

Performance Studies of Out-of-Core Computing on Various Storage Devices

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Fusion-IO's IOSan, SuperTalent's
RaidDrive, OCZ Vertex 3, Kingston V+

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Computer Systems, Cluster, and Networking Summer Institute 2011



Outline

- Out of Core Testing
 - Introduction
 - Devices Used
 - Types of Benchmarks
 - Results from Benchmarks
 - Cost Efficiency
 - Areas for Improvement
 - Conclusion



Introduction

- Datasets are characterized by their very large sizes with multiple superposed scalar and vector fields, demanding an imperative need for new interactive exploratory visualization capabilities
- Sequence of Out-of-core benchmarking tests were done on various storage devices such as SATA based Solid State Devices and PCI-Express based SSD

Devices

- System
 - Fedora 13 64bit
 - RAM: 144GB, 16 Cores
 - Devices
 - Fusion IO IOSAN SSD 640GB
- System
 - Fedora 15 64bit
 - RAM: 8GB, 8 Cores
 - Devices
 - SuperTalent RAID Drive 512GB
 - APTEC PCI-Express 4-Port SATA Controller
 - 4x 240 GB OCZ Vertex 3
 - 4x 256 GB Kingston V+ Series

Benchmark Tests

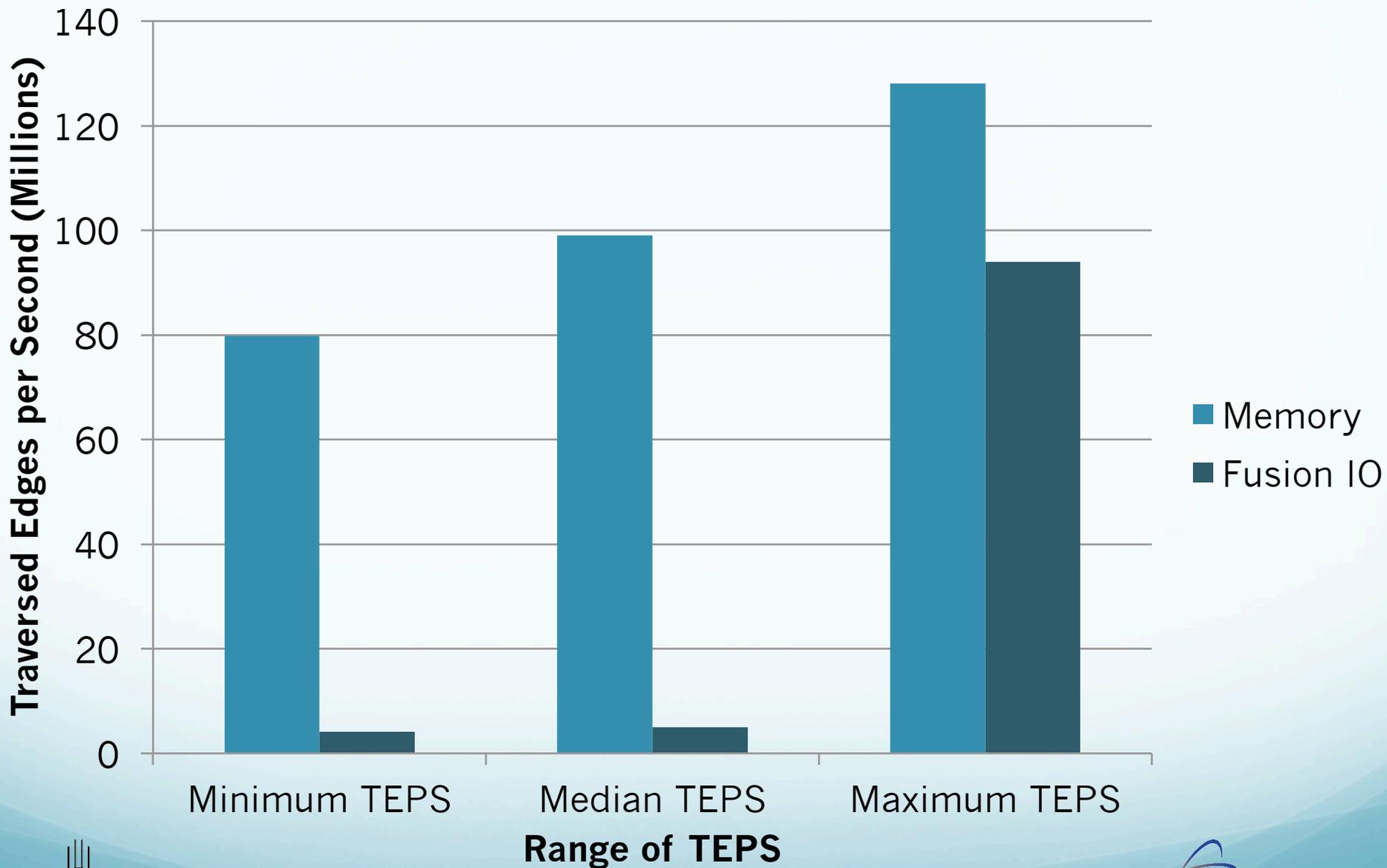
- FIO (File Input/Output) Benchmark
 - Unbuffered/Buffered I/O
 - Sequential Read
 - Sequential Write
 - Random Read
 - Random Write
- Graph 500
 - Scale 28
 - Cores: 16

FIO Benchmark

- Three types of results done
 - Aggregate Bandwidth
 - I/O Operations per Second
 - Completion Latency

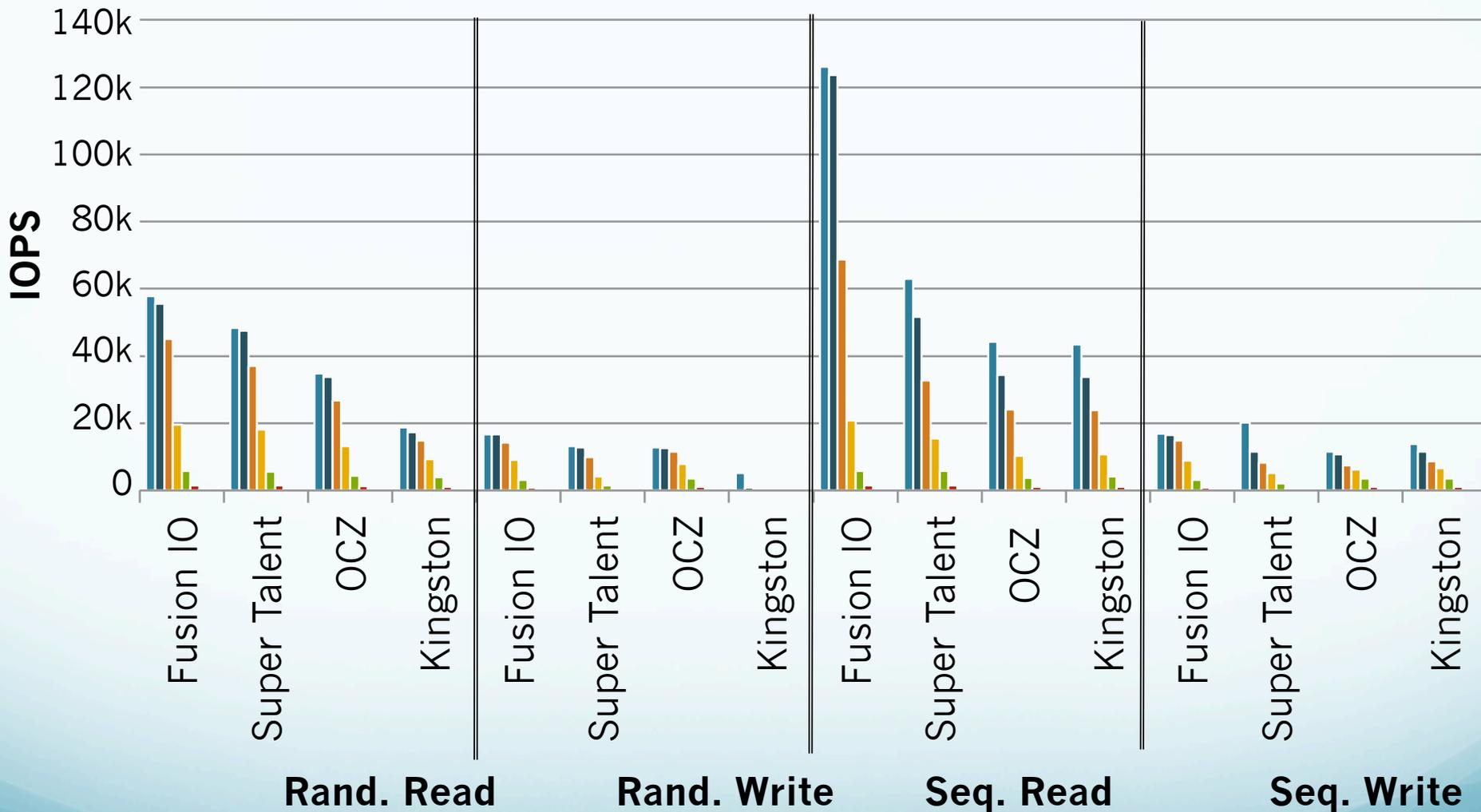
- Ext2 File systems were created on the devices

Graph 500 Results

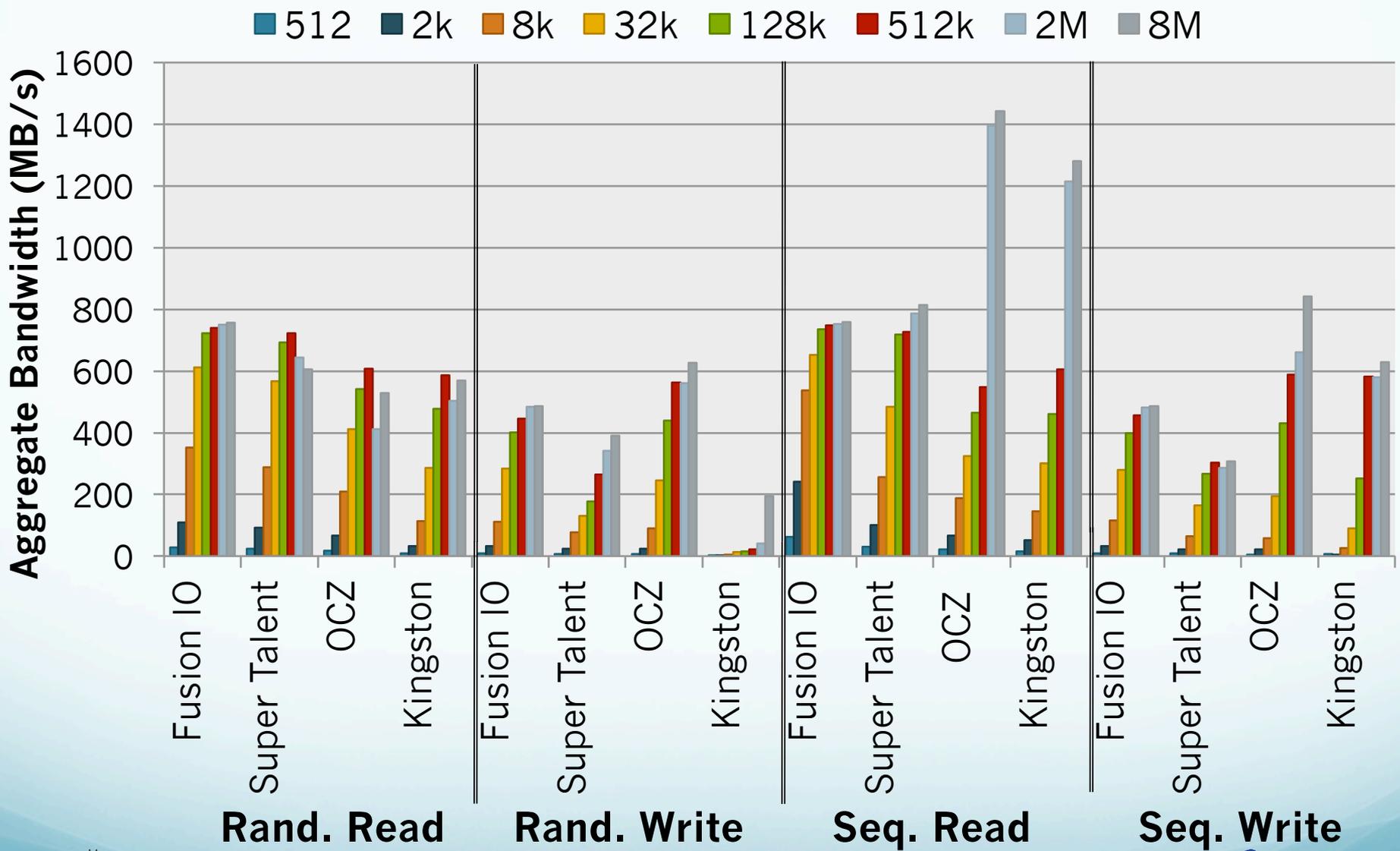


FIO Benchmark - IOPS - Unbuffered - 64 Jobs

512 2k 8k 32k 128k 512k 2M 8M



FIO Benchmark - Aggregate Bandwidth - Unbuffered - 64 Jobs

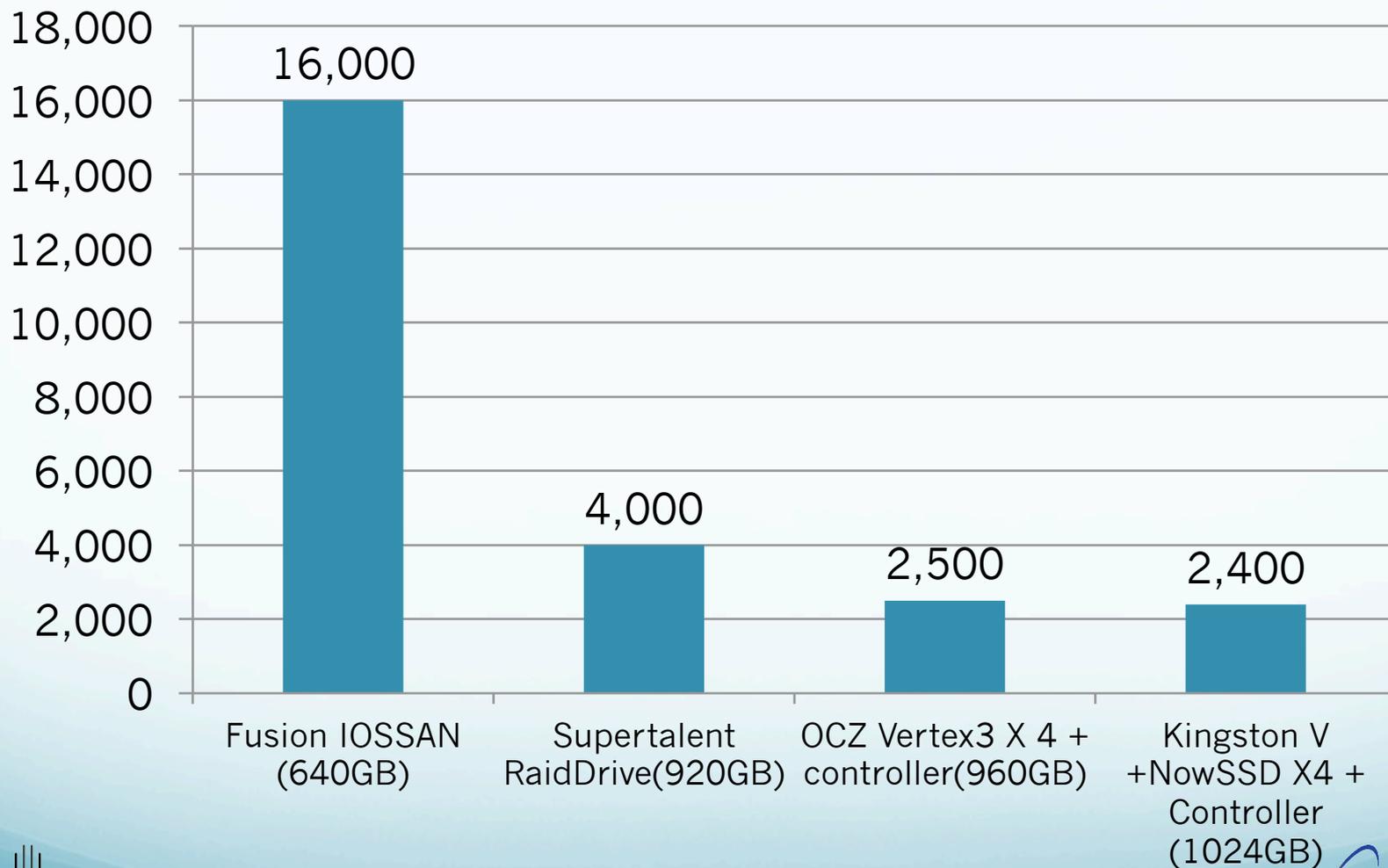


FIO Benchmark Cost Efficiency

Device (MTBF)	Capacity (GB) / \$	Bandwidth (MB) / \$	IOPS / \$
Fusion IO	0.040	0.012	3.011
Super Talent (1.5 mil. Hours)	0.256	0.056	14.355
OCZ Vertex 3 (2 mil. Hours ea.)	0.426	0.035	8.904
Kingston V+ (1 mil. Hours ea.)	0.499	0.021	7.224

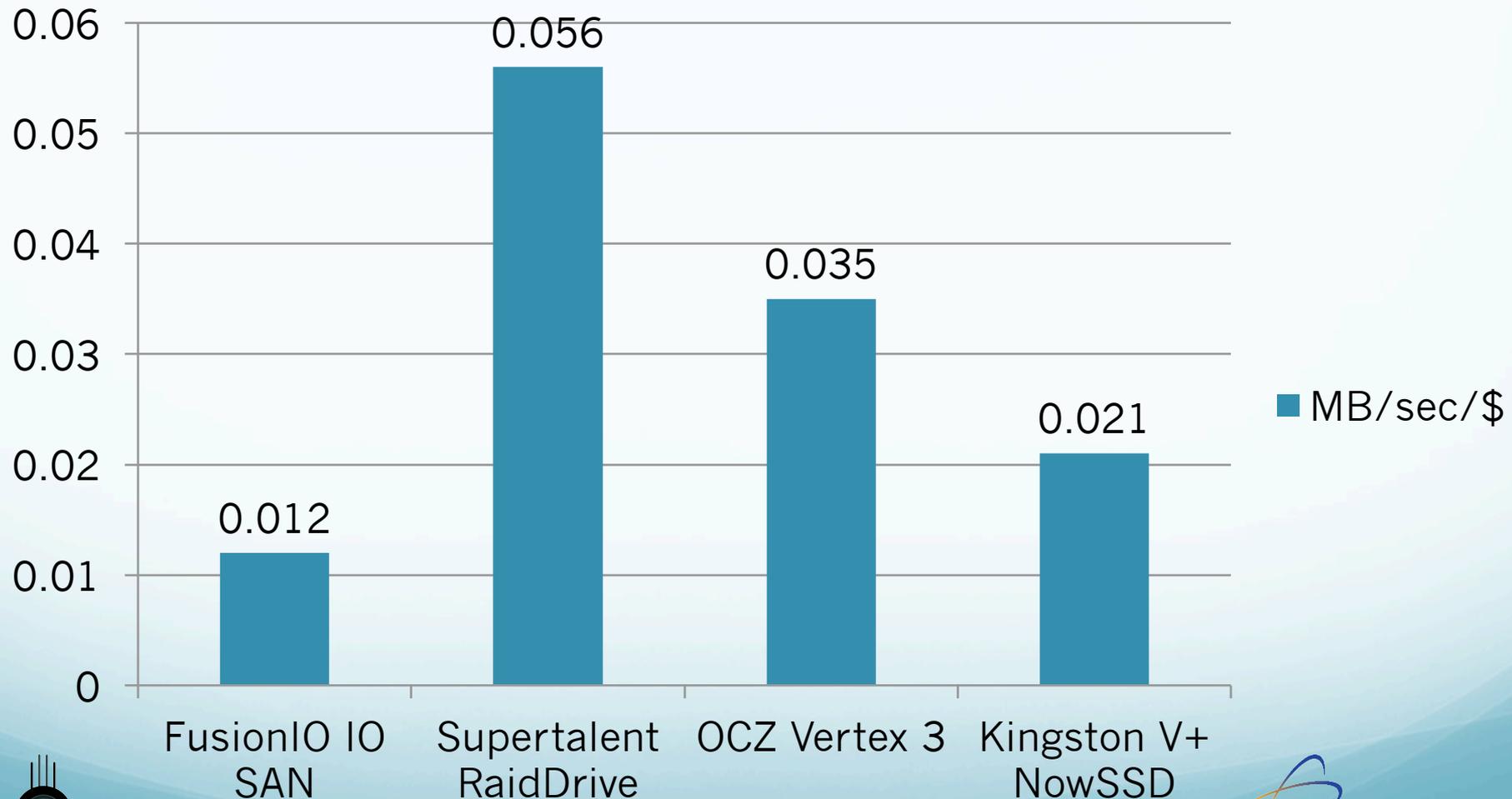
Cost/Capacity List

Cost(\$)



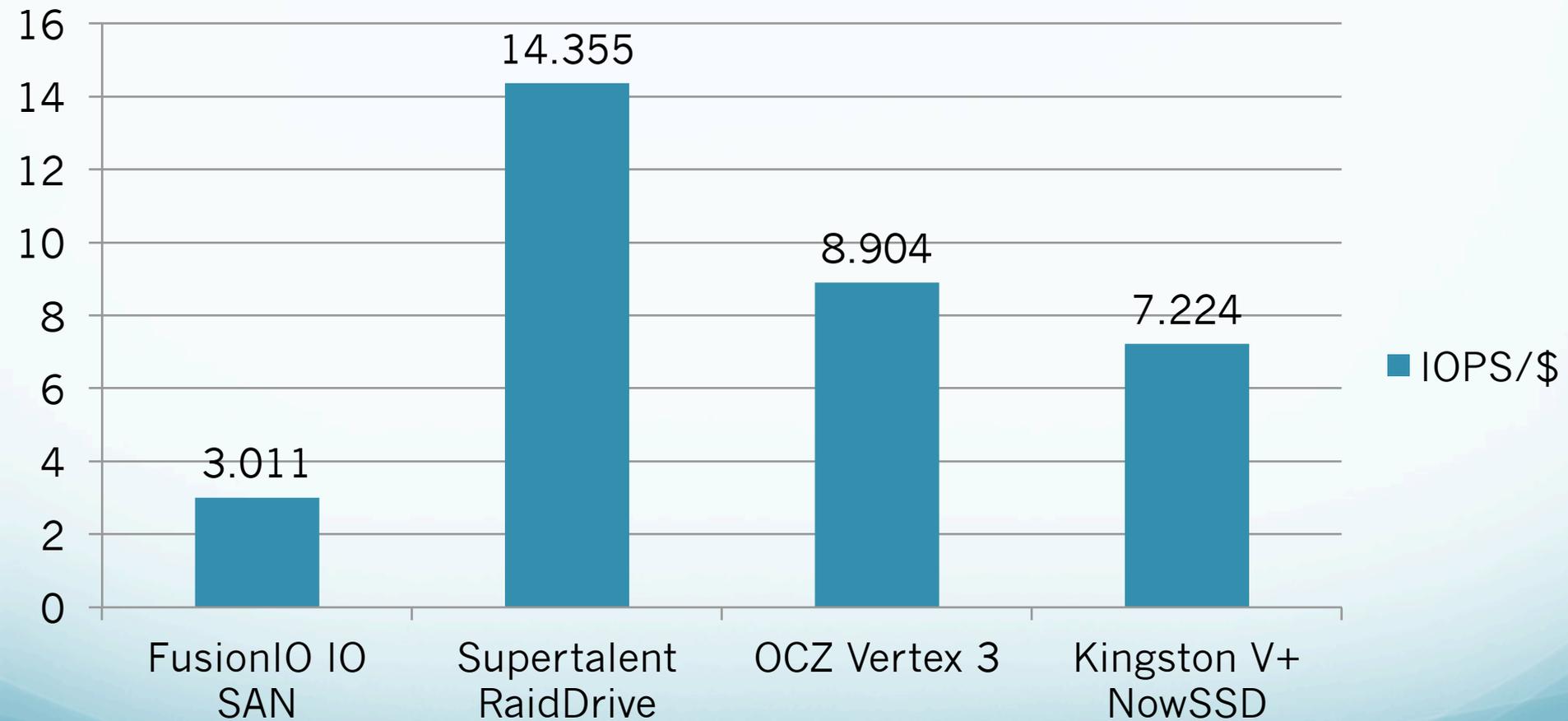
Bandwidth Cost Comparison

MB/sec/\$



IOPs Cost Comparison - IOPs/\$

IOPS/\$



Areas for Future Improvement

- Benchmarks
 - IOZone
 - XDD
 - Bonnie++
 - Bandwidth+
 - STREAM
 - ScaLAPACK
- Performance Analysis of SSDs in Larger Systems
 - Memory Swap Performance
- File Systems Formats

Conclusion

- In respect to processing power, FIO test results also showed that the Fusion IO drive displayed significantly better performance. However, performance per dollar indicates that the smaller SSDs had a higher cost efficiency rating.
- Graph500 benchmark testing showed that the Fusion IO had a high edge traverse rate with the swap system but baseline results showed to be higher.
- Although the Fusion IO had higher performances, the performance/cost results showed to be lower than the rest of the SSD devices.

Questions?