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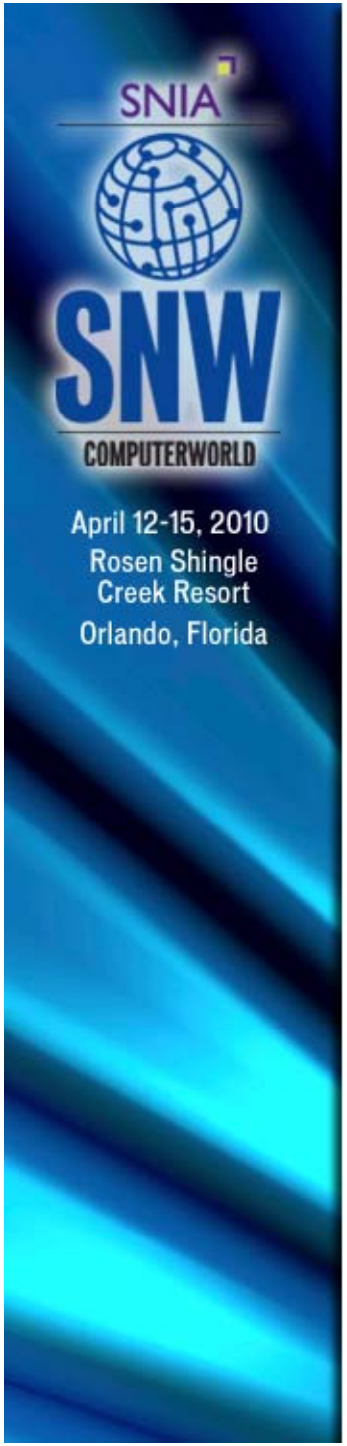

Top Ten Things
You Need to Know About **SSDs** and **HDDs** for Enterprise Applications

John Rydning
Research Director, Hard Disk Drives
Jeff Janukowicz
Research Manager, Solid State Drives

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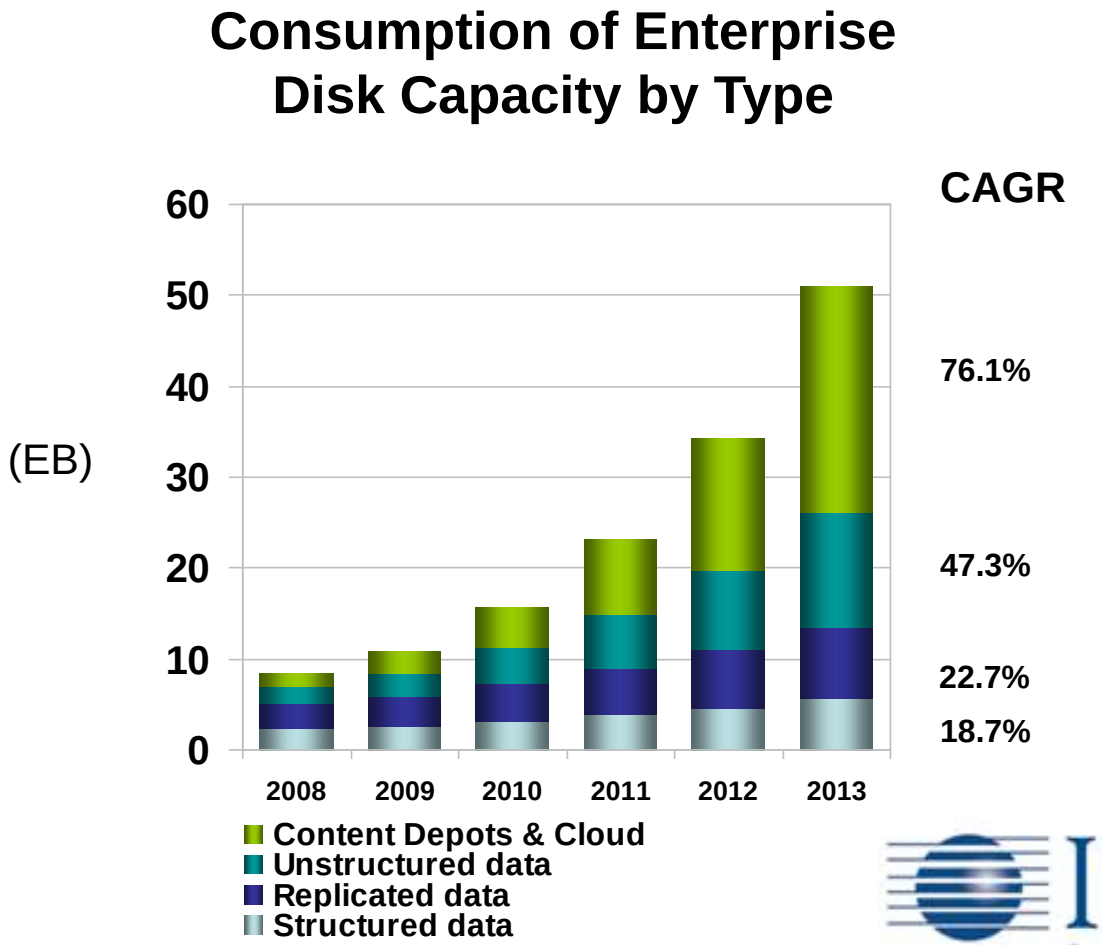
Changing Data Profiles:
Development of Role-base Storage



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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

SSD	FC	SAS	SATA	PCIe
2.5in				
3.5in				
Module				
Rackmount		+ InfiniBand,	iSCSI, FCoE	

SSD Form Factor

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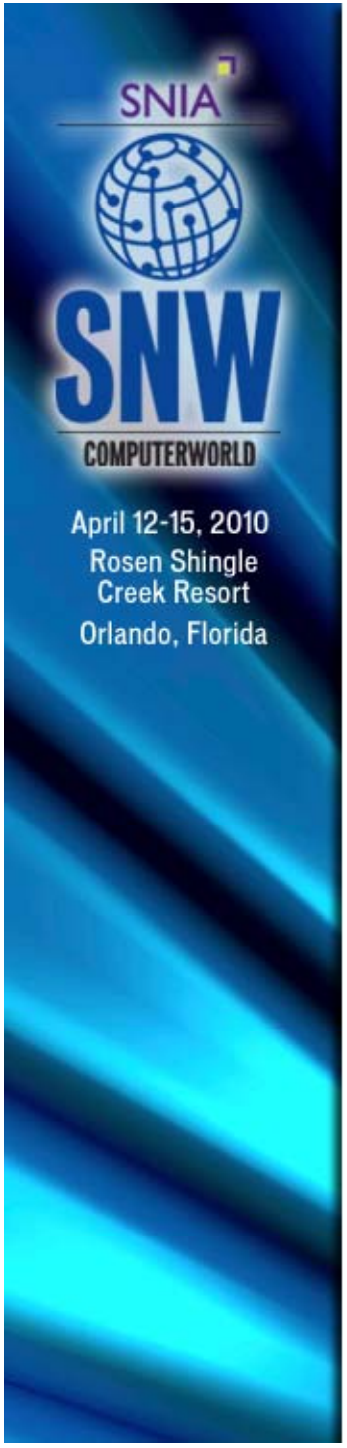

Top Ten List

1. Proliferating HDD and SSD form factors

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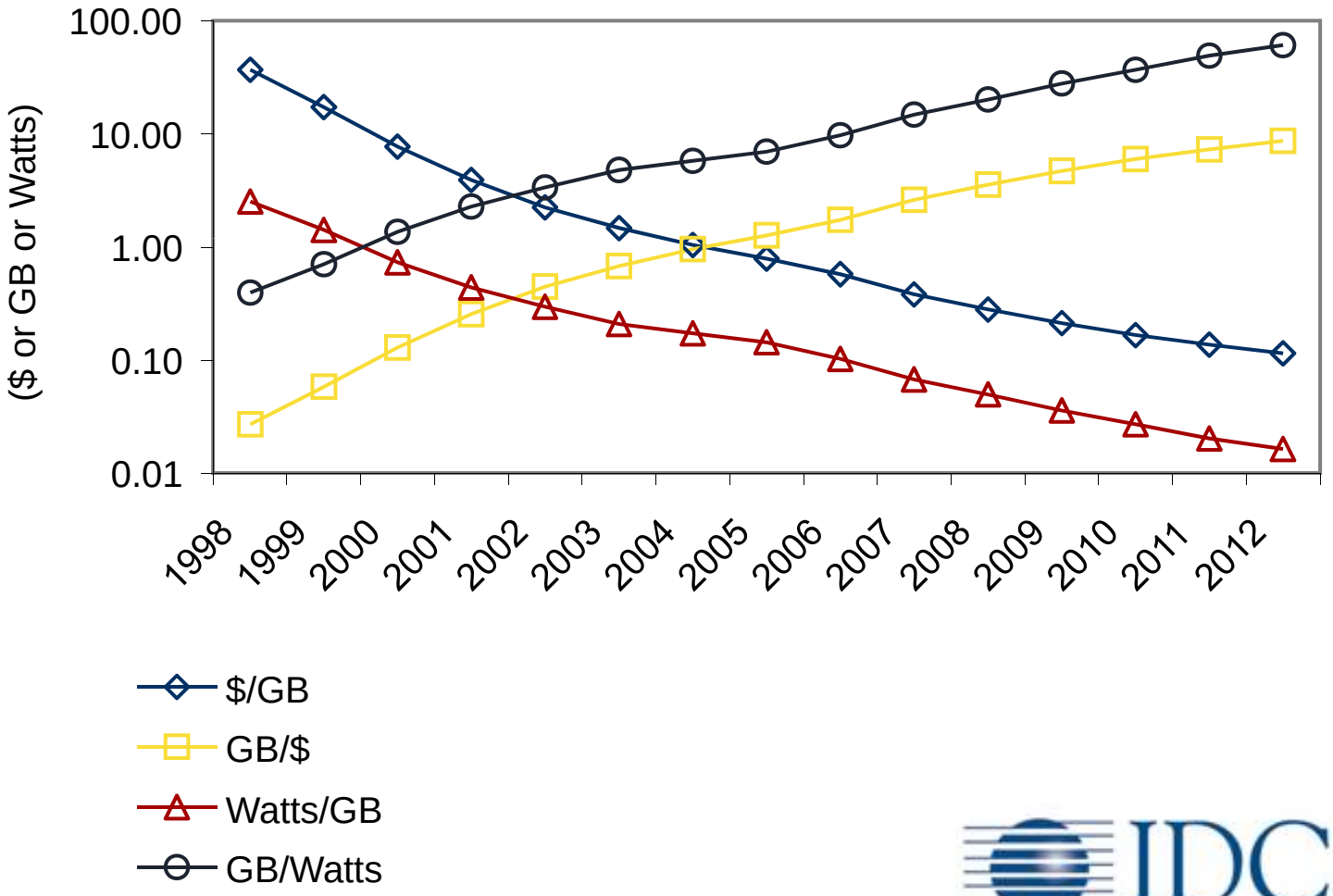
HDD-related Metrics - All Good?



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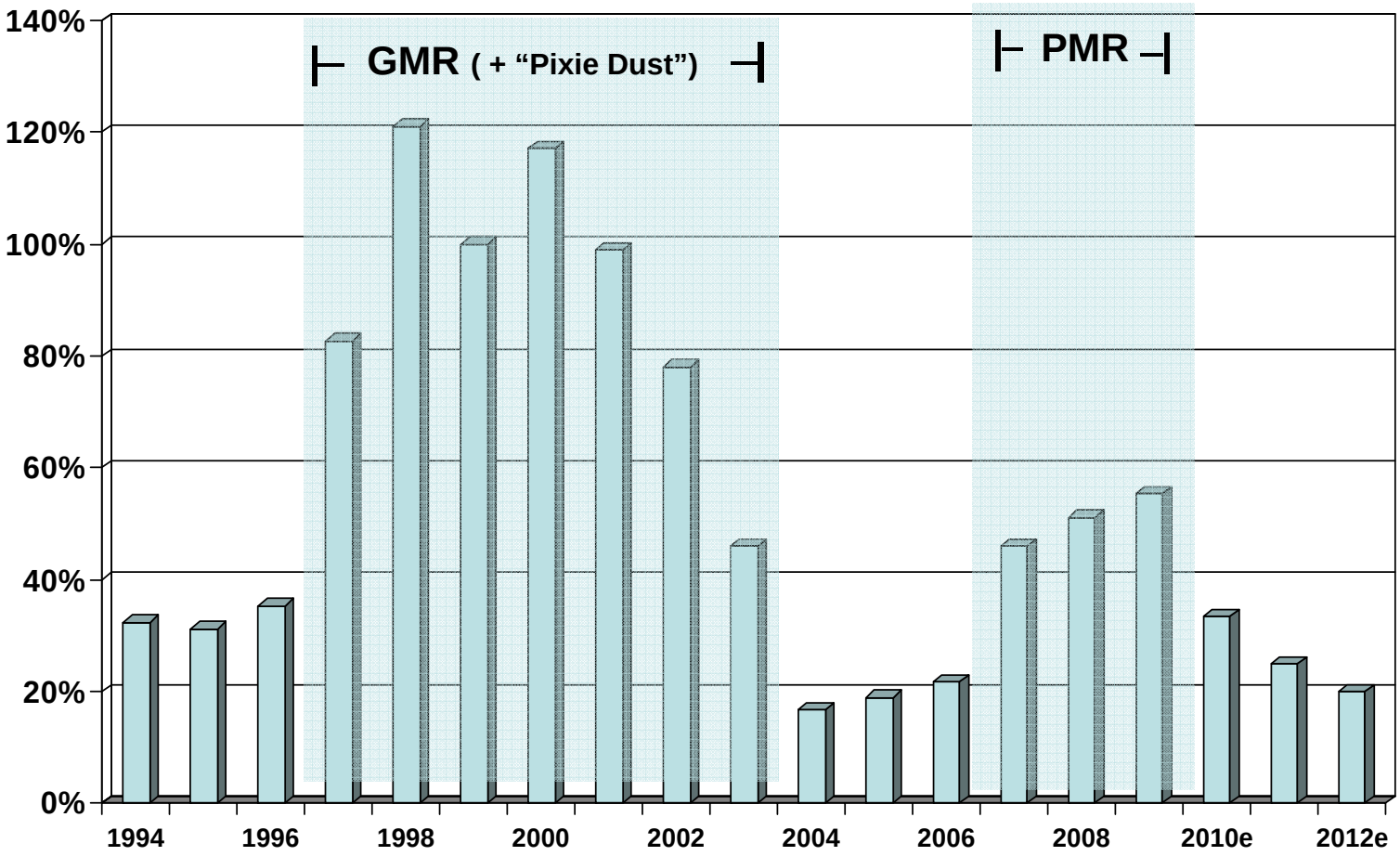
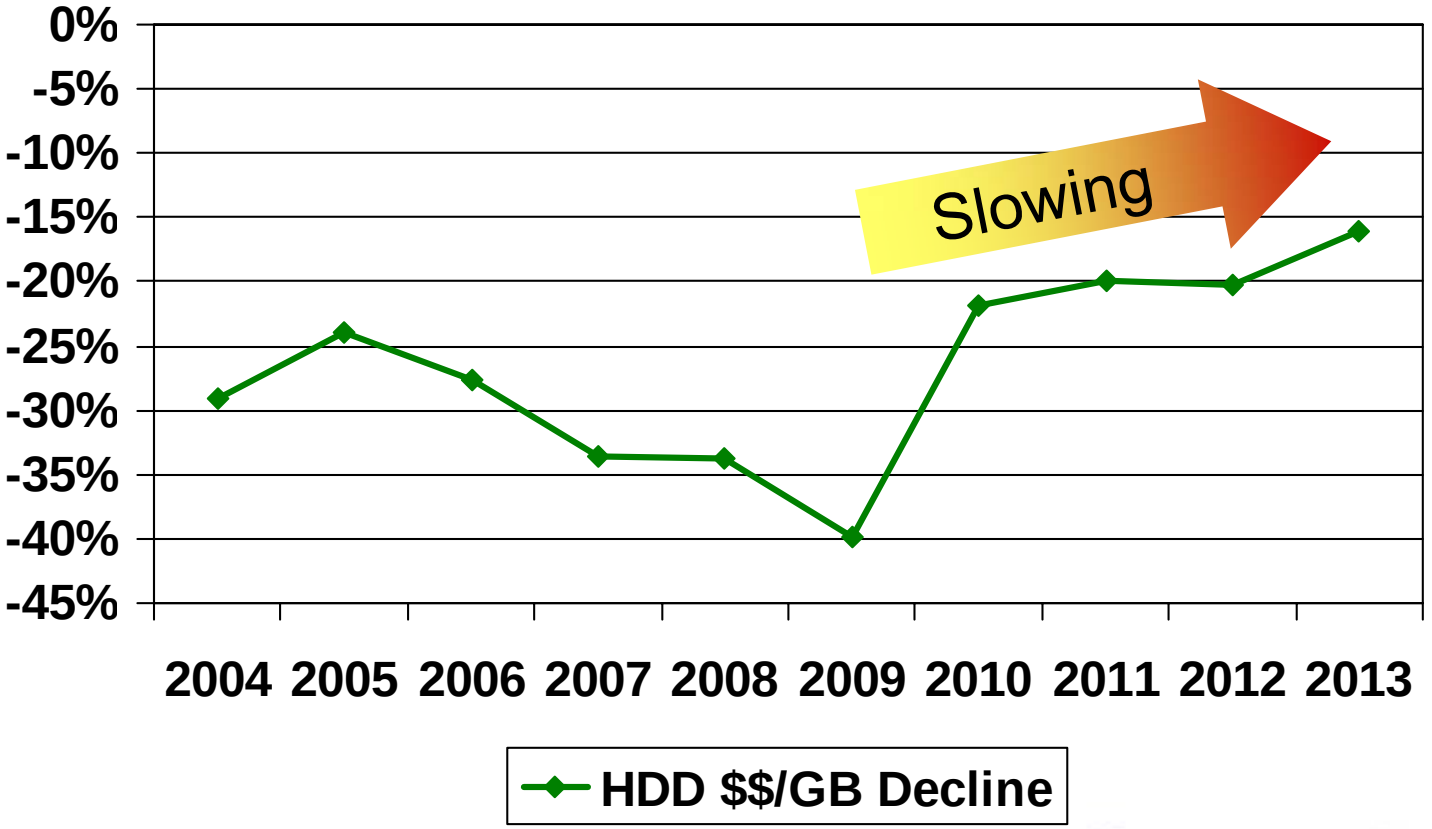
A Fundamental Issue

Slowing HDD Areal Density Growth



HDD $$ per GB Y-o-Y Change



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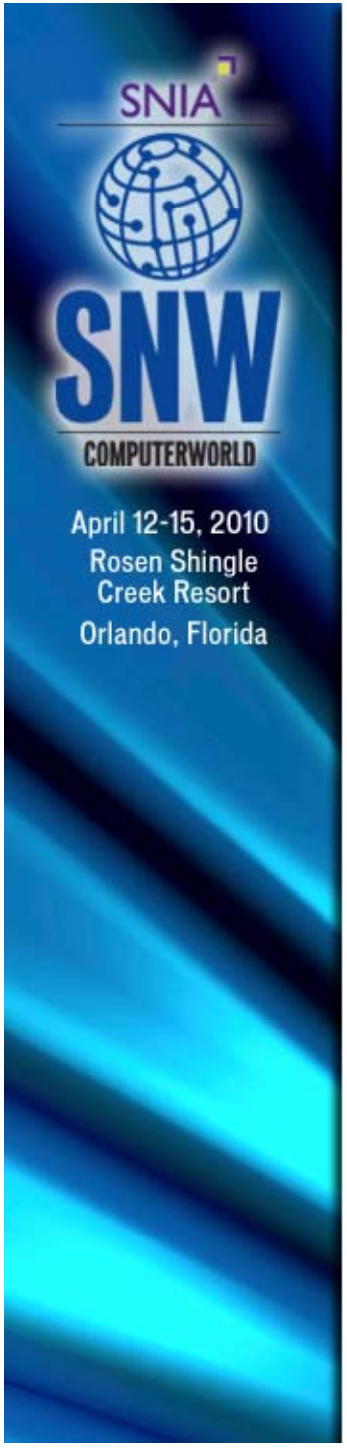

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1. Proliferating HDD and SSD form factors
2. HDD $$-per-GB declines are slowing as areal density growth slows

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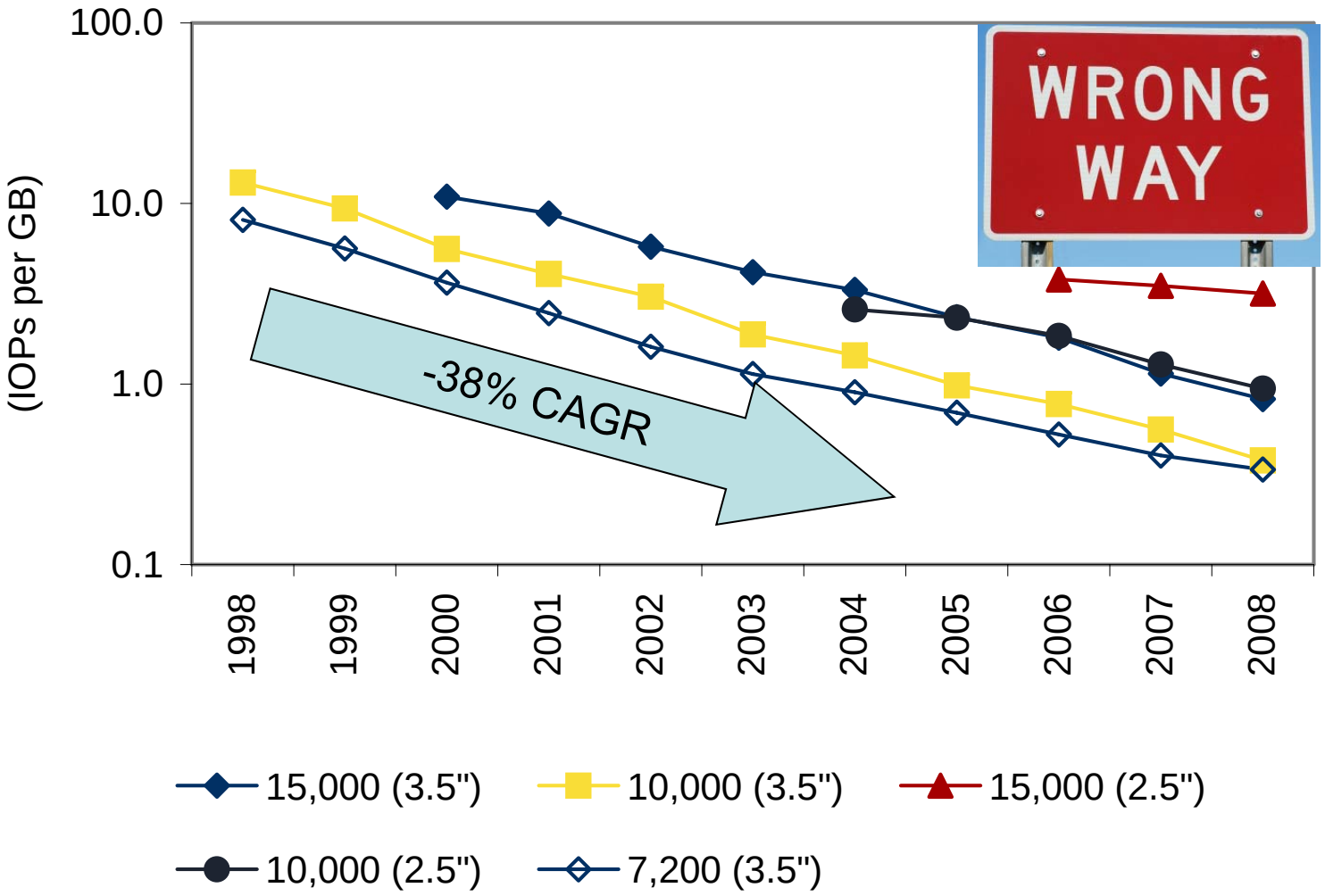
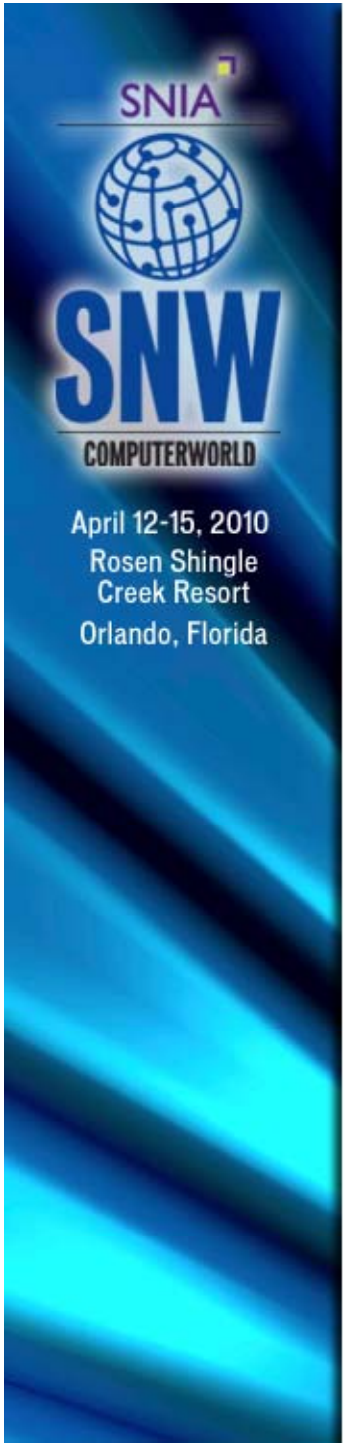
I/Os per GB





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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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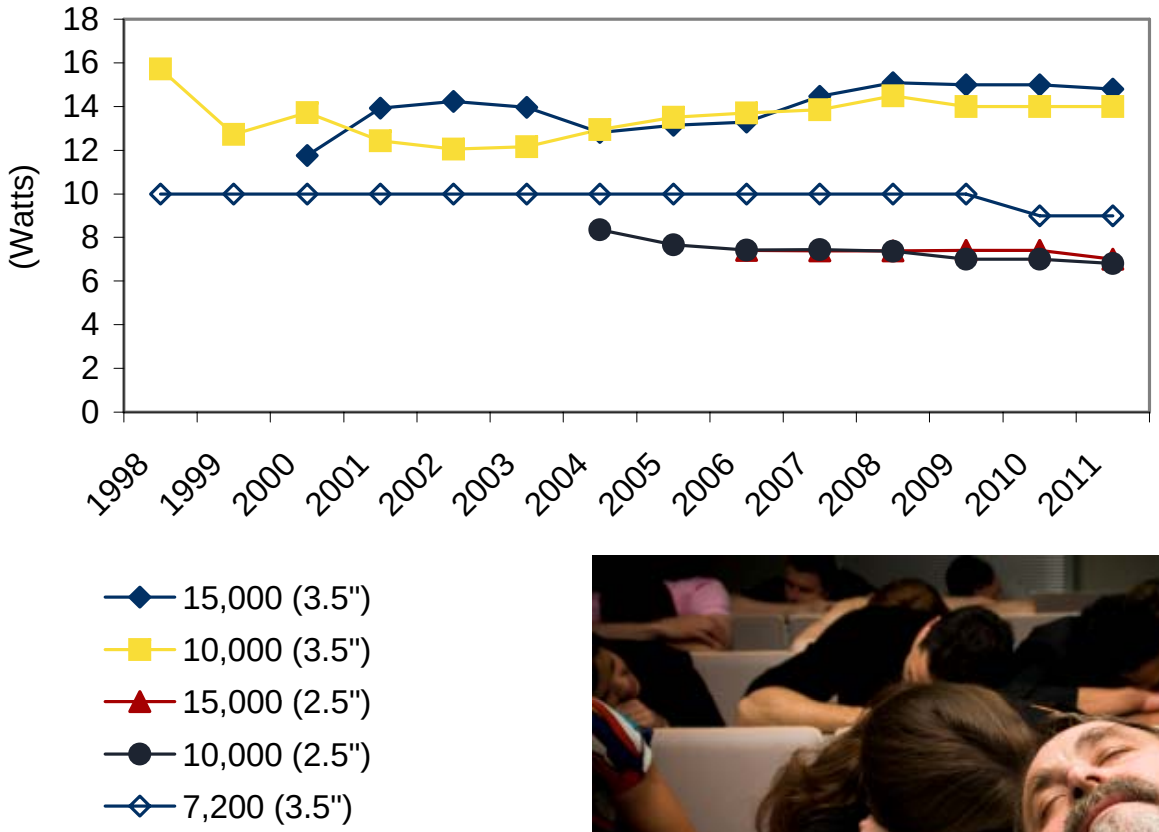
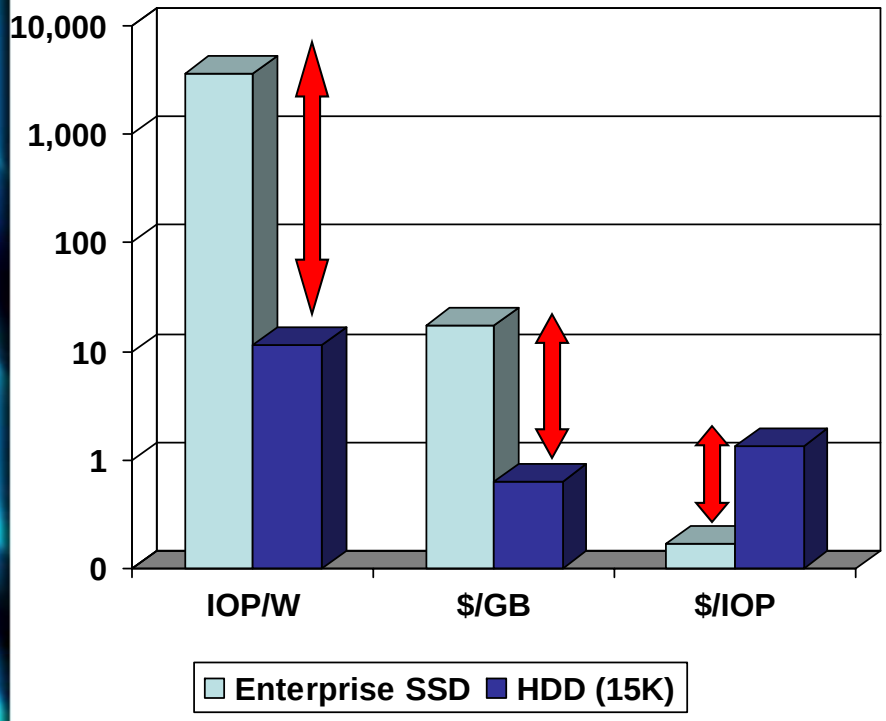
Watts/HDD over Time



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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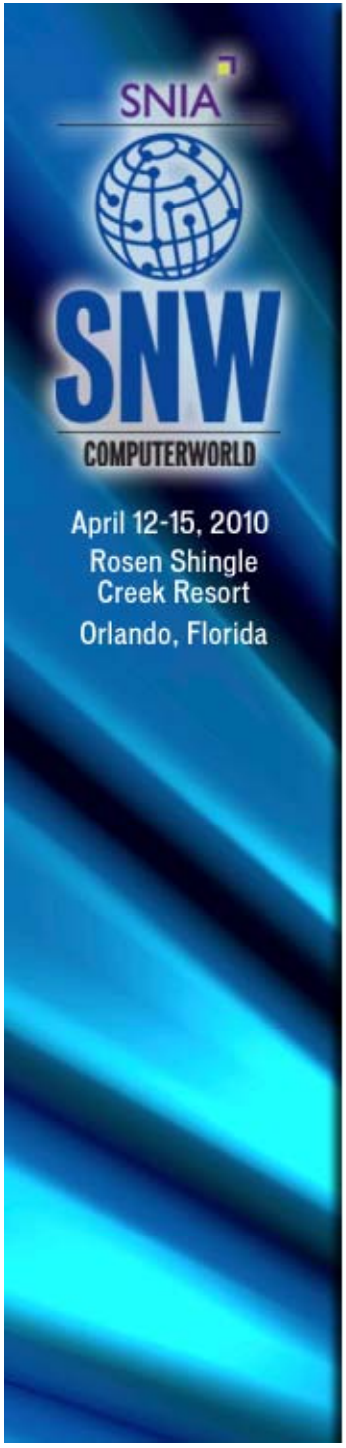

SSDs Deliver IOPs and Improve Latency

Drive	IOPs
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

Drive	Access Times
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 bette
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

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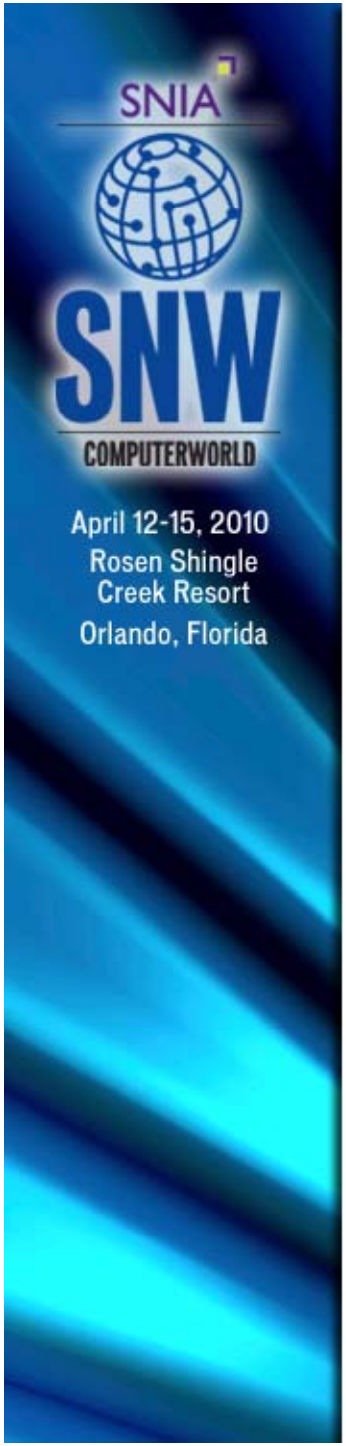

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1. Proliferating HDD and SSD form factors
2. HDD $$/GB declines slowing as areal density growth slows
3. HDD performance is improving, but very slowly
4. SSDs address both HDD performance and power-consumption shortfalls

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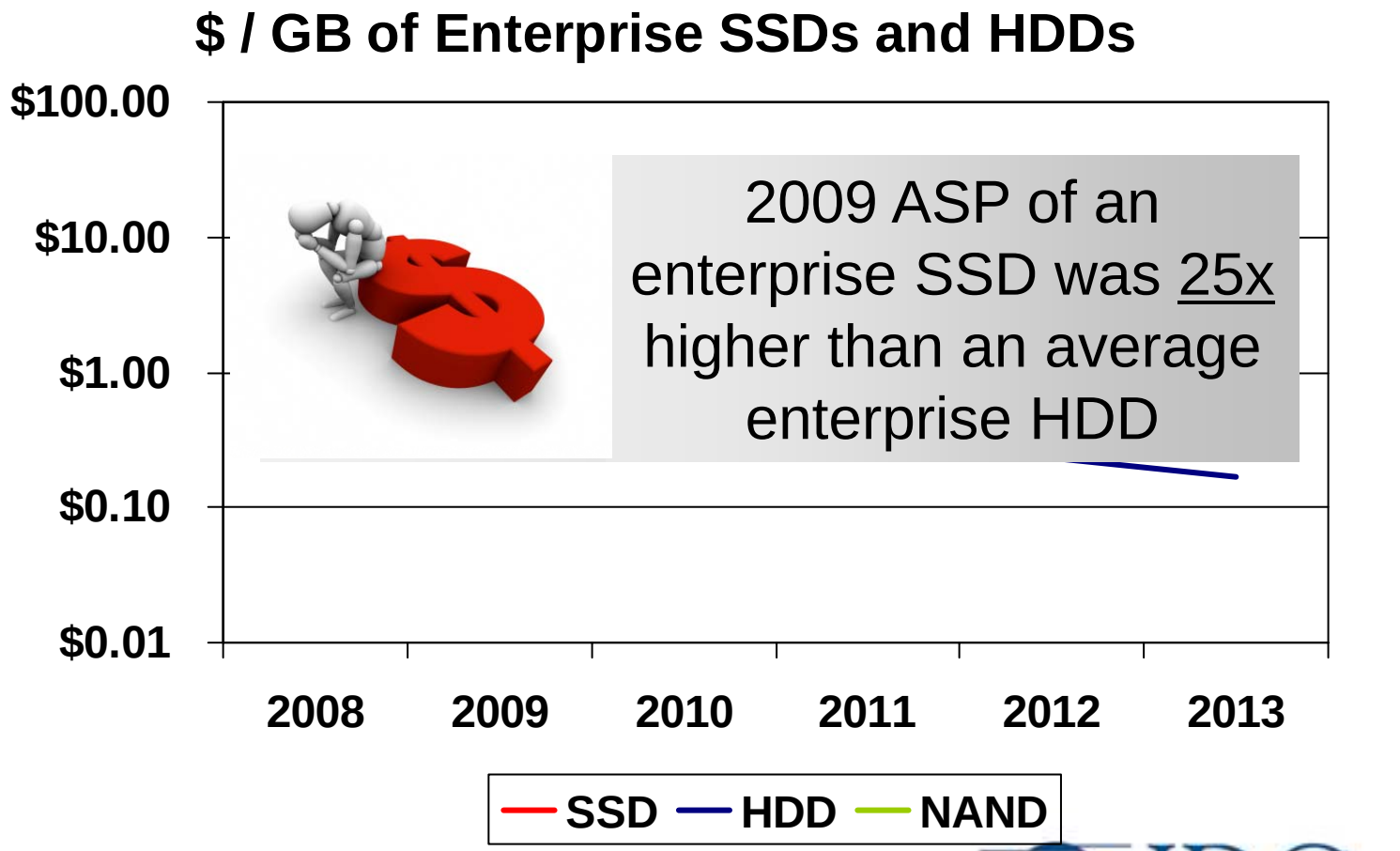
Cost is always a factor



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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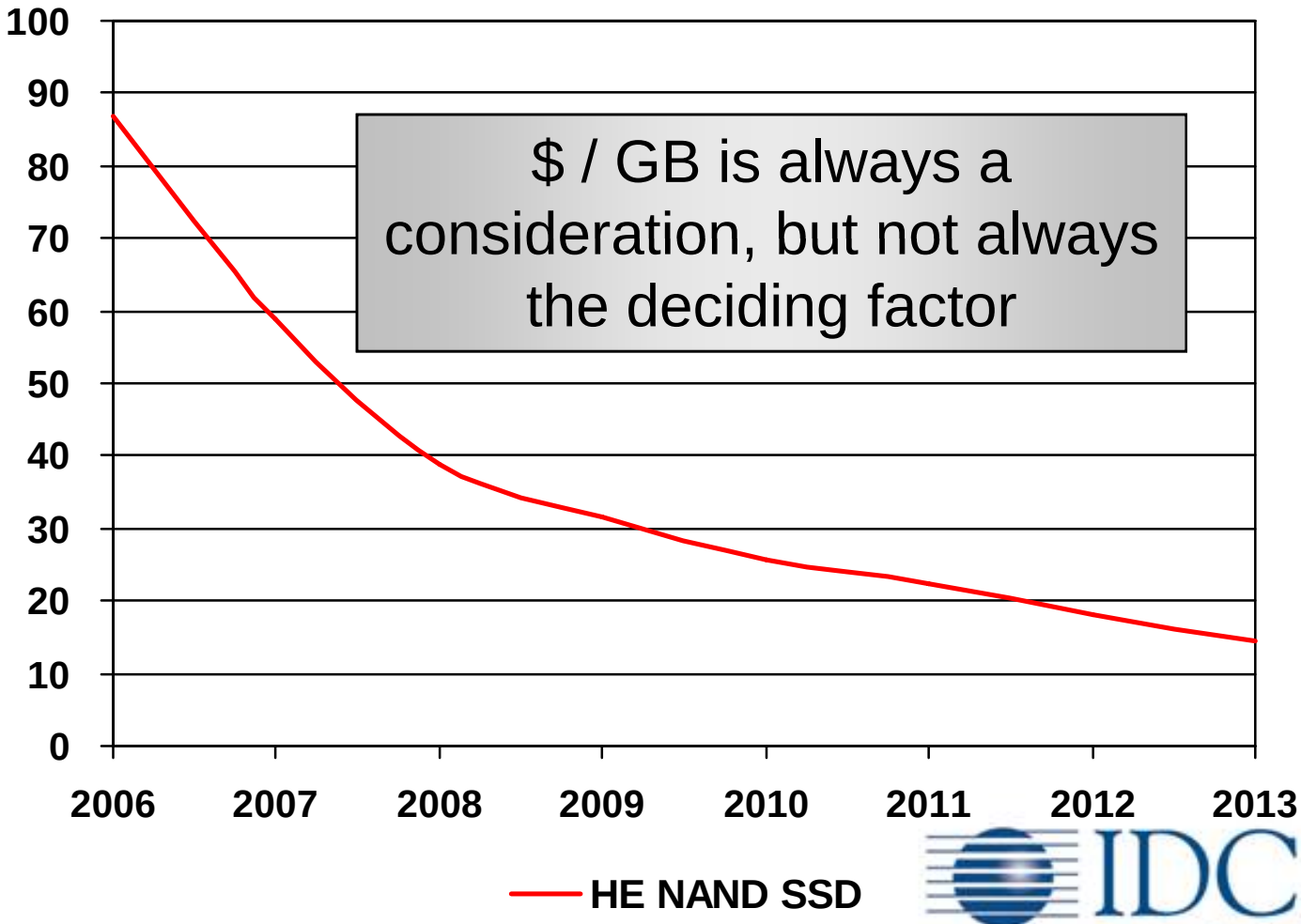
SSDs are Becoming More Affordable

Ratio of $/GB of Enterprise SSDs to Enterprise HDD



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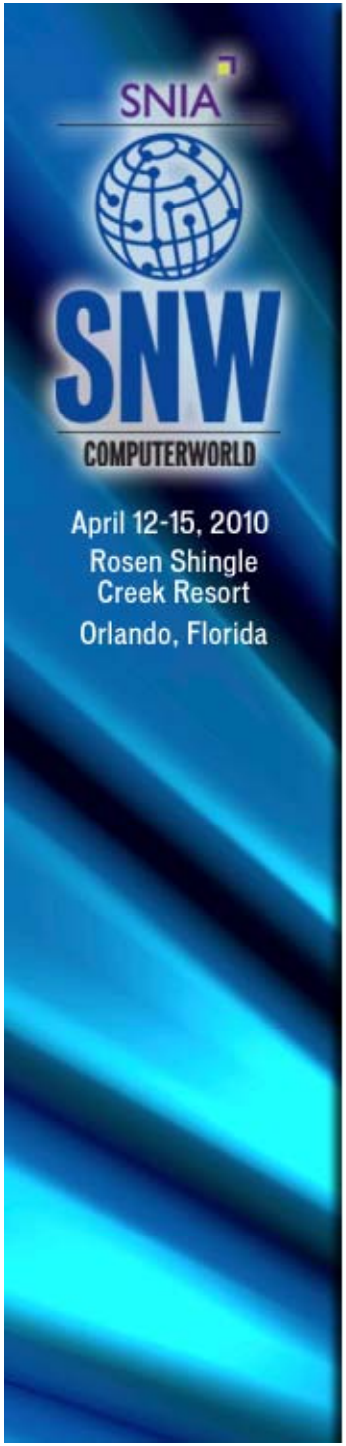

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2. HDD $$/GB declines slowing as areal density growth slows
3. HDD performance is improving, very slowly
4. SSDs address both HDD performance and power-consumption shortfalls
5. Cost is always a factor. Current SSD prices are inhibiting SSD adoption

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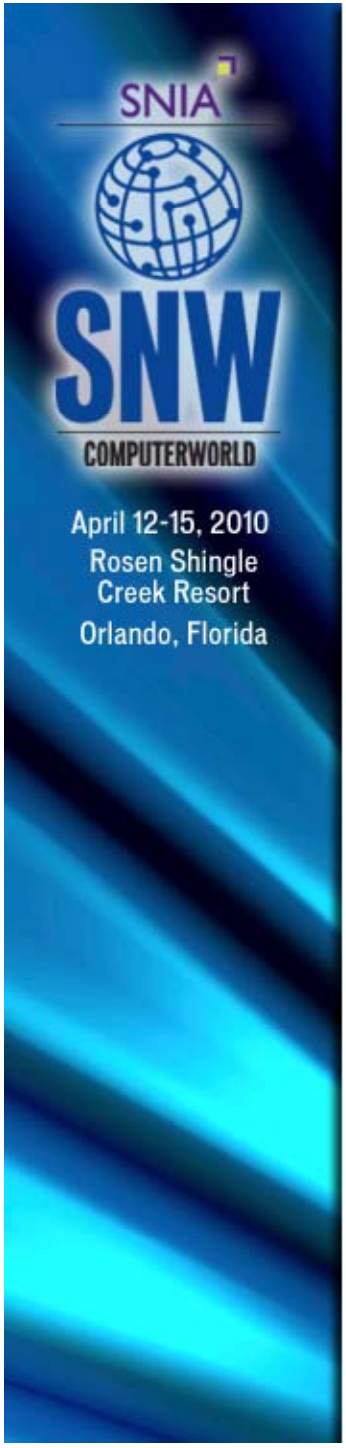

SSDs are Not Created Equal

	SSD A	SSD B	SSD C	SSD D	SSD E
Form Factor	3.5“	3.5”	2.5”	2.5”	Module
IOPs	Reads: 46K Writes: 16K	Up to 180K	Reads: 35 K Writes: 3.3 K	Reads: 25K Writes: 6K	Up to 115K
Interface	FC, SAS	SAS	sATA	sATA	PCIe
Power	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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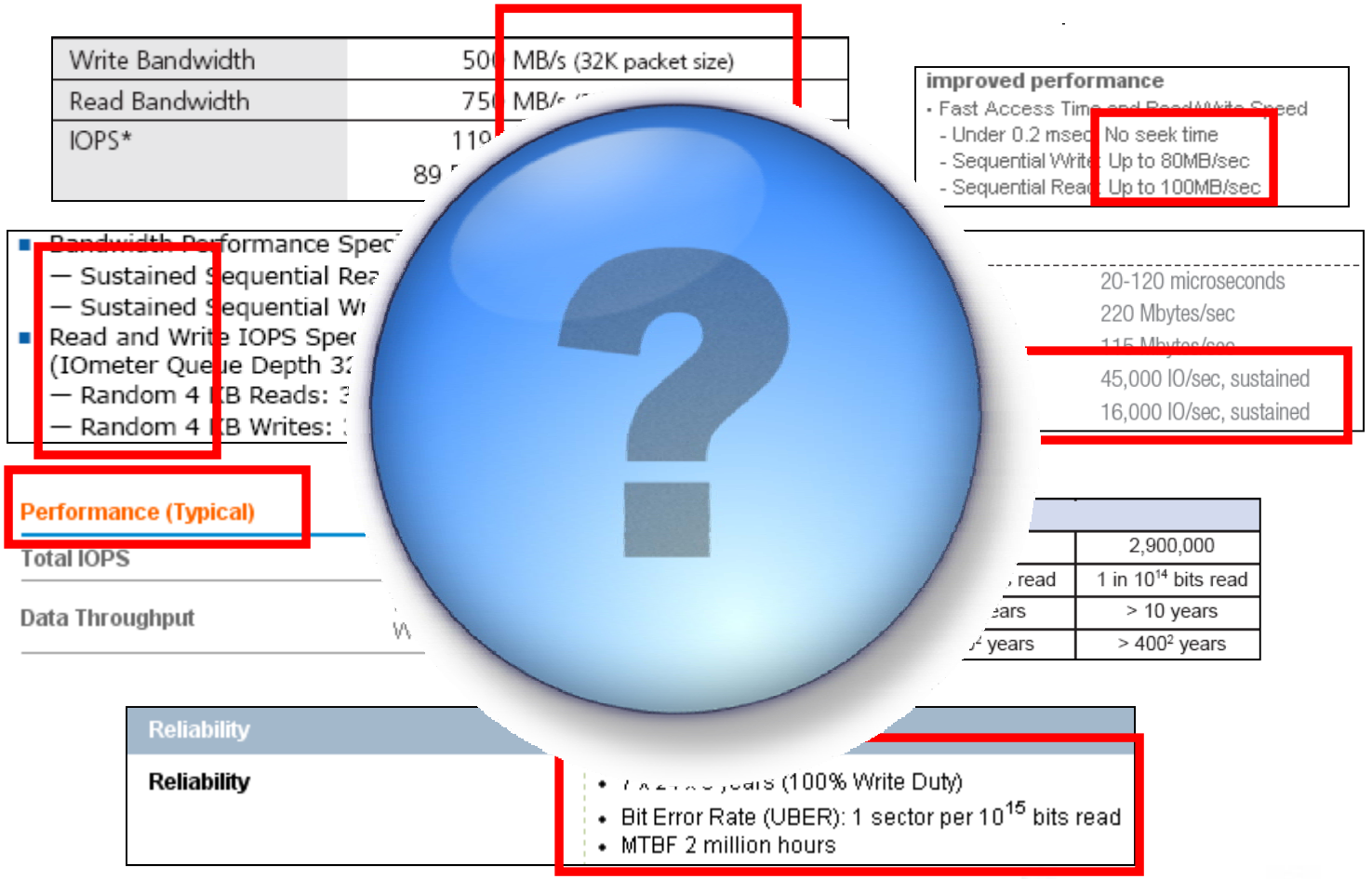
The SSD Landscape



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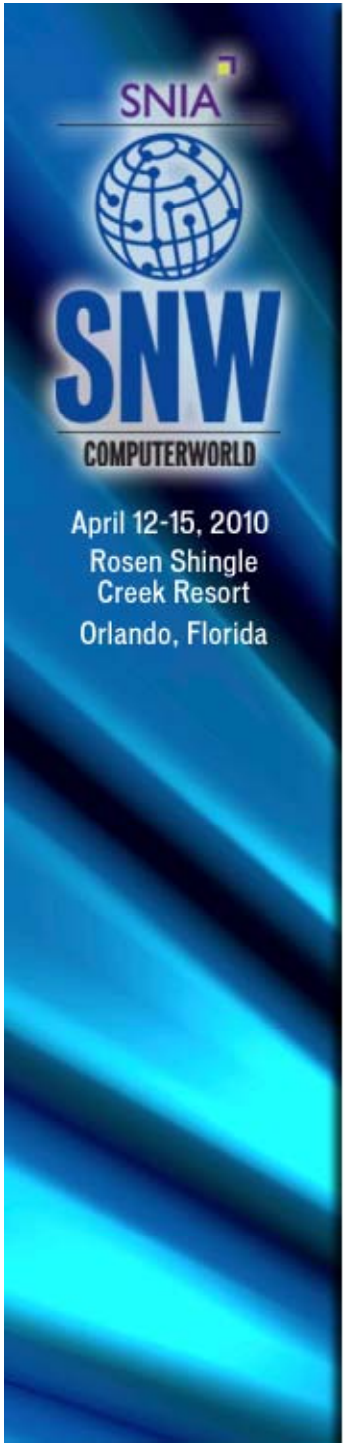

Standards are coming

- 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

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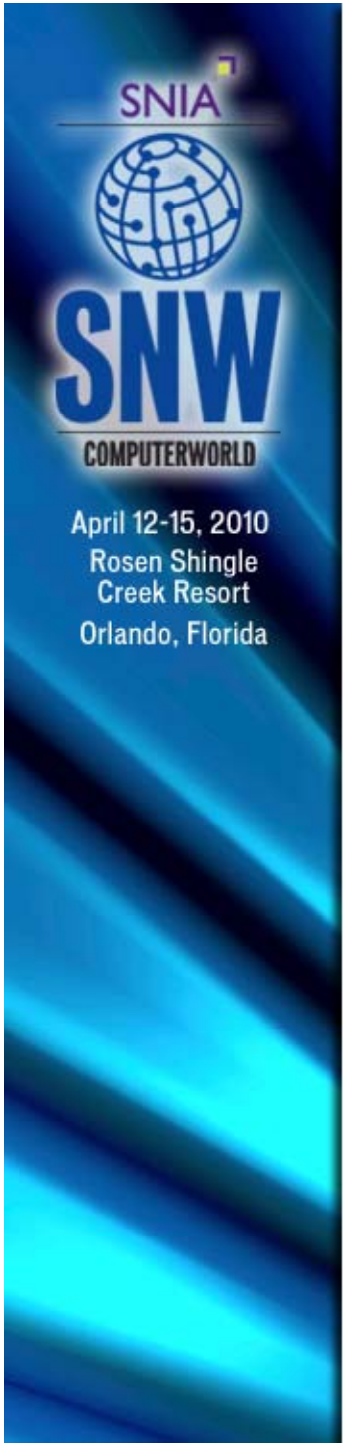

Top Ten List

6. Industry efforts are underway to help better understand SSDs

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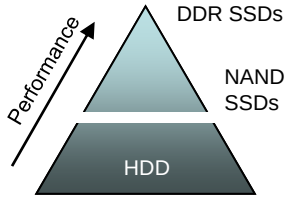
Where do SSDs fit?

Vertical	Requirements	Target Application
Portal (IPDC)	• Low Latency • Longer Lifecycle • Energy & Space Efficient	Portal Search, Search video, Search index, social networking, web cache
Cloud (IPDC)	• High Throughput • Energy and Space Efficient	High performance database, Virtualization
Financial Services	•Low Latency •Energy & Space Efficient	Transaction processing, OLTP, Analytics
HPC	•High Throughput	CAD, CT Scans, Seismic, Visualization, Modeling
Telco (IPTV)	•High Throughput •Longer Lifecycle	IPTV, IPDC, VOD, video editing, web casting
External Storage	• Longer Lifecycle • High Throughput • Energy & Space Efficient	OLTP, Databases, Messaging, ERP, CRM, Virtualization, Portals, Data Warehousing, Business intelligence, Business analytics, Decision Support
IT	• Longer Lifecycle • High Throughput • Energy & Space Efficient	

Performance



Green

Reliability

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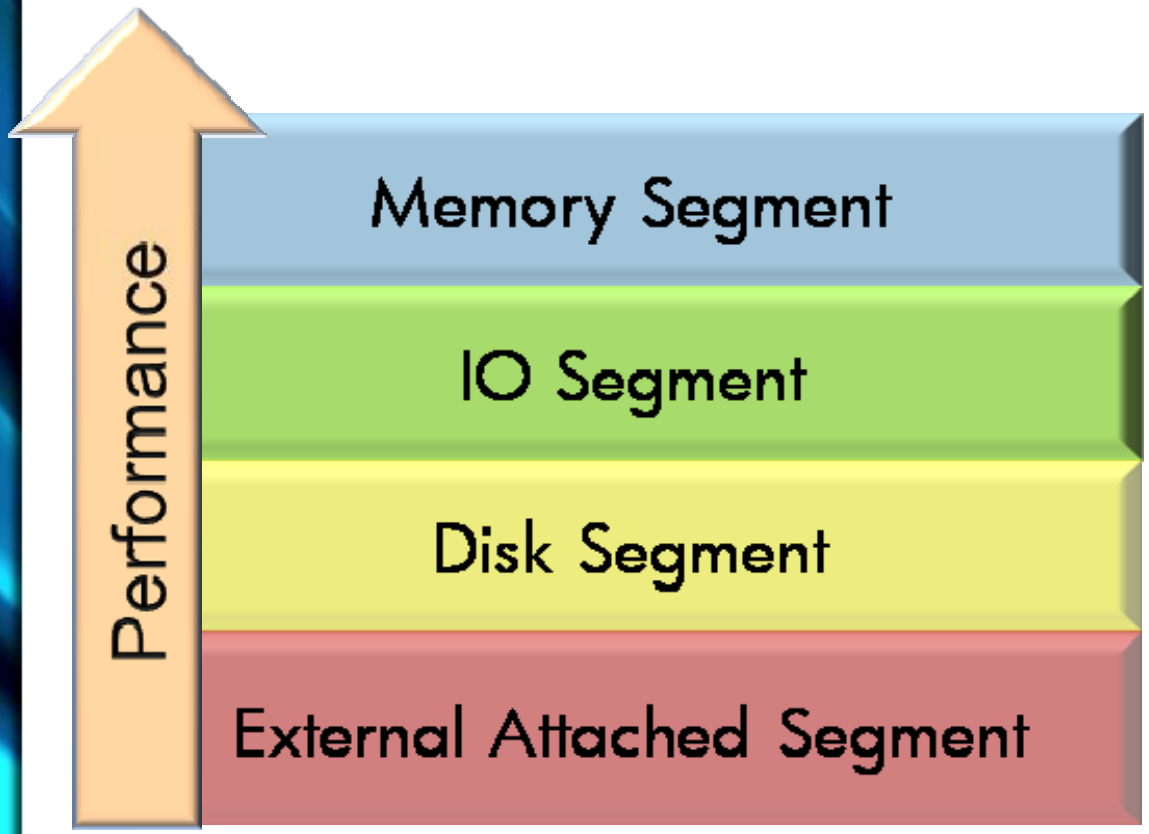
Storage Hierarchy



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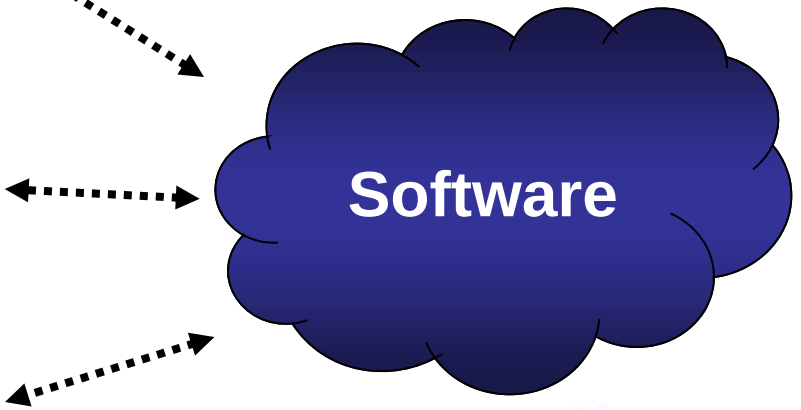
Better Integration is Coming

Automated data management across tiers of storage

→ **<u>Enables easier, more efficient use of SSDs</u>**



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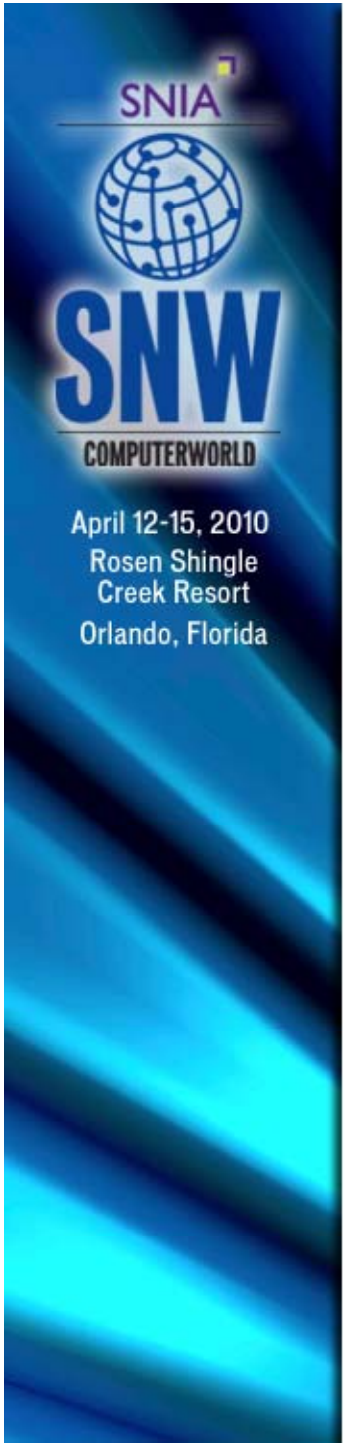

Top Ten List

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

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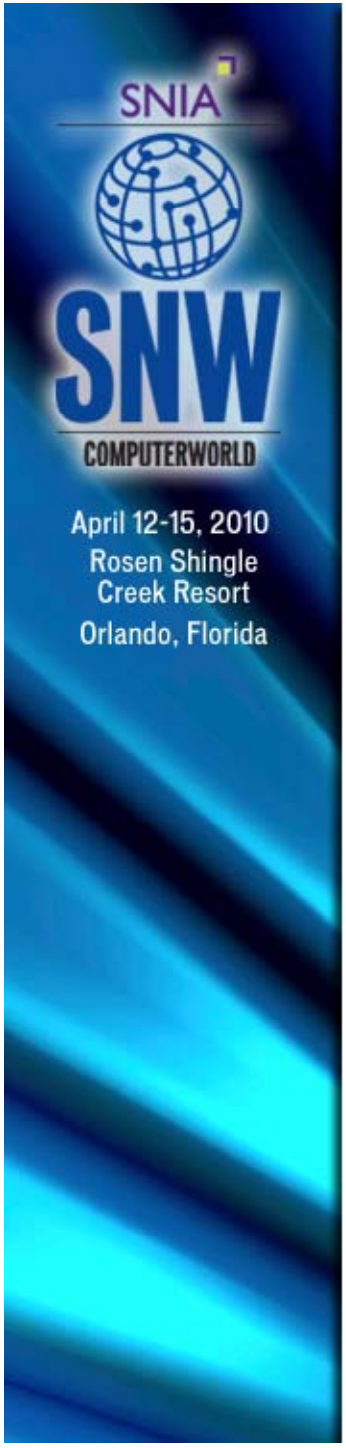

Enterprise SSDs – Past and Present

The Past

"SSDs will replace HDDs"

State of Enterprise SSDs

- Co
- Simple
- Pe
- y: Que

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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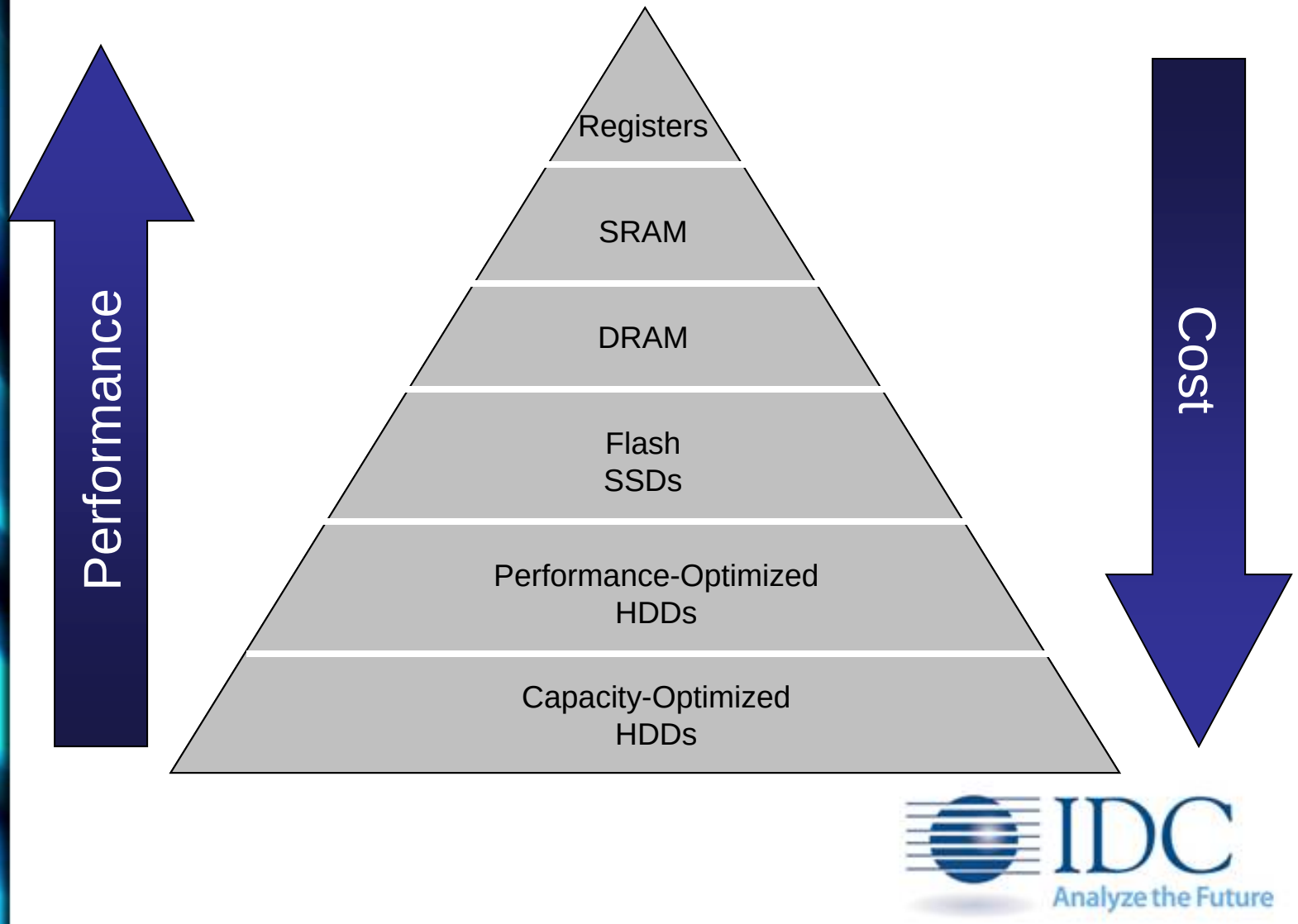
SSDs will compliment in system architectures



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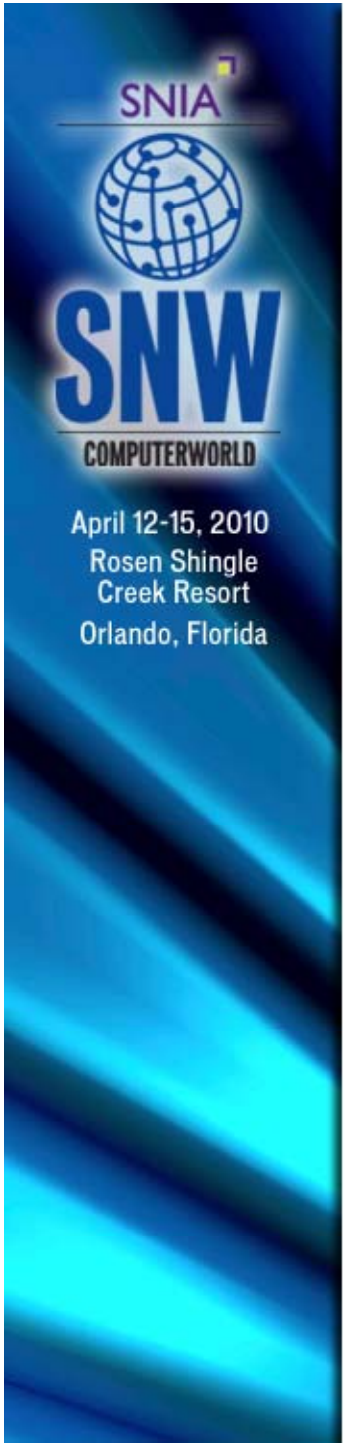

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Why the Imbalance

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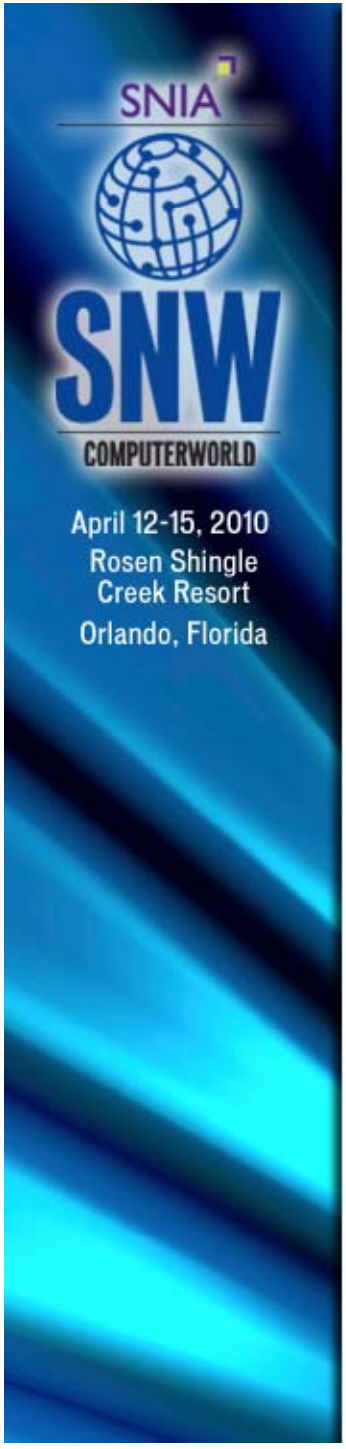

Performance-Optimized HDD Trends

	2009	2010	2011	2012	2013	2014
3.5" Maximum Capacity	600 GB	600 GB	600 GB	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	900 GB	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
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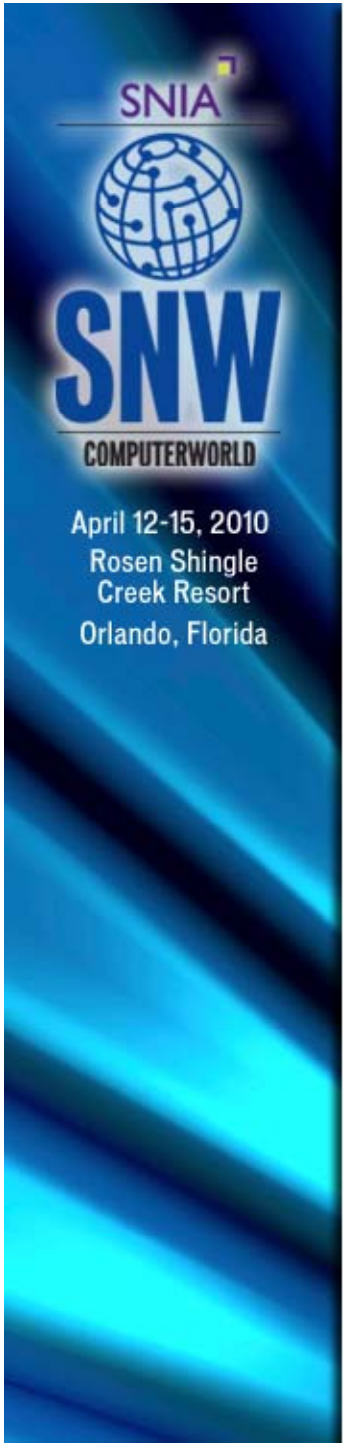

Capacity-Optimized HDD Trends

	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 < ½ the capacity of 3.5”…

until 2014

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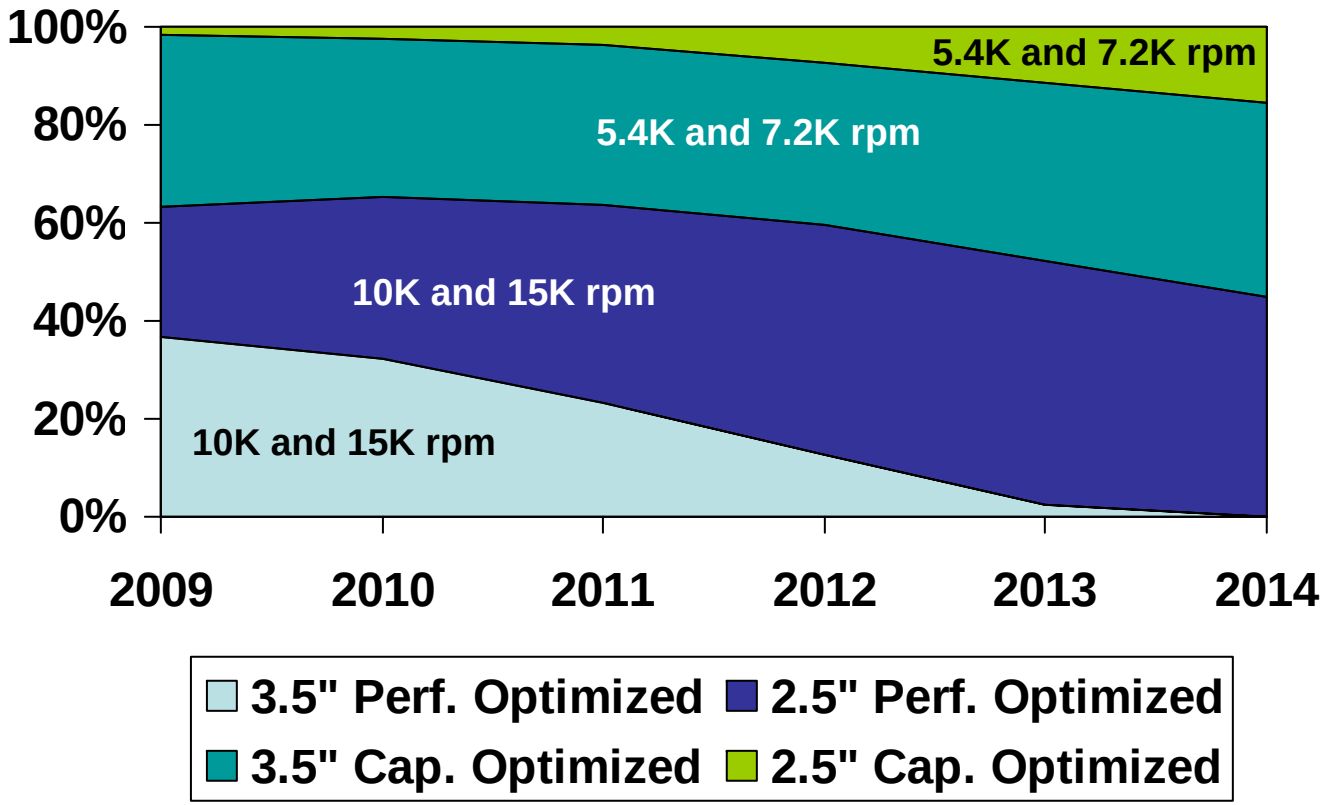
HDD Form Factor Transitions For Enterprise Applications



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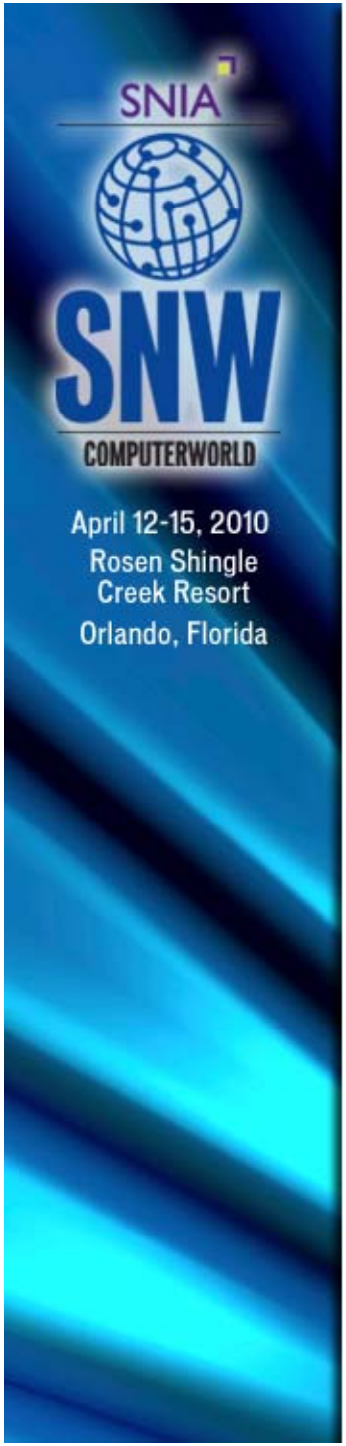

Top Ten List

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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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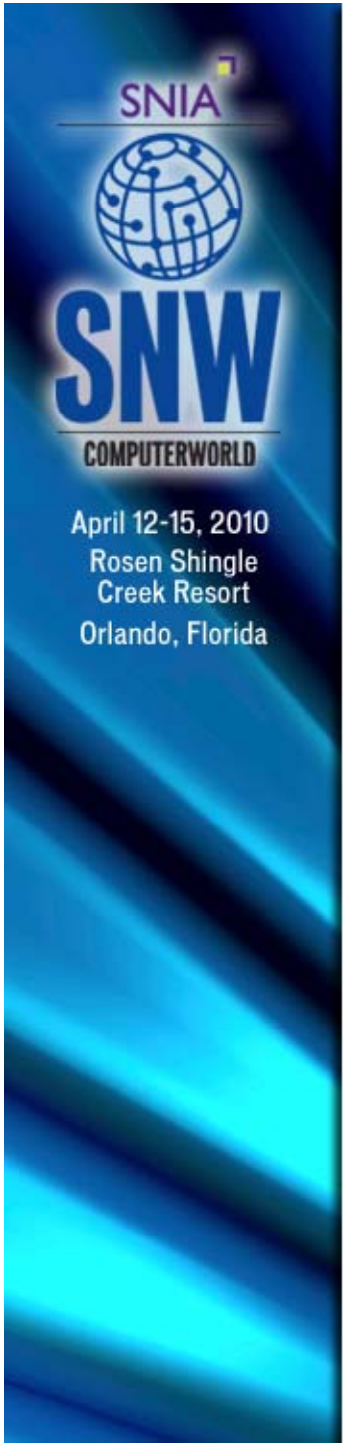

HDD Technology Introduction: Relative Cost

PMR	$ $
DSA	$ $
DTM / BPM	$ $ $ $
HAMR	$ $ $ $

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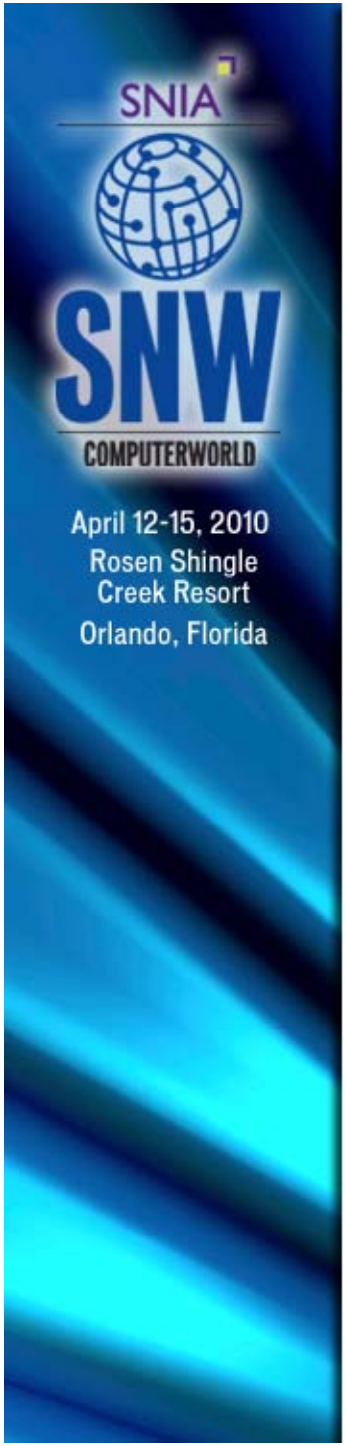

Lower Cost (But Complex) HDD Technology Options

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

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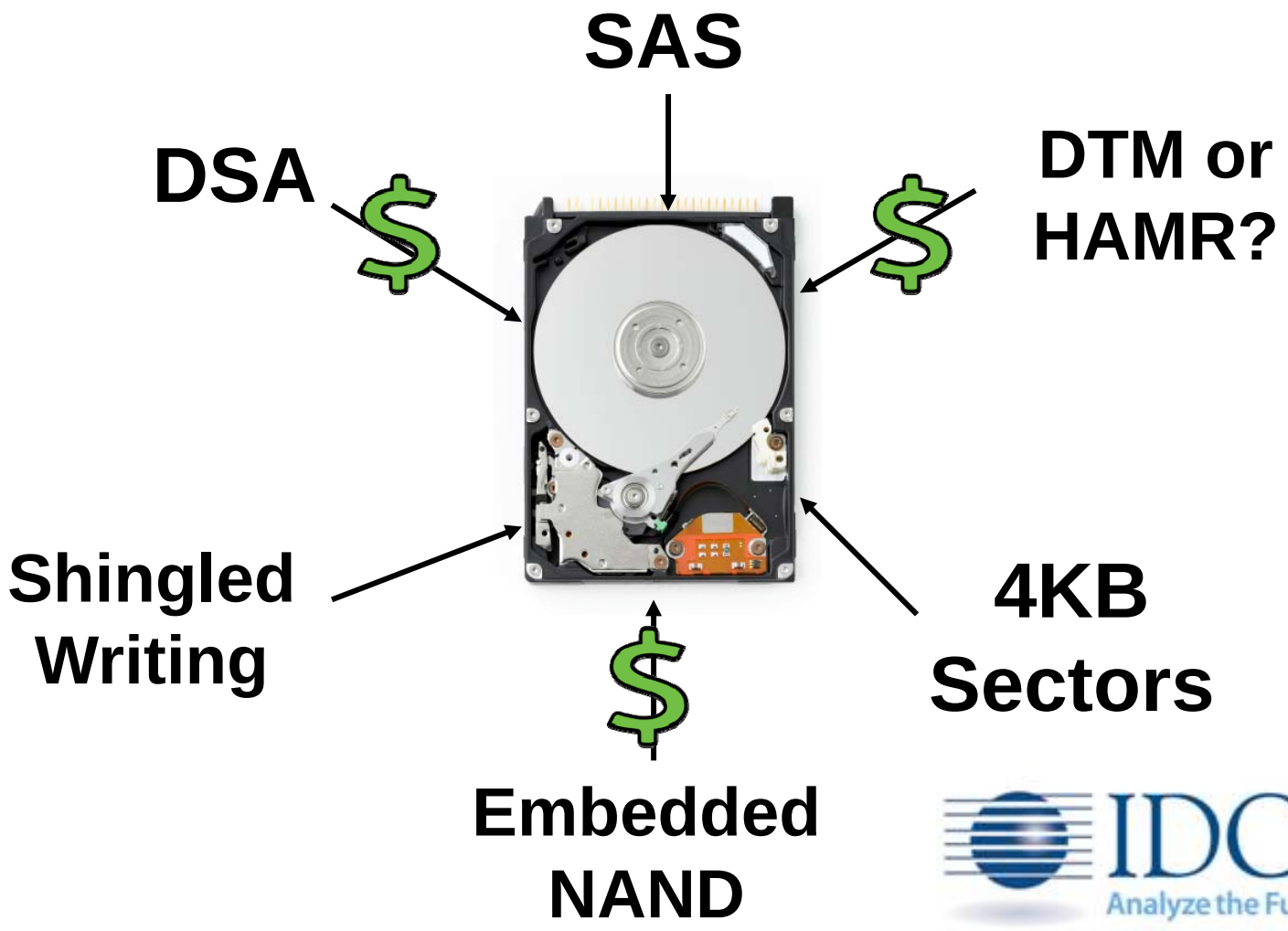
The 5 TB HDD



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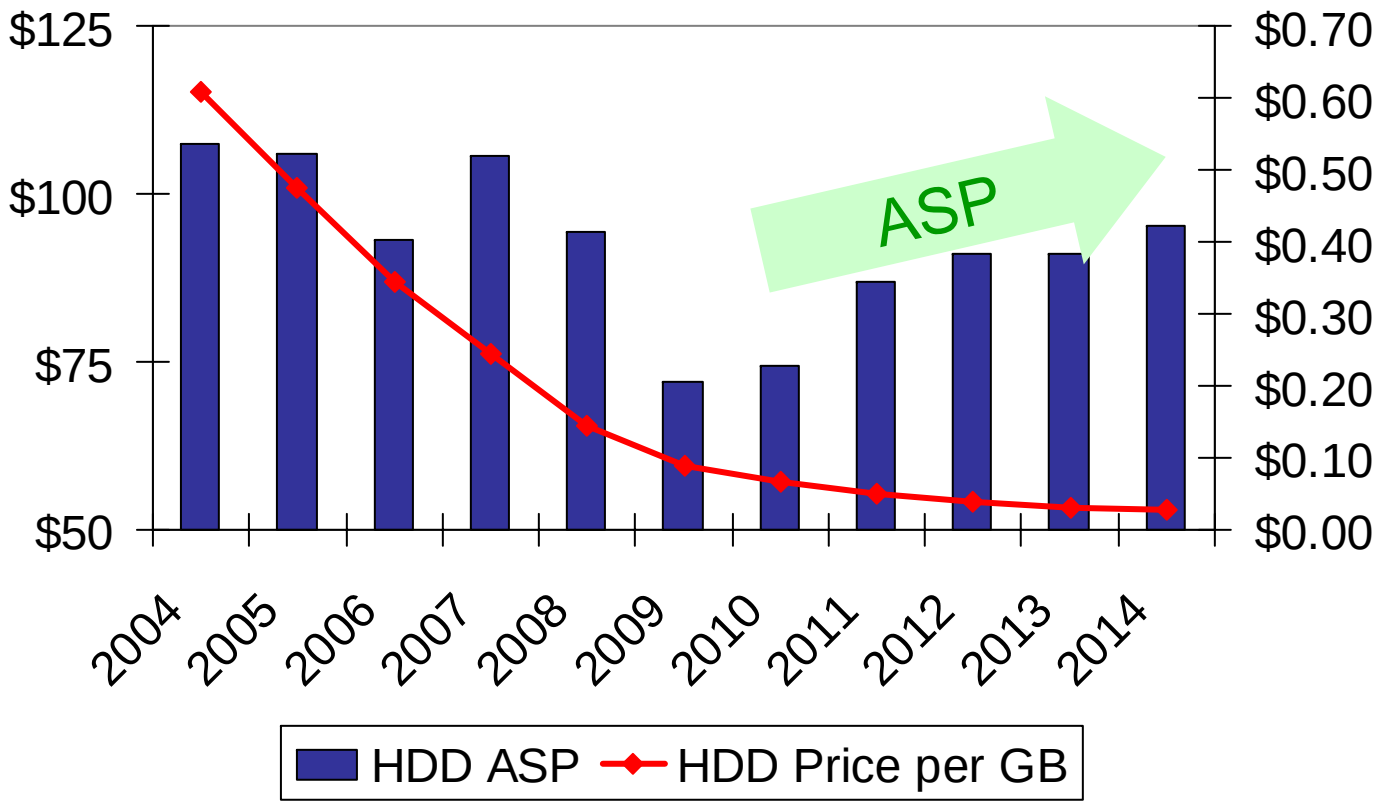
3.5” Capacity-Optimized HDD



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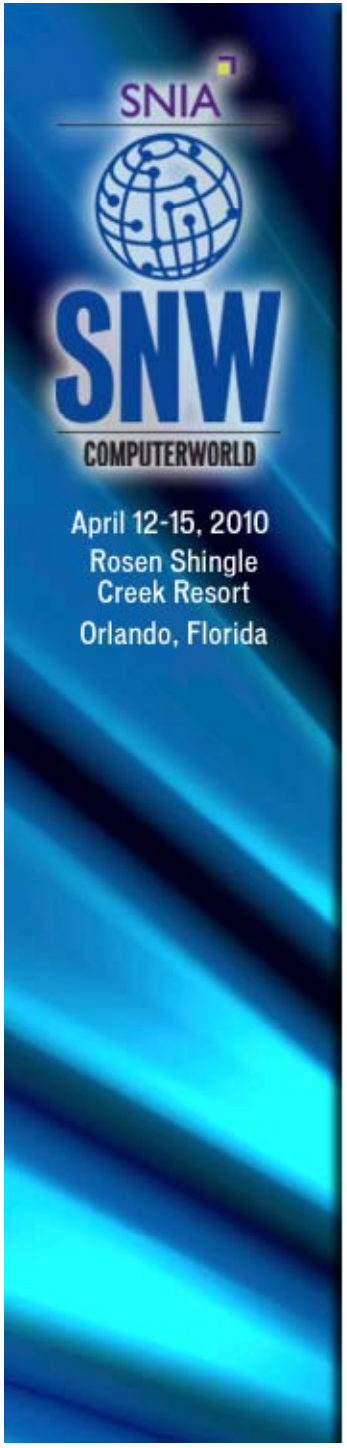

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10. Technology is being ‘stuffed’ into HDDs to increase storage capacity
    - $$/GB will continue to decline
    - But capacity-optimized HDD ASPs may actually *increase*

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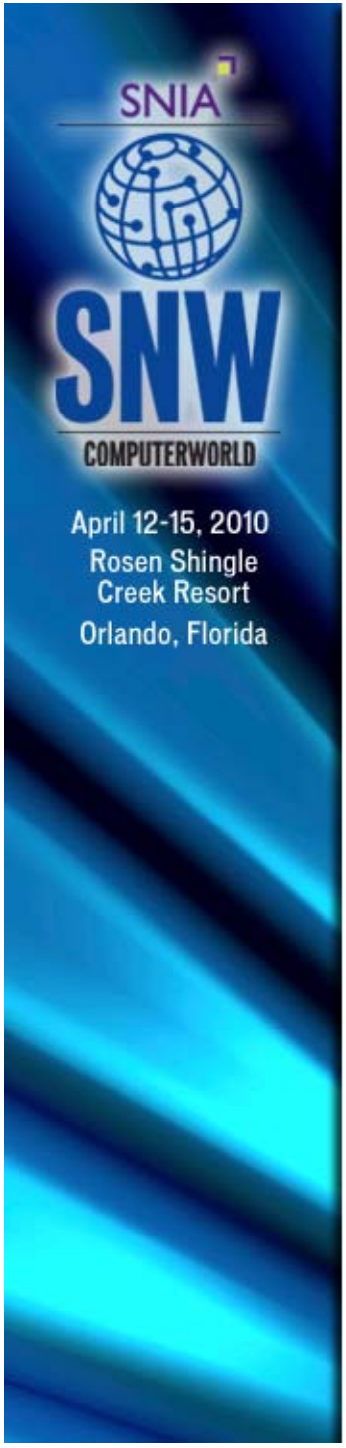

Takeaway Points

- 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”.

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Thank You

Questions ?

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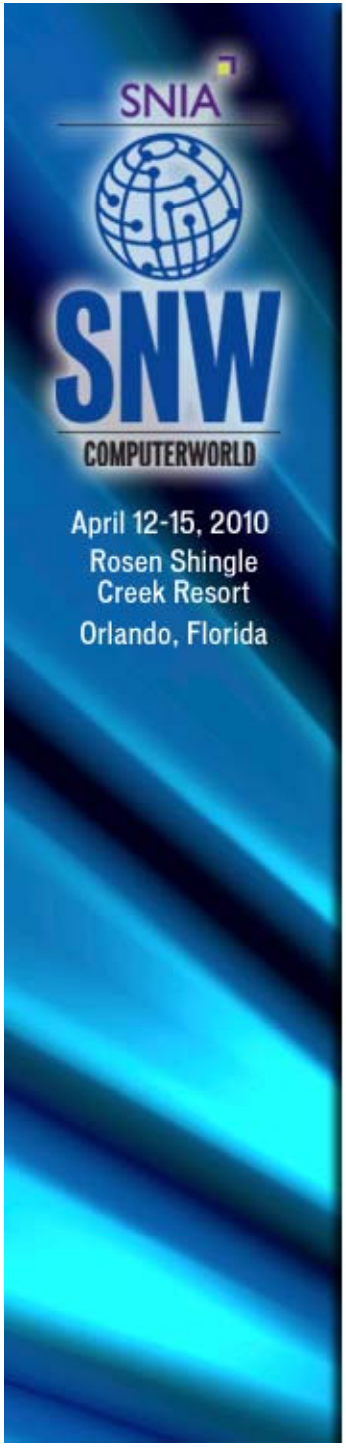

IDC Cross Talk IT Community

Join IDC & your peers in the conversations in our IDC Cross Talk IT Community at:

idc-insights-community.com

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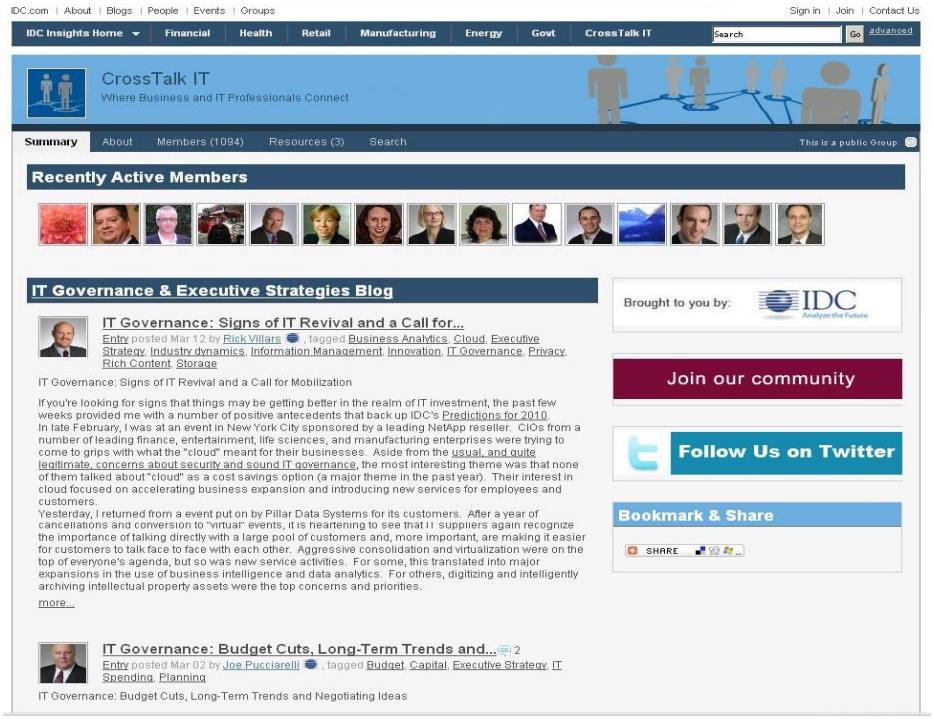
IDC Cross Talk Community

Community Goal:

- To create a forum for IT and business professionals to discuss technology issues within the context of their business

Features Include:

- Networking – Invite, Find and Interact with Analysts and Other Members
- Global Analyst Blogs and Videos
- Discussion Forums
- Live Chat
- Polls
- Events Calendar
- Resource Library/ Complimentary Research



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