STORAGE INDUSTRY SUMMIT

The Future of Computing: The Convergence of Memory and Storage through Non-Volatile Memory (NVM)

JANUARY 28, 2014, SAN JOSE, CA

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Objective Analysis

Director

Why is SSS Crucial to the Data Center?

SNIA
Solid State Storage Initiative

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OBJECTIVE ANALYSIS

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Semiconductor Market Research

- Market consulting/research firm
  - Market analysis, strategies, white papers
- Highly-respected lead analysts
  - Jim Handy: Memories & SSDs
  - Lane Mason: Memory chips
  - Tom Starnes: Processors
- Industry experience & 25+ years in field
- Reports, Competitive Analysis, Consulting

Agenda

- Flash rationales are maturing
- The form factor conundrum
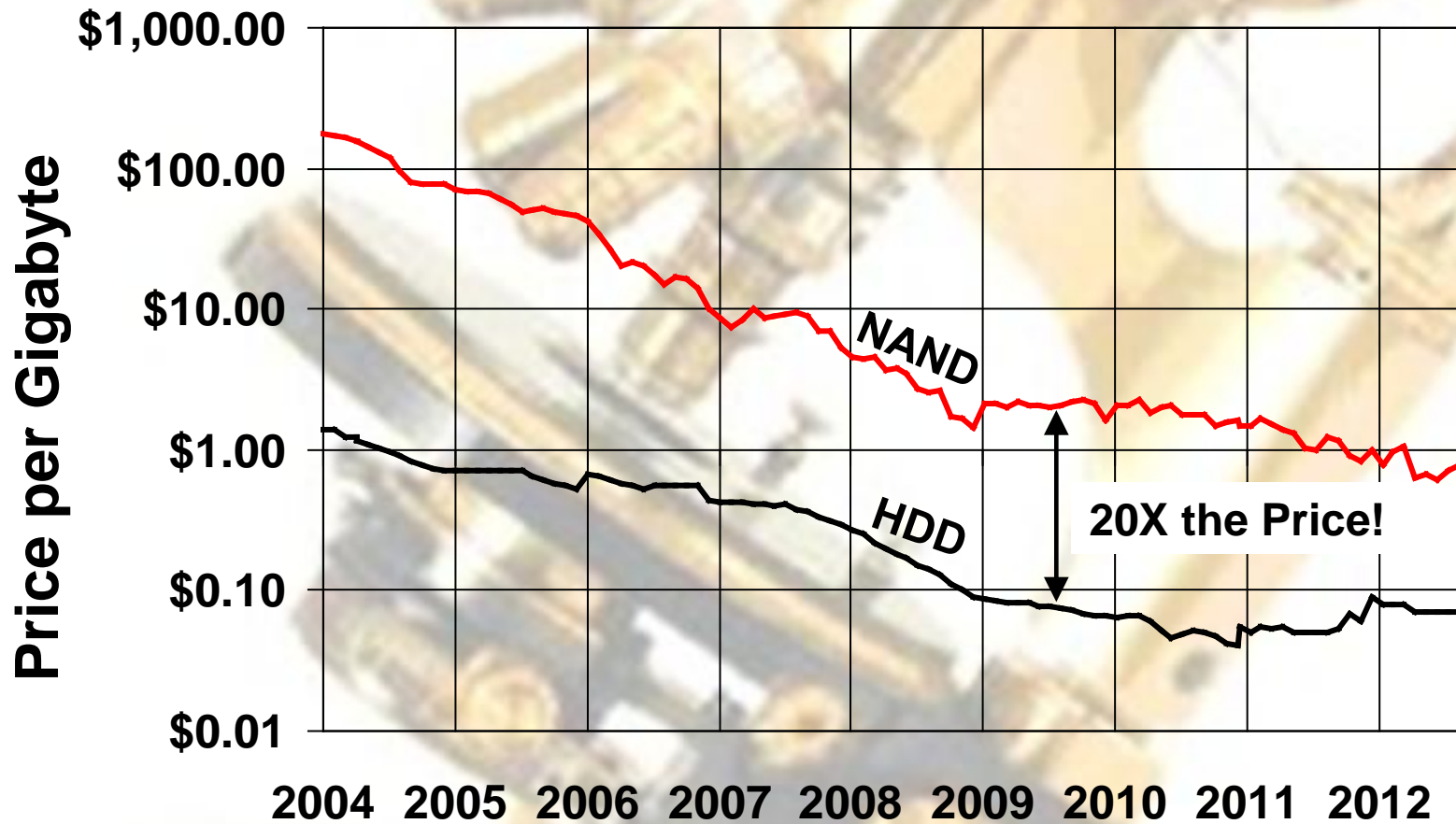- The "Computer of Tomorrow"

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What Folks Said About SSDs in 2005

- "It's fast and rugged."
  - Military: "We'll take rugged!"
    - "We'll also take fast erase!"
- "It has no mechanical wear."
  - HDD Makers: "What about wear-out?"
- "$/GB will fall below that of HDDs."
  - Mother Nature: "Don't count on it!"

NAND vs. HDD $/GB

Price per Gigabyte (y-axis)

- $1,000.00
- $100.00
- $10.00
- $1.00
- $0.10
- $0.01

x-axis: 2004 2005 2006 2007 2008 2009 2010 2011 2012

NAND

HDD

20X the Price!

HDD Pricing Courtesy of PriceG2

Viewpoints Matured by 2009

- "Lower power than HDDs."
  - Everyone: "Damn costly way to save power!"
- "Super-high IOPS"
  - SNIA: "Is that FOB or over time?"
  - Users: "How many IOPS do I need?"
- "Works well as a cache"
  - Start-Ups: "Want some software with that?"
    - "How about some deduplication and compression?"
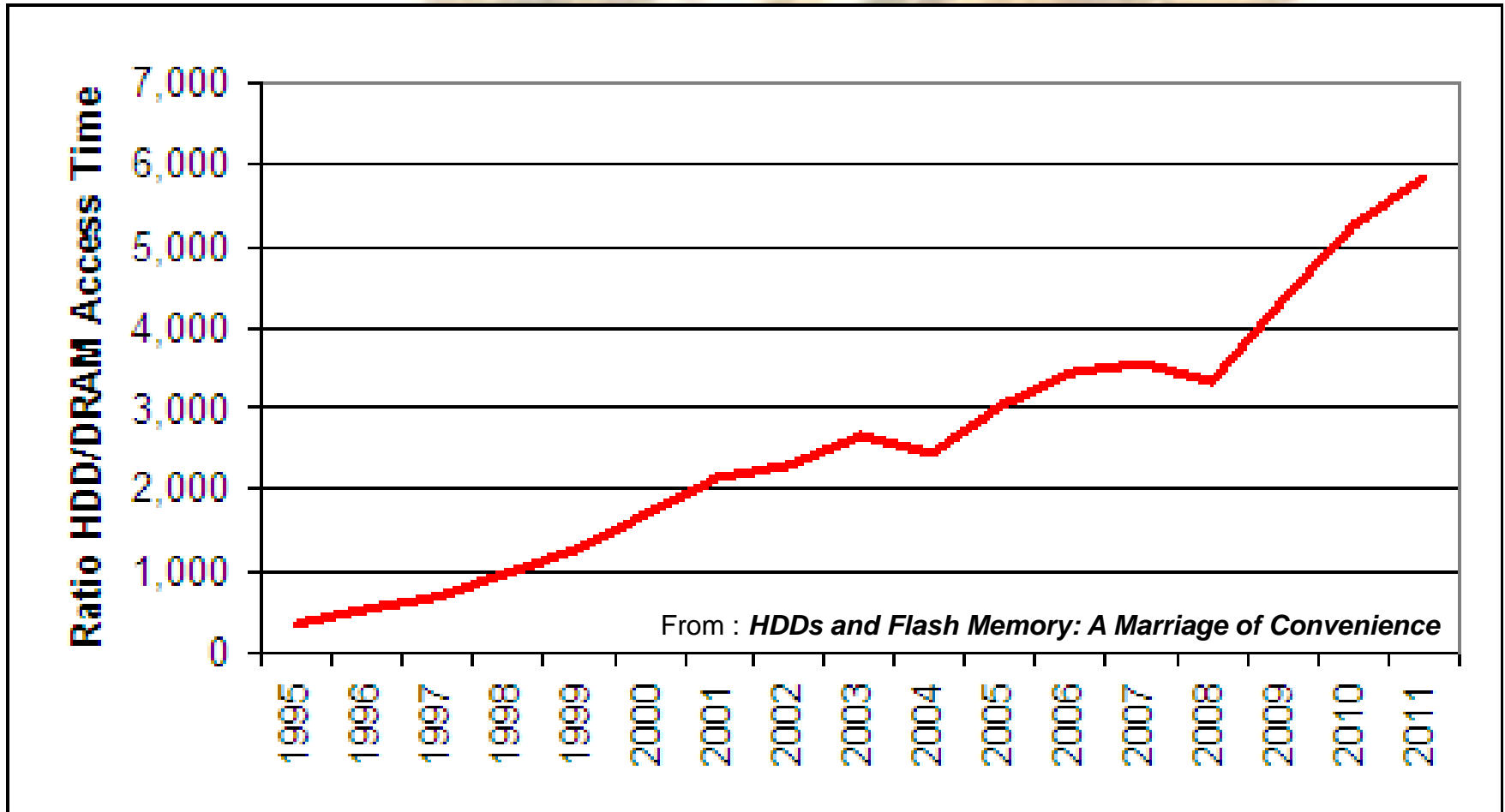
Report: *How Many IOPS is Enough?*

What We Think in 2014

- "It reduces footprint, power, licensing…"
  - "Hard to predict without actually <u>doing</u> it, though!"
- "It saves money"
  - "Same reply."
- "It <u>augments</u> HDDs"
  - HDD Makers: "We <u>told</u> you so!"
- "It's been proven – it works"

Why Flash is Imperative

Today's DRAMs are 6,000 Times HDDs' Speed

From : *HDDs and Flash Memory: A Marriage of Convenience*
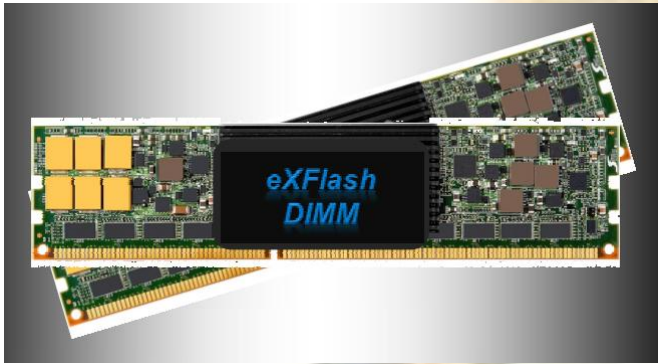
Flash in Computing

- It's a migration:
  - 2004: SSD
  - 2005: Turbo Memory
  - 2006: PCIe SSDs
  - 2007: Hybrid HDD
  - 2008: Flash-based appliances
  - 2009: Compression
  - 2010: Caching, Braidwood
  - 2011: Deduplication
  - 2012: Ultrabook
  - 2013: Flash DIMMs

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Which Form Factor Is Right?

Why SSDs?

- Because flash is storage
  - Storage belongs in an HDD package
- Because it smoothes the transition from HDD to flash
- Because nothing has to be redesigned
  - Same hardware
  - Same software

Why <u>NOT</u> SSDs?

- Because the I/O hardware slows it down

- Because the I/O software slows it down

- Because SSDs behave differently than HDDs:
  - Irregular delays
  - Wear issues

Why PCIe?

- Because it's faster than disk interfaces
- Because all servers have a free PCIe slot
- Because it's close to the CPU
- Because there's a lot of power
- Because PCIe RAID cards are well supported

Why <u>NOT</u> PCIe?

- Because you can't hot swap, and <u>all storage must be hot swappable</u>

- Because standards are relatively new
  - Many devices were designed prior to the advent of these standards

- Computing has abandoned DAS for a shared storage model

Why All-Flash Arrays?

- Because they can be optimized for flash
  - A closed system can do things that an open system cannot
  - Many include deduplication and compression
- Because they compete head-on with NAS and SAN
- Because you can fit more flash in if you don't use an SSD form factor

Why <u>NOT</u> All-Flash Arrays?

- Because you're going up against established vendors

- Because most systems don't need that much performance

Why Hybrid HDDs?

- It's a natural evolution from DRAM cache to flash cache
  - Similar algorithms, similar hardware
- All of the storage of an HDD with most of the performance of an SSD
- Because hybrids are cheaper than SSDs

# Why <u>NOT</u> Hybrid HDDs?

- Because HDDs are still cheaper
  - This will fade over time
- Because the technology is new and unknown
- Because most users don't think that an 8GB cache is big enough

Why Flash as Memory?

- Because it *IS* memory!
  - Random access
  - Bus architecture
- Because that's the fastest interface
- Because it scales better than PCIe
- Because flash is cheaper than DRAM
  - DRAM: $7.20/GB
  - NAND: $0.38/GB
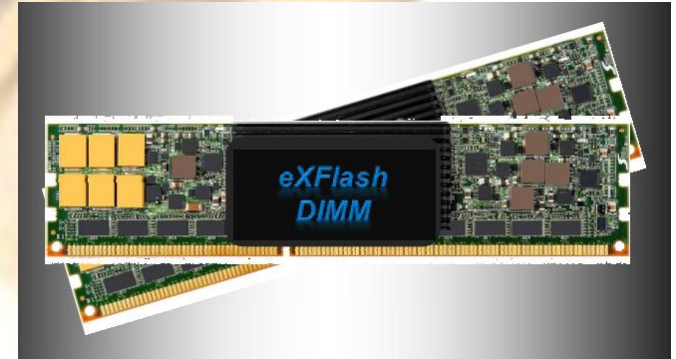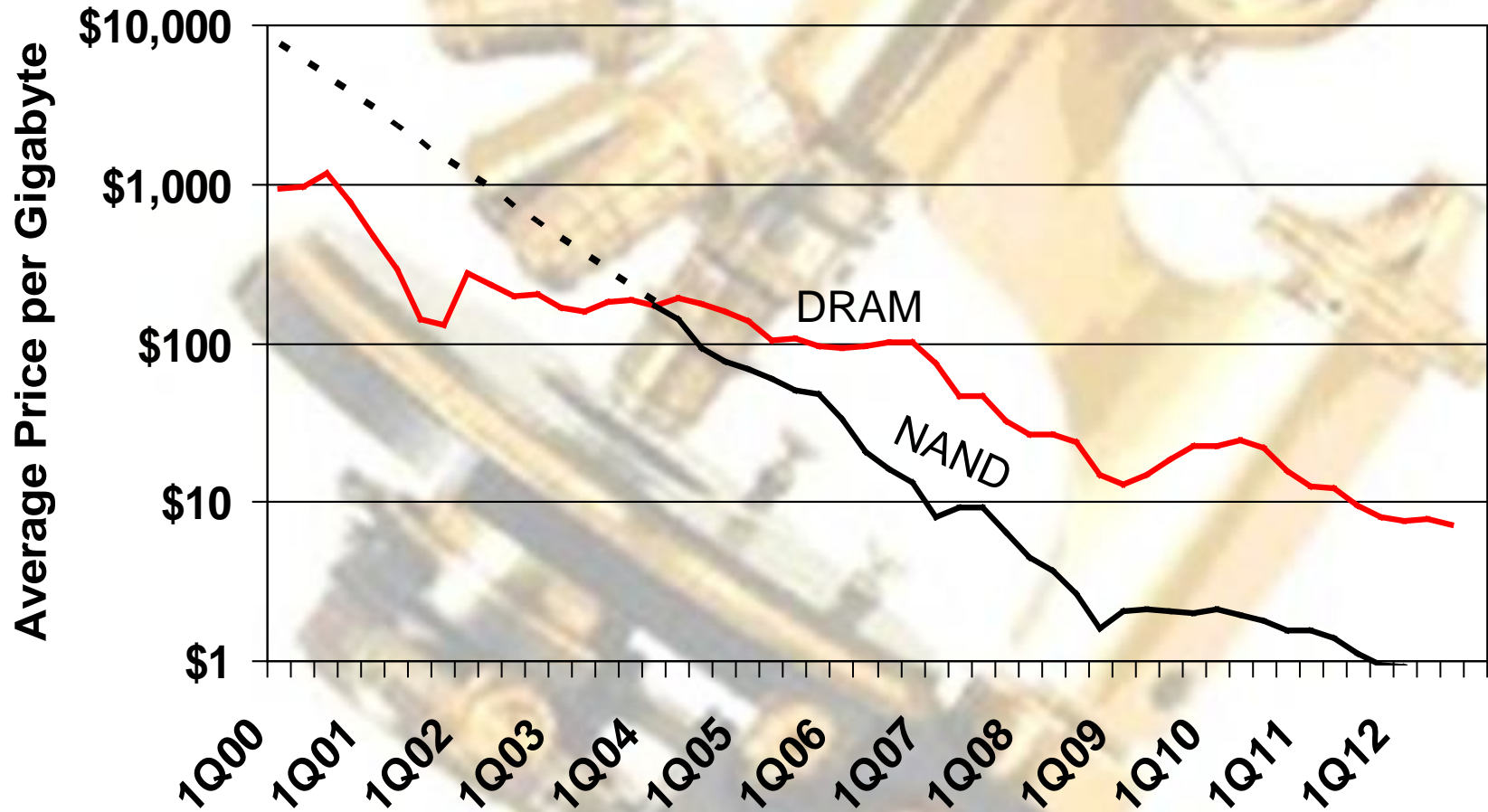
Why <u>NOT</u> Flash as Memory?

- Because it's not already supported by standard software

- Because it's storage, and until that mind-frame is shaken it can't play a role of cheap/slow memory
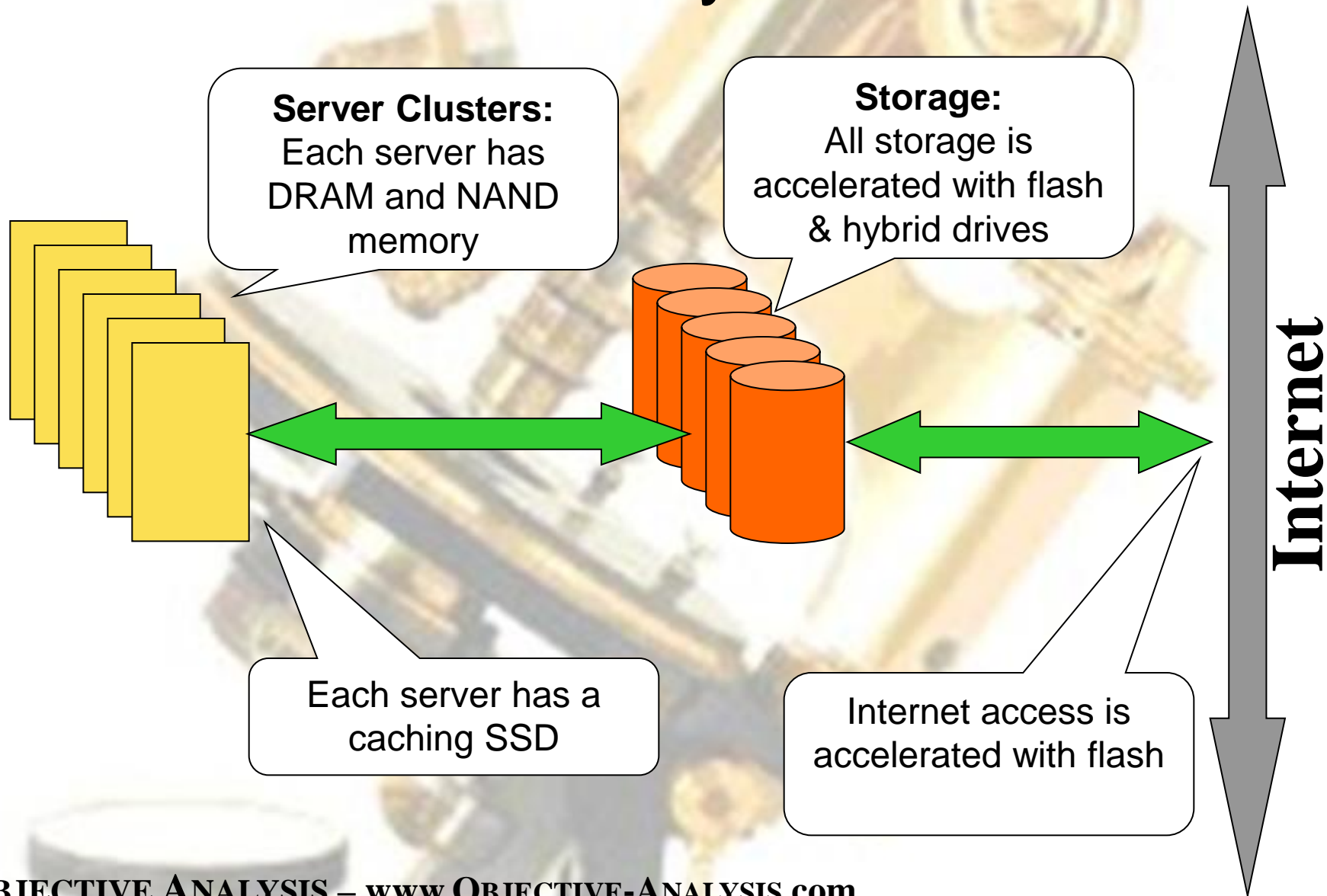
- Because users worry about wear

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The Computer of the Future

Flash is Everywhere!

Server Clusters:
Each server has DRAM and NAND memory

Storage:
All storage is accelerated with flash & hybrid drives

Internet

Each server has a caching SSD

Internet access is accelerated with flash

Summary

- The industry's vision for flash use is maturing

- Eventually flash will break away from storage form factors

- Tomorrow's computers will sprinkle flash liberally throughout the system

Thank You!

Jim Handy

OBJECTIVE
ANALYSIS