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 SSD?

- **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.
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®

Data Center

- HD SSD FF
- U.2 (SFF-8639)
- Add in Card
- M.2

Client

- BGA
- BGA SSD
- M.2
- 2.5in U.2 (SFF-8639)
- AIC

M.2

BGA SSD

HD SSD FF
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

![OCuLink internal cables and connectors diagram]

![Drive Connectors diagram]

![PCIe® SSD Topologies diagram]
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

- Cabled add in card
- Backplane
- Board to board connections
- PCIe® SSD
- U.2 (SFF-8639) Connector
Basic PCI Express® SSD Topology – 2 Connector

- miniSAS HD Connector
- U.2 Connector
- PCIe® Cable
- PCIe 3.0 x4 Enterprise SSD
- External Power
Basic PCI Express® SSD Topology – 3 Connector

1. miniSAS HD Connector
2. SSD Drive Carrier
3. U.2 Connector

Backplane

PCle® Cable
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

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