SSD Performance Profiling

ECSE 4320

Ben Herman

Content

Experiment Setup

Timing Measurement:

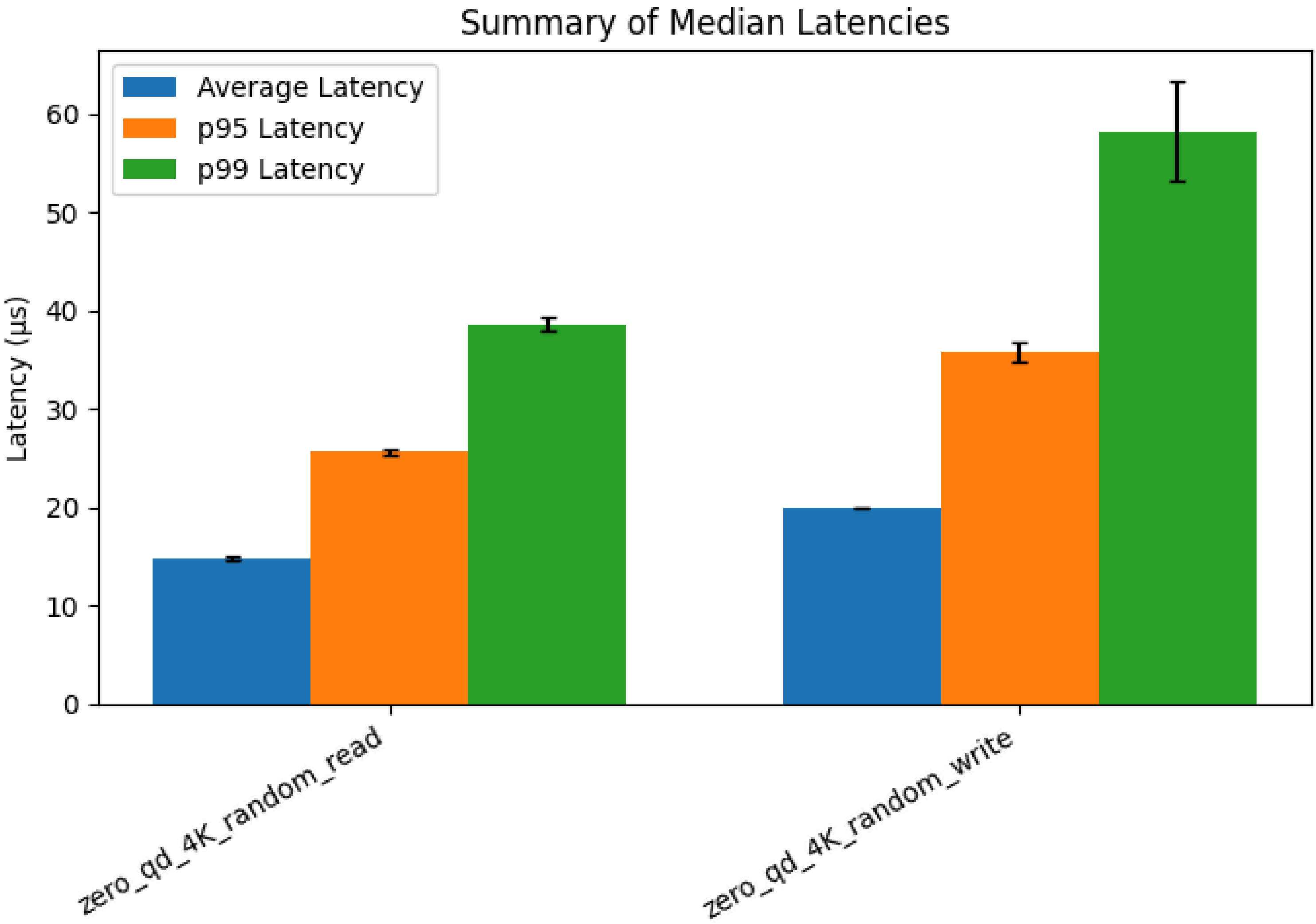
- Execution time is measured using `mach_absolute_time()`.

Conditions:

- Model: M2 Mac
- OS: Sequoia 15.6
- Powersource: Wall outlet
- Ram: 16 GB

Zero-Queue Baselines

Zero-queue latency for 4 KiB random read and write.

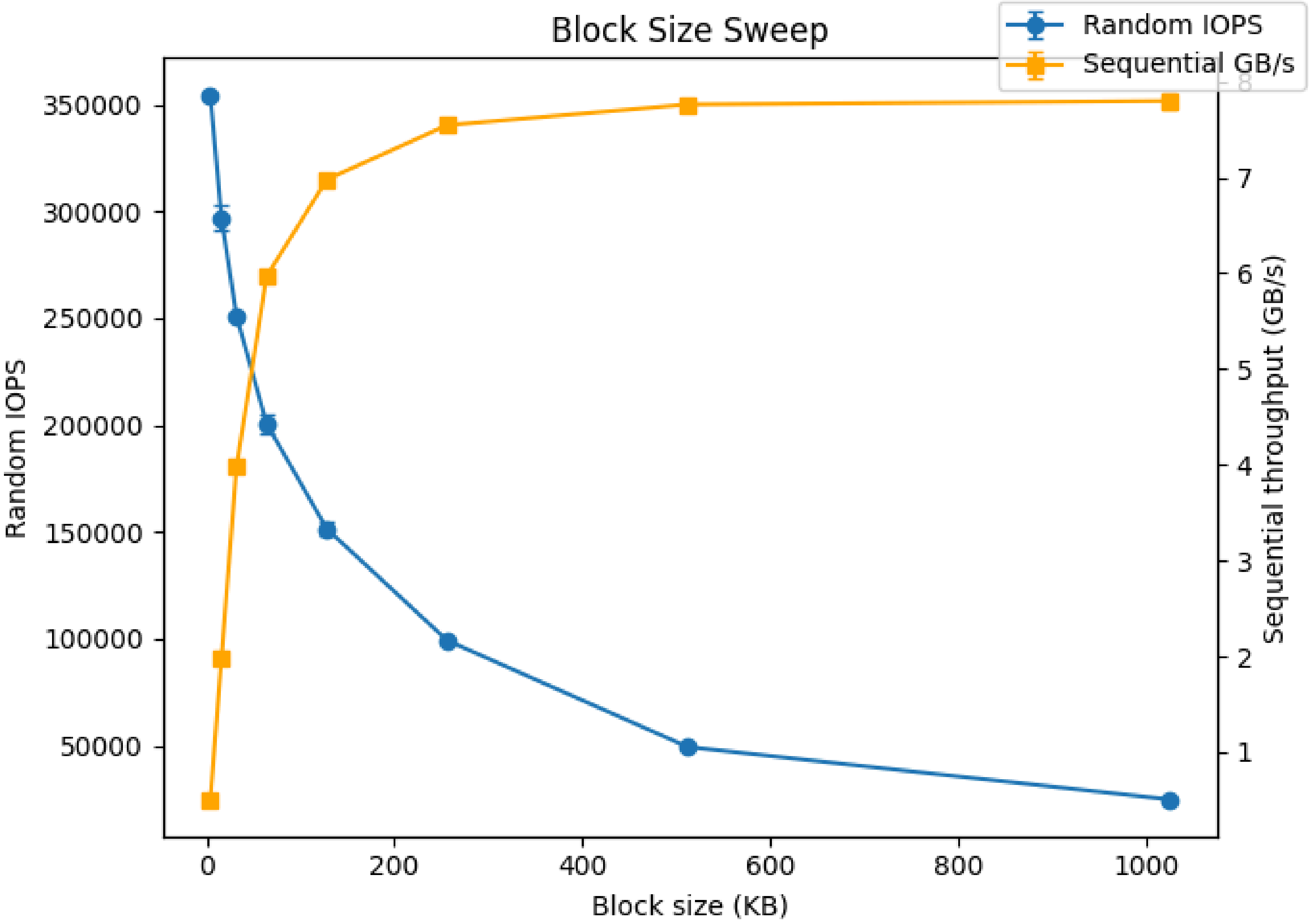


Block-Size Sweep

Impact of block size on random IOPS and sequential throughput.

We see in the graph:

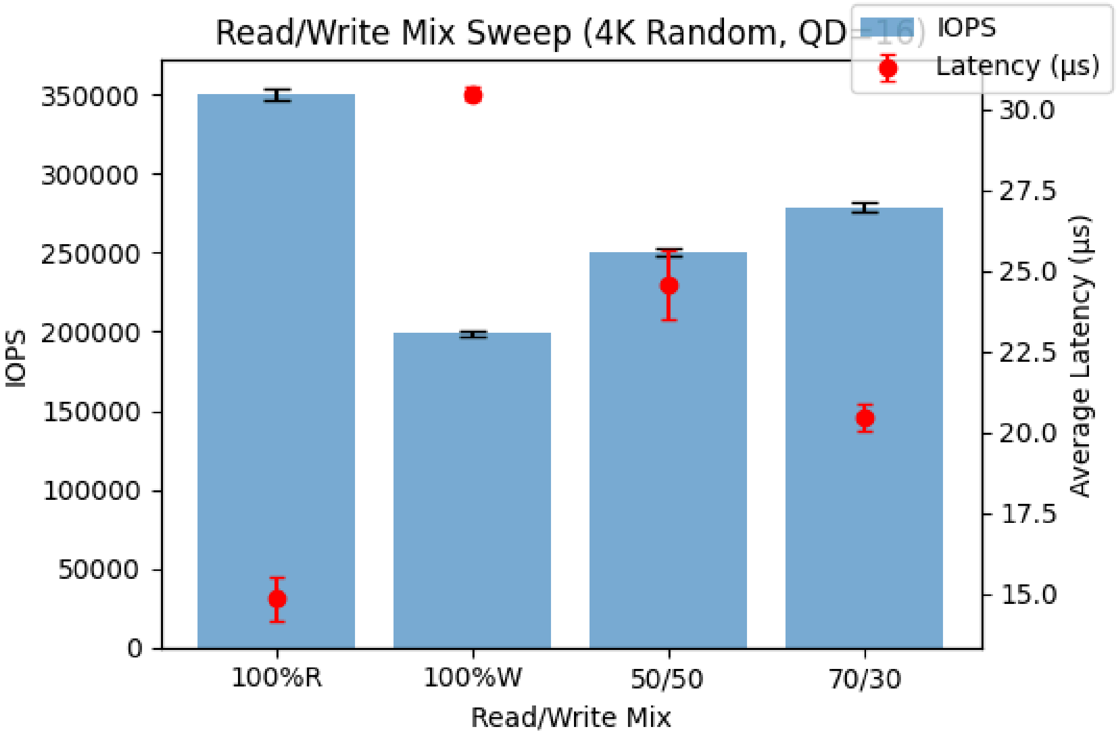
- Small blocks less than 192 KB are throughput limited by IOPS
- Large blocks more than 192 KB are throughput limited by the PCIe because its saturated with too many requests.



Read/Write Mix Sweep

Effect of varying read/write ratio at fixed block size (4 KiB random).

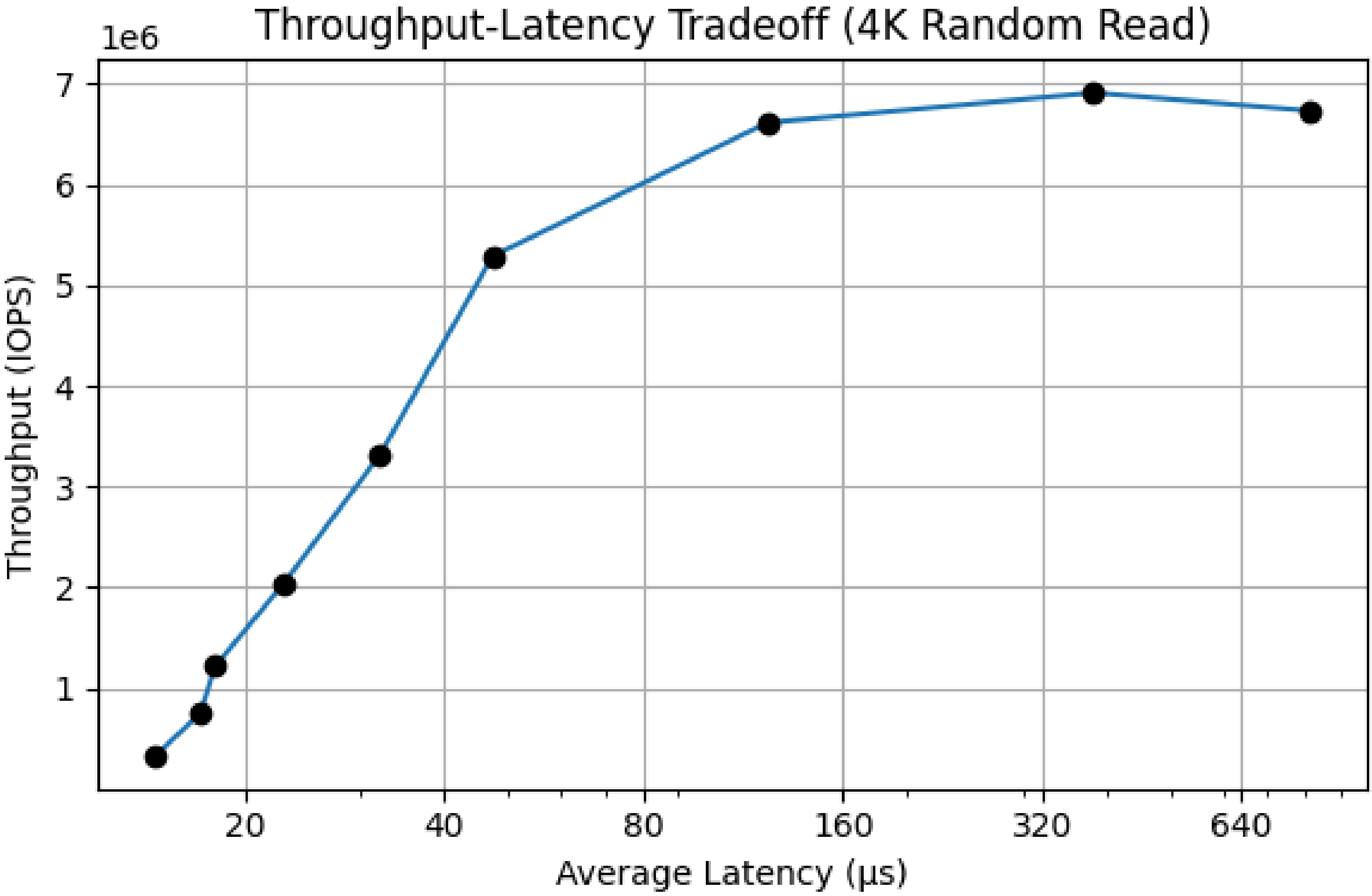
- 100% read yields highest IOPS and lowest latency and the opposite for 100 write
- Increasing write fraction increases latency and decreases IOPS
- We see the other ratios also follow these trends



Queue Depth Sweep

Throughput-latency trade-off curve for 4 KiB random reads.

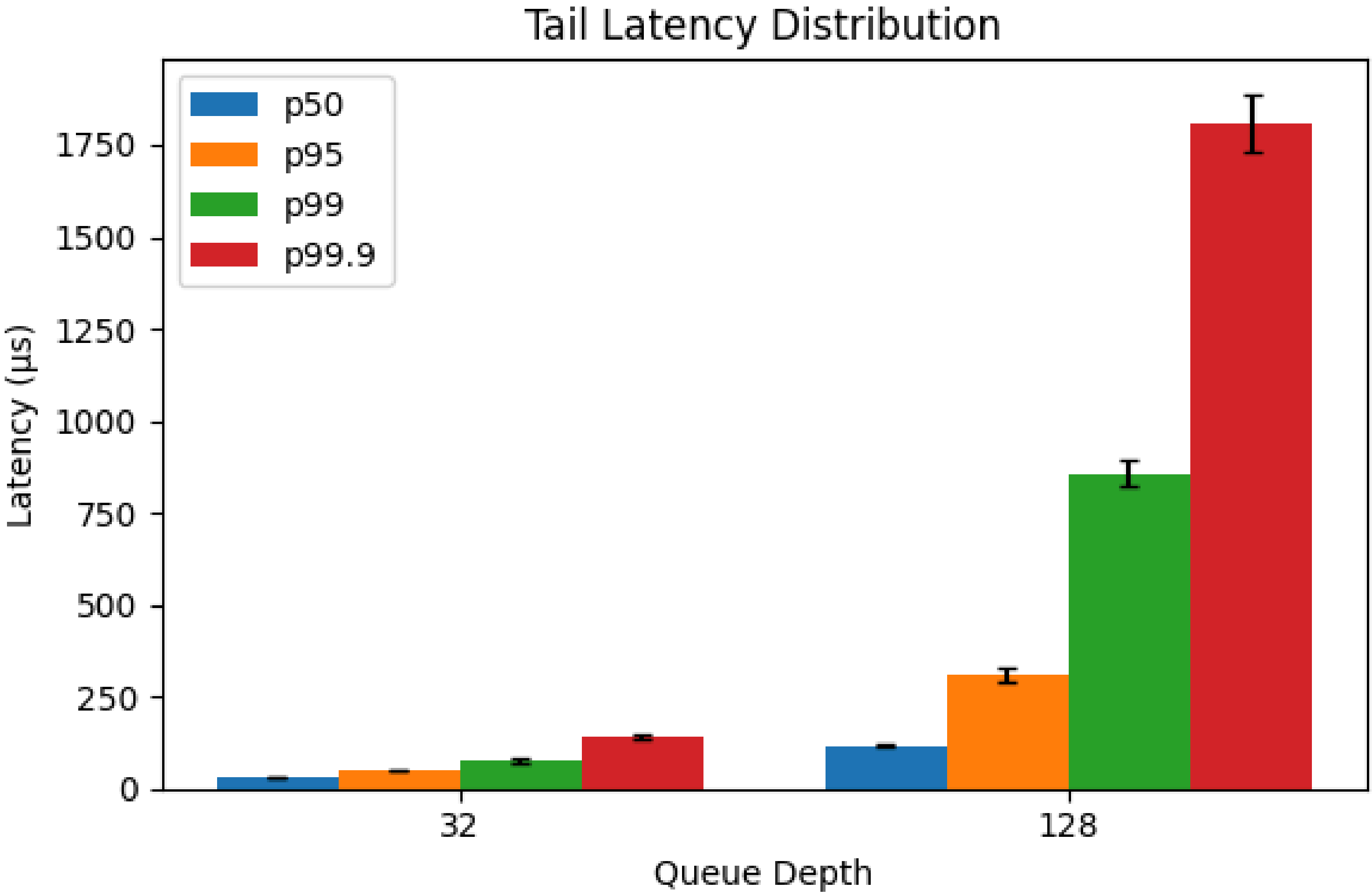
- Throughput rises with QD until saturation (QD 32-64)
- Latency grows sharply past the knee
- We can see Little’s Law holds because throughput and latency are inversely proportional



Tail Latency

Tail latency distribution (p50/p95/p99/p99.9) at different QDs.

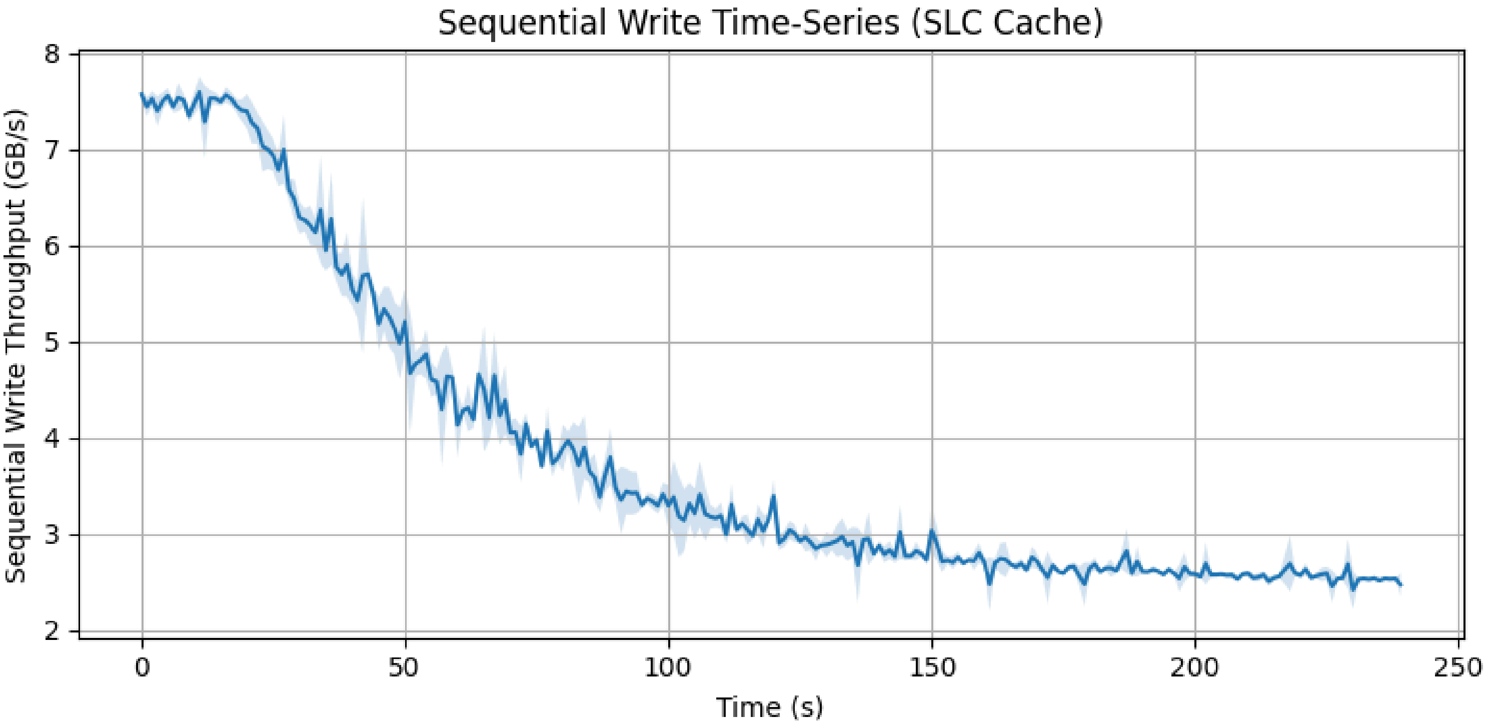
- p99.9 latency spikes significantly at high queue depth
- Important for SLA-sensitive workloads
- Highlights worst-case latency scenarios beyond average



Sequential Write Time-Series

Sequential write throughput over 240s, simulating SLC cache behavior.

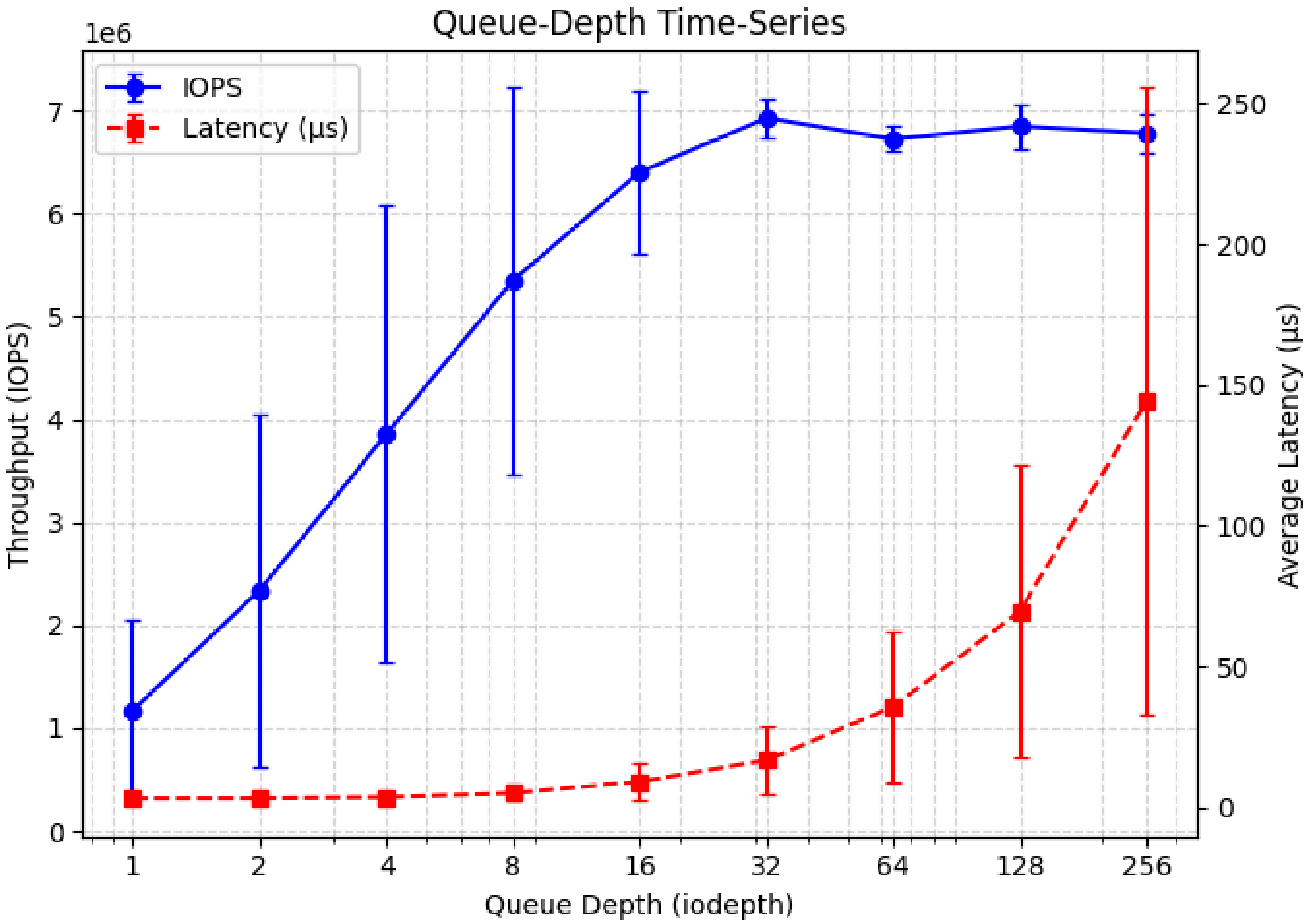
We can see that the throughput starts out at 7.5GB/s and starts decreasing till it plateaus out at 2.5GB/s.



Queue Depth Time-Series

IOPS and latency vs iodepth (1-256) time series.

Throughput increases as the queue depth decreases and plateaus out at an iodepth of 32. Average latency seems to increases exponentially with Queue Depth.


Queue-Depth Time-Series
1e6
IOPS
Latency (µs)
Throughput (IOPS)
Average Latency (µs)
Queue Depth (iodepth)