necessary changes to the data. The low latency and high performance that the SSD provides enable the database to retrieve the records quickly from the SSD, which is critical in reducing the time it takes for each individual update to complete. With a database consisting of three hundred million records, the system took 18.33 hours to complete two billion operations within the database workload.



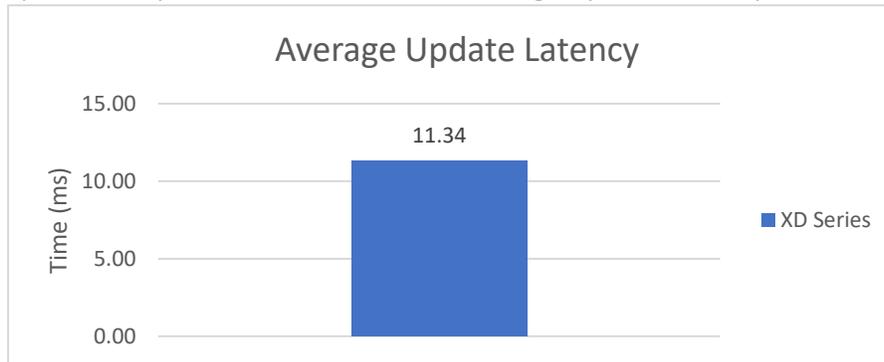
### **Average Read Latency**

This metric represents the time it takes to perform a read database operation. It includes the average time it takes for the YCSB workload generator to issue the read operation and the time it takes for the operation to be successfully completed. This is an important metric to present as it can positively impact database performance and application response times that can translate into a better user database experience. The average read latency delivered was 5.54 milliseconds (ms), indicating very fast database performance.



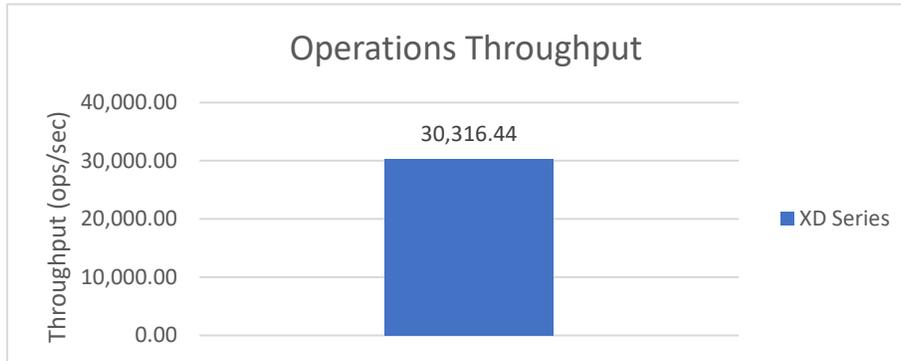
### **Average Update Latency**

This metric represents the time it takes to perform an update database operation. It includes the average time it takes for the YCSB workload generator to issue the update operation and the time it takes for the operation to be successfully completed. This metric can also affect database performance and application response times, translating into a better user database experience. The average update latency delivered was 11.34 ms, indicating very fast database performance.



### **Operations Throughput**

This metric represents the number of operations per second a system can complete on average. It also measures how quickly a given server solution can process incoming database queries related to database throughput. This is a critical metric to discern if the number of incoming queries is much higher than the achievable database throughput. If this occurs, the server can overload, creating longer waiting times per query, negatively impacting application performance and the user experience. It is essential when a mix of operations, such as reading and updating operations from a large group of users, must be simultaneously processed at sub-second response times. The throughput delivered was 30,316.44 operations per second, indicating fast database performance.



## Summary

Though E1.S platforms are being supported by a number of server and storage vendors, there are very few tested solutions available today. The Supermicro Petascale storage server and KIOXIA XD6 Series SSDs represent an E1.S server/storage solution currently available and well-suited for database applications showcased by these test results. This E1.S server/storage combined with XD6 Series SSDs demonstrated very low read and update latencies, fast workload throughput, and high overall performance.

This Supermicro and KIOXIA solution can support up to 6 terabytes<sup>5</sup> (TB) of system memory and up to 32 KIOXIA XD6 Series SSDs. As XD6 Series SSDs are available in 1 TB, 2 TB, and 4 TB storage capacities, the solution can hold up to 128TB in the 1U Supermicro SSG-1029P-NES32R E1.S server. The E1.S form factor is a good fit for MongoDB enabling high storage density in a server, performance per watt, and IOPS per GB, in a fully populated system. With two NUMA balanced PCIe Gen3 x16 slots, up to 200Gb/s bandwidth is available to accommodate widely deployed 25g/50g/100g infrastructure. Hot-swap capabilities are also featured, making this E1.S solution well-suited for today's hyperscale and enterprise-class applications.

The E1.S media features heat sink options at varying sizes integrated directly into XD6 Series SSDs, enabling SSD cooling options for applications requiring higher performance. This ensures that storage performance is not throttled due to heat, enabling XD6 Series SSDs to achieve optimal performance. In addition, since XD6 Series SSDs fit directly within the Supermicro Petascale storage servers without carriers (as with M.2 drives), the system provides very efficient cooling with high storage density.

Additional Supermicro SSG-1029P-NES32R E1.S server information is available [here](#).

Additional XD6 Series SSD information is available [here](#).

## Appendix

### Test Equipment

The hardware and software equipment used to perform the synthetic test include:

- **Supermicro SSG-1029P-NES32R Server:**  
One (1) dual-socket server with two (2) Intel® Xeon® Gold 6226R processors, featuring 16 processing cores, 2.90 GHz frequency, and 192 gigabytes<sup>5</sup> (GB) of DDR4 DRAM
- **Operating System:**

- Ubuntu® v20.04.3 (Kernel 5.4.0-89-generic)
- **Application:**  
 MongoDB v5.0.3:  
 Database size = 460.04 GB  
 Maximum Allocated Memory = 150 GB  
 Number of Connections / Threads = 256  
 Number of Records = 300 Million  
 Number of Operations = 2 Billion
- **Test Software:**  
 Synthetic tests run through YCSB software (version 0.17.0)
- **Storage Devices** (Table 1):  
 One (1) KIOXIA XD6 Series PCIe 4.0 data center NVMe SSD with 3.84 TB capacity

Specifications	XD6 Series
Form Factor	E1.S
Package	9.5mm
Interface	PCIe 4.0
Capacity	3.84 TB
NAND Flash Type	BiCS FLASH™3D flash memory
Endurance Rating	1 Drive Write Per Day <sup>6</sup> (DWPD)
Endurance Time Frame	5 years
Power	<14W
DRAM Allocation	192 GB

Table 1: SSD specifications and set-up parameters

## Test Set-up

The Supermicro SSG-1029P-NES32R E1.S server was configured with the Ubuntu v20.04.3 operating system and YCSB v0.17.0 test software. The YCSB software was used to create a database on the XD6 Series SSD to run a 50% read and 50% update YCSB workload against the MongoDB database. The 50%/50% mixed workload represented a common workload for many applications, including database applications.

The Supermicro SSG-1029P-NES32R E1.S server using Intel Xeon Gold 6226R processors are PCIe 3.0 capable, so the XD6 Series SSD was tested at Gen3 speeds. The XD6 Series SSD connects directly to the Supermicro server via an E1.S connector.

## Test Procedures

The benchmark test performed on the XD6 Series SSD included the following metrics: (1) Run Time; (2) Average Read Latency; (3) Average Update Latency; (4) Operations Throughput; The results of these metrics and others were recorded providing ample evidence the XD6 Series E1.S form factor SSD was a good fit for large scale, latency dependent applications.

## FOOTNOTES:

<sup>1</sup> Developed by the Small Form Factor Technical Affiliate (SFF-TA) working group as part of the Storage Networking Industry Association (SNIA).

<sup>2</sup> Source: Supermicro SSG-1029P-NES32R online product flyer - 6x E1.S drives = 2x U.2 drives in space utilization.

<sup>3</sup> 2.5-inch and 3.5-inch indicate the form factor of the SSD and not the drive's physical size.

<sup>4</sup> A NoSQL database stores data in a format other than relational tables.

<sup>5</sup> 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 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 = 230 bits = 1,073,741,824 bits, 1GB = 230 bytes = 1,073,741,824 bytes, 1TB = 240 bytes = 1,099,511,627,776 bytes, and 1PB = 250 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.

<sup>6</sup> 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, for the specified lifetime. Actual results may vary due to system configuration, usage, and other factors.

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