SSD Cache for Client Computing? A Killer App for OEM & Aftermarket!

- Kevin Silver, NVELO

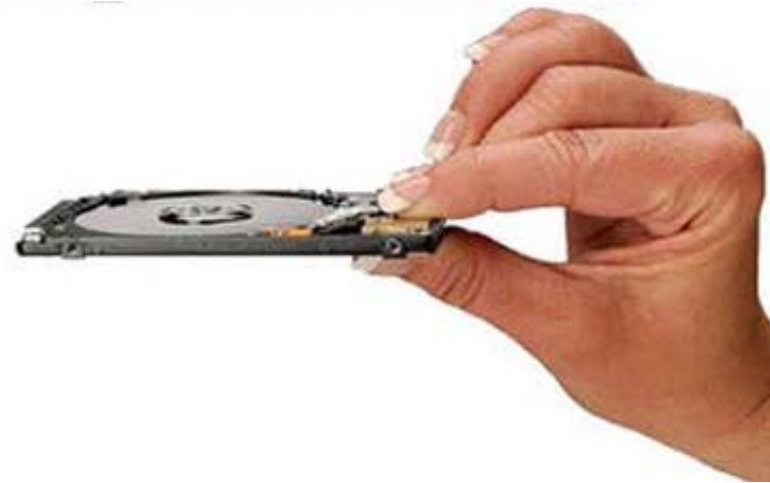# Why Cache?

HDD SSD

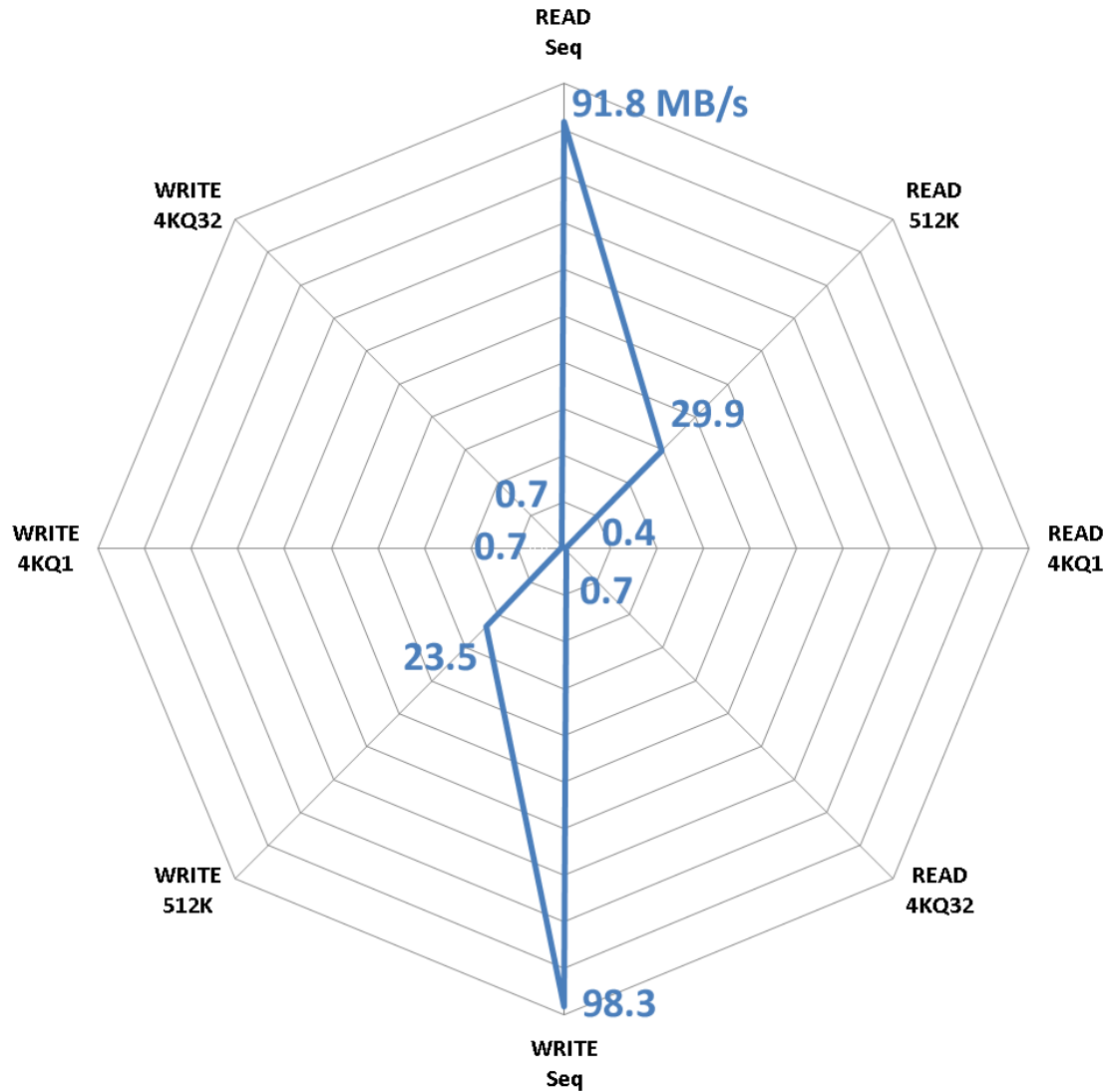- Low performance
- Low price, $0.10/GB

- High performance
- High price, $1.00/GB

The goal is pretty simple
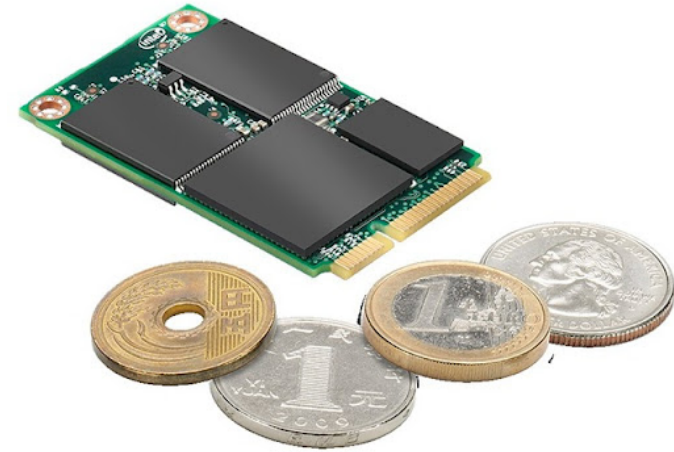- Get the best of **both**!
- SSD performance with HDD $/GB

State-of-the-Art HDD...

"Ultrabook" HDD
- **500GB**
- **7200 RPM**
- **2.5", 7mm**
- **$0.10/GB**

State-of-the-Art SSD...

READ Seq
477.3 MB/s

READ
512K
360.6

183.5

WRITE
4KQ32

WRITE
4KQ1

44.6 **23.7**

READ
4KQ1

195.0

188.4 **305.7**

WRITE
512K

READ
4KQ32
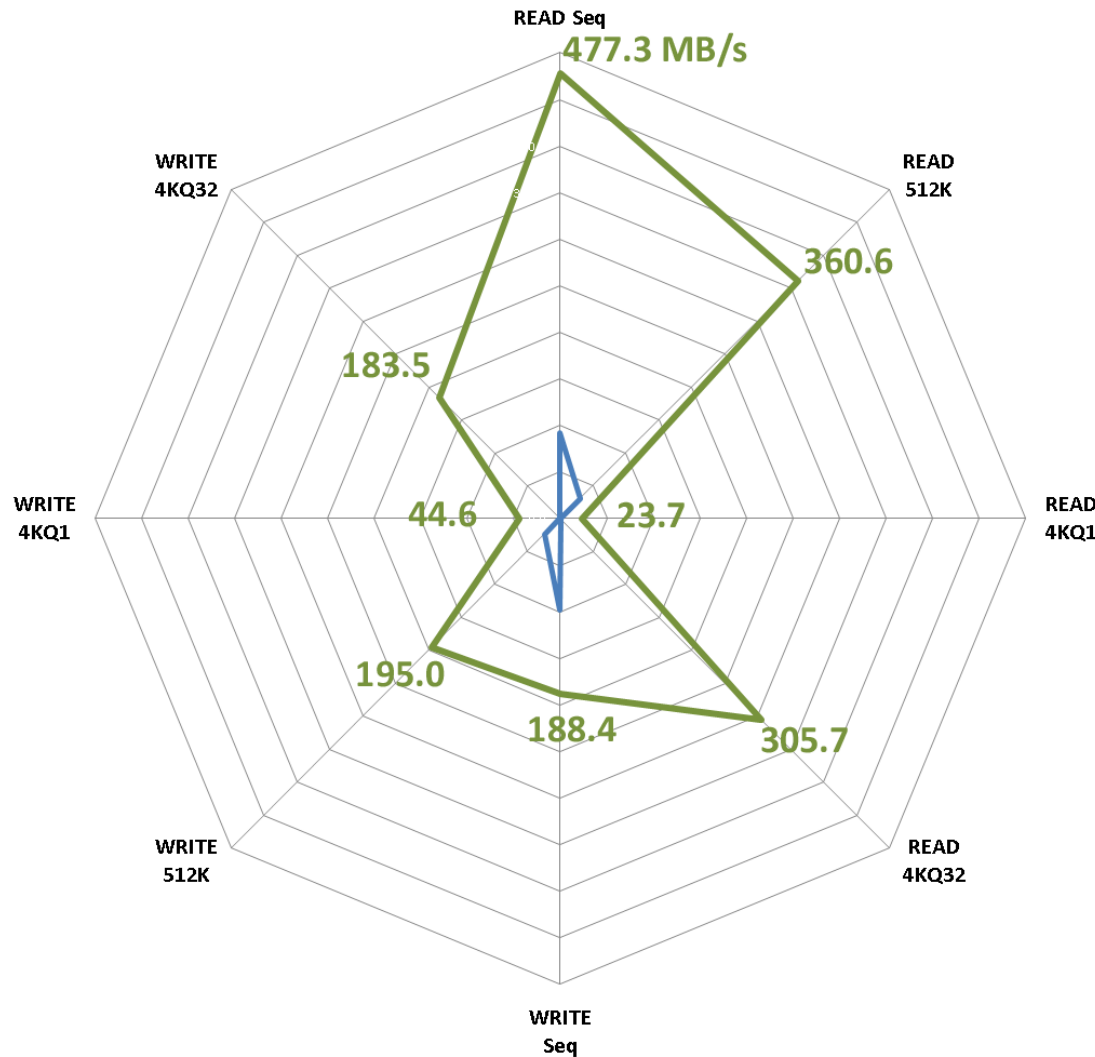
WRITE
Seq

"Ultrabook" SSD
- **128GB**
- **MLC NAND**
- **mSATA**
- **$1.00/GB**

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Performance Differences?

Traffic	HDD	SSD	SSD > HDD	HDD/SSD
READ Seq	91.8	477.3	4x	19.2%
READ 512K	29.9	360.6	11x	8.3%
READ 4KQ1	0.4	23.7	67x	1.5%
READ 4KQ32	0.7	305.7	430x	0.2%
WRITE Seq	98.3	188.4	1x	52.2%
WRITE 512K	23.5	195.0	7x	12.1%
WRITE 4KQ1	0.7	44.6	61x	1.6%
WRITE 4KQ32	0.7	183.5	248x	0.4%

READ Seq
477.3 MB/s

WRITE
4KQ32

WRITE
4KQ1

WRITE
512K

WRITE
Seq

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A Benchmark View

PCMark Vantage – HDD Suite

A Benchmark View

PCMark Vantage – HDD Suite

Bar chart showing PCMark Vantage HDD Suite scores:
- 500GB HDD: 4659
- 750GB H-HDD (G2): 12,032
- 128GB SSD: 42049

A Benchmark View

PCMark Vantage – HDD Suite

	Value
500GB HDD	4659
750GB H-HDD (G2)	12,032
SSD Cache: Write-Around	29,146
SSD Cache: Write-Back	35,204
128GB SSD	42049
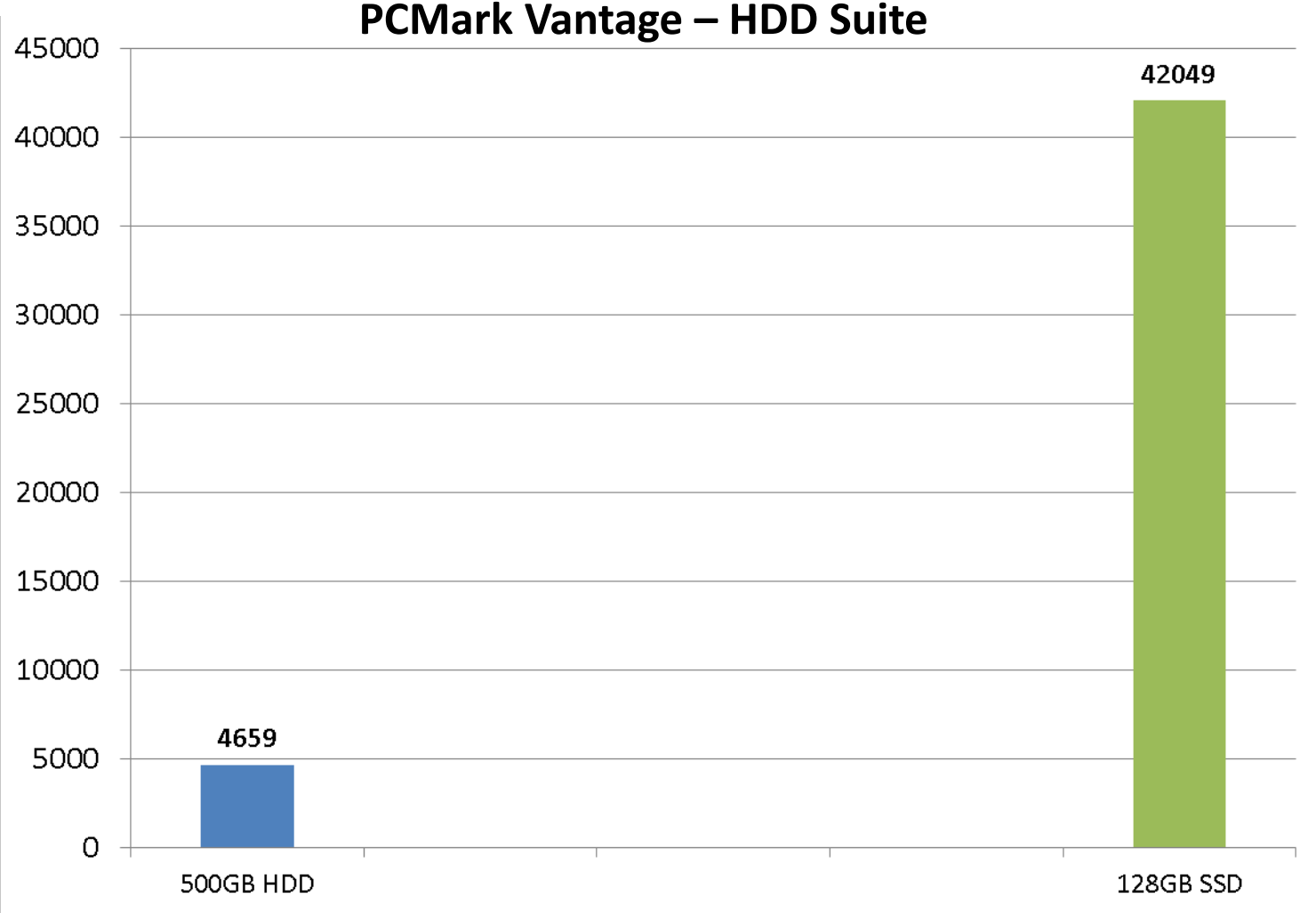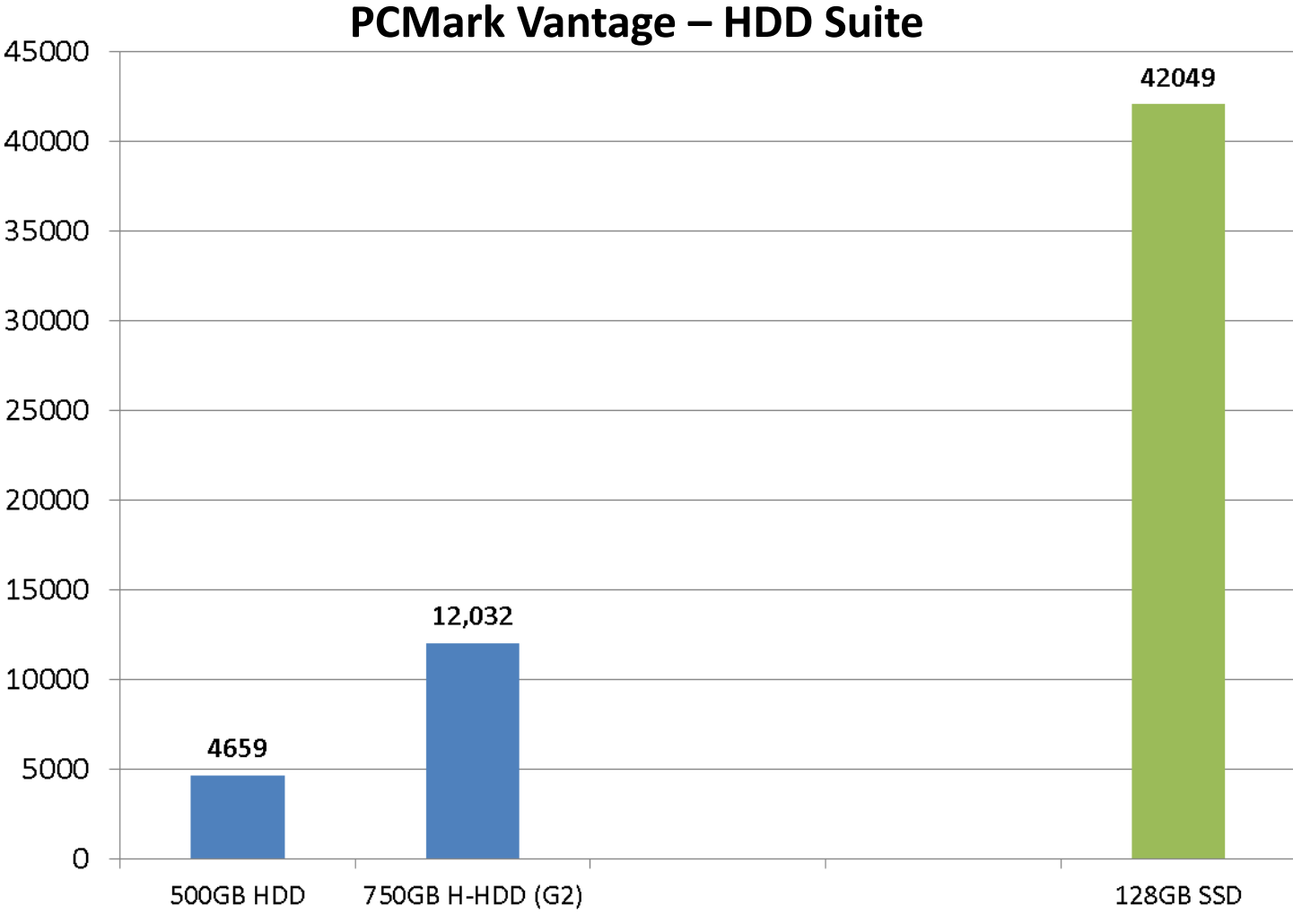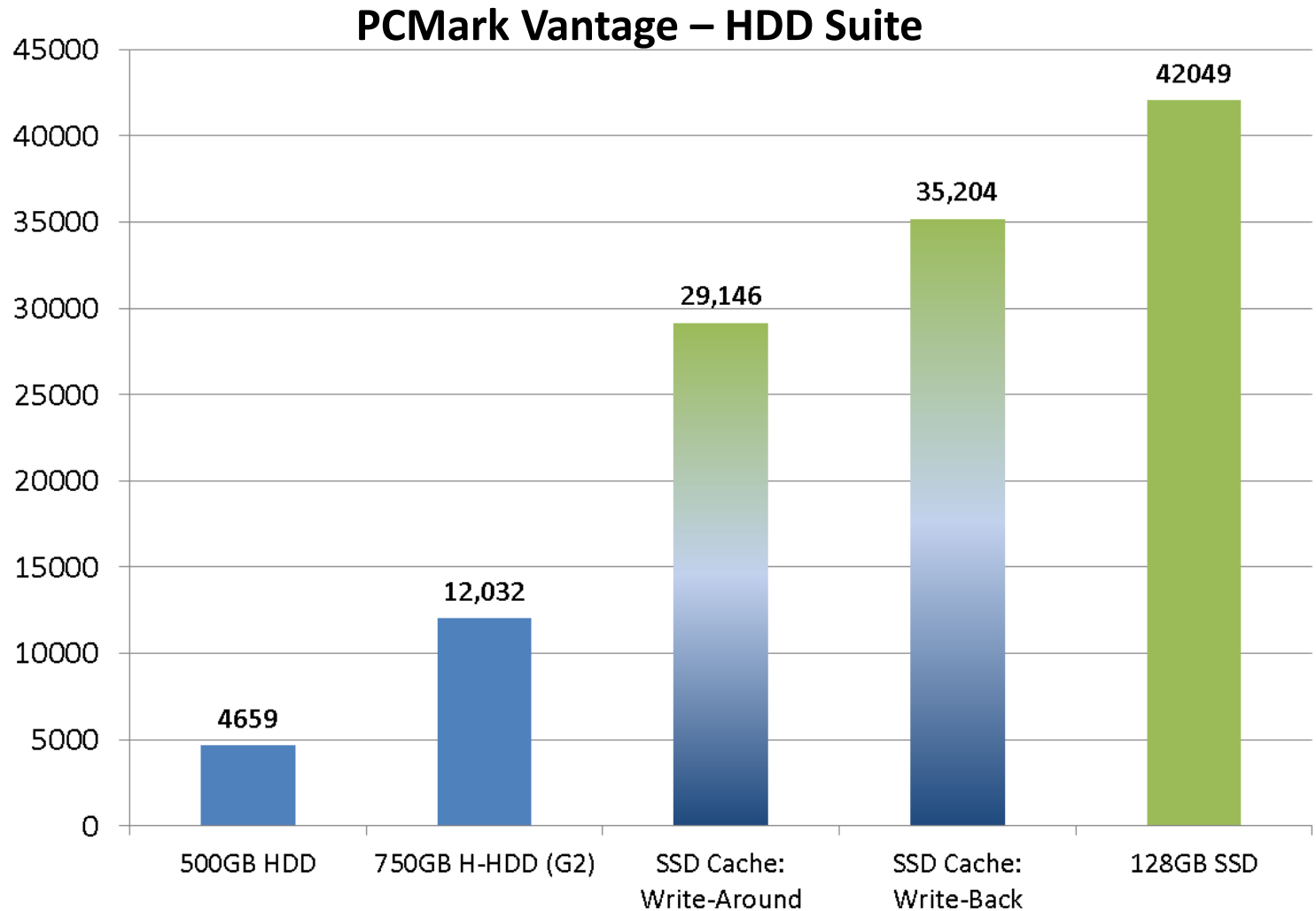
We Can Bridge the SSD–HDD Gap

PCMark Vantage – HDD Suite
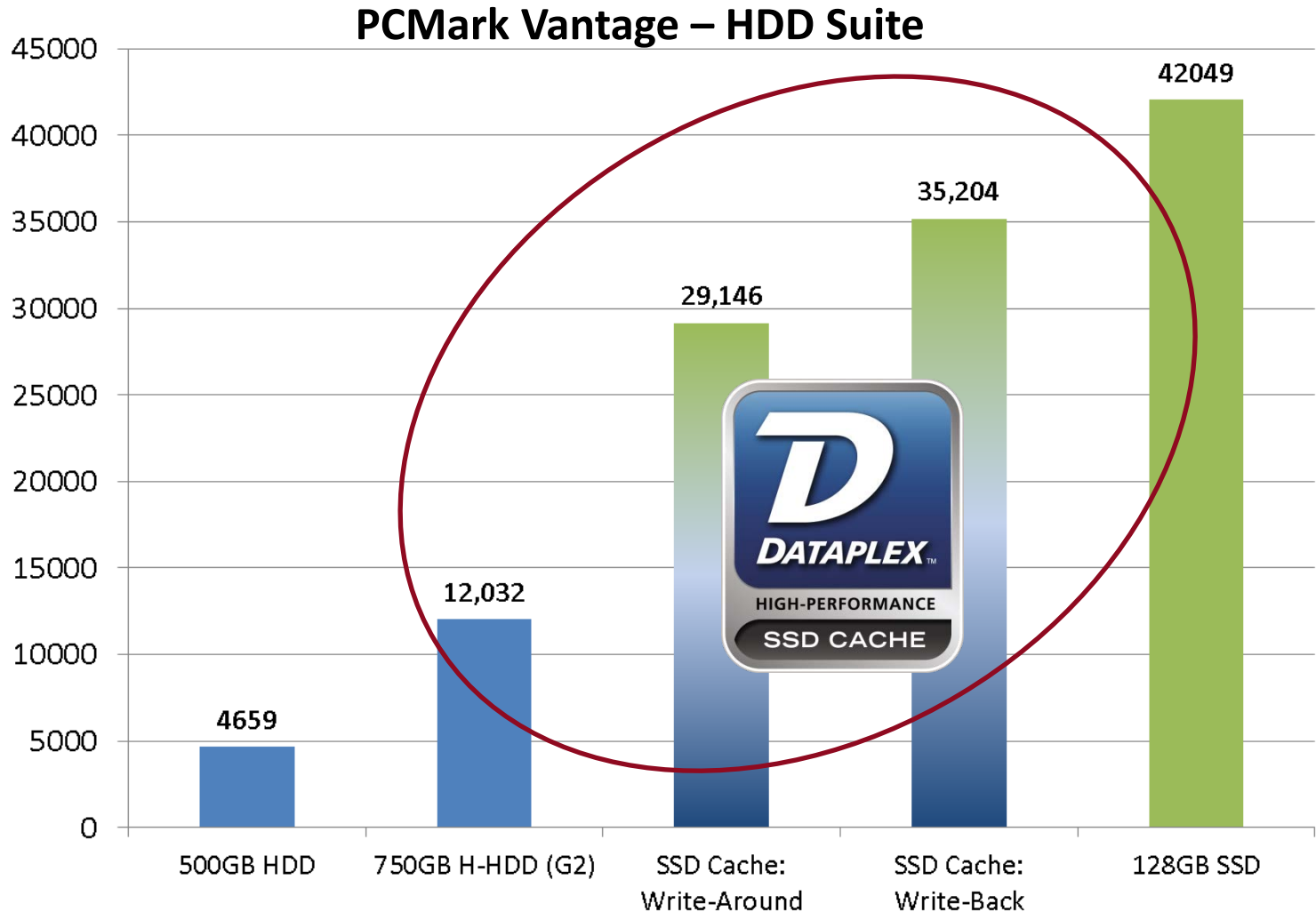
What about Price/Capacity?

Storage Configuration	HDD		SSD		Totals		
	($)	(GB)	($)	(GB)	($)	(GB)	$/GB
HDD Only	$50	500			$50	500	$0.10

Price/Capacity

Storage Configuration	HDD		SSD		Totals		
	($)	(GB)	($)	(GB)	($)	(GB)	$/GB
HDD Only	$50	500			$50	500	$0.10
Hybrid-HDD (G2)	$135	750			$135	750	$0.18
SSD Cache: Write-Around	$50	500	$24	24	$74	500	$0.15
SSD Cache: Write-Back	$50	500	$48	48	$98	500	$0.20
SSD Only			$128	128	$128	128	$1.00

Price/Capacity/Performance

Storage Configuration	HDD		SSD		Totals			Perf.	Value
	($)	(GB)	($)	(GB)	($)	(GB)	$/GB	PCMV-H	$/PB/Perf.
HDD Only	$50	500			$50	500	$0.10	4,659	$21.46
Hybrid-HDD (G2)	$135	750			$135	750	$0.18	12,032	$14.96
SSD Cache: Write-Around	$50	500	$24	24	$74	500	$0.15	29,146	$5.08
SSD Cache: Write-Back	$50	500	$48	48	$98	500	$0.20	35,204	$5.57
SSD Only			$128	128	$128	128	$1.00	42,049	$23.78

There is tremendous value in SSD caching...

Storage Configuration	HDD		SSD		Totals			Perf.	Value
	($)	(GB)	($)	(GB)	($)	(GB)	$/GB	PCMV-H	$/PB/Perf.
HDD Only	$50	500			$50	500	$0.10	4,659	$21.46
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...the Death of the HDD has been greatly exaggerated.

Different Approaches to Caching

- **SSD Cache**
  - Host Software Manages SSD cache + HDD storage
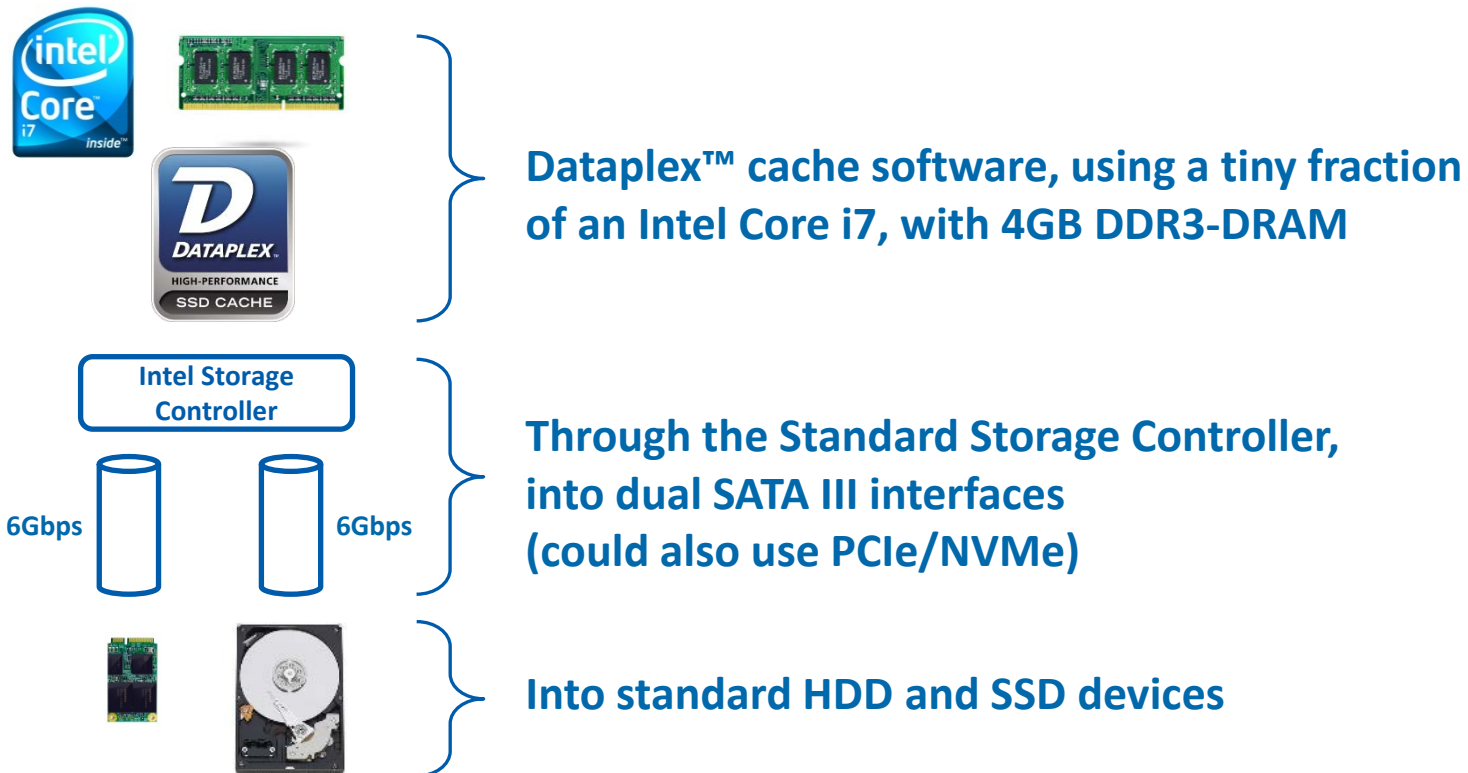
  - Example:
    - 24GB mSATA SSD

    - 500GB HDD

- **Hybrid**
  - Single "Hybrid-HDD" containing SSD + HDD

  - Caching done with host software + device firmware

SSD Cache (e.g. Intel, NVELO)

Dataplex™ cache software, using a tiny fraction of an Intel Core i7, with 4GB DDR3-DRAM

Intel Storage Controller

6Gbps   **6Gbps**

Through the Standard Storage Controller, into dual SATA III interfaces (could also use PCIe/NVMe)

Into standard HDD and SSD devices

Hybrid-HDD (e.g. Seagate, WD)

New software, running on an Intel Core i7, with 4GB DDR3-DRAM, to determine data "hotness"

New Storage Controller passes data "hotness" information downstream through a modified SATA protocol.

New H-HDD Firmware, running on new/additional CPU and DRAM resources, interprets data "hotness", moves data to-from HDD and SSD, using new SSD controller HW/FW.

New Host Software:

Are you Hot or Not?

New (Intel?) Storage Controller
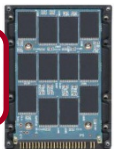
6Gbps   New SATA Protocol

(All this fits inside here)

New Firmware for Caching

Firmware runs on new CPU & DRAM

New SSD Controller

Different Approaches to Caching

- SSD Cache (e.g. Intel, NVELO)

- Hybrid HDD (e.g. Seagate, WD)

Standard Intel Storage Controller

6Gbps   **Standard SATA Or PCIe**   6Gbps

Standard SSD, HDD

New Host Software:

Are you Hot or Not?

New (Intel?) Storage Controller

6Gbps   **New SATA Protocol**

(All this fits inside here)

New Firmware for Caching | **Firmware runs on new CPU & DRAM** | **New SSD Controller**
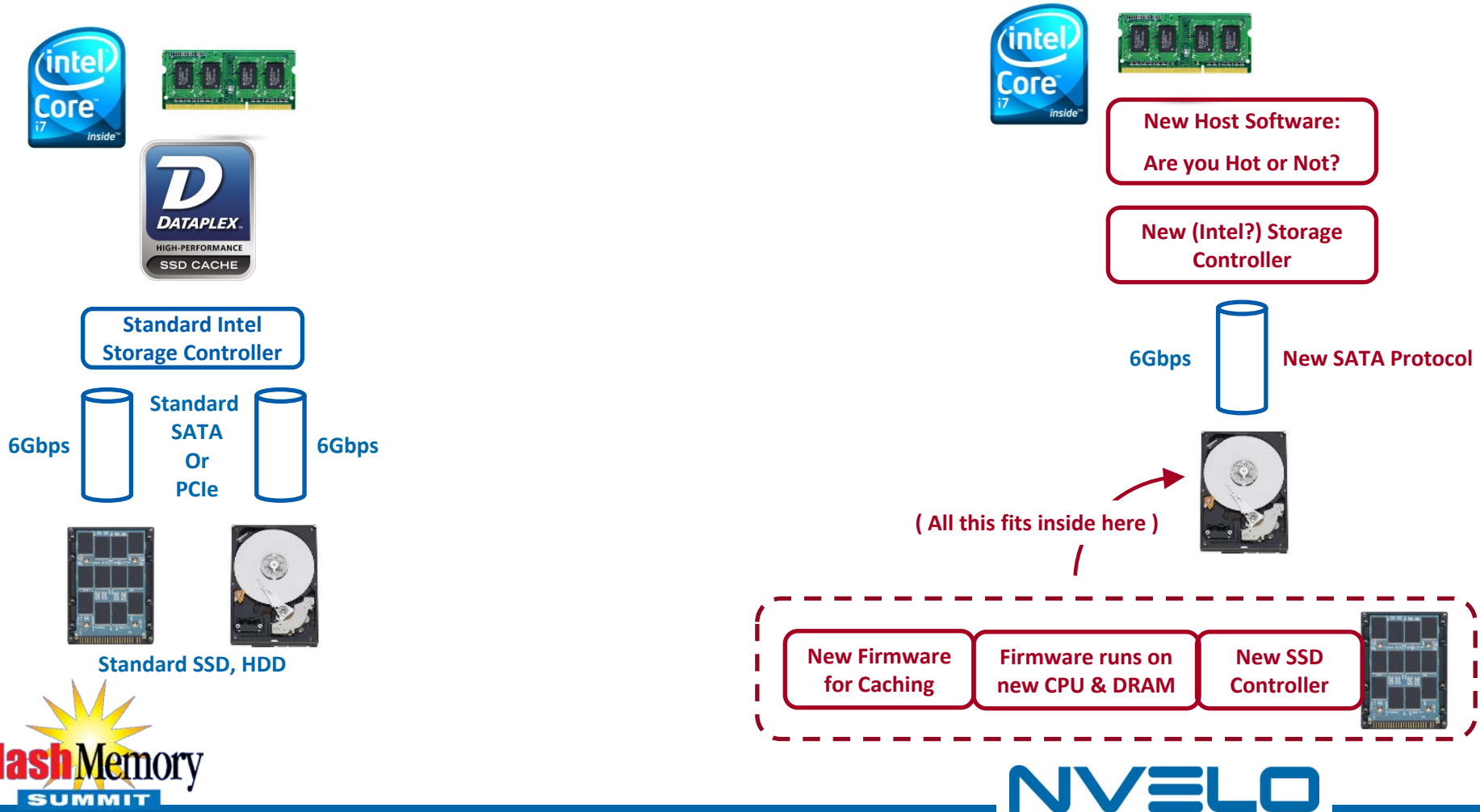
HDD's are Amazing Works of Engineering
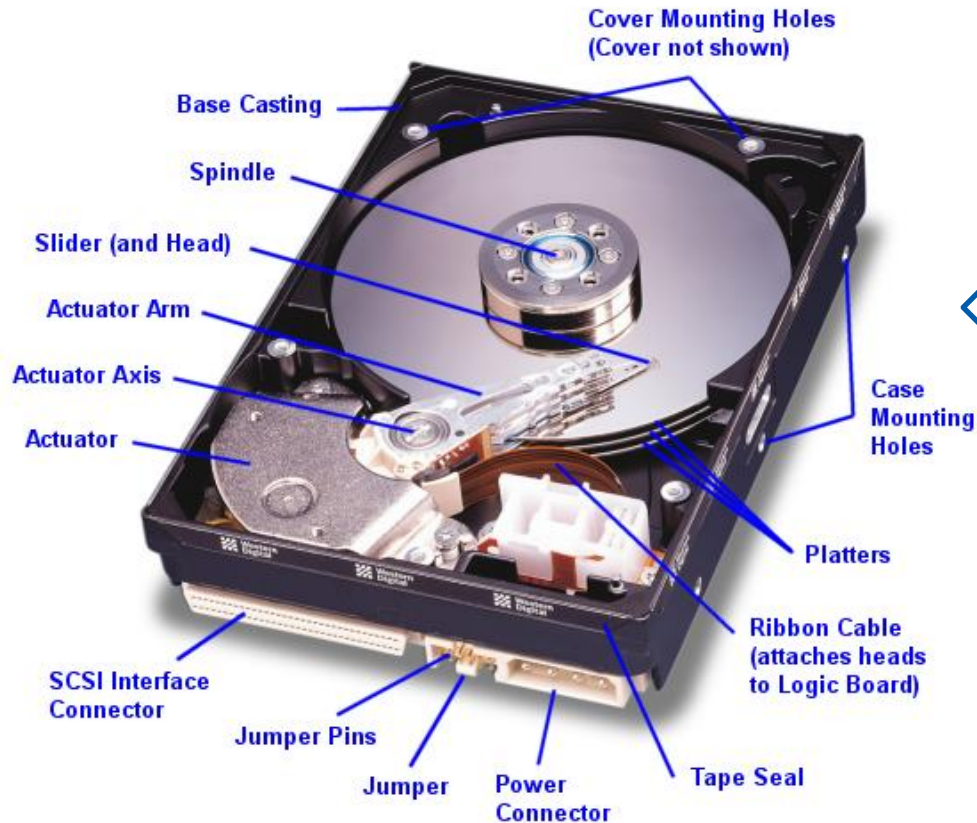
30 years of technical innovation

Why Take a Nearly "Perfect" Device...

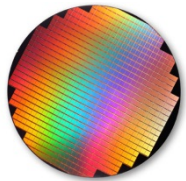**...and Force it to do Unnatural Things?**

One Size Does Not Fit All...

Many new devices & applications, means many new storage requirements...
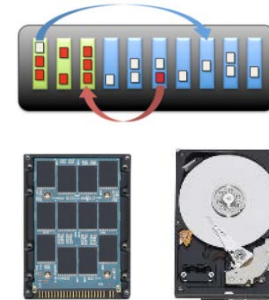
A PERSPECTIVE ON NAND ENABLEMENT

1995

2005

TODAY

NAND

Controller

Software

Storage Element

Storage Device

Storage Subsystem

Technology Innovations for Cache/Storage

- **Device Level:**
  - Specialized SSD's, optimized for caching

- **Storage Stack:**
  - Utilize all levels: DRAM Memory, SSD Cache, HDD Storage

- **Storage Protocol:**
  - PCIe, NVMe

- **Software:**
  - "Cache Aware" applications

Summary

- SSD Cache is a viable/valuable storage configuration for PC's Today
  - Products are on the market today
  - Popular in Ultrabook configurations, moving to other PC categories

- Plenty of room for different cache/hybrid implementations
  - Lots of new innovations in the labs today
  - Expect 2013 to be a "break-out" year for cache/hybrid solutions

- You can upgrade your existing PC with SSD caching today
  - Cache SSD's w/Dataplex available from: Corsair, Crucial, Edge, Mushkin, OCZ

- Visit the NVELO booth here at FMS to learn more about SSD cache solutions!

Thank you!

For more information, please contact:

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Tutorial Session?

If you really want to understand SSD caching:

1. Review the following 3 cache strategies:
    a) Write-Around
    b) Write-Through
    c) Write-Back

2. Understand the impacts of each strategy on:
    a) Overall READ and Write performance
    b) SSD Endurance
    c) Cost (Minimum SSD capacity)

Answers: Visit the NVELO booth