

NVM Express™ Ecosystem Enabling PCIe NVMe Architectures

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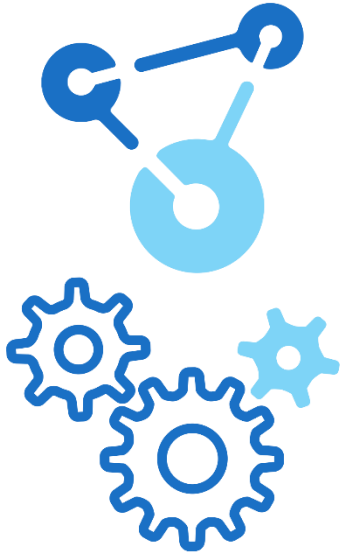
Agenda - NVM Express™ Ecosystem

- How do I get started and what do I need
 - Driver ecosystem , Management & Security
 - NVMe and PCIe components
- PCIe Host Topologies and Scalable Architectures
 - PCIe® cables, connectors and infrastructure
 - Architectures deployed
- Bringing it all together - Interoperability



What do I need to start using an **nvm**™ **EXPRESS** SSD?

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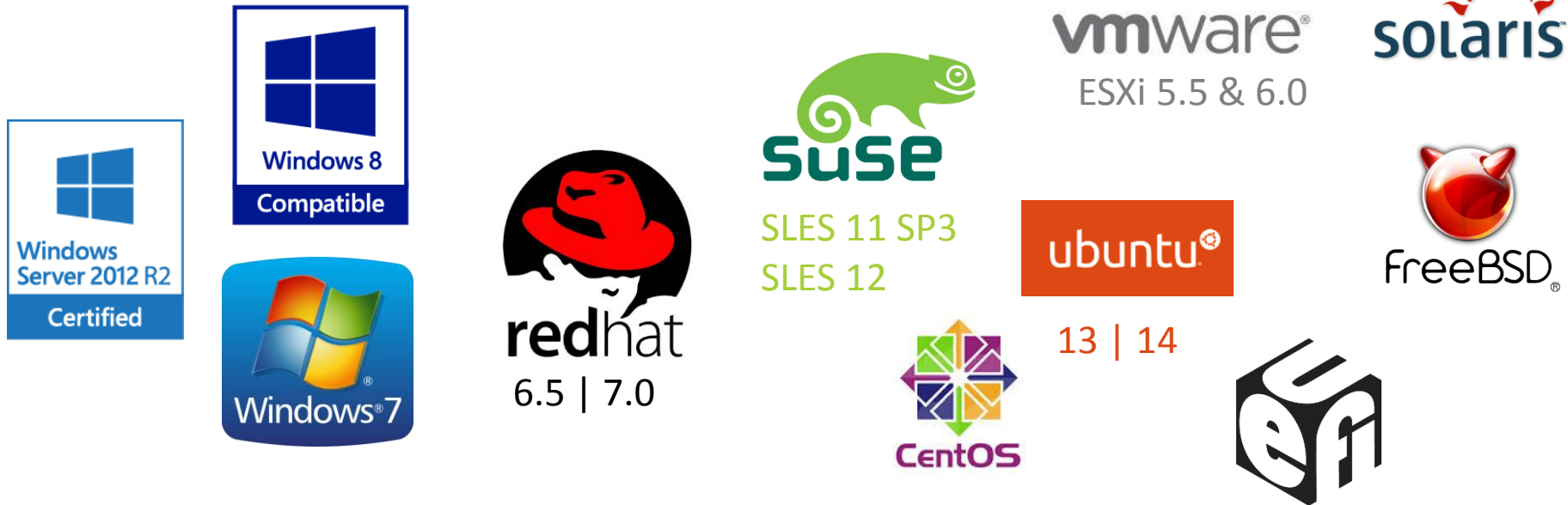


- ✓ Software: NVMe™ drivers & Management
- ✓ Functions: Security & Hot Plug
- ✓ Hardware: Components, Backplanes, Switches, Cables

NVMe sits on top of PCIe

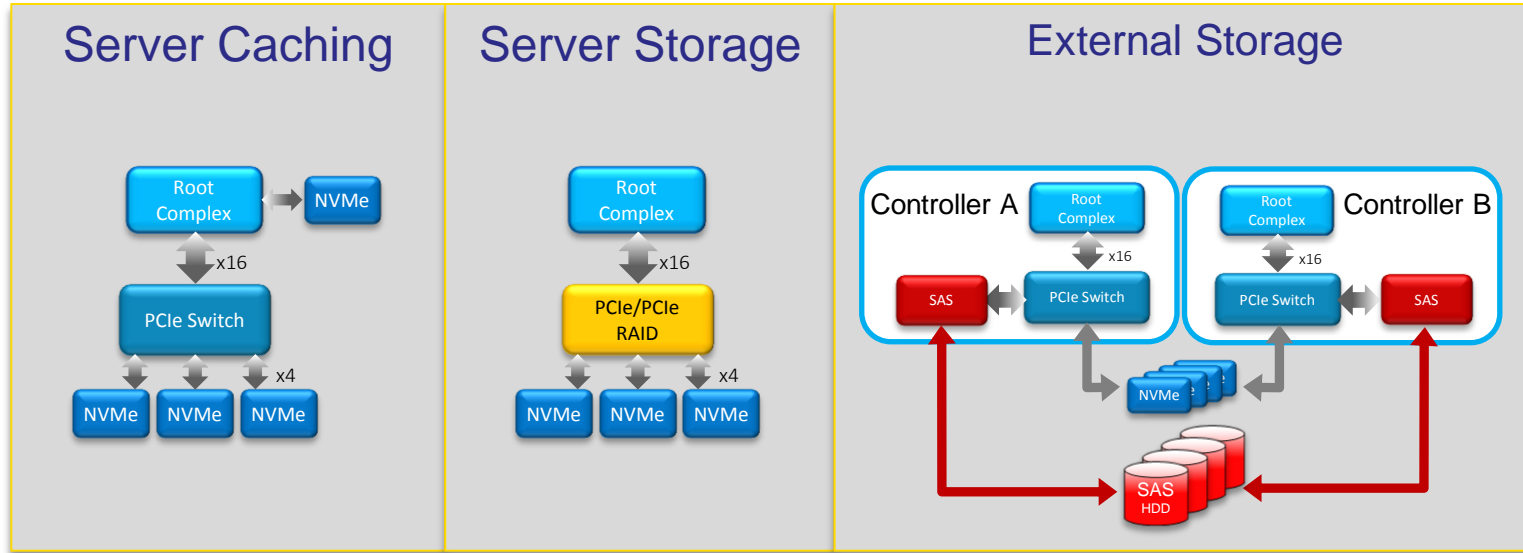
NVMe Driver Ecosystem is Strong

- NVMe drivers available on Windows*, Linux*, Solaris*, VMware*, UEFI
- Many are native / in-box drivers



*Other names and brands may be claimed as the property of others.

NVMe Storage Device Management



Example Pre-boot Management

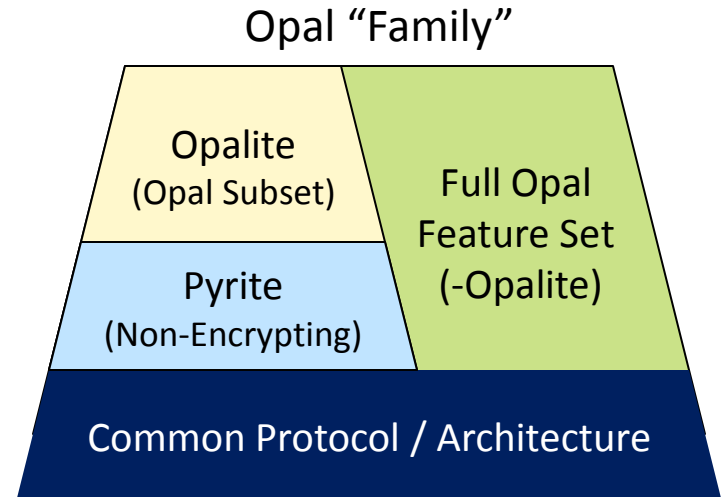
- Inventory, Power Budgeting, Configuration, Firmware Update

Example Out-of-Band Management During System Operation

- Health Monitoring, Power/Thermal Management, Firmware Update, Configuration

Security – The NVMe and TCG Partnership

- NVMe is leveraging the security expertise of the Trusted Computing Group (TCG)
- TCG has developed a “family” of specifications to scale across the needs of NVMe in different Client and Enterprise solutions
- NVMe and TCG plan to continue collaborating on future security features for NVMe



Commercially Available NVMe Flash Controllers

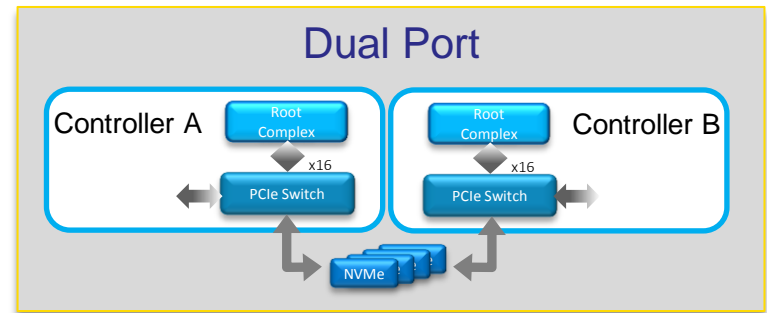
Best-in-class performance: 1M IOPs

Flexible programmable platform

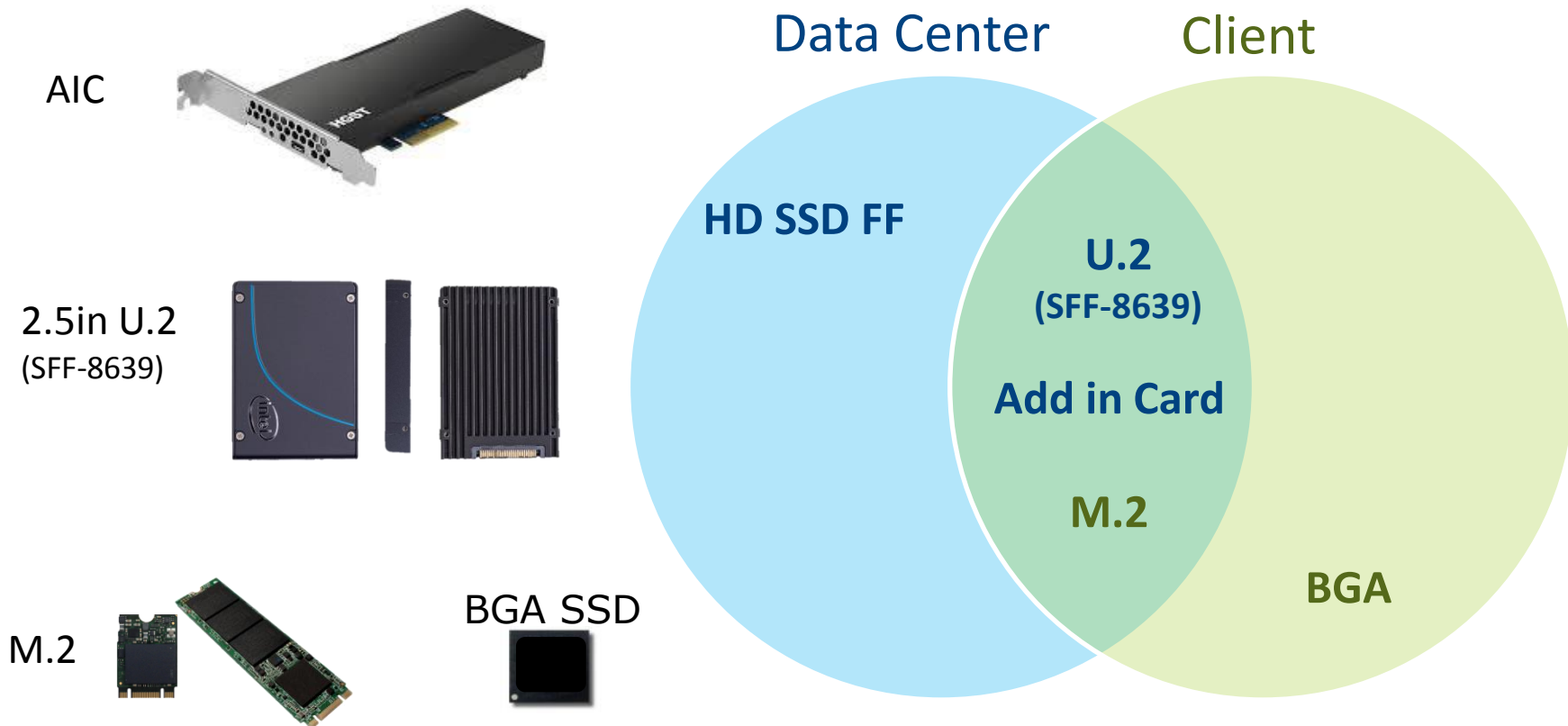
- Differentiate Features
- Flexible Flash Interface

“Enterprise Class” features

- Dual Port functionality
- Data Protection
- High reliability

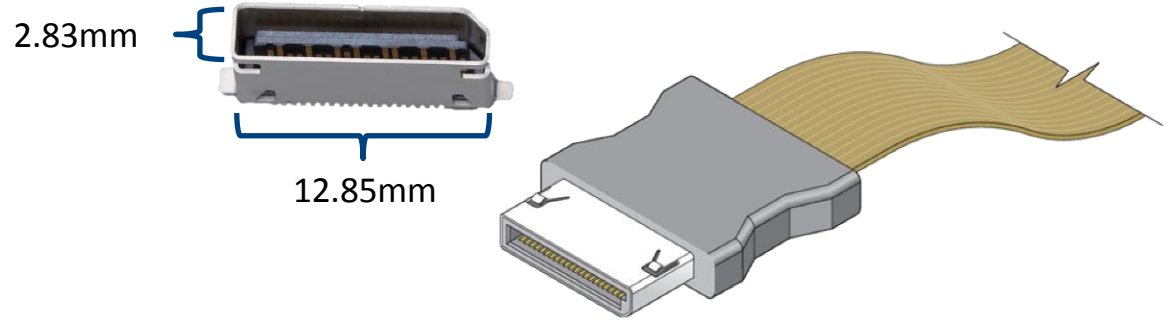


Form Factors for NVMe PCI Express®



Cabling Options for PCIe[®] SSD Topologies

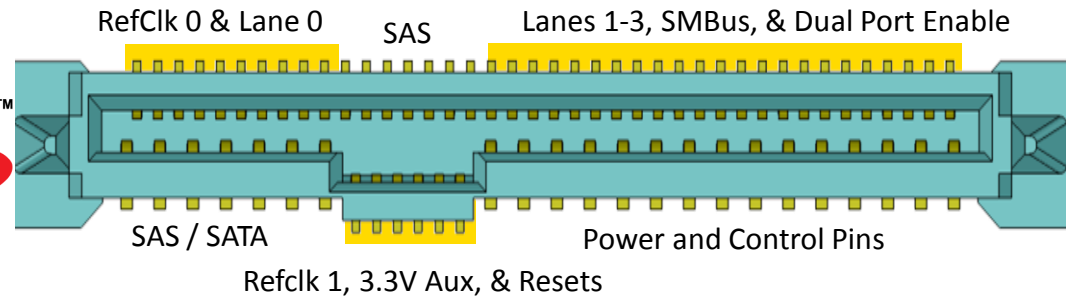
OCuLink internal cables and connectors



Drive Connectors

U.2 : SFF-8639

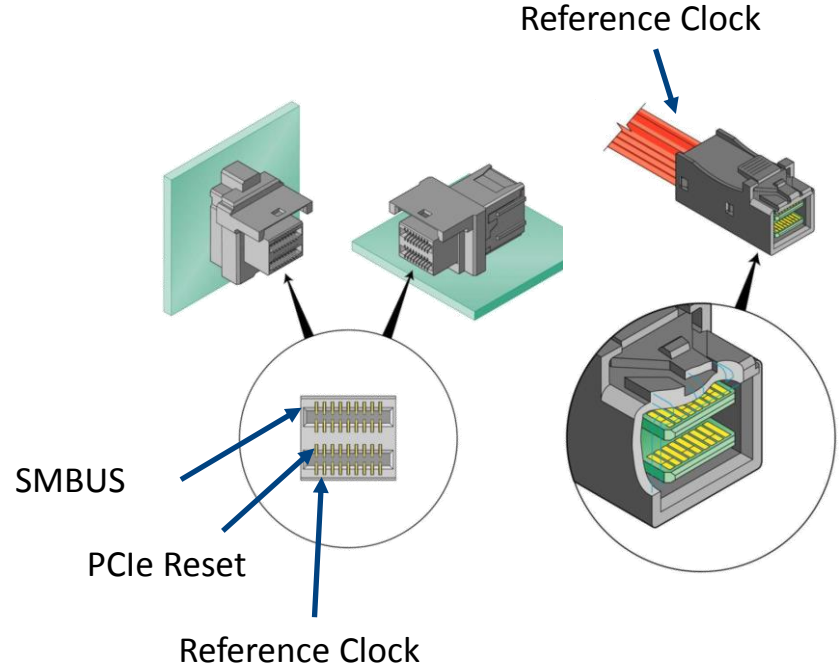
- Supports SATA, SAS, and PCIe[®] x4 or two x2
- PCIe data, reference clock, and side band



MiniSAS HD Cabling Option for PCIe® SSD Topologies

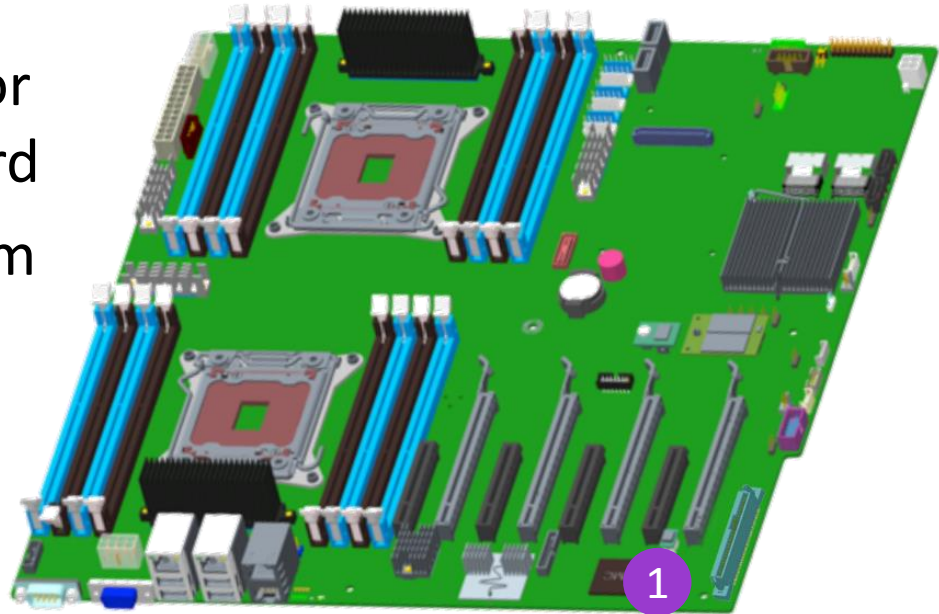


miniSAS HD cables lightly modified for PCIe are being used due to the robust connector and high volume manufacturing.

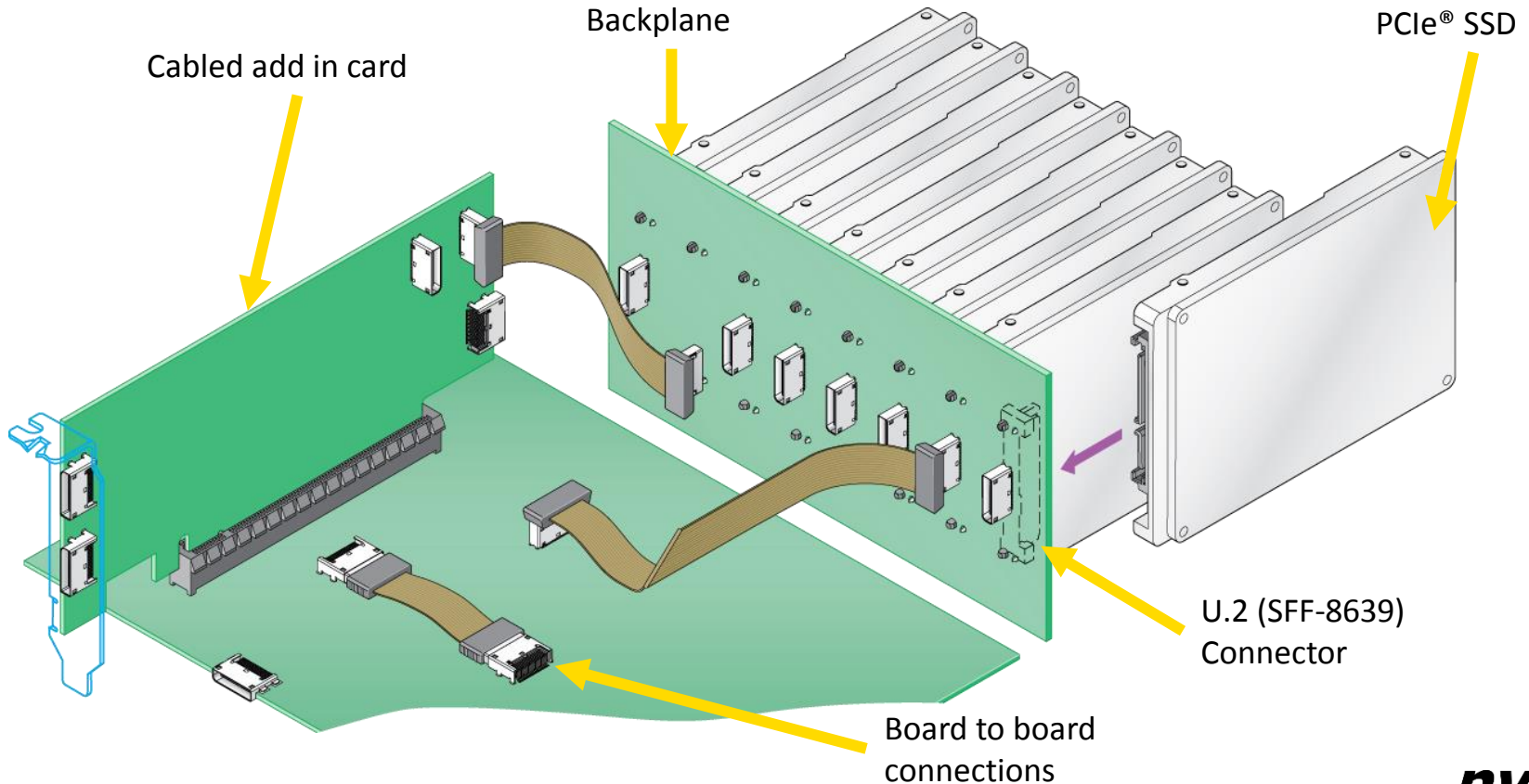


Basic PCI Express® SSD Topology – 1 Connector

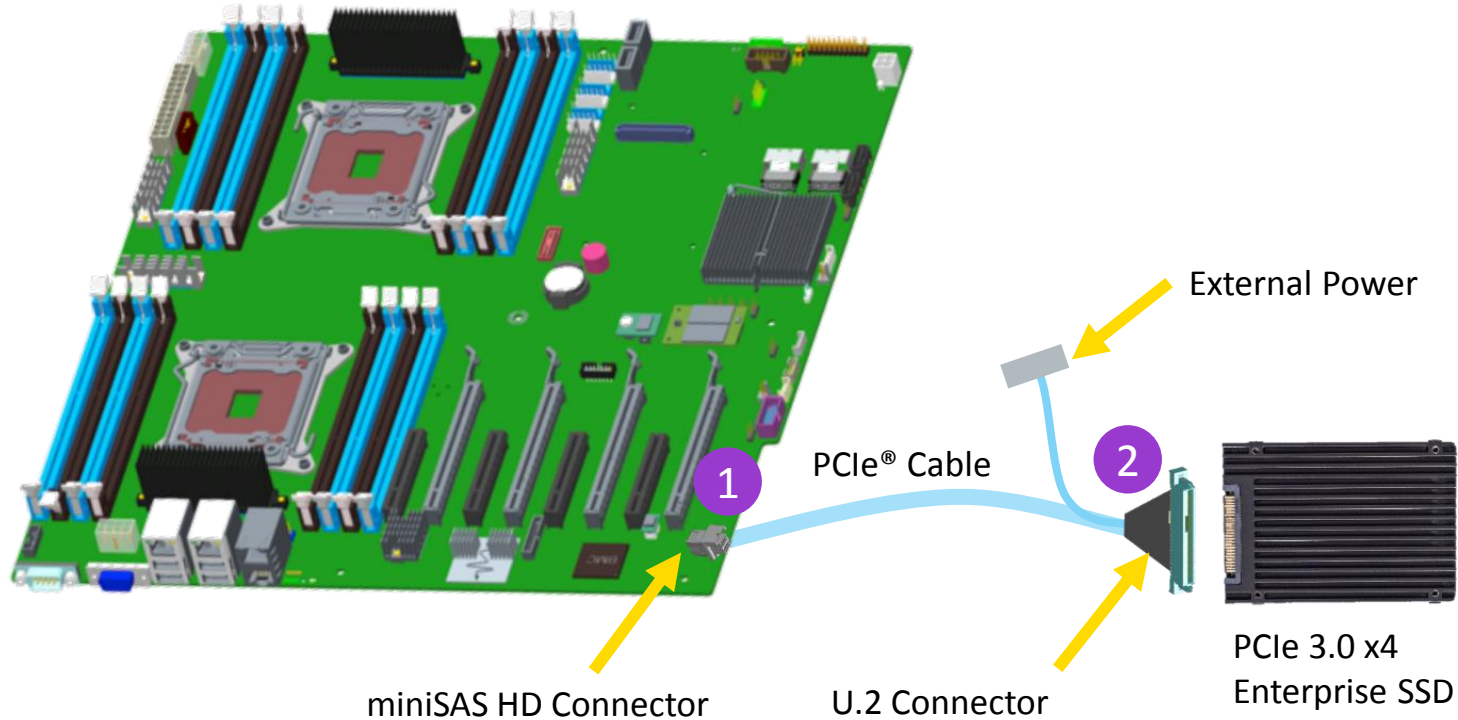
- U.2 (SFF-8639) Connector directly attached to board
- Mostly used in small form factors such as compute node, blade, etc.



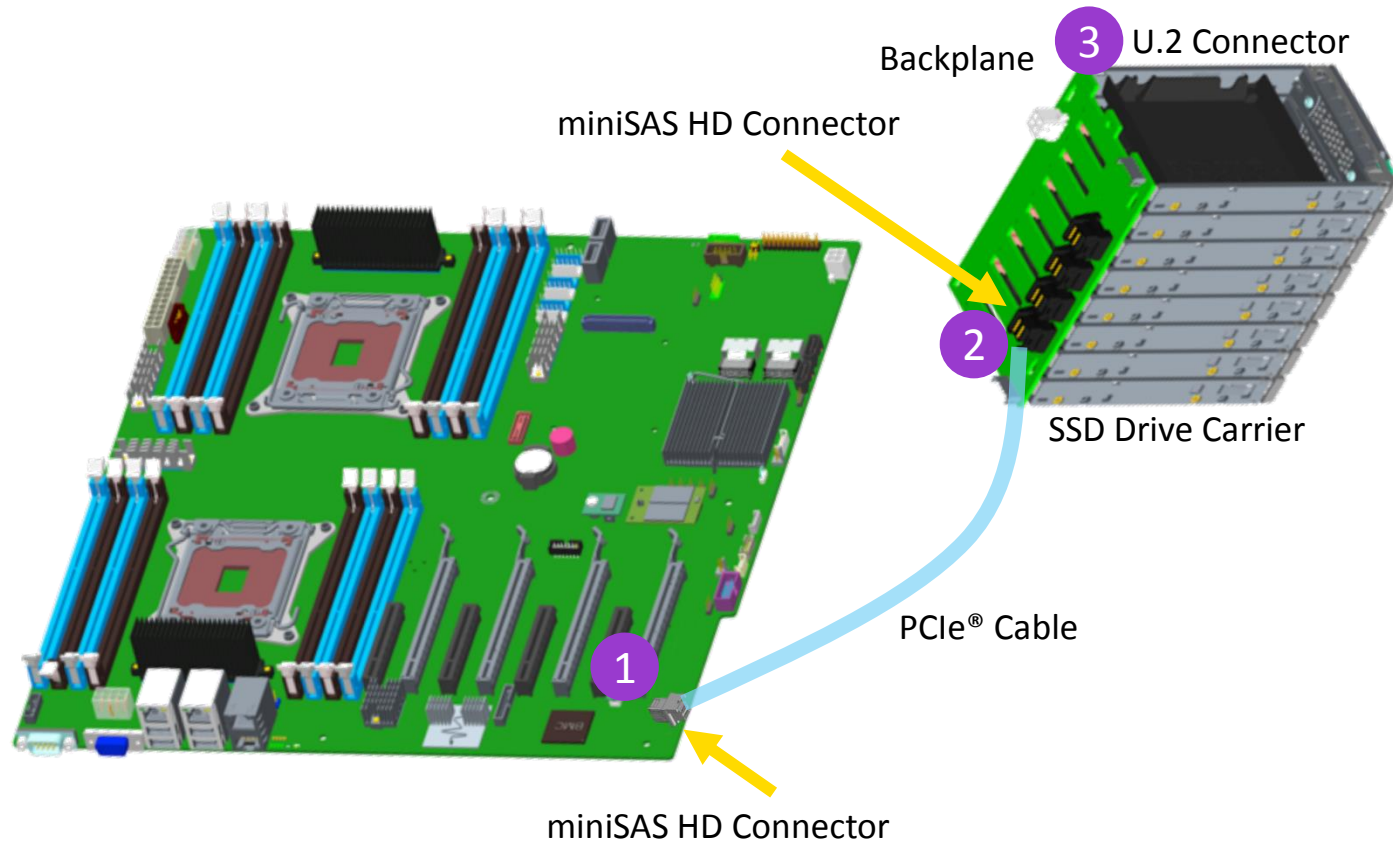
OCuLink* Provides Flexible Data Center Topologies



Basic PCI Express® SSD Topology – 2 Connector

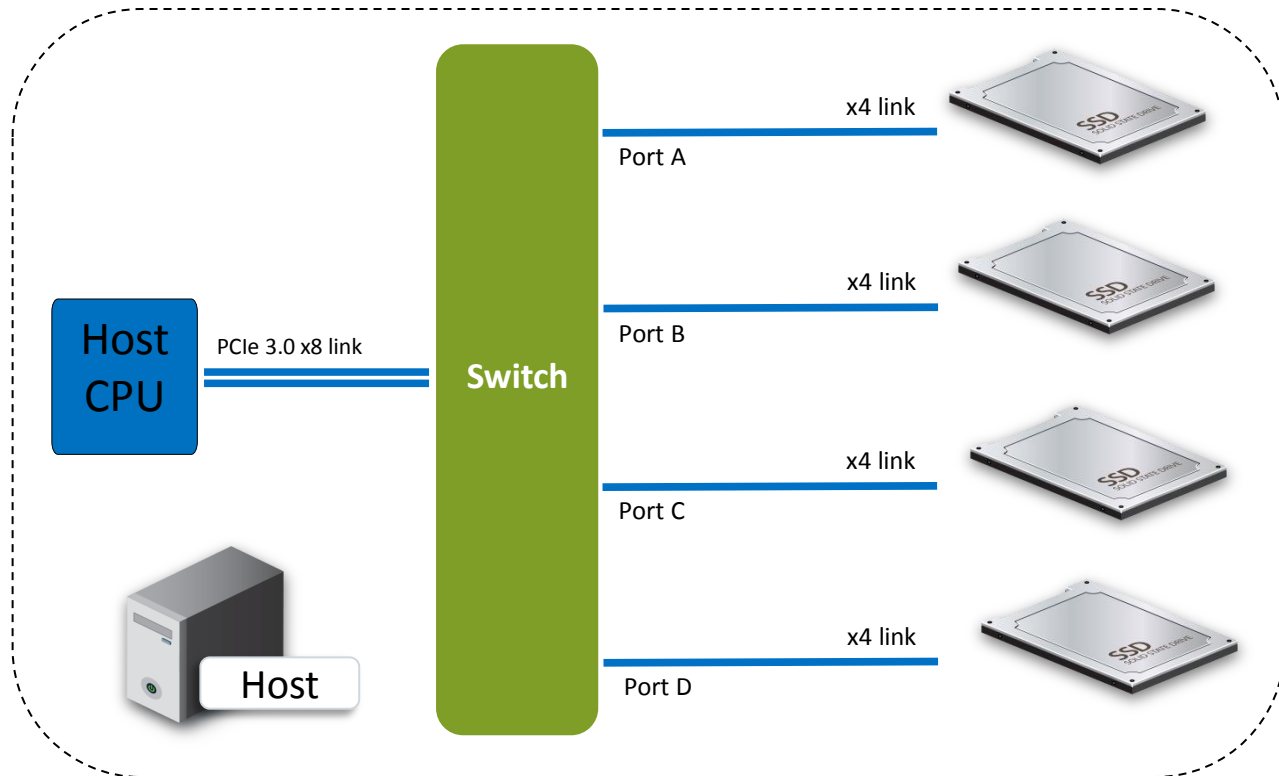


Basic PCI Express® SSD Topology – 3 Connector

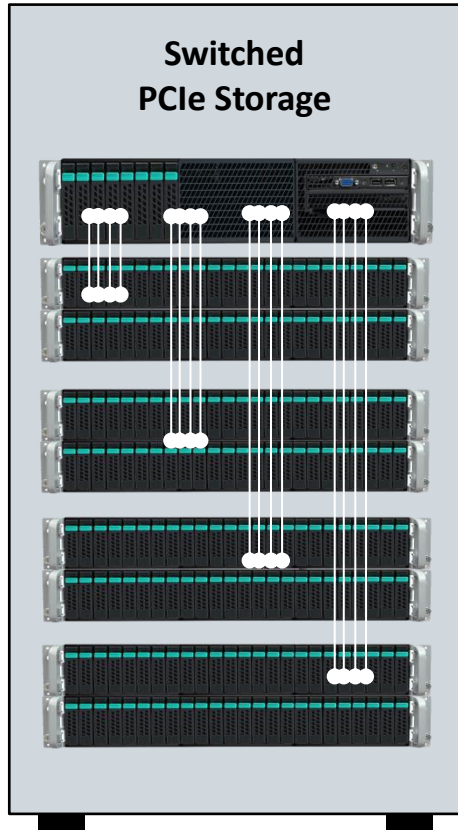


Host NVMe PCIe Architectures & Components

Use Switches to expand number of NVMe PCIe[®] SSDs



Scalable External NVMe PCIe Storage Architectures

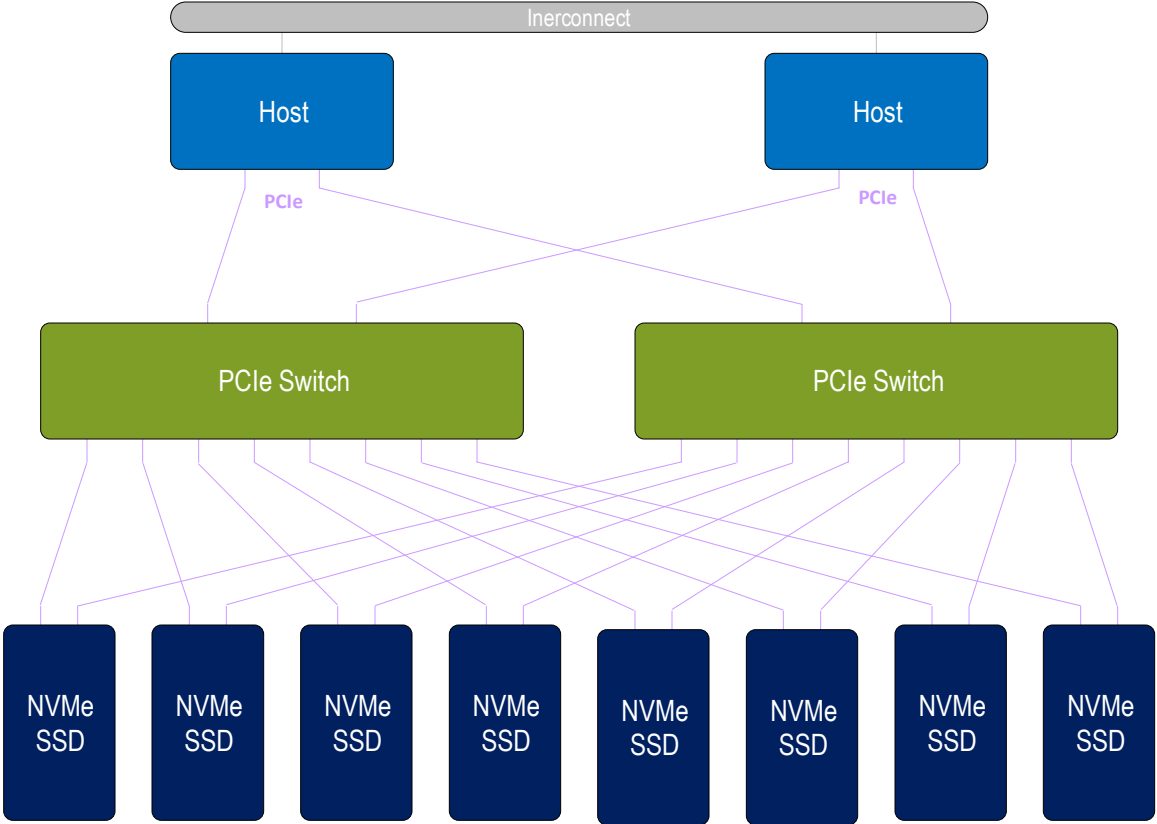


High density Switching architectures

1. Increase flash storage density and improve MTBF
2. External Cabled PCIe support
3. Storage Switches Provides Error containment
 - Preventing System Crashes and “Blue-Screening”



High Reliability NVMe PCIe Architectures



NVMe NVRAM Non-Volatile Memory Tier

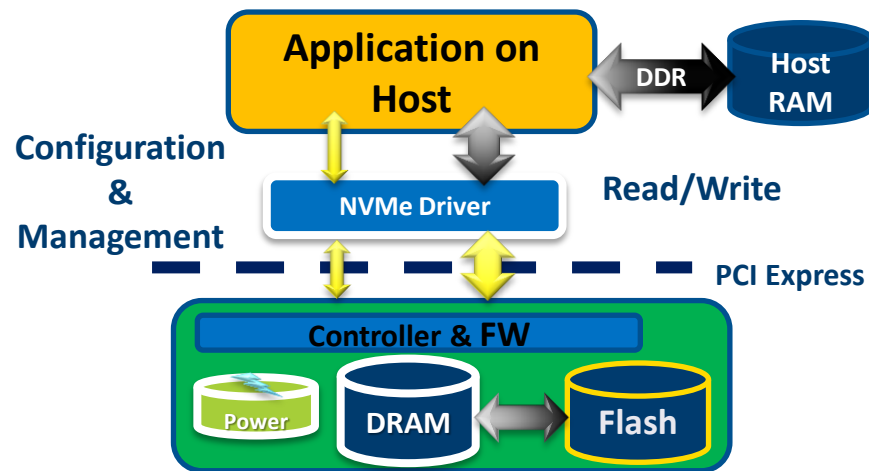


Mission Critical applications

- High performance all flash arrays
- Scale-Out Storage Systems
- Database Systems
- Distributed File System
- Server-Side Caching

DRAM endurance with flash
persistency

Management functions



Bringing it all together – UNH-IOL Interop

- 30+ Products on Integrators List
- The University of New Hampshire Interoperability Lab (UNH-IOL) and NVMe deliver a robust interop program
- Four plugfests have been held – populating robust NVMe Integrator’s List

Portion of Integrator’s List

NVMe Integrator's List v1.2

- NVMe Integrator's List Policy v1.2

NVMe Devices

Product	Product Type	Firmware Version	Interop Program Revision	Date Listed	Further Info
Intel SSD DC P3608 Series	NVMe SSD	8DV10160	v1.2	7/6/15	http://www.intel.com
Memblaze Pblaze4 Card Series	NVMe SSD	v0.08.0060	v1.2	7/21/15	http://www.memblaze.com
Phison NVMe PS5007-E7	NVMe SSD Controller	v1.0	v1.2	7/17/15	http://www.phison.com
PMC Flashtec™ NVMe2016/2032	NVMe SSD	NA	v1.2	7/16/15	http://pmcs.com/products/
Seagate SandForce SF3700 SSD Controller	NVMe SSD Controller Chip	G.0.1	v1.2	7/6/15	http://www.seagate.com
SK Hynix SSD PE3000 Series	NVMe SSD	20050A00	v1.2	7/6/15	ssd.skhynix.com

More details at www.iol.unh.edu/services/testing/NVMe.

NVMe Solutions Continue to Proliferate

Ever Increasing Server and OEM deployment

Scalable External PCIe Architectures

50+ Unique NVMe SSD SKUs

- 2.5in, HHHL, FHHL
- U.2, M.2

Deployments include all major NAND Manufacturers

- SLC, MLC, 3D and TLC





Architected for Performance