



# New economies of storage with the Compellent Flash-optimized solutions

Flash at the price of disk for I/O-intensive applications

A Dell Business White Paper  
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# 1 Executive Summary

Trends such as server virtualization and the proliferation of multi-core processors are increasing the requirement for high I/O performance with ultra-fast response times. Flash storage is the leading technology that enables IT to turbocharge I/O intensive applications and deliver the low latencies and ultra-fast response times that they need. Workloads such as OLTP, Data Warehousing and Virtual Desktop in particular can reap the benefits of flash storage, delivering impressive results in operations such as on-line queries, batch processing, retail transactions, business analytics, peak-time VDI logins, and many others. But until now, flash storage has been too expensive for most customers to deploy on a large scale, and was mostly used for the select, high priority workloads. With the introduction of the Dell Compellent flash-optimized solutions, Dell changed the economics of flash storage and broke the current pricing boundaries. By offering solutions that can provide performance at the capacity and price of a rotating disk, Dell is making flash storage affordable and accessible to a broader segment of the market.



## 2 Not one disk drive type can address all storage needs

With the exponential data growth and increasing pressure on the data center to efficiently handle many diverse types of application workloads, a traditional “one size fits all” strategy for storage design no longer works. In order to determine the best architecture of a storage system, IT administrators need to understand the characteristics of each application: what type of performance it requires as measured in IOPS vs. throughput; how much data is hot and frequently accessed vs. cold or not performance sensitive; what is the ratio of heavily read vs. heavily written data; are the I/O patterns sustained or bursty; what are the typical transfer rates; and how much business value does the data deliver. Understanding these workload characteristics is the first step in designing a storage architecture that can align the application performance with cost requirements. Since there is not one type of a disk drive that can address all these needs, IT managers search for flexible, scalable storage solutions that can handle these requirements in a cost-effective way.

In parallel, the reliance of IT organizations on business critical, IOPS-hungry workloads that run key operations is increasing. This dependency is being fueled by market trends such as server virtualization, which increases the demand for random I/O with the “mixer effect,” stressing the rotating disks which do not handle random I/O well, and a proliferation of multi-core processors which leads to a higher demand for I/O per server. On the other side of the spectrum, an explosive growth of unstructured data drives the need for less expensive high capacity storage. These escalating but opposite requirements leave IT managers looking for storage solutions that can efficiently span both hot and cold data, optimizing for performance and value based on specific workload requirements.

To respond to these challenges Dell has introduced the Compellent flash-optimized solutions which combine enhancements in Data Progression (Compellent’s tiering engine) with new flash and dense enclosures. Data Progression automates the process of matching the right media with the right workload, in this case, seamlessly leveraging the unique strengths of different types of SSDs. This innovation delivers flash solutions for performance-sensitive workloads at the price of a traditional rotating disk storage system<sup>1</sup>. Compellent all-flash and hybrid-flash configurations are based on a variety of SSD and HDD disk types, addressing a broad range of enterprise workloads, and delivering the highest economic value to the customer.

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<sup>1</sup> The Dell Compellent all-flash solutions cost less than a comparable 15K disk drive solution. Source: Internal Dell analysis in July 2013 based on Dell Compellent flash-optimized and spinning disk US list pricing.



### 3 Leveraging flash to improve workload performance

Organizations are finding that traditional spinning disk storage can no longer address the requirements of many business critical workloads efficiently. As one of the last remaining mechanical devices in the server to storage data path, spinning disks in HDD-based storage systems introduce inherent rotational and seek latencies that limit application performance. Flash has emerged as a storage medium that can address many of the demanding characteristics of high I/O workloads, and the single easiest way to provide dramatic performance gains for applications that need new levels of real time responsiveness. In addition to excelling at random I/O performance and delivering predictable ultra-low latency, SSD-based arrays can pack many more IOPS into a smaller footprint than a comparable HDD system, using less power and space and allowing customers to scale out capacity in place.

But for many organizations, cost (as measured in \$/GB) is still the top barrier to the broad adoption of flash. A majority of all-flash solutions on the market today do not meet the cost or capacity requirements of today's demanding applications, and many do not offer the enterprise-class features that the customers need to run an agile and resilient data center. Because of its high price, until recently flash storage was predominantly used in the PCIe SSD form factor within application servers as cache memory (Tier-0) for niche applications, or within shared storage systems reserved for the highest-priority, targeted workloads. In both cases, flash SSDs were often used as point solutions, with the customers "carving out" space for high performance storage needs.

This pricing model is now changing. The \$/GB flash prices, although coming down, are expected to remain considerably higher in the coming years than the prices of the 15K RPM HDDs. This drop in price has accelerated the adoption of flash solutions, addressing the pent up demand for high I/O application performance. Once flash reaches the right price point, enterprises will be able to deploy it in larger capacities, more like HDDs, with multiple flash drive types used to populate multiple tiers of storage in an array. In the meantime, solution-level innovations such as the ones introduced on Dell Compellent, disrupt the traditional storage boundaries, bringing in new economics of storage with advances in intelligent tiering and a unique use of multiple types of SSD drives to deliver a significant price advantage. Dell's flash-optimized solutions offer an opportunity to take advantage of the leading-edge flash technologies today without taking the risk of waiting for the uncertain future.



## 4 How does flash-based storage deliver business value?

Flash storage can deliver the biggest performance boost to the applications that run highly transactional, I/O-intensive workloads with random read-intensive or write-intensive I/O, including OLTP, Data Warehousing and VDI. In these workloads, flash storage can support business-accelerating projects by bringing new levels of real-time responsiveness.

**OLTP** workloads are used by the transaction processing applications such as e-commerce, banking, on-line catalogs, store registers and ATMs, where the response times to user requests are critical. Flash storage can help improve the e-commerce web page responsiveness during the peak hours and shorter wait times, resulting in a higher customer satisfaction; slow responses, on the other hand, may mean a loss of business. Faster user access to product features or pricing may mean higher profitability and more web revenue through a higher number of completed and fewer abandoned sales transactions.

**Data warehousing** workloads include data mining, trend analysis, business modeling and hypothesis testing that are vital in today's competitive environment for creating business strategy. To stay competitive, enterprises need to process analytical intelligence or generate reports just-in-time to make data-related decisions that provide an immediate ROI, or to formulate or adjust their business strategy based on the incoming sales results. For these workloads flash can help deliver quicker business insights by increasing the speed of completing batch jobs.

In **VDI** deployments, where a centralized server hosts desktop OS within a Virtual Machine, flash can reduce desktop log-on time latencies during boot storms and help maintain high host IOPS and throughput. This can be essential to the end-user satisfaction level, VDI adoption rates and often the overall success of the VDI deployment project.

In addition to supporting the initiatives designed to accelerate business, increasing operational efficiencies is another major benefit of flash. Since a flash storage solution needs less hardware than a traditional storage platform for the same workload, enterprises can minimize the data center footprint. Less hardware also means lower power consumption and cooling, lower software license and support costs, and an overall reduction of operational expenses. Finally, a smaller system with fewer disks is simpler to manage, may be less prone to outages and downtime and requires fewer administrators, further reducing operational expenses.



## 5 How Compellent changes the economics of flash storage

By delivering flash at the price of disk, Compellent's enterprise-class software and unique way of tiering sub-LUN data across multiple types of SSDs and traditional rotating drives, Dell can help achieve significant cost savings compared to competing storage solutions.

### 5.1 New Compellent Storage Center 6.4, flash and dense enclosures

With its recent enhancements, the Compellent array, Dell's, enterprise-class, unified block and file storage platform, changes the economics of flash storage and opens up the use of flash to a broader set of deployments at a more accessible price point. Continuing the evolution of the Compellent platform, Dell leveraged flash, storage tiering and dense storage technology advancements to drive down costs of storage while boosting performance of the applications:

- Compellent Storage Center (SC) 6.4 extends tiering to multiple flash drive types, combining it with enhancements in Data Progression, to deliver the best application performance at the lowest possible cost.
- A flash enclosure, designed to be used for all-flash and hybrid-flash arrays, supports multi-tiering of flash between new higher capacity and lower cost read-intensive multi-level-cell (MLC) SSDs, and write-intensive single-level-cell (SLC) SSDs, and the traditional rotating drives. Combined with flash enclosures, SC 6.4 delivers high-performance flash storage at a fraction of the cost compared to other storage solutions.
- A dense enclosure, which with 336TB in 5U is the densest solution of any major vendor<sup>2</sup>, is ideal for cost and capacity optimized cold data. It can be architected into hybrid-flash Compellent configurations as Tier 3 to provide an efficient, low-cost storage for cold data.

### 5.2 Introducing high capacity, read-intensive MLC SSDs

There are several types of SSDs on the market, each with different attributes designed to deliver the best performance, cost or endurance (see Table 1). Most of the available flash shared storage solutions use a single type of SSDs, usually a write-intensive (WI) SLC SSDs which have high endurance but lower capacity and a high cost. In Compellent's innovative approach in which two types of flash drives are deployed in a single enclosure, flash is tiered across the SLC SSDs and MLC SSDs, which have a higher capacity and lower endurance but a considerably lower price, blending the attributes of these SSDs to achieve a superior \$/GB<sup>3</sup>. Since competitive flash solutions do not separate data reads from data writes, they are not able to use the read-intensive MLC SSDs and rely only on a single SSD type, eMLC or SLC. As these systems address all performance needs with a single flash tier, they waste the expensive capacity on data that is frequently read but not frequently written to, keeping their \$/GB pricing very high.

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<sup>2</sup> Based on February 2013 internal Dell analysis comparing SC280 to comparable 2U 3.5" disk drive enclosures.

<sup>3</sup> The Dell Compellent all-flash solution costs less than a comparable 15K disk drive solution based on internal Dell analysis in July 2013 using Dell Compellent flash-optimized and spinning disk US list pricing.

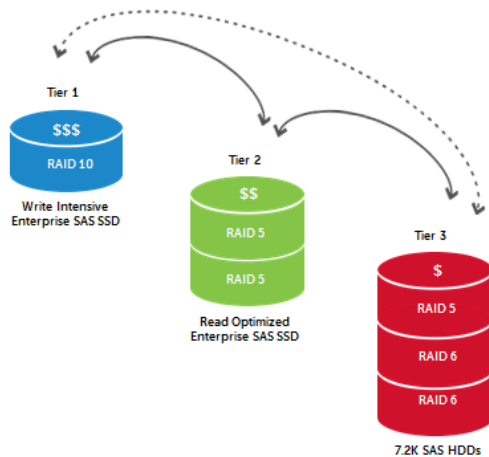


	Write-Intensive (WI) SLC SSDs	Read-Intensive (RI) MLC SSDs
Workload	Mainstream applications	Mostly Read 90/10 R/W Mix
Capacity	400 GB	1.6 TB
Write endurance	Great	Moderate
Full-drive writes/day	30	3
Random read performance	Great	Great
Write performance	Great	Moderate to poor
Relative costs	4x	1x

Table 1 SSDs are designed with various attributes to address different data requirements.

### 5.3 Data Progression is the secret sauce

Dell Compellent virtualizes the placement of data on the optimal storage tier and RAID level using technology called Data Progression. Based on the actual use of data, Data Progression can determine if a block is heavily accessed and how often access typically occur. If a block is heavily used, Data Progression automatically moves that block to a high-performance disk. If the block is inactive, it is migrated to lower cost, high-capacity disk. Unlike other arrays that require time consuming and complex disk pool management, Data Progression automates the placement of data where it belongs, streamlining management and reducing storage costs.



In Compellent SC 6.4, Data Progression was optimized for flash drives, automating the process of matching the workload with the most advantageous storage media. The incoming data writes are written to the write-intensive SLC SSDs in Tier 1 for fast access and high endurance. The reads are identified and automatically moved to less expensive, larger capacity read-intensive Tier 2 MLC SSDs, keeping Tier 1 free for new incoming writes. Cold and non-performance data is subsequently migrated to less expensive rotating disk in Tier 3 which is optimized for large capacity, lowest \$/GB. Taking advantage of the best attributes of SLC and MLC SSD drives, as well as capacity-optimized spinning drives, performance is optimized with price for the most advantageous total cost of ownership (TCO).

Figure 1 Flash optimized Data Progression leverages the endurance of SLC SSDs and the value of MLC SSDs.



## 5.4 Use case 1: Compellent all-flash array vs. a single SSD-type competitive all-flash array

In this example, we compare the total cost of a Compellent all-flash system (with flash tiering across SLC and MLC SSDs) with a competitive all-flash system based on a single SSD type. Because the Compellent solution mixes different types of SSD drives, it uses larger, lower cost MLC SSDs to provide most of the required capacity. Consequently, to reach the same storage capacity, the Compellent solution will need less hardware, power and cooling, software and support, resulting in a system that is 1/5<sup>th</sup> of the price of a competitive all-flash configuration.

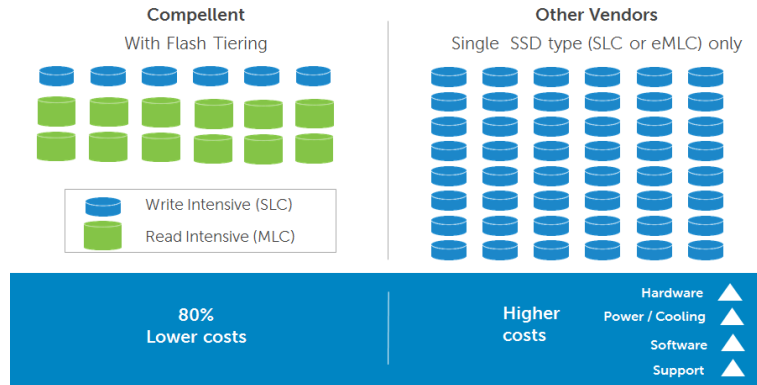
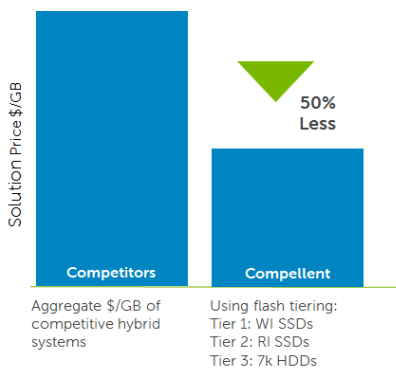


Figure 2 New economies of flash with Compellent: 1/5<sup>th</sup> the price vs. competitive all-flash solutions<sup>4</sup>.

## 5.5 Use case 2: Compellent hybrid-flash array vs. a competitive hybrid solution



In this example, we compare the \$/GB solution price of a Compellent hybrid array with that of an aggregate \$/GB of a competitive hybrid system. As discussed, the Compellent hybrid array has three storage tiers, with Tier 1 populated with the SLC SSDs, Tier 2 with the MLC SSDs and Tier 3 with the 7K RPM HDDs. The competitive hybrid systems are based on a single type of SSD drive such as SLC or eMLC and HDD drives. Blending the \$/GB across multiple drive types achieved with flash tiering results in a significant price advantage of the Compellent system which is 1/2 the price of a comparable aggregate competitive system.

Figure 3 New economies of flash with Compellent: 1/2 the price vs. competitive hybrid solutions<sup>4</sup>.

<sup>4</sup> Competitive US list pricing from Gartner Inc, CP Storage, as of June 2013. Market price calculated assuming a discounting of approximately 50% for all competitive systems and Dell Compellent.



## 5.6 Aligning storage performance with workload requirements

Since environments and applications each have unique performance requirements, IT managers need a variety of options to choose from to meet their specific storage needs. Designed for flexibility and agility, Compellent can address multiple performance environments, aligning storage performance with workload requirements of enterprise applications. It helps maximize the value of storage by addressing:

- Business critical workloads with Compellent all-flash solutions. With large capacity flash that delivers both scalability and low latency, they are ideal for OLTP Oracle or SQL databases, VDI gold images and logs and big data analytics.
- General workloads with Compellent hybrid-flash solutions. In these workloads, which require both, high capacity storage and mainstream application performance, application performance can be dynamically increased for selected workloads with limited flash capacity while cold or infrequently-accessed data can reside on capacity-optimized HDDs.
- Non-performance sensitive workloads with Compellent cost-optimized, HDD-based solutions. With large capacity and the lowest available \$/GB, they are ideal for applications that require large datasets such as backup and archive.

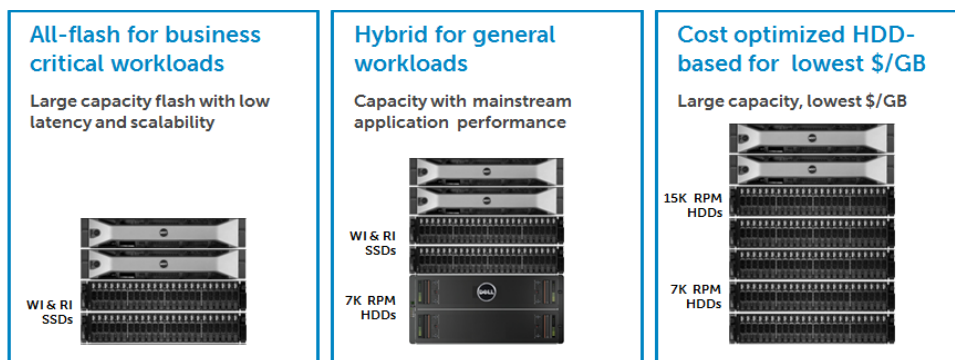


Figure 4 Compellent is designed to address multiple performance levels, helping to align storage performance with workload requirements.

## 6 Compellent extends the economic value with a feature-rich storage platform

Architected to enable the most efficient use of every disk, Compellent storage provides exceptional efficiency and an outstanding TCO. Tiered flash innovations further extend the economic value of Compellent while bringing higher performance to the workloads that need it. A multi-purpose storage platform which brings enterprise-class features to the mid-tier market, Compellent provides enterprise-class features such as thin provisioning, automated tiering, replication, unified file and block storage, replays, and 3rd party application integrations with VMware, Oracle and Microsoft, to ensure the highest utilization of storage resources. Compellent maximizes value to the customers through a variety of other innovative features such as seamless capacity scalability across block and file data without rip-and-replace upgrades, and a perpetual software licensing model which ensures that customers never need to re-purchase the same software again, making it a future-proof platform which can evolve to address changing customer needs. This system agility and resilience are some of the Compellent attributes that other flash storage providers, particularly the smaller startups, can't deliver.

With a complete portfolio of primary, archive and backup products, Dell offers a broad choice of storage solutions for various enterprise needs. Dell's storage portfolio is designed to help organizations manage valuable business information more effectively in virtualized data centers.

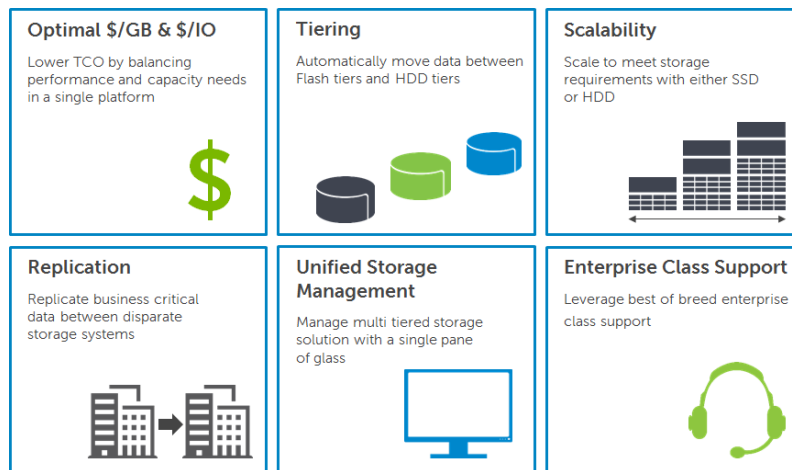


Figure 5 Compellent's enterprise-class features deliver exceptional performance, scalability and efficiency.

## 7 For more information

- Product web pages: [dellstorage.com/Compellent](https://dellstorage.com/Compellent) and [dell.com/flash](https://dell.com/flash)
- [Storage Switzerland Lab Validation: Mixed All-Flash Array Delivers Safer High Performance](#)
- [Dell Compellent Flash-optimized Solutions Spec Sheet](#)
- [Dell Compellent SC200 and SC220 Enclosures Spec Sheet](#)
- [Dell Compellent SC280 Dense Enclosure Spec Sheet](#)
- [Dell Compellent Family of Products](#)
- [Efficient Storage Consolidation with Compellent Solution Brief](#)

