
Changing the economics of flash storage

Flash at the price of disk



Peter Trevaskis

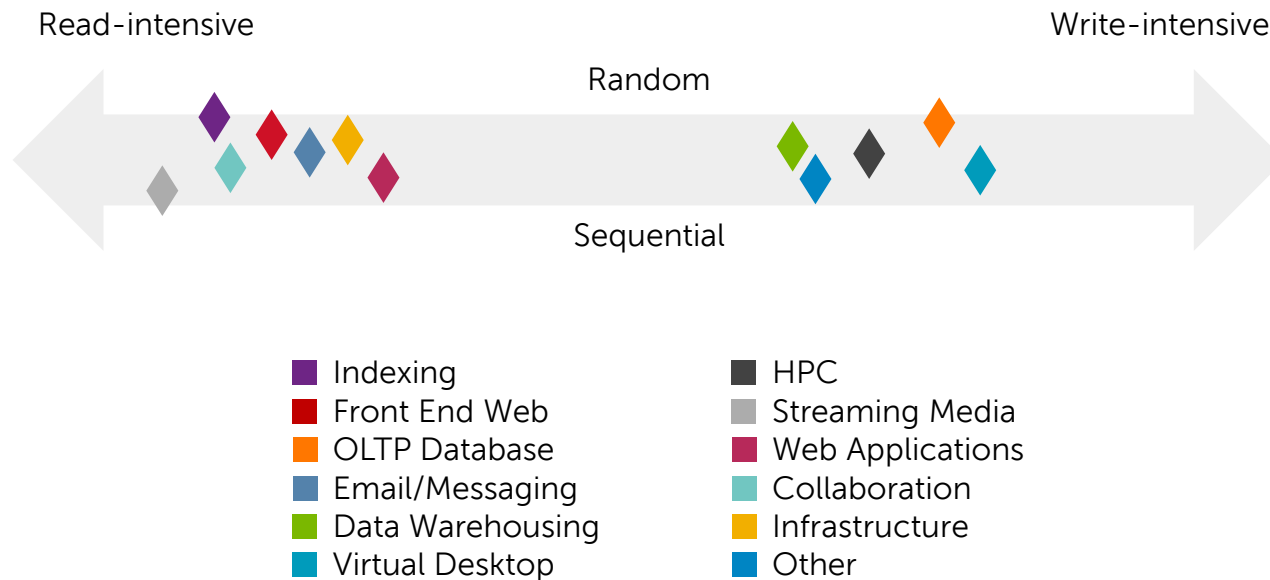
Enterprise Marketing Manager

Agenda

- 01** Traditional “one size fits all” data storage strategy no longer works
- 02** Increasing reliance on I/O-intensive applications and solutions
- 03** Adoption of flash is accelerating
- 04** Dell Compellent changes the economics of flash storage
- 05** Dell EqualLogic Flash Solutions
- 06** Aligning storage performance with workload requirements
- 07** Enterprise features extend the economic value



Data centers need to handle many types of diverse application workloads



- Applications are getting more dependent on higher I/O performance
- Traditional storage systems are optimized for the middle of the spectrum
- Data stored, backed up and archived is growing exponentially
- SLAs are becoming more rigorous
- IT budgets are often staying flat

What characterizes **your workloads**?

Traditional “one size fits all” data storage strategy is inefficient

Performance

- Hot data that needs to be retrieved extremely fast without latency
- IOPS vs. throughput

Access patterns and frequency

- Data accessed frequently vs. cold, rarely accessed data
- Heavily read vs heavily written data
- Data optimized for tiering vs caching

I/O patterns

- Read and write percentages
- Transfer sizes
- Sustained vs. bursty I/O patterns

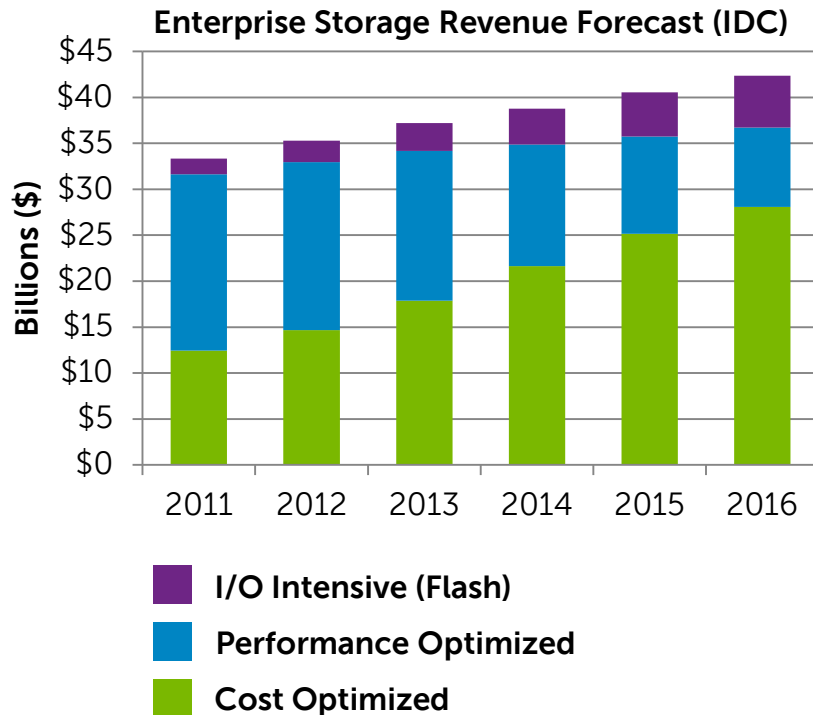
Business value

- Data that is highly valuable to the business and can be used for deriving business intelligence, financial analysis, etc.

Each type of data needs to be treated differently to align the application performance with capacity and cost requirements



Reliance on I/O-intensive solutions for critical applications is growing



Hot/
Active
Data

I/O intensive solutions growing at 57% CAGR as SSD prices are reduced

Cold/
Static
Data

Cost/capacity optimized 19% CAGR growth is driven by the explosion of unstructured data

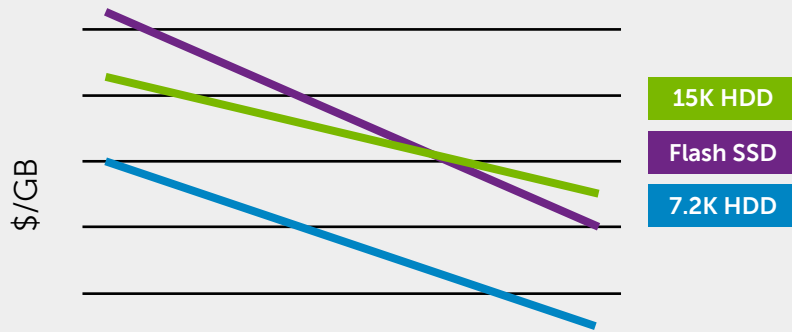
IT Managers are looking for storage solutions that can span both, hot and cold data, optimizing for performance and value

IDC., Worldwide Enterprise Storage Systems 2013–2017 Forecast, May 2013; Doc #241033

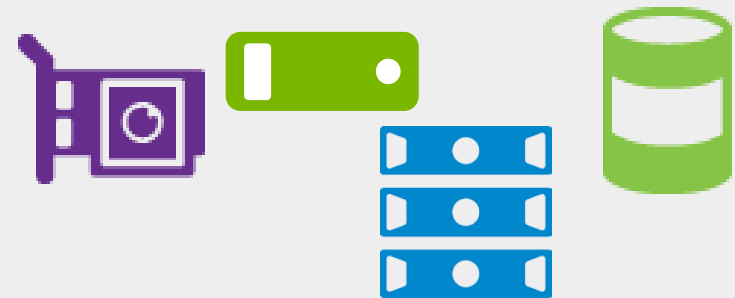
Flash adoption is accelerating

Pent-up demand for improving application performance at the right price point

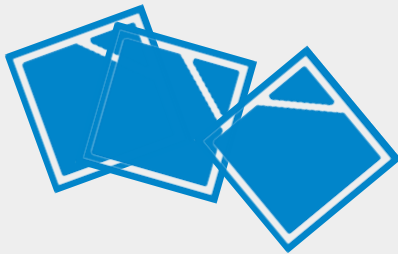
Flash prices falling faster than HDDs but still considerably higher than 15K HDDs



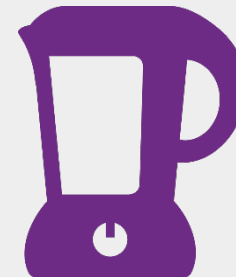
New form factors: PCIe cards, appliances, shared storage



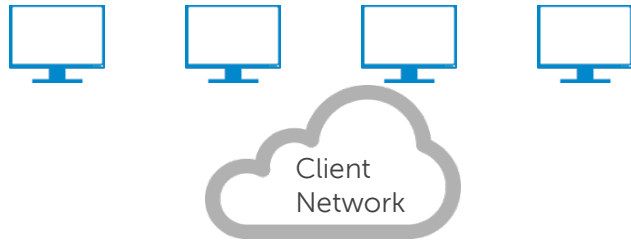
Multi-core processors drive up processor utilization and demand for more I/O per server



Virtualization is increasing the demand for random I/O with the "mixer effect"



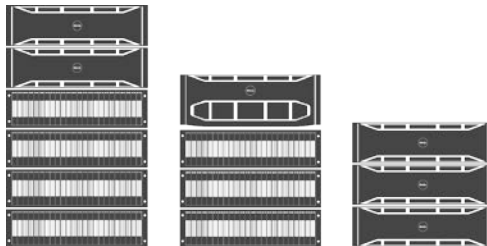
Flash storage can be deployed at **various layers** to accelerate application performance



Dell
Fluid Cache
for DAS on
PowerEdge



Dell
Compellent
All-Flash or
Hybrid-Flash
Array



Server-based cache (Tier-0)

- Flash drives placed directly on high speed PCI bus in application servers
- Caching software enables server to leverage flash storage as an extension of memory cache

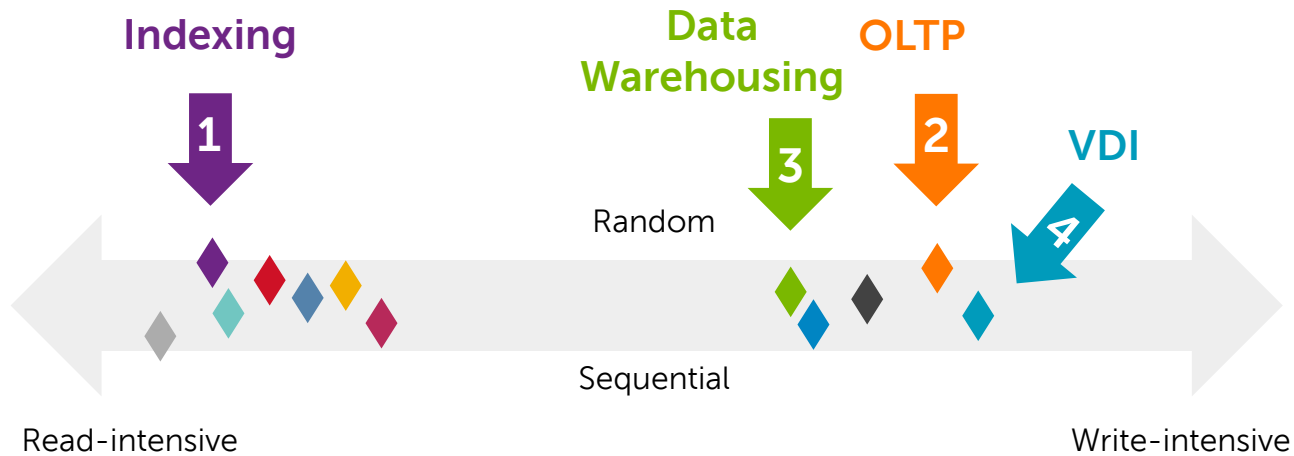
SSD tiering in shared storage

- A few SSDs can be added to the array to dramatically increase performance for targeted workloads
- OR**
- An entire storage tier can be deployed on SSDs so that complete volumes and datasets can be fit in flash

Fluid Cache for SAN

- Benefits of Fluid Cache extended to the entire SAN for maximum performance and reliability

Best use of flash storage: **transactional, IOPS-intensive workloads**



Indexing

- Maintains indexes to allow quicker access to data
- Runs on databases to accelerate locating a block of data in queries

Data Warehousing

- Stored data used to create reports or derive Business Intelligence
- Used for data mining, analysis, hypothesis testing, modeling

OLTP

- Manage transaction-oriented applications, i.e. retail, banking
- Business can be hurt if data not accessible, slow
- During peak usage, customer experience can be effected

VDI

- Hosting desktop OS within a VM on a centralized server
- Facilitate a quick retrieval of gold images
- Boot storms, write allocations and latency are issues

What can flash storage do in **your data center?**

A way to accelerate business results and improve operational efficiency



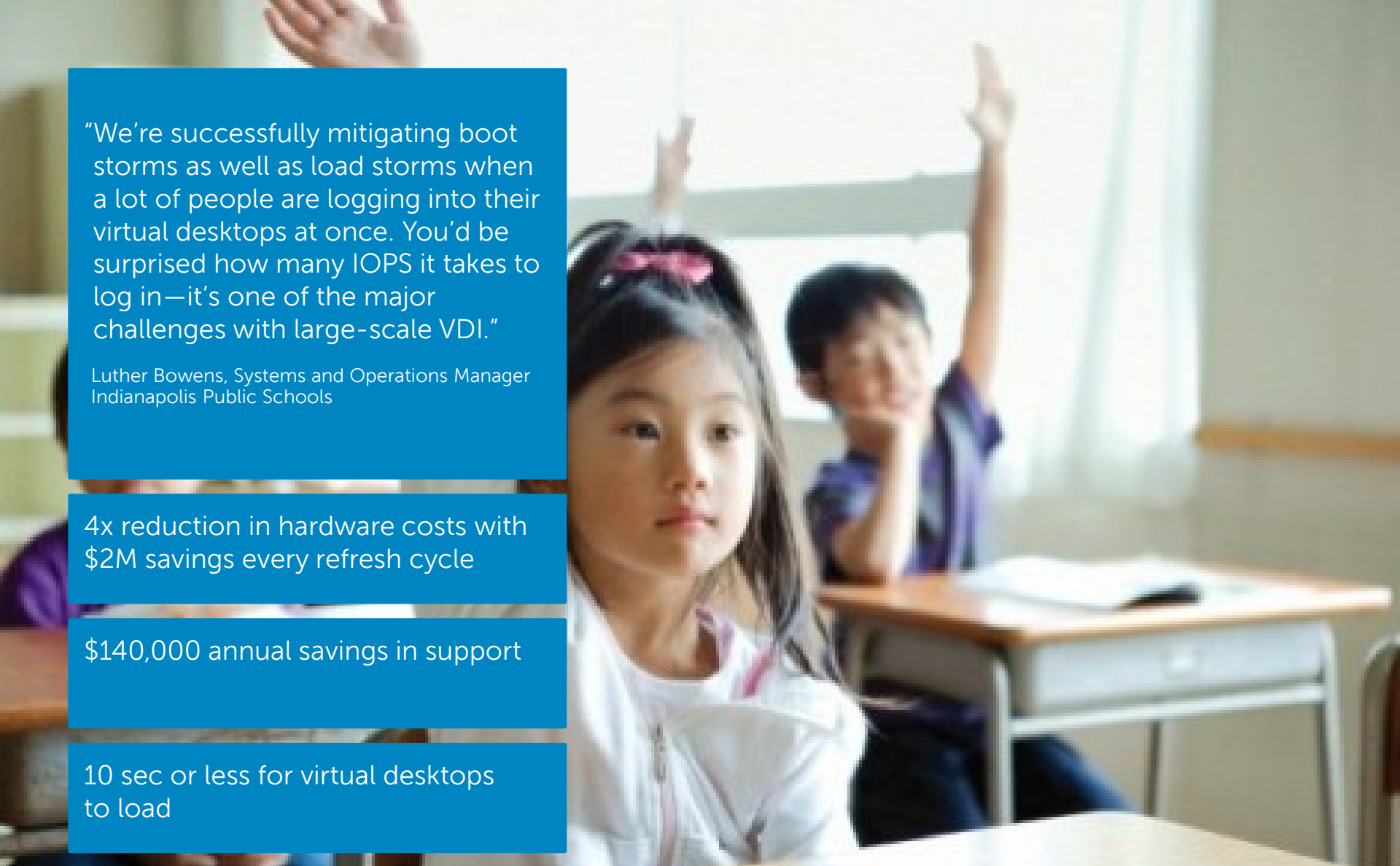
Accelerate business

- New revenue streams through reduction in latency and increase in IOPS
- Quicker business insights
- Faster user access
- Better customer experience



Increase operational efficiency

- Minimized datacenter footprint
- Lower power consumption
- Lower cost of software licenses
- Simplified management



“We’re successfully mitigating boot storms as well as load storms when a lot of people are logging into their virtual desktops at once. You’d be surprised how many IOPS it takes to log in—it’s one of the major challenges with large-scale VDI.”

Luther Bowens, Systems and Operations Manager
Indianapolis Public Schools

4x reduction in hardware costs with
\$2M savings every refresh cycle

\$140,000 annual savings in support

10 sec or less for virtual desktops
to load

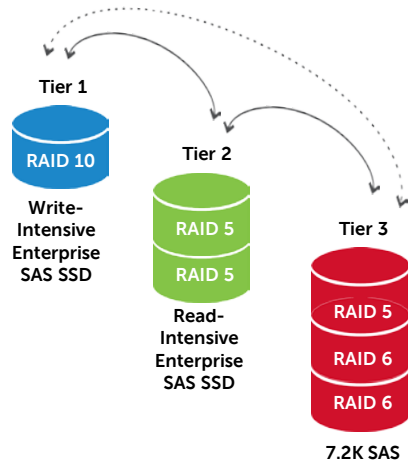
Indianapolis Public Schools deployed Compellent with
SSDs to optimize **storage performance for VDI**



Compellent introduces **flash innovations** that **change the economics of flash storage**

Storage Center 6.4

- Extends tiering to multiple flash types
- Data progression enhancements
- Best performance at the lowest possible cost



Flash enclosure

- 80% lower cost than most all-flash solutions
- Industry's first MLC & SLC SSD intelligent flash tiering
- Introduces new 1.6TB MLC SSDs



Dense enclosure

- Densest solution of any major vendor with 336TB in 5U
- Designed for cost/capacity optimized data growth
- Ideal as Tier 3 in hybrid arrays

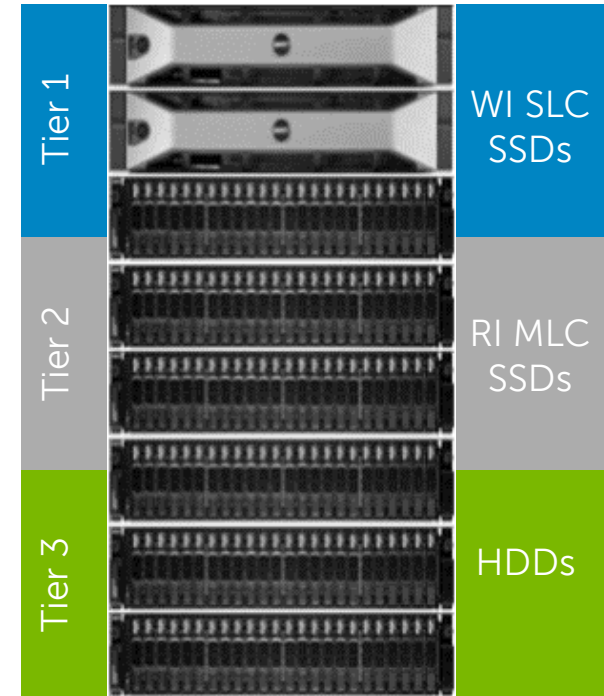


SC 6.4 combined with flash enclosures delivers high-performance flash storage at a fraction of the cost compared to other storage solutions.

SSDs have different characteristics

Compellent is the first storage solution to tier sub-LUN data across SSDs

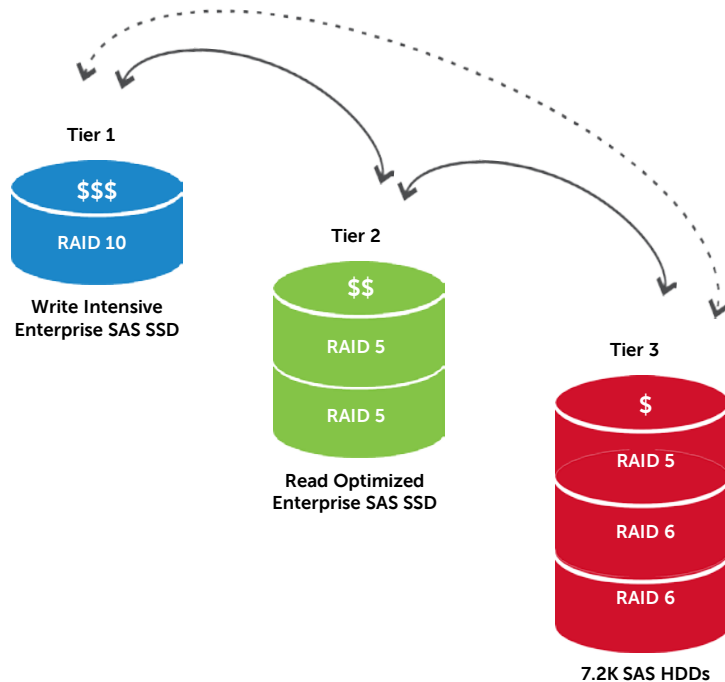
	Write-Intensive (WI) SLC SSDs	Read-Intensive (RI) MLC SSDs
Workload	Mainstream Applications Any usage	Mostly Read 90/10 R/W Mix
Capacity	400 GB	1.6 TB
Write endurance	Great	Moderate
Full-drive writes/day	30	3
Random read perf.	Great	Great
Write performance	Great	Moderate
Relative costs	4x	1x



Compellent Hybrid-Flash Array

Tiering flash across multiple SSD types enables Compellent to disrupt the flash cost model with a superior \$/GB ratio.

Secret sauce behind the flash optimized Compellent: **tiering with Data progression**



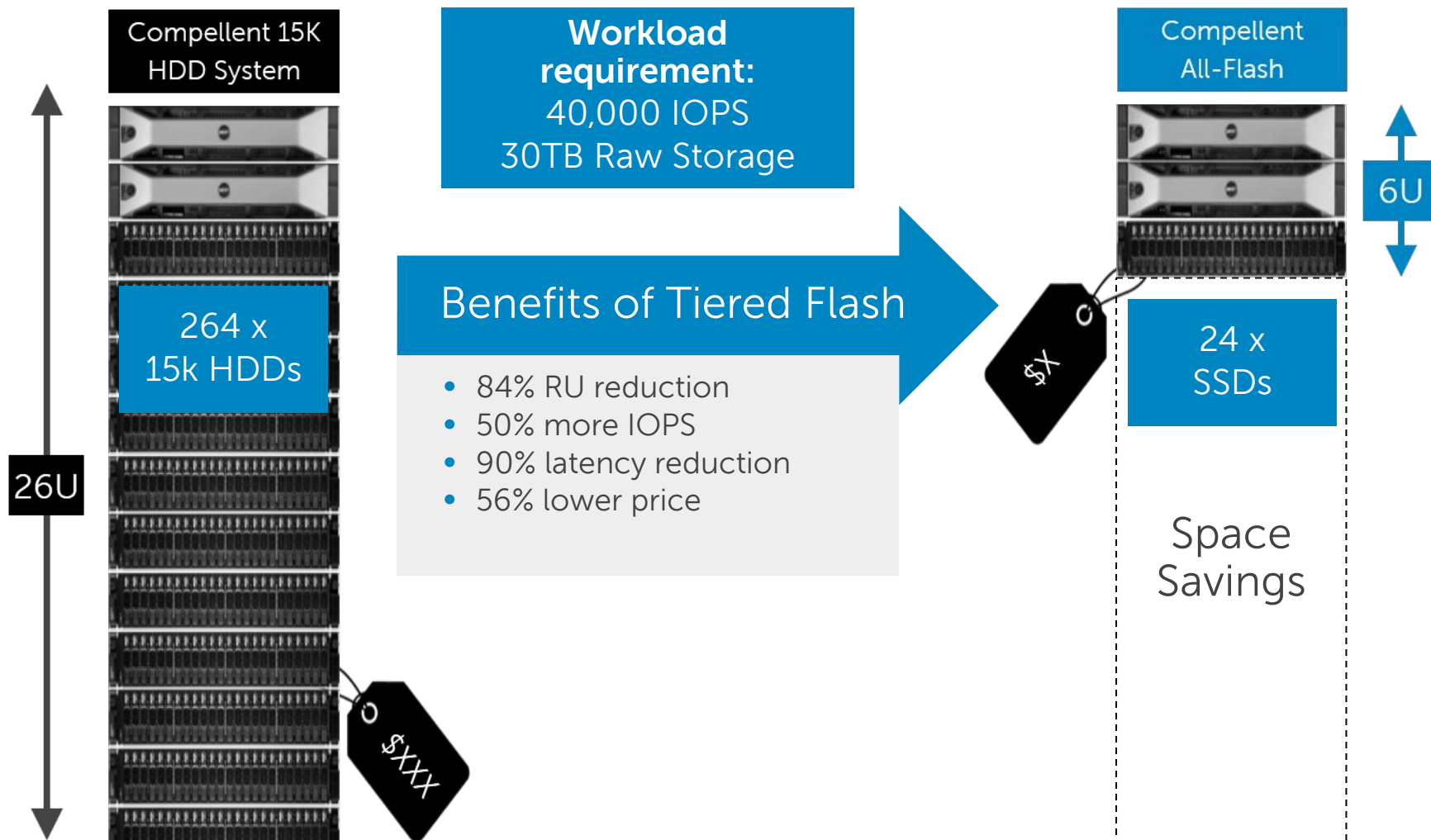
Flash-optimized Data Progression leverages the endurance of write-intensive SSDs and the value of read-intensive SSDs.

Advanced software tiering seamlessly manages data

- Incoming writes are written to the write intensive SSDs for fast access
- Read intensive data is automatically moved to less expensive read optimized SSDs keeping Tier 1 free for new incoming writes
- Cold and non-performance data is migrated to lower tier, less expensive rotating disk



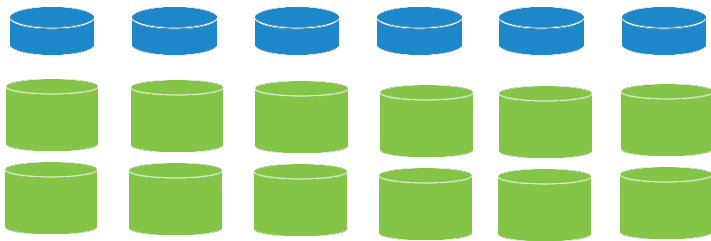
New economies of flash: tiering innovations allow Compellent to offer **flash at the price of disk**



New economies of flash with Compellent : 1/5th the price vs. competitive all-flash solutions

Compellent

With Flash Tiering

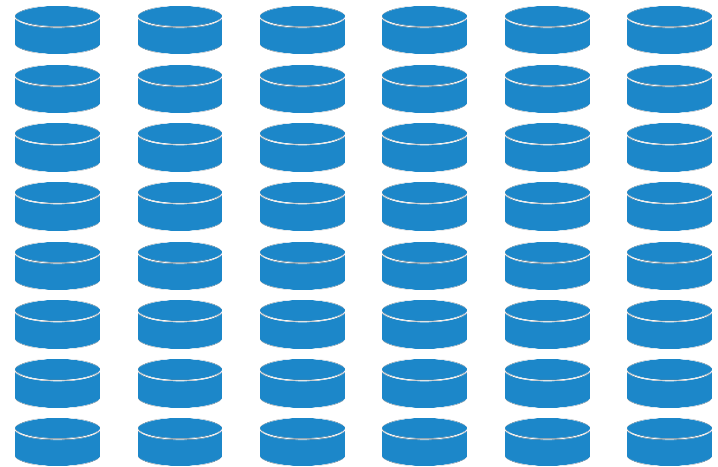


Write Intensive (SLC)

Read Intensive (MLC)

Other Vendors

Single SSD type (SLC or eMLC) only



80%
Lower costs

Higher
costs

Hardware ▲

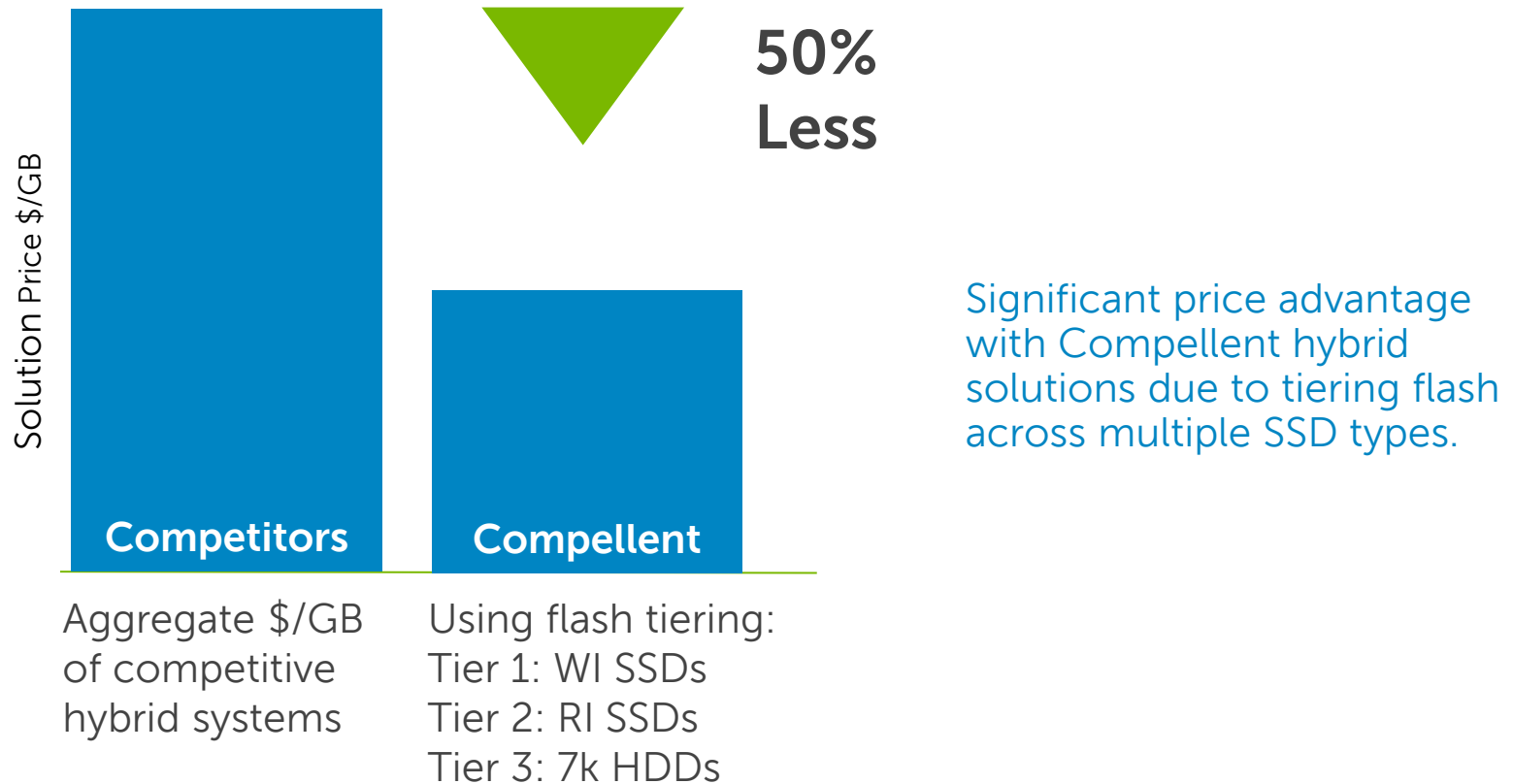
Power / Cooling ▲

Software ▲

Support ▲



New economies of flash with Compellent : 1/2 the price vs. competitive hybrid solutions



Designed to address **multiple performance levels**

Compellent helps align storage performance with workload requirements

All-flash for business critical workloads

Large capacity flash with low latency and scalability

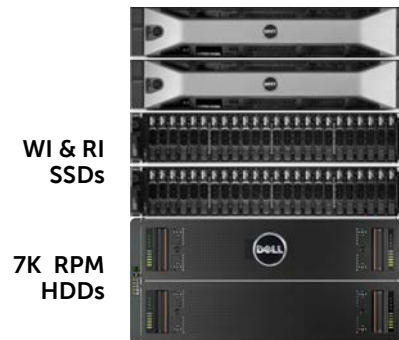
- Tier 1 applications
- OLTP Oracle database
- VDI gold images and logs
- Big data analytics



Hybrid for general workloads

Capacity with mainstream application performance

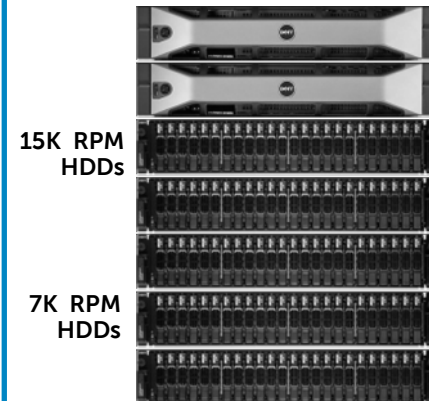
- Better performance with limited flash capacity
- General workloads



Cost optimized HDD-based for lowest \$/GB

Large capacity, lowest \$/GB

- When large datasets are required
- Data that is not performance sensitive
- Backup and archive



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

Optimal \$/GB & \$/IO

Lower TCO by balancing performance and capacity needs in a single platform



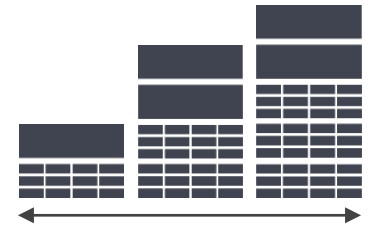
Tiering

Automatically move data between Flash tiers and HDD tiers



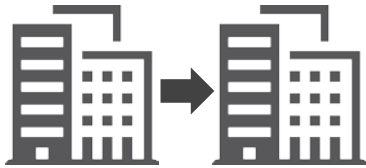
Scalability

Scale to meet storage requirements with either SSD or HDD



Replication

Replicate business critical data between disparate storage systems



Unified Storage Management

Manage multi tiered storage solution with a single pane of glass

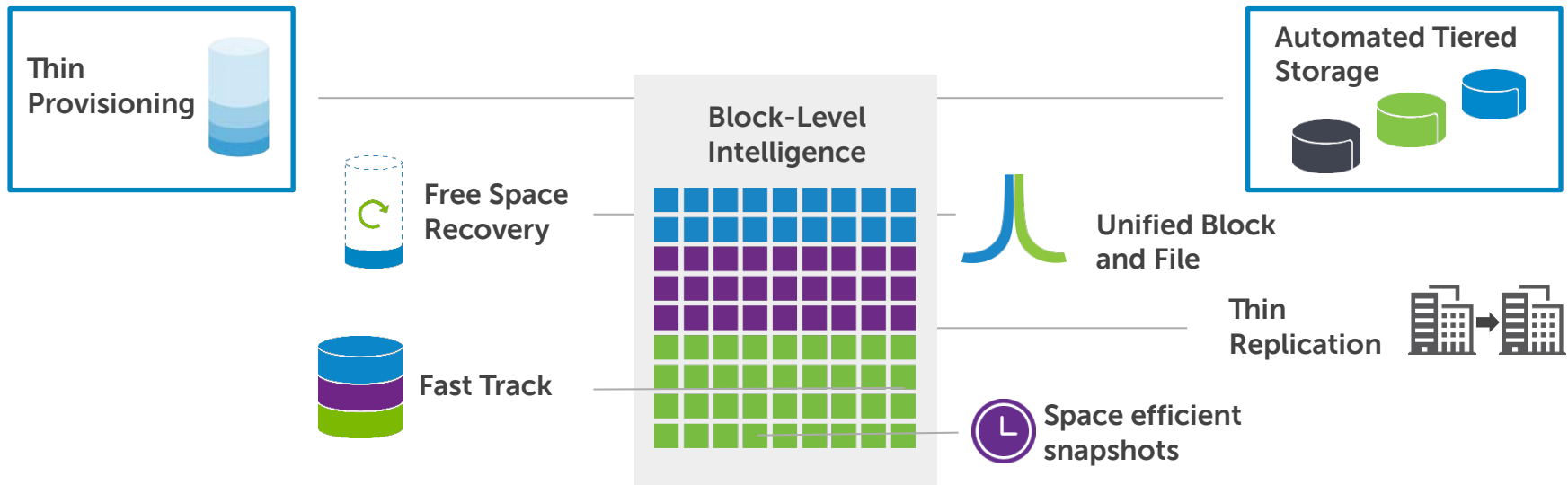


Enterprise Class Support

Leverage best of breed enterprise class support



Slash costs with more efficient use of every disk

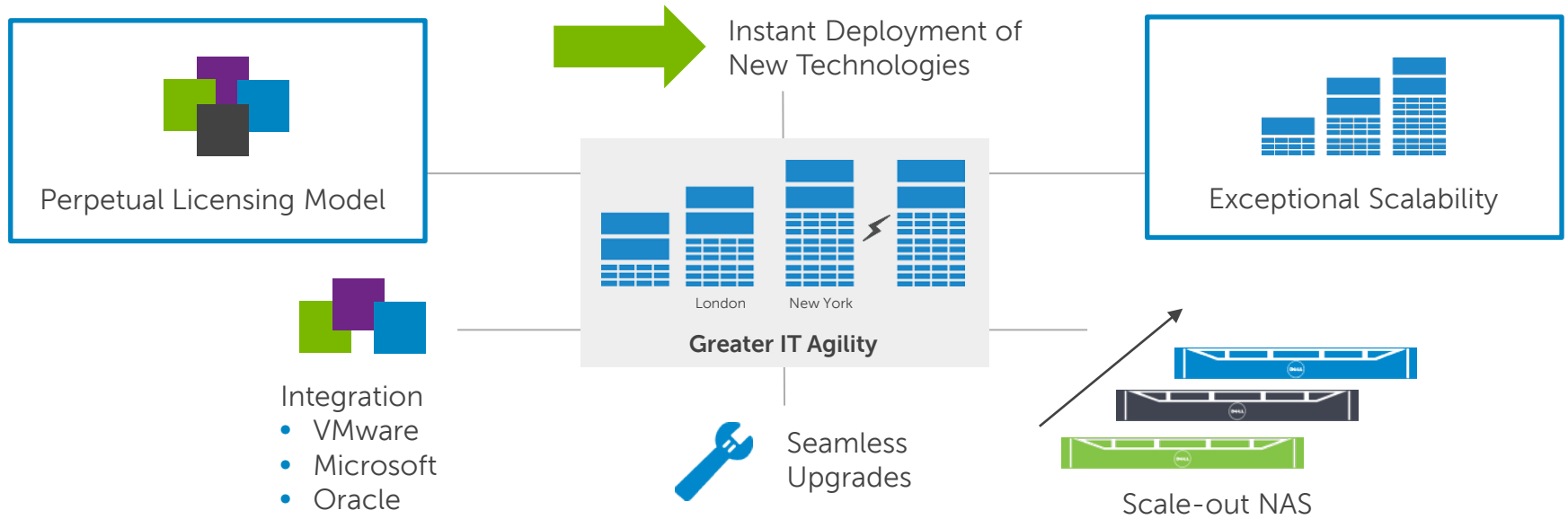


Compellent can reduce total storage software costs up to 96% and hardware costs up to 44% over a 10 year period.

- No pre-allocation required with Thin provisioning
- Buy fewer and less expensive drives with Automated tiered storage
- Cost-effective Disaster Recovery with Thin Replication
- Single solution for unified block and file



Scale without disruption and **buy only what you need today**



Up to 92% of all Compellent systems ever shipped are still in use.

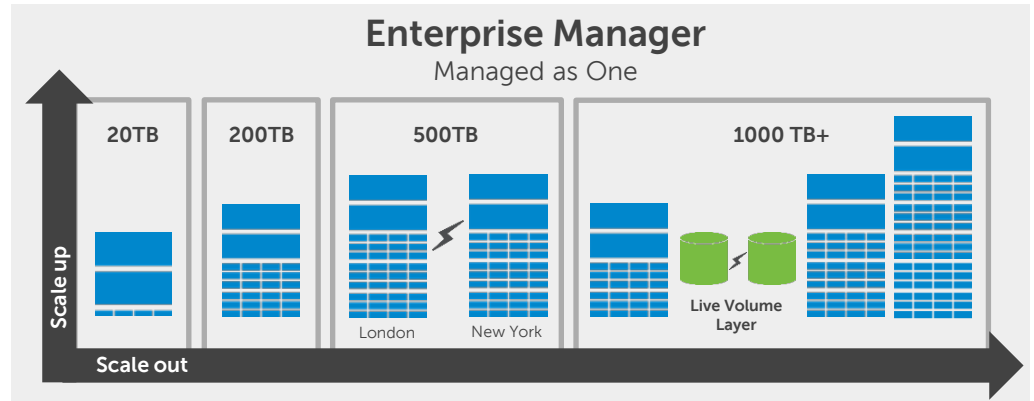
- Scale across block and file without disruption of rip-and-replace
- Add capacity non-disruptively as you grow
- Persistent licensing protects storage investment
- Dozens of points of engineering integration



Add capacity when you need it and **avoid forced refresh cycles**

Never be limited by initial hardware platform choice; **scale up and out on a unified file and block platform**

Add capacity and new functionality on-the-fly on the same single platform with a **perpetual licensing model**



- FC drives
- SATA drives
- 2Gb FC
- 1TB SATA
- 1Gb iSCSI
- FATA drives
- 4Gb FC
- 3Gb SAS
- SSD
- SAS drives
- 10Gb iSCSI
- 2.5" drives
- FCoE
- 6GbSAS

Single scalable platform



Legacy SAN

?



Dell Storage delivers economic value with Compellent for enterprise workloads

Flash at the price of disk:

- $\frac{1}{5}$ the price of competitive all-flash systems
- $\frac{1}{2}$ the price of competitive hybrid systems
- Reduction in RU, latency, power consumption
- Increase in IOPS



Use Compellent Flash-optimized solutions to address the need for high I/O performance with low latency

- Accelerate application performance for business critical workloads such as OLTP, Data Warehousing and VDI
- Reduce costs up to 80% compared to other flash-optimized solutions
- Benefit from enterprise-class storage features on a platform designed for exceptional scalability and operational efficiency



EqualLogic Flash Solutions



Dell EqualLogic improves and simplifies performance with new **flash storage** launches

PS6210S (all flash) and PS6210XS (hybrid flash+HDD)

Higher performance, low latency

- Offers a powerful controller with 16GB of memory
- Host 2000 virtual desktops on hybrid flash arrays



Ideal for OLTP workloads and DSS databases

- Up to 2X the OLTP workload performance with less than half the latency of prior generations
- Approximately 2x the throughput per array for sequential, large-block workloads, such as DSS database queries



The EqualLogic advantage

- Linear performance and capacity scalability- simply add arrays based on your requirements
- All-inclusive software licensing
- Lowest total cost of ownership over a five-year period compared to comparable arrays.*



EqualLogic offers advanced technology that brings a new level of performance for your most demanding applications, while delivering the simplicity of the EqualLogic management experience.



Benefits of EqualLogic flash: **flash at the price of disk**

Workload requirement
30,000 IOPS for OLTP Database
10TB Usable Storage

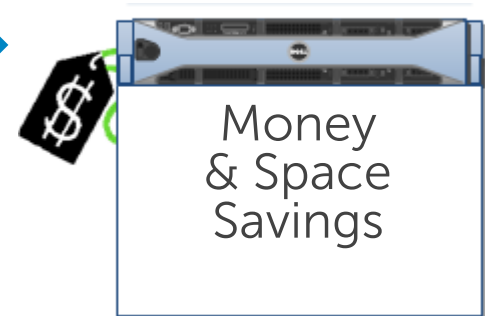
4x EqualLogic HDD arrays
96x300GB 15K disks
@RAID 10



Benefits of EqualLogic Flash

- 11% lower price
- Up to 35% more IOPS
- 75% Rack U reduction
- 64% lower latency
- 8% more capacity
- Lower power

EqualLogic all-flash
24x800GB SSD
@RAID 50



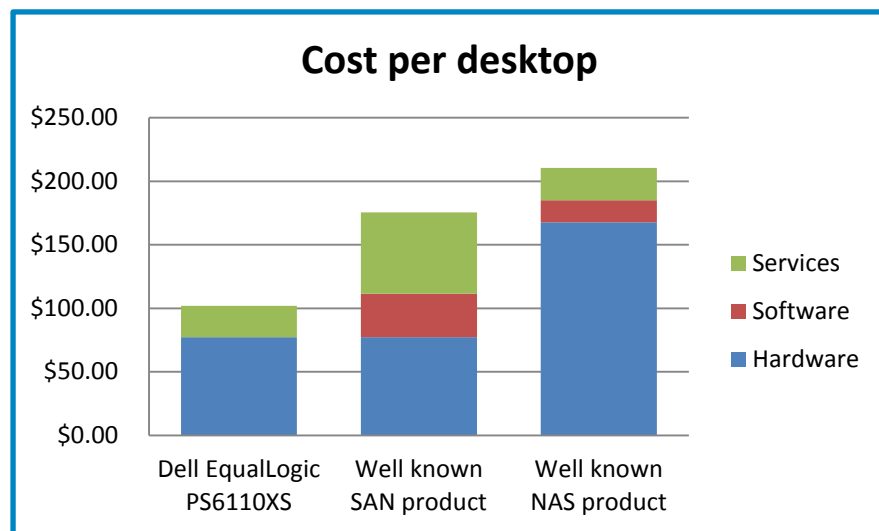
EqualLogic Hybrid Flash Arrays

Fast, automated tiering for VDI image data

- **2000 desktops/ array**
 - 2.4x the prior generation
 - VMware View Horizon
- **Ideal for VDI & mixed workloads**
 - Continuously, quickly balances hot & warm data between SSD & HDD tiers
 - Write cache acceleration
- **For growing VDI deployments**
 - Scale out performance & capacity predictably
 - Avoid break points that plague traditional architectures
- **Keep roll-outs on track & Minimize storage management**
 - Legendary EqualLogic ease-of-use
 - Extensive vSphere integration

*Sources: Principled Technologies Report, May 2013 <http://dell.to/1312rBH> & Principled Technologies Report, January 2013, <http://dell.to/14zBJiS>

- **Exceptional economics for VDI**

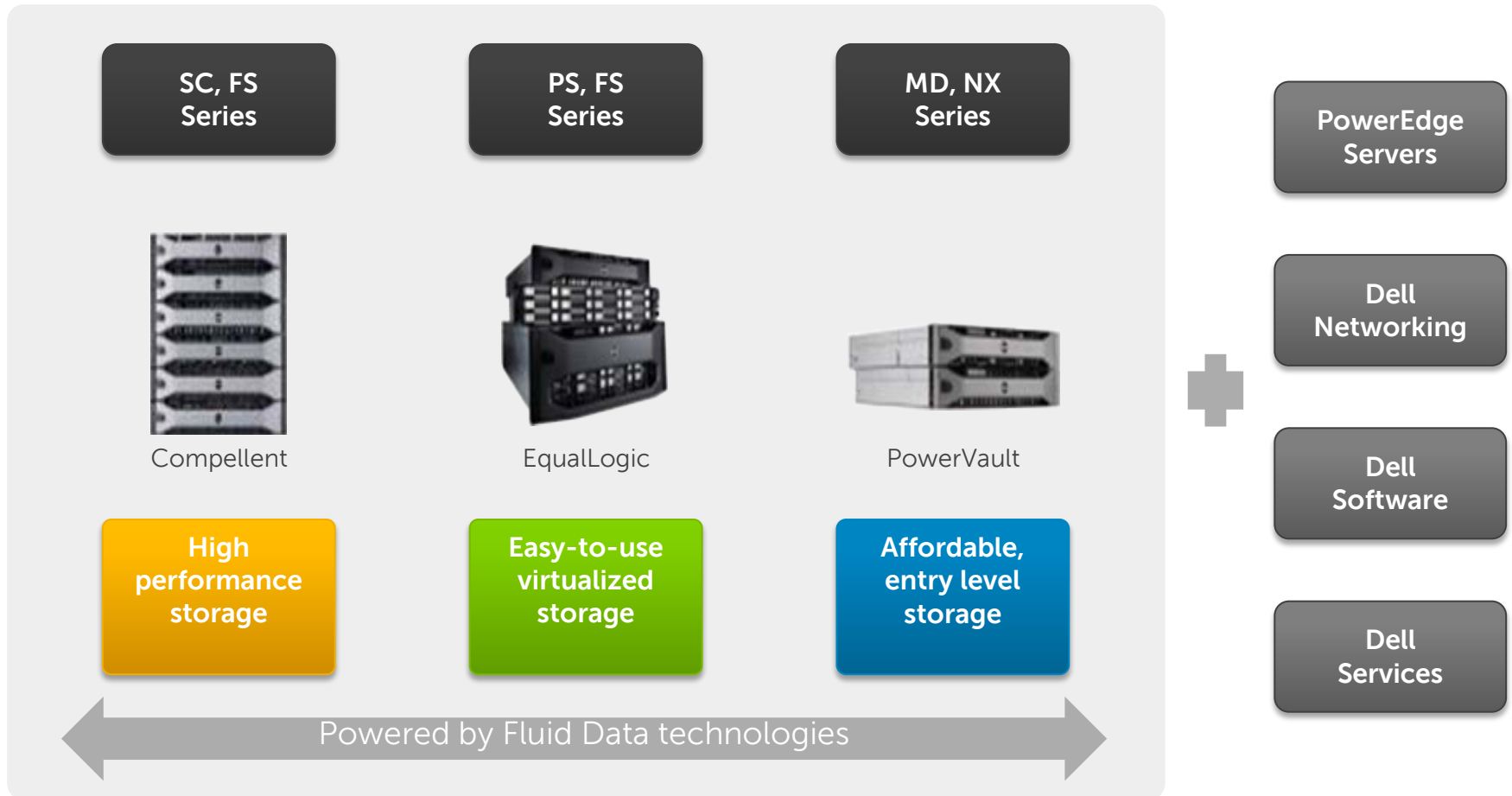


- **\$/Desktop**: Up to 51% less than alternative products*
- **Performance**: Similar (or better during boot storms)*
- **Power**: Up to 68% less*



The Dell Storage Portfolio

Workload-optimized solutions for any size enterprise



DPACK



Individual Server Report: hou-rm04-centre.local			
Host Operating System	VMware ESX 4.1.0 build-260247		
Time Recorded	3 Hour(s) 56 Minute(s) 8/23/2011 - 8/23/2011		
Collector Version	0.7.0.190171		
Output Summary:		Output Summary:	
Throughput	13.8 MB/sec Peak	Average R/O/WD size	Read: 57.7 KB / Write: 26.2 KB
IOPS	320 avg and 917.3 at peak	Latency	12 ms read and 1 ms write
Read/Write Ratio	91% Reads / 9% Writes	Peak Queue Depth	0
Total Capacity	48.8 GB	Peak/Min CPU	1489.2% / 944.8%
Free Capacity	43.1 GB Free	Peak/Min Free Memory	38.3 GB / 38.2 GB
Used Capacity	5.6 GB Used	Peak/Min Memory In Use	47.8 GB / 47.8 GB

Transfer Size is the average size of an IO
Latency is the time it takes to complete an IO. It is a key factor in performance.
VMware does not collect Disk Queue Depth

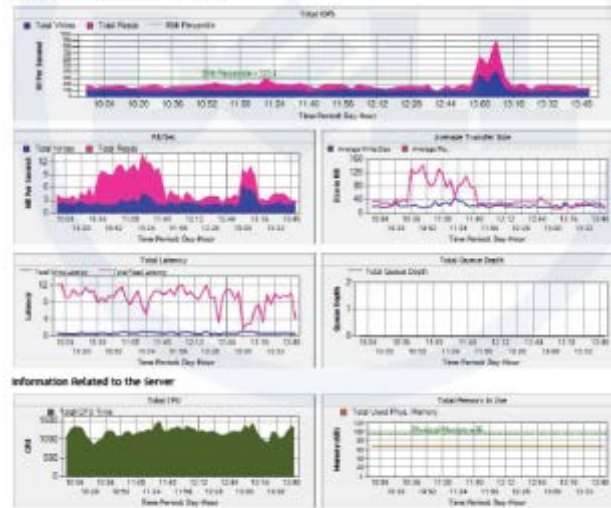
IOPS – Measures performance

MB/Sec - Measure of Utilization

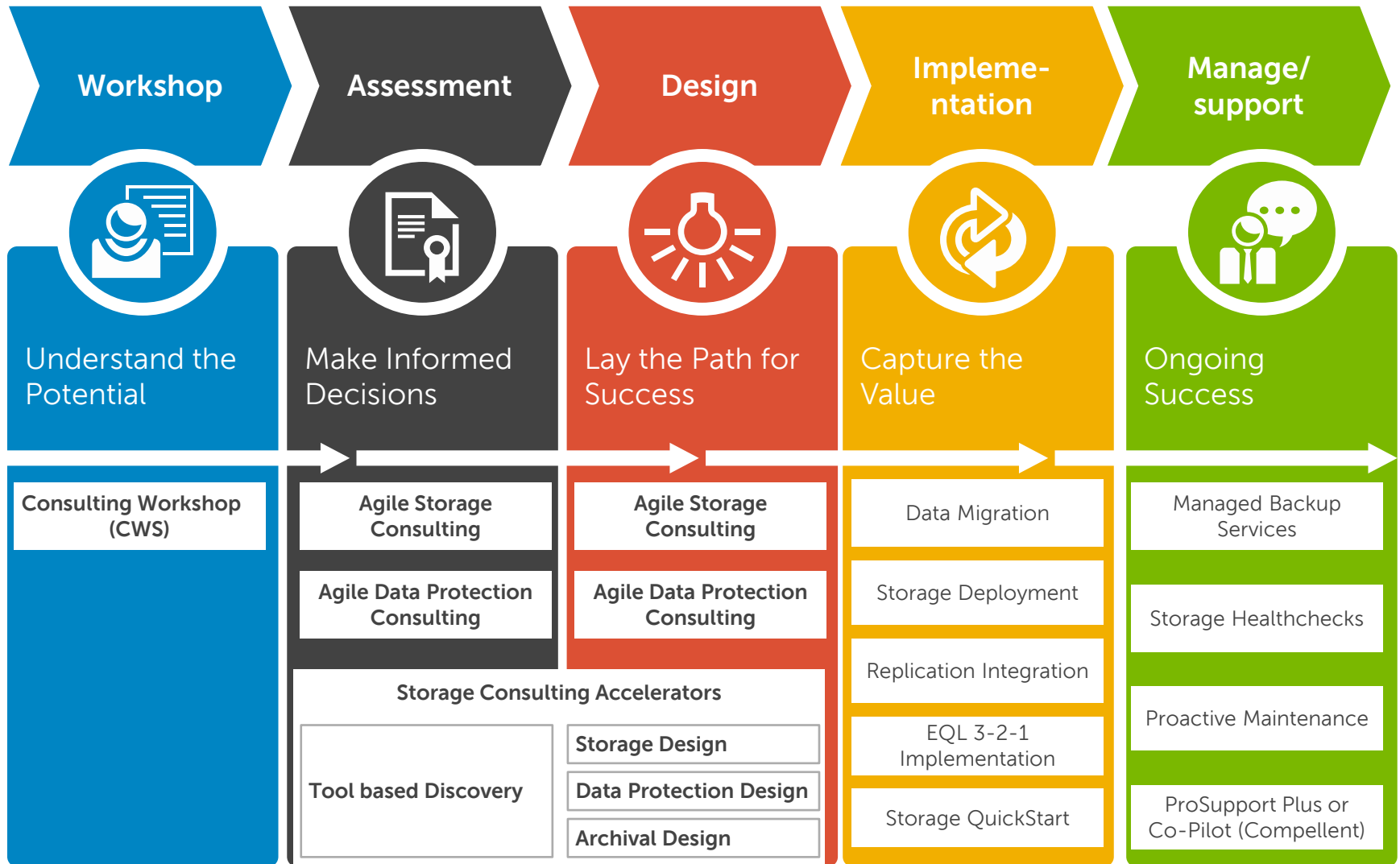
Latency – measure of time to process

Average IO size – IO Payload

Disk Queue – IO Payload



Storage services portfolio



With an industry leading \$8.5B end-to-end Services portfolio

Application Services



- [Development & Maintenance](#)
- [Management & Support](#)
- [Modernization](#)
- [Testing](#)
- [Business Intelligence and Data Warehousing](#)
- [Enterprise Applications](#)
- [Industry Applications](#)

Business Process Outsourcing Services



- [Consulting & Social Media Services](#)
- [Customer Service](#)
- [Finance and Accounting](#)
- [Healthcare](#)
- [Knowledge Process Outsourcing & Analytics](#)
- [Life Insurance](#)
- [Procurement](#)

Infrastructure

Consulting Services | Managed Services | Cloud Services



- [End User Computing](#)
- [Unified Communication & Collaboration](#)
- [Virtualization & Private Cloud](#)
- [Data Center](#)
- [Education & Training Services](#)
- [End User IT Outsourcing](#)
- [Data Center IT Outsourcing](#)
- [Cloud on Demand](#)
- [Cloud Dedicated](#)
- [Cloud for HPC](#)
- [Cloud for SharePoint](#)
- [Cloud Transformation Services](#)

Deployment Services | Support Services



- [End User Deployment Services](#)
- [Enterprise Deployment Services](#)
- [Asset Resale and Recycling](#)
- [ProSupport Client Suite](#)
- [ProSupport Enterprise Suite](#)
- [Tools & Technology](#)

Security Services



- [Managed Security](#)
- [Security and Risk Consulting](#)
- [Counter Threat Unit \(CTU\) intelligence](#)
- [Incident Response and Digital Forensic Services](#)

End to End Lifecycle Services

Design and Optimize

Implement and Deploy

Manage

Support

Protect



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