



I D C T E C H N O L O G Y S P O T L I G H T

The Value of SSD Integration in Evolving Storage Architectures

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The overall amount of data being generated continues to expand enormously. It is continuing to deluge networks and datacenters, which in turn has created new needs and requirements in the area of storage optimization. In the storage arena, however, there has been a growing performance gap between today's virtualized multicore-based compute capabilities and the I/O performance of traditional hard disk drive (HDD) storage systems. Solid state drives (SSDs), using state-of-the-art controller technology and NAND flash memory, can address this issue when integrated into enterprise storage systems and servers. With technological advancements and the declining cost of semiconductor technology, SSDs have been pushed into the spotlight as a strategic technology in the storage market. While HDDs will continue to provide cost-effective high-capacity storage as measured by cost per gigabyte, the additional use of SSDs can provide a number of benefits that align with the desire for increased performance, more efficient storage utilization, faster access times, and lower power consumption in the datacenter. This Technology Spotlight examines these trends and discusses the role that STEC SSD technologies and products play in the new environment.

Introduction

The amount of data being generated continues to grow exponentially. IDC predicts that the "digital universe" — the total aggregation of information and content created — will grow to 1.8ZB in 2011, up 47% from 2010, and rocket toward over 7ZB by 2015. This growth is not without impact on IT organizations as the amount of data continues to deluge networks and datacenters, creating challenges for IT staff as well as opportunities for whoever figures out how to best manage and store all of this information.

As the data deluge continues, IT organizations are being presented with a host of new needs and requirements for storage optimization as traditional approaches have been bumping up against the limits of currently deployed legacy systems. In particular, a performance gap has emerged between today's virtualized multicore-based compute capabilities and the I/O performance of traditional HDD storage systems.

Fortunately, new storage technologies, and their incarnation in specific vendor solutions, are moving forward rapidly to address these needs. Among the important trends fostering new approaches to storage optimization are advances in SSDs, which can deliver substantial increases in I/O performance compared with the legacy HDDs that are in widespread use today. Recent advancements in performance, combined with the declining cost of semiconductor technology, have pushed SSDs into the spotlight as a strategic technology for growth in the storage market. This has been bolstered by increasing interest and support from forerunner IT organizations, which have moved beyond early concerns around SSD-based solutions in an enterprise market where high performance, reliability, and endurance are paramount. As the market momentum continues, enterprise storage vendors and system OEMs have also shown strong support for SSDs, with most already announcing solutions that leverage SSDs. One example of this is the use of SSDs in a tiered storage environment where SSDs represent a tier 0 or a tier of the most frequently accessed data.

How SSD Technology Can Augment Legacy Storage System Performance

SSDs are semiconductor-based data storage devices that behave and appear to a host as a traditional storage device. SSDs are constructed out of either nonvolatile semiconductor memory (typically NAND flash memory) or volatile semiconductor RAM memory (typically DRAM) with a built-in power backup system. IDC classifies SSDs as self-contained devices that consist of an interface to connect to the host device, an advanced SSD controller to provide increased performance and reliability (e.g., lifecycle management, built-in wear leveling, and error correcting codes [ECCs]), and semiconductor memory components in a single device. The advanced SSD controller capability is an important dimension in terms of overall functionality and one of the distinguishing aspects of an enterprise SSD compared with many consumer-grade SSDs.

HDDs are currently in wide usage in datacenters but have limitations in terms of access times imposed by their mechanical design. To achieve higher performance in today's storage systems and servers, HDDs are often aggregated into RAID-based systems or short-stroked and, in many cases, overprovisioned. While these techniques increase performance, they are not cost effective in terms of either capital or operational outlays, including floor space, power, and cooling considerations. SSDs can be used to alleviate these problems but until recently have not been cost effective as a standalone alternative. However, using state-of-the-art controller technology and lower-cost multilevel cell (MLC) NAND flash memory, enterprise-class SSDs can address storage optimization performance issues when integrated with HDD systems.

The Benefits of SSDs

IT organizations are increasingly finding that the use of SSDs can provide a number of benefits that align with the desire for increased performance, more efficient storage utilization, faster access times, and lower power consumption in the datacenter.

The first major benefit of an SSD implementation is higher performance because SSDs can process multiple gigabytes per second of random data throughput. They also offer high input/output operations per second (IOPS) performance and more consistent I/O response time because of low access time and high bandwidth. Another key benefit at the system level is improved energy efficiency. By removing the need for additional HDD spindles required to achieve the desired performance, SSDs offer lower power consumption, which translates into less heat generation and, in turn, lowers cooling costs at the system level. With datacenter processing power continually on the rise because of the use of dual-, quad-, and multicore processors, as well as limited (and expensive) DRAM cache, it's vital to keep hardware in synch and running efficiently.

SSDs offer higher reliability than legacy HDD-based storage systems. While SSDs have yet to be fully validated in the market by a sufficient span of historical statistics and experience, it's important to note that SSDs have no moving or mechanical parts that can fail. Early customer data reports and measurements indicate that SSDs provide a high mean time between failure (MTBF), and, in general, there's a low probability of mechanisms causing entire SSDs to fail.

IDC believes that because of these and other benefits, combined with the broad trends in the storage market described earlier, solid state storage has the potential to address up to 20% of enterprise data needs, depending on various workloads. These workloads include but are not limited to applications such as online transaction processing, ERP, data warehousing, data mining, and Web serving.

Key Trends in the Evolving SSD Environment

Datacenters are now increasingly virtualized and typically are built on industry-standard server platforms leveraging x86-based CPUs. Server virtualization is showing robust growth of over 30% per year. In fact, IDC projects that the installed base of virtual servers will equal that of physical servers by the end of 2011. Well-architected server virtualization, however, places big demands on IT organizations to optimize storage capabilities. This is because virtualization further exacerbates the performance gap described earlier by concentrating application I/O demands across fewer and fewer servers and randomizing these I/O requests.

The growing interest in virtual desktops also gives rise to another important new use case for SSDs. Large enterprises have the opportunity to consolidate multiple virtual desktops onto a single server that ultimately converges the I/Os of these desktops into a single I/O path. While desktop I/Os don't rival the performance requirements of servers, the concentration of these I/Os during peak periods (such as the beginning of a workday, when users are more likely to log in simultaneously) may cause delays if the underlying storage system is HDD based. Another related use case involves the need to launch multiple new virtual desktops at the same time. To overcome these I/O demand spikes, current technologies could require tens to hundreds of HDDs to match the performance of a single SSD. SSDs, however, have the capability to provide an answer to this problem.

Another key trend is that storage systems with enterprise SSDs have emerged, targeting a broad range of high-end applications (e.g., ERP, CRM, and HPC) with high I/O rate requirements.

In general, IDC remains positive on the outlook for SSDs and believes the trajectory for units and revenue growth is a source of optimism for SSD vendors and server/system OEMs. While solutions vary widely with various companies, the torrid pace of technological advancement at both the SSD component level and the system level is impressive. Key to this advancement is the critical IP in the SSD controller.

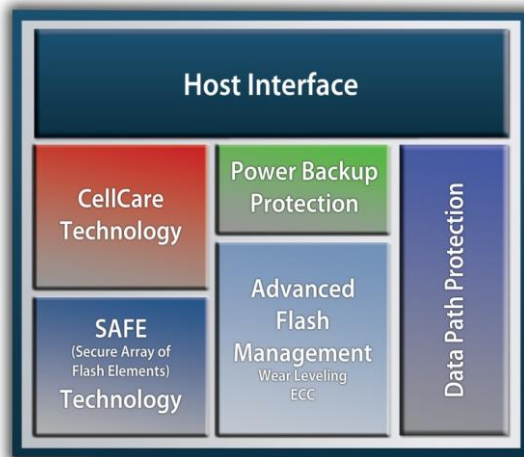
Considering STEC's Approach to Features and Functionality

As mentioned earlier, advanced controller technology is a crucial element in the overall performance of current-generation enterprise SSDs. STEC has placed a strong emphasis on developing its controller technology for enterprise-class adoption, whereas controllers used in the consumer market are typically low-cost, off-the-shelf devices that are not engineered for the demand of enterprise environments.

Endurance is a key consideration for differentiating between enterprise- and consumer-class products. In terms of advancing the state of the art, several companies, including STEC, have launched architectures that would provide enough write endurance for MLC implementations in an enterprise. Approaches to increasing enterprise endurance include sophisticated wear leveling, overprovisioning, strong ECC algorithms, and data path protection features. STEC SSDs have specifically been designed to extend MLC media life and performance for applications that may involve environments with more demanding workloads (see Figure 1).

Figure 1

STEC SSD Controller Architecture



Source: STEC, 2011

STEC's CellCare Technology is one of the company's key differentiators. CellCare Technology improves the endurance of MLC media, enhances performance, and reduces media access error rates for consistent performance over the entire useful life of the drive. This is done through the use of adaptive flash management algorithms, sophisticated digital signal processing techniques, and advanced ECC. The proactive NAND management provides improved overall endurance and performance over the useful life of the drive — which STEC warrants to be 10 full capacity writes to the drive per day, every day, for five years or more.

STEC's Secure Array of Flash Elements (S.A.F.E.) Technology, which is another of the company's key differentiators, reduces the faults and failures of SSDs by offsetting the reliability degradation of the underlying flash media. S.A.F.E. Technology is advanced redundancy technology developed by STEC that enables an SSD to recover from media errors and improve key reliability metrics, including MTBF and mean time to data loss (MTTDL). Using SSDs with CellCare Technology and S.A.F.E. Technology leads to lower total cost of ownership (TCO) by minimizing expensive system downtime, returns, and replacements and ultimately saving capex and opex dollars.

Market Challenges

Despite the numerous advantages that NAND-based SSDs provide, a number of associated challenges need to be addressed by STEC and other vendors as the market progresses. For many IT departments, the orders of magnitude in the price of SSDs, using a cost-per-gigabyte metric compared with traditional HDDs, remain one of the biggest hurdles for adoption. But as the growth in data to be managed and stored accelerates, the conversation changes to cost per I/O for performance-oriented applications. It is in this cost-per-I/O metric that SSDs become an order of magnitude more effective than their HDD counterparts.

As alluded to earlier, endurance in the enterprise is another ongoing challenge. Unlike HDDs, flash-based SSDs have limited device-level endurance (i.e., the underlying NAND technology has specific wear-out limits). As a result, customers and system designers need to become aware of the parameters that impact the endurance of the underlying NAND components, efficiency between the data written to the NAND media and the data received from the host (or write multiplication/reduction factors), and how efficiently data is managed across all cells in the NAND media (i.e., wear leveling). Clearly, the use of consumer-grade MLC devices with an advanced SSD controller cannot support the endurance requirements of demanding enterprise customers.

Conclusion

Looking forward, IDC envisions a set of growing IT organization needs that can be addressed by emerging SSD technology. Data content continues to grow exponentially, and, in general, system performance can clearly improve with SSDs. More specifically, IDC research shows that across the spectrum of datacenters today, a portion of total storage data in use is accessed frequently enough to benefit significantly from SSD implementations.

IDC believes that in the context of this broader adoption, SSDs will complement existing HDDs in certain applications and within a number of architectures. Technological advancements, such as STEC's CellCare Technology and S.A.F.E. Technology found in the STEC SSD controller, enable the increased use of SSDs across the enterprise. When combined with the declining cost of semiconductor technology and increased use of MLC media, SSDs have been pushed into the spotlight as a strategic technology for the storage market.

In sum, HDDs will continue to provide high-capacity storage and cost-effective (as measured by dollar per gigabyte) storage. However, the use of SSDs can provide a number of benefits that align with the desire for increased performance, more efficient storage utilization, faster access times, and

lower power consumption. IDC expects to see additional use cases emerge to bolster these trends and make SSD implementation increasingly beneficial for IT organizations.

A B O U T T H I S P U B L I C A T I O N

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