Interface Standards Drive Enterprise Capabilities Forward

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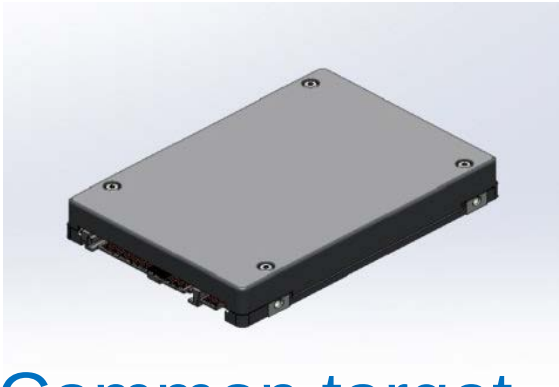
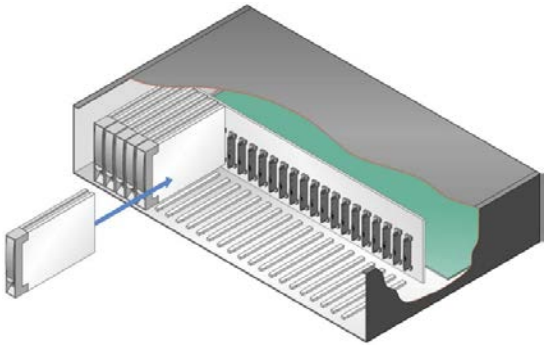
SanDisk

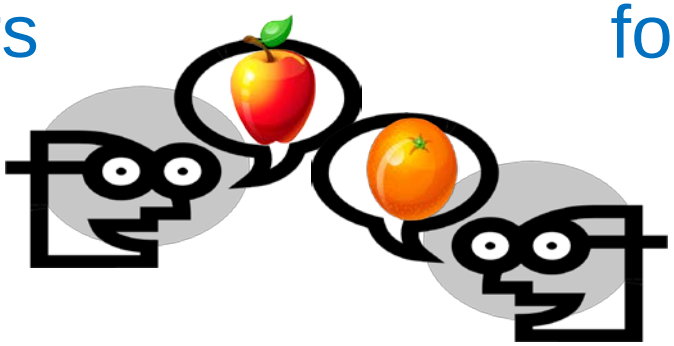
Importance of Standards



Common target for vendors



Common receptacle for servers



Common command protocol

Key Enterprise Standards Bodies

- T13, SATA-IO
- T10, SCSI Trade Association
- NVM Express Work Group
- SSD Form Factor Work Group
- SFF WG
- PCI-SIG

SATA Express

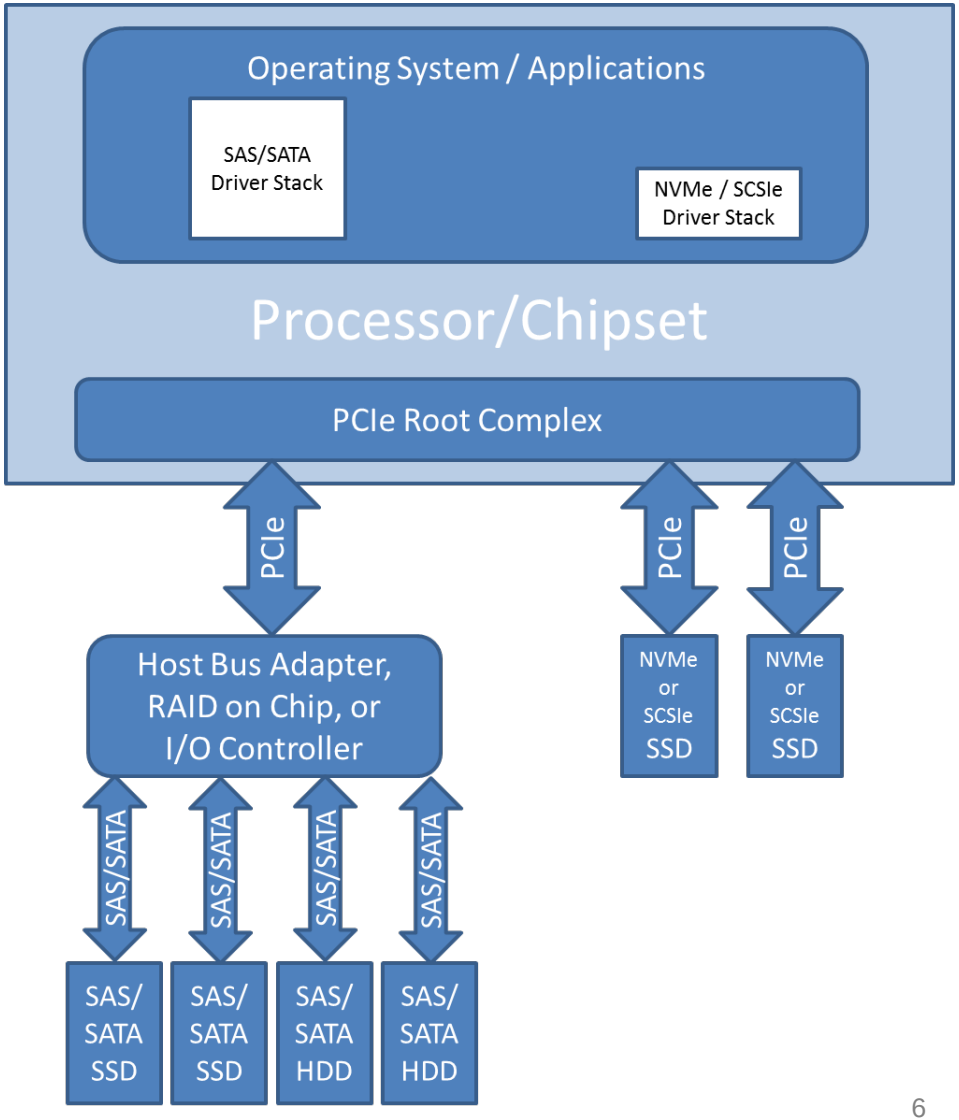
- SATA will not extend past 6 Gb/s
- SATA Express leverages advances in PCIe
  - Gen 2 X2 supports 8 Gb/s
  - Gen 3 X2 supports 16 Gb/s
- SATA Express supports any command protocol across PCIe
  - AHCI (current SATA commands)
  - NVMe

Next-Generation Standardized SSD Interfaces

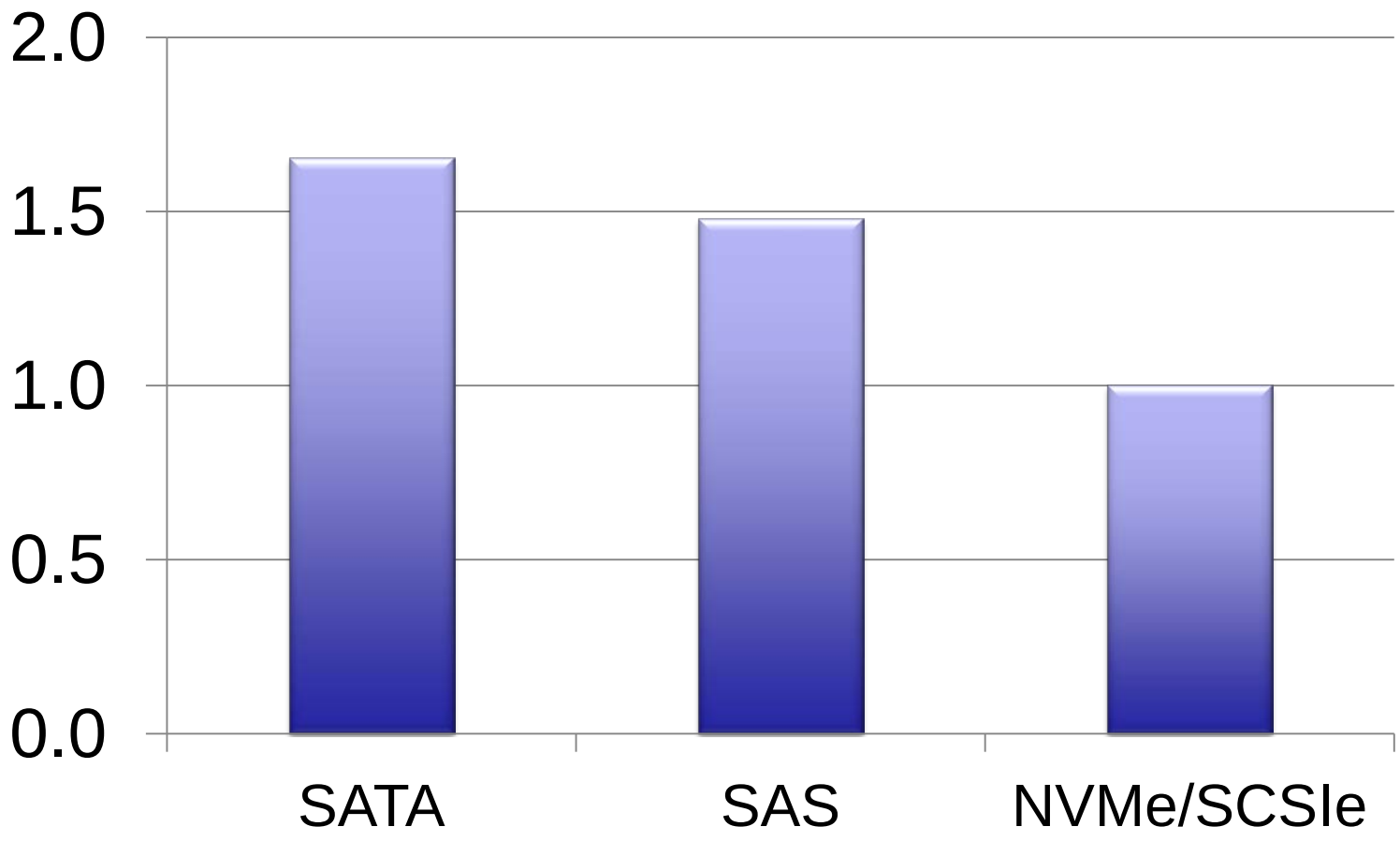
- NVMe optimized for low-latency SSD and utilizes PCIe transport
- SCSIe optimized for low-latency SSD, leverages SCSI stack, and utilizes PCIe transport

Benefits

- Optimized protocol
  - Reduces processor bandwidth per I/O
  - Allows scaling to more IOPs per system
- Reduced latency
- Multiple Queues
  - Allows for increased parallelism in the host



Normalized CPU Utilization per I/O



SAS Complexity

HBAs/ROCs/IOCs	2 or 3
Expanders	2
Combinations	**5**

PCIe Complexity

Processor Vendors	3 or 4
Operating Systems, Hypervisors, BIOSs	15 or so
Switch combinations	2 or 3
Combinations	**100+**

What does it mean?

- Driver Matrix is quite large for PCIe
- A standardized solution allows for the industry to work together to cover the set of combinations
  - A Proprietary PCIe solution needs to support 100+ combinations
  - Driver development can be amortized across the ecosystem

PCIe-connected SSD Status

NVM Express

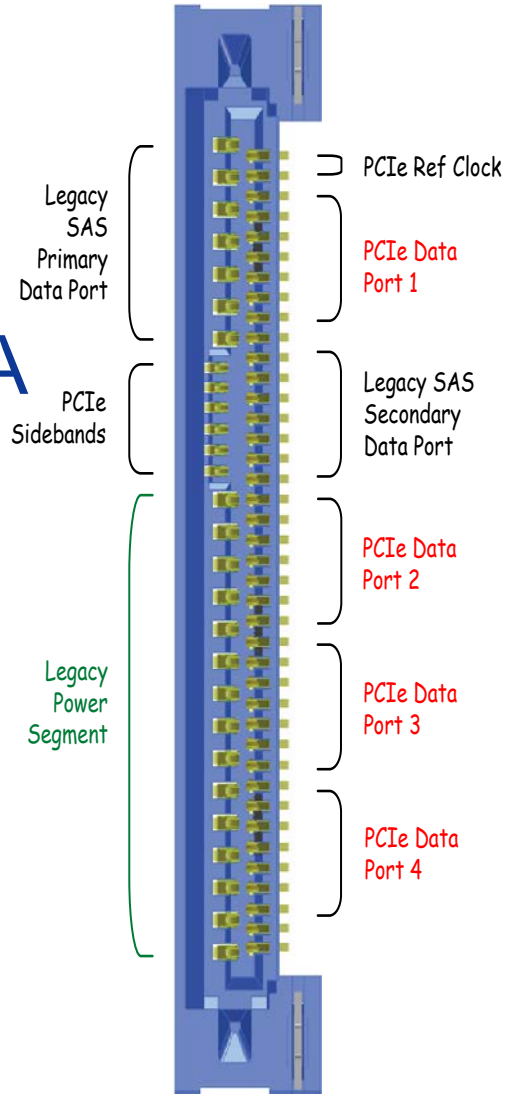
- NVMe 1.0 published March, 2011
- NVMe 1.1 published October, 2012 adding Enterprise and Client capabilities
- UNH-IOL NVMe plugfest May, 2013
- Linux and Windows open source drivers available
- 1st product announced in July

SCSI Express

- SOP and PQI specs completed Letter Ballot and in Comment Resolution
- Likely publication late 2013
- SOP-PQI plugfest in Q3 being discussed
- Linux open source driver available

SSD Form Factor / SFF WG

- Defines 2.5” SFF for PCIe-connected SSDs
- Compatible with SAS and SATA
- Serviceable slot
- SFF-8639 connector
- 25W available
- Sideband definitions



PCI-SIG

- Defines electrical connection
- Defines Card Form Factor (CEM Specification)
- Compliance Workshops

Summary

- Standards create commonality that the ecosystem can target
- PCIe offers performance benefits attractive to enterprise applications
- Efforts leveraged across the industry to accelerate infrastructure development

Thank You