Storage Performance
1M IOPS and 5GB/s

SEPTEMBER 2015

OVERVIEW

The demand for performance is continually increasing. Applications like big data analytics, server virtualization, and high-performance databases require low latency and extreme storage performance to deliver unmatched application results. Large amounts of data must be consumed and processed rapidly in order to improve end user application experience, which is impacted by the underlying system-level storage capabilities. Numerous methods are currently being utilized to achieve high levels of performance in storage applications, but not all methods yield the same results.

BACKGROUND

Many of today's data center architects are forced to use legacy "good enough" technologies in order to deliver the high performance required by new and existing applications, while also attempting to lower overall cost. This approach often increases complexity without providing the sought after benefits of improved TCO. The industry is beginning to look to newer technologies like NVMe and PCIe, the next generation storage protocol and interface, to replace legacy interfaces such as SATA/AHCI. Replacing these technologies will help reduce complexity and cost while increasing performance and improving latency.

PERFORMANCE ANALYSIS

The primary goal of this white paper is to study different methods of achieving 1M IOPS and 5GB/s of storage performance with different types of SSDs. Specifically, what are the differences when using SATA compared to NVMe SSDs? It is important to understand the number of devices required, the requirements for HBAs, the differences in total power consumption, and the impact on application latency. It is expected that a single NVMe SSD will be able to replace banks of legacy SATA SSDs deployed behind host bus adapter cards. NVMe will reduce complexity, lower power consumption, provide increased performance, and improve data center TCO.

Table 1: SATA SSD vs. NVMe SSD requirements for 1M IOPS and 5GB/s

	SATA SSD	NVMe SSD
# of SSD	12	1
# of HBA	3	-
IOPS	~850K IOPS	~1.1M IOPS
Seq Read	~6.7 GB/s	~6.4 GB/s
Latency	~175 us	~60us
Total Power	~90W	~27W

Based on testing, three important findings surfaced:

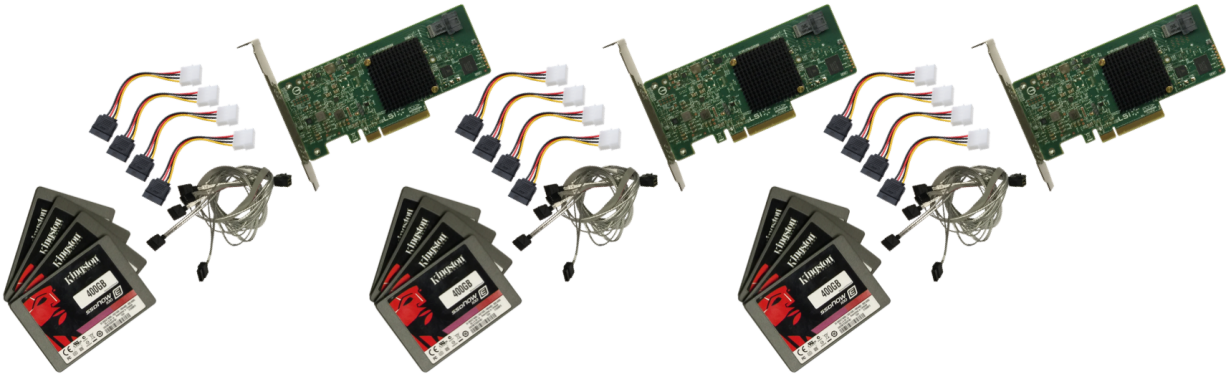
1) NVMe enables a better method to deliver 1M IOPS and 5GB/s
2) NVMe enables 70% lower power compared to 12xSATA SSD, plus 3xHBA
3) NVMe enables 65% lower latency compared to the legacy SATA approach
4) NVMe enables much lower complexity and improves data center TCO

TEST SETUP

NVMe Setup:

*NVMe setup based on direct connect Kingston E1000 Gen3x8 PCIe NVMe SSD

SATA Setup:



*SATA setup based on Kingston SATA SSD and LSI HBA

SATA Setup:	12xSATA SSD SATA 6Gb ~100K IOPS ~550 MB/s 3xLSI 4-Port HBA Total HW: 30 pcs	**NVMe Setup**:	1xNVMe SSD PCIe Gen3x8 ~1M IOPS ~6GB/s Direct Connect PCIe Total HW: 1 pcs

Application:	IOMeter	Rev 1.1.0
Random Access Pattern:	4KB Rnd Rd	QD=64
Sequential Access Pattern:	64 KB Rnd Rd	QD=8
Latency Measurement:	4K Rnd Rd	QD=1

Windows edition

Windows Server 2012 R2 Datacenter

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Windows Server 2012 R2

System

Processor:	Intel(R) Core(TM) i7-4700EQ CPU @ 2.40GHz 2.40 GHz
Installed memory (RAM):	16.0 GB (15.8 GB usable)
System type:	64-bit Operating System, x64-based processor
Pen and Touch:	No Pen or Touch Input is available for this Display

STORAGE SELECTION

The benefits enabled by NVMe-based storage are significant. What was previously accomplished by banks of SATA SSDs connected with complex wiring to multiple HBA cards can now be achieved with a single, high-performance PCIe card. This technology reduces complexity and lowers cost while improving overall performance. NVMe allows more work to be accomplished with fewer devices. Fewer devices allow for fewer components, which in turn reduces the number of points of failure and therefore achieving increased reliability. The benefits of NVMe-based storage can dramatically improve data center TCO by increasing reliability and reducing the total number of system deployed for the same application workload.

APPLICATION RESPONSIVENESS

One of the main benefits of NVMe is the improvement in latency. NVMe delivers up to 65% reduced storage latency when compared to SATA-based devices deployed behind a host bus adapter. NVMe enables system designers to direct connect the storage and utilize the lower latency to deliver higher levels of application performance. NVMe will enable higher levels of efficiency and responsiveness for next generation data centers.

SUMMARY

Testing revealed a clear advantage of using NVMe-based storage compared to the legacy “good enough” approach of SATA-based storage. Compared to using banks of SATA SSDs behind host bus adapters, direct connect NVMe SSDs enable higher performance, higher reliability, lower power, and improved TCO for data centers demanding solid-state storage. What previously required an entire box of SATA devices now can be done with a single NVMe card. As the benefits to NVMe are better understood there will be a natural migration away from legacy protocols towards PCIe and NVMe-based storage.

ABOUT LIQID

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