PETABYTE SCALE (→) OBJECT STORAGE

MinIO's Benchmark Testing on the SANDISK® DC SN655 SSD

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Executive Summary

MinIO AIStor and Sandisk's high-capacity DC SN655 NVMe SSDs combine to deliver a flash-native, performance-driven object storage stack for enterprise AI workloads. In recent benchmark testing, MinIO sustained more than 100GB/s of aggregate throughput across a 4.4PB usable (7.86PB raw) deployment using 128 x 61.44TB SSDs in an 8+3 erasure coding configuration. Production-grade performance, delivered on commodity infrastructure, without the complexity of custom hardware or fine-tuning.

Benchmark Introduction

As enterprises continue to advance into the AI era, the volume and intensity of data creation and usage have risen exponentially. In the past, deploying flash-based storage at petabyte scale was not only cost-prohibitive but also required substantial physical space — since HDDs offered higher capacity per drive, albeit with a slightly larger footprint. These environments often relied on complex software that demanded specialized hardware to function optimally.

Fast forward to today: SSD capacities have scaled significantly, often rivaling or surpassing those of HDDs, while offering a smaller footprint and higher performance. Additionally, the advent of cloud computing has accelerated the adoption of object storage as a primary storage architecture, valued for its scalability, performance, and cost-effectiveness.

This shift has accelerated the rise of high-performance, software-defined object storage solutions like MinIO AIStor, which bring simplicity in deployment and management, along with the flexibility to run on commodity hardware — making them ideal for AI, analytics, and cloud-native workloads.

SANDISK® SN655 SSD: High-Capacity NVMe SSD

The SANDISK® DC SN655 SSD is a PCIe® Gen4 NVMe™ SSD designed for enterprise and cloud-scale environments. It supports capacities up to 61.44TB[1] and is optimized for read-intensive workloads such as streaming, AI/ML pipelines, and advanced analytics.

Key Specifications:

- Interface: PCIe Gen4, NVMe 1.4b
- Sequential Read: Up to 6,800 MB/s
- Sequential Write: Up to 2,600 MB/s®
- Random Read: Up to 1,000,000 IOPS
- Random Write: Up to 112,000 IOPS[2]
- Endurance: 1.0 DWPD (Drive Writes Per Day)[3]
- MTBF: 2.5 million hours[4]
- Security: SE, ISE, TCG Ruby
- Power Loss Protection: Yes

These features make the SN655 SSD an ideal match for MinIO's flash-optimized architecture, enabling ultra-fast object storage at scale.

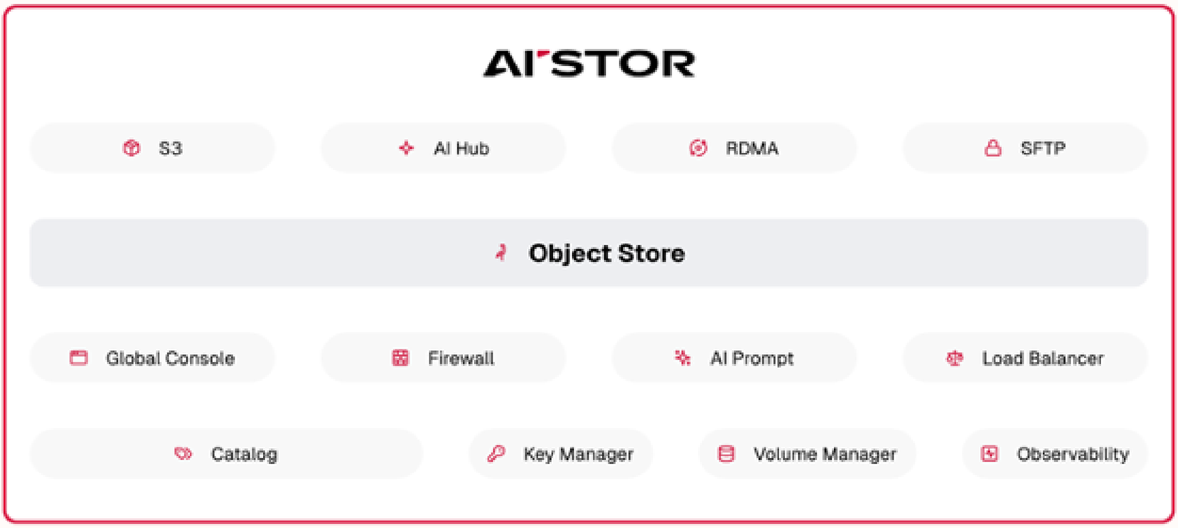
1. One megabyte (MB) is equal to one million bytes, one gigabyte (GB) is equal to 1,000MB (one billion bytes), one terabyte (TB) is equal to 1,000GB (one trillion bytes), and one petabyte (PB) is equal to 1,000TB. Actual user capacity may be less due to operating environment.up to 60°C. Non-operational storage temperature does not guarantee data retention.
2. Based on internal testing. Performance will vary by capacity point, or with the changes in useable capacity. Consult product manual for further details. All performance measurements are in full sustained mode and are peak values. Subject to change.
3. Endurance rating based on DWPD using 4KiB 100% random write and JESD 219 workloads over 5 years.
4. MTBF and AFR specifications will be based on a sample population and are estimated by statistical measurements and acceleration algorithms under typical operating conditions for this drive model. MTBF and AFR ratings do not predict an individual drive's reliability and do not constitute a warranty.

MinIO AIStor

MinIO AIStor extends the proven foundation of the world's fastest, most widely deployed object store, providing performance and scalability improvements along with additional enterprise grade capabilities. Designed for the petascale and exascale data infrastructure challenges presented by modern application workloads like AI/ML and advanced analytics, AIStor delivers exceptional throughput and IOPS by combining direct I/O (O_DIRECT) and erasure coding optimized for NVMe SSDs.

AIStor's stateless, software-defined architecture enables horizontal scalability and consistent performance even at peak capacity. With no metadata overhead and minimal memory footprint, performance scales linearly with the underlying flash hardware, making AIStor ideal for petabyte or exabyte-scale deployments on commodity infrastructure. In short, AIStor was built for the world where everything matters — performance, security, scalability, stability, and support.

The diagram below highlights the core components that make MinIO AIStor the object store of choice for enterprise-grade AI infrastructure.



The Benchmark Setup

8 Client Servers:

Chassis
Dell PowerEdge R7615 Single socket AMD EPYC™ 9754

CPU/DRAM
128 CPU cores and 256 threads, 8 x 64GB (512GB) RAM

Network
400GbE ConnectX-7 NIC

8 Nodes MinIO AIStor Cluster:

Chassis
Dell PowerEdge R7615 Single socket AMD EPYC™ 9754

CPU/DRAM
128 CPU cores and 256 threads, 8 x 64GB (512GB) RAM

Disk
16 x 61.44TB SANDISK® SN655 NVMe SSD

Network
400GbE ConnectX-7 NIC

Software configuration for all servers:

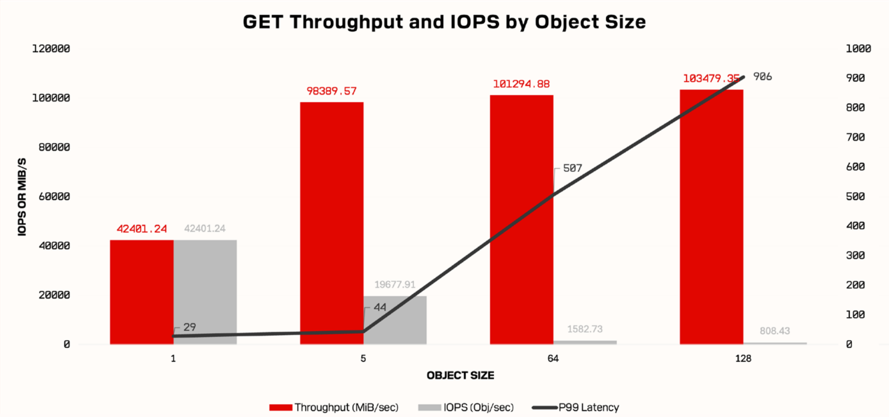
- Running Ubuntu 24.04 + AIStor version: RELEASE.2025-03-29T19-13-44Z
- /etc/default/minio file was configured with:
- MINIO_VOLUMES="http://server{1...8}/drive{1...16}"
- MINIO_ERASURE_SET_DRIVE_COUNT=8
- MINIO_ERASURE_PARITY_COUNT=3

Networking Topology:

- All 16 Servers Connected to an SN4700 Mellanox switch (32 x 400GbE ports)

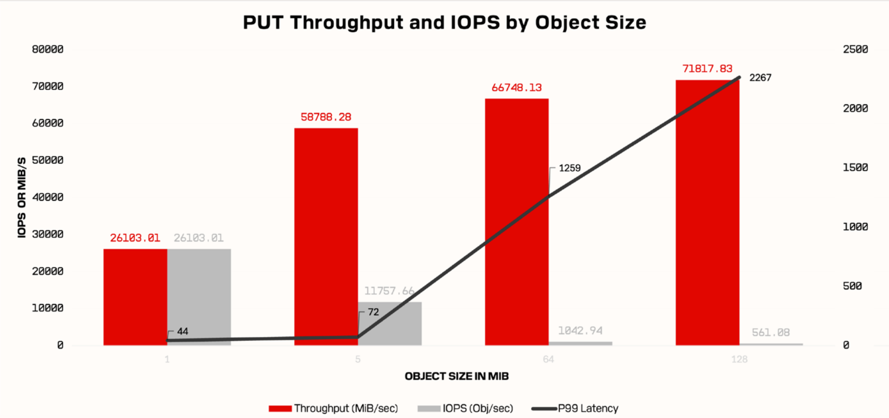
Benchmarking Results

The benchmarking tests were conducted on an 8-node MinIO AIStor cluster using Dell PowerEdge R7615 servers, each equipped with 16 x 61.44TB SANDISK® SN655 NVMe SSDs. The system was configured with an 8+3 erasure coding scheme, delivering 4.4 PB usable capacity from a 7.6 PB raw capacity. The tests used the WARP benchmarking tool with varying object sizes and concurrency levels.



GET Operation Highlights:

- Peak Throughput: 103.5 GB/sec achieved with 128 MB objects and 64 threads.
- Peak IOPS: 42,401 ops/sec with 1 MB objects and 64 threads.
- Latency: Even at high throughput, average latencies remained within acceptable ranges (e.g., 12ms for 1 MB objects at peak IOPS).



PUT Operation Highlights:

- Peak Throughput: 72.2 GB/sec with 1024 MB objects and 64 threads.
- Peak IOPS: 26,103 ops/sec with 1 MiB objects and 64 threads.
- Latency: PUT operations showed slightly higher latencies, especially for larger object sizes (e.g., 7.2s for 1024 MiB objects).

These results demonstrate that MinIO AIStor, when paired with high-capacity SANDISK® NVMe SSDs, can deliver exceptional throughput and IOPS at petabyte scale using commodity hardware.

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