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April 12-15, 2010 | Rosen Shingle Creek Resort | Orlando, Florida



# Top Ten Things You Need to Know About **SSDs** and **HDDs** for Enterprise Applications

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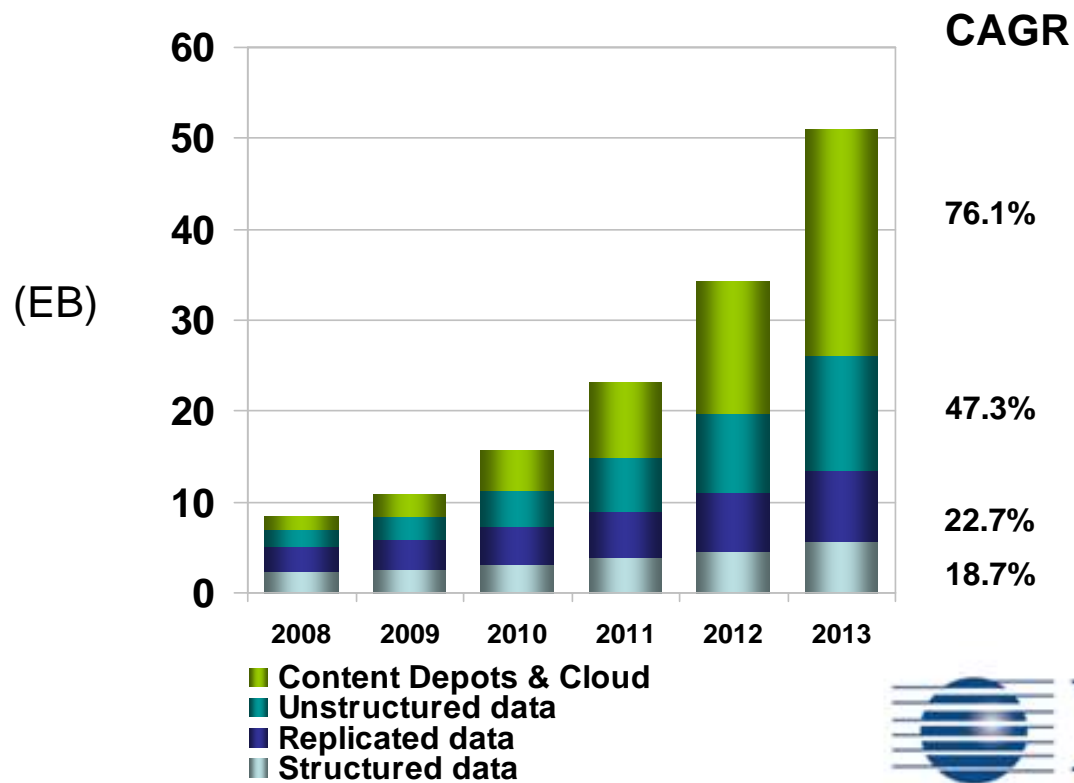
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# Changing Data Profiles: Development of Role-base Storage

## Consumption of Enterprise Disk Capacity by Type



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# Storage Systems Leverage Available Storage Devices

## Interface

HDD	FC	SAS	SATA
2.5in 10K			
2.5in 15K			
3.5in 10K			
3.5in 15K			
3.5in 5.4 & 7.2K			
2.5in 5.4 & 7.2K			

HDD Form Factor and RPM

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# Storage Systems Leverage Available Storage Devices

## Interface

<b>SSD</b>	FC	SAS	SATA	PCIe
2.5in				
3.5in				
Module				
Rackmount		+ InfiniBand, iSCSI, FCoE		


SSD Form Factor



# Top Ten List

1. Proliferating HDD and SSD form factors

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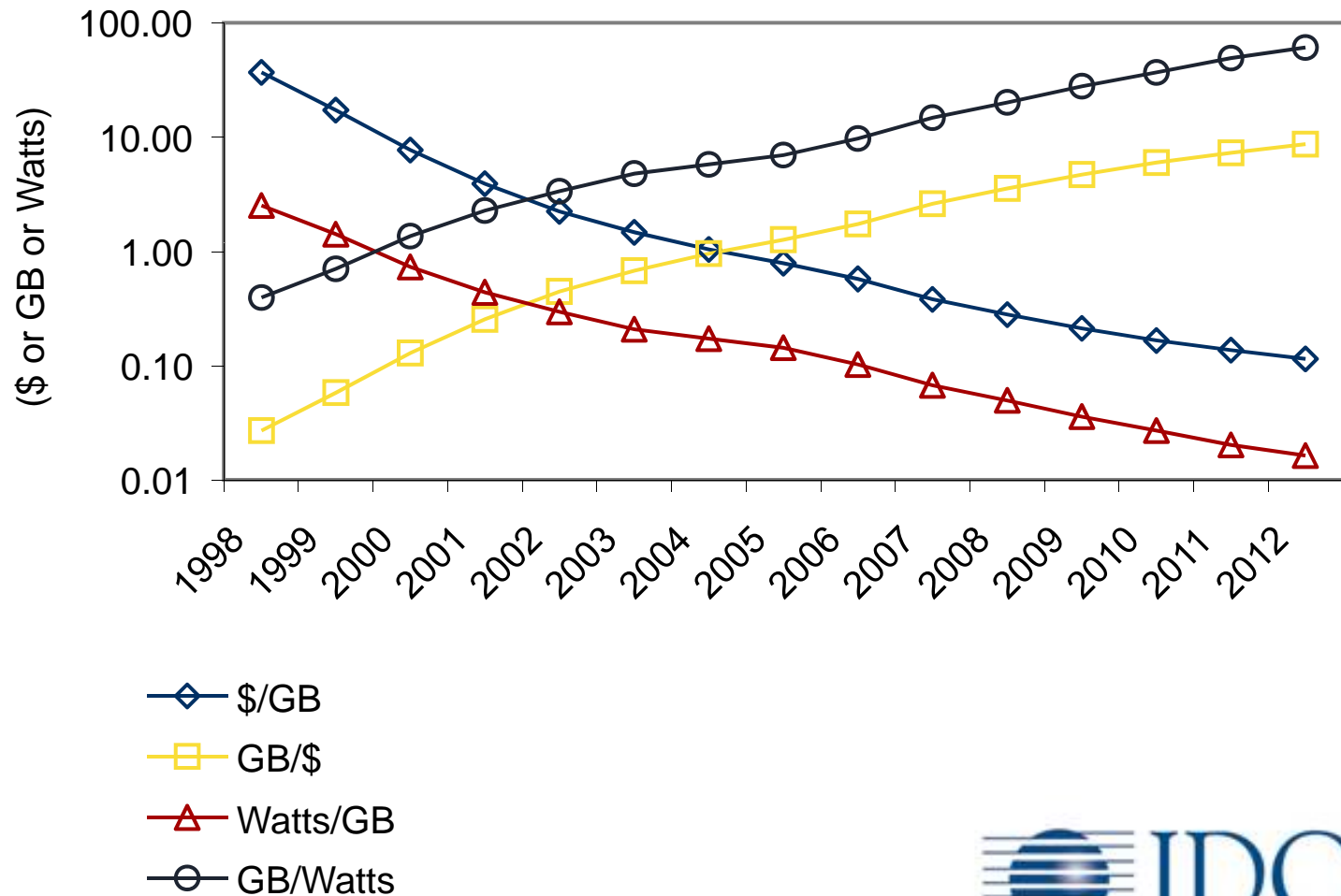


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# HDD-related Metrics - All Good?





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# *A Fundamental Issue*



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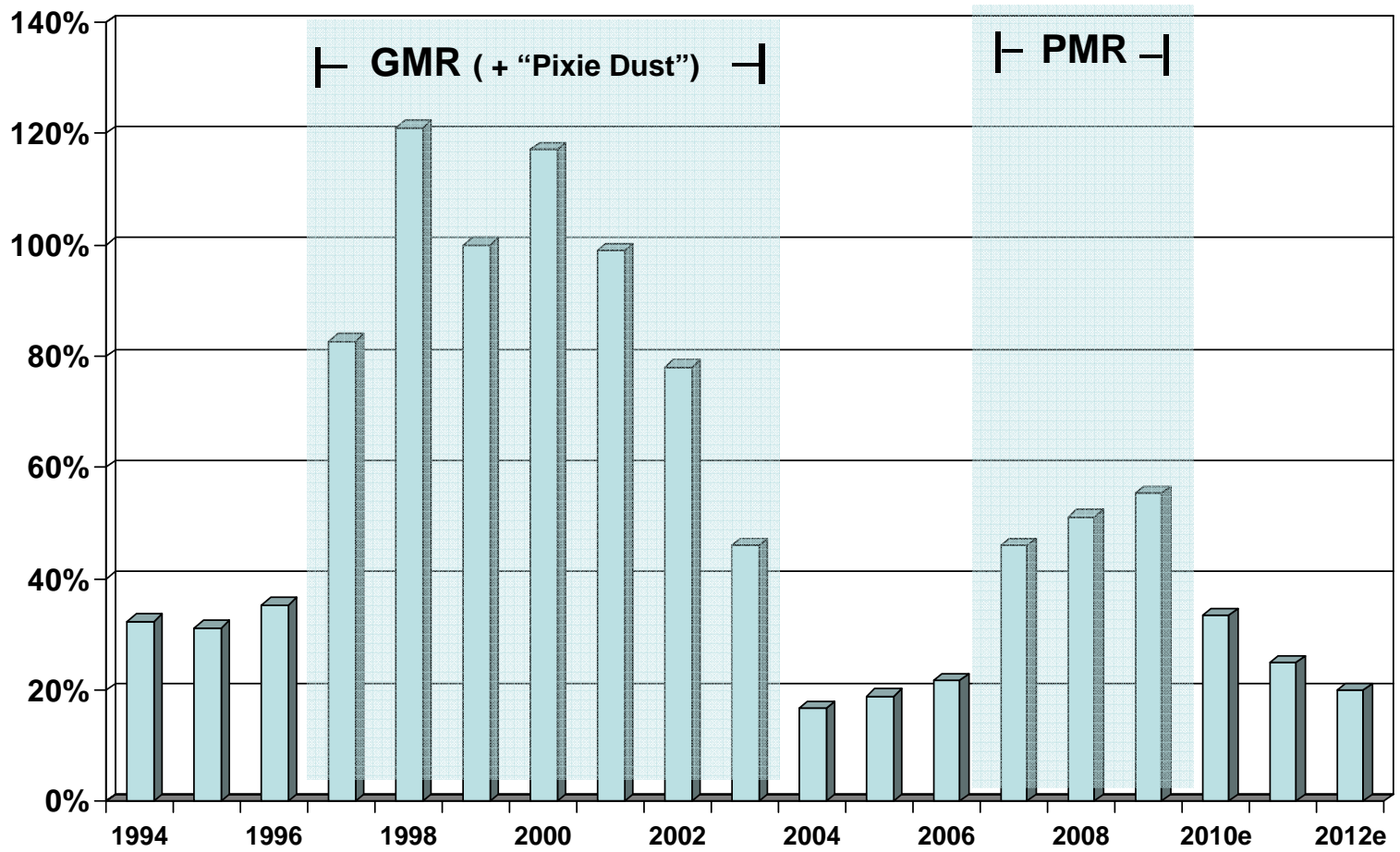


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# Slowing HDD Areal Density Growth



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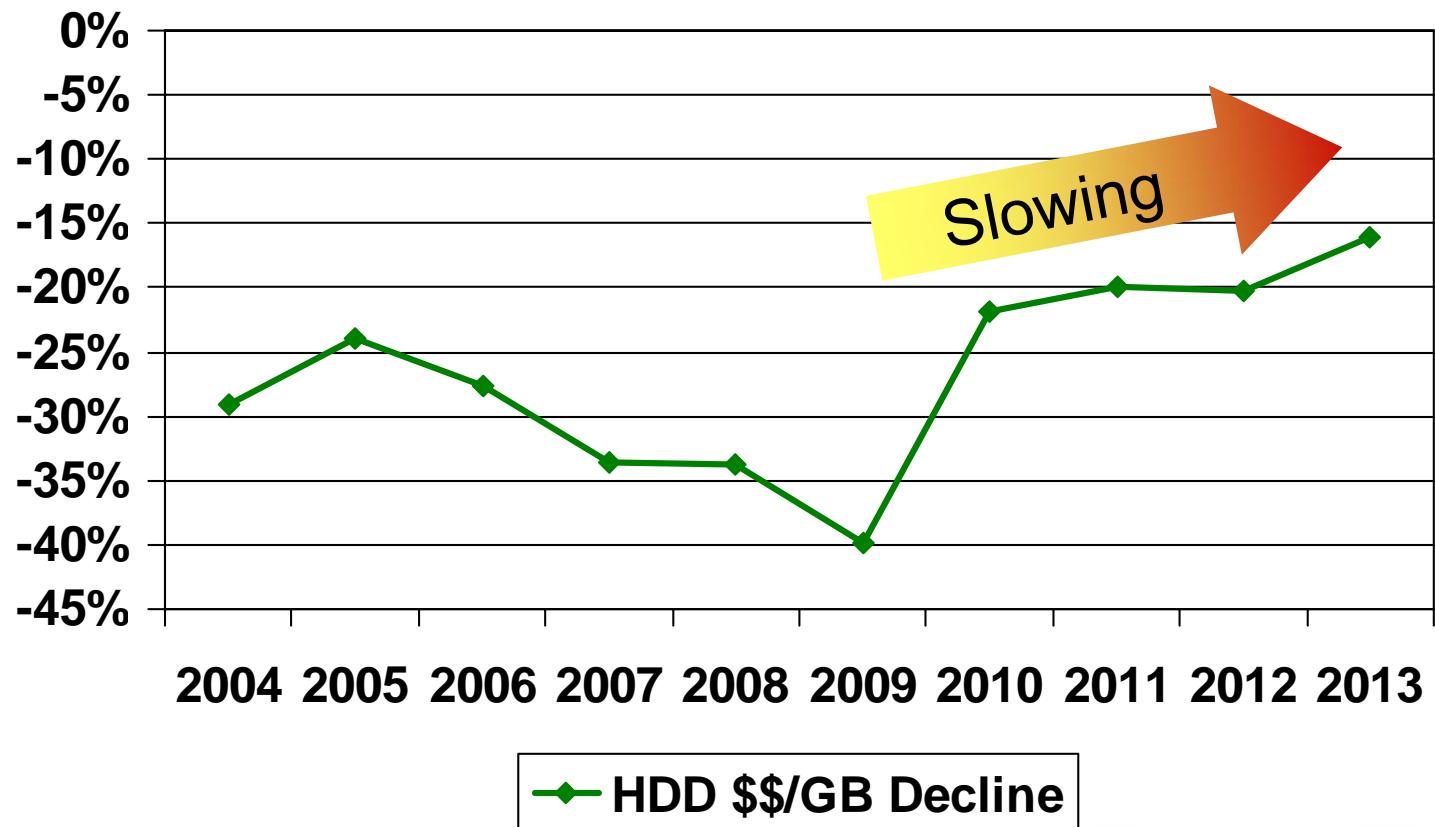


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# HDD \$\$ per GB Y-o-Y Change






## Top Ten List

1. Proliferating HDD and SSD form factors
2. HDD \$\$-per-GB declines are slowing as areal density growth slows

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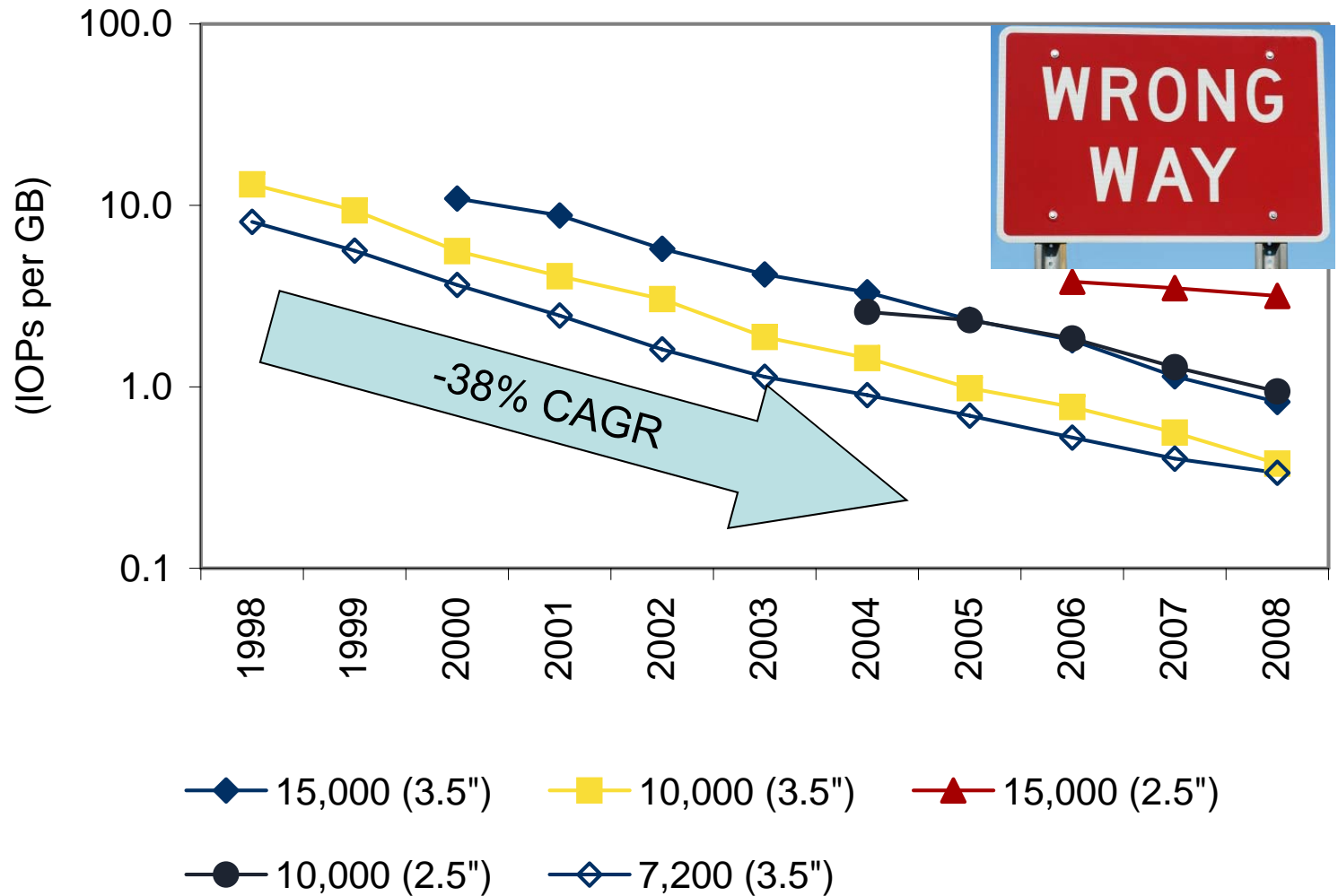


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# I/Os per GB





## Top Ten List

1. Proliferating HDD and SSD form factors
2. HDD \$\$/GB declines slowing as areal density growth slows
3. HDD performance is improving, but very slowly

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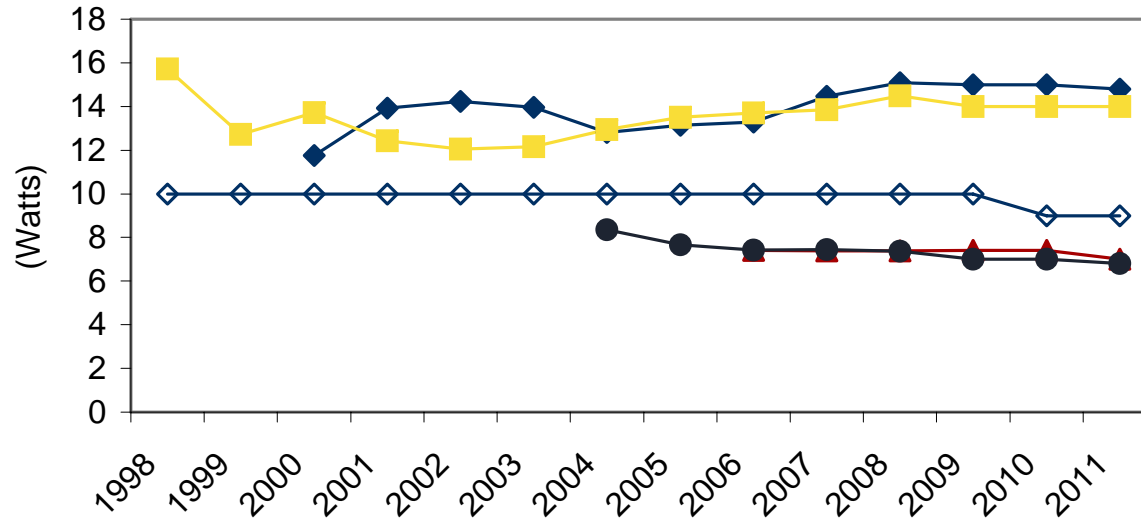


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# Watts/HDD over Time




- ◆ 15,000 (3.5")
- 10,000 (3.5")
- ▲ 15,000 (2.5")
- 10,000 (2.5")
- ◇ 7,200 (3.5")





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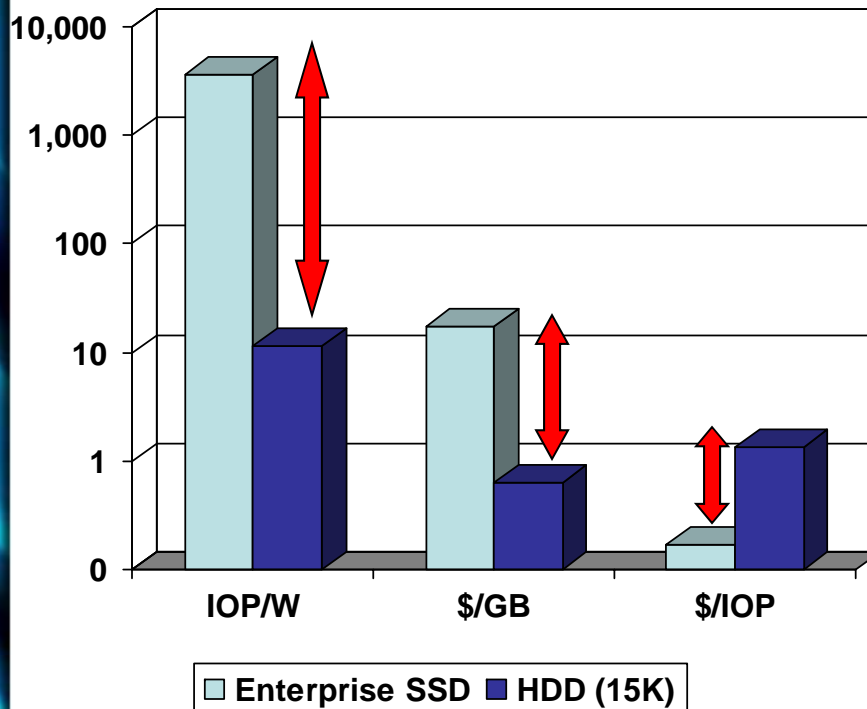


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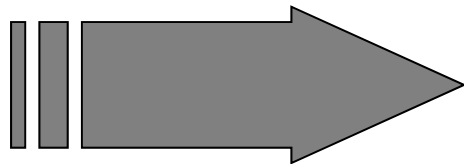
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# Storage Tradeoffs in the Enterprise




## Other Tradeoffs

- Additional spindles
- Recurring energy for power & cooling
- Floor space
- Maintenance and Reliability



**Balancing these tradeoffs is key**




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# SSDs Deliver IOPs and Improve Latency

<u>Drive</u>	<u>IOPs</u>
7,200 HDD	80
10K 2.5" HDD	120
10K 3.5" HDD	140
15K 3.5" HDD	170
15K 2.5" HDD	190
SSD	<10K

<u>Drive</u>	<u>Access Times</u>
10K HDD	7.8ms
15K HDD	5.5 ms
SSD	<60us



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# SSD are about Improving Storage System Efficiency

**EXTRA!!! The Times EXTRA!!!**

... gains significant system-level performance and a 98% reduction in energy consumption with the adoption of SSDs

**The Chronicle**

... efficiently reduces cost per video stream and improves system reliability by using SSDs in its digital on-demand system

**The**

6 internal SSD d  
higher and better  
our OLTP tests th  
enclosure of 15K R SAS HDDs

**EXTRA!!! The Times EXTRA!!!**

**... Delivers Cost- and Performance-Optimized Storage for Up to 30% Less**






## Top Ten List

1. Proliferating HDD and SSD form factors
2. HDD \$\$/GB declines slowing as areal density growth slows
3. HDD performance is improving, but very slowly
4. SSDs address both HDD performance and power-consumption shortfalls

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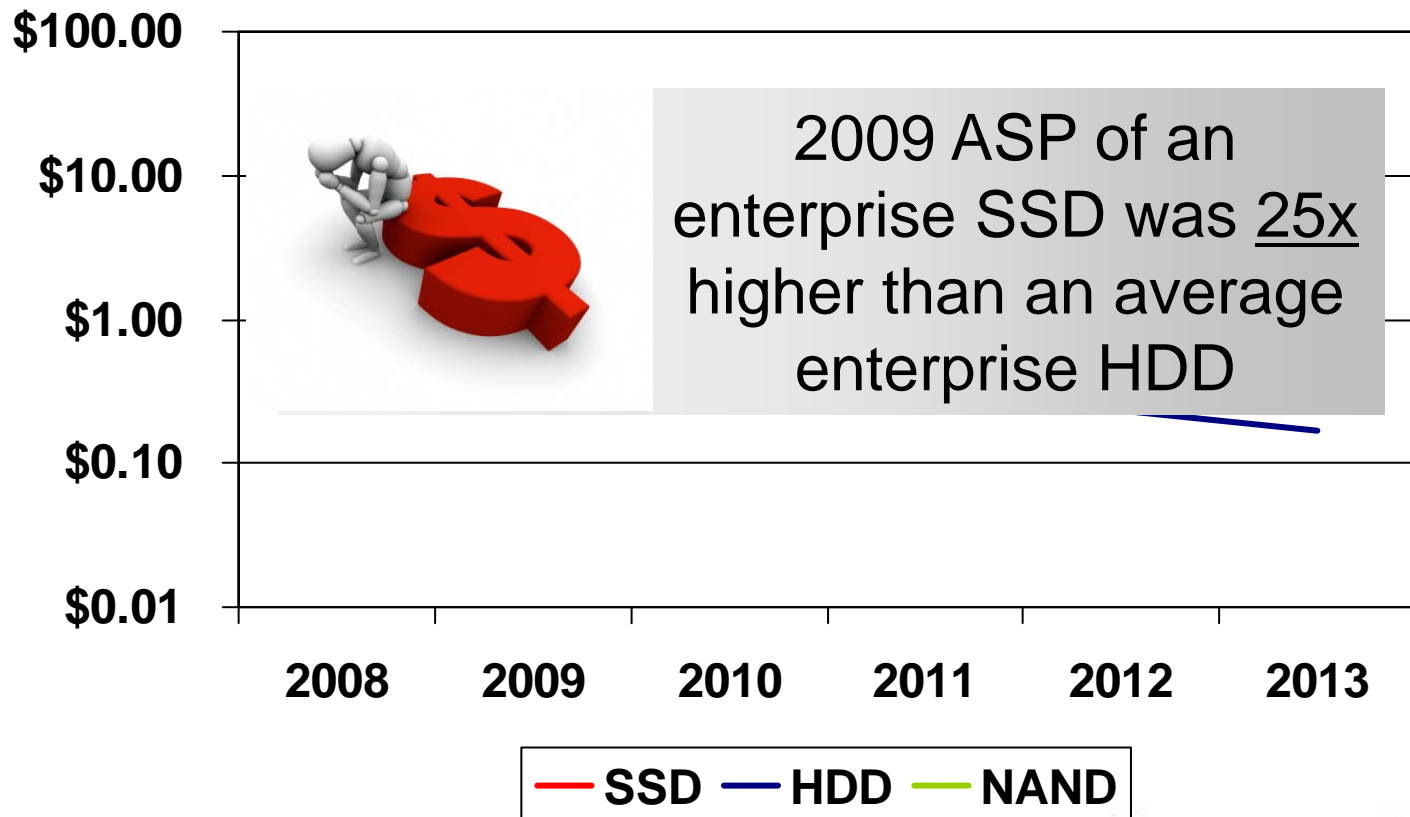
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# Cost is always a factor

## \$ / GB of Enterprise SSDs and HDDs



Worldwide Solid State Drive  
2009–2013 Forecast – Dec 2009

Note: Enterprise SSD tends to use higher price SLC NAND and may be over-provisioned



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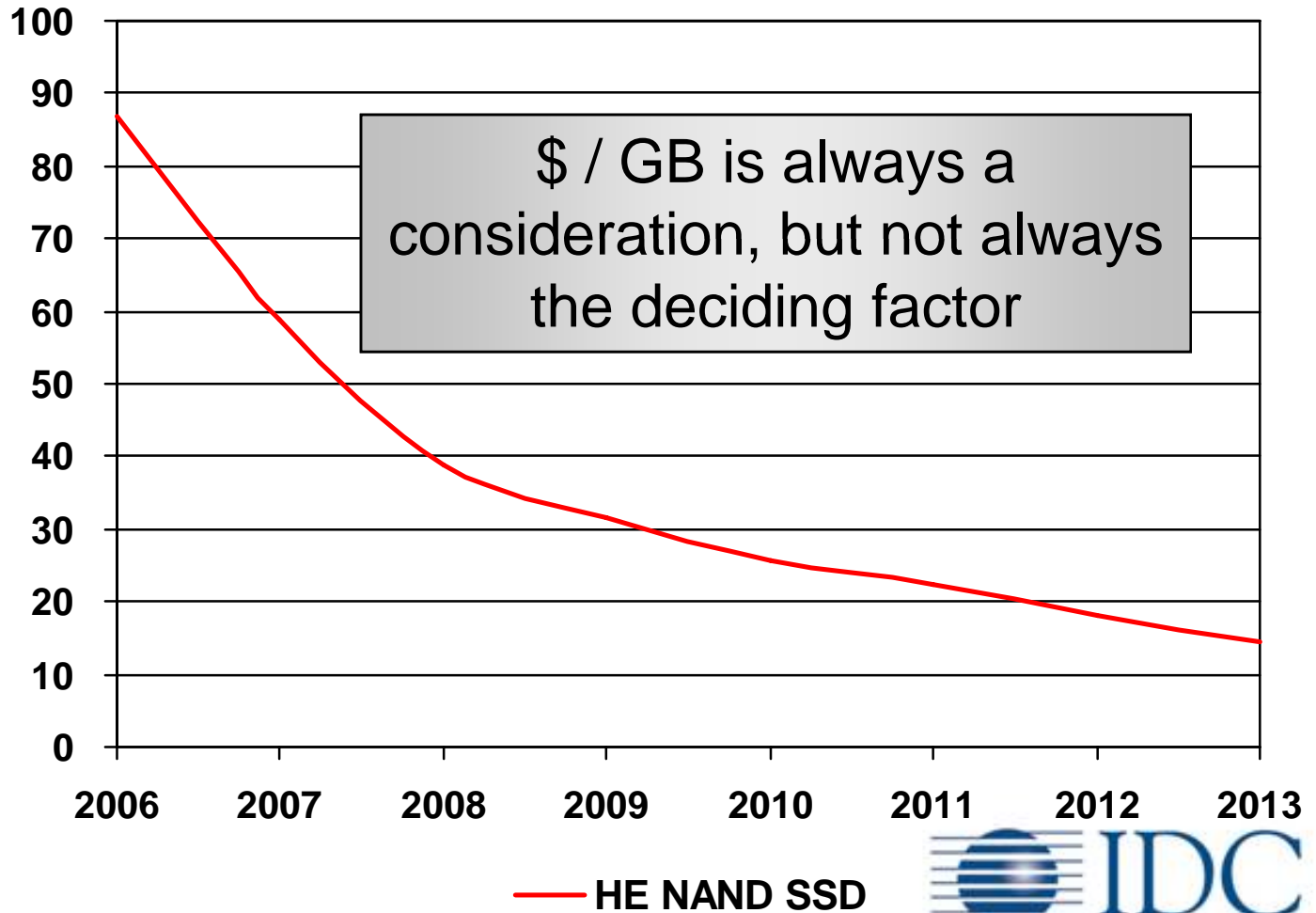
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# SSDs are Becoming More Affordable

Ratio of \$/GB of Enterprise SSDs to Enterprise HDD



Worldwide Solid State Drive  
2009–2013 Forecast – Dec 2009






## Top Ten List

1. Proliferating HDD and SSD form factors
2. HDD \$\$/GB declines slowing as areal density growth slows
3. HDD performance is improving, very slowly
4. SSDs address both HDD performance and power-consumption shortfalls
5. Cost is always a factor. Current SSD prices are inhibiting SSD adoption





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# SSDs are Not Created Equal

	<u>SSD A</u>	<u>SSD B</u>	<u>SSD C</u>	<u>SSD D</u>	<u>SSD E</u>
<u>Form Factor</u>	3.5"	3.5"	2.5"	2.5"	Module
<u>IOPs</u>	Reads: 46K Writes: 16K	Up to 180K	Reads: 35 K Writes: 3.3 K	Reads: 25K Writes: 6K	Up to 115K
<u>Interface</u>	FC, SAS	SAS	sATA	sATA	PCIe
<u>Power</u>	Active: 8.4W Idle: 5.4W	Active: 7.9W Idle: 3.9W	Active: 2.4W Idle: 0.06W	Active: 1.9W Idle: 0.6 W	Active: 6W

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# The SSD Landscape

Write Bandwidth	500 MB/s (32K packet size)
Read Bandwidth	750 MB/s
IOPS*	110,000
	89,500

<b>improved performance</b>	
- Fast Access Time and Read/Write Speed	
- Under 0.2 msec	No seek time
- Sequential Write	Up to 80MB/sec
- Sequential Read	Up to 100MB/sec

- Bandwidth Performance Specifications
  - Sustained Sequential Read
  - Sustained Sequential Write
- Read and Write IOPS Specifications (IOmeter Queue Depth 32)
  - Random 4 KB Reads: 30,000 IOPS
  - Random 4 KB Writes: 15,000 IOPS

**Performance (Typical)**

Total IOPS	110,000
Data Throughput	750 MB/s



Access Time	20-120 microseconds
Sequential Read	220 Mbytes/sec
Sequential Write	115 Mbytes/sec
Random I/O	45,000 IO/sec, sustained
	16,000 IO/sec, sustained

Capacity	2,900,000
Endurance (read)	1 in 10 <sup>14</sup> bits read
Life (years)	> 10 years
Life (years)	> 400 <sup>2</sup> years

<b>Reliability</b>	<ul style="list-style-type: none"> <li>• 7 years (100% Write Duty)</li> <li>• Bit Error Rate (UBER): 1 sector per 10<sup>15</sup> bits read</li> <li>• MTBF 2 million hours</li> </ul>
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# Standards are coming

- Solid State Storage Initiative (SSSI) of SNIA has created a Solid State Storage Technical Work Group (SSS TWG)
  - Performance Benchmark Standard: defines preconditioning, reference test platform, benchmark profiles, etc.
  - First draft available to public: 4Q09
- JEDEC 64.8
  - Specification for SSD endurance measurement
- Solid State Drive Alliance (SSDA)
  - Testing of reliability (power cycling, data retention, endurance) and OS compatibility (Windows 7)
- IDEMA
  - Standards program for HDDs and SSDs





## Top Ten List

6. Industry efforts are underway to help better understand SSDs

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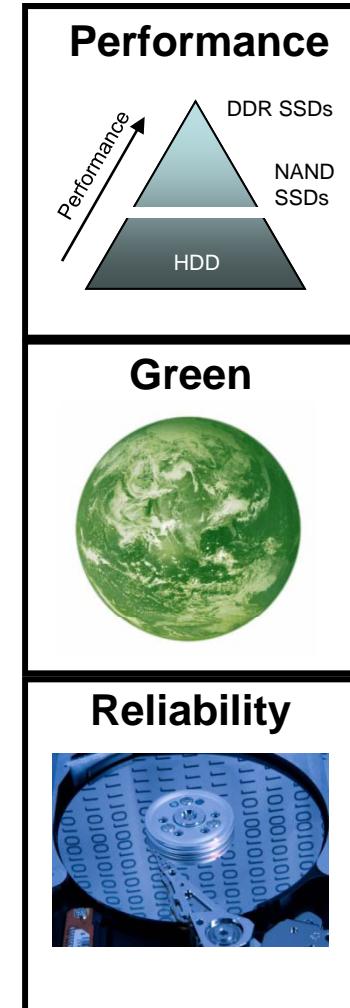
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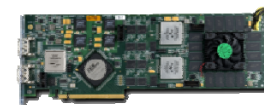
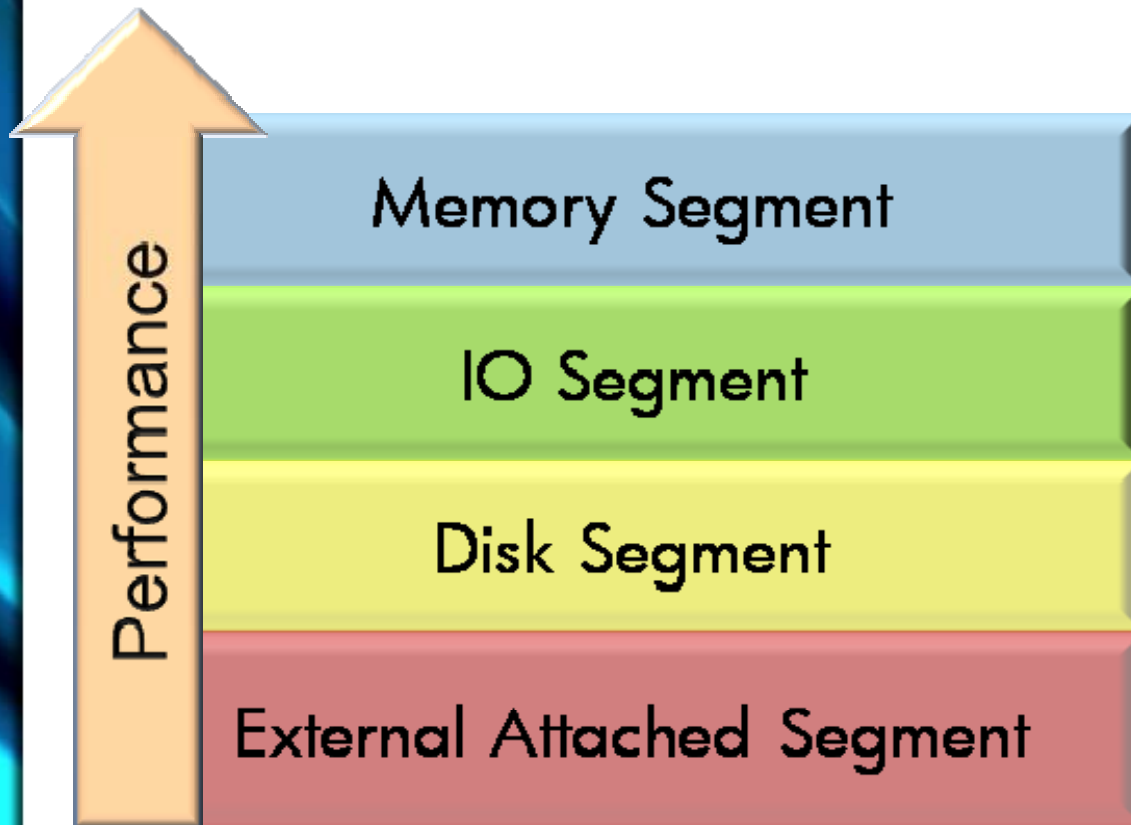
# Where do SSDs fit?

<u>Vertical</u>	<u>Requirements</u>	<u>Target Application</u>
<b>Portal (IPDC)</b>	<ul style="list-style-type: none"> <li>• Low Latency</li> <li>• Longer Lifecycle</li> <li>• Energy &amp; Space Efficient</li> </ul>	Portal Search, Search video, Search index, social networking, web cache
<b>Cloud (IPDC)</b>	<ul style="list-style-type: none"> <li>• High Throughput</li> <li>• Energy and Space Efficient</li> </ul>	High performance database, Virtualization
<b>Financial Services</b>	<ul style="list-style-type: none"> <li>• Low Latency</li> <li>• Energy &amp; Space Efficient</li> </ul>	Transaction processing, OLTP, Analytics
<b>HPC</b>	<ul style="list-style-type: none"> <li>• High Throughput</li> </ul>	CAD, CT Scans, Seismic, Visualization, Modeling
<b>Telco (IPTV)</b>	<ul style="list-style-type: none"> <li>• High Throughput</li> <li>• Longer Lifecycle</li> </ul>	IPTV, IPDC, VOD, video editing, web casting
<b>External Storage</b>	<ul style="list-style-type: none"> <li>• Longer Lifecycle</li> <li>• High Throughput</li> <li>• Energy &amp; Space Efficient</li> </ul>	OLTP, Databases, Messaging, ERP, CRM, Virtualization, Portals, Data Warehousing, Business intelligence, Business analytics, Decision Support
<b>IT</b>	<ul style="list-style-type: none"> <li>• Longer Lifecycle</li> <li>• High Throughput</li> <li>• Energy &amp; Space Efficient</li> </ul>	



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# Storage Hierarchy



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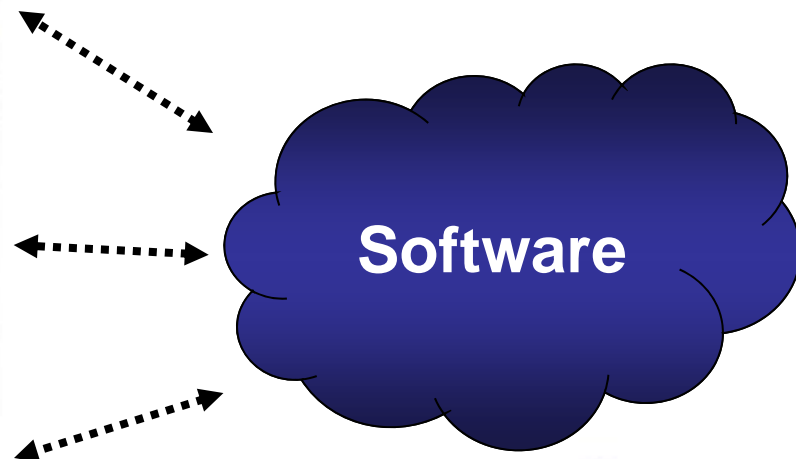
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# Better Integration is Coming

Automated data management across  
tiers of storage



→ Enables easier, more efficient use of SSDs

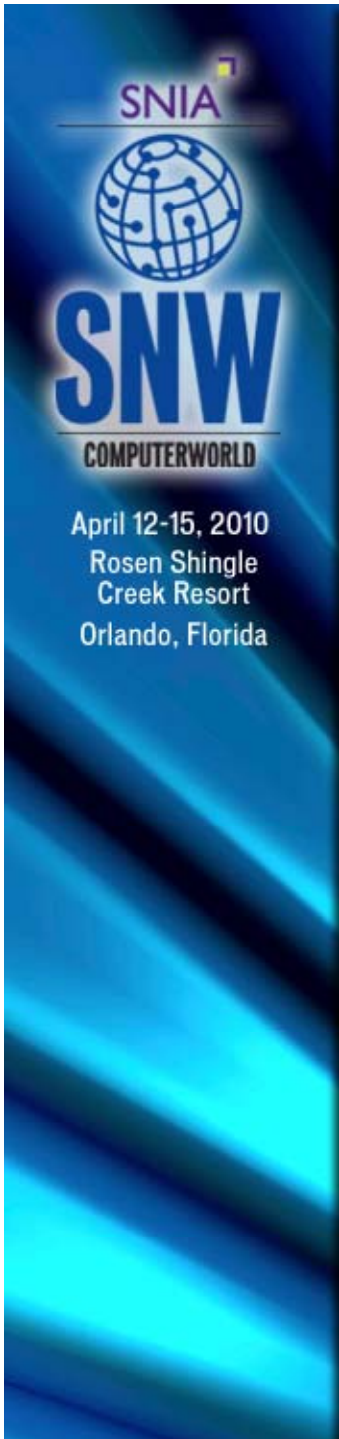




## Top Ten List

6. Industry efforts are underway to help better understand SSDs
7. Data environments and system architectures influence choice of SSD

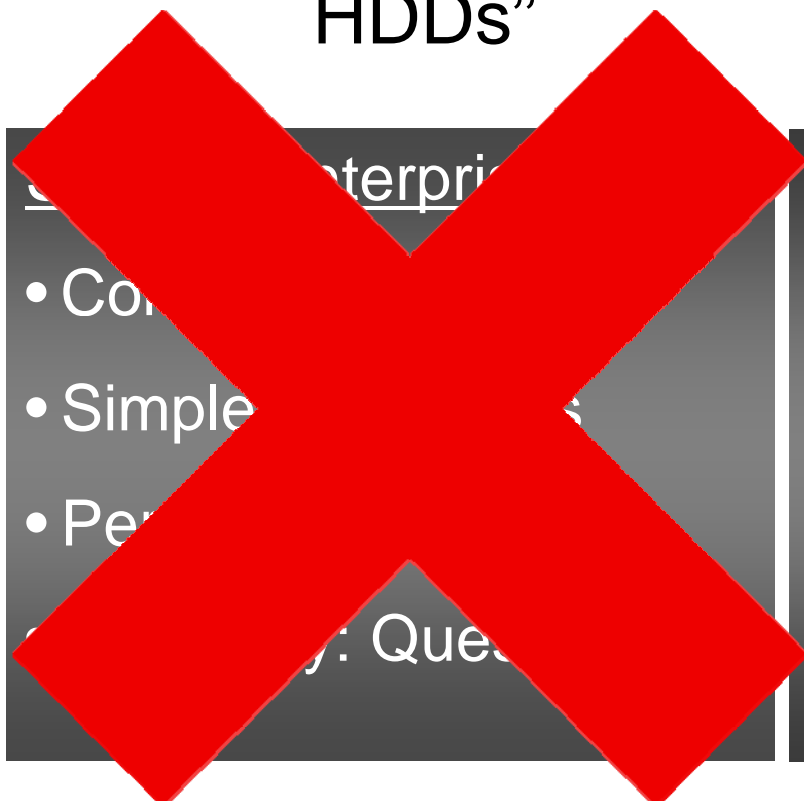




# Enterprise SSDs – Past and Present

## The Past

“SSDs will replace HDDs”



## The Present

“SSDs complement HDDs”

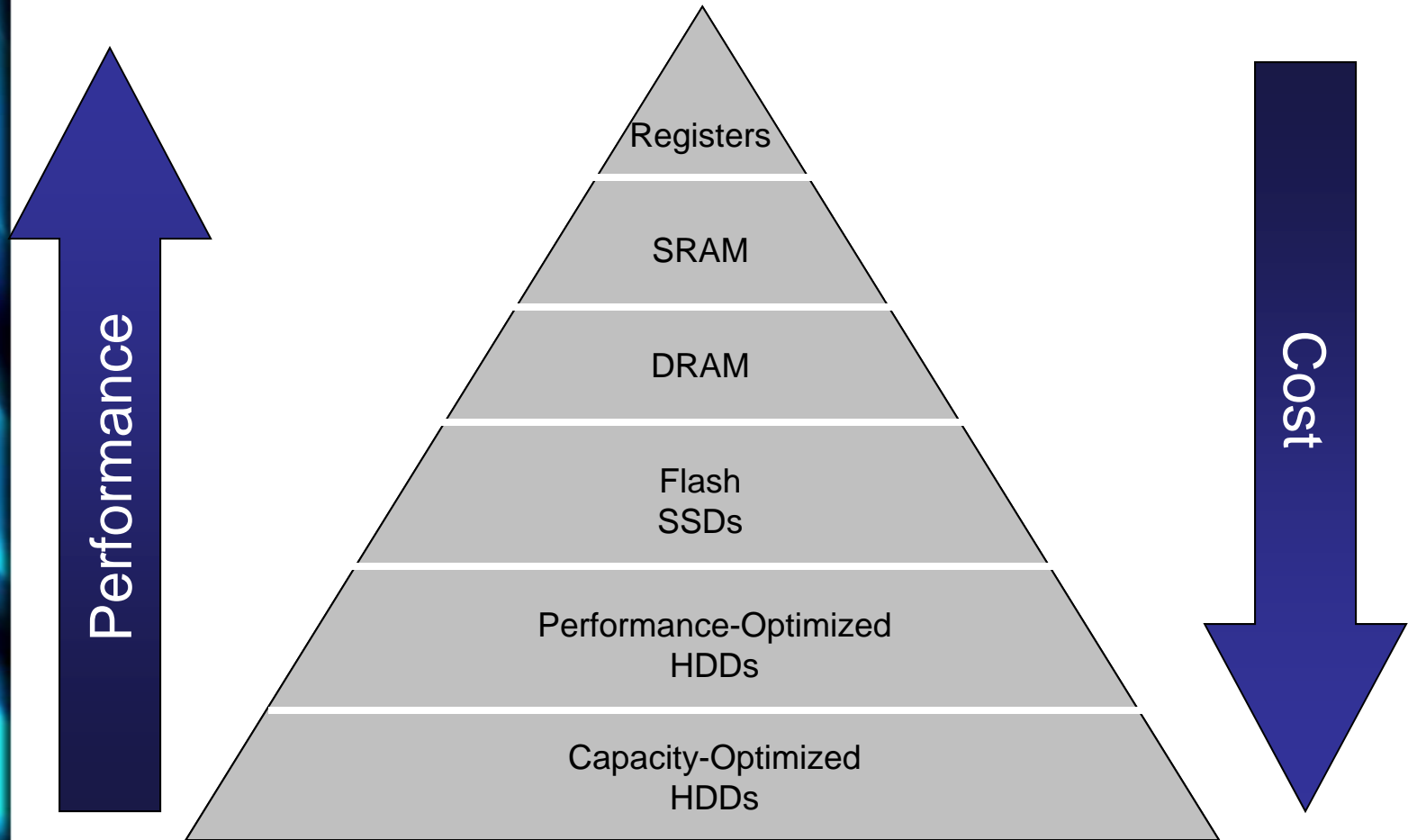
### **Strong OEM Support ...**

#### State of Enterprise SSDs

- Enterprise-Ready
- Advanced Controllers
- Performance: Great
- Reliability: Greatly Improved

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# SSDs will compliment in system architectures





## Top Ten List

6. Industry efforts are underway to help better understand SSDs
7. Data environments and system architectures influence choice of SSD
8. SSDs will compliment in system architectures

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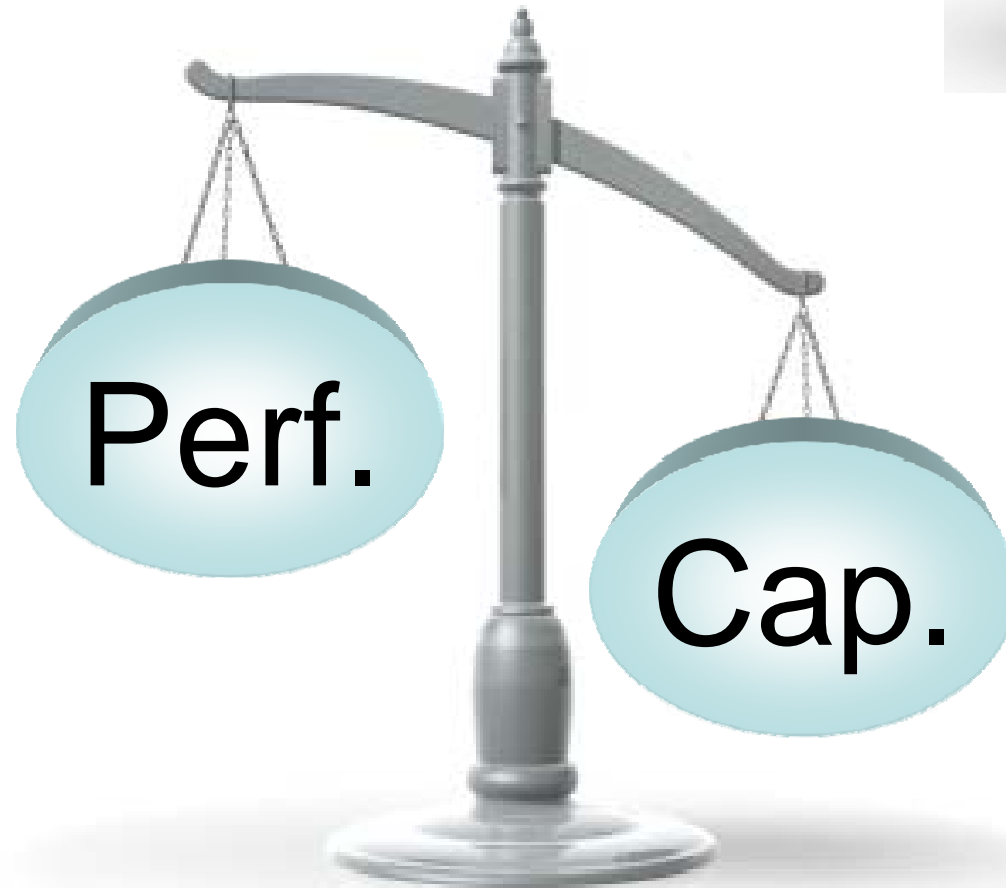



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# *Why the Imbalance*





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# Performance-Optimized HDD Trends

	2009	2010	2011	2012	2013	2014
3.5" Maximum Capacity	600 GB	600 GB	<u>600 GB</u>	600 GB	600 GB	NA
3.5" Maximum disks per drive	4	4	4	4	4	NA
3.5" Maximum Spinspeed (RPM)	15,000	15,000	15,000	15,000	15,000	NA
2.5" Maximum Capacity	300 GB	600 GB	<u>900 GB</u>	1.2 TB	1.2 TB	1.5 TB
2.5" Maximum disks per drive	2	3	3	3	3	3
2.5" Maximum Spinspeed (RPM)	15,000	15,000	15,000	15,000	15,000	10,000

Worldwide Hard Disk Drive 2009–2013  
Enterprise HDD Forecast – April, 2009  
IDC #222797





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# Capacity-Optimized HDD Trends

	2009	2010	2011	2012	2013	2014
3.5" Maximum Capacity	2.0 TB	3.0 TB	4.0 TB	5.0 TB	5.0 TB	6.0 TB
3.5" Maximum disks per drive	5	5	5	5	5	5
3.5" Maximum Spinspeed (RPM)	7,200	7,200	7,200	7,200	7,200	7,200
2.5" Maximum Capacity	500 GB	1.0 TB	1.5 TB	2.0 TB	2.0 TB	3.0 TB
2.5" Maximum disks per drive	2	3	3	3	3	3
2.5" Maximum Spinspeed (RPM)	7,200	7,200	7,200	7,200	7,200	7,200

*2.5" capacity < 1/2 the capacity of 3.5"...*  
*until 2014*

Worldwide Hard Disk Drive 2009–2013  
 Enterprise HDD Forecast – April, 2009  
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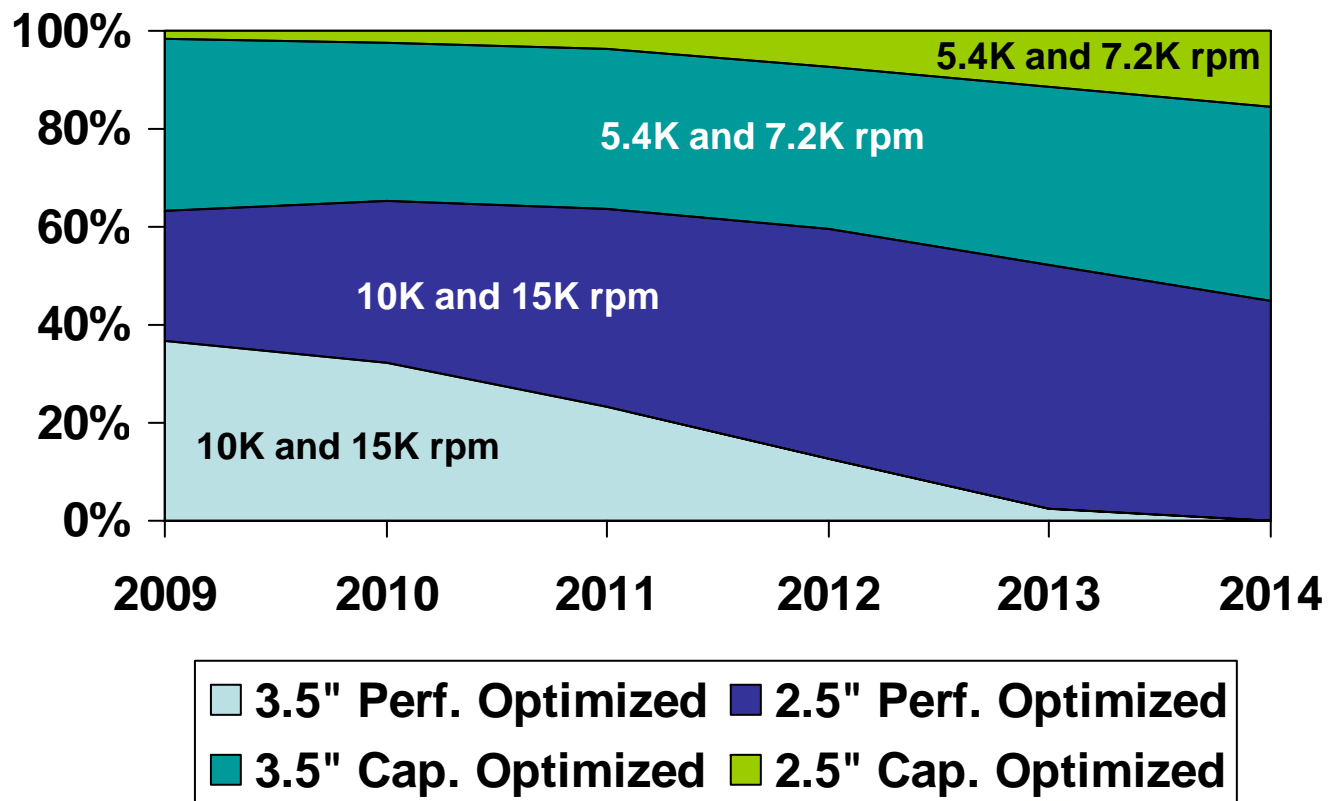


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# HDD Form Factor Transitions For Enterprise Applications



Worldwide Hard Disk Drive 2009–2013  
Enterprise HDD Forecast – April, 2009  
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## Top Ten List

6. Industry efforts are underway to help better understand SSDs
7. Data environment and system architectures influence choice of SSD
8. SSDs will compliment in system architectures
9. Performance-optimized 3.5" HDDs are reaching end of life. In contrast, growing use of capacity-optimized HDDs



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## Who is This?



***An HDD Technologist....***

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# HDD Technology Introduction: Relative Cost

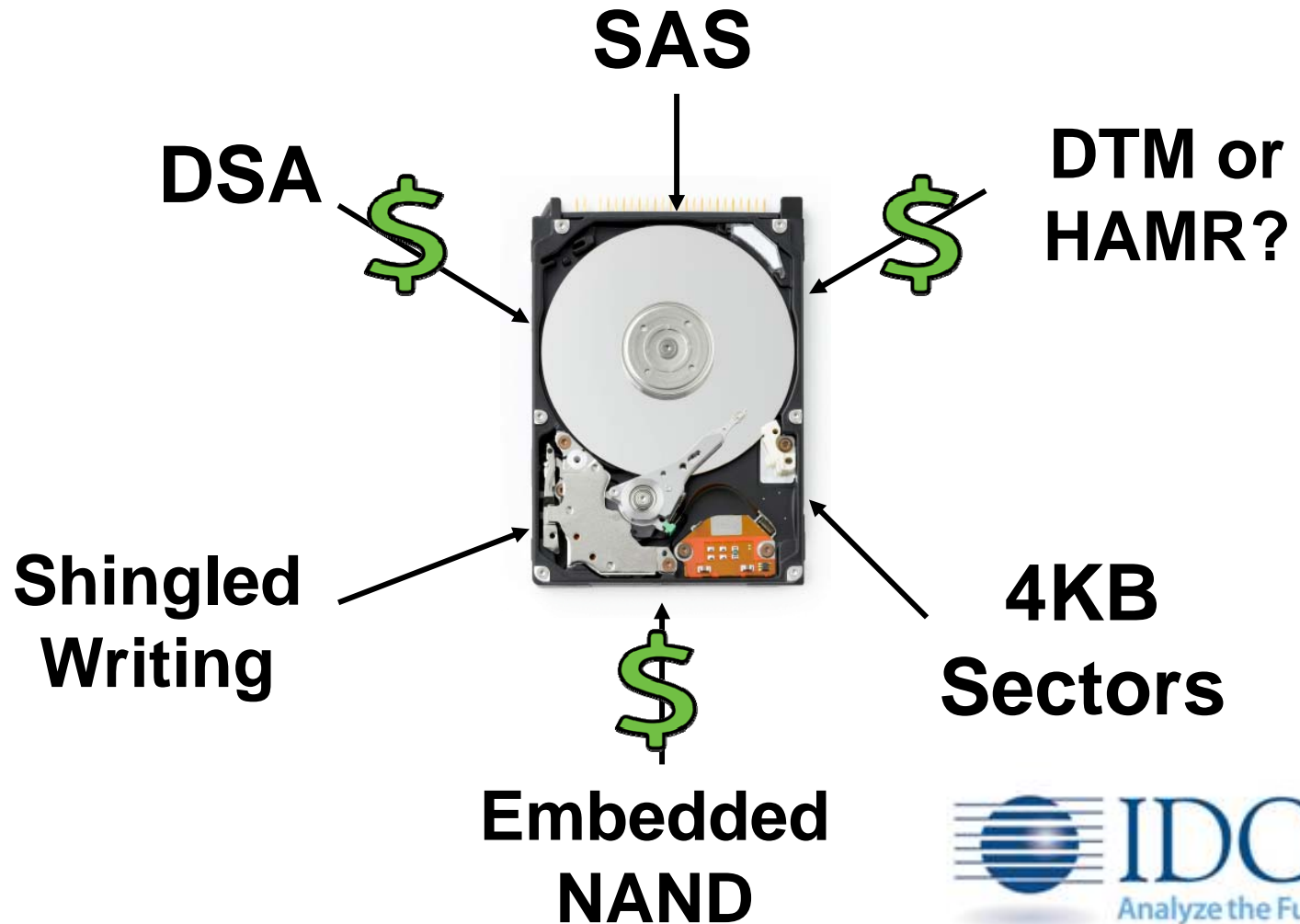
<b>PMR</b>	\$	\$		
<b>DSA</b>	\$	\$		
<b>DTM / BPM</b>	\$	\$	\$	\$
<b>HAMR</b>	\$	\$	\$	\$




## Lower Cost (But Complex) HDD Technology Options

- 4KB Sectors
- Iterative decoding error correction code (ECC)
- Fly height sensors to improve dynamic fly height
- “Shingled” or “banded” writing...  
*intentionally overwriting tracks???*

# The 5 TB HDD



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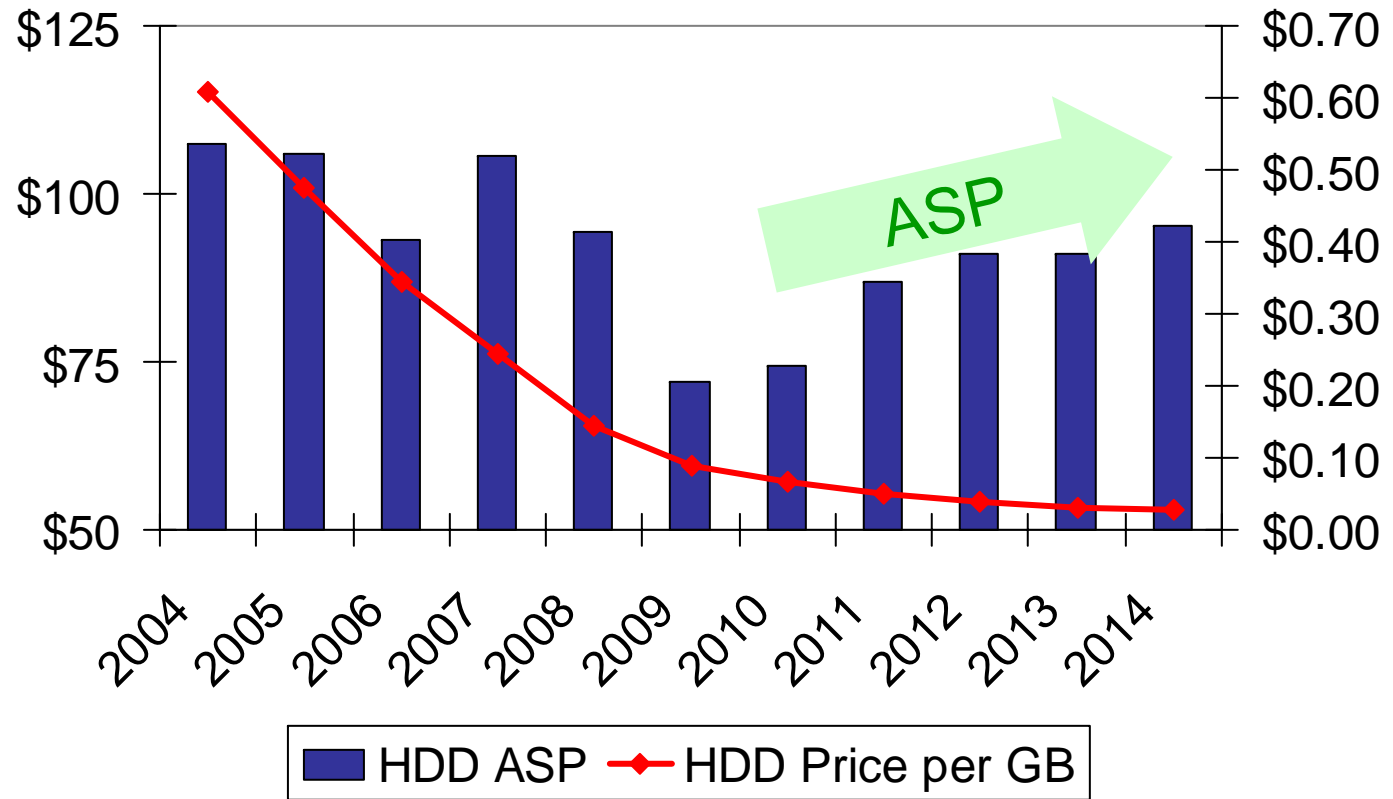


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# 3.5" Capacity-Optimized HDD



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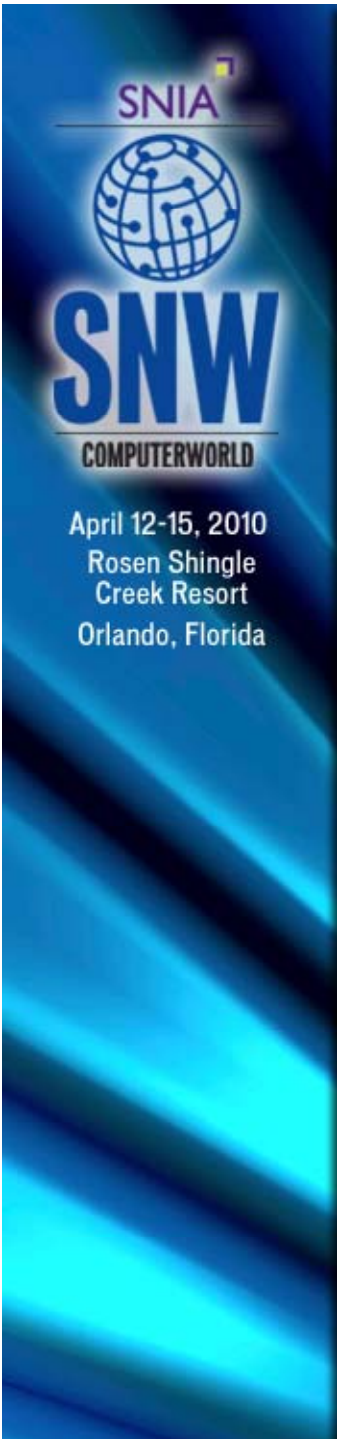
## Top Ten List

10. Technology is being 'stuffed' into HDDs to increase storage capacity
  - \$\$/GB will continue to decline
  - But capacity-optimized HDD ASPs may actually *increase*



# Takeaway Points

- Storage system architectures today are diverse, demanding diversity of HDD and SSD form factors.
- Capacity-optimized HDDs are lower cost (\$\$/GB) than performance-optimized HDDs, but increasingly include features not found on the SATA HDDs used in PCs; expect ASPs to rise.
- SSD adoption grows slowly over time due to cost, and the time to absorb SSD technology adoption at the storage system level.
- SSDs used in conjunction with Capacity-Optimized HDDs *is not* automatically disastrous to HDD industry profitability.
- SSDs will complement HDDs in many storage systems architectures, including storage systems designed for “clouds”.



# Thank You



## Questions ?

Send us an email:

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[jjanukowicz@idc.com](mailto:jjanukowicz@idc.com)







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IT Governance: Signs of IT Revival and a Call for Mobilization

If you're looking for signs that things may be getting better in the realm of IT investment, the past few weeks provided me with a number of positive antecedents that back up IDC's [Predictions for 2010](#). In late February, I was at an event in New York City sponsored by a leading NetApp reseller. CIOs from a number of leading finance, entertainment, life sciences, and manufacturing enterprises were trying to come to grips with what the "cloud" meant for their businesses. Aside from the [usual, and quite legitimate, concerns about security and sound IT governance](#), the most interesting theme was that none of them talked about "cloud" as a cost savings option (a major theme in the past year). Their interest in cloud focused on accelerating business expansion and introducing new services for employees and customers.

Yesterday, I returned from an event put on by Pillar Data Systems for its customers. After a year of cancellations and conversion to "virtual" events, it is heartening to see that IT suppliers again recognize the importance of talking directly with a large pool of customers and, more important, are making it easier for customers to talk face to face with each other. Aggressive consolidation and virtualization were on the top of everyone's agenda, but so was new service activities. For some, this translated into major expansions in the use of business intelligence and data analytics. For others, digitizing and intelligently archiving intellectual property assets were the top concerns and priorities.

[more...](#)

**IT Governance: Budget Cuts, Long-Term Trends and...** 2  
 Entry posted Mar 02 by [Joe Pucciarelli](#) | tagged [Budget](#), [Capital](#), [Executive Strategy](#), [IT Spending](#), [Planning](#)

IT Governance: Budget Cuts, Long-Term Trends and Negotiating Ideas

