NVMe Plugfest #5 Webinar

An Interop Event for NVMe SSDs
Wednesday January 27, 2016 2PM Eastern

Presented by:
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david@iol.unh.edu

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UNH-IOL

- Industry leading 3rd-party test facility for data, telecom and storage networking technology & consumer electronics
- 100% funded by commercial industry
  - 150+ companies
- 28,000 sq. ft lab facility – Boston, USA Metro Area
- 4,000 sq. ft pre-wired space dedicated to Plugfests
Member Involvement
(150+ Companies)
UNH-IOL NVMe Consortium

- Access to UNH-IOL NVMe test services.
- Attendance at NVMe Plugfest
- Ability to list qualifying products on the NVMe Integrators List:
- Place products in the UNH-IOL NVMe Interop test bed for continuous interop testing.
- Support for UNH-IOL Administration of open source tNVMe tool
- PCIe Electrical testing available through UNH-IOL PCIe Consortium
NVMe Plugfest #5
February 29 – March 3, 2016
UNH-IOL
21 Madbury Rd Suite 100
Durham, NH 03824 USA
Agenda

• NVMe Integrators List
• Plugfest Components
  • Interop Tests
  • Conformance Tests
  • Supplementary Tests
• Plugfest Logistics
  • Registration
  • Reporting
• Listing Products
• Testing After the Plugfest
Agenda

- **NVMe Integrators List**
  - Plugfest Components
    - Interop Tests
    - Conformance Tests
    - Supplementary Tests
  - Plugfest Logistics
    - Registration
    - Reporting
  - Listing Products
  - Testing After the Plugfest
There is a strong need to demonstrate the interoperability of NVMe products. The NVMe Plugfest at UNH-IOL and NVMe Integrators List are key components in accomplishing this.
NVMe Integrators List

- Since 2012 NVMe Promoters Group collaborating with UNH-IOL to manage the Integrators List based Test Program for NVMe.
NVMe Integrators List

As of January 12, 2016:
• 42 products listed from 20+ companies

https://www.iol.unh.edu/registry/nvme
Agenda

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NVMe Plugfest Components

- NVMe Plugfest #5 February 29-March 3, 2016 will test according to version 1.2.1 of the NVMe Test Program.
  - Check IL policies here: https://www.iol.unh.edu/registry/nvme
  - After the Plugfest, UNH-IOL members can request 1.2.1 Integrators List testing throughout the year.
Test Plans

2 Test plans will be executed at the plugfest.

1. UNH-IOL NVMe Interoperability Test Suite Document v1.2.1
2. UNH-IOL NVMe Conformance Test Suite Document v1.2.1
SFF-8639 / M.2 Adapters

- UNH-IOL will have U.2/SFF-8639 to CEM adapters on hand.
- If you have a **non CEM** form factor, please bring it, and also please bring at least 2 of your own adapters. This will facilitate interop testing.
- Adapters available from serialcables.com and teledynelecroy.com
Please bring 2 samples!

- Conformance tests will only require 1 sample.
- Interop tests require that 2 samples be used simultaneously.
- Please bring at least 2 samples of your product, this will facilitate interop testing.
Common Test Terms

Mandatory

• DUT must pass test in order to qualify for IL.

Optional

• If DUT supports an optional NVMe feature, it must pass test in order to qualify for IL. If option is not supported, the test is not performed and does not affect IL qualification.

FYI

• Test does not affect IL qualification, but may be mandatory in the future. Experimental.
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Interop Test Plan

- 1.1 Install SSD, identify drive in OS
- 1.2 Format drive,
- 1.3 Write/Read/Compare
- 1.4 Multiple Devices on Bus
- 1.5 Boot from NVMe device
- 1.6 Hotplug test (U.2 SFF-8639 only)
- 1.7 Dual Port Device (FYI)

  - Will run all SSD and Host combinations possible at the event.
  - Only required to test on primary port
  - Multi-port devices will have secondary ports tested as FYI tests
  - Test Plan Publically available at:
    https://www.iol.unh.edu/testing/storage/nvme/test-suites
# Interop Systems

<table>
<thead>
<tr>
<th>Platform</th>
<th>OS</th>
<th>Intended Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerEdge R720</td>
<td>Windows Server 2012 R1 or R2</td>
<td>Hotplug also Write/Read/Verify</td>
</tr>
<tr>
<td>ASUS X79 Deluxe LGA 2011</td>
<td>TBD – Likely Use Linux with Kernel 4.0</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>ASUS X79 Deluxe LGA 2011</td>
<td>TBD – Likely Windows</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>SUPERMICRO MBD-X10SAT-O ATX Server Motherboard</td>
<td>RHEL 6.5</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>SUPRMMICRO MBD-X10SAT-O ATX Server Motherboard</td>
<td>Ubuntu 14.04 / Windows 8.1 (Microsoft Driver) / FreeBSD</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>Cisco UCSC C240</td>
<td>RHEL 6.5</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>Dell PowerEdge R720</td>
<td>UEFI / Windows 8.1</td>
<td>Boot also Write/Read/Verify/</td>
</tr>
<tr>
<td>ASRock Z97</td>
<td>Windows 8.1</td>
<td>Write/Read/Verify</td>
</tr>
<tr>
<td>Dell PowerEdge R730XD</td>
<td>TBD</td>
<td>Write/Read/Verify</td>
</tr>
</tbody>
</table>
Interop Test Tools – VDBENCH 5.04.03

- Command Line utility for generating IO Workloads to disk.
- Java program works on Windows, Solaris, Linux stations.
- Available at oracle.com
- Download vdbench Parameter File for NVMe Interop Tests created by UNH-IOL.
  - [https://www.iol.unh.edu/sites/default/files/testsuites/nvme/unh_interop_1_2_linux.txt](https://www.iol.unh.edu/sites/default/files/testsuites/nvme/unh_interop_1_2_linux.txt)
  - [https://www.iol.unh.edu/sites/default/files/testsuites/nvme/unh_interop_1_2_windows.txt](https://www.iol.unh.edu/sites/default/files/testsuites/nvme/unh_interop_1_2_windows.txt)
Interop Test Tools – Quarch Torridon

- Automate capability to break link
- Used for creating consistency in Hot plug tests
- Further info at quarch.com
Interop Test Tools – Quarch Torridon

- Breaking/connecting links at different times mimics the effects of varying insertion times.
- Hot plug tests performed 10x at 4 different speeds:
  - 10 (fast insertion)
  - 25 (nominal insertion)
  - 100 (slow insertion)
  - 500 (very slow insertion)
What Interop Tests are Required for Plugfest #5?

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Mandatory</th>
<th>Optional/FYI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1.1 – Storage Device Identified</td>
<td><img src="image" alt="Green Circle" /> Pass with 5/6 Hosts/Devices</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.2 – Format Storage Device</td>
<td><img src="image" alt="Green Circle" /> Pass with 5/6 Hosts/Devices</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.3 – Write Read Compare</td>
<td><img src="image" alt="Green Circle" /> Pass with 5/6 Hosts/Devices</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.4 – Multiple Devices on Bus</td>
<td><img src="image" alt="Green Circle" /> Pass with 5/6 Hosts/Devices</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.5 – Boot from NVMe Device</td>
<td><img src="image" alt="Green Circle" /> Pass with 2 Hosts/Devices</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.6 – Hotplug NVMe Device</td>
<td><img src="image" alt="Green Circle" /> Pass with 1 Host (SFF-8639/U.2 Only)</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
<tr>
<td>Test 1.7 – Dual Port Device</td>
<td><img src="image" alt="Green Circle" /> Pass with 1 Host (SFF-8639/U.2 Only)</td>
<td><img src="image" alt="Yellow Circle" /> Experimental / FYI run on all ports if multi-port device</td>
</tr>
</tbody>
</table>

Experimental / FYI: This test is experimental or for your information (FYI) and is not mandatory.

Pass with: Indicates the minimum number of hosts/devices required for the test to pass.
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  - Supplementary Tests
- Plugfest Logistics
  - Registration
  - Reporting
- Listing Products
- Testing After the Plugfest
Conformance Test Plan

- Use Host Emulator to exercise and stimulate SSD.
- Focus on completion of Admin Commands, NVM Commands, Controller Registers

Publically available at:
https://www.iol.unh.edu/testing/storage/nvme/test-suites
Passing Requirements Overview

Conformance Tests

• DUT must pass all mandatory conformance tests supported by test tools
• If optional feature is supported, DUT must also pass optional tests supported by test tools
Passing Requirements Overview

Example

• Write Zeroes is *optional* to support
  • DUT indicates support in ONCS field
• If DUT sets ONCS Bit 3 to 0, the Write Zeroes test is not applicable
• If DUT sets ONCS Bit to 1, the DUT must pass the Write Zeroes test.
Passing Requirements Overview

Q: Is there a *required* NVMe revision to support (1.0, 1.1, 1.b, 1.2)?

A: No, DUT can indicate support for any NVMe revision
New FYI Tests: Group 9

New Namespace Management Tests
All Group 9 tests are FYI
Test 9.1: Namespace Management

Identify Command

Procedure:

• Send Identify Command to receive Namespace List

• Get the Namespace Data Structure for each Namespace in the received Namespace List
Test 9.2: Namespace Management

Procedure:
• Create and delete specified Namespaces
Test 9.3: Namespace Attachment

Procedure:

• Issue Namespace Attachment request for unattached and already attached namespaces.

• Issue Namespace Detach for attached and not attached namespaces.
Conformance Test Tools

- IOL INTERACT PC EDITION v1.2.2
- IOL INTERACT TELEDYNE-LECROY EDITION v1.2.3
IOL INTERACT PC EDITION v1.2.2.

- Linux based NVMe Conformance Test Station uses:
  - tNVMe v.3.0 available from github (UNH-IOL admin)
- IOL INTERACT 1.2.2 (available from UNH-IOL) RELEASED Jan 8, 2016
- Recommend Ubuntu 14.04
- Executes most required conformance tests defined in UNH-IOL NVMe Conformance Test Suite Document
- Obtained through UNH-IOL membership
- Contact: kerry.munson@iol.unh.edu
released Jan 25, 2016

- Requires Teledyne-LeCroy Summit Z3 Exerciser and Analyzer, Windows PC, PETracer Build 7.35.

- Executes required conformance tests defined in UNH-IOL NVMe Conformance Test Suite Document

- For final IL Qualification UNH-IOL will examine bus traces from IOL INTERACT TELEDYNE-LECROY EDITION

- Contact: kerry.munson@iol.unh.edu
Why 2 Conformance Tools?

• Community needs a tool with a relatively low cost barrier, to be able to determine conformance. The PC Edition meets that need.
• Community also needs a tool with deep debug and analysis capability. Teledyne-LeCroy edition meets that need.
• Tradeoff: Cost vs. Debug Capability + Trace Analysis
## Test Support

<table>
<thead>
<tr>
<th>Test Group</th>
<th>IOL INTERACT PC Edition v1.2.2</th>
<th>IOL INTERACT Teledyne-LeCroy Edition v1.2.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: Admin Command Set</td>
<td>All tests supported</td>
<td>All tests supported</td>
</tr>
<tr>
<td>Group 2: NVM Command Set</td>
<td>All tests supported</td>
<td>All tests supported</td>
</tr>
<tr>
<td>Group 3: NVM Features</td>
<td>Tests 3.2 not implemented.</td>
<td>All Tests Supported</td>
</tr>
<tr>
<td>Group 4: Controller Registers</td>
<td>All Tests Supported</td>
<td>All Tests Supported</td>
</tr>
<tr>
<td>Group 5: System Memory Structure</td>
<td>All Tests Supported</td>
<td>All Tests Supported</td>
</tr>
<tr>
<td>Group 6: Controller Architecture</td>
<td>Tests 6.1 and 6.2 not implemented.</td>
<td>Test 6.1 not implemented.</td>
</tr>
<tr>
<td>Group 7: Reservations</td>
<td>Not Implemented</td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Group 8:</td>
<td>Not Implemented</td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Group 9: Namespace Management</td>
<td>All Tests Supported (FYI Only)</td>
<td>Not Implemented</td>
</tr>
</tbody>
</table>
### What Conformance Tests are Required?

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Mandatory</th>
<th>Optional (if supported must be supported correctly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: Admin Command Set</td>
<td>All Tests Mandatory</td>
<td>None</td>
</tr>
<tr>
<td>Group 2: NVM Command Set</td>
<td>2.3, 2.4, 2.6</td>
<td>2.1, 2.2, 2.5, 2.7</td>
</tr>
<tr>
<td>Group 3: NVM Features</td>
<td>3.3</td>
<td>3.1, 3.2</td>
</tr>
<tr>
<td>Group 4: Controller Registers</td>
<td>4.1-4.5, 4.6-4.17</td>
<td>4.6 – Arbitration Mechanism</td>
</tr>
<tr>
<td>Group 5: System Memory Structure</td>
<td>All Tests Mandatory</td>
<td>None</td>
</tr>
<tr>
<td>Group 6: Controller Architecture</td>
<td>6.1, 6.2, 6.3</td>
<td>6.4</td>
</tr>
<tr>
<td>Group 7: Reservations</td>
<td></td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Group 8: Automated Power States</td>
<td></td>
<td>Not Implemented</td>
</tr>
<tr>
<td>Group 9: Namespace Management</td>
<td></td>
<td>All Tests FYI Only</td>
</tr>
</tbody>
</table>
Agenda

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• Testing After the Plugfest
Supplementary Tests

- Other test stations may be available during the event.
- These are not required, but may provide useful data and insight into product conformance.
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Plugfest Logistics - Registration

Registration open to UNH-IOL members:

- [https://www.iol.unh.edu/event/2016/02/nvm-express-plugfest-5](https://www.iol.unh.edu/event/2016/02/nvm-express-plugfest-5)
- Membership
- [https://www.iol.unh.edu/membership/join](https://www.iol.unh.edu/membership/join)

NVM Express Plugfest #5

**Welcome**
The University of New Hampshire InterOperability Laboratory’s (UNH-IOL) NVMe Consortium will be hosting the fifth NVM Express Interoperability Plugfest the week of February 29-March 3, 2016. This event is an opportunity for NVMe Implementors to test the interoperability of their products.

The Plugfest will be held at the University of New Hampshire InterOperability Laboratory’s new facility located at 21 Madbury Rd. in Durham, NH.

**Travel Info**
Participants will have to make hotel and transportation arrangements. Breakfast and afternoon snacks, and a catered lunch will be available on site. Information for visitors to our facility can be found on our Visitor Information page. Here you’ll find information on options for airports, lodging, and dining.

**Registration**
Plugfest registration is now open. Registration will close February 5, 2016. Register here.

**FAQ**
For questions not addressed here, please check our NVMe Plugfest FAQ page. If your issue is not addressed in the FAQ, feel free to use the comment space at the end of the registration form.
Plugfest Logistics – Parking

• The IOL has a new home in downtown Durham.
• 21 Madbury Rd, Durham, NH
• For pick-up/drop-off of equipment there are temporary spots right outside our front door.
Plugfest Logistics – Parking

• If you stay in Durham, it is likely you can walk to the IOL without a problem. (Holiday Inn Express is 10 min walk)
Plugfest Logistics – Parking

• Otherwise, UNH-IOL will provide you a code to use the UNH Mill Rd Visitor Parking Lot.
Plugfest Schedule

- Each Product will be cycled through all required conformance and interop test
- Most products will also be cycled through the FYI Test Stations
- UNH-IOL will release test schedule the week of February 8, 2016.
- Schedule based on registrations.
- Registration closes February 5, 2016
- Do Not Register Late
Reporting

- Conformance Test Data will be collected directly by UNH-IOL Staff
  - Bus traces and logs
- Interop Data may be collected by UNH-IOL staff, or engineers supporting their companies equipment
  - Summary and Error logs produced by VDBENCH
Reporting

- UNH-IOL will use collected test data to produce Interop and Conformance Test Reports for all products at the Plugfest.
- Test Reports are necessary to list a product on the NVMe Integrators List.
- Reports can be shared with partners and customers.
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Listing Products

- NVMe Integrators List 1.2.1 Policy:
  - [https://www.iol.unh.edu/registry/nvme](https://www.iol.unh.edu/registry/nvme)
- Test Reports are necessary to list a product on the NVMe Integrators List
- UNH-IOL Report will indicate whether a product is eligible or not
- Products are not automatically listed
- In order to list a product, companies must make specific email request to UNH-IOL through nvmelab@iol.unh.edu
Listing Products

Listed Information Includes:

- Product, includes Manufacturer, Model Name and Family Name (i.e. different capacities of one SSD are in a single family)
- Product type (accepted products types are: NVMe SSD, SSD Controller, or SSD Controller IP, server, server board, motherboard, add-in card, RAID Controller, or IP device).
- Operating System and Driver (Host Only)
- Firmware revision (Device Only)
- Interop Program Revision (1.2.1 for February 2016 plugfest)
- Date of listing and Test ID
- Further Information (primary contact or website)

Not NVMe Spec. Version
Listing Similar Products

- Products with differences that do not affect NVMe operation (form factor, storage capacity) can be listed under a single product listing, “listed by similarity”.
- The products listed by similarity must have the same Firmware revision and Model Name, and the listing company confirms that the products are materially similar with no substantive changes to the NVMe interface.
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Post-Plugfest Testing

- Products will continue to be tested at UNH-IOL throughout the year.
- Test requests can be made through: https://www.iol.unh.edu/my/
- Passing products can be listed on the NVMe Integrators List

- NVMe Plugfest #6, currently scheduled for September 19-22, 2016
UNH-IOL NVMe Consortium

Benefits:
• Access to UNH-IOL NVMe test services.
• Attendance at NVMe Plugfest
• Access to UNH-IOL INTERACT PC Edition and UNH-IOL INTERACT Teledyne-LeCroy Edition software for performing NVMe Conformance Tests
• Ability to list qualifying products on the NVMe Integrators List
• Place products in the UNH-IOL NVMe Interop test bed for continuous interop testing
• Support for UNH-IOL Administration of open source tNVMe tool

PCI testing available through UNH-IOL PCIe Consortium
Review

• NVMe Test Program focused on Integrators List to showcase interoperable and conformant products.
• Test tools and plans available from UNH-IOL.
• Plugfest will allow the first opportunity to list products on the NVMe Integrators list v1..2.1.
• Plugfest will walk SSDs through multiple conformance and interop stations.
• Testing can continue after the Plugfest for those unable to attend.
Resources

• UNH-IOL Membership
  • https://www.iol.unh.edu/membership/join
• Plugfest Registration
  • https://www.iol.unh.edu/testing/storage/nvme/grouptest
• NVMe Conformance and Interop Test Suites
  • https://www.iol.unh.edu/testing/storage/nvme/test-suites
• NVMe Integrators List and Policy Document
  • https://www.iol.unh.edu/registry/nvme
Q&A

Contact: david@iol.unh.edu
Q&A

Q: Is the Boot Test required for Hosts?
A: Yes, Test 1.5 is required for Hosts. This was decided by the NVMe Promoters group in November 2015.
Q&A

Q: What known issues are there with IOL INTERACT PC Edition v1.2.3?

A: As of January 27, 2016, IOL INTERACT PC Edition has the following known issues:

- Test 1.1, 32:4.0.0 – Test enables controller without initializing required registers
- Test 1.2, 23:3.0.0 – Needs to be updated to 1.2 spec
- Test 1.2, 23:6.0.0 – Needs to be updated to 1.2 spec
- Test 2.6, 9:0.3.0 – Needs to be updated to 1.2 spec
- Test 6.4, 6:4.0.0 – NVM subsystem reset writes to wrong address
- Test 4.15, 1:13.0.0 – Writes to ASQ doorbell while CSTS.RDY is 0