

STORAGE INDUSTRY SUMMIT

Realizing the
Benefits of the
Convergence of
Storage and Memory

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Supermicro

Storage Application Manager

Implementation of high speed storage solutions



Agenda

- Why High Speed Storage Solutions?
- Usage models for High Speed Storage
- Limitations of Existing Technologies
- Introduction to NVMe
- Introduction to NVDIMM
- Supermicro's implementations

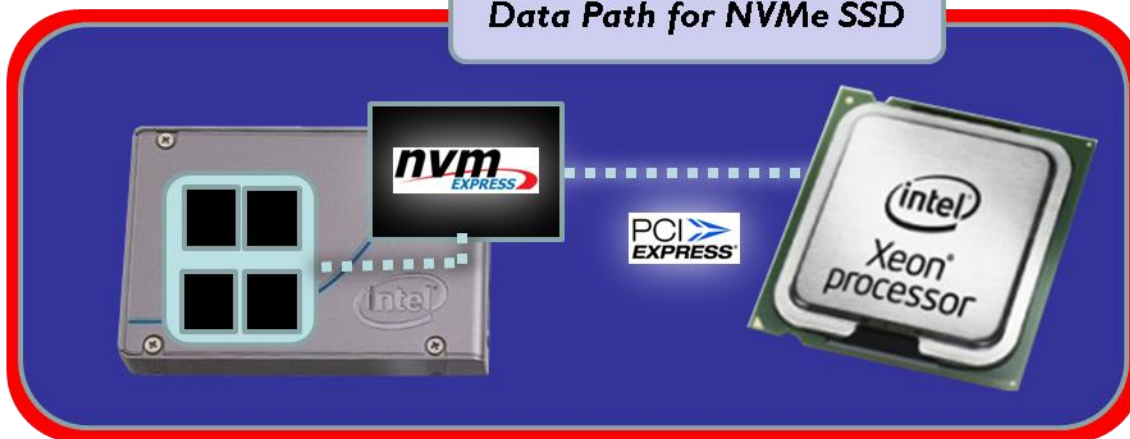
Why High Speed Storage Solutions

Data Path for Traditional HBA + SSD



nvm
EXPRESS

Data Path for NVMe SSD



Direct Attach to CPU

**Higher Performance /
Lower Latency**

Eliminate HBA

**Lower System Cost &
Power Requirement**

NVMe



NVMe Intro:

- NVMe is a scalable Host Controller interface designed to address the needs of Enterprise, Data Center and Client storage applications
- NVMe protocol was designed for non-volatile memory, such as PCIe-SSD's
- NVMe design was developed to improved low latency times and high performance
- The interface provides for an optimized and simplified I/O stack with a simplified command set
 - 13 original founding promoter companies
 - ~ 100 NVMe member companies
 - Spec. v-1.1, released in October, 2012
 - Spec. v-1.2 ratified November 2014



Evolution - NVMe

- PCI express Solid State Drives (PCIe SSDs) provide significant performance benefits in enterprise applications
 - Not burdened by traditional hard disc drives (HDDs) and SSDs with a legacy storage interface.
- The current legacy SCSI interface design, imposes limitations that can compromise the potential throughput of Solid State Devices.
 - (NVMe, allows SSD devices to reach the desired throughput
- Applications can easily transition to NVMe and realize the associated benefits

NVMe Key Attributes:

- Performance across multiple cores
- End-to-end Data protection
- Enhanced security
- Encryption
- Error Reporting and management
- Power efficiency (power consumption per I/O)
- Support for multi-path I/O
- Support for up to 64k I/O queues, with each I/O queue supporting up to 64k commands
- Optimized queuing, command set(10-Admin & 3-I/O) and feature set for PCIe-SSD'S

➤ Caching

- ◆ Speed up access
- ◆ Temporary data
- ◆ Non redundant

➤ Storage

- ◆ Can be used to provide Redundant high speed storage
- ◆ Can act as fast tier
 - Microsoft™ Spaces, ...
- ◆ Metadata, journaling, ...

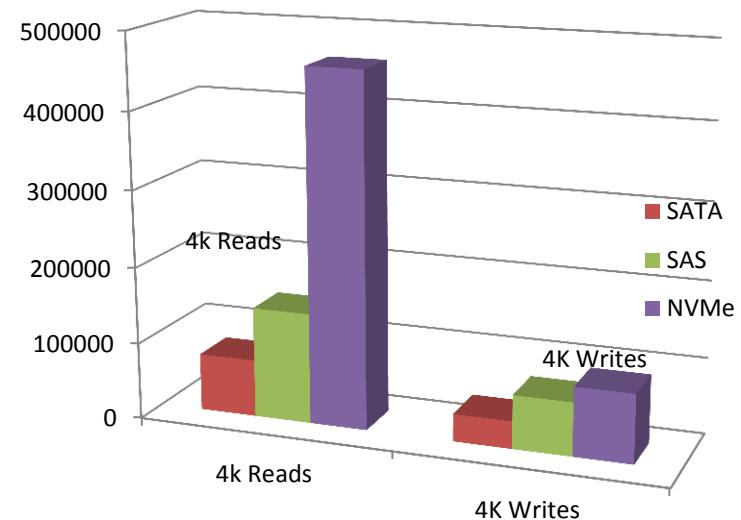
➤ Client Side

- ◆ Fast Boot disk
- ◆ RAMdrive
- ◆ Cache

SSD Performance Comparison*

➤ 4K Random Reads and Writes

- ◆ SATA3 Vs SAS3 Vs NVMe
 - › Writes ~ 3 X SATA
 - › Reads ~ 6 x SATA

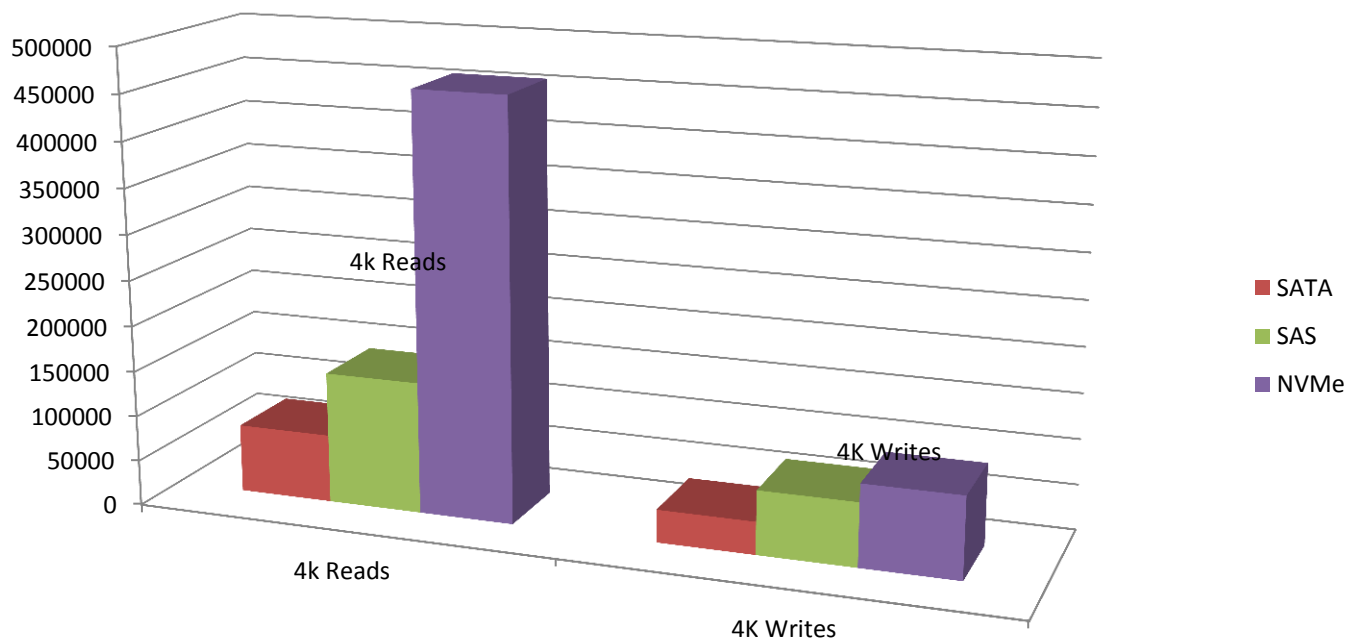


NVMe - PCIe SSD: Intel® DC P3700 800 GB(PCIe Gen3 x4)
SAS3 - SSD: HGST Ultrastar® SSD800MM
SATA3 - SSD: Intel DC S3700

* Source Product Data Sheets

Performance (Latency) SATA SSD, SAS SSD, NVMe

- Random Read
- Queue depth of 16 and 32
- 32 logical cores (Sandy Bridge)



Physical Characteristics*

Source: Flash Industry Report IMEX Research ©2009-12

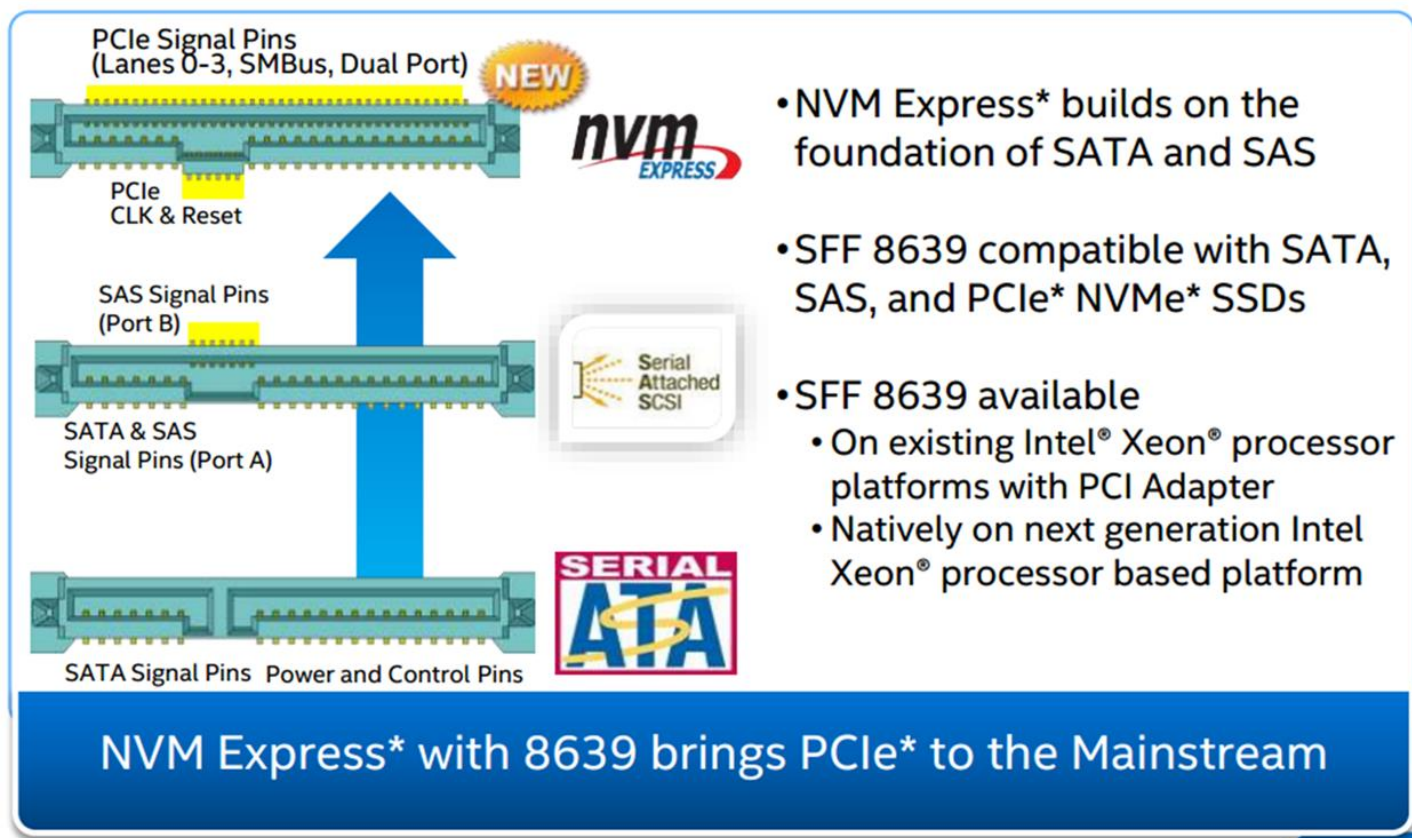
	SATA	SAS		PCIe	
	SATA	SAS	Multilink	SOP/PQI	NVMe express
DriveForm Factors	1.8", 2.5", 3.5"	2.5", 3.5"	2.5"	2.5"	2.5", Card 1, 2, 4 (8 on card)
No of Ports/ Lanes	1	1, 2	1, 2, 4	1, 2, 4	
Command Set/Que Interface	ATA / SATA-IO	SCSI / SAS	SCSI / SAS	SCSI / SOP/PQI	NVM Express
Transfer Rate	6Gb/s	12Gb/s	12Gb/s	8 Gb/s	8 Gb/s
DriveConnector	SFF-xxxx	SFF-8680	SFF-8639	SFF-8639	SFF-8639 (2.5"), CEM (Edge-Card)
Express Bay Compatible?	Yes, 2.5"	Yes, 2.5"	Yes, 2.5"	Yes, 2.5"	Yes, 2.5"
Drive Power (Typical)	9W Typical	9W Typical	Upto 25W	Upto 25W	Upto 25W
Max Bandwidth	0.6GB/s	4.8 GB/s (x2)	9.6GB/s (x4)	8 GB/s (x4)	8 GB/s (x4)
Host DriverStack (Stg Cntlr/Direct Drives)	AHCI	IHV	IHV	Common Driver (SOP/PQI)	Common Driver (NVMeExpress)

* SNIA Education Slide – NVMe: Next Generation SSD Interface

Implementation - NVM Express with SFF-8639 connector

➤ 2.5" Small Form Factor

- ◆ From ATA to SAS to SFF-8639





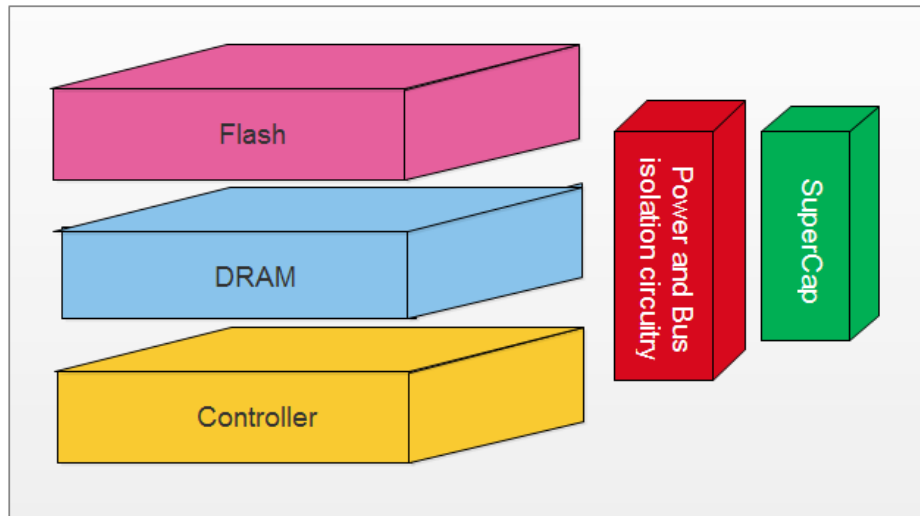
NVDIMM

Evolution - NVDIMM

- Technology evolved from BBU (Battery Back Up) DIMM
 - ◆ Over two decades of development evolution
 - ◆ Current technology combines the speed of DDR3 DRAM with the persistence of NAND flash together with SuperCap power
- DDR4 solutions currently under development (JEDEC)
- Numerous vendor solution providers
 - ◆ Agiga Tech, Micron Technologies, Netlist, SMART Modular, Viking Technologies . . .
- Advantages
 - ◆ The current legacy standard (SAS, SATA) interface design, poses architectural limitations that prohibit them to deliver much desired throughput for SSD.
- NVDIMM aware BIOS in Supermicro® Systems
- More info at <http://www.snia.org/forums/sssi/NVDIMM>

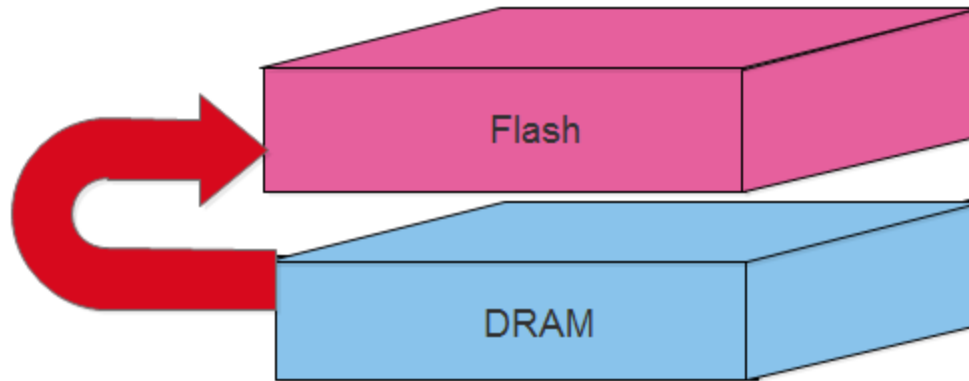
NVDIMM Block Layout

- Flash – Provides persistence
- DRAM – Provides speed
- SuperCap provides backup power to flush DRAM contents to Flash



NVDIMM Backup

- Initiated by an NMI or ADR* event, the contents of the NVDIMM DRAM are moved into the integrated flash
- All NVDIMM DRAM data including ECC information is saved to flash
- A SuperCapacitor power pack keeps the NVDIMM alive during the transfer
- NVDIMM is isolated for the System Bus

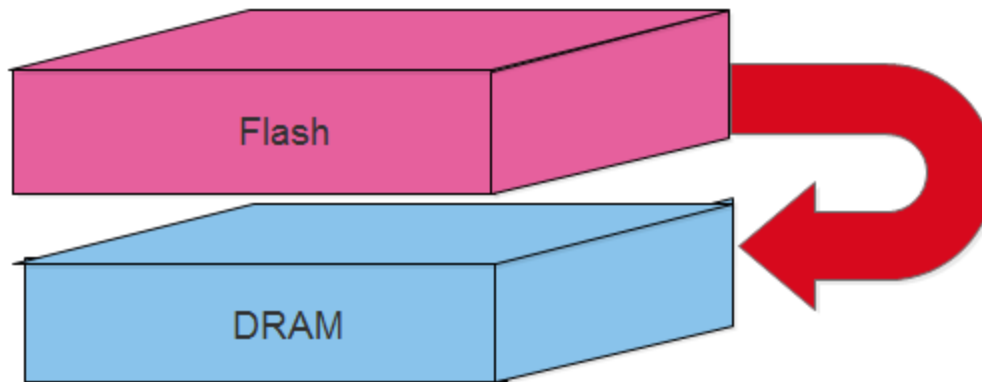


* See later slide

NVDIMM Restore

➤ Restore

- ◆ Data is restored back to DRAM once system power is restored



Hardware Backup Methods

- ADR (Automatic DRAM self-Refresh) trigger method is Intel's™ recommended approach which disables all sections of the CPU except the memory controller and allows only a portion of the CPU cache to be preserved NVDIMM
- NMI (Non-Maskable Interrupt) trigger method allowing increased system performance in the event of a power loss by not disabling the CPU entire Cache

Technology Comparison



Feature	NV-DIMM	NVMe	SAS3 (SSD)	SATA3 (SSD)
Interface	Memory Channel DDR3/DDR4	PCI-E 3.0	SAS	SATA
Bandwidth Performance	High	Med-High	Medium	Low
Latency Performance	Lowest	Low-Medium	Medium	High
Persistence of Data	Yes	Yes	Yes	Yes
Software Overhead	High	Low	Low	Low
BIOS Support	Yes (limited)	Yes	Yes	Yes
Cost	\$\$\$\$\$	\$\$\$	\$\$	\$



Supermicro Solutions



Featured Supermicro NVMe SuperServers®

2U SuperServers – Up to 4 NVMe Drives Supported

EX DP SuperServer® SYS-2028UT-BTNR

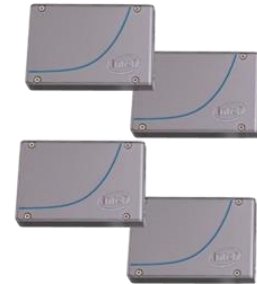


*2 NVMe Drives per Node

DCO SuperServer® SYS-6028R-TDWN



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1U SuperServers – Up to 2 NVMe Drives Supported

WIO SuperServer® SYS-1028R-WC1R(T)*



Ultra SuperServer® SYS-1028U-TNR4T+/-TNRT+

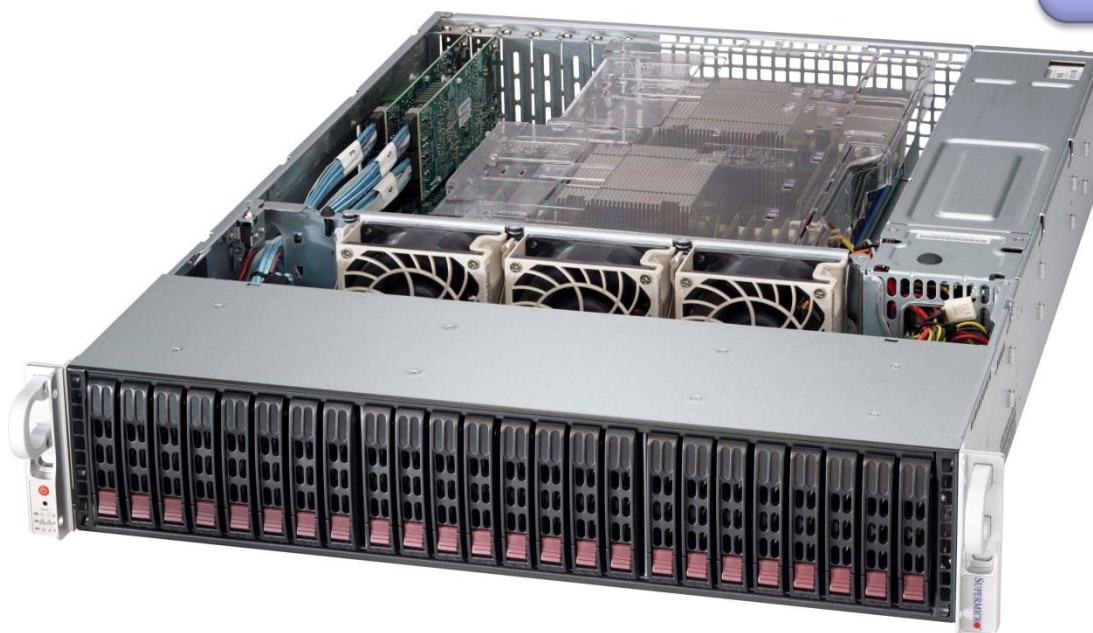


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*Optional NVMe Support, AOC Required and Sold Separately

X9 SuperStorage DDR3/NVDIMM



NV-DIMM support to provide extreme IOPs performance and data security

Dual Intel® Xeon® Sandy Bridge E5-2600v2 Series



3x 12G SAS Controllers
8X SAS/SATA devices per/Controller for low-latency and maximum data bandwidth

Hot-swap 24 x 2.5"
SAS/SATA/SSD Drive

SSG-2027R-AR24NV

X9DRH-iFNV Motherboard

X10 SuperStorage

DDR4/NVDIMM ready models

U Height	2U		3U	4U		
Disk qty	2.5" x 24	3.5" x 12	3.5" x 16	3.5" x 24	3.5" x 36	3.5" x 72
Hardware RAID (LSI3108)	 2028R-ACR24H					
		 6028R-E1CR12T				
	 2028R-E1CR24N	 6028R-E1CR12N	 6038R-E1CR16N	 6048R-E1CR24N	 6048R-E1CR36N	
	 2028R-E1CR24H	 6028R-E1CR12H	 6038R-E1CR16H	 6048R-E1CR24H	 6048R-E1CR36H	
	 2028R-ACR24L					
IT Mode (LSI3008)	 2028R-E1CR24L	 6028R-E1CR12L	 6038R-E1CR16L	 6048R-E1CR24L	 6048R-E1CR36L	 6048R-E1CR72L
		 5028R-E1CR12L			 5048R-E1CR36L	

UP

References

- <http://www.nvmexpress.org/>
- <http://www.snia.org/forums/sssi/NVDIMM>
- <http://www.supermicro.com/products/nfo/nvme.cfm>
- <http://www.supermicro.com/products/system/2u/2027/ssg-2027r-ar24nv.cfm>

**Thanks for your
time today – any
questions?**

