Improve HPC Performance and Reduce Latency with NVMe SSDs

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Many of today’s High-Performance Computing (HPC) workloads are impacted by performance and latency problems. There are additional problems in these areas as organizations move to highly virtualized environments and adopt private cloud architectures. In all cases, there are greater demands being placed on IT infrastructures, in general, and the storage solutions, in particular.

The traditional approach to address these issues is to resort to expensive over-provisioning of resources by increasing compute and memory capacity or adding large amounts of high performance storage. This is expensive and in many cases still does not rectify the situation.

Increasingly, organizations are finding that a more cost-effective way to meet today’s performance and latency requirements is to use Non-Volatile Memory Express (NVMe) based solid state drives (SSDs).

Advantages and benefits of using NVMe SSDs

NVMe is a communications interface and protocol developed specially for SSDs by NVM Express Inc., an industry consortium. Specifically, NVMe is a scalable host controller interface designed to address the needs of high-end systems that utilize PCI Express® (PCIe®) based solid state drives. It was designed to overcome the bottleneck of legacy storage buses when using SSDs.

Certainly, SSDs deliver a performance improvement over hard drives for many applications. However, the common technologies used to connect SSDs to the compute infrastructure have limitations. In particular, while Serial ATA (SATA) and Serial Attached SCSI (SAS) have adequate bandwidth for hard drives, they are not optimal for today’s SSDs.

As one review of the limitation noted: “Because of SATA’s 6Gbps ceiling, just about any top-flight SATA SSD will score the same in testing... around 500MBps. Even 12Gbps SAS SSD performance stalls at around 1.5Gbps.”

SSD technology is capable of much more. Today, NVMe brings almost 3 Gbps of read bandwidth and about 500K IOPs.

Simply put, NVMe-based SSDs offer best in class performance. Compared to SATA SSDs, NVMe offers up to 6x the performance, half the latency and double the CPU efficiency. These attributes can
NVMe SSDs offer a cost-effective way to meet today's performance and latency requirements.

accelerate workloads, allow more jobs to run in a given time, enable more simultaneous reads/writes and reduce the number of processing cores needed to do the same work.

The performance boost and latency reduction is achieved by several factors. The interface provides an optimized command issue and completion path. It includes support for parallel operation by supporting up to 64K commands within a single I/O queue to the device.

Additionally, NVMe uses a reduced driver stack and provides direct CPU access via a PCIe bus. This reduces latency, allowing systems to deliver excellent performance for sequential and random workloads.

Moreover, interest in NVMe SSDs is growing due to the decrease in price of SSDs and the relatively high cost of DRAM. As the cost difference narrows, acceptance of DRAM extension solutions using NVMe SSDs, are on the rise. As such, NVMe SSDs in an HPC environment can act as a local drive and help accelerate workloads running on an HPC cluster.
Use cases that can benefit from NVMe SSDs

Examining the main use cases for NVMe SSDs will put the performance improvements and latency reductions into perspective and highlight the benefits an organization can realize when using systems that include the devices.

In general, NVMe SSDs will improve overall operations. When used in some fairly common scenarios and IT environments, they offer specific improvements including:

**HPC clusters:** NVMe SSDs handle the high bandwidth demands of HPC, speeding overall workflows. This yields several organizational benefits.

First, a single job will execute faster. This provides results and insights in shorter times. In a R&D environment, this allows researchers and scientists to make decisions more quickly as to which step to take next or which path to abandon. In a business environment, organizations can derive insights faster, offering a competitive advantage in today’s fast-paced markets.

Second, more jobs can be run in a given time frame. This allows organizations to increase their computational output without having to invest in more compute power. Alternatively, organizations can run the same workloads using less equipment. This might allow an organization to free up installed equipment for use on other projects or new endeavors. In either case, fewer servers and storage devices need to be purchased, managed, housed in racks, powered and cooled. This can represent significant CAPEX and OPEX savings.

**Virtualization:** In today’s highly virtualized server environments, numerous virtual machines (VMs) simultaneously need access to storage. Each workload can have highly variable IO and throughput requirements on that storage. In order to meet the performance requirements of the various applications and workloads, organizations typically use highly scalable servers with more processing cores. Unfortunately, much of today’s OS and application software is licensed per-core. Adding cores to ensure adequate performance drives up operating costs.

Systems with NVMe-based SSDs that offer low latency and high IOPS can reduce the CPU load and reduce the number of processors required...
to meet end-to-end performance requirements. In other words, fewer server OS and application licenses are required to perform the same amount of work. This lowers the total cost of ownership for a virtualized server environment.

**Private cloud:** Many organizations today are adopting private cloud architectures to effectively utilize compute, storage and networking resources, providing organizational agility by virtue of fast provisioning and self-service capabilities. Unfortunately, performance issues may arise due to the dynamic nature of the workloads that can run on such a flexible platform.

To address the issues of private cloud performance, NVMe SSDs provide affordable high performance caching which enables the software-defined infrastructures and hyper convergence found in today’s private clouds.

**Other application areas:** The low latency and high performance of NVMe SSDs can be used to improve database performance and Big Data analytics applications. In such use cases, organizations can realize near real-time results, which is a competitive differentiator in businesses today.

*Systems with NVMe-based SSDs can reduce the CPU load.*

2U NVMe-Enabled Server from Silicon Mechanics
Silicon Mechanics as your trusted technology partner

When deploying NVMe SSDs, organizations need to find a trusted technology partner who can deliver zero-defect products, understand the trends that are driving changes, and has the flexibility to adapt to customer-specific environments.

This is where a company like Silicon Mechanics, with more than a decade of providing servers, storage and high performance computing technologies to the world’s most innovative organizations, is there to support you. Every engagement includes their “Expert included.” approach, drawing on their industry experience and in-depth knowledge of commodity hardware and open source software to design a solution tailored to the customer’s needs.

Silicon Mechanics offers complete solutions that feature Intel® NVMe-based SSDs. The Intel Solid-State Drive (SSD) Data Center Family for PCIe brings extreme data throughput directly to Intel® Xeon® processors with up to six times faster data transfer speed than SATA SSDs. The Intel SSD DC Family (P3500, P3600, P3700) is capable of reading data up to 2.8GB/s and 460k IOPS and writing up to 2.0GB/s and 175k IOPS.

The performance of a single drive from the Intel SSD DC Family for PCIe, specifically the Intel SSD DC P3700 Series (450K IOPS), can replace the performance of 7 SATA SSDs aggregated through an HBA (~500K IOPS).

These SSDs offer best in class performance, are easier to deploy than last generation PCIe SSDs and offer unsurpassed value for organizations looking for lower latency and improved performance.
Summary

Many of today’s most demanding IT environments are being stressed as organizations require faster execution of jobs, use of more data or try to run many more virtual machines on their servers. Unfortunately, whether it is an HPC cluster, a highly virtualized server or a private cloud infrastructure, latency and performance issues arise.

In nearly all cases, NVMe SSDs can speed operations and improve performance. Integrating these SSDs into an infrastructure requires expertise in order to optimize their benefits. Silicon Mechanics can architect, build, deploy and support a complete solution for your organization that will future-proof your IT infrastructure.

To learn more about their NVMe-optimized offerings, visit: siliconmechanics.com/nvme.

To configure your custom system with one of their experts, call them at 866-352-1173.

Intel Corporation manufactures industry-leading solid-state drives targeting data center, professional and consumer products. Intel SSDs feature leading performance, high levels of reliability, and are manufactured by one of the most trusted brands in the world.

To learn more about the Intel SSD Data Center Family for NVMe, visit intel.com/ssd.