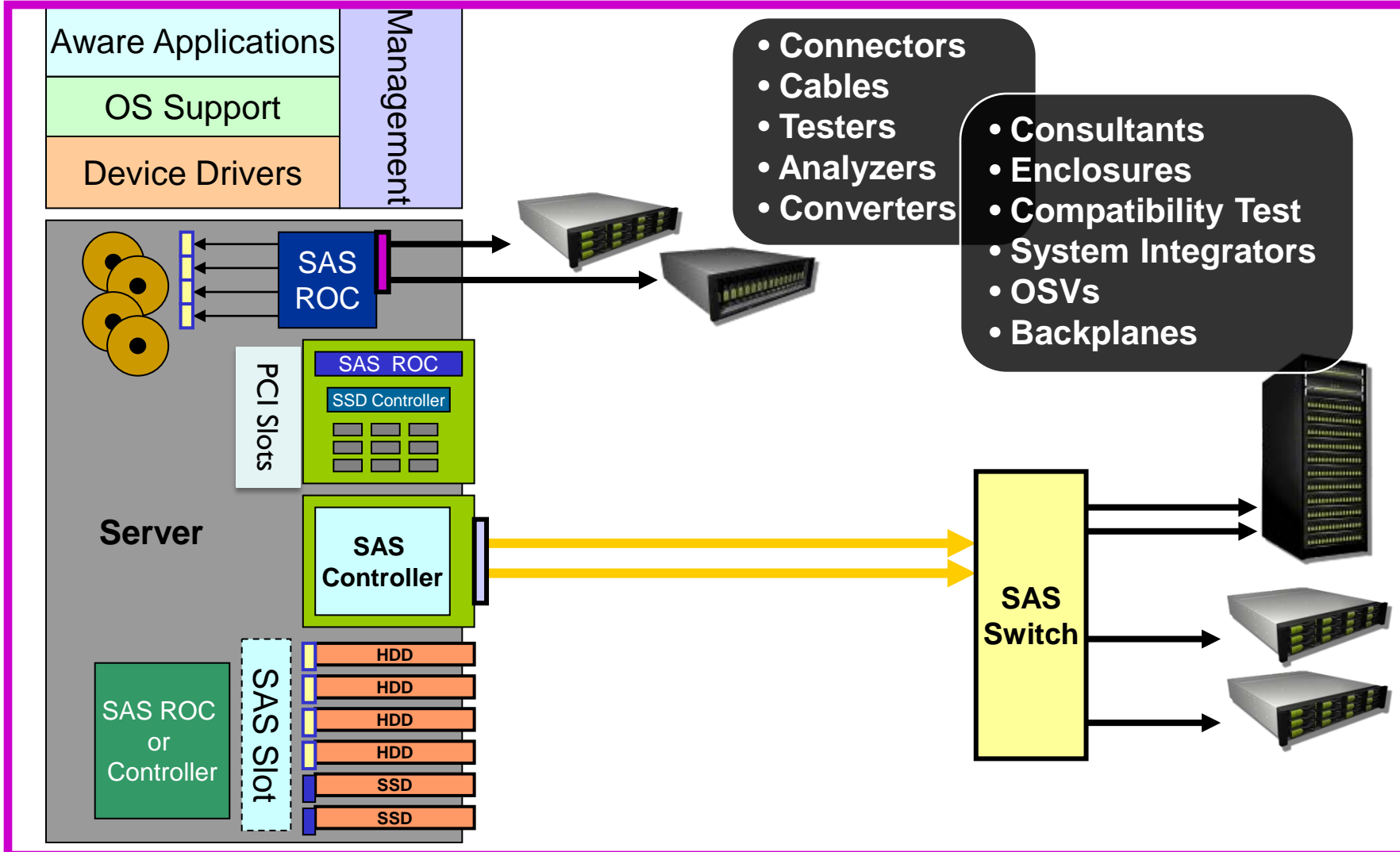


SAS Standards and Technology Update

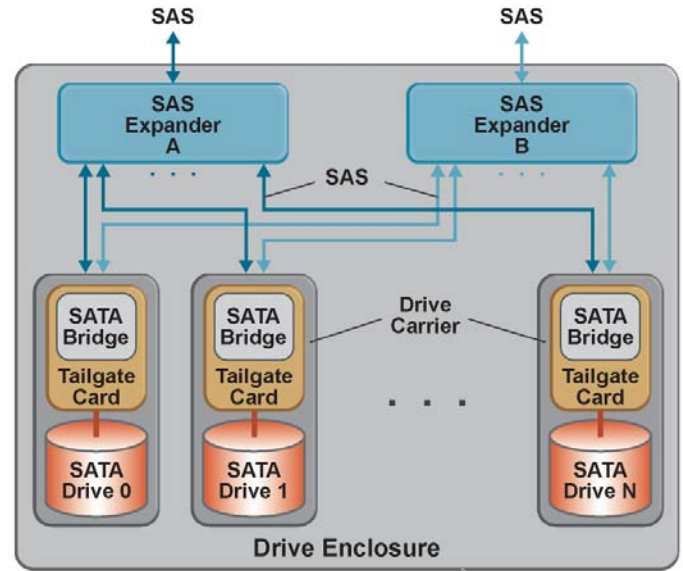
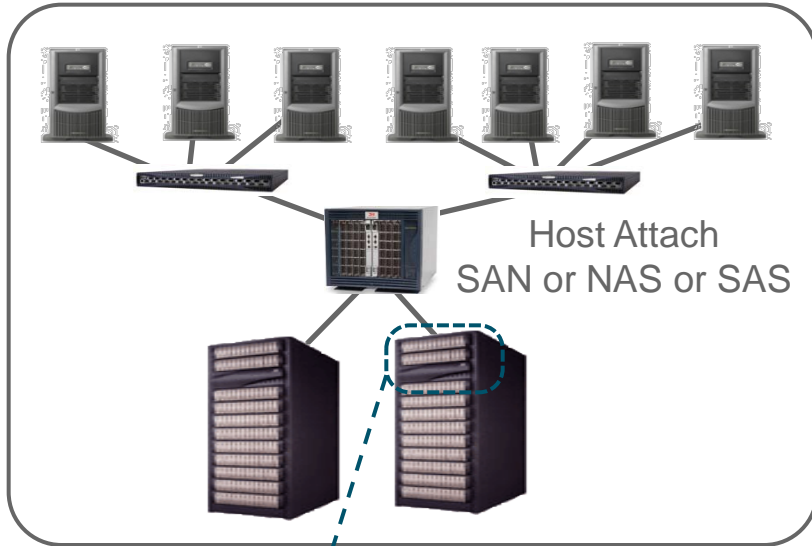
Harry Mason – LSI Corp.
Marty Czekalski – Seagate

- ❑ SAS Overview
- ❑ SAS Performance Roadmap and 12Gb/sec SAS staging
- ❑ MultiLink SAS™ and Advanced Connectivity
Connectivity Update
- ❑ SCSI over PCIe (SOP)
- ❑ Backplane Receptacle Compatibility

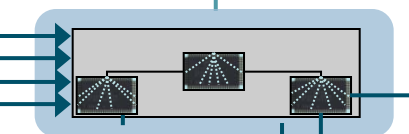
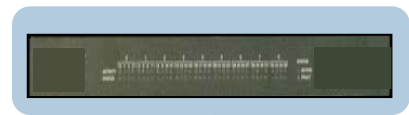
Mature - Market Readiness



Scaling SAS Architecture



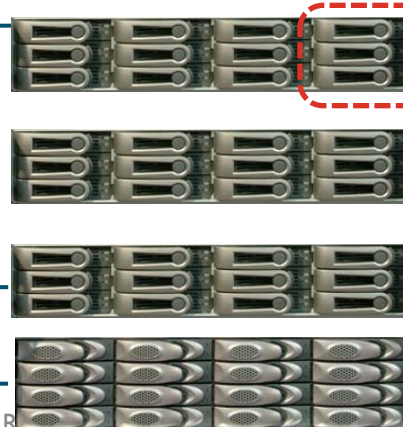
SAS Switch (packaged view)



Embedded Controllers
SAS Connected



Various JBODs

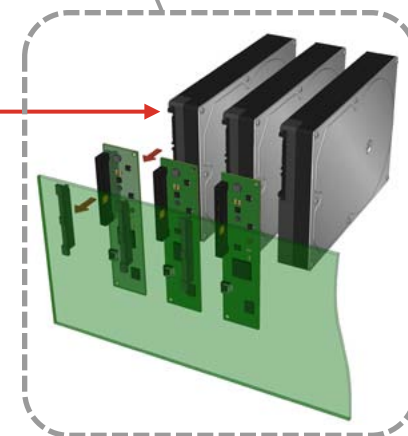


SATA HDDs

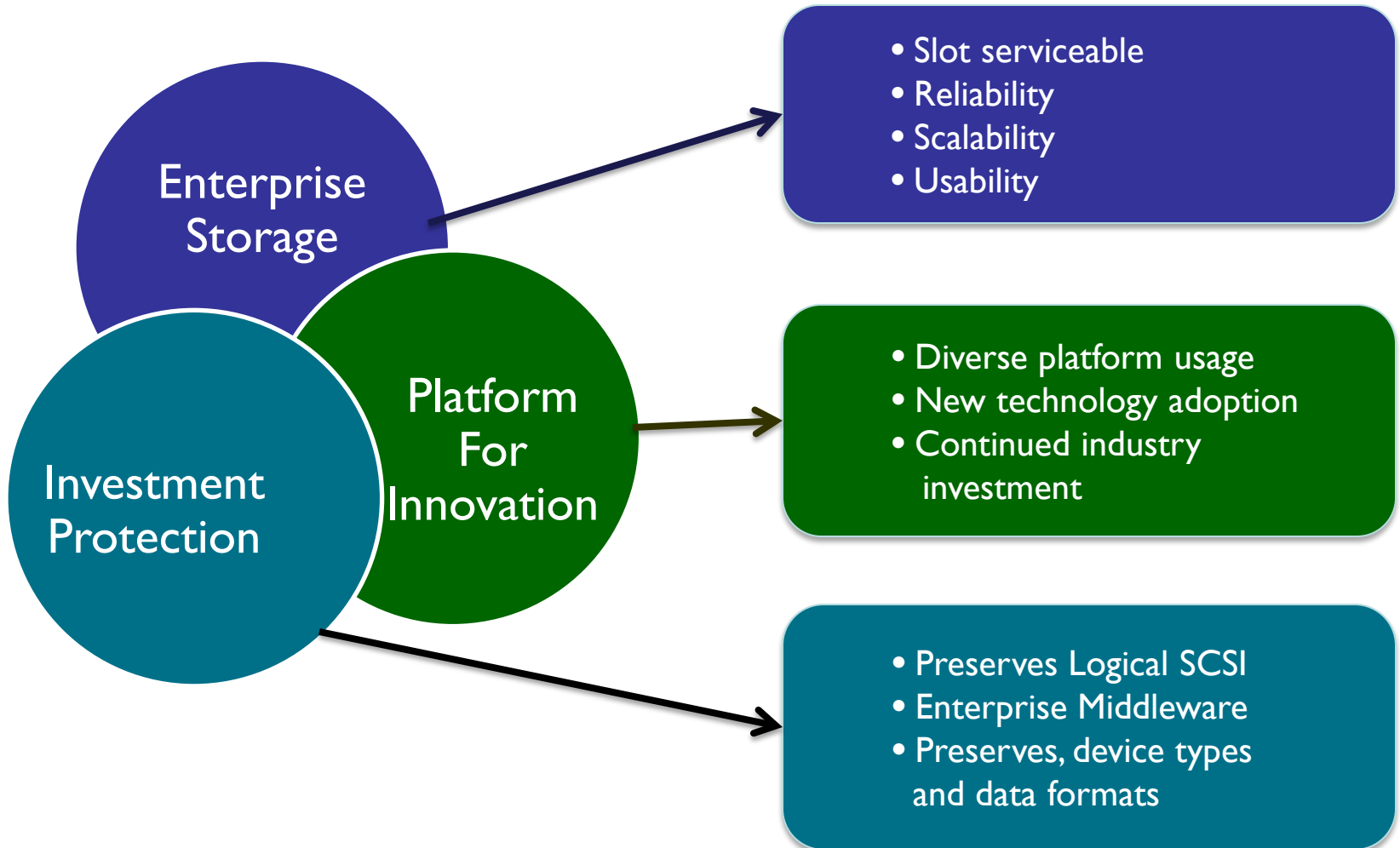
SATA HDDs

SATA HDDs

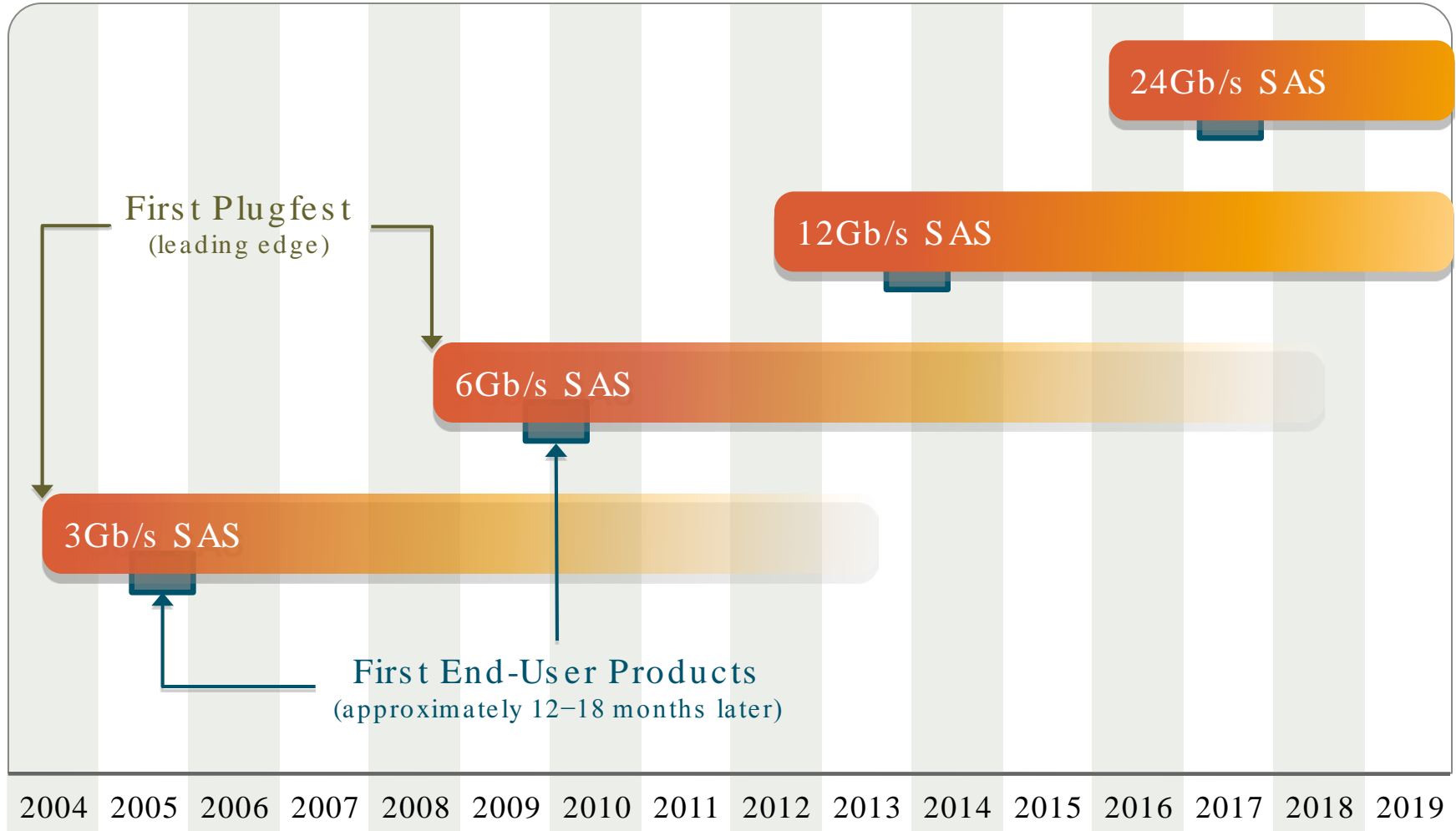
SAS HDDs



SAS – Preservation and Innovation



SAS Performance Roadmap



**SAS Roadmap updated Nov 2010.*

12Gb/s SAS Market Objectives

- ❑ Preserve existing SAS architecture
 - ❑ Preserve 3Gb/s SAS & 6Gb/s SAS usage models
 - ❑ Maintain backward compatibility and intermatability to current 3Gb/s & 6Gb/s SATA/SAS backplane device connectors
- ❑ Continue 6Gb/s SATA and future SATA compatibility
- ❑ Encourage improved storage system RAS attributes
- ❑ Double transfer rate
 - ❑ Improve cost/performance & power/bandwidth ratio
 - ❑ Reduced # of connections per Gb/s
- ❑ Maximize link utilization when using devices operating at less than 12Gb/s
- ❑ Maintain and support SAS Advanced Connectivity roadmap
 - ❑ Encourage broad adoption of Mini-SAS HD required for external
- ❑ Supports MultiLink SAS™ implementations

12Gb/s SAS Value Proposition

- ❑ Performance
 - ❑ Low latency storage devices (SSDs, etc.)
 - ❑ MultiLink SAS™ connector
- ❑ Greater scaling due to increased bandwidth
 - ❑ Capacity, performance, etc.
- ❑ Storage connectivity
 - ❑ Device interconnect
 - ❑ System interconnect (fabric)
- ❑ Improved cost/performance benefit
- ❑ Investment protection

12Gb/s SAS Industry Timelines

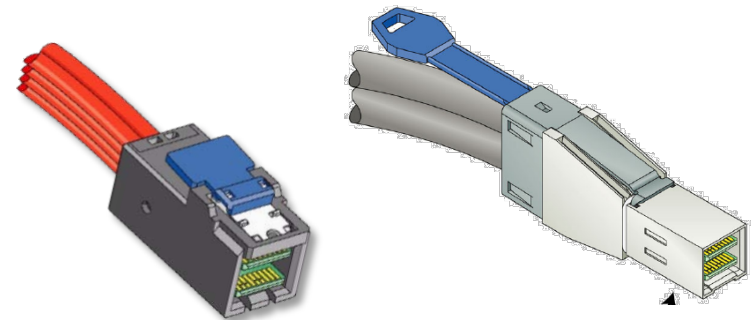
- ❑ T&M Equipment & Protocol Analyzers - early availability
- ❑ Internal & External Connectors - available or being tooled
- ❑ Early Component/HBA Testing - 4Q 2011
- ❑ HDDs and SSDs - 1H 2012
- ❑ Industry Plugfest - 3Q 2012
- ❑ System Shipments - 2H 2013

12Gb/s SAS - Technology

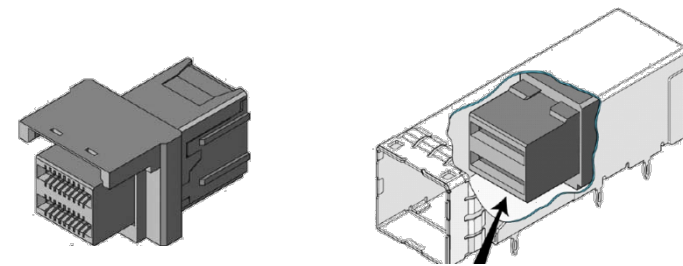
- ❑ Preserves 8b/10B encoding/decoding
- ❑ Uses Training Sequence to “tune” both transmitter and receiver characteristics
- ❑ Preserves 6m external passive copper connection
- ❑ Alternatively uses “Active” connections (Advanced Connectivity) to achieve longer distances
- ❑ Preserves motherboard slot oriented usage model and internal cabling (Mini-SAS)
- ❑ Uses upgraded backward compatible 12Gb/s backplane connector (SFF – 8680)

SAS Advanced Connectivity Objectives

- ❑ Drive market consistency
- ❑ Simplify cable & connector options
- ❑ 2X density improvement
- ❑ Provide converged high-density connectivity
- ❑ Provide managed connectivity standards
- ❑ Provide active copper solution to 20m
- ❑ Provide optical solution to 100m
- ❑ Support 6Gb/s SAS deployments
- ❑ Extensible to 12Gb/s SAS deployments

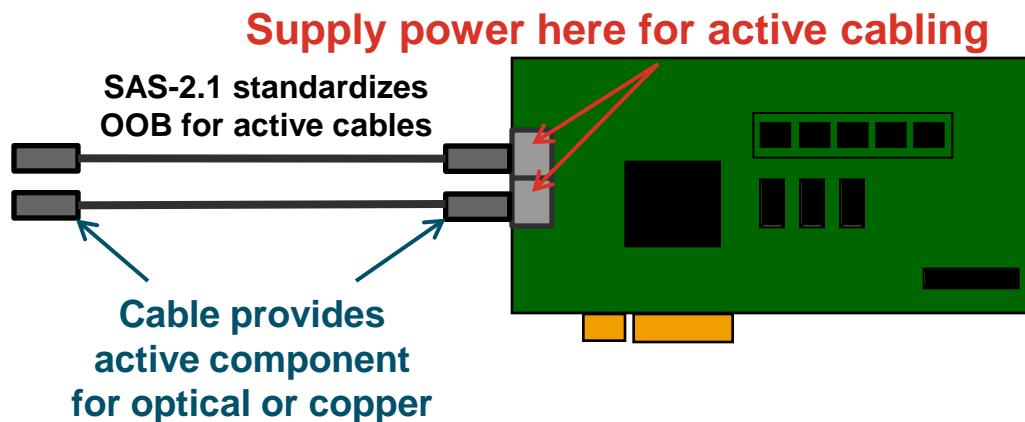


Internal similar to External

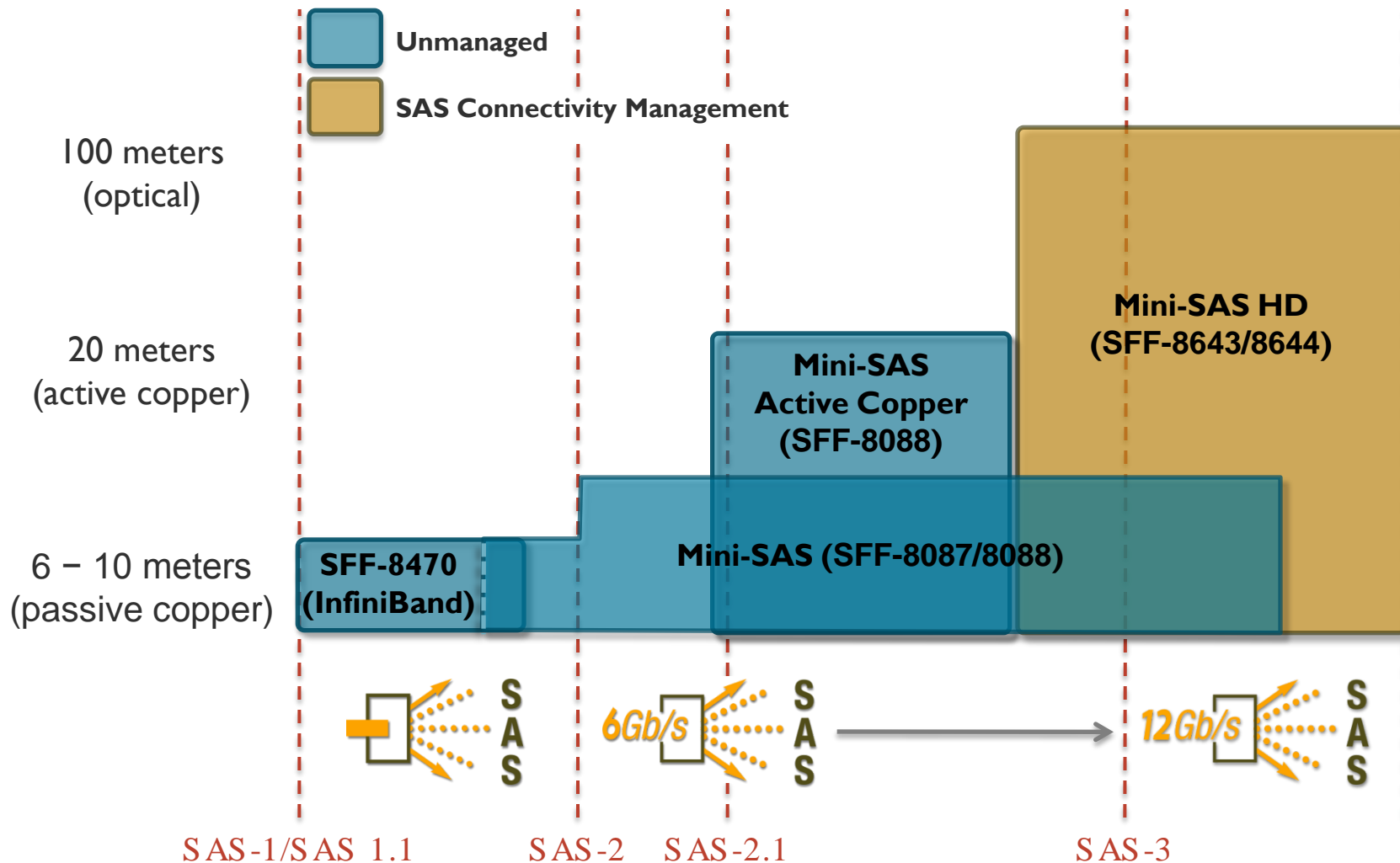


Passive, Active Copper, or Optical use same connector

Mini-SAS HD connectors courtesy:
Project T10/2125-D Revision 04
17 September 2009, ANSI SAS-2.1



SAS Advanced Connectivity Roadmap - 2011



12 Gb/s SAS Connectivity Update

Mini-SAS HD Internal Connectors

Redesign of the current 6Gb/s connector to run 12Gb/s

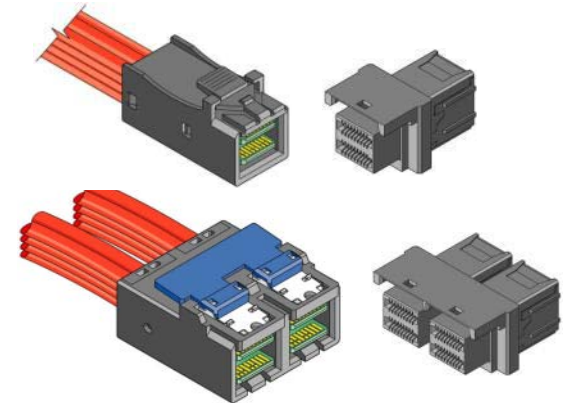
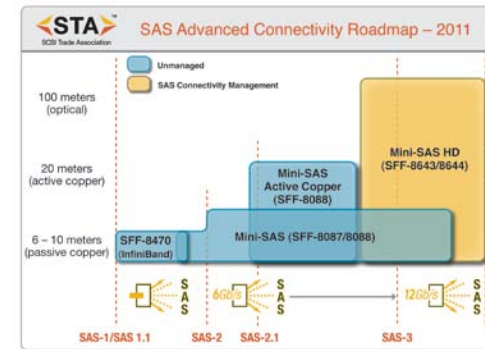
- 6Gb/s – SFF-8643 → 12Gb/s – SFF-8643

Parts Availability for Right angle Receptacles

- First Pass Plugs for evaluation – see below
- Low Volume Plugs for First Pass Systems – see below
- Volume ramp – 1x1, 1x2 Parts Shipping in High Volume

Parts Availability for Cable Assemblies

- First Pass Plugs for evaluation – see below
- Low Volume Plugs for First Pass Systems – see below
- Volume ramp
 - The (3) versions in SAS 2.1 are shipping for 4x
 - Lower volumes shipping for 8x



Note:

- The technical content of SAS-3 is not final.
- 12Gb/s component availability is based on currently available information.

12 Gb/s SAS Connectivity Update

Mini-SAS HD External Connectors

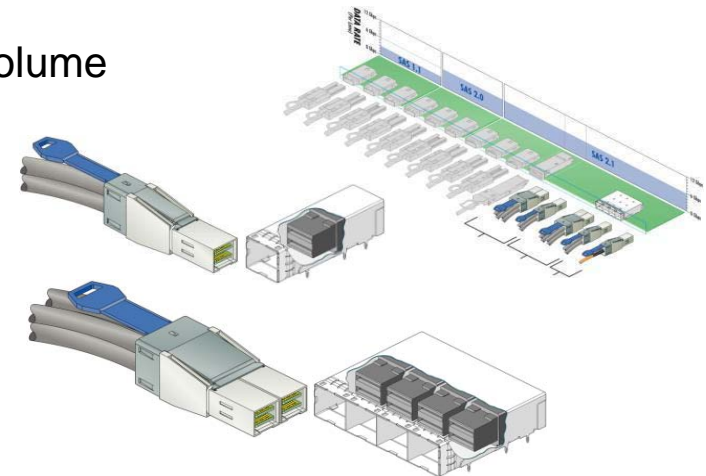
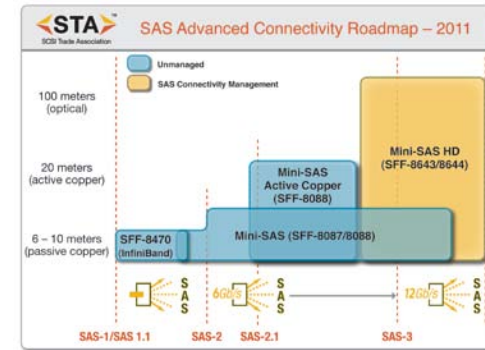
Redesign of the current 6Gb/s connector to run 12Gb/s
- 6Gb/s – SFF-8644 → 12Gbps – SFF-8644

Parts Availability for Right angle Receptacles

- First Pass Parts for evaluation – see below
- Low Volume Parts for First Pass Systems – see below
- Volume ramp – 1x1, 1x2, 1x4 Parts Shipping in High Volume

Parts Availability for Cable Assemblies

- First Pass Plugs for evaluation – see below
- Low Volume Plugs for First Pass Systems – see below
- Volume ramp
 - The SAS 2.1 versions are shipping for 4x
 - Lower volumes shipping for 8x



Note:

- The technical content of SAS-3 is not final.
- 12Gb/s component availability is based on currently available information.

12 Gb/s SAS Connectivity Update

12Gb/s HDD/Backplane Connectors

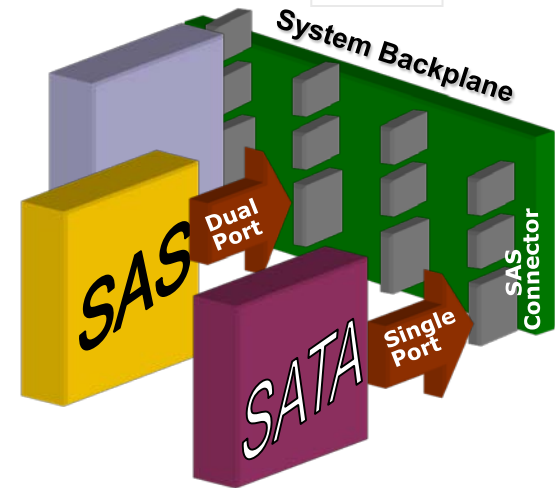
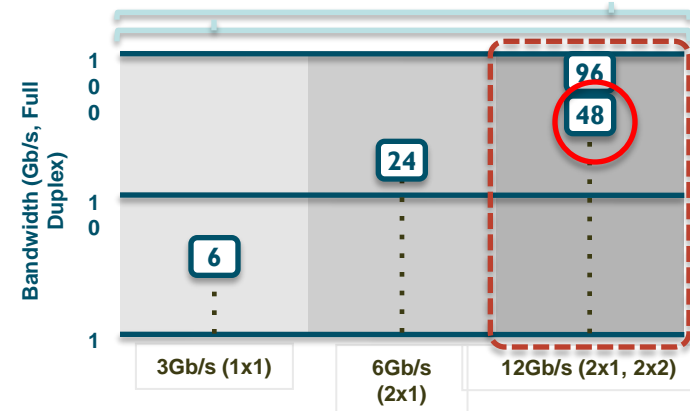
Redesign current 6Gb/s connector to run 12Gb/s
- 6Gb/s – SFF-8482 → 12Gb/s – SFF-8680

Parts Availability for Vertical Mid-plane Receptacles

- First Pass Plugs for evaluation – 3Q 2011
- Low Volume Plugs for First Pass Systems – 4Q 2011
- Volume ramp – first half of 2012

Parts Availability for Right angle Plugs for HDD's

- First Pass Plugs for evaluation – 3Q 2011
- Low Volume Plugs for First Pass Systems – 4Q 2011
- Volume ramp – first half of 2012



Note:

- The technical content of SAS-3 is not final.
- 12Gb/s component availability is based on currently available information.

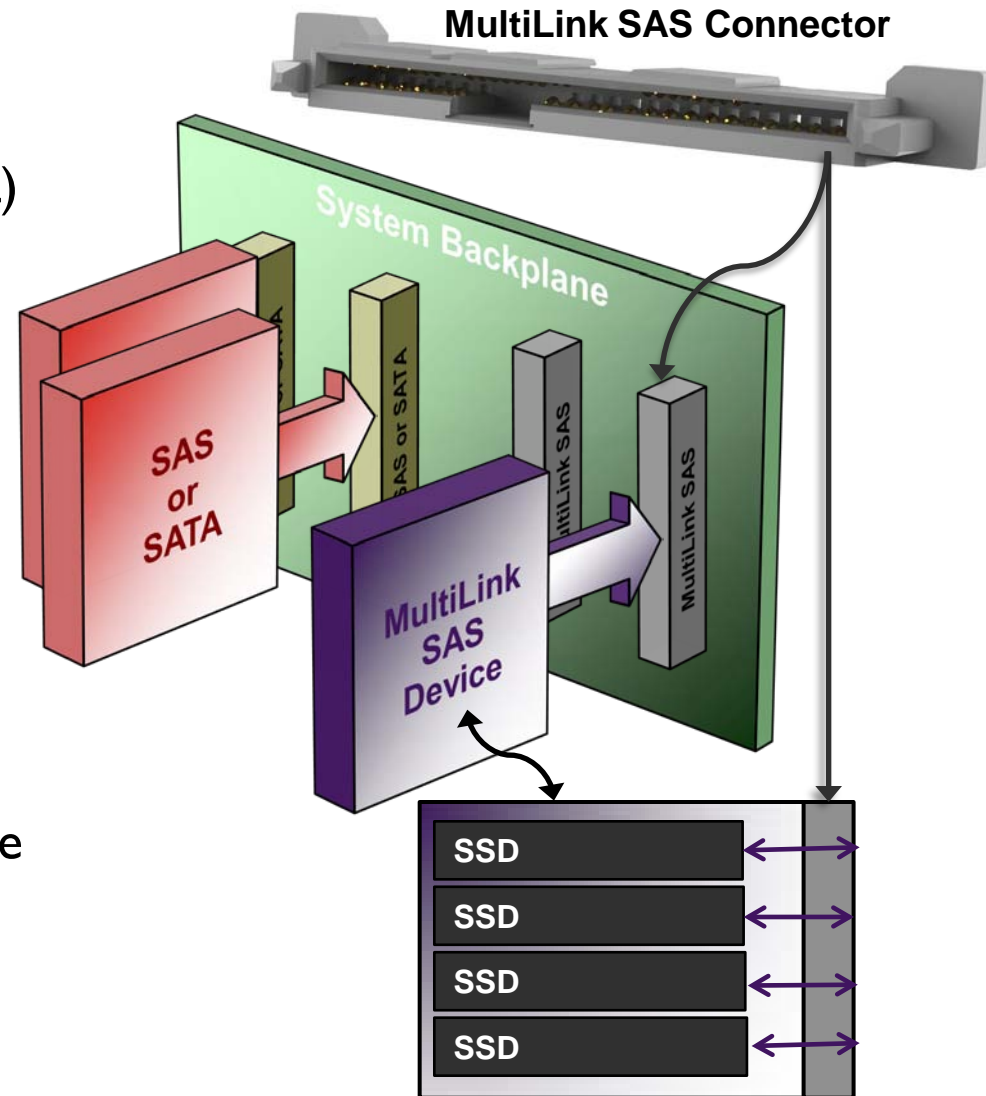
MultiLink SAS™ Initiative

- ❑ STA Endorsed May 2010
- ❑ Defines New Type of SAS Drive Slot
 - ❑ Increased power/slot
 - ❑ Multiple SAS links
- ❑ No Protocol Changes
 - ❑ Works with existing infrastructure components
- ❑ 12Gb/s and 24Gb/s Link Performance
- ❑ Standardization Underway in T10 & SFF

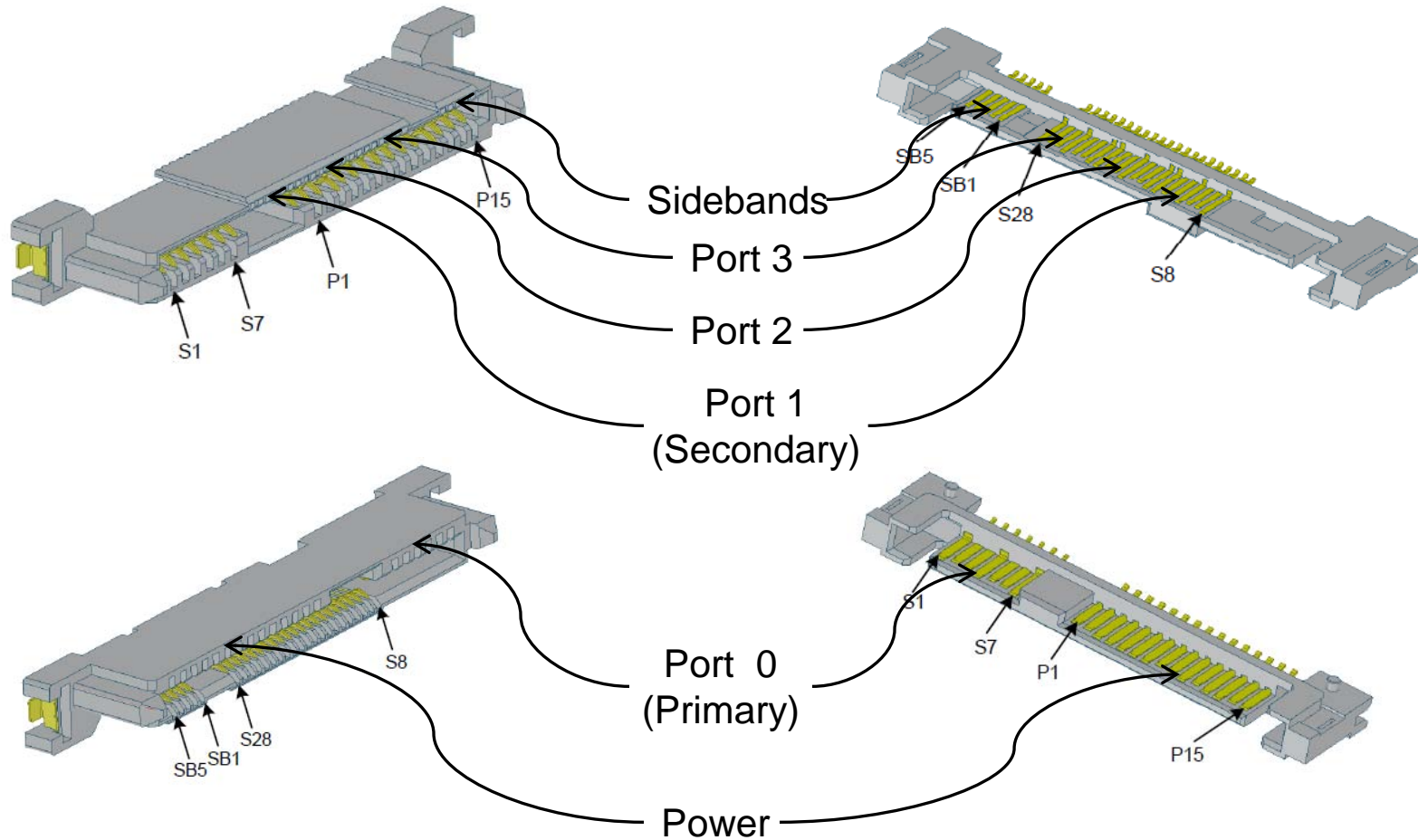
MultiLink SAS™ Slot

MultiLink SAS™

- High performance (20+W per slot)
- Hot swap, serviceability
- High availability (2 fault domains possible)
- Low implementation risk:
 - Standard SAS drivers
 - Fully hardened protocol stack
 - Common management stack
- Low investment (repackaging)
- Flexible: Independent SSDs or wide port SSDs
- Able to isolate tier-tier traffic w/o accessing system memory



MultiLink SAS™ Connector



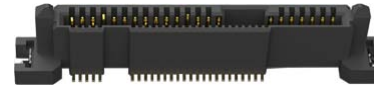
MultiLink SAS™ Roadmap: Backplane Slot Location



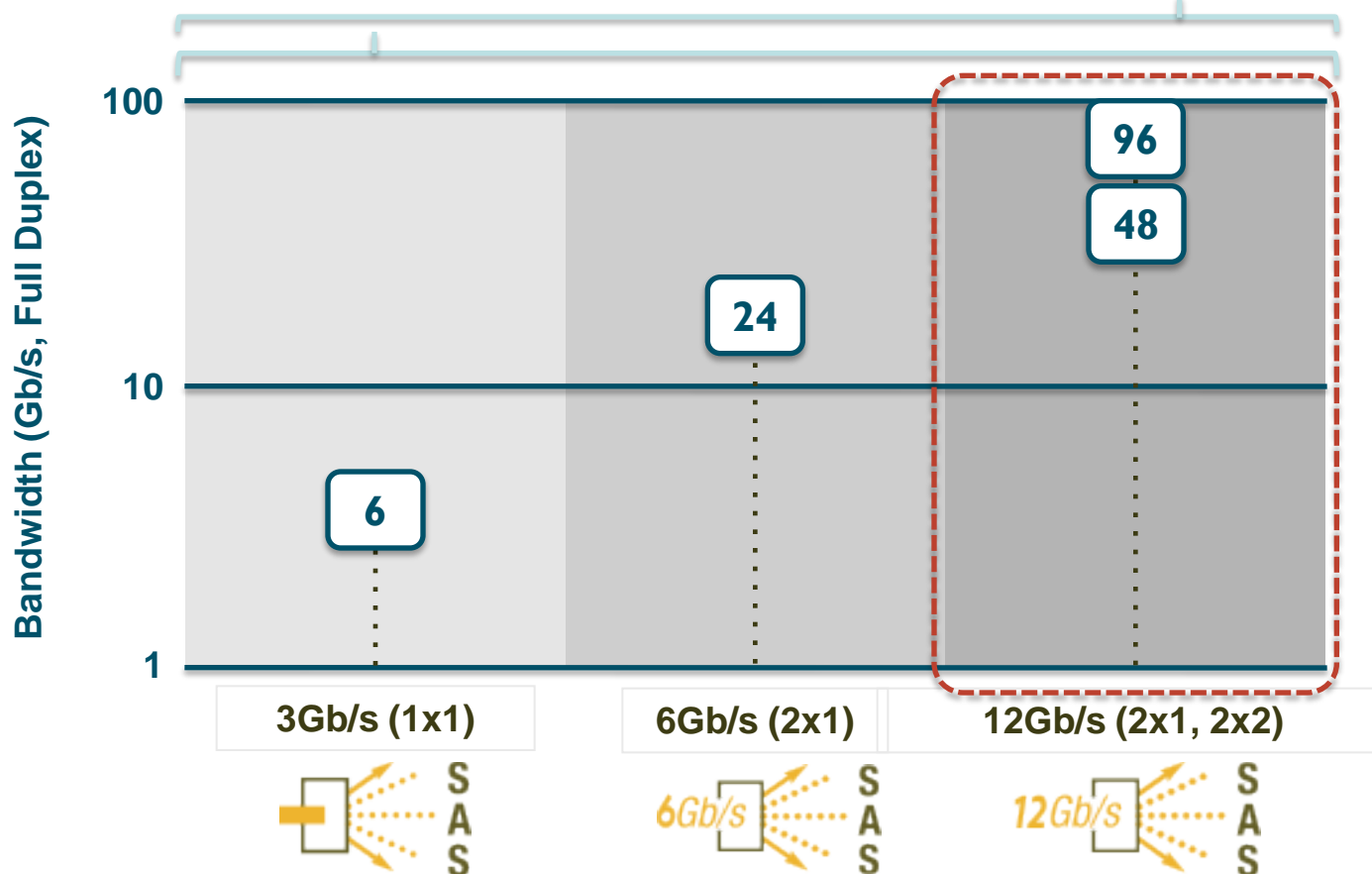
SAS Connector
(SFF-8482 & SFF-8680)



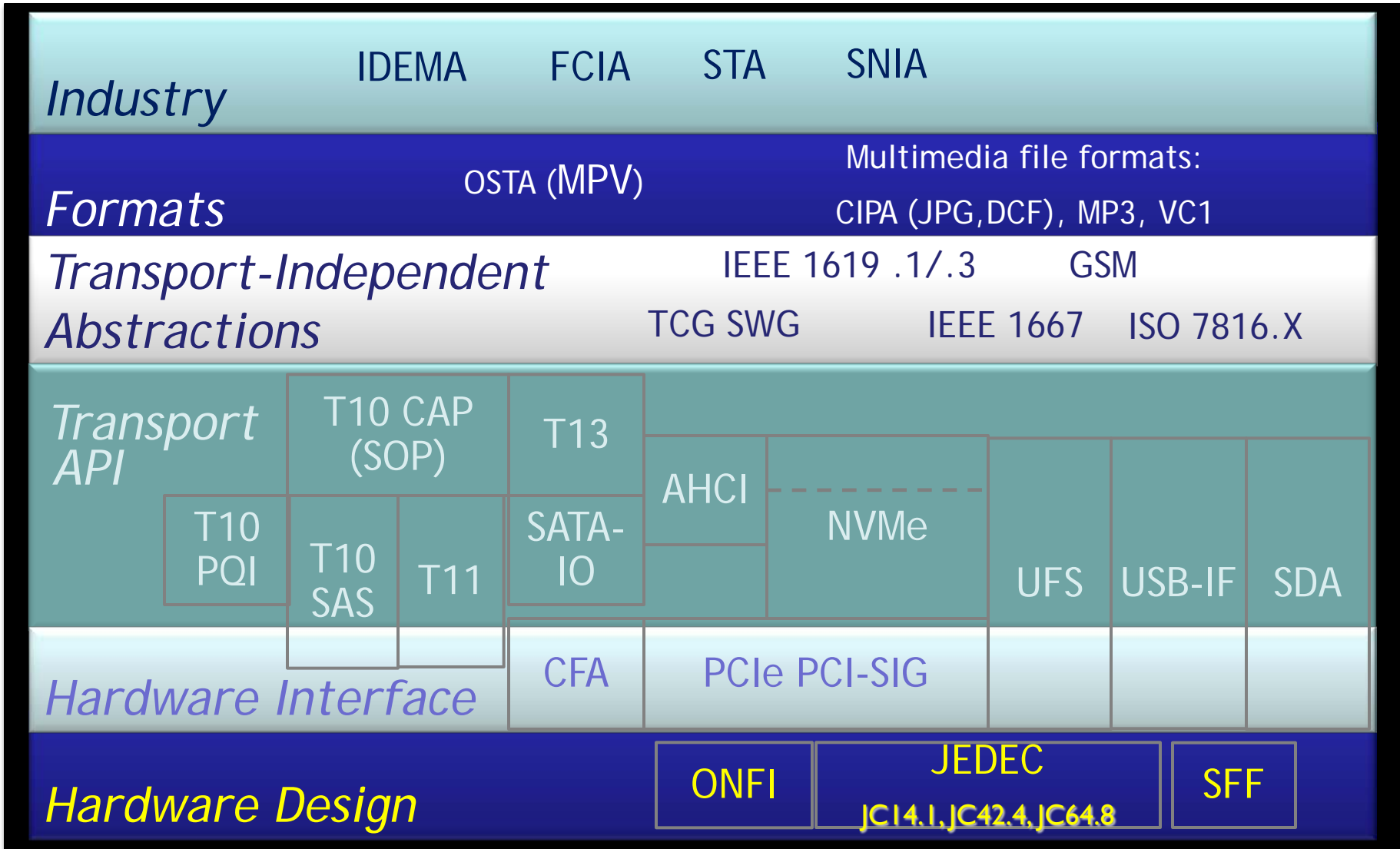
S™
A
S



MultiLink SAS Connector
(SFF-8630)

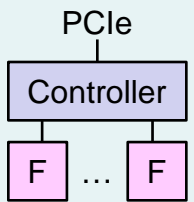
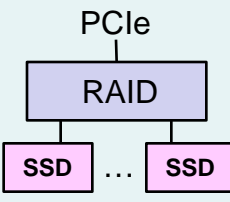


Standards and Specification Soup

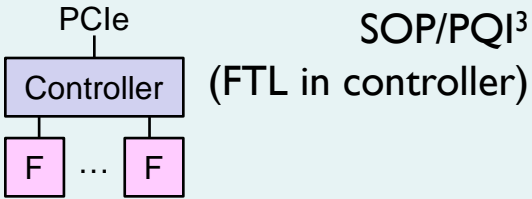
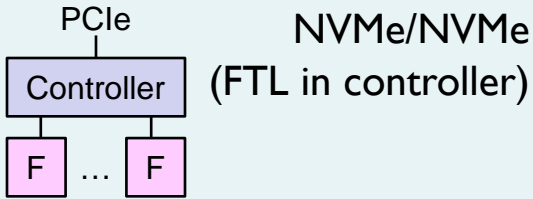


Enterprise Interfaces: PCIe SSDs

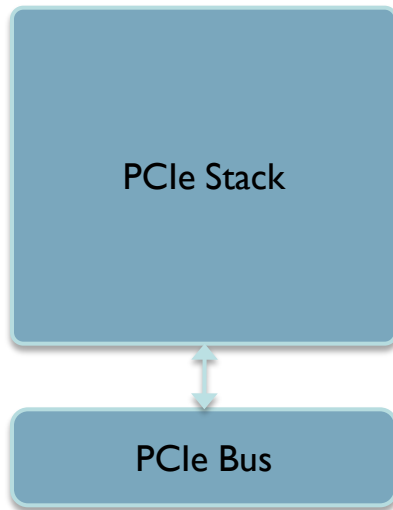
Today

	Native	Aggregator
Commands/Transport	 <p>Proprietary (FTL¹ in host/ main memory)</p>	 <p>SCSI or SATA (Multiple SSDs and controller on card)</p>
Committee	None	None
Standards Based	No	Yes
Performance with Flash	High	High
CPU Overhead	High	Low
Latency with short queue	Very Low	Low
Latency with deep queue	Moderate	Low
Use Case Extensibility	No	Yes (RAID, HBA, etc)
Maturity	Evolving	Based on Proven Industry Architectures
Enterprise feature set (PI, Security, Mgmt, etc.)	No	Depends on implementation

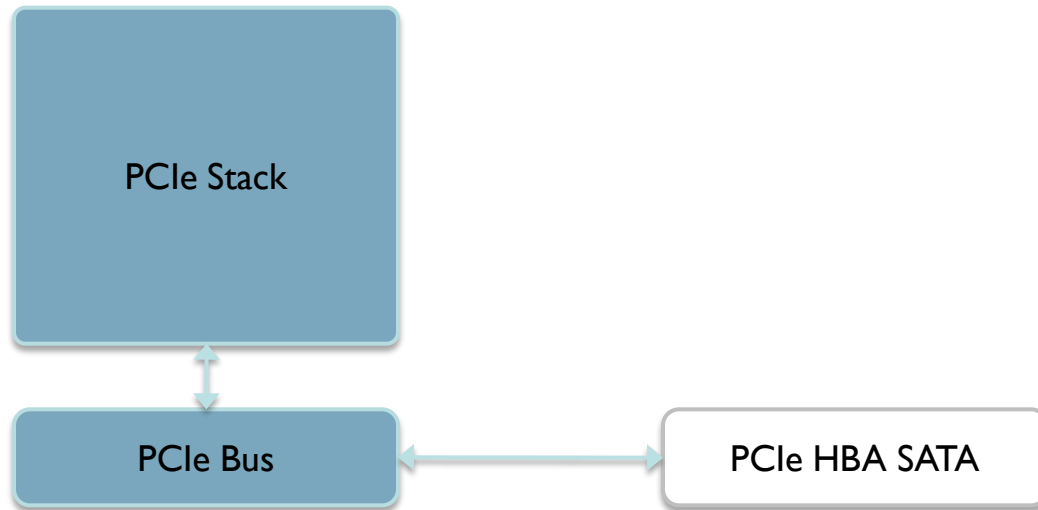
Enterprise Interfaces: The Future of PCIe SSDs

	SOP¹	NVMe²
Commands/Transport ¹ SOP : SCSI over PCI Express ² NVMe : Non- Volatile Memory Express ³ PCIe Queuing Interface ⁴ INCITS : International Committee for Information Technology Standards		
Committee	TI0/INCITS⁴	Industry Working Group
Standards Based	Yes (ANSI/ISO)	No
Performance with Flash	Very High	Very High
CPU Overhead	Low	Low
Latency with short queue	Very Low	Very Low
Latency with deep queue	Low	Low
Use Case Extensibility	Yes (RAID, HBA, etc.)	No (NVM only)
Maturity	Based on Proven Industry Architectures	TBD
Enterprise feature set (PI, Security, Mgmt, etc.)	Full Support	Limited

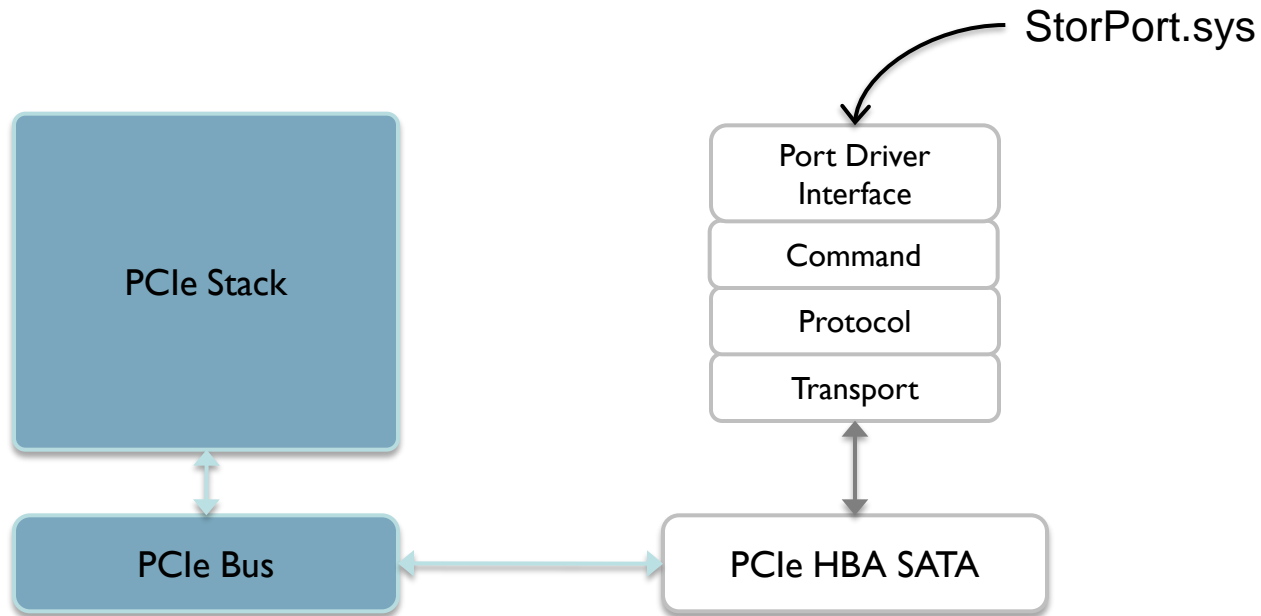
PCIe Stack



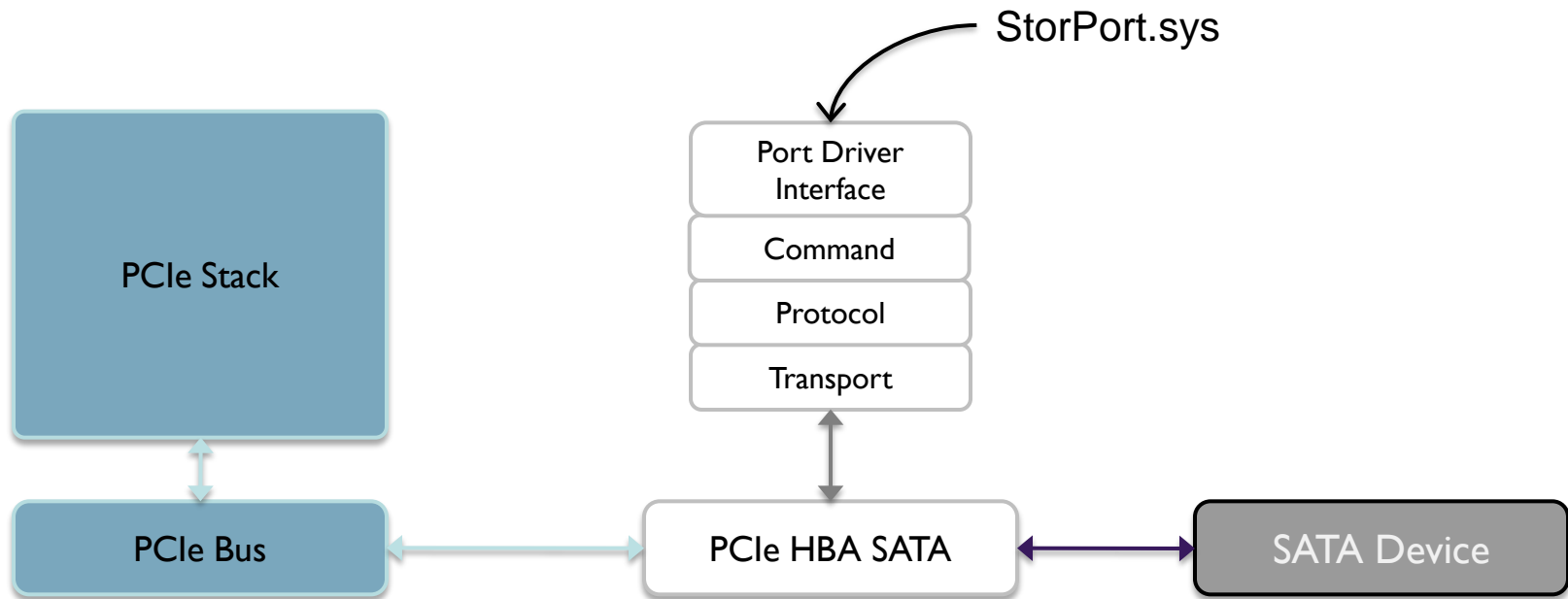
PCIe HBA Discovery



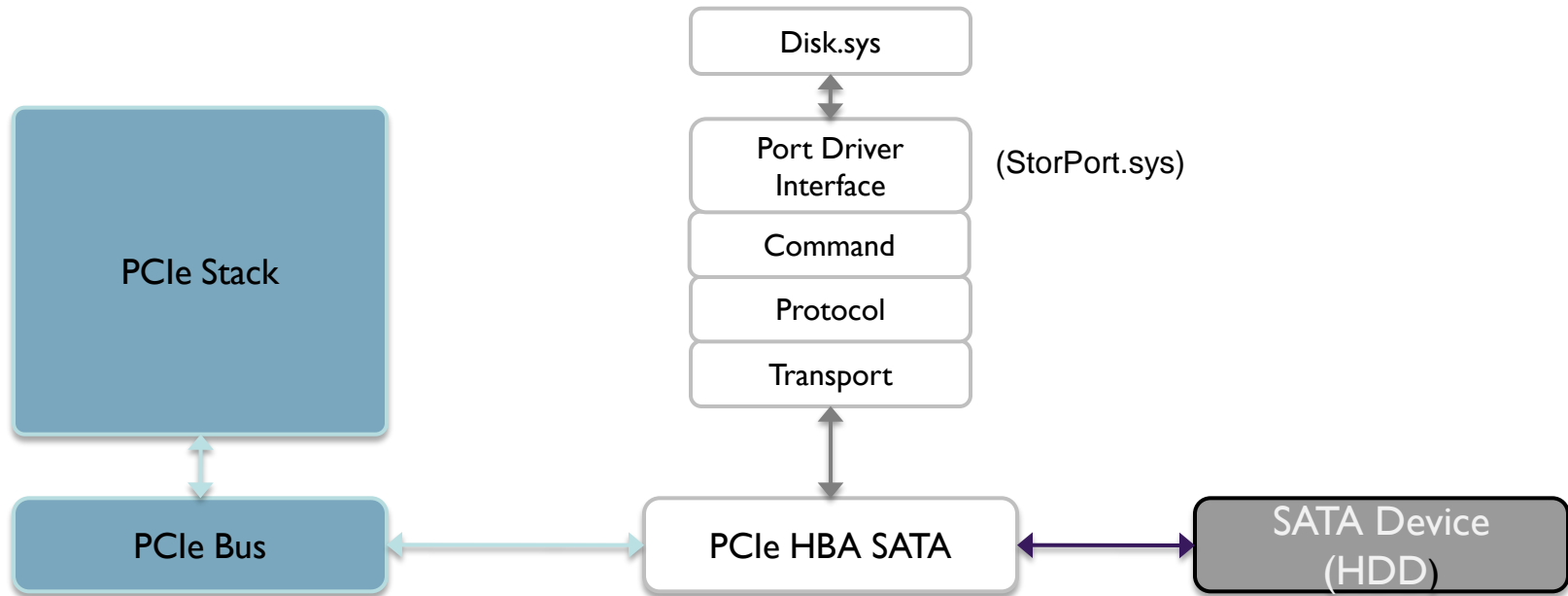
PCIe Loads StorPort based on the HBA type



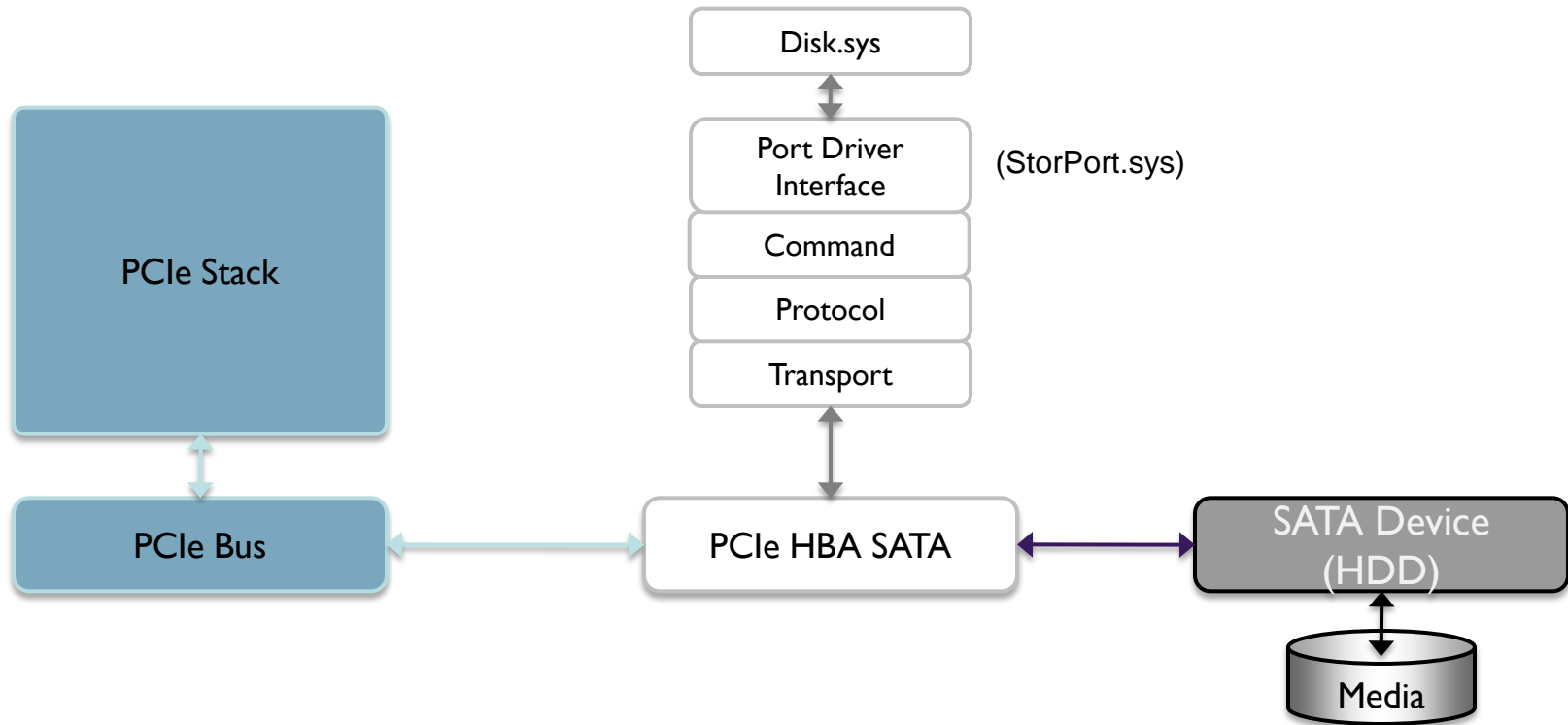
StorPort Discovers the SATA device



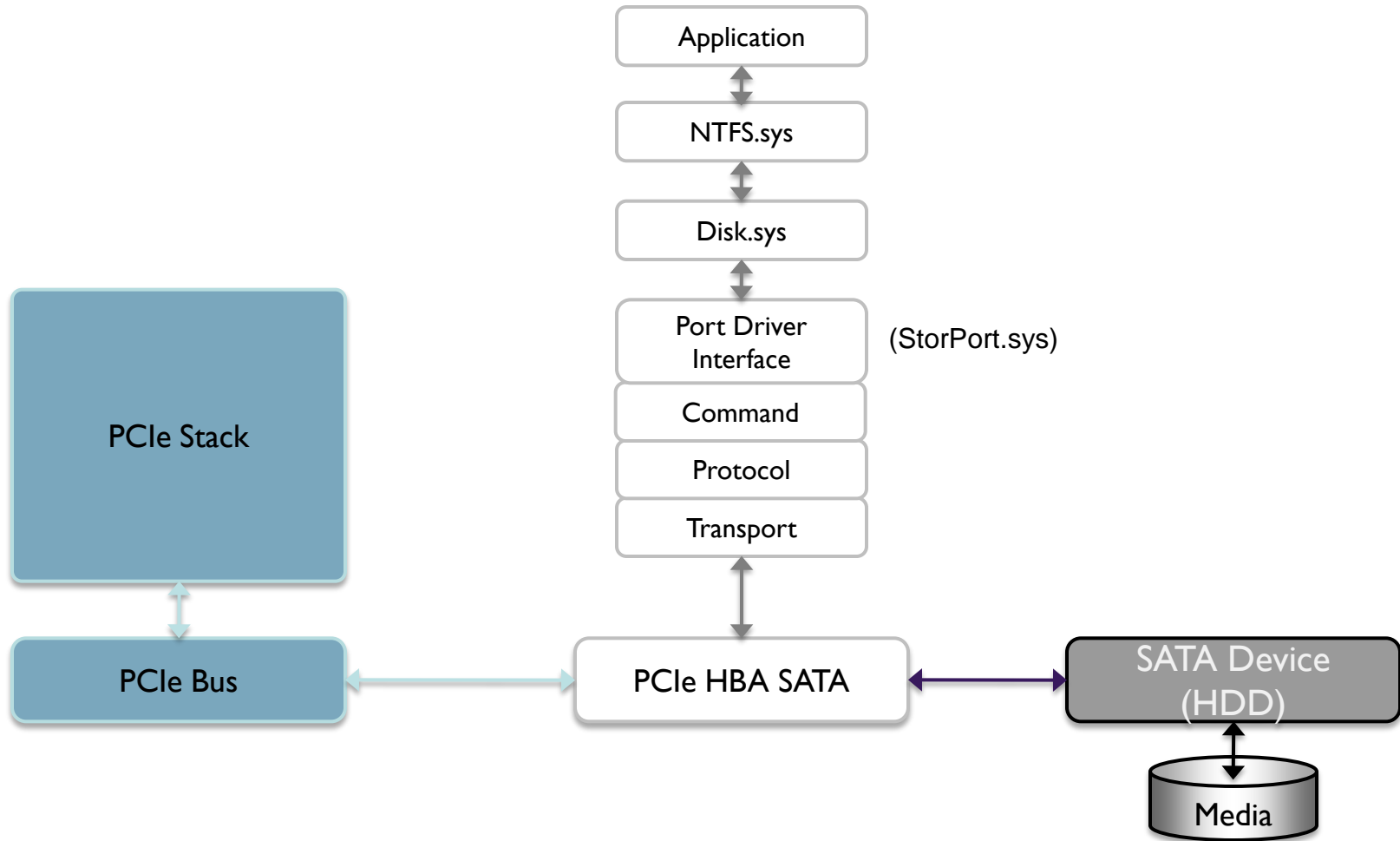
The SATA device is determined to be an HDD



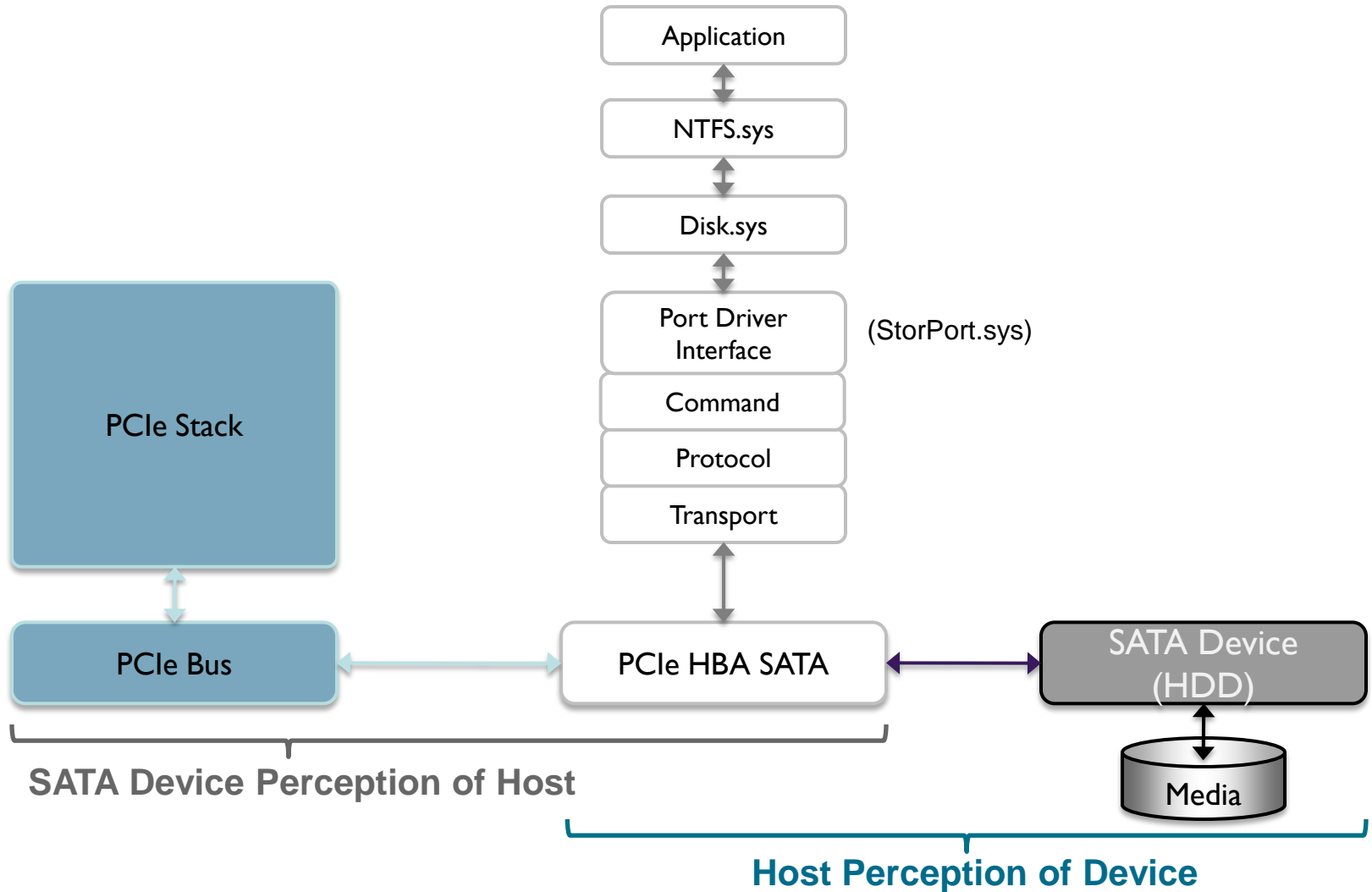
Disk class driver queries the media and finds partitions



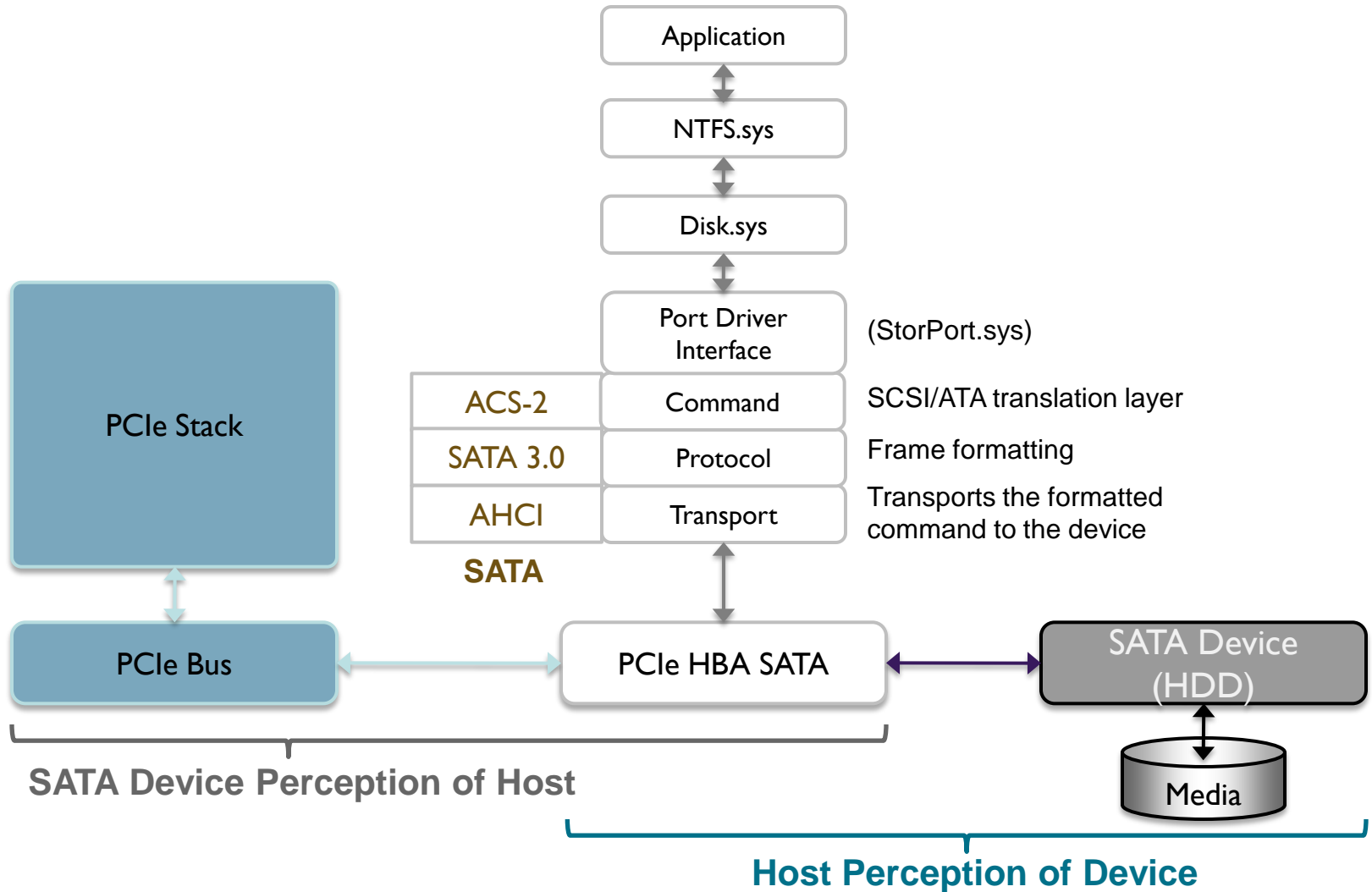
This causes the remaining upper layers to be loaded



The device perceives the HBA and stack as a unit

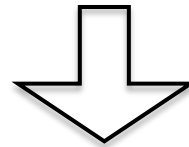
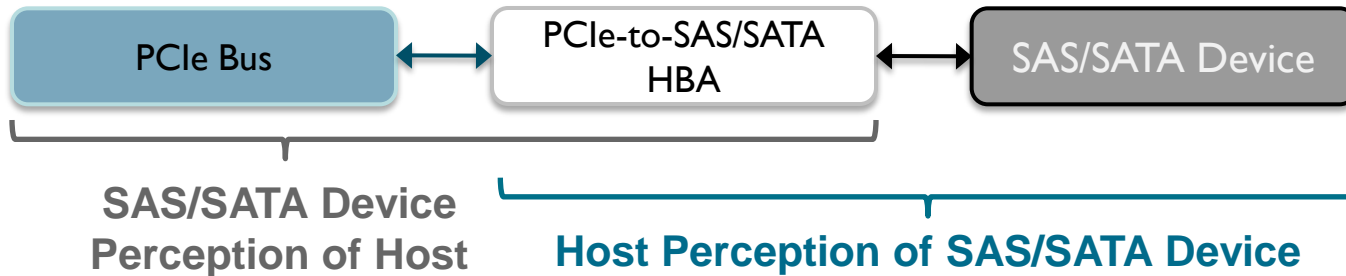


SATA Architecture Example

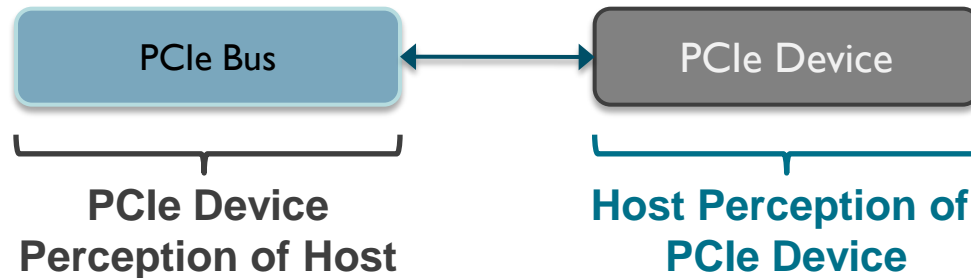


System Architecture switching from SAS/SATA to PCIe

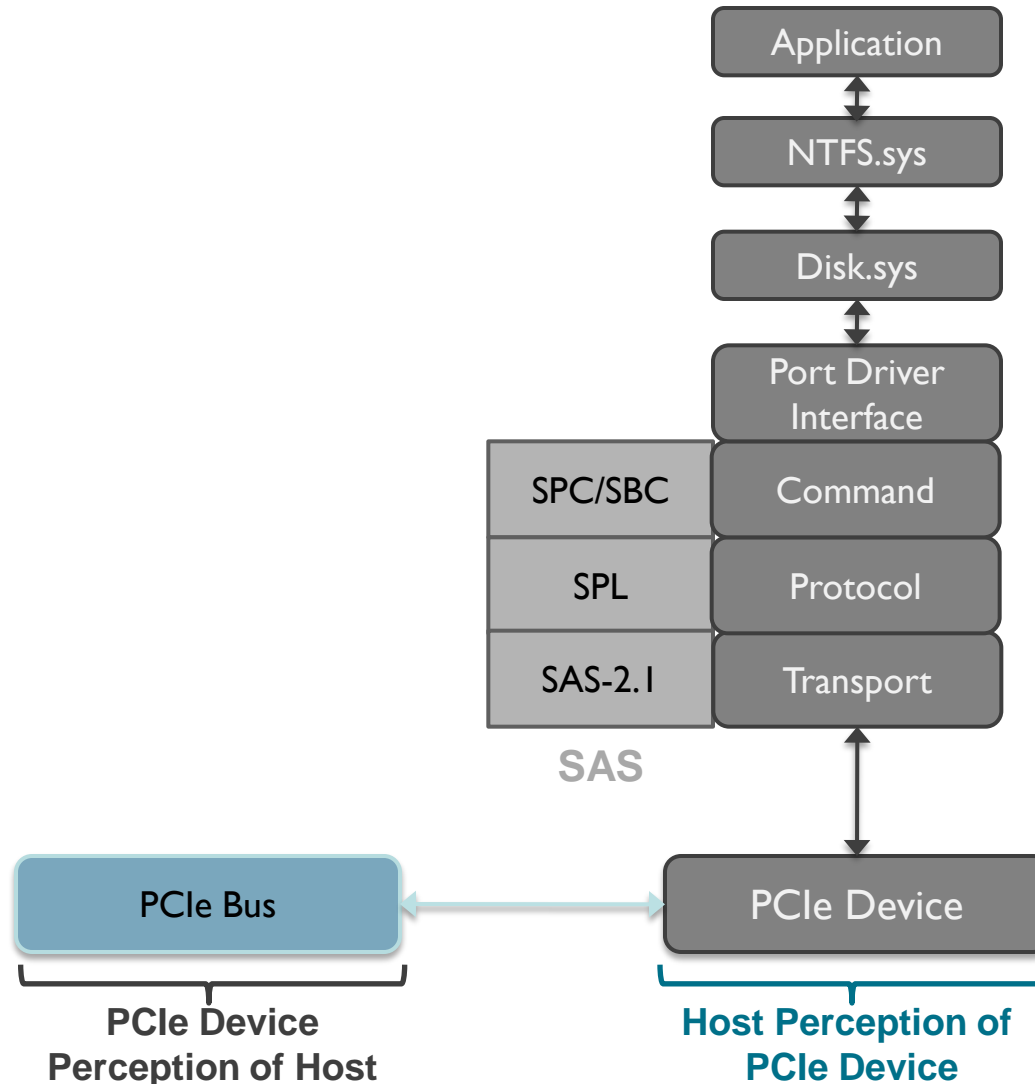
SAS/SATA:



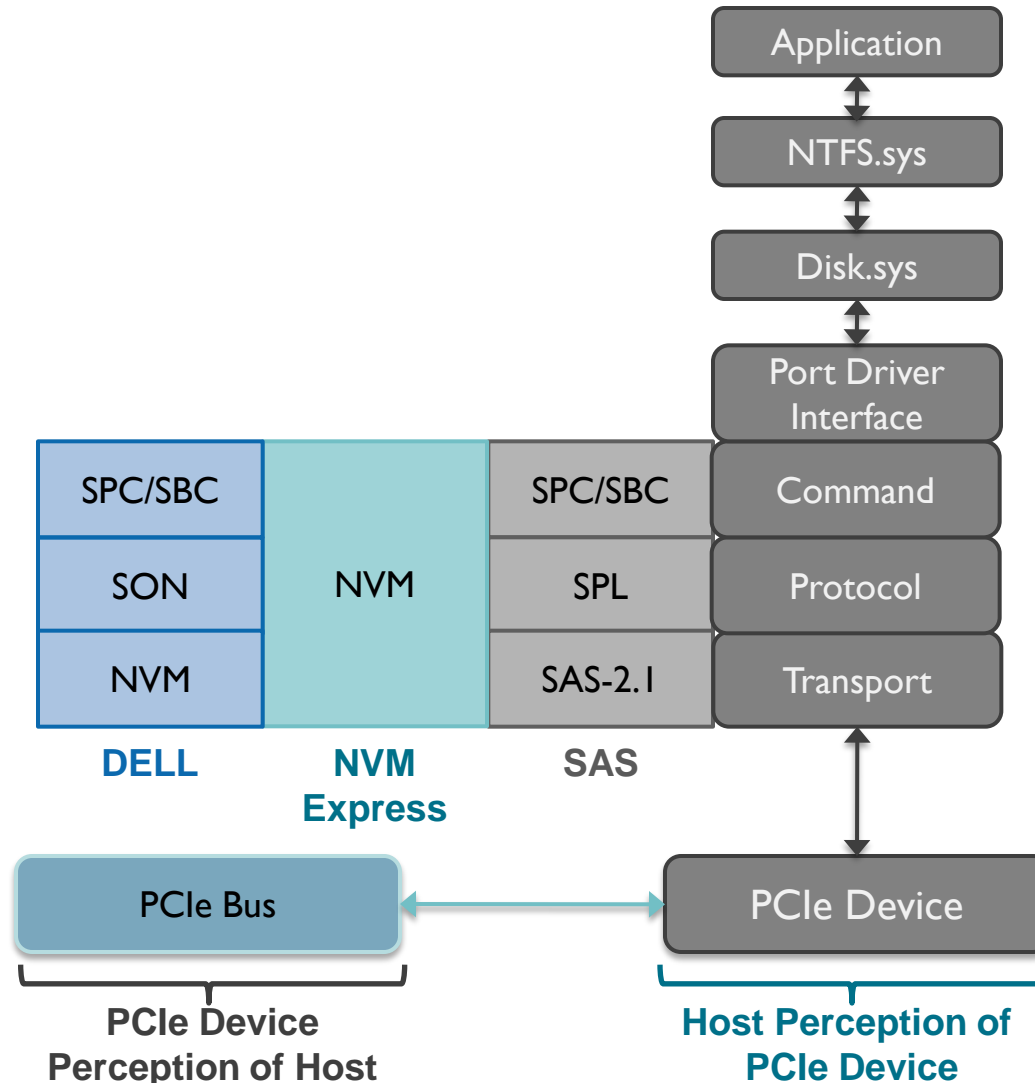
PCIe:

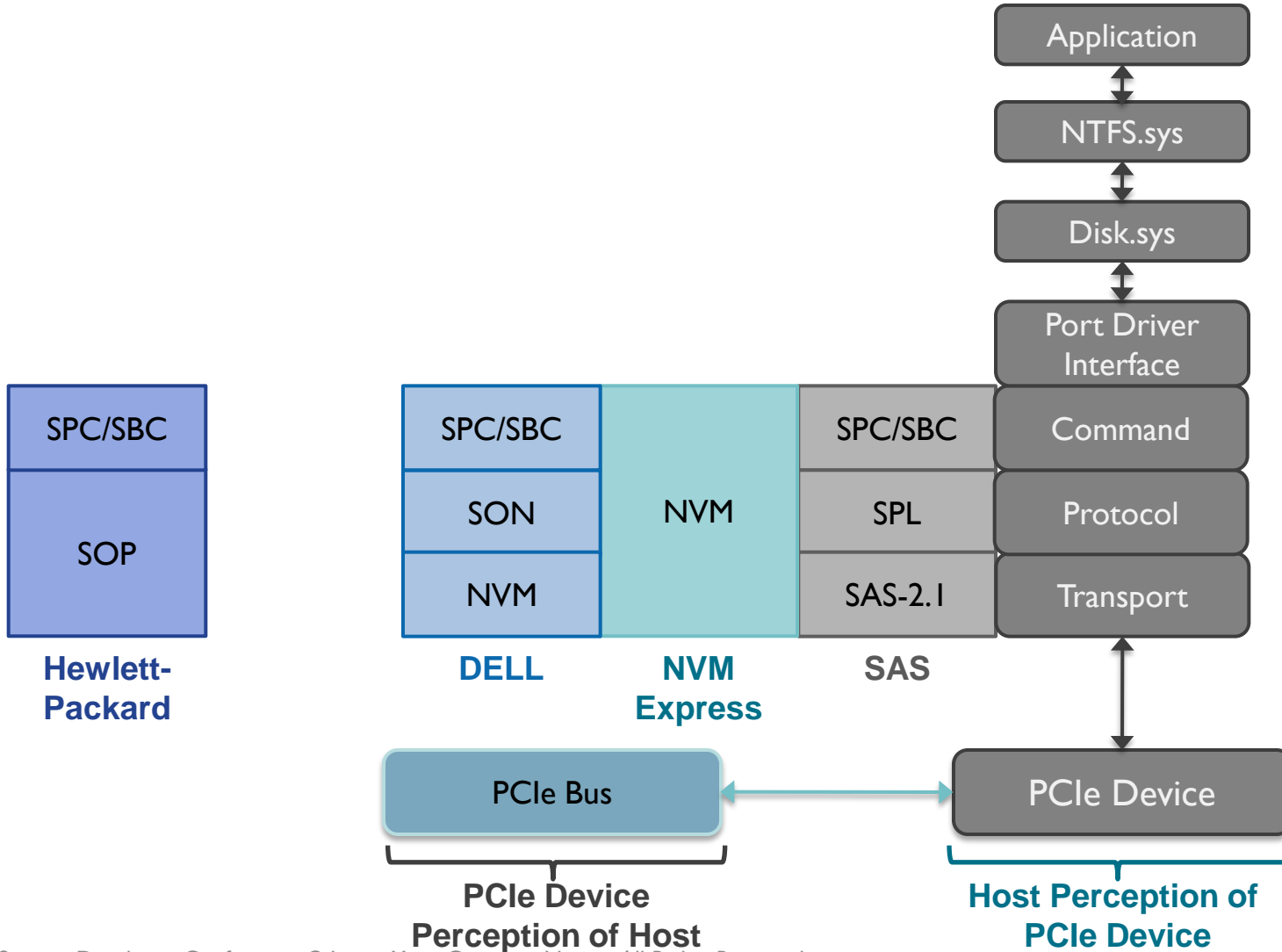


SAS Architecture

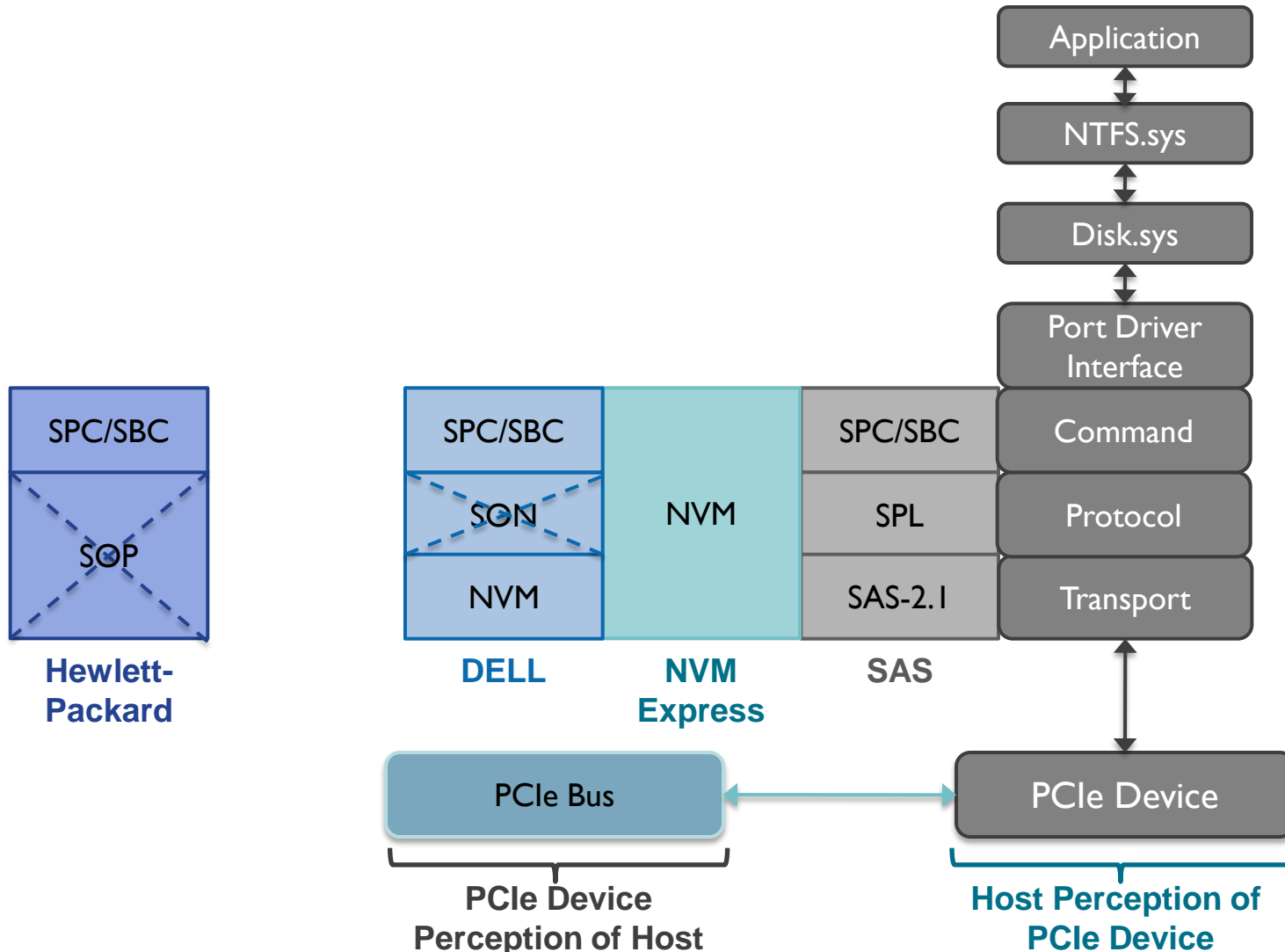


SCSI over NVM Express

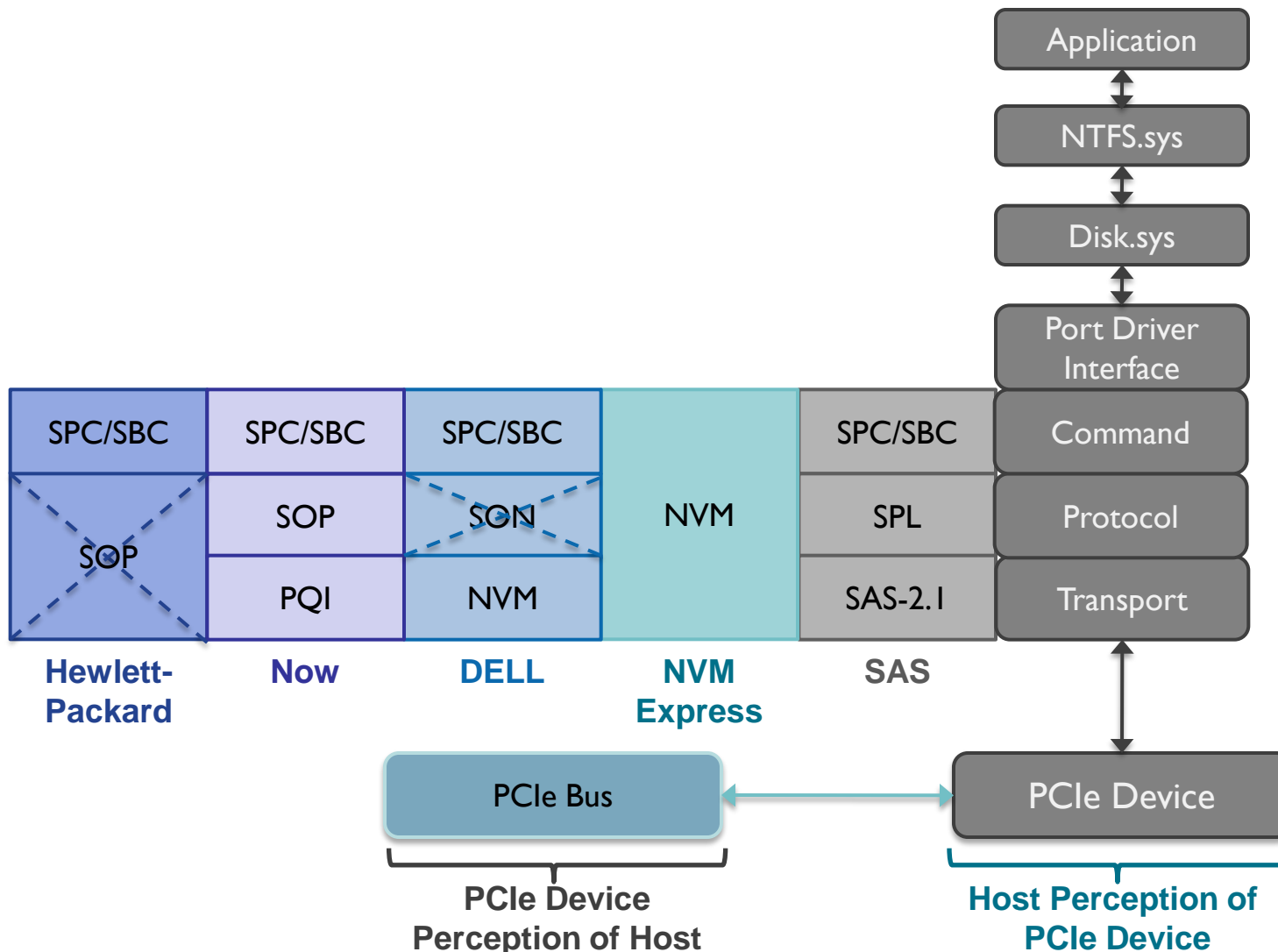




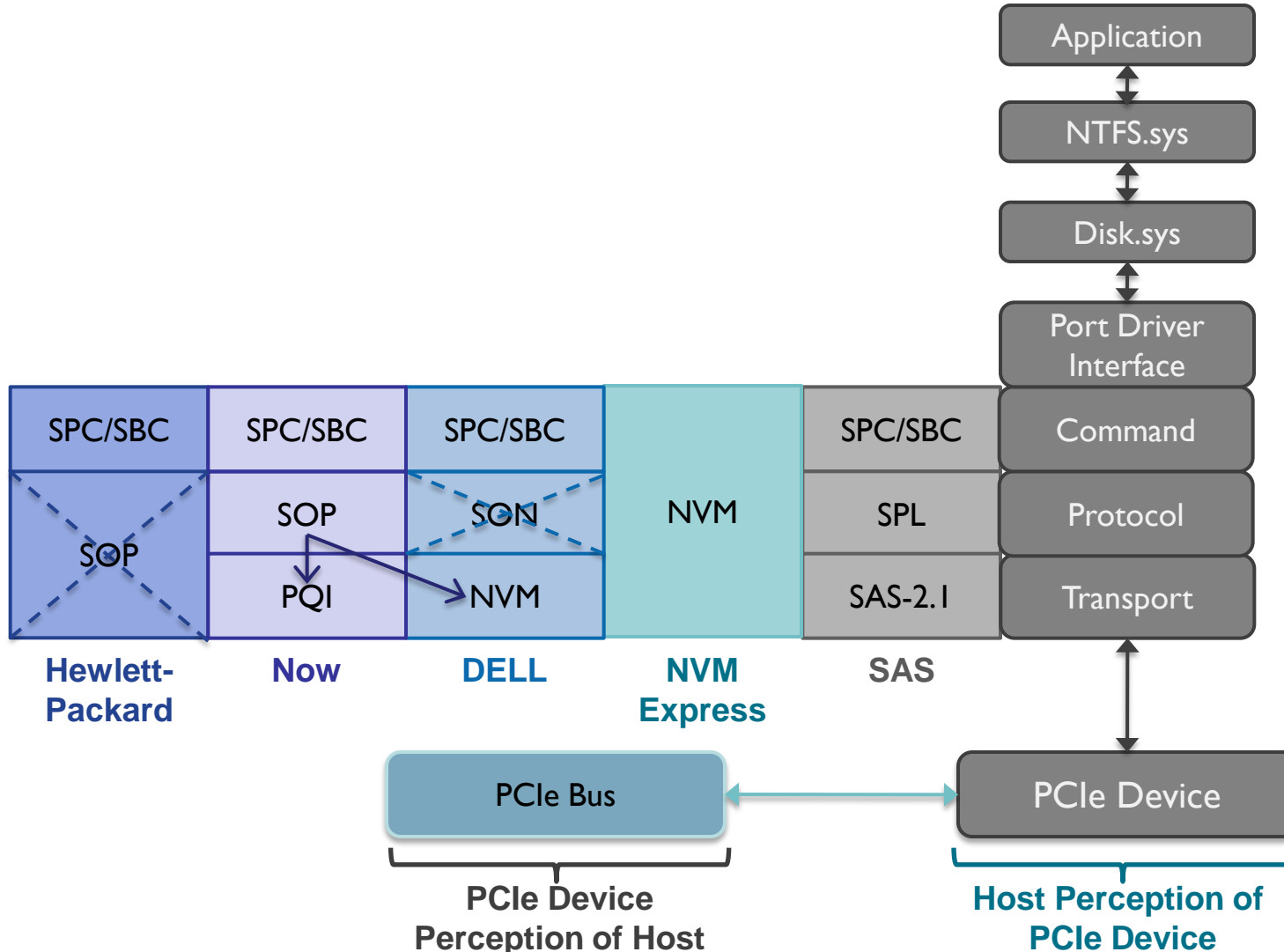
Current Proposal



Final Proposals for Approval



SOP is a neutral standard that supports NVMe and PQI

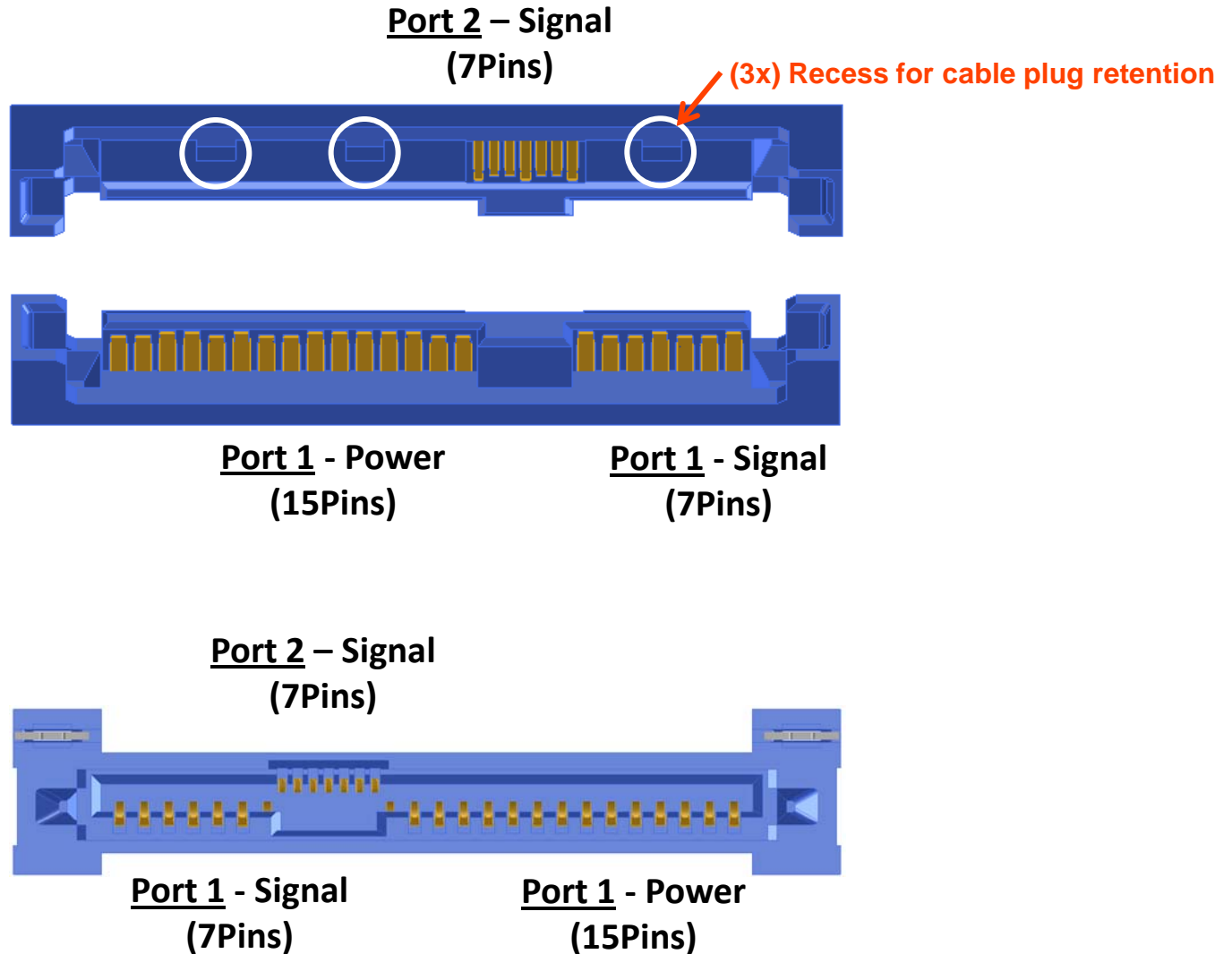


Backplane Receptacle Objectives

- ❑ Incorporate additional contacts within the current SAS backplane receptacle to:
 - ❑ Include (2) additional SAS ports plus sidebands: total of (4) ports
 - ❑ Include (2) SAS ports plus (4) Enterprise PCIe ports; including sidebands & power
 - ❑ Support new and existing devices – HDD's, SSD's, & others
 - ❑ Support devices with differing port densities
 - (1) SATA, (1/2/4) SAS, (1/2/4) PCIe + sidebands & power
 - ❑ Accommodate faster data rates – 12Gb/s SAS, 8GTs for PCIe
 - ❑ Allow for increased power requirements – up to 25W / slot

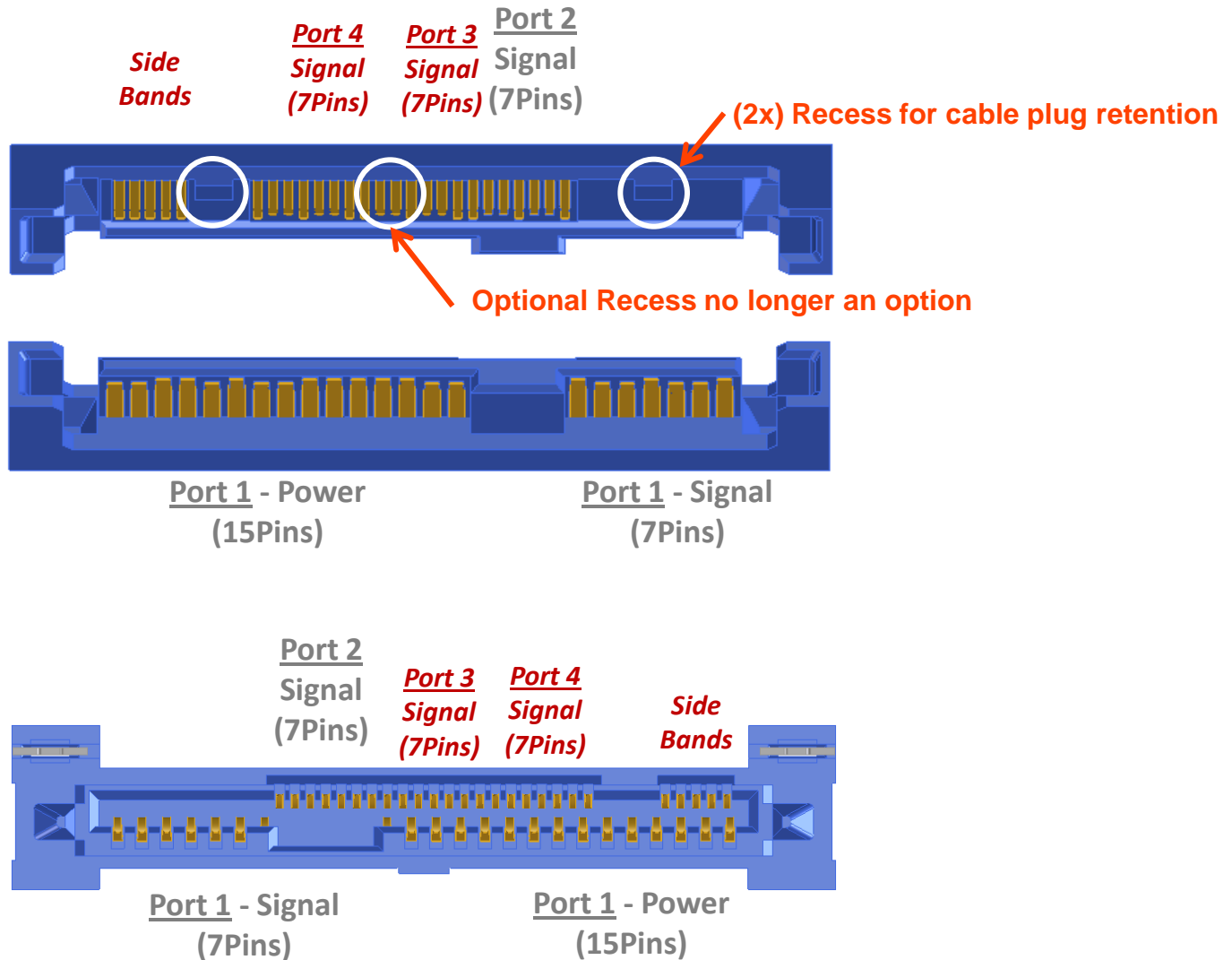
Real time activities. Changes are occurring as we present
– check with latest standards activities for updates

Dual Port 12Gb/s SAS (SAS-3) (Preliminary SFF-8680)

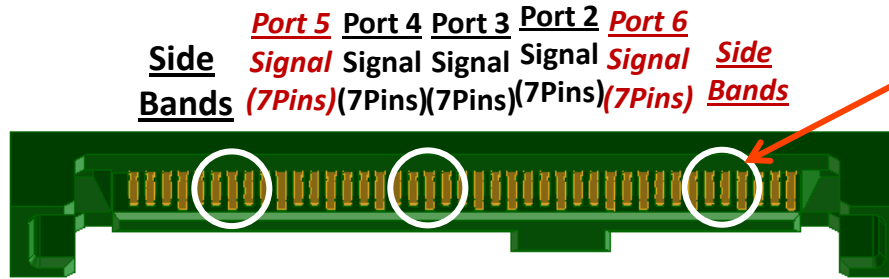


Quad Port 12Gb/s SAS (SAS-3)

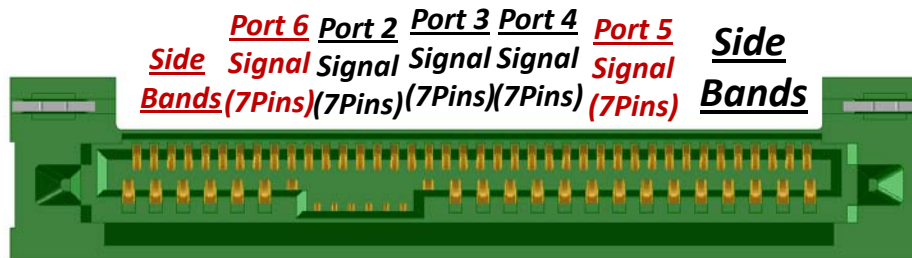
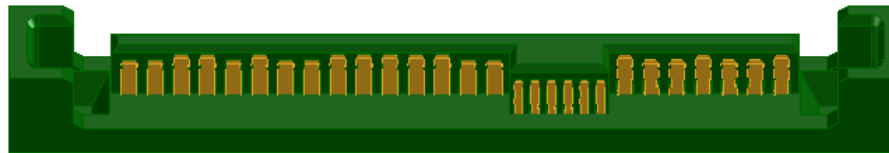
(Preliminary SFF-8630 – Partially Linked to SFF 8639 Development)



Dual/Quad-Port 12Gb/s SAS (SAS-3) plus Quad-Port 8GT/s Enterprise PCIe (Preliminary SFF-8639 – still in Development)



(3x) Recess for SAS/SATA cable plug retention no longer available – new cable retention design required. This is a work In-process.



Cabling Objectives

- ❑ **Legacy SATA cables**
 - ❑ The independent power and signal cable receptacles may mate with the new PCIe device plugs but will not be retained
- ❑ **Legacy SAS Cables**
 - ❑ Will mate with all device plugs but will not be retained when mated to PCIe device plugs
- ❑ **SAS-3 Cables**
 - ❑ Will mate with all device plugs but will not be retained when mated to PCIe device plug and shall have retention
- ❑ **Enterprise PCIe Cables**
 - ❑ Will mate with all device plugs but will not be retained when mated with legacy SAS/SATA or SAS-3 device plugs
 - ❑ This is a work in-process
- ❑ **Client PCIe Cables**
 - ❑ This is a work in-process

High Speed Signal Parameters

- ❑ Performance requirements developed by respective groups (T10 SAS, PCI-SIG)
- ❑ Connector interoperability with previous generations of SAS
- ❑ MultiLink SAS requirements (defined up to 6GHz)
 - ❑ -36dB crosstalk limit, power sum of all near-end and far-end aggressors, as defined by specification Tx/Rx signal assignment
 - ❑ -1dB connector and PCB attach insertion loss limit
 - ❑ -12dB connector and PCB attach return loss limit
- ❑ Channel application spaces, and performance objectives, drive necessary connector characteristics
 - ❑ -25dB at 6GHz end-to-end (between BGA attach on Transmit and BGA attach on Receive) channel insertion loss
 - ❑ Crosstalk limit derived from this to provide sufficient SNR

- ❑ SAS and SCSI continue to innovate and provide value in the storage ecosystem
- ❑ Activity is happening in real time
- ❑ Follow activities in T10 and SFF to make sure your designs take full advantage of these improvements