University of New Hampshire
InterOperability
Laboratory

NVMe Protocol Testing over TCP

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Student Engagement

The University of New Hampshire InterOperability Laboratory (UNH-IOL) is a neutral and independent lab that tests networking and data communications products for businesses across the globe, effectively bridging industry and academia.

More than 120 graduate and undergraduate students are employed, gaining hands-on experience with developing technologies and products, working closely with engineering teams from our partners in industry.

Collaboration with NVMe Org

Since the original NVMe specification release in 2012, NVMe has proven to be a compelling low latency interface for connecting host systems with SSDs over PCIe.

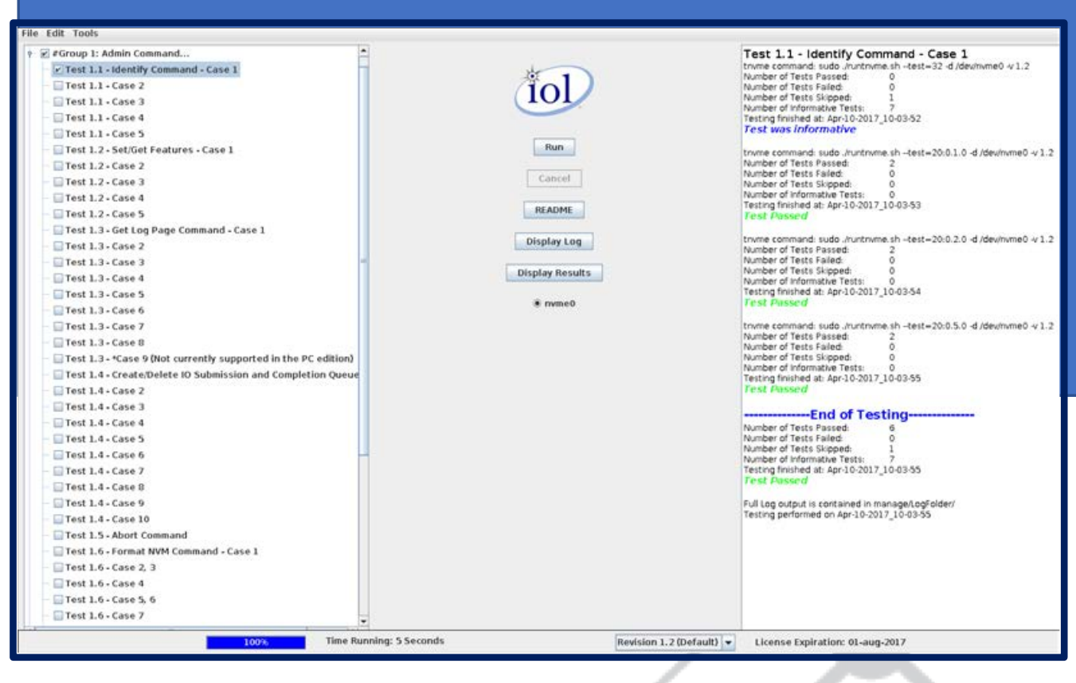
Complementing this, UNH-IOL (University of New Hampshire InterOperability Laboratory) has collaborating with NVMe Org to document and design NVMe test procedures and tools. This is the foundation for the NVMe interop and compliance program. Through this program, test services and tools are made available, as well as a series of plugfests. This has led to the creation of UNH-IOL INTERACT NVMe protocol test tools

June 2018 NVMe Plugfest
UNH-IOL Durham, NH USA

UNH-IOL INTERACT NVMe Protocol Test Tool

The UNH-IOL NVMe test tools perform automated test vectors to check for compliant behavior of an NVMe/PCIe SSD or NVMe-oF NVM Subsystem (sometimes referred to as a ‘target’).

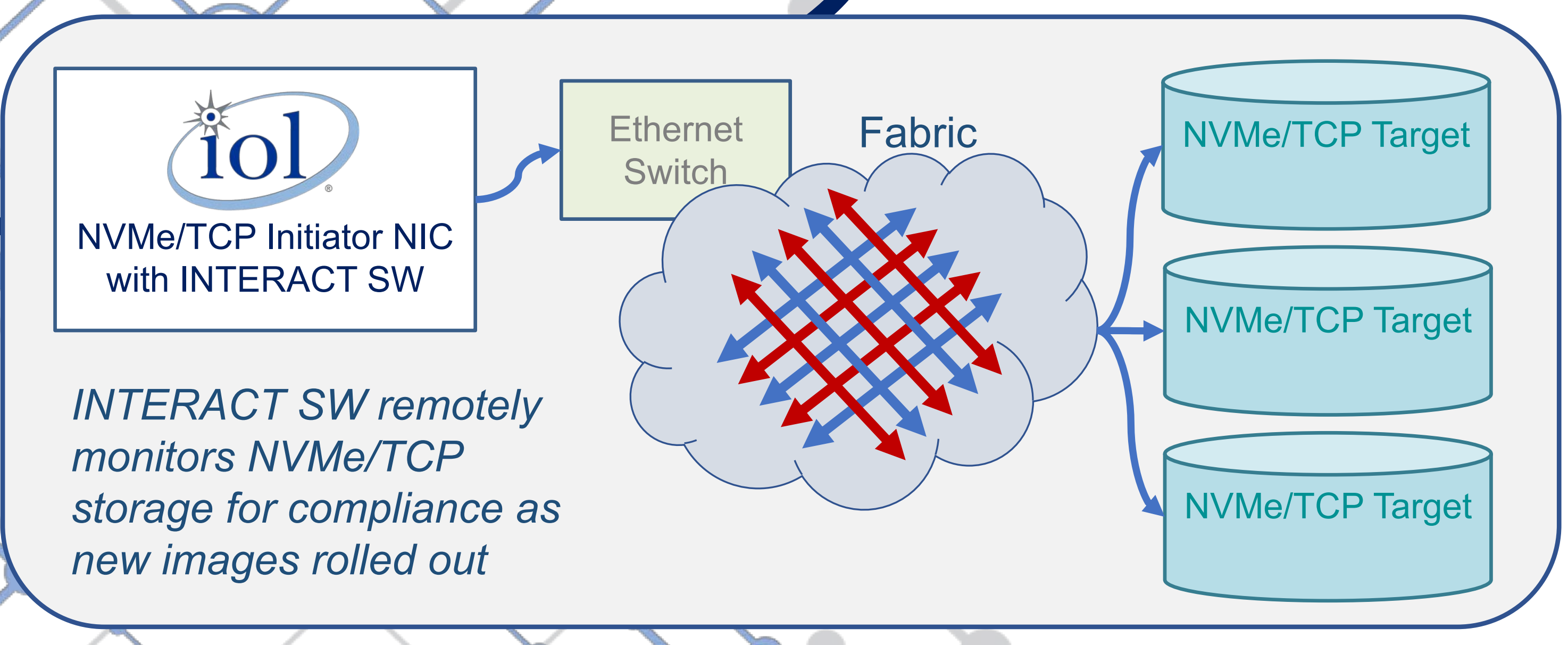
While primarily used on the test bench, the tools have also been deployed by cloud providers to perform *continuous compliance monitoring* within the datacenter.



NVMe over Fabrics (NVMe-oF)

The release of the first NVMe-oF specification in 2016 expanded the potential transports that NVMe could be used with beyond just PCIe. Thus the complexity of testing NVMe protocol increased greatly, with the need to test the protocol operation over this variety of transports.

To support this, a series of NVMe-oF plugfests was started, as well as the creation of NVMe protocol test tools that could be used in a fabric environment. In late 2018, TCP was added a fabric transport for NVMe.



INTERACT SW remotely monitors NVMe/TCP storage for compliance as new images rolled out

NVMe/TCP PoC @ 2018 Plugfest

As NVMe/TCP was going through ratification in late 2018, a Proof of Concept interop test was held at UNH-IOL. This was a chance to check commercial prototypes, as well as the NVMe/TCP version of the UNH-IOL tools.

To prepare for this, the test vectors were modified to use an NVMe/TCP host driver (sometimes referred to as an ‘initiator’) which has since been contributed to the Linux kernel. The operation of the test vectors was checked at UNH-IOL against available open source NVMe/TCP target drivers. Additionally, test vectors which only applied to PCIe based products needed to be eliminated.

During the course of the PoC tests at UNH-IOL, testing uncovered bugs which, which led to several patches being submitted to the open source project to improve the NVMe/TCP driver code.

Next plugfest will be June 2019

What’s Next

Further work is necessary to enable additional testing on more protocol features and more NVMe/TCP NVM subsystems, as well as more remote monitoring and compliance checking capability. Additional features are:

- OCSSD features
- Future NVMe protocol revisions
- NVMe-oF Features
- NVMe Binding Spec Features
- Comparison of network performance and drive performance.
- Check performance and compliance over different TCP stacks
- DCTCP feature testing