WHITEPAPER

PERFORMANCE OF SUPERMICRO A+ SERVERS UTILIZING THE 3RD GEN AMD EPYC™ PROCESSOR WITH RED HAT CEPH STORAGE

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Image 1 - A+ Server 2124US-TNRP

Introduction

Enterprise storage infrastructure and related technologies continue to evolve year after year. In particular, as IoT, 5G, AI, and ML technologies are gaining attention, the demand for Software-Defined Storage (SDS) solutions based on clustered storage servers is also increasing. Red Hat ® Ceph Storage (Ceph) is a leading SDS solution that enables high performing workloads to run efficiently. The high throughput and low latency features of modern storage devices are important factors that improve the overall performance of the Ceph cluster. Adopting a Ceph cluster utilizing NVMe Solid State Drives (SSD) maximizes the overall application performance. Supermicro designed Ceph clusters based on the Supermicro AS -2124US-TNRP storage server with the 3rd Gen AMD EPYC™ CPUs with all-flash NVMe SSDs and then conducted various tests to design and deliver Ceph users with optimized Ceph configurations.

Red Hat Ceph Storage Description

Red Hat Ceph Storage is a production-ready implementation of Ceph. This open-source storage platform manages data on a distributed computer cluster and provides interfaces for object-, block-, and file-level storage. Proven at web-scale, Red Hat Ceph Storage offers the data protection, reliability, and availability required by demanding object storage workloads. This solution is designed for modern workloads, such as AI, cloud infrastructures, and data analytics. Industry-standard application programming interfaces (APIs) allow migration of and integration with your applications. Unlike traditional storage, Red Hat Ceph Storage is optimized for large installations, typically a petabyte (PB) or larger.

Supermicro Setup

Supermicro has run several performance tests with the following setup. Figure 1 shows the Supermicro architecture with three monitor nodes, four Object Storage Daemon (OSD) nodes, and 10 RADOS BLOCK Device (RBD) loadgen client nodes.

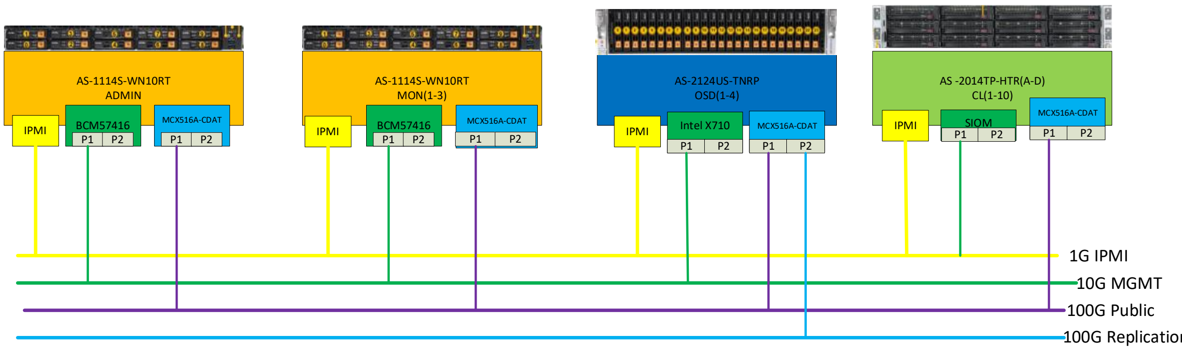


Figure 1 - Supermicro Configuration Test Setup

Supermicro Hardware and Red Hat Software Specifics

The Red Hat Ceph Storage cluster is deployed on the Supermicro A+ servers containing the 3rd Gen AMD EPYC processors. The software versions used were Red Hat Ceph Storage 4.2, Red Hat Enterprise Linux® 8.2, and Flexible I/O Tester (fio) 3.25

OSD	
System/Node	AS-2124US-TNRP
CPU	2 x AMD EPYC 7713 64-Core Processors
Memory	16x32GB DDR4-3200 2Rx8 (16Gb) LP ECC RDIMM (512GB)
HDD/SSD (OS)	2 x KIOXIA CM6 3.84TB NVMe PCIe 4x4 2.5" 15mm SIE 1DWP
NVMe SSD (Data)	22 x KIOXIA CM6 3.84TB NVMe PCIe 4x4 2.5" 15mm SIE 1DWP
AOC	1x Dual port 200GB AOC-653106A-HDAT

Table 1 - Specifics of the OSD Nodes

ADMIN/MON	
System/Node	AS-1114S-WN10RT
CPU	1x AMD EPYC 7713 64-Core Processor
Memory	8x32GB DDR4-3200 2Rx8 (16Gb) LP ECC RDIMM (512GB)
HDD/SSD (OS)	KIOXIA CM6 3.84TB NVMe PCIe 4x4 2.5" 15mm SIE 1DWP
HDD (Data)	
AOC	1x Dual port 100GB AOC-MCX516A-CDAT

Table 2 - Specifics of the ADMIN Nodes

Load Generators	
System/Node	4 x AS -2014TP-HTR(10 Nodes)
CPU	1 x AMD EPYC 75F3 32-Core Processor
Memory	8X MEM-DR464L-HL02-ER32 (512GB)
HDD/SSD (OS)	2x HGST/WD 3.5" 8TB SATA 6Gb/s 7.2K RPM 256M 0F27610 512e ISE
HDD (Data)	1xHGST/WD 3.5" 8TB SATA 6Gb/s 7.2K RPM 256M 0F27610 512e ISE
AOC	1x Dual port 100GB AOC-MCX516A-CDAT

Table 3 - Specifics of the Load Generators

Baseline Test Results

The purpose of this first test is to measure the pure I/O performance of the storage at each node where the Ceph package is not installed. Each node has a 22 KIOXIA CM6 3.84TB NVMe SSD, and the performance was measured using the Fio (Flexible I/O tester) benchmark tool with libaio IO engine. IOPS performance was evaluated for random IO workloads of a small IO size (4 KB). Sequential performance was also assessed for sequential IO workloads of a large IO size (128 KB). The test was performed three times, and the results were averaged. Below, we show the baseline test results.

SUPERMICRO

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

Fio options for random workload: Number of jobs - 8, Queue depth - 32, IO engine – libaio

Fio options for sequential workload: Number of jobs - 1, Queue depth - 32, IO engine – libaio

Image 2 - Supermicro A+ Server 2014TP-HTR

Image 3 - Supermicro A+ Server 1114S-WN10RT

	Vendor Specifications/Drive	Tested/Drive	OSD1	OSD2	OSD3	OSD4
	4K Random Writes					
Avg. Throughput (KIOPS)	170K	700K	2358.67	2340.67	2367.00	2380.00
Avg. 99.99%th Latency (ms)		1.91	0.15	0.18	0.18	0.17
Avg. Latency (ms)		0.37	0.13	0.11	0.11	0.11
	4K Random Reads					
Avg. Throughput (KIOPS)	1400K	1299k	2204.00	2227.33	2332.67	2333.67
Avg. 99.99%th Latency (ms)		0.81	0.27	0.23	0.22	0.22
Avg. Latency (ms)		0.20	0.12	0.11	0.11	0.11
	128K Seq Writes					
Avg. Throughput (GB/s)	4200MB/S	4045MiB/s	21.33	22.13	21.37	21.43
Avg. 99.99%th Latency (ms)		4.29	0.59	0.78	0.57	0.80
Avg. Latency (ms)		0.99	0.18	0.18	0.18	0.18
	128K Seq Reads					
Avg. Throughput (GB/s)	6900MB/s	6625MiB/s	23.73	24.10	23.67	26.77
Avg. 99.99%th Latency (ms)		3.16	0.54	0.44	0.64	0.37
Avg. Latency (ms)		0.60	0.16	54.16	0.16	0.15

Table 4 - Results from Baseline Tests

Benchmark Configurations and Results

The following sections provide the results of synthetic benchmark performance for all-flash based Ceph clusters using the KIOXIA HDS-SMP-KCD6XLUL3T84 NVMe SSD. The test was conducted in the RBD-based storage pool, which is the block storage component for Ceph. Workloads were generated using the Fio benchmark with ten client servers. Before starting the test, we created 200 RBD images that generated a total of 20 TB of data. We then applied a 2x replication, resulting in the total size of the data stored in the cluster being 30 TB.

• 10 Clients x 20 RBD images per client x 100 GB RBD image size = 20 TB (2x Replication: 15 TB x 2 = 40 TB)

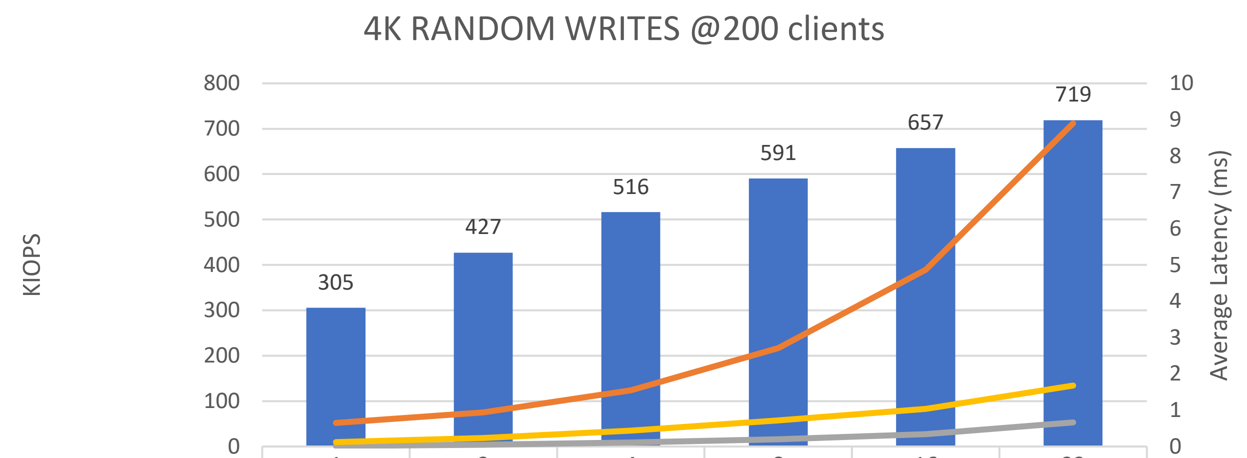
A Random test was created and run with a 4 KB small IO workload and with the number of jobs equal to 8 and queue depth 32 per Fio instance. A sequential test was also created and run with a 128 KB large IO workload with the number of jobs equal to 1 and queue depth 32 per Fio instance. We also measured latency variation across each test. The test was performed three times, and the results were averaged.

Details	
OS	RHEL 8.3
CEPH Storage	Red Hat Ceph Storage 4.2
Ceph storage type	RBD (RADOS Block Device)
Load generation tool Fio	3.25
Replication factor	2x
# of client node 10	10
# OSD Daemons	176 (2 per NVMe)
# of client RBD image	200 (20 RBD images per client)
RBD image size	100GB
# of monitor daemons	3
# of manager daemons	3

Table 5 - Specifics of Random and Sequential tests

4 KB Random write workload

We measured the performance and latency of 4 KB random writes with increasing queue depths on 200 clients. At a queue depth of 32, 4 KB random write performance was measured at an average of 719K IOPS, with an average latency of 8.9 ms and an average tail latency (99.99%th latency) of134.23ms. As queue depth increased, performance and latency tended to increase. Tail latency (99.99%th latency) increased significantly at queue depths of 16 and higher.



IO Depth	1	2	4	8	16	32
KIOPS	305	427	516	591	657	719
99.00pctLat(ms)	1.12	4.01	9.01	15.59	26.95	53.06
99.99pctLat(ms)	9.66	18.85	34.87	57.55	83.07	134.23
avgLat(ms)	0.65	0.94	1.55	2.71	4.87	8.9

IO Depth

Table 6 - 4K Random Writes @200 Clients

4 KB Random Read Workload

We measured the performance and latency of 4 KB random reads with increasing queue depths on 200 clients. At a queue depth of 32, 4KB random read performance was measured at an average of 3194K IOPS, with an average latency of 2ms and a tail latency (99.99%th latency) of 683ms. As the queue depths increased, performance and latency tended to increase. Tail latency (99.99%th latency) increased significantly at queue depths of 16 and higher.

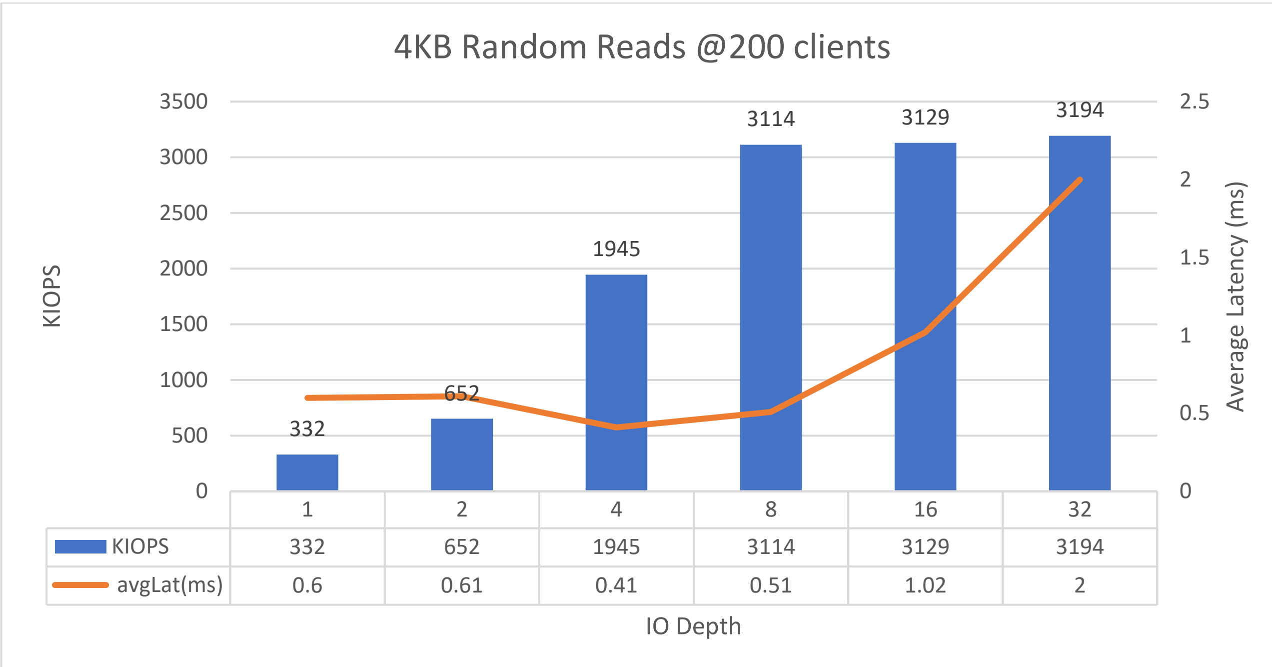


Table 7 - 4KB Random Reads @200 Clients

128 KB Sequential Write Workload

The average throughput for 128 KB sequential writes was 16 GB/s up to 60 clients. Latency increased steadily as the number of clients increased.

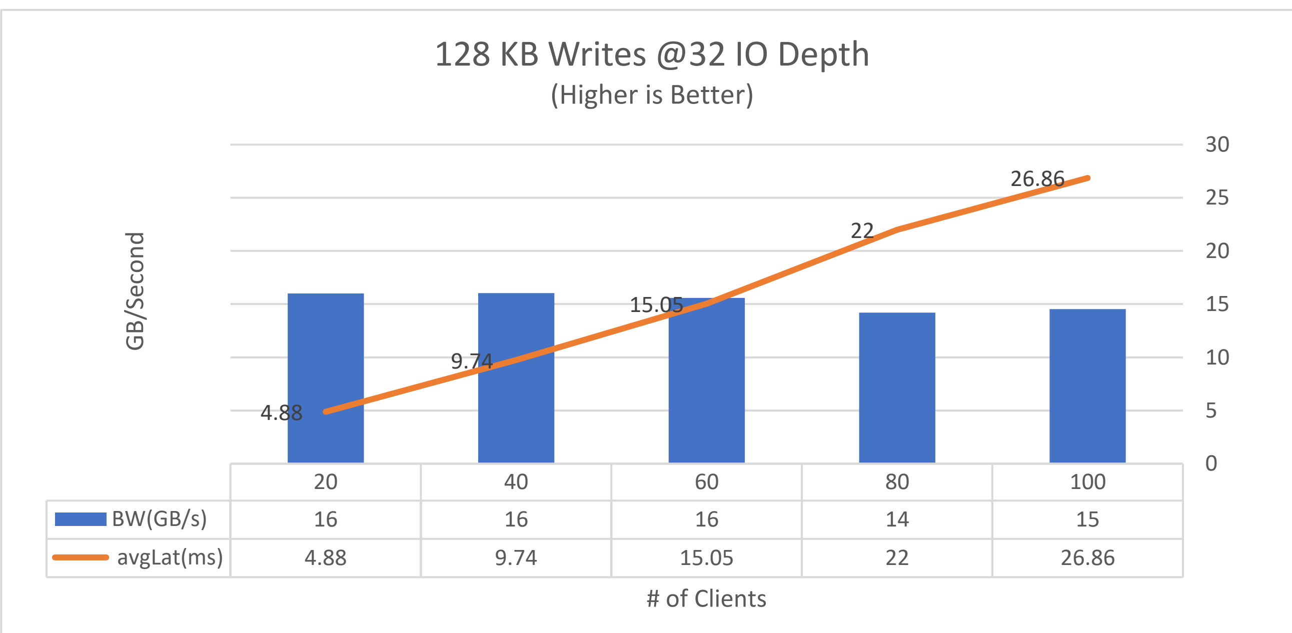


Table 8 - Results from 128 KB Sequential write workload

128 KB Sequential Read Workload

The average throughput for 128 KB sequential reads was 39 GB/s with 100 clients. Latency increased steadily as the number of clients increased, while throughput remained relatively constant once the number of clients reached 100.

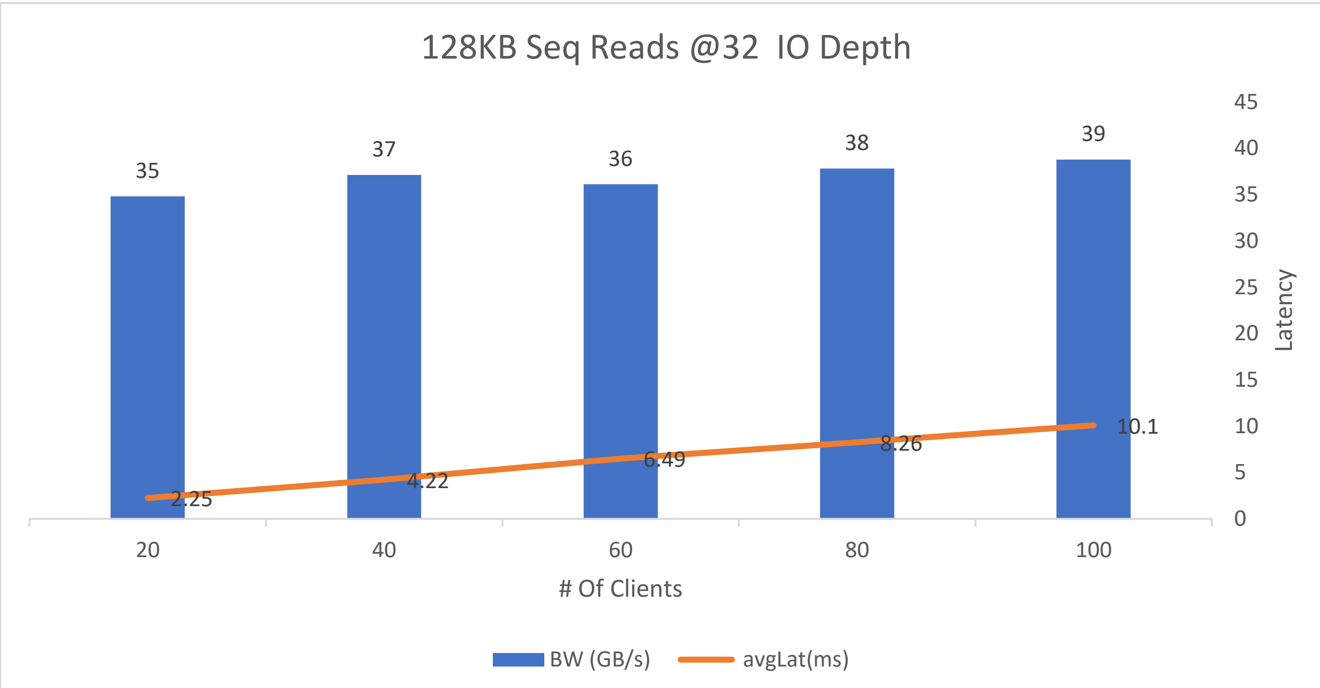


Table 9 - 128 KB Sequential Read Workload

SUMMARY OF RED HAT CEPH STORAGE PERFORMANCE

- 4K Random Writes Latency @32 IO Depth 8.9ms
- 4K Random Writes throughput @32 IO Depth 719K IOPS
- 4K Random Reads Latency @32 IO Depth 2ms
- 4K Random Reads throughput @32 IO Depth 3.19M IOPS
- 128K Seq Writes throughput 16GB/s @60 clients
- 128K Seq Reads throughput 39GB/ s @200 clients

Conclusion

Supermicro A+ servers are optimized for enterprise environments and deliver consistently high performance, making them an ideal solution for software-defined storage such as Red Hat Ceph Storage. Supermicro has designed a performance-optimizing, all-flash-based Ceph cluster using the AS -2124US-TNRP servers, using the 3rd Gen AMD EPYC 7713 CPUs, and PCI-E

Gen4 NVMe SSDs, and Red Hat Ceph Storage. This solution can achieve over 3.19 Million 4 KB random read performance and excellent sequential performance.

Supermicro optimized the CPU-to-drive ratios to unlock the maximum balanced bandwidth on the latest U.2, and E1.S NVMe drives with Supermicro Ultra and BigTwin™ systems. All-flash NVMe-based configurations deliver extremely high-performance storage with the highest IOPS per system and per Gigabyte to enable a rich set of data services across the IT infrastructure.

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