



# NVMe™ ‘Interoperability’ – Conformance, Interoperability, Stress/RAS testing, and Support

Conformance, Interoperability, Test Plans, and Plugfest updates



# Abstract and Agenda

- Abstract:
  - Testing and Interoperability: This session will cover testing for Conformance, Interoperability, Resilience/error injection testing, and support infrastructures to ensure interoperable supported solutions base on NVM Express® solutions.
- Panel
  - NVMe™ Interoperability Panel Introduction – Brandon Hoff, Broadcom
  - Conformance and Interoperability Testing at the UNH-IOL – Tim Sheehan
  - FC-NVMe Testing and Interoperability – Mark Jones, FCIA
  - Testing and Validation - Nick Kriczky, Teledyne LeCroy – Austin Labs
  - Support for NVMe over Fabrics in production environments – Brandon Hoff, Broadcom

# Definitions

- Conformance: This refers to a product being tested for conformance in reference to a standard. For NVM Express®, this refers to NVMe™, NVMe-oF™, and NVMe-MI™.
  - Example: <https://www.iol.unh.edu/testing/storage/nvme/test-plans>
- Interoperability: While two devices may conform to a standard, they may not be interoperable. Interoperability testing proves that multiple devices can be connected and work together, as expected.
  - Ex. IoL and FCIA Interoperability Testing
- RAS testing via Error Injection: RAS (Reliability, Availability, and Scalability) are required by Enterprise customers.
  - Testing covers error injection, large fabrics, etc. Example is the FCIA plugfest
  - IoL?
- Vendor Supported: Server Vendors, OS Vendors, storage vendors, and HBA/NIC vendors take support calls



# NVMe<sup>™</sup> Conformance and Interoperability Testing at the UNH-IOL

Conformance, Interoperability, Test Plans and Plugfest updates

Tim Sheehan - UNH-IOL



# Today's NVMe™ 9.0 Integrators List News

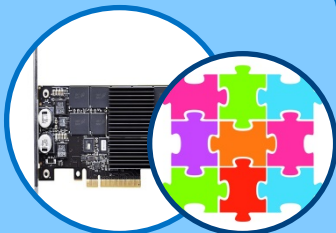
- UNH-IOL offering **NVMe PCIe** Testing Services and Integrator's List in 2012 (150+ Products listed)
- UNH-IOL offering **NVMe-MI™** Testing Service and Integrators List in June 2017 (7 Products listed)
- UNH-IOL launched **NVMe-oF™** Testing Services and Integrators List in December 2017 (22 Products listed)

# NVMe™ Integrator's List Conformance Testing



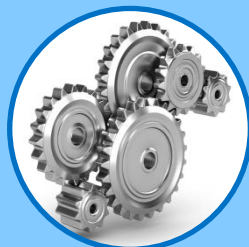
NVMe  
Conformance  
Test Cases

220



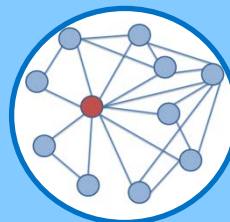
NVMe Interop  
Test Cases

9



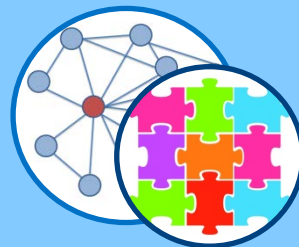
NVMe-MI™  
Conformance  
Test Cases

53



NVMe-oF™  
Conformance  
Test Cases

132



NVMe-oF  
Interop  
Test Cases

4

# NVMe™ Integrator's List Interoperability Testing

- NVMe™ over PCIe® Interoperability requires running against 5 unique configurations
- NVMe-MI™ Interoperability is something that requires additional attention, no test plan today
- The NVMe-oF™ Interoperability testing requires the following:
  - Target – run against two unique Initiator products
  - Switch – run against two unique Target products
  - Initiator – run against two unique Target products



# NVMe™ Next

## Continual evolution of the NVMe Integrator's List program in 2H18

- NVMe Plugfest #10 covering PCIe SSDs and NVMe-oF™, November 12, 2018 in Durham NH. NVMe PCIe, NVMe-MI, NVMe/FC, & NVMe/RoCE
- NVMe/TCP Conformance test offering as Proof of Concept

### NVMe™ Integrator's List

The NVMe Integrator's List (IL) contains useful information about NVMe Products that UNH-IOL has performed interoperability and conformance testing during an NVMe plugfest or through test reservations at our lab. Successful completion of such conformance tests when combined with satisfactory operation in UNH-IOL's interoperability tests provides a reasonable level of confidence that the Product Under Test will function properly in many NVMe environments.

UNH-IOL is happy to be collaborating with the NVMe Organization on the creation and maintenance of the NVMe Integrators List. More information on NVMe Products can be found at [nvmexpress.org/products](http://nvmexpress.org/products).



#### NVMe™ Integrator's List v8.0

- [NVMe Integrator's List Policy v8.0a](#)
- [NVMe Integrator's List Policy v8.0a Redline](#)

#### NVMe Devices

Product	Product Type	Firmware Version	Interop Program Revision	Date Listed	Further Info
LiteOn EPX series (E)	NVMe SSD	NA	v8.0	11/29/2017	<a href="http://www.liteon.com/">http://www.liteon.com/</a>
SK Hynix PE4011	NVMe SSD	80030E00	v8.0	11/27/2017	<a href="http://ssd.skhynix.com">http://ssd.skhynix.com</a>
Starblaze Star1000	NVMe SSD	1.0.1.2	v8.0	11/27/2017	<a href="mailto:yongqiang.wang@starblaze-tech.com">yongqiang.wang@starblaze-tech.com</a>





# FC-NVMe<sup>™</sup> Conformance, Interoperability, and Error Injection

Mark Jones - FCIA



# Fibre Channel Industry Association (FCIA) Plugfest Legacy

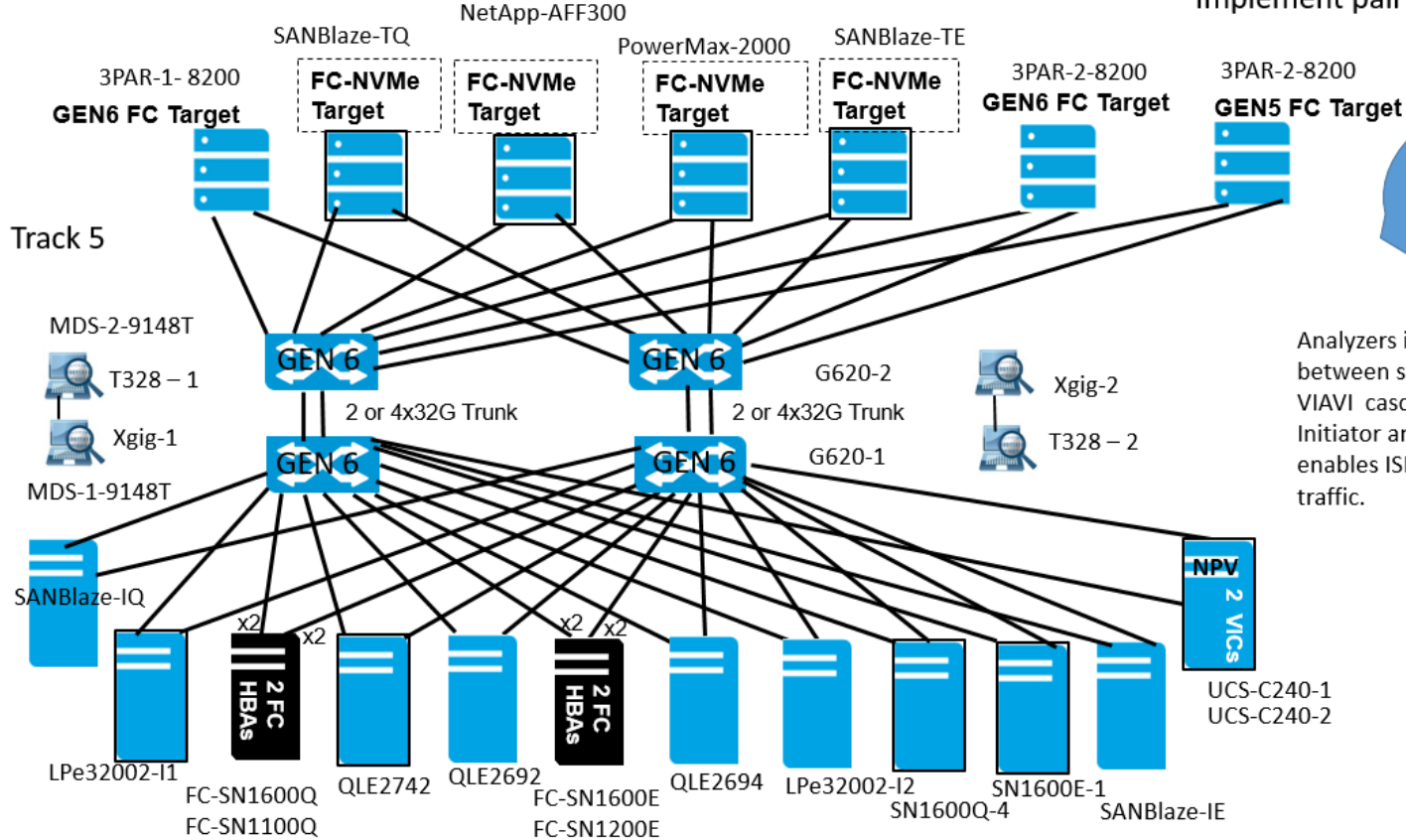
- Fibre Channel – Legacy of Interoperability, reliability and robustness
  - Products have been shipping in volume for more than 20 years – 120M ports shipped, 43M in current use.
- Key Factors to Fibre Channel's success
  - Industry-wide participation in FC standards – INCITS T11
  - ~Avg of Two Plugfests per year that ensure vendors conform to industry standards

# FCIA FC-NVMe™ Plugfest Events

- July 23, 2018 - 4<sup>th</sup> FC-NVMe plugfest
  - 13 Companies/products tested
    - HBAs, Switches, Storage Arrays, Analyzers/Jammers
  - Key Accomplishments
    - Testing of End-end commercial available products
    - Multi vendor interoperability, standards conformance
    - Data Integrity validation over switch multi-hop fabrics
    - Error injection to validate correct FC-NVMe and FC recovery
    - Concurrent FC-NVMe + FC over same Initiator, fabric, target ports
    - “Big Build” overnight stress testing of all of the above.

# Test Track 5 GEN6, GEN5 FC and FC-NVMe Dual Fabric HA Large Fabric Build

Implement pair wise zone for each I-T



Concurrent FC and FC-NVMe outlined in black

Analyzers inserted inline between switches and T328 and VIAMI cascaded; Initiator and Target separation enables ISL visibility to all I-T traffic.

Native FC

# How to Participate in FCIA Plugfests

- <https://fibrechannel.org/plugfest-general-info/>
  - FCIA member and non-members welcome
  - Plugfest fees apply to cover event costs
  - Call for Interest Meetings – Logistics agreement
  - NDA restricted planning meetings
  - Results of testing are confidential
  - Post event PR opportunities
- Everyone always learns something!



# Testing and Validation

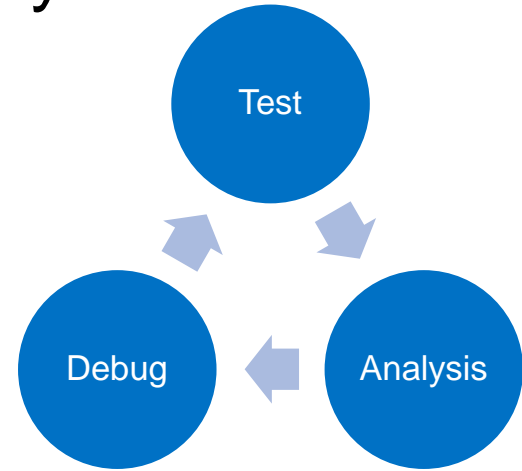
Third-party validation and pre-compliance testing

Nick Kriczky - Teledyne LeCroy, Austin Labs



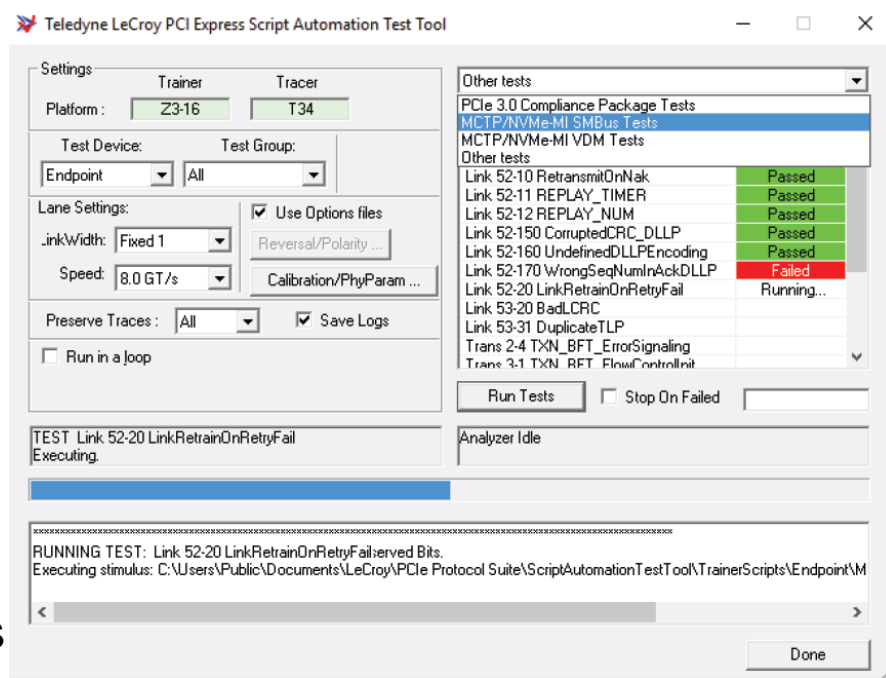
# Third-Party Testing – What and Why?

- Customized testing solutions
  - Built to fit your needs
- Labs that specialize in testing as a service
- Provides additional resources for validation
  - Hardware
  - Headcount
- Interoperability
- Customer environment
- Extra set of Eyes
- Improved time to market



# What Type of Testing is Available?

- Data Integrity
- Performance Analysis
- Interoperability
- Compliance and Pre-certification
  - PCI-SIG® PCI Express®
  - NVMe™ Conformance Test
  - NVMe-MI™ Conformance Tests
  - NVMe-oF™ validation







# Where Can I Find Help?

Plugfest – Industry standard organizations host Plugfests throughout the year for NVMe™ and NVMe-oF™.

Compliance workshops – Industry standard events for compliance and certifications.

Teledyne LeCroy's Austin Labs – Provides testing and training for protocols supporting NVMe, PCIe®, and NVMe-oF™. Complete testing partner for customized testing requirements and pre-compliance. Austin Labs is also the host for industry Plugfests.





# FC-NVMe<sup>™</sup> Supported Solutions

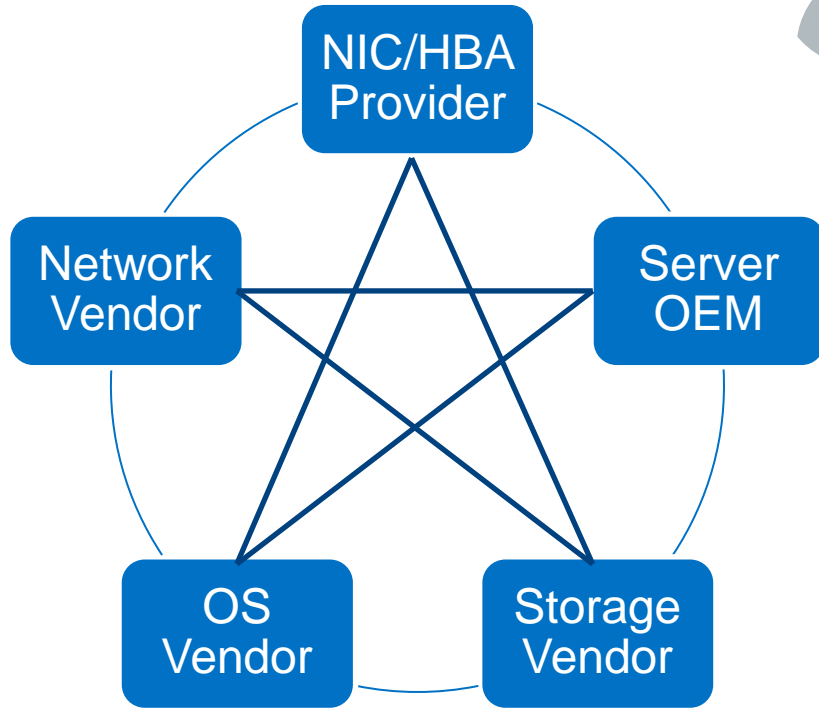
Brandon Hoff - Broadcom



# Support Types

- Roll your own
  - E.g. upstream Linux and taking off-the-shelf parts and assembling
  - Customer troubleshoots and fixes solutions on their own
  - Vendors provide basic hardware repair/replacement
- Supported Solutions
  - SUSE + Lenovo + Broadcom + NetApp
  - Vendors take first call for support and work with each other to close support issues for software and hardware
- Support Contracts – Vendor Specific

# Support Ecosystem



- Customers will want to get support from their vendors
  - Servers, storage, NIC/HBA, Network, and OSVs
- Launch of a new technology is requires each to qualify the solution
- Supported products are listed on a list of supported hardware or software



# Contact Information

For more information please contact the following:

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