

# Meeting the Demands of Virtual Storage in the Cloud

## Intel® Solid-State Drives -- Designed for the Job

As the storage demands of virtualized and cloud computing continue to escalate, companies and cloud providers seek the most cost-effective approaches to scaling their storage performance. Traditional hard disk drives (HDDs), spinning disks with mechanical parts, are stretched to their limits by virtual machines (VMs) that demand high levels of random input/output (I/O) performance. Solid-State Drives (SSDs), with no moving components, are better equipped to perform the intense I/O required by multiple VMs residing in the same VM datastore. SSDs can do the job more efficiently while providing a simple, high performance, low cost, and low power storage solution. A sample configuration, tested by Intel's IT Research organization, demonstrates a multi-VM random workload achieving 90-100K I/Os per second (IOPS) using only 24 300GB Intel® Solid-State Drives 710 Series (Intel® SSDs), a typical cloud workload that would require 450 traditional 15k RPM HDDs to accomplish the same results.



"Workload demands would have required 450 HDDs; instead, the tests proved that 24 SSDs could achieve the same outcome."

- Christian Black,  
Intel architect and IT researcher

## CHALLENGES

- **Cloud computing demands.** Companies seeking to reduce IT costs are moving their computing tasks to the cloud, both public and private. The data access demands of multiple VMs on a single VM datastore can be more than traditional HDDs are equipped to handle because of the head travel limitations and increased power consumption required.
- **Traditional storage solutions are stretched.** Some companies address the challenge of increasing storage performance by adding more physical disks; others may add more cache space to a storage area network (SAN) to handle increased random I/O. These solutions are reaching their physical limitations; the mechanical operation of HDDs is not optimized for the random I/O demands of densely packed VMs, and caching algorithms fail to predict what should be cached with that same random I/O stream.
- **Traditional solutions are cost-prohibitive.** While a single HDD or small RAID array is a cost-effective solution for stand-alone servers, the number of disks required to meet intensive virtualized compute demands makes HDDs ultimately cost-prohibitive. Scaling data performance for the cloud requires a fundamentally different approach.

## SOLUTION

- **A better approach.** The IT Research organization at Intel has tested a 'build your own' virtual storage solution that achieves 90-100K IOPS by deploying 24 Intel® SSD 710 Series using an open source SAN software stack, for a cost of US \$43,000.<sup>1</sup> Similar performing solutions are currently available from several hardware vendors; however, costs are typically in the US \$200,000 range.<sup>2</sup>
- **Higher performance at lower cost.** Test results demonstrate that SSDs, as part of an all-Intel solution, can achieve better performance at a lower cost than traditional storage solutions for high random IOPS configurations. This same solution also consumes a fraction of the power consumption and physical space requirements.

## IMPACT

- **Improved cloud storage performance.** CIOs and IT managers can scale their virtualized workloads and cloud data storage performance by using SSDs instead of HDDs, while simultaneously reducing rack and power footprint.
- **Expanded performance at a lower cost.** By building an open source SAN solution with Intel® SSDs for use with virtualized workloads, companies can extend their virtual data storage at significantly lower cost versus comparable solutions.

## Intel IT Research Tests Cloud Scenario

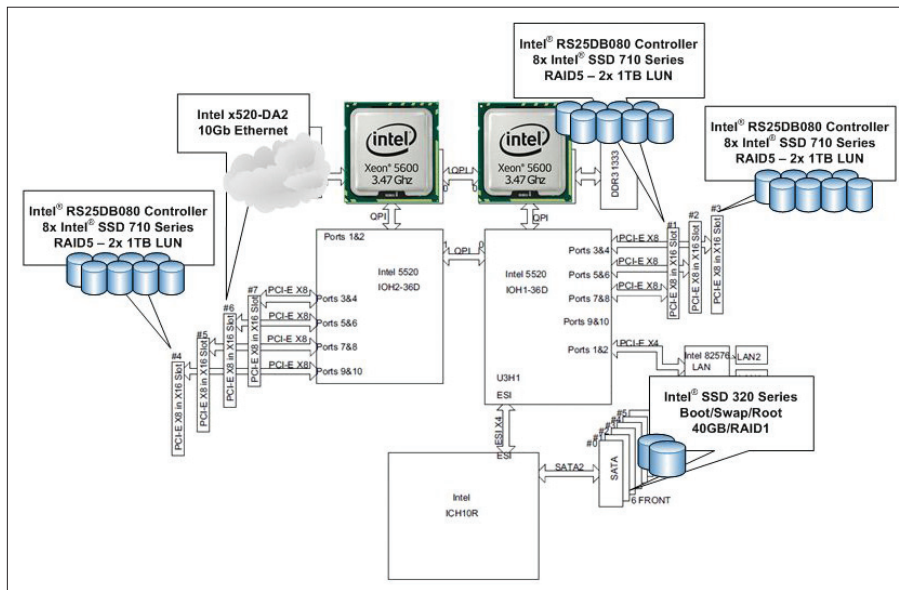
Typically, when many small VMs are added to a single datastore, the I/O becomes highly random and storage performance needs to be increased to handle this intensive random access. For smaller or consolidated workloads typical of traditional data centers, expanding storage capacity may be a simple process of adding HDDs or adding cache storage to a storage area network (SAN). However, when deploying 20 or more VMs on the same datastore, head travel limitations, caching algorithm limitations, and high power consumption make adding HDDs or cache no longer feasible. SSDs excel in this usage as they are designed to handle intensive random I/O with reduced power consumption.

## An In-House Solution

Recognizing the challenge IT professionals face as they migrate more workloads to the cloud, the Intel IT Research organization decided to test a low-cost, easy-to-assemble configuration that resembled a typical private cloud environment with a small storage footprint and densely packed small VMs. For their software, they chose a free open source SAN software vendor that promised to meet their 75K IOP requirement and provided acceptable levels of both redundancy and high availability. They tested this configuration with a 300GB Intel® SSD 710 Series housing the high-density VM environment, ran a number of configurations to generate a 4k 100 percent Random/ 90 percent Read workload from each VM, and scaled this load out over multiple hosts with an industry leading hypervisor solution. Had the team used physical hard disks in this scenario, they would have needed over 450 traditional 15k RPM HDDs to achieve the same performance as 24 Intel® SSD 710 Series. The test solution consumed 550 watts of power, compared to 4.8 kilowatts consumed by an equivalent HDD solution, and used a fraction of the physical space.

## SPOTLIGHT ON INTEL IT RESEARCH

The Intel IT Research organization performs testing of usage scenarios for numerous leading edge technologies. When a particular scenario demonstrates promising results, they publish the results as an example of what other IT departments can accomplish. The goal is to demonstrate sample usage cases that will help IT managers and CIOs deploy leading edge technology as productively and cost effectively as possible.



System Configuration Diagram

## Significant Savings

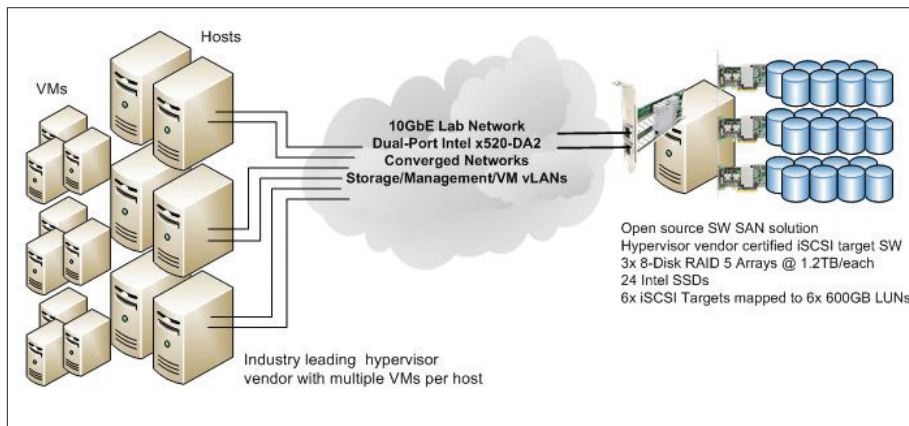
Results of the test demonstrated that a US \$43,000 solution is capable of supporting a continuous stream of 90-100K IOPS with a 100 percent random workload at only 550 watts of power and 2U of rack space. Intel architect and IT researcher Christian Black recounts, "when I share the results of our 100k random IOPS home-built SAN, most people are amazed. Buying the parts from NewEgg<sup>3</sup>, an IT professional could build this solution for US \$43,000 whereas something from an OEM would cost US \$200,000 or more."

## Ideal for High Density VM Environments

In the past, data center IT managers would typically configure a single server with between 5 and 8 dedicated hard disks. In cloud environments, it is more typical to reverse the server-to-datastore ratio. A cloud configuration, for example, will likely have multiple VMs residing on a single array of 10-15 disks in a SAN. This greatly increases the need for storage performance and increases both the randomness and the intensity of I/O to the storage device. Simply put, the I/O demands in the cloud are outpacing the capabilities of traditional HDD storage, SAN, and caching algorithms. Only SSDs can deliver the dense IOPS that multiple VMs require. Optimally designed for the enterprise, Intel® SSD 710 Series incorporates High Endurance Technology (HET) to enhance write endurance, or drive lifetime. In addition, advanced encryption and data security features improve reliability and reduce system downtime, while low active power consumption reduces overall energy costs.

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Sample Cloud Configuration with 24 Intel® SSDs

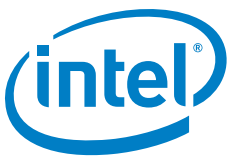
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<sup>1</sup> The test system included hardware components purchased from [www.newegg.com](http://www.newegg.com) and [www.amazon.com](http://www.amazon.com), and iSCSI software purchased from Openfiler.com.

<sup>2</sup> <http://www.informationweek.com/news/storage/systems/232600911>

<sup>3</sup> NewEgg refers to [www.newegg.com](http://www.newegg.com), an online retailer of hardware, software and electronics products.

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