Technical Paper

Intel® Xeon® Processors

Benchmarking MinIO AIStor on Intel® Xeon® 6781P Processors, Designed for Scale-out Cloud, with Storage & I/O Flexibility Optimized for AI Workloads

Delivering Exceptional I/O with Compute Performance Across a Wide Range of Storage Workloads

Executive Summary

When paired with MinIO* AIStor* software defined storage, Intel® Xeon® 6781P processors deliver exceptional I/O and compute performance across a wide range of storage workloads. This technical paper presents benchmarking results from running MinIO AIStor on a single socket Intel Xeon 6781P processor-based system, showcasing excellent performance in object storage, encryption, hashing, and erasure coding.

Introduction

Disaggregated compute and storage architecture has become the backbone of modern AI and cloud infrastructure. Fast GPUs and NVMe drives have pushed the bottleneck to the PCIe® I/O subsystem. For example, each NVMe drive typically requires x4 PCIe lanes, and high-speed NICs demand x16. Systems with insufficient lanes must scale out horizontally, increasing complexity and cost. Modern AI and cloud workloads demand massive data throughput, driving a shift back to I/O subsystems as a performance bottleneck. To address these needs, the Intel Xeon 6781P processor offers architecturally optimized, industry leading I/O with 136 PCIe Gen5 lanes per socket.

In this landscape, MinIO AIStor emerges as a crucial component of the modern data infrastructure. MinIO AIStor is a high-performance, enterprise-grade, distributed object storage system designed to efficiently manage the unstructured data that AI and cloud workloads generate. Its full compatibility with Amazon* S3 API, and other cloud storage systems, combined with support for hybrid and multi-cloud environments, makes it an ideal storage solution. AIStor's speed and scalability align with the demands of modern architecture, providing seamless data access and management even as compute and storage resources are increasingly disaggregated.

The Case for Intel Xeon 6781P Processors

With 80 cores and 136 Gen5 lanes, Intel Xeon 6781P processors feature an industry-leading PCIe lane count. These architectural improvements make it ideal for workloads requiring maximum data movement per socket—particularly relevant for AI inference, real-time analytics, and object storage backends.

Hardware & Software Configuration

- Server: 2U rackmount server
- CPU: 1x Intel Xeon 6781P processor (80 cores, 160 threads, 3.8 GHz max)
- Memory: 256 GB DDR5 ECC RDIMM (6400 MT/s)
- Networking: 400 Gbps via Mellanox* ConnectX-7
- Storage: 24× Dell* DC NVMe ISE 7450 RI U.2 drives (184.32 TB total)
- Tools: MinIO dperf and warp, custom benchmarking for RS, AES-GCM, HighwayHash, Memcpy, MinLZ
- Performance Results Date: May 2025

The hardware and software configuration used for testing consisted of 2U rackmount server equipped with a single Intel Xeon 6781P processor, featuring 80 cores and 160 threads with a maximum frequency of 3.8 GHz. The system was configured with 256 GB of DDR5 ECC RDIMM memory running at 6400 MT/s. Networking was provided through a 400 Gbps Mellanox ConnectX-7 adapter, while storage included 24 Dell DC NVMe ISE 7450 RI U.2 drives, offering a total capacity of 184.32 TB. Benchmarking and performance evaluation were conducted using MinIO's dperf and warp tools, as well as custom scripts for testing Reed-Solomon encoding, AES-GCM encryption, HighwayHash, memory copy (Memcpy), and MinLZ compression.

Storage I/O Benchmarks

Single Drive Test

- Read 5.9 GiB/s, Write: 5.2 GiB/s
- Observation: Excellent per-drive throughput baseline

24-Drive Parallel Test

- Read: 142 GiB/s, Write: 120 GiB/s
- Observation: Linear scaling with no bottlenecks

MinIO Warp Benchmark (Single-Node, EC:3)

- GET: 46.9 GiB/s (peak)
- PUT: 28 GiB/s + parity = ~40 GiB/s
- Observation: Near-saturation of 400 Gbps NIC during reads

The single drive test demonstrated impressive performance, achieving a read speed of 5.9 GiB/s and a write speed of 5.2 GiB/s, indicating an excellent per-drive throughput baseline. In a 24-drive parallel test, the system maintained linear scaling with no bottlenecks, reaching read speeds of 142 GiB/s and write speeds of 120 GiB/s. The MinIO Warp benchmark, conducted on a single node with erasure coding (EC:3), recorded a peak GET speed of 46.9 GiB/s and a PUT speed of 28 GiB/s, including parity, resulting in an approximate total of 40 GiB/s. During reads, the system nearly saturated the 400 Gbps NIC, showcasing its high data transfer efficiency.

CPU Performance Benchmarks

Reed-Solomon Encoding

- Throughput: 130–145 GB/s (optimal at 20–40 threads)
- Observation: Strong SIMD workload performance; cache pressure limits scaling beyond 40

threads

AES-GCM Encryption

- Peak: 115 GB/s (10M objects)
- Optimal Threads: ~20–25
- Intel Xeon 6781P processor achieves excellent peak performance
- Disabling Hyper-Threading boosts Intel performance

HighwayHash

- Intel Xeon 6781P Processor: ~300 GB/s peak with modest variability
- Competition: Consistent ~270–280 GB/s
- Observation: Intel excels in bursty, high throughput hashing workloads

Reed-Solomon encoding demonstrated strong Single Instruction, Multiple Data (SIMD) workload performance, achieving throughput between 130 and 145 GB/s, with optimal performance observed at 20 to 40 threads. However, scaling beyond 40 threads is limited due to cache pressure. For AES-GCM encryption, the peak throughput reached 115 GB/s when processing 10 million objects, with optimal performance observed at around 20 to 25 threads. Disabling Hyper-Threading on Intel systems led to improved performance. In HighwayHash tests, the Intel Xeon 6781P processor peaked at around 300 GB/s with some variability, suggesting that Intel Xeon processors are well suited for bursty, high throughput hashing workloads.

Memory & Compression Benchmarks

Memory Copy (Memcpy)

- Intel Xeon 6781P Processor: 204 GB/s, 5134 ns/op
- Observation: Intel excels in memory-bound operations

MinLZ Compression

- Intel Xeon 6781P Processor: 87 GB/s compression, 210 GB/s decompression (160 threads)
- Observation: Intel ideal for read-heavy workloads

In memory copy (Memcpy) tests, Intel performed well with a throughput of 204 GB/s and a latency of 5134 ns per operation, indicating that Intel excels in memory-bound operations. In MinLZ compression tests, Intel achieved a compression speed of 87 GB/s and a decompression speed of 210 GB/s using 160 threads. These results suggest that Intel is well suited for read-heavy workloads.

Intel Xeon 6781P Processor vs. Competitive CPU PCIe Fanout Summary

- PCIe Lanes: Intel Xeon 6781P processor, 136 PCIe Gen5 lanes > competitive CPUs with 128

PCIe Gen5 lanes

- Peak Throughput: Intel excels in AES-GCM, RS, decompression
- Scalability: Intel benefits from tuning and disabling Hyper-Threading

The Intel Xeon 6781P processor demonstrates excellent performance in several key areas. Intel processors offer more PCIe lanes, with 136 compared to 128 on other CPUs, providing greater connectivity and bandwidth potential. In terms of peak throughput, Intel Xeon processors perform well in AES-GCM encryption, Reed-Solomon encoding, and decompression workloads. Additionally, Intel's scalability is enhanced through tuning and the option to disable Hyper-Threading, allowing for improved performance in certain multi-threaded scenarios.

Optimization Tips

- Disable Hyper-Threading on Intel for encryption and erasure coding
- Tune concurrency for cache-sensitive workloads
- Use 10–25 MiB object sizes for peak performance in AES-GCM

To optimize performance on Intel processors, Intel sometimes recommends disabling Hyper-Threading when running encryption and erasure coding workloads, as this can lead to improved throughput. Additionally, tuning concurrency is crucial for cache-sensitive workloads to avoid performance bottlenecks. For AES-GCM encryption, using object sizes between 10 and 25 MiB helps achieve peak performance by balancing processing efficiency and data throughput.

Conclusion

The Intel Xeon 6781P processor, when paired with MinIO AIStor SW Defined Storage, demonstrates exceptional I/O and compute performance across a range of storage workloads. With an industry leading 136 PCIe Gen5 lanes, excellent per-core throughput, and balanced architecture, it enables modern AI and cloud platforms to meet the most demanding object storage requirements. These benchmarks confirm its value for disaggregated storage systems where every GB/s of throughput counts.

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