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Why Solid-State Drives Usage Scenarios Are Expanding for the Datacenter

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Executive Overview

Solid-state drives (SSDs) typically have been used in situations in which applications required high data throughput or very high transaction rates between a server and the storage media. However, they are now being eyed for broader usage scenarios, because of their myriad of cost-saving benefits.

Specifically, IT administrators are under increased pressure in today's tough economic times to help the organizations they serve rein in costs wherever possible. As such, they are being called upon to make more-efficient use of IT resources, lower power consumption, and reduce operating expenses across the board.

Introduction

To accomplish the objectives of making more-efficient use of IT resources, lowering power consumption, and reducing operating expenses, many companies are turning to server consolidation and virtualization efforts—endeavors that increase server CPU utilization and reduce the number of discrete servers in a datacenter.

These efforts rely on the performance delivered by powerful new servers such as those based on the Intel® Xeon® processor 5500 and Intel Xeon processor 7400 series to run multiple applications on fewer devices. The benefits such systems deliver are further enhanced by SSDs. Specifically, today's more powerful servers enable more applications to run on a single device, which means there will be more simultaneous data read and write requests to storage systems. SSDs can deliver higher input/output operations per second (IOPS) performance than hard disk drives (HDDs).

In particular, when it comes to server drives, the performance of HDDs has not been able to keep up with the demands of today's newest servers. This fact is creating an I/O bottleneck that slows down overall system performance. As a result, SSDs such as the Intel X25-E

Extreme SATA Solid-State Drive are increasingly being implemented, because they offer I/O performance of up to 35,000 IOPS.[1]

Additionally, because SSDs have no moving parts, they offer greater shock and vibration resilience than HDDs and improved energy efficiency[2] versus standard HDDs, thus helping lower TCO.

Because of the benefits SSDs afford, their sales are expected to grow significantly over the next few years. A 2009 *eWEEK* article[3] noted market research that pegged SSD sales at US$400 million in 2007, with expectations that revenues would grow at a 70 percent CAGR (compound annual growth rate) between 2007 and 2012.

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[1] Product brief: "Intel X25-E Extreme SATA Solid-State Drives"
download.intel.com/design/flash/nand/extreme/extreme-sata-ssd-product-brief.pdf
[2] Intel white paper: "Solid-State Drives in the Enterprise: A Proof of Concept," March 2009, page 8
download.intel.com/it/pdf/Solid_state_drives_in_Enterprise.pdf
[3] "Sun Expands SSD Technology to Servers and Blade Systems," *eWEEK,* March 11, 2009
eweek.com/c/a/IT-Infrastructure/Sun-Expands-SSD-Technology-to-Servers-and-Blade-Systems/

Collaborative work toward the improvement of SSD products makes them an essential tool for meeting numerous challenges common in real-world IT environments. The newest generation of Oracle systems with Intel SSDs can help improve the economics of your datacenter by helping lower datacenter power usage, boosting performance levels, decreasing operating costs, and providing higher reliability.

Overcoming the I/O Bottleneck

Since early 1996, CPU performance has scaled by a factor of approximately 175, whereas HDD performance has had only modest performance gains. This has caused a mismatch between improving server performance and the ability of storage solutions to keep pace with the data demands of new servers. This mismatch in performance, combined with several industry trends, is compounding the I/O bottleneck situation.

First, datasets are exploding in size, which means that more and more data must be moved between servers and storage drives and systems. Second, with both consolidation and virtualization being widely embraced, companies that are leveraging the power of these strategies typically achieve higher server CPU utilization rates as well. This can drive up server-to-storage system I/O performance requirements, because many applications simultaneously read and write data to and from storage. And third, the increased processing power of today's servers enables companies to run high-performance computing (HPC) applications that used to be relegated to proprietary systems.

HPC applications often place additional demands on I/O performance, because the servers can process, analyze, or visualize more data per second than was possible in the past.

So the situation comes down to this: How do you effectively feed the more powerful and highly utilized CPUs in today's datacenter servers?

Companies have tried several approaches to solve this problem. One solution is to increase the amount of DRAM memory where the application would store the data it would need in DRAM memory rather than retrieving the data from an HDD. The benefit of this approach is improved performance of I/O-bound applications, but the downside is that additional and expensive DRAM memory must be purchased.

A second common solution for improving I/O between a server CPU and storage drives is to add more hard disks and use software, such as RAID software, that enables data to be spread over multiple drives. Here, data needed by an application is retrieved from multiple drives and the aggregate throughput improves data retrieval rates over the rates with a single drive. However, the downside of this approach is that additional drives and RAID software must be used, which adds management complexity, increases the total amount of power consumed, and requires more datacenter space.

Neither approach fits within the context of the new demands being placed on IT administrators. What's needed to address the changing economics of the datacenter are solutions that deliver more performance in less space, with lower power consumption and lower TCO.

Enter SSDs: Built for Performance

Oracle servers with Intel SSDs offer the characteristics necessary to help meet these demands. Intel SSDs are based on NAND Flash, a nonvolatile memory, and an Intel controller. And unlike traditional HDDs, Intel SSDs have no moving parts, resulting in a quiet, cool storage solution that also offers significantly higher performance than conventional HDDS.

Intel high-performance SSDs essentially provide shorter access time to stored information. This helps companies

- Meet I/O-constrained application performance needs
- Unleash the full power and efficiency of Intel Xeon processors
- Decrease the response times of demanding applications
- Provide I/O flexibility to support new applications and rising workloads

Let's take a closer look at the benefits Oracle servers with Intel SSDs can afford today's datacenters.

First, Oracle servers can be ordered with internal storage SSDs. Such systems can deliver substantially better performance than systems with a standard HDD. For example, a 2008 Embedded.com article noted that the X-25E Extreme SATA SSD increases server performance a hundredfold over conventional HDDs when measured in IOPS.[4] This benefit can be leveraged even further to make more-efficient use of server CPU cycles and to accelerate the completion of computational tasks.

Using SSD drives in this manner (as internal storage for a server) can provide a substantial performance boost in terms of the number of IOPS the drive can perform, compared to HDDs. Alternatively, if data throughput is a limiting factor, the SSDs can be incorporated into an external (network-attached storage [NAS] or storage area network [SAN]) storage solution to help alleviate bottlenecks and enable the support of additional simultaneous users or transactions per second.

These performance benefits enable fewer servers to support a company's work. This, in turn, helps drive down datacenter space requirements, power requirements, and management costs, thus lowering TCO.

The bottom line when it comes to SSDs is that they should be viewed not as a replacement for existing storage but rather as a means of enhancing it. Conventional storage systems mix DRAM and HDDs; SSDs, on the other hand, fall in a cost and performance sweet spot between those two components. (A discussion of specific SSD usage scenarios follows later in this paper.)

SSDs also consume less power. The reason: SSDs have no moving parts, so they require less power to operate and they generate less heat (so they don't require as much cooling). Intel estimates that its SSDs have as little as one-fifth the power requirements of a typical 15,000 RPM HDD. Under load, its SSDs generate as much as 39 percent less heat and use as much as 91 percent less power.[5]

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[4] "SSDs break performance barriers, lower overall costs," Embedded.com, November 10, 2008 embedded.com/products/oem/212001590?_requestid=19579

[5] Intel white paper: "Solid-State Drives in the Enterprise: A Proof of Concept," March 2009, download.intel.com/it/pdf/Solid_state_drives_in_Enterprise.pdf

The power savings from SSDs can be significant as well. In fact, a 2009 *eWEEK* article noted that the increased deployment of SSDs could enable the world's datacenters to reduce their cumulative electricity consumption by 166,643 megawatt-hours from 2008 to 2013.[6] This figure is based on an assumption that only a small percentage (up to 10 percent) of the HDDs in use would be replaced by SSDs. To put the 166,643 megawatt-hours figure into perspective, this is roughly the amount of electricity used in one year by 15,000 U.S. homes.[7]

Application Usage Areas That Can Benefit from Oracle Servers with Intel SSDs

Oracle offers several servers with Intel SSDs that can be used in several general IT infrastructure configurations. These servers include the Sun Blade X6270 server module and the Sun Fire X2270, X4170, X4270, and X4275 servers.

With these servers, Oracle delivers numerous features that complement Intel SSDs so as to enhance system performance.

For example, Oracle offers its Sun Flash Analyzer, server software that helps companies evaluate where SSDs can accelerate system performance.

Oracle servers can also be ordered with internal storage SSDs. This "marriage of hardware" eases the use of Flash technology for companies, according to a 2009 *eWEEK* article.[8]

Additional benefits can be derived when the Oracle Solaris file system—Oracle Solaris ZFS—is used. Designed to maximize the power of Intel SSDs, Oracle Solaris ZFS automatically treats Intel SSDs like any other drives. Oracle Solaris ZFS also enables the creation of hybrid storage pools that make optimal use of DRAM, SSDs, and HDDs.

For example, Oracle Solaris ZFS examines data access patterns and stores frequently accessed data in a read cache. It also bundles I/O into sequential staged writes for more-efficient use of low-cost mechanical disks. And it enables very fast synchronous writes to a fast SSD pool, thereby helping accelerate many database applications.

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[6] "Electricity Savings from Data Center SSDs Could Power an Entire Country, Researcher Says" *eWEEK,* May 6, 2009

eweek.com/c/a/Data-Storage/Researcher-Electricity-Savings-from-Data-Center-SSDs-Could-Power-an-Entire-Country-669508/

[7] Based on the U.S. Energy Information Administration estimates of the average home electricity usage for 2008

eia.doe.gov/cneaf/electricity/esr/table5.html

[8] "Sun Expands SSD Technology to Servers and Blade Systems," *eWEEK,* March 11, 2009

eweek.com/c/a/IT-Infrastructure/Sun-Expands-SSD-Technology-to-Servers-and-Blade-Systems/

So how can organizations use Oracle servers with Intel SSDs, and what are the benefits of these uses?

Intel SSDs are the same size—a standard 2.5 inches—as HDDs. Thus, SSDs can be used as a direct replacement for internal server spinning drives for I/O-intensive applications.

SSDs can also be used as a "tier 0" storage layer in storage systems, either as cache for spinning drives or as primary storage to accommodate large datasets associated with a company's highest-performance transactional applications.

Companies can also use SSDs as high-speed boot drives or memory-expansion devices, filling the gap between high-performance DRAM and traditional HDDs.

Used in these ways, Oracle servers with Intel SSDs are well suited to improving the performance of many classes of applications.

For example, the higher data throughputs and low latencies afforded by SSDs make them ideal for database applications that incorporate large datasets; transactional processing applications; streaming media applications; and HPC business applications such as financial analysis, modeling, and prediction.

To see the potential benefits, let's look at an example of a common business application: online customer registration at an e-commerce Web site. Here, because the process requires interaction with a database, the bellwethers of performance include both the response time required to access or enter information and the number of transactions that can be conducted in a given time. According to an Intel data sheet, the X25-E has write latencies of 85 µs, which reduces response times and increases overall system performance.[9]

In addition to improving application performance and cutting power requirements, SSDs may also help reduce a company's DRAM requirements. Boosting DRAM is a common method for improving the performance of many transactional and database applications. Storing a dataset in such memory provides CPUs with much shorter access times. Moreover, the performance advantage of SSDs over HDDs reduces data access times. This can help reduce the amount of DRAM purchased, because additional memory does not need to be added to every server in a cluster.

Synergies Abound

Combined, Oracle servers and Intel SSDs offer a powerful new alternative that helps meet today's datacenter requirements for high performance while using less equipment and lowering TCO.

[9] Datasheet comparison between Intel X25-E SSD and Seagate Savvio 15K.2 HDD

Intel data sheet: "Intel X25-E SATA Solid State Drive"
download.intel.com/design/flash/nand/extreme/319984.pdf

Seagate data sheet: "Savvio 15K.2"
seagate.com/docs/pdf/datasheet/disc/ds_savvio_15k_2.pdf

TABLE 1. BENEFITS OF SSDs

High IOPS	Up to 35,000 IOPS[10]
Improved system performance	Server performance 100x that of conventional HDDs[11]
Energy savings	Use of up to 91 percent less power[12]

By using Oracle servers with Intel SSDs, applications are able to access the data they need at the speeds they demand, with only a slight decrease in response times for demanding applications. Additionally, the systems provide the I/O flexibility to support additional applications and growing workloads. The integration of SSDs into Oracle servers also offers more-efficient capital expenditures by virtue of enabling better utilization of server resources.

The benefits extend to an organization's storage systems as well: lower storage TCO is realized, because fewer drives are needed to meet performance requirements. Specifically, because fewer drives are needed, companies save money that would have been spent to purchase new drives. They also lower operational costs that use of those drives would have entailed if they were installed. These costs include paying IT staff for management of the storage drives, warranties and service contracts to maintain the drives, and electricity to power and cool the storage systems.

Conclusion

All of these benefits translate into helping reduce energy consumption, requiring less space, significantly lowering operating expenses, and increasing operational efficiencies—which, together, can help enable your own organization streamline its operations, shorten time to insight for end users, and grow the bottom line.

To learn more about how your company can benefit from using Oracle servers outfitted with Intel SSDs, visit the Intel Extreme SATA Solid-State Drive product page.[13]

[10] Product brief: "Intel X25-E Extreme SATA Solid-State Drives" download.intel.com/design/flash/nand/extreme/extreme-sata-ssd-product-brief.pdf

[11] "SSDs break performance barriers, lower overall costs," Embedded.com, November 10, 2008 embedded.com/products/oem/212001590?_requestid=19579

[12] Intel white paper: "Solid-State Drives in the Enterprise: A Proof of Concept," March 2009, download.intel.com/it/pdf/Solid_state_drives_in_Enterprise.pdf

[13] intel.com/design/flash/nand/extreme/index.htm

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