Lab Report

Dell Compellent

Breakthrough Savings with Flash Optimized SSD Tiering

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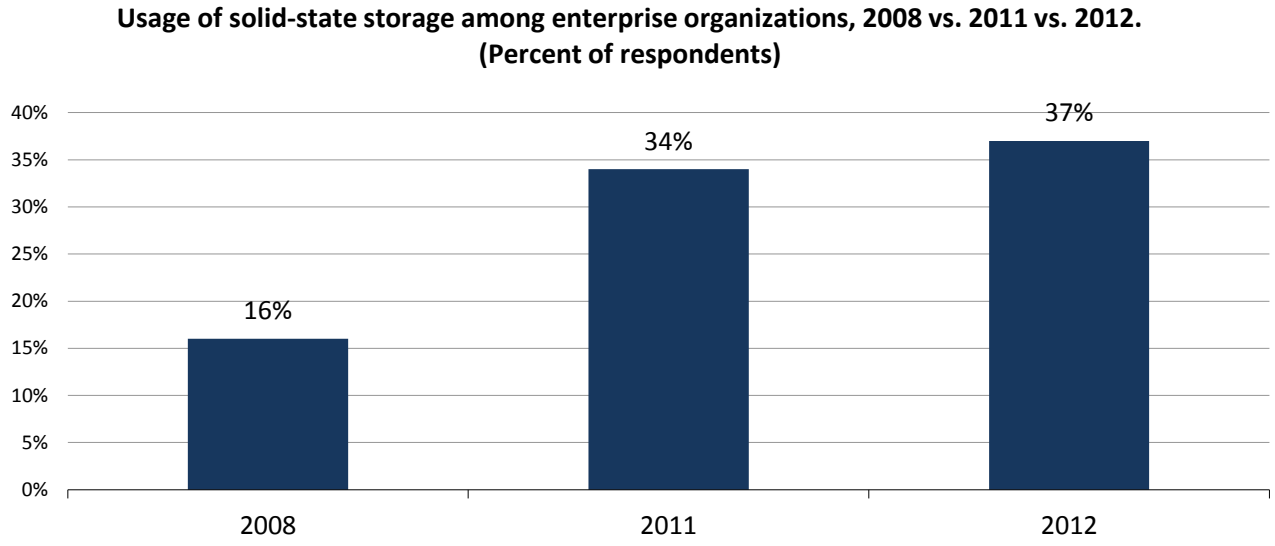
ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Dell.

Flash Trends and Challenges

A growing number of organizations are deploying solid-state storage solutions because they provide faster access to data while taking up less space and using less power than a traditional disk-based storage solution. In fact, ESG research has found that the percentage of respondent enterprise organizations that reported leveraging solid-state storage technology has more than doubled between 2008 and 2012. While more than a third of organizations are leveraging the technology in some form, 54% are in various stages of potential adoption: 17% plan on deploying the technology within the next year, 19% are currently evaluating the technology, and 18% are familiar with and interested in the technology. [1]

Figure 1. Solid-state Storage Adoption Is on the Rise



Source: Enterprise Strategy Group, 2013.

While the advantages of solid-state storage are compelling, the high price of flash compared with disk poses challenges for IT organizations that are struggling to contain costs while keeping up with growth. In fact, cost was reported by 65% of ESG research respondents as one of the most important criteria when they are selecting a storage vendor or solution, making it the number one response.[2] The goal of keeping costs down makes it hard for organizations to justify single-level cell (SLC) flash costs of up to ten times more than traditional disk drive capacity. While the acquisition cost of the SLC capacity in modular and enterprise-class storage solutions has been dropping in recent years, the price of disk capacity has been falling at close to the same rate.

Multi-level cell (MLC) flash costs less per gigabyte than SLC, which helps narrow the pricing gap between flash and disk, but MLC doesn't have the same write performance or durability as SLC. Some storage vendors are using enterprise-class MLC to address those performance and durability concerns. Dell is taking a different approach with a Flash Optimized architecture that leverages the lower cost (approximately 4X less) and higher capacity (approximately 4X more) of MLC, and the enterprise-class endurance and durability of SLC.

[1] Source: ESG Research Report, *2012 Storage Market Survey*, November 2012.
[2] Ibid.

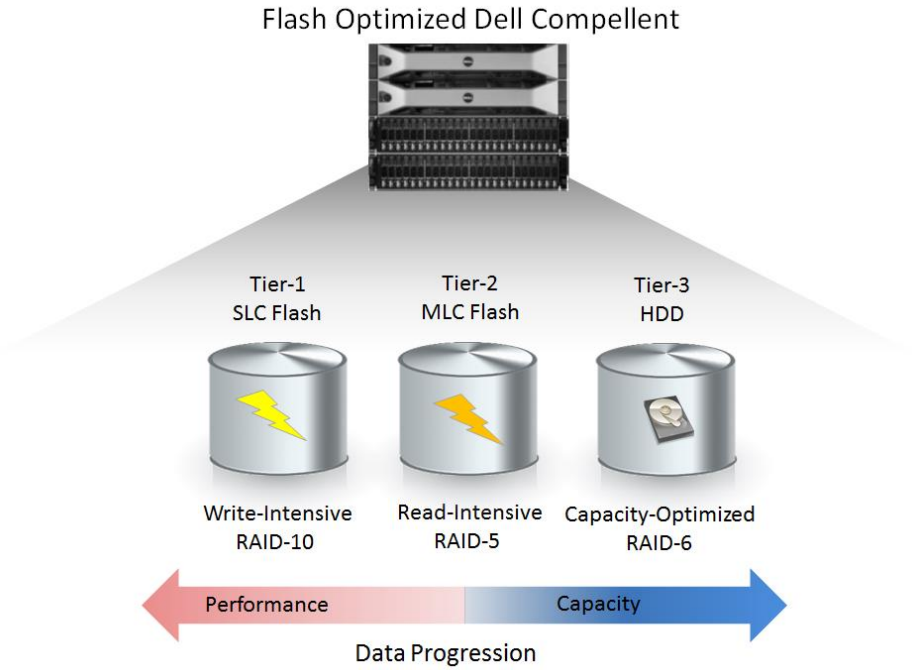
Fluid Flash Optimized Storage

Dell Compellent was architected from the ground up with a fluid architecture that automates the movement and protection of data at the block level by using capacity residing on different tiers of storage media. This capability, which Dell refers to as Data Progression, is ideally suited to get the most out of the latest innovations in storage media technology.

Data Progression makes it easy for Dell customers to cost-effectively take advantage of new media types that start at a price premium. For example, Data Progression provided a cost-effective performance boost for Dell customers a few years ago when 15K RPM drives first became available. More recently, Data Progression was used to get the most bang for the buck from high-speed SLC flash SSDs. Recently added MLC support and a new Flash Optimized architecture have once again proven the future-proof benefits of the Data Progression architecture.

The Flash Optimized Dell Compellent architecture leverages high performance SLC with enterprise-class endurance and reliability for writes and frequently accessed data. High-density MLC support, which was introduced in 2013, delivers the read performance benefits of flash at a lower cost per gigabyte. Traditional hard drives provide the best bang for the buck for long-term storage. In other words, tier-1 SLC flash is write-intensive, tier-2 MLC flash is read-intensive, and tier-3 hard disk drive (HDD) is capacity-optimized as shown in Figure 2.

Figure 2. Fluid Flash Optimized Storage



A comparison of the capabilities of currently supported flash SSDs illustrates why Dell uses SLC for the write-intensive tier and MLC for the read-intensive tier. Note how the 1.6TB MLC SSDs have great read performance at a fourth of the cost of SLC, but aren't as well suited as SLC for writes.

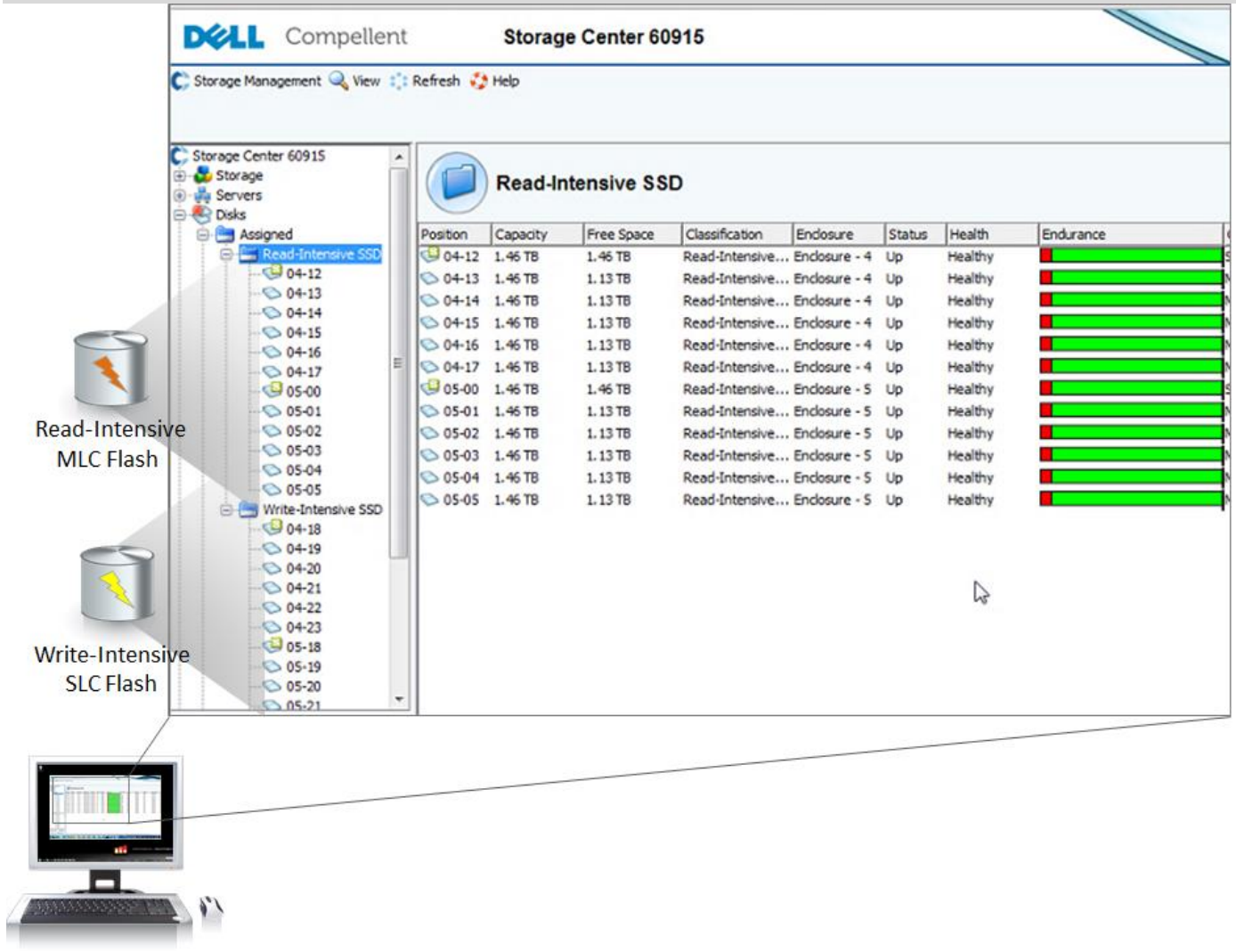
Table 1. SSD Flash Technology Comparison

	Write-intensive SLC	Read-intensive MLC
Cost	More (4x)	Less
Capacity	Less	More (4x)
Write endurance (written Petabytes)	More (10x)	Less
Read performance	Great	Great
Write performance	Good	Moderate/poor

ESG Lab Testing

ESG Lab performed a series of tests on a Flash Optimized SC8000 located in a Dell facility in Eden Prairie, Minnesota. The Dell Compellent Storage Center management console shown in Figure 3 was used to verify the configuration and health of an SC8000 configured with 12 1.6TB read-intensive MLC SSDs and 12 400GB write-intensive SLC SSDs.

Figure 3. The Flash Optimized SC8000 ESG Lab Test Bed



Note the high usable capacity of 1.46TB for the 1.6TB MLC SSD devices which Dell began shipping in 2013. 1.6TB is four or more times the capacity of the SLC SSDs used in enterprise-class modular storage systems from Dell and major vendors. 1.6TB is not only greater than the capacity of a typical SLC SSD, but is also greater than the capacity of the enterprise-class 10K and 15K RPM disk drives that have traditionally been used to alleviate performance bottlenecks in I/O-intensive application workloads.

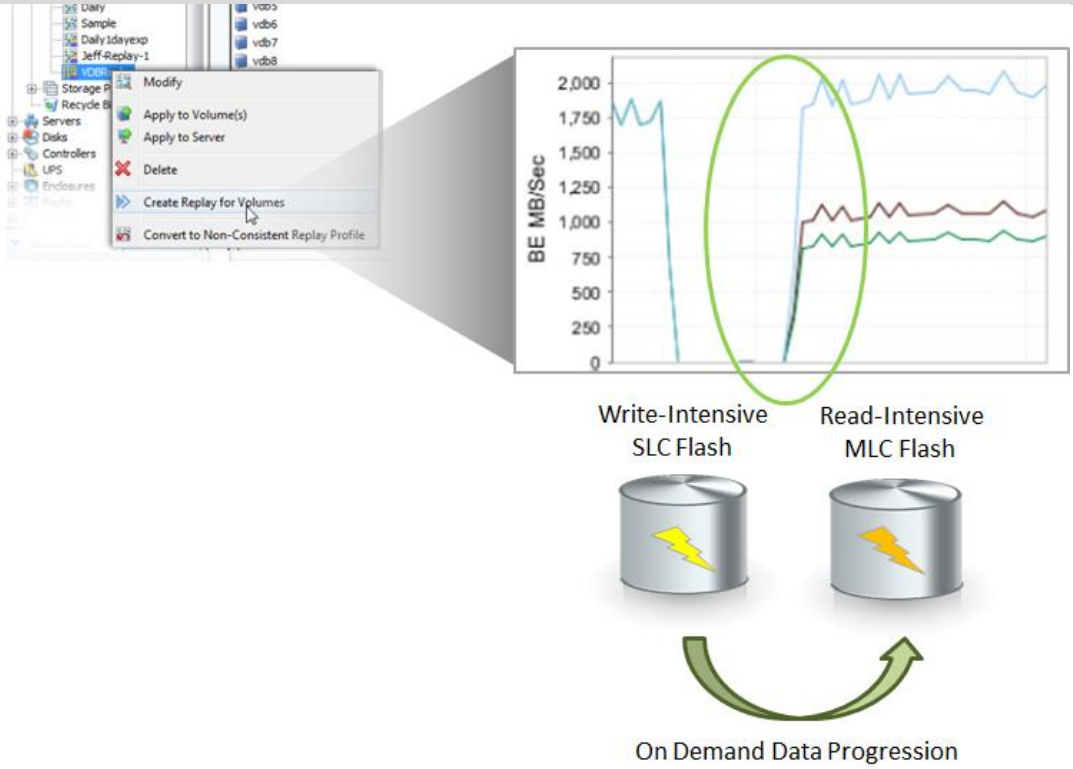
ESG Lab was impressed with the intuitive method of depicting MLC SSD write endurance shown toward the right in Figure 3. Write endurance is a measure of how long a flash device can continue processing writes. This is an important metric to monitor because flash memory can be overwritten a finite number of times before it has to be reallocated or replaced. In this example, the green bar shows that there is plenty of write endurance left for a set of MLC SSDs, which had been used heavily for months in a Dell lab.

On Demand Data Progression

Dell's Flash Optimized architecture ensures that data is written to the highest performing SLC tier. On Demand Data Progression kicks in later and migrates data from write-intensive SLC to read-intensive MLC when a Data Instant Replay (i.e., snapshot) is taken. This frees up resources with a goal of ensuring that newly arriving I/O requests get the write performance and endurance benefits of the write-optimized SLC tier. It also ensures that recently written data gets the great read performance of flash at the lower cost of MLC.

ESG Lab's testing of On Demand Data Progression on the Flash Optimized SC8000 configuration is shown in Figure 4. The SC8000 was primed with a random mixed workload that emulated the activity of a typical OLTP database application with the industry-standard IOmeter utility. Performance was monitored with the Dell Enterprise Manager utility to confirm that I/O requests were being handled by the write-intensive SLC flash tier. As shown in Figure 4, On Demand Data Progression was kicked off by configuring a replay from the Storage Center console and the Enterprise Manager Utility confirmed that recently written data was migrating from write-optimized SLC to read-optimized MLC flash.

Figure 4. On Demand Data Progression in Action



Why This Matters

Slow application response times can lead to a loss of sales, loss of customer goodwill, loss of productivity, and increased costs. Using flash instead of traditional disk drives improves the performance of I/O-intensive applications, but the cost per gigabyte of SLC flash adds a lot of cost compared to disk. Large capacity MLC flash SSD reduces that cost differential significantly, but isn't ideally suited for enterprise-class application workloads with heavy write traffic.

ESG Lab has confirmed that the Flash Optimized Dell Compellent architecture with On Demand Data Progression delivers the performance benefits of flash at a dramatically lower cost with an innovative approach that leverages SLC for writes and MLC for reads.

The Bottom Line

ESG Lab examined Dell's claims that an all-flash Compellent SC8000 can be less expensive than the price of a 15K RPM all-disk configuration. We also compared the cost of a Flash Optimized mix of MLC and SLC with the cost of all-flash modular disk arrays from major storage and systems vendors. Dell's all-flash price advantages are fueled by a number of factors, including:

- Dell's buying power and supply chain management, which reduces the cost of flash in storage arrays, servers, laptops, and consumer devices.
- Recently introduced MLC SSDs with capacities of up to 1.6TB in a 2.5" form factor.
- Flash optimization with On Demand Data Progression, which reduces the cost of a mix of SLC and MLC flash.
- A fluid architecture that reduces cost and optimizes performance with policy-based data placement and tiering.

Fluid Flash at the Price of Disk

The cost per gigabyte of the high-capacity MLC devices that Dell recently started shipping is about the same as the cost per GB of the low-capacity 15K RPM hard drives that have typically been used to address I/O performance problems. This is a surprising and significant development given the fact that the price differential between flash and disk remains significantly high for the enterprise-class SLC and MLC that has been deployed to date in most disk array solutions. A comparison of the street price and performance of all-disk and all-flash Dell Compellent SC8000 systems as of June 2013 is summarized in Figure 5 and Table 2.

Figure 5. Fluid Flash at the Price of Disk

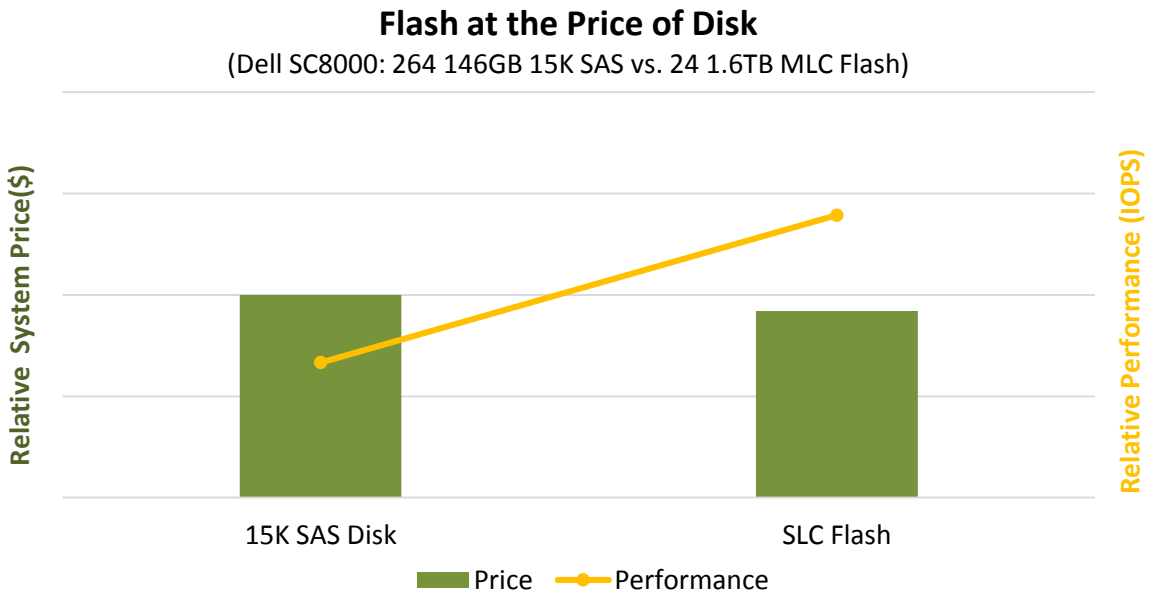


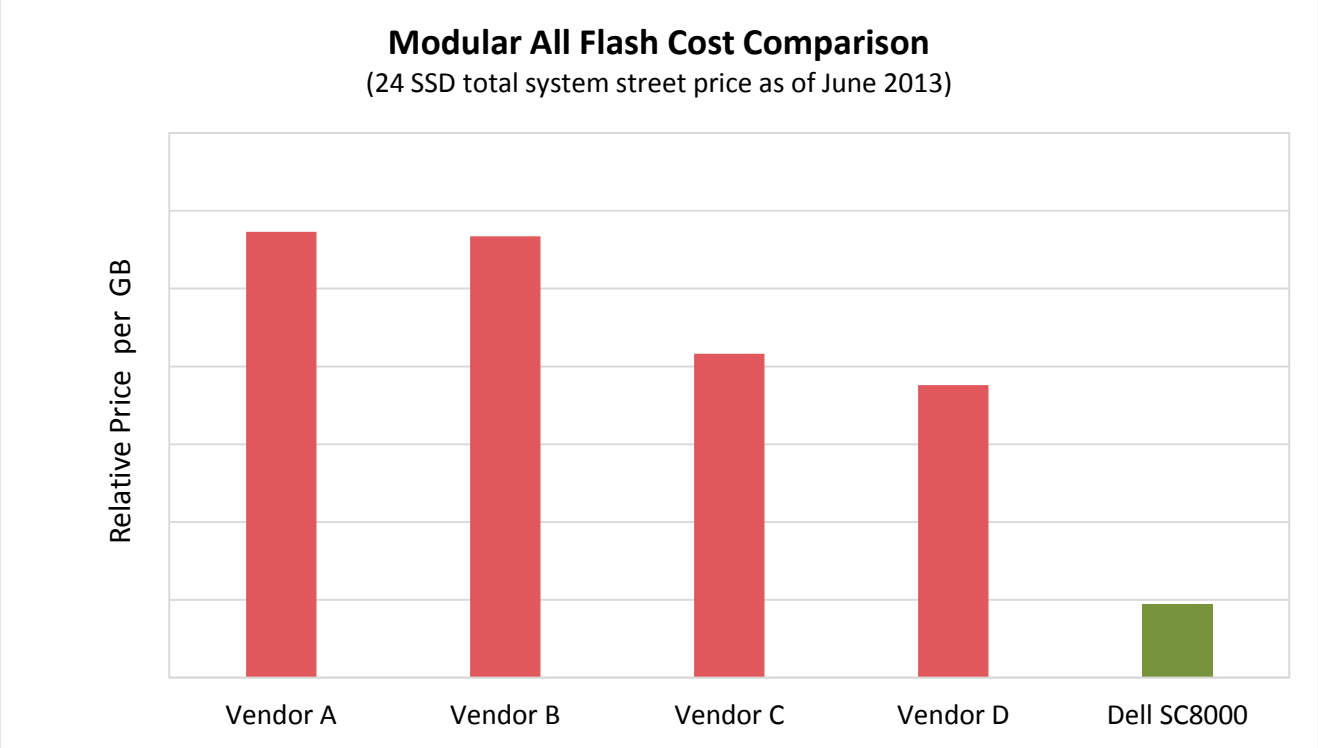
Table 2. Dell Compellent SSD vs. 15K SAS HDD

	SC8000 HDD	SC8000 SSD	SSD vs. HDD
System Capacity (TB)	38.5	43.2	Slightly more raw capacity
Relative System Price	100%	92%	Slightly less cost
Rack Units	26	6	77% less rack space
Relative Performance (latency)	100%	14%	86% faster response times
Relative Performance (IOPS)	100%	209%	More than twice the I/O per second

Four to Six Times More Cost-effective

ESG Lab compared the cost of an all-flash Dell Compellent SC8000 with the 24 SSDs with the cost of all-flash modular storage solutions with 24 of the highest capacity SSDs from major storage and systems vendors as of June, 2013. As shown in Figure 6, the street price of the Dell SC8000 with a mix of fast SLC and slower but less expensive 1.6TB MLC SSD is four to six times lower than all-flash solutions from major vendors. The Flash Optimized SC8000 not only reduces the cost of an all-flash storage solution, but also provides 3.5 to 8.75 times more capacity.

Figure 6. Modular All-flash Cost Comparison



Why This Matters

Companies continuously face challenges in cost-effectively meeting service level agreements for business-critical applications—especially for I/O-intensive applications with strict performance requirements. Failure to meet performance requirements can result in lost productivity and costly loss of services. Over-provisioning to avoid performance problems is a waste of money.

Leveraging the affordability of commodity MLC flash technology and an intelligent Flash Optimized architecture with On Demand Data Progression, the Dell SC8000 can be configured as a cost-effective all-flash storage solution. ESG Lab confirmed that the cost per gigabyte of an all-flash SC8000 is about the same as an all-disk SC8000 with 15K RPM disk drives, and is four to six times less than all-flash modular solutions from major storage and systems vendors.

The Bigger Truth

Storage Center was architected from the ground up with the efficiency and savings of tiering between different types of storage media in mind. Long before Dell acquired Compellent, Storage Center was one of the first products in the market with built-in sub-LUN tiering (a.k.a. Data Progression).

When ESG Lab first tested a Compellent solution in 2008, we were impressed by the cost-effective flexibility of a fluid architecture that automatically leverages the highest performing tier of storage for writes and recently accessed reads as it migrates less frequently used data to a more cost-effective tier of storage over time. Back then, the fluid architecture was not only tiering between drives with different rotational speeds and RAID levels, but also providing the unique ability to configure the faster outer regions of spinning disk drives as the highest performing tier. Since then, Dell has acquired Compellent and that fluid architecture provided a sound foundation for a new family of Flash Optimized storage solutions that leverage the unique characteristics of the latest SLC and MLC flash technology.

The Flash Optimized architecture of the SC8000 with On Demand Data Progression provides a compelling alternative to competitive all-flash approaches. Instead of using enterprise-class MLC to increase write endurance and performance, Dell uses SLC as a write-optimized first tier and high-capacity MLC as a cost-effective read-optimized second tier. Instead of using data deduplication, which adds overhead and can impact performance with a goal of reducing costs, Dell leverages the compellingly low cost of the latest high-capacity MLC to reduce the cost of flash capacity. Instead of writing data to disk and using tiering or caching after the fact to get a flash performance boost, Dell's fluid architecture always writes to the highest performing tier.

ESG Lab has confirmed that a Flash Optimized SCS8000 with a hybrid mix of SLC and high-capacity MLC can be used to create an all-flash storage solution that's four to six times more cost-effective than an all-flash modular array from major storage and systems vendors.

While the street prices presented in this report were accurate to the best of ESG Lab's knowledge as of June 2013, you're encouraged to perform your own pricing analysis, taking into account a number of factors, including the unique capacity and performance requirements of your organization, the constantly falling price of flash memory, and the fact that at least one major vendor had announced, but not yet publicly priced, MLC flash support as this report was being prepared for publication. That said, ESG Lab is confident that the SC8000 will continue to be known as the value leader due to Dell's world-renowned supply chain efficiency and a Flash Optimized architecture that lowers the cost of solid-state storage with a mix of high-performance SLC and high-capacity MLC.

So, if you're a Dell Compellent customer looking to get more performance out of your existing investment, a no-cost online Storage Center upgrade and a touch of SLC and MLC is a no-brainer. If you're shopping for a net-new all-flash array to boost the performance of a business-critical application, you should seriously consider the compelling economic advantages of a Flash Optimized SC8000.

Enterprise Strategy Group | **Getting to the bigger truth.**

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