Testing for PCIe SSD Compatibility and Performance

January 20, 2014

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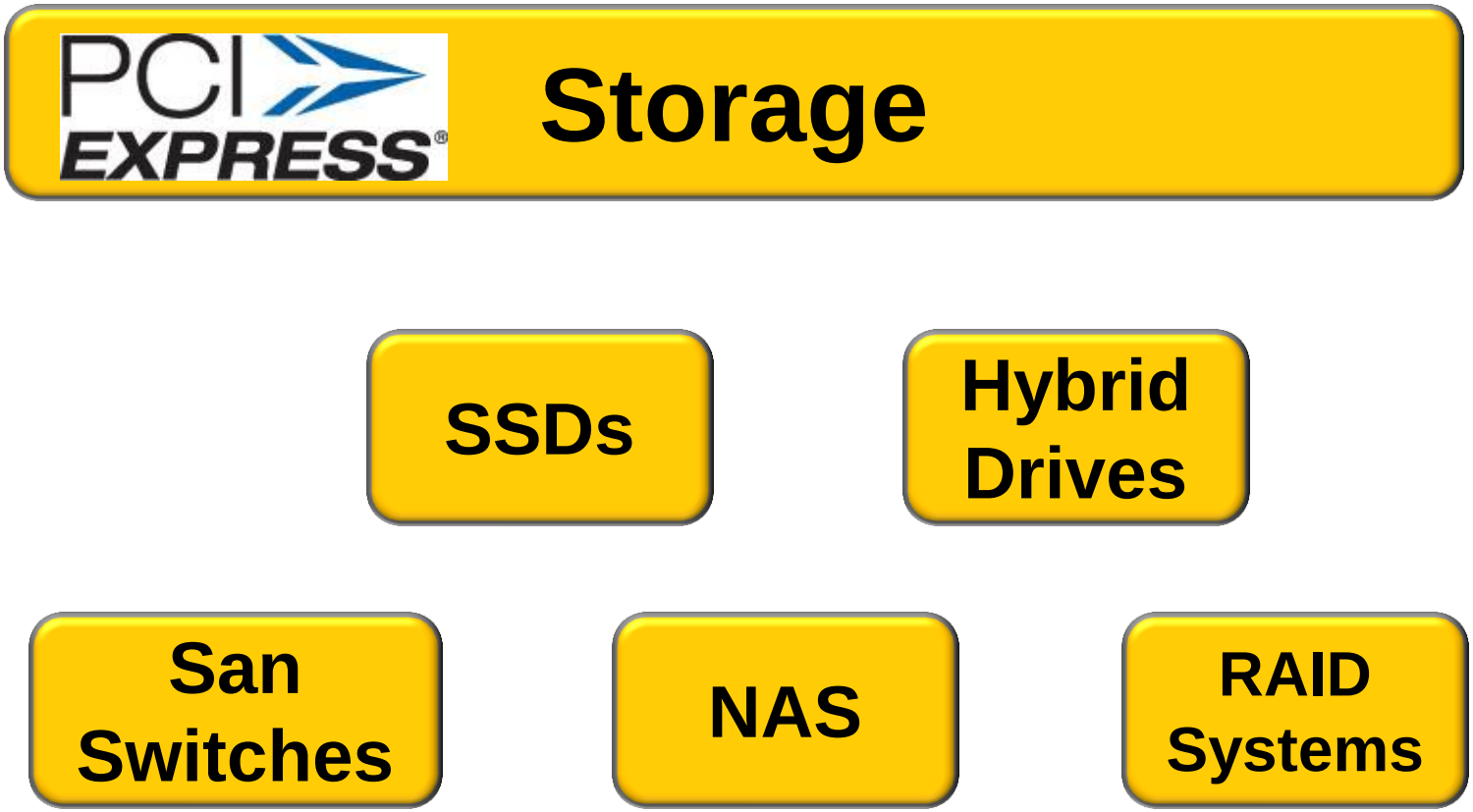
Product Marketing Manager

TELEDYNE LECROY
Everywhereyoulook™

Teledyne LeCroy

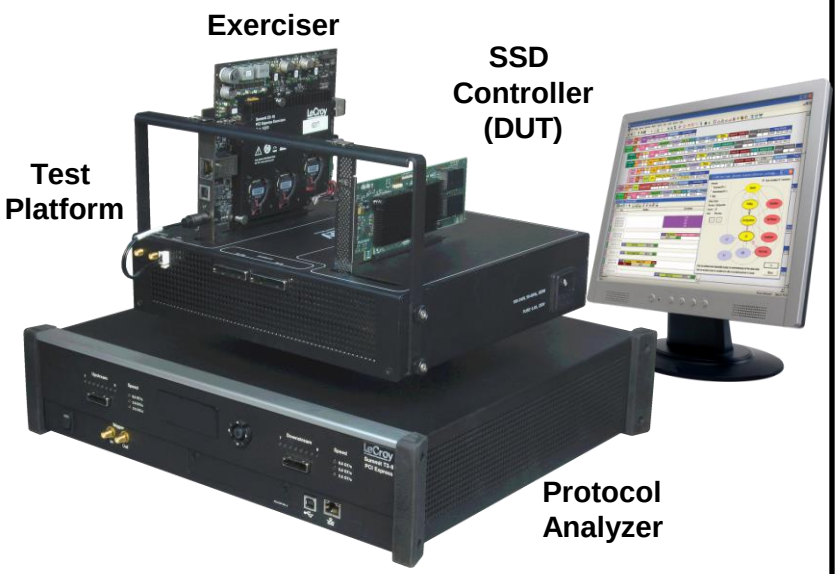
- Teledyne LeCroy Corporation is the leader in Serial Data Test solutions
  - Founded in 1964
  - Headquarters in Chestnut Ridge, NY
- Teledyne LeCroy's Protocol Solutions Group (PSG) was formed in October 2004 with the acquisition of CATC Corporation
  - PSG Headquarters in Santa Clara, CA
  - Part of the Serial Data Division of LeCroy
  - Catalyst was acquired & added to PSG in 2006
- PSG specializes in providing complete protocol solutions for a wide range of serial data standards
  - Products range from production tools to full protocol analysis systems with intuitive user interfaces and complete traffic generation

PCI Express is Moving to Storage

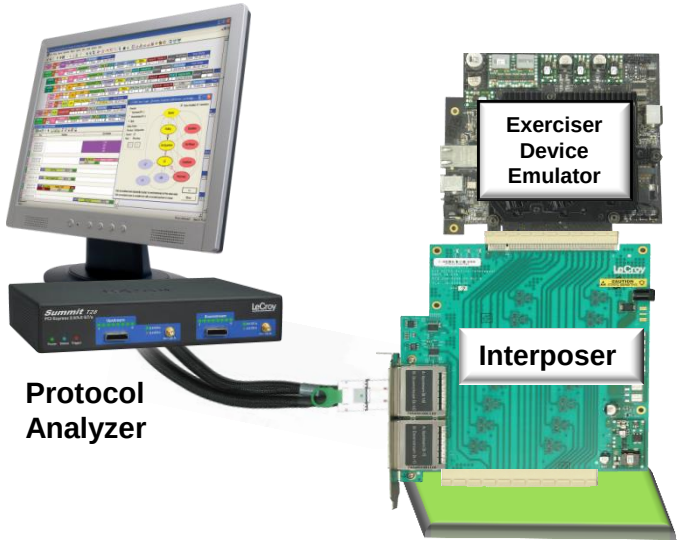


Common SSD Test Setup

SSD Device Controller Test

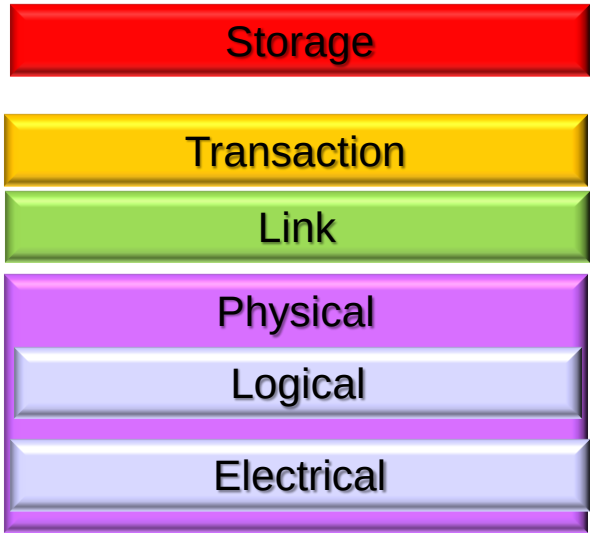


SSD Driver Host Test

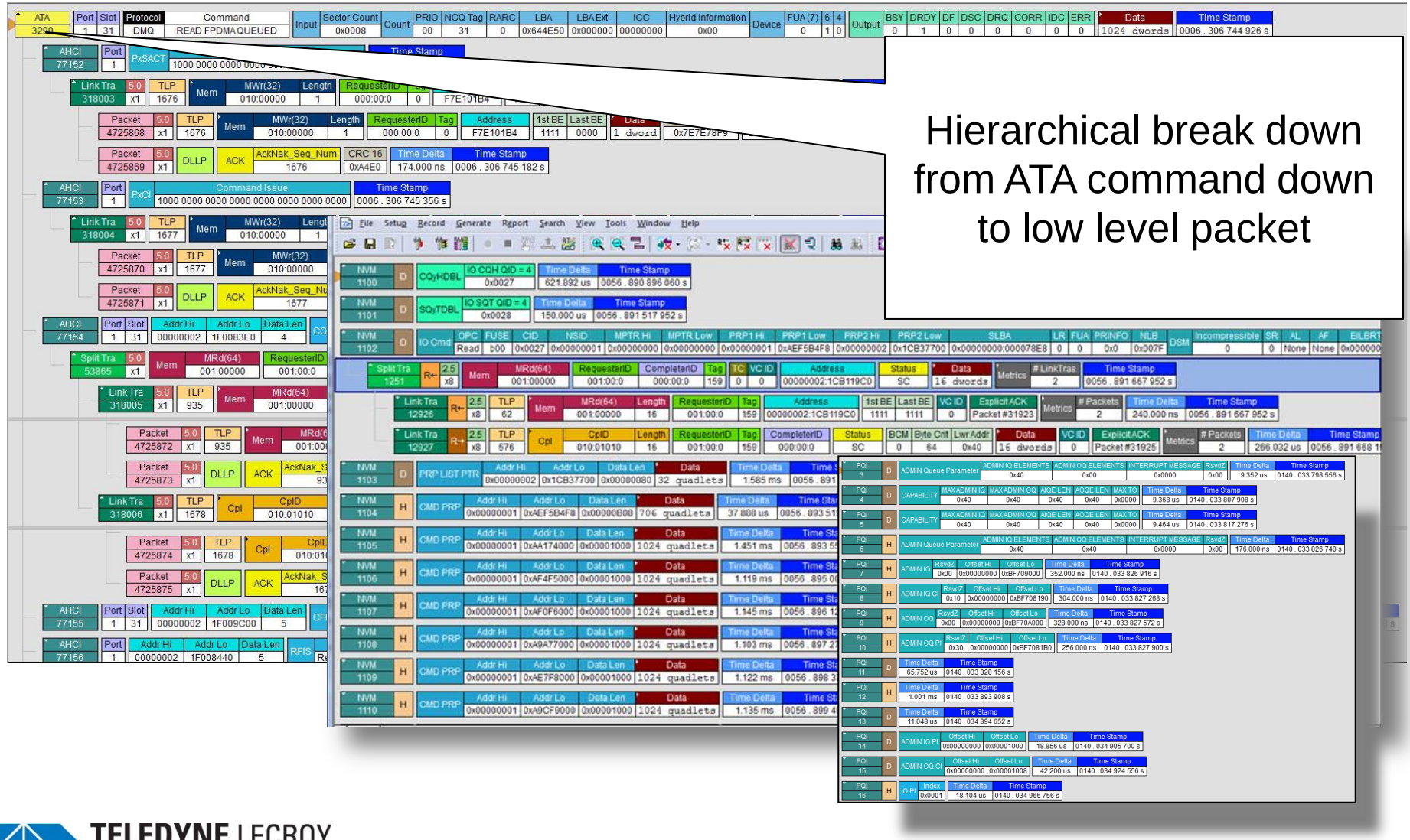


PCIe SSDs Require New Testing Methodologies

- PCIe SSDs combine various storage protocol layers on top of the PCI Express electrical, link and transaction layers.
- The PCIe protocol is very different than previous storage protocols.
- New tools and testing methodologies are required to meet the challenges of high performance SSDs.

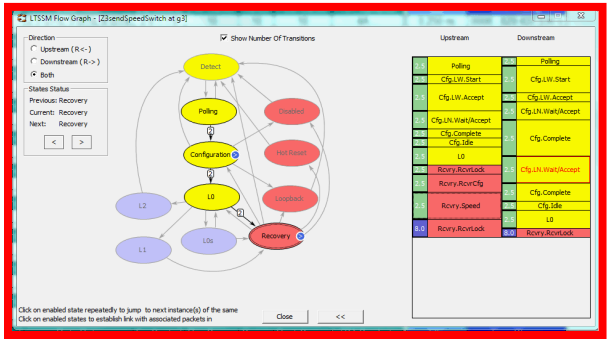


High Level Decoded Commands

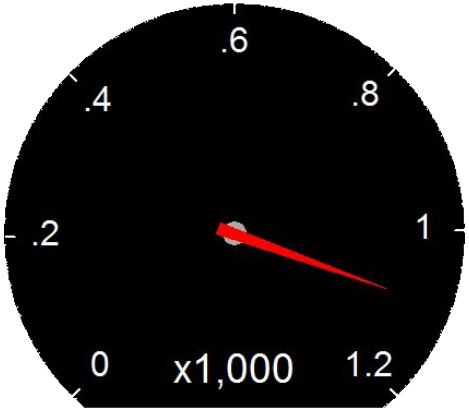


PCI Express Performance Tools

- **Measure and monitor PCIe SSD performance details**
  - PCIe Packet Metrics
  - Timing Calculator- Bandwidth, Link Utilization
  - Post Capture Bus Utilization Graph Tool
    - Latency, Throughput Views
  - Real Time Statistics Graph Tool

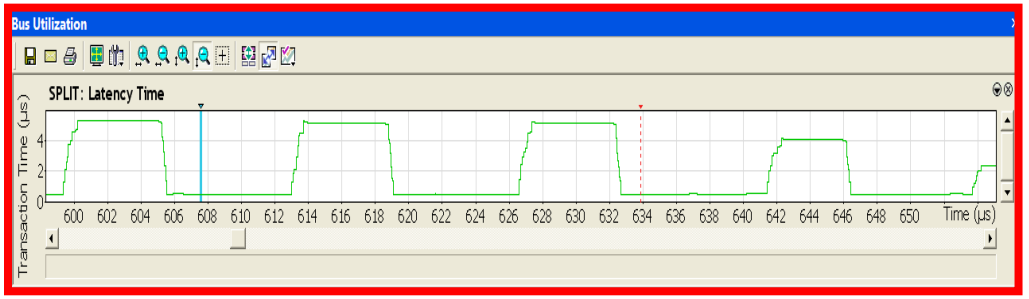


- **Understand link behaviors and improve SSD performance**
  - Flow Control View
  - Link Tracker
  - LTSSM State View



Bus Utilization

	Upstream	Downstream
Link Utilization	45.127 %	44.546 %
Time Coverage	45.072 %	44.493 %
Bandwidth	9025.43 Mb/s	8909.10 Mb/s
Data Throughput	592.29 MB/s	598.72 MB/s
Packets/second	19696168.45	24833612.81



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Most Application Targeted Adaptors/Probes in the Industry

G2 AMC Interposer

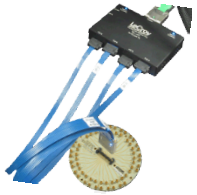
G2 External PCIe Cable Interposer

G2 Express card Interposer

G3 90 Degree Interposer

G2 XMC Interposer

G2 HP Blade Interposer

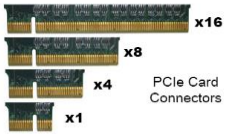


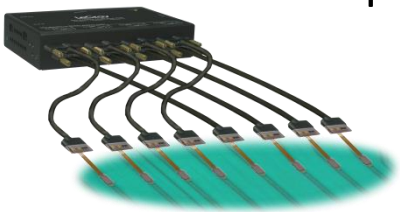
G3 MidBus Probe

G2 VPX Interposer

G3 M.2 Interposer

Reducers & Adapters





G3 Multi-lead Probe

G2 MiniCard Interposer

G2 CPCI Serial Interposer

G3 ExpressModule Interposer

G3 SFF-8639 Interposer(S/D)

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Form Factor/Connectivity and Probing

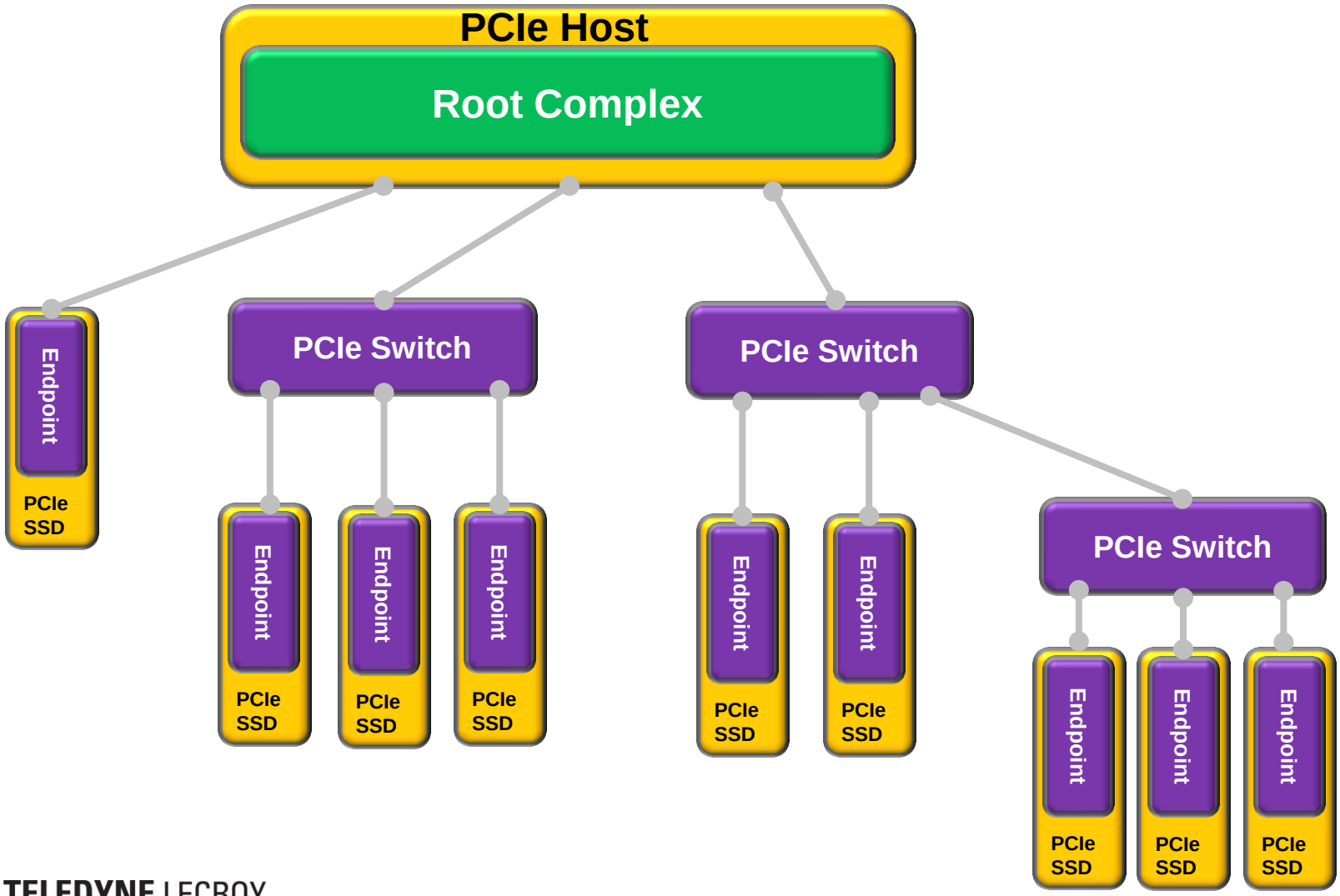
- **CEM add-in card**
  - NVMe/SATA/SCSI
  - PCIe 2.0/3.0
  - x1, x4, x8
- **M.2 storage card** (i.e., NGFF)
  - NVMe/SATA
  - PCIe 2.0/3.0
  - X2, x4
- **SFF-8639 based drive**
  - NVMe/SATA/SCSI
  - PCIe 2.0/3.0
  - x2, x4

Interposer for CEM add-in card

Interposer for M.2 storage card

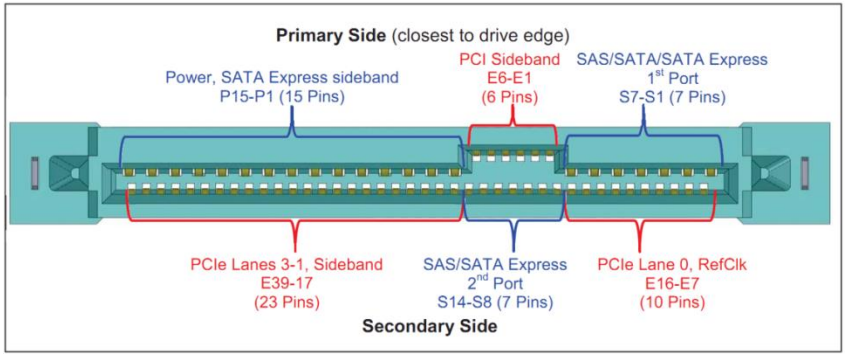
Interposer for SFF-8639 based drive

PCIe Single Port Usage Model

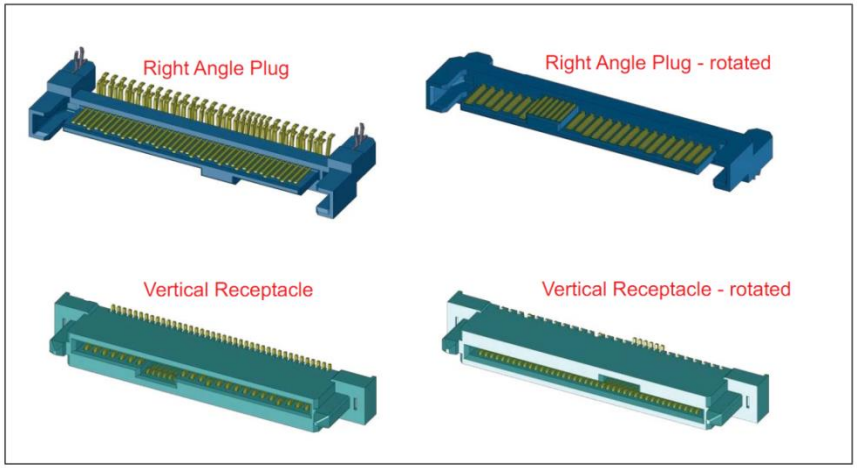


SFF 8639 Connector

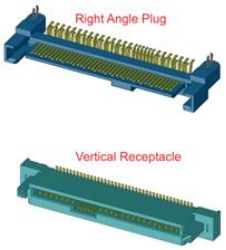
- The SFF Committee has developed the specification.
- Intended for PCIe connections to SSDs (Solid State Drives) for the enterprise market of servers and storage systems
- Supports
  - Single port SATA
  - Dual port SCSI Express
  - Dual port SAS
  - Multilane SAS(12 Gb/s, 4 lanes)
  - PCIe Gen3x4 (8 GT/s, 4 lanes)



SFF 8639 Connector



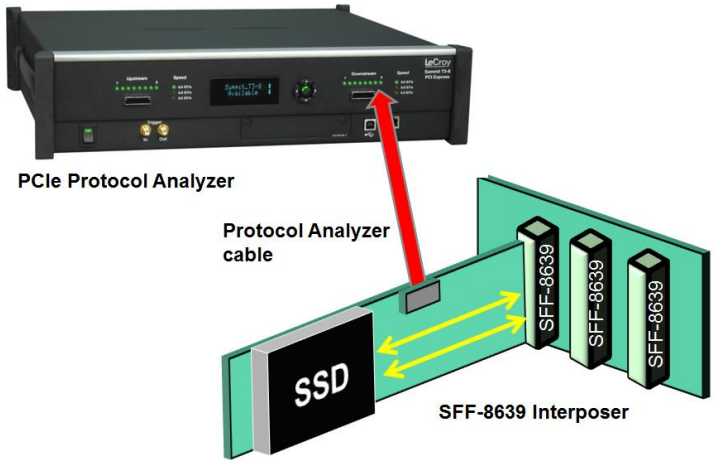
Protocol Analysis with the Single Port SFF-8639 Interposer



SFF-8639 Connector

Supports

- NVM Express G3x4
- SATA Express G3x2
- SCSI Express G3x4



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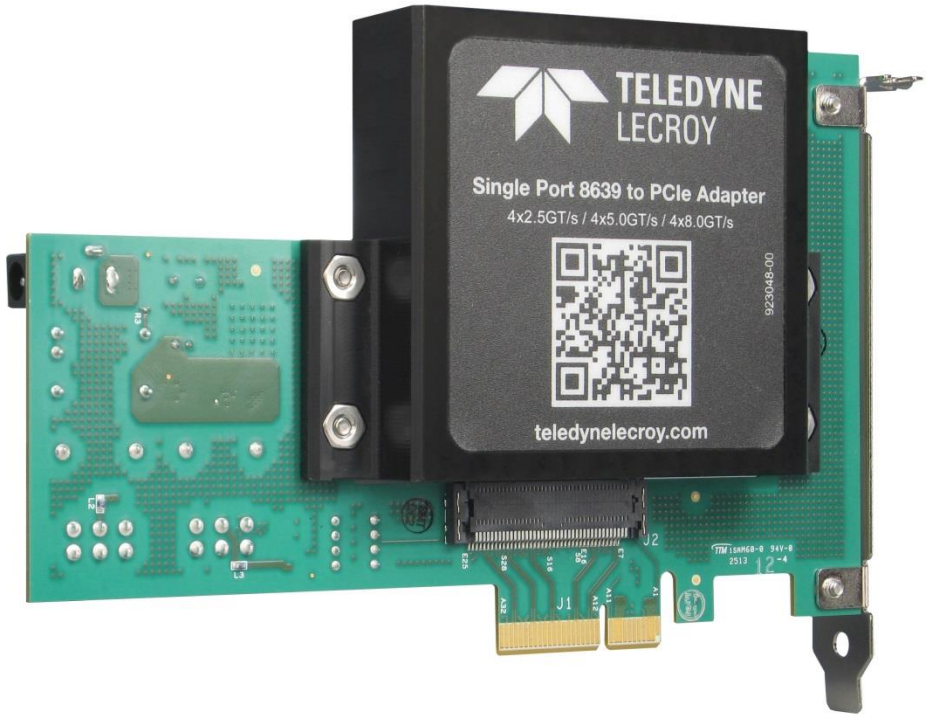
SFF-8639 to PCIe Connector Adaptor

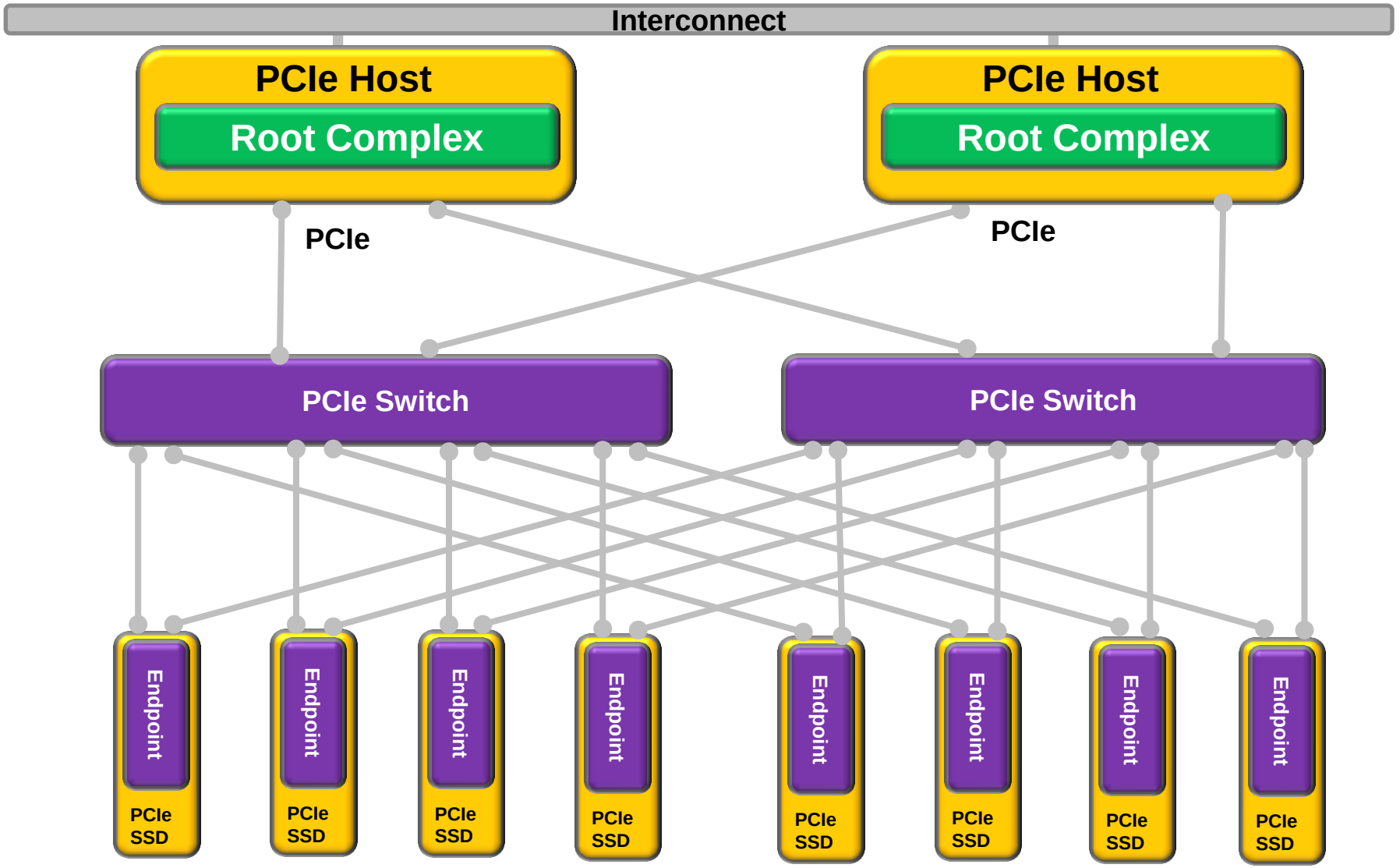
Supports Single Port Drives

- PCIe 1/2/3
- x1, x2, x4
- 2 ½ inch drives

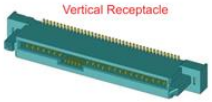


The answer to companies looking for 8639 backplanes for test

Dual Port PCIe Usage Model



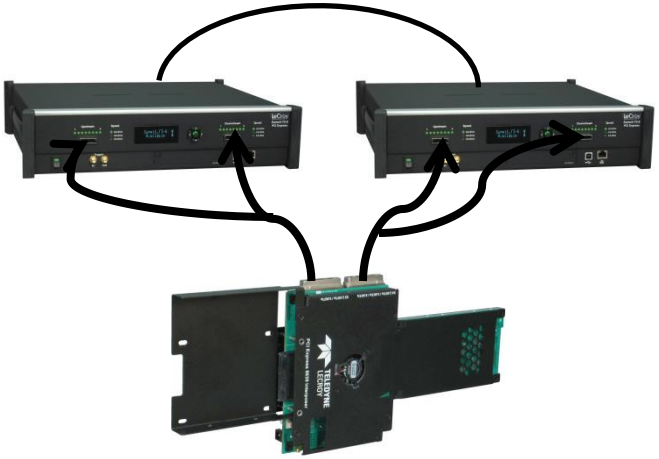
Dual Port SFF-8639 Interposer



SFF-8639 Connector

Supports

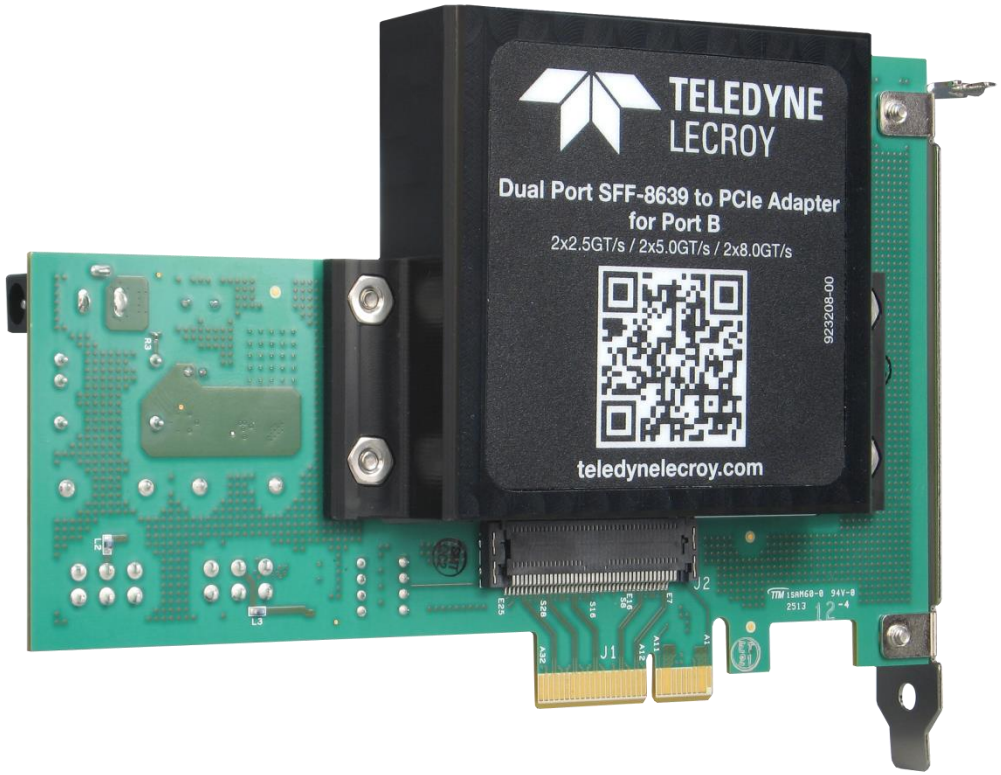
- Gen3 Supported
- Host Interface Support
  - NVM Express Dual x2
  - SCSI Express Dual x2
- 2 PCIe link A/B port support
- 2 ½ and 3 inch drive support



SFF-8639 to PCIe Connector Adaptor

Supports Port B

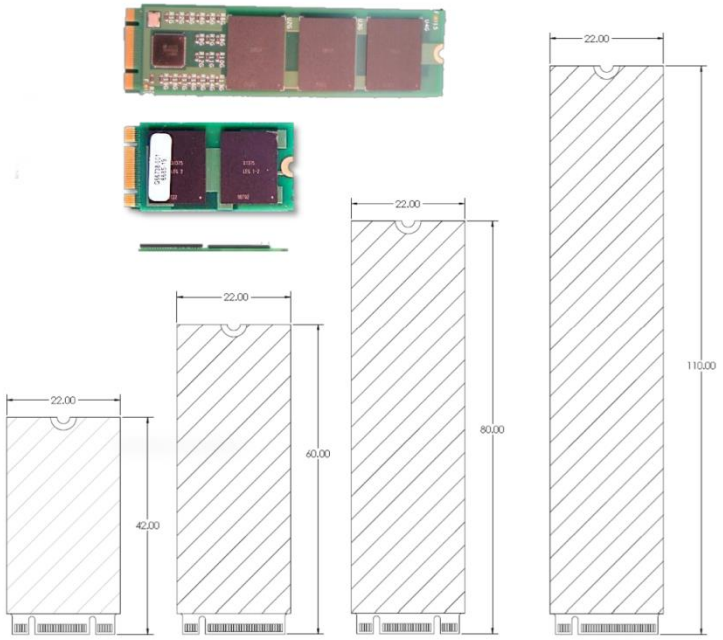
- PCIe 1/2/3
- x1, x2, x4
- 2 ½ inch drives



The answer to companies looking for 8639 backplanes for test

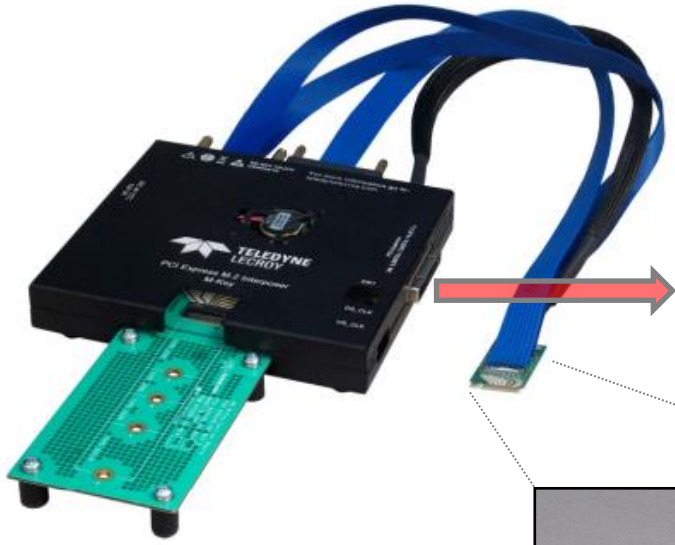
M.2 Card Format Defined

- 5 lengths from 30mm-110mm
- Single and double sided versions
- Double sided connector will accept both modules

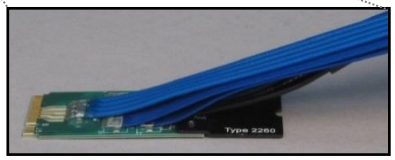


M.2 Interposer for PCIe 3.0

- Speeds: PCIe 1/2/3
- Lane width: x2/x4
- Socket types: 2/3
- M.2 module lengths: 42mm x 22mm, 60mm x 22mm, 80mm x 22mm , and 110mm x 22mm
- SRIS supported
- Dimensions
  - Connector cable 18 inches
  - Carrier Board 5.13 x 9.05 inches
  - Interposer Board .824 x 1.65 inches

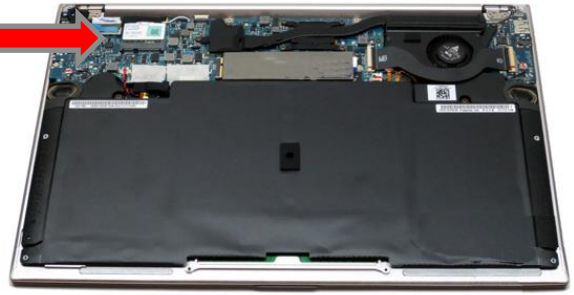


Protocol Analyzer



M.2 Interposer

M.2 SSD



Laptop

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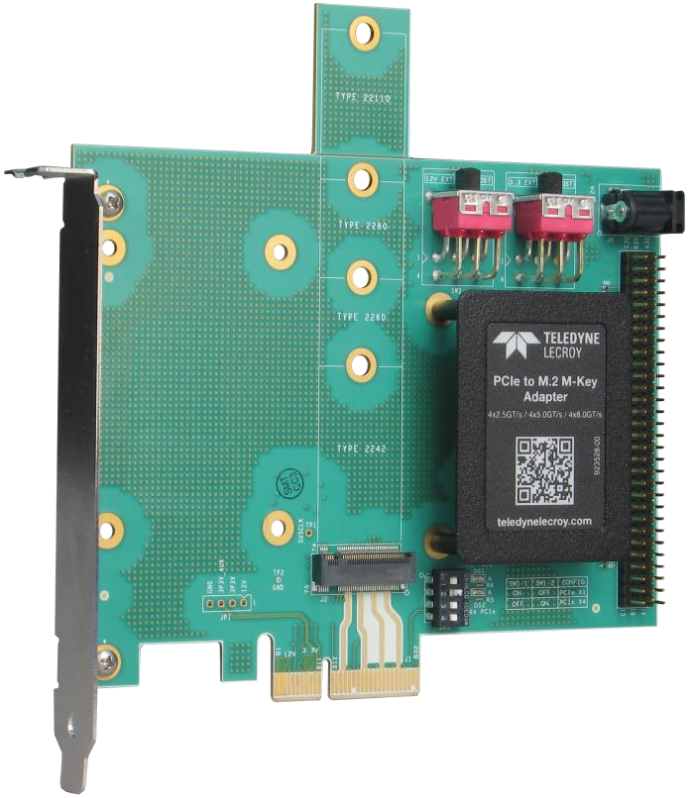
M.2 to PCIe Connector Adaptors

Two types of Interposer

- Socket 2 devices
  - B-type
  - PCIe 1/2/3
  - x1, x2
- Socket 3 devices
  - M-type
  - PCIe 1/2/3
  - X1, x2, x4



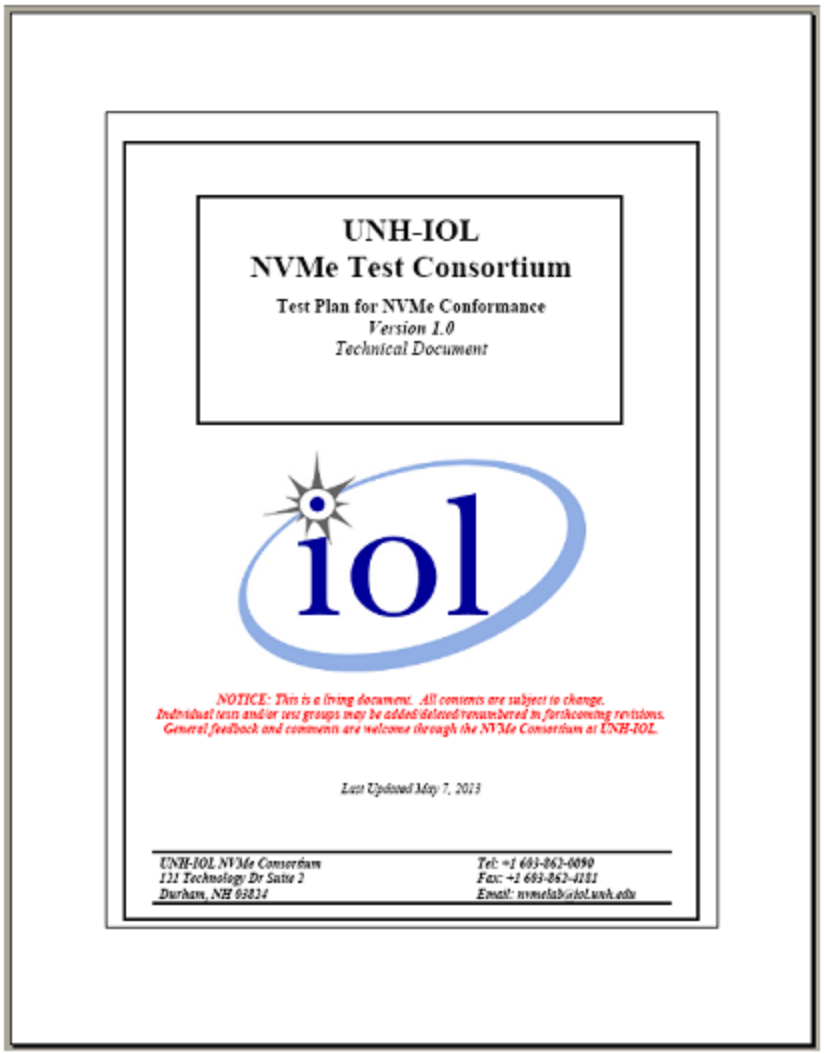
Testing PCIe SSD and Systems

- Exercisers are the best way to test error handling between systems and storage devices in PCI Express.
- Emulation Scripts are run on exercisers and create low level bus traffic that can be accurately, repeatedly, and precisely created to assess performance in real-world conditions for a drive or host. No software driver required.

Summit Z3-16 Protocol Exerciser

NVMe Conformance Testing

- Tests defined in NVMe Interop Test Suite document (publically available at www.iol.unh.edu)
- Test tools used to check proper construction and response to different NVMe Stimuli
- Admin Commands, NVM Commands, Controller Registers



UNH-IOL
NVMe Test Consortium

Test Plan for NVMe Conformance
Version 1.0
Technical Document

iol

NOTICE: This is a living document. All contents are subject to change.
Individual tests and/or test groups may be added/deleted/renumbered in forthcoming revisions.
General feedback and comments are welcome through the NVMe Consortium at UNH-IOL.

Last Updated May 7, 2013

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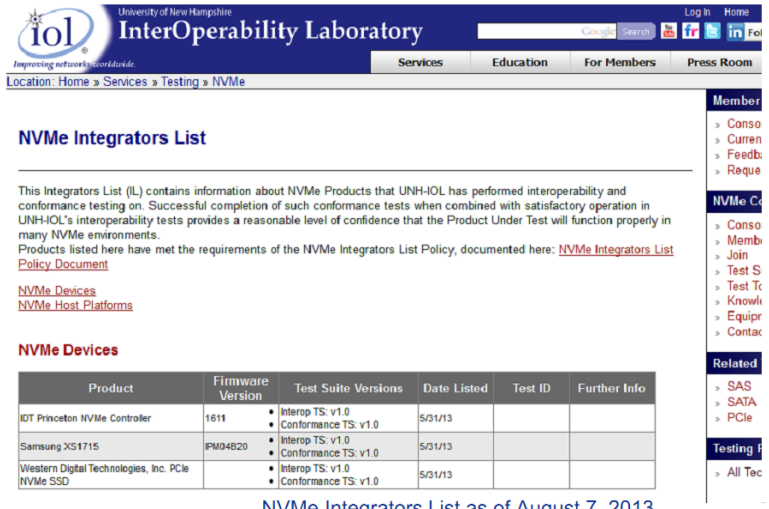
NVMe Integrators List

- Hosted by UNH-IOL at ww.iol.unh.edu
- Opt-in list of qualifying NVMe products
- No PCIe component to qualification today
- UNH-IOL does offer PCIe testing to complement NVMe testing, but it is not a component of the NVMe IL qualification
- NVMe Host Qualification
  - Perform Interop Test against 4 different SSDs
  - Pass with 3 SSDs
  - Pass = data transfers without errors
- NVMe Device Qualification
  - Perform Interop Test against 4 different hosts, pass with 3 Hosts
  - One of the hosts must be either the Windows or Linux Reference Driver
  - Pass all conformance tests



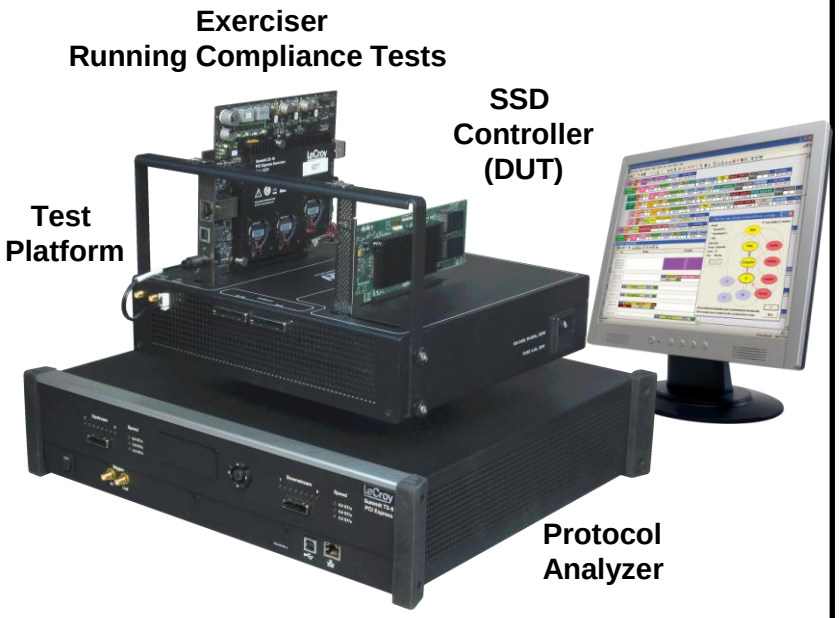
NVMe Integrators List as of August 7, 2013

NVMe Compliance and Interoperability Testing

- UNH-IOL(University Of New Hampshire IOL) and the NVM Express Promoters Group are collaborating to create an interop and conformance test program centered at UNH-IOL.
- They have created a multi-vendor test bed to help products prove interoperability, and conformance test services to prove that products follow the NVMe specification correctly.
- Feb 24, 2014.

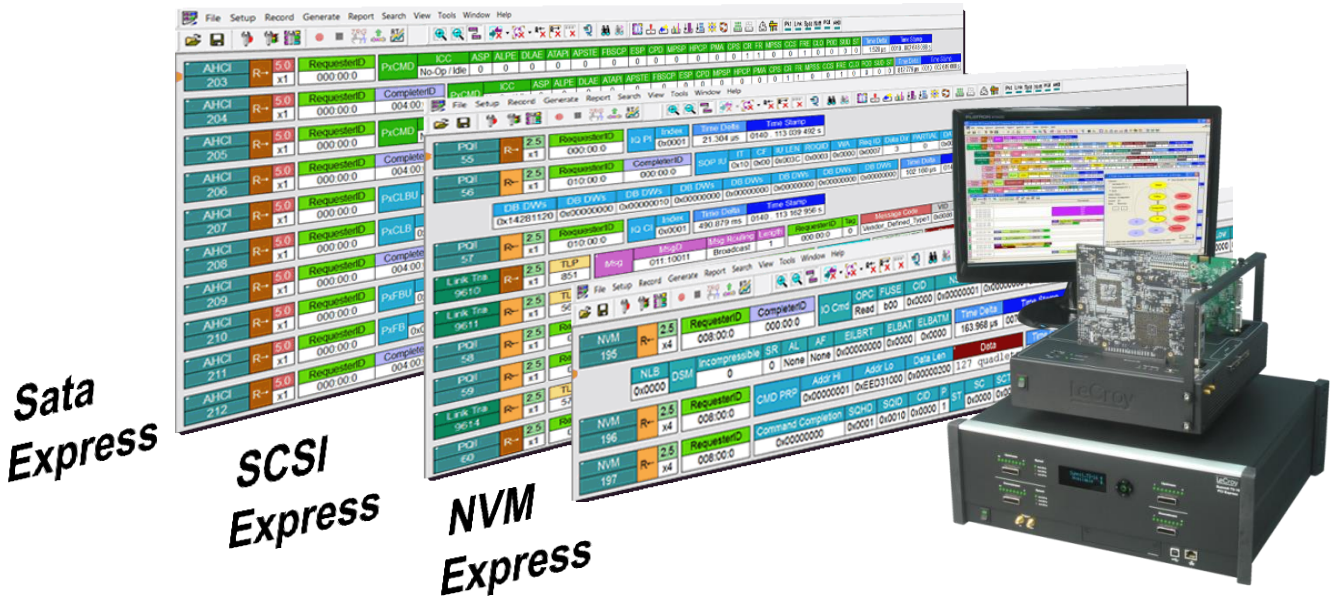
University of New Hampshire InterOperability Laboratory

NVMe SSD Compliance Tester



Conclusion

- New testing methodologies are needed for NVM Express, SCSI Express and SATA Express
- Protocol analysis and test tools can show developers useful details about PCIe SSD transactions between the storage host and controller.
- Host and device emulation can discover performance, error handling and protocol issues that affect the quality of products.



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