



Education

Solid State Storage for the Enterprise

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Solid State Storage for the Enterprise

This presentation will discuss the types of solid state storage systems directed at enterprise. The presentation will look at DDR-RAM and Flash based storage devices and their technical differences. The presentation will discuss the fit of various memory based storage devices with enterprise applications. Discuss the fit of solid state disk in ILM.

Learning Objectives

- Understand types of solid state storage available for enterprise applications.
- Discuss applications for solid state storage in the enterprise.
- Discuss solid state storage as part of a broader ILM strategy.

Agenda Topics

- What is a Solid State Disk?
- Flash and DDR Memory Characteristics
- Why Solid State Disk?
- SSD Killer Applications
- SSD and ILM

What is a Solid State Disk?

➤ “A solid state drive (SSD) is a semiconductor-based block storage device that behaves as a virtual HDD and appears to the host device as a disk drive.”

- > IDC, Worldwide Solid State Drive 2007-2011 Forecast and Analysis: Finding Space in the Expanding Digital Universe, Doc # 207739, July 2007.

What is a Solid State Disk?

➤ Flash Memory Based

- ◆ Same class of memory used in consumer electronics
- ◆ Inherently non-volatile
- ◆ Best known for ruggedness and good random read performance.

➤ DDR Memory Based

- ◆ Same memory used in enterprise servers
- ◆ Requires batteries and backup hard disks for non-volatility
- ◆ Best known for outstanding performance and high cost.

➤ Cached Flash

- ◆ Mix of DDR RAM and NAND Flash.

Flash Memory Characteristics

- Two types of NAND Flash Memory
 - ◆ SLC – single layer
 - › 100,000 writes per cell
 - › Primarily used in industrial and military applications
 - › Higher cost
 - › 1.5 millisecond erase times; 200 microsecond write times; 25 microsecond read times
 - › Highest density – 16Gbit with 32Gbit on the way
 - › SLC memory is best suited for the enterprise
 - ◆ MLC – multi layer
 - › 10,000 writes per cell
 - › Primarily used in consumer electronics
 - › Lower cost
 - › Half the performance of SLC
 - › Highest density – 32Gbit with 64Gbit on the way.
- Expect mixed SLC – MLC flash SSDs in the near future.

- The process to write data to flash follows these steps:
 - ◆ Determine “block” to update. NAND flash is typically divided into 128KB blocks and further subdivided into 2KB pages.
 - ◆ Copy data from the existing “block” (if necessary)
 - ◆ Erase the “block” and reset cell to all “1’s”
 - ◆ Rewrite the “block”, only 0’s can be written to a flash cell.

DDR RAM Characteristics

- Unlimited writes per cell
- Primarily used as computer memory
- Higher cost and lower density than NAND flash
- Inherently volatile
- Highly reliable chip design
- 10-15 nanoseconds read and write times
- Highest density 1Gbit
- DDR RAM is well suited for the enterprise.

What is a Solid State Disk?

1.8"



2.5"



3.5"



JBOD



Rack Mount



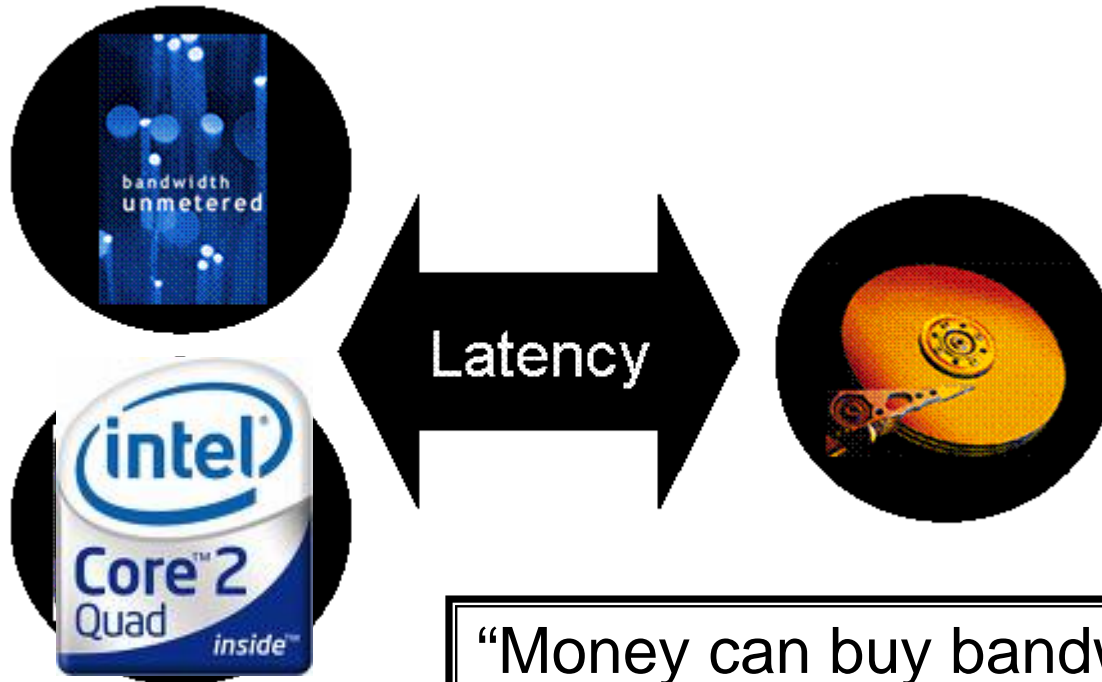
Flash	Flash	DDR/Flash	DDR/Flash	DDR/Flash
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Why Solid State Disks?

Converging Trends



Why Solid State Disks? Latency Matters



“Money can buy bandwidth, but
latency is forever”

John R. Mashey, Chief Scientist SGI,
“Big Data and the Next Wave of InfraStress”, USENIX, 1999

Why Solid State Disks?

Little Change in HDD RPM

- 1956 RAMAC
 - ◆ the first disk drive
 - ◆ 5 MB storage
 - ◆ 1,200 RPM
- 2007 Seagate Cheetah Drive
 - ◆ 400 GB storage
 - ◆ 15,000 RPM
- From 1956 to 2007:
 - ◆ 12.5 times increase in RPM
 - ◆ 80,000 times increase in capacity

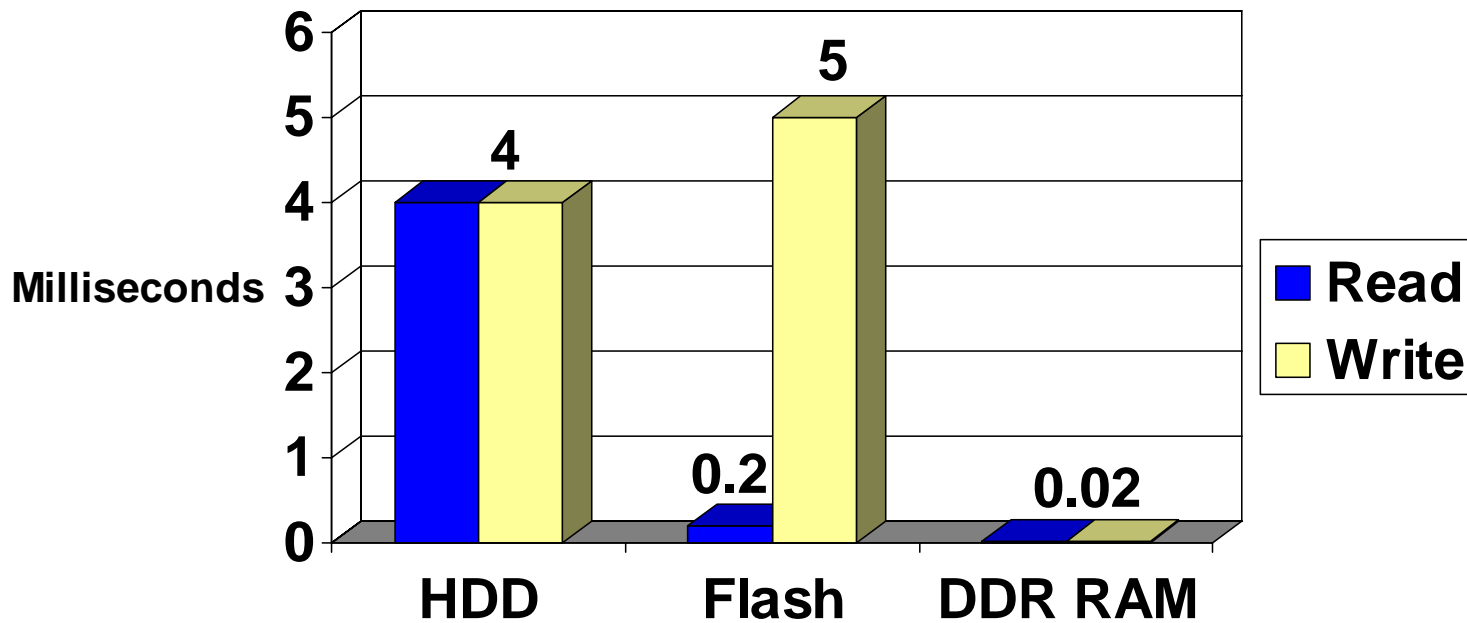


Why Solid State Disks?

Data Access Times

Data Access Times

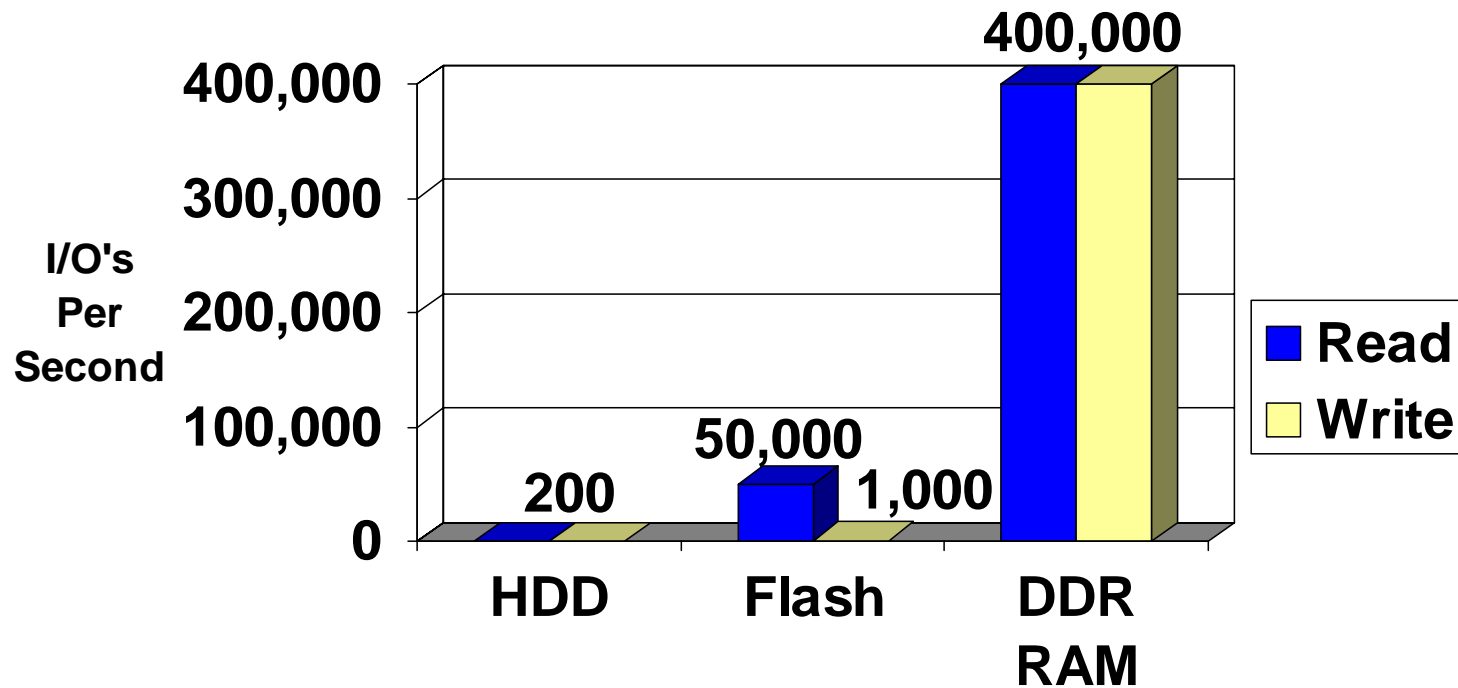
(assumes a cache-miss)



Why Solid State Disks?

Random I/O's

Random I/O's Per Second (assumes a cache-miss)



Why Solid State Disks? Rugged

- ▶ Flash Hard Disk drives are rated to handle up to 1,500 G-Forces
- ▶ Laptop Hard Disk drives are rated to handle up to 400 G-Forces



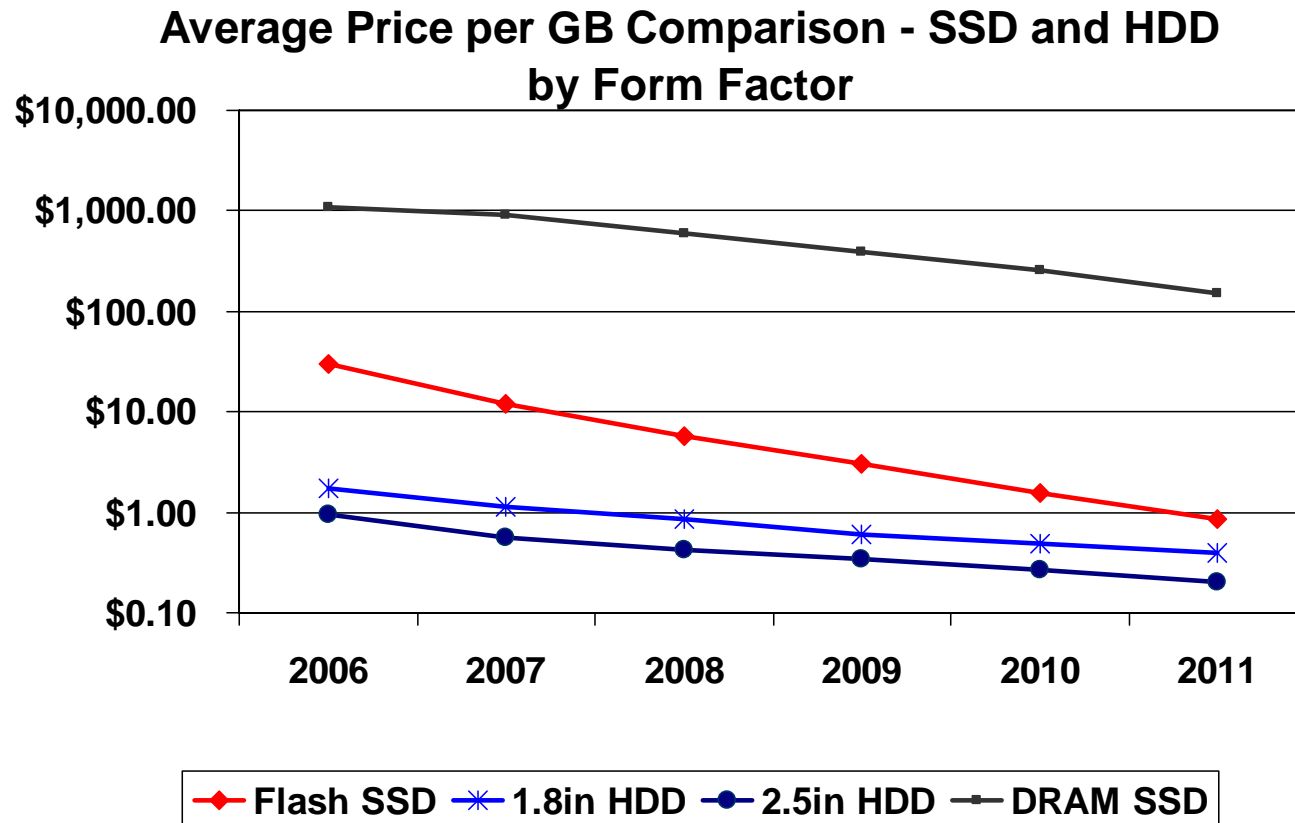
Why Solid State Disks?

Low Power

- At small capacities flash SSD offers the lowest power consumption ($1/2$ watt).
- At larger capacities (>150GB) FDD and HDD draw up to 18 watts.
 - ◆ Interface type impacts power consumption.
- Flash SSD has the best performance/power.



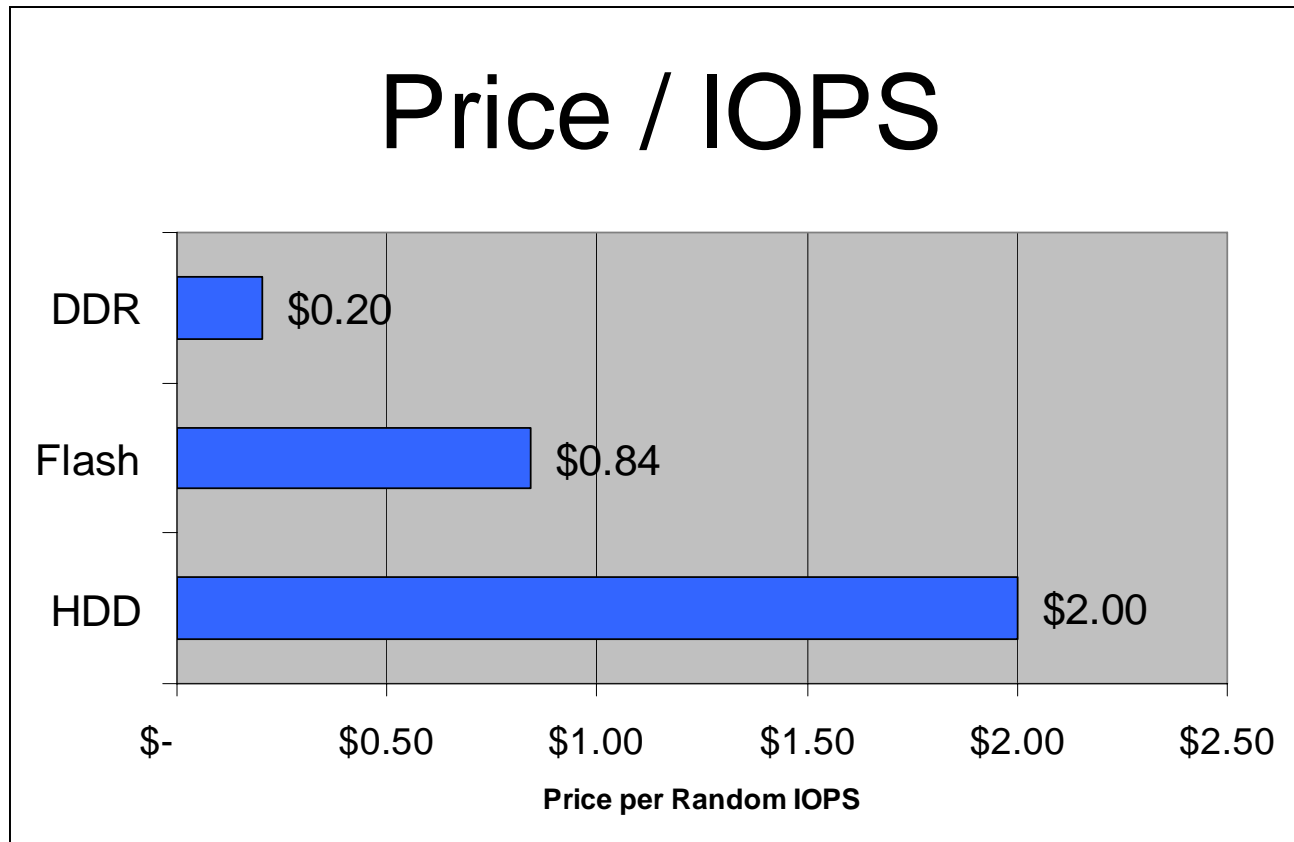
Why Solid State Disks? Dropping Prices



Source: IDC, Worldwide Solid State Drive 2007-2011 Forecast and Analysis: Finding Space in the Expanding Digital Universe, Doc # 207739, July 2007.

Note: DRAM SSD include additional components (I.e. batteries, etc)

Why Solid State Disks? Low Price for Performance

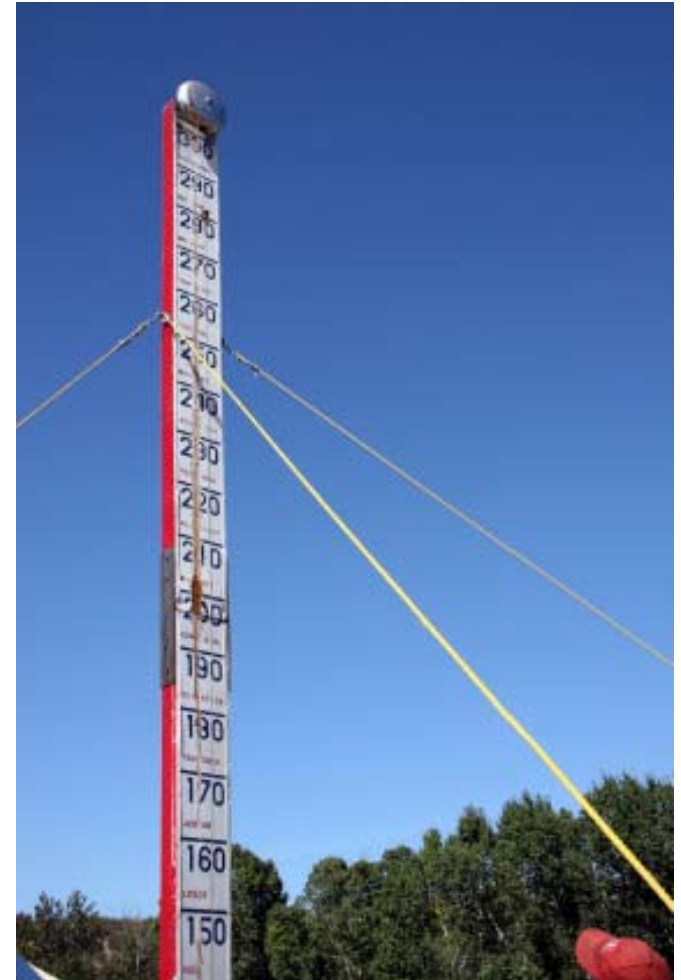


Why Solid State Disks?

Improving Density






















- Largest Hard Disk Drive:
 - ◆ 1 Terabyte
- Largest Flash Disk:
 - ◆ 352GB Flash Disk Drive
- Largest DDR Drive:
 - ◆ 12GB DDR SSD Disk Drive

- All drives can be arrayed for larger capacities.



Why Solid State Disks?

Small Block Random Data Accesses

Data Patterns	Tend to be...	HDD	Cached RAID	Flash	Cached Flash RAID	DDR Solid State Disk
High writes, mostly random	Small Block					
High reads, mostly random	Small Block					
High writes, Sequential, Single Threaded	Small Block					
High reads, reads quickly follow writes	Small Block					
High writes, mostly sequential	Big Block					
High reads, mostly sequential	Big Block					

Flash SSD Killer Applications

- Business notebook computer storage
 - ◆ Faster OS startup
 - ◆ Improved notebook read performance
 - ◆ Low power
 - ◆ Rugged

Cached Flash RAID SSD

Killer Applications

➤ Data warehousing

- ◆ Terabytes of capacity needed as hot files are difficult to isolate to a small amount of data
- ◆ Very read intensive applications
- ◆ Cache will preserve write performance at levels the enterprise is accustomed to receiving

➤ Rendering

- ◆ Small block random I/O application
- ◆ Very read intensive application
- ◆ Hot files are difficult to isolate

Cached Flash RAID SSD

Killer Applications

➤ Video on demand

- ◆ Storing frequently accessed movies requires 1TB plus capacity
- ◆ Very read intensive applications
- ◆ Less frequently accessed content still stored in HDD RAID

➤ Seismic processing

- ◆ Large capacity of data (4TB plus), broadly and randomly accessed
- ◆ Very read intensive application

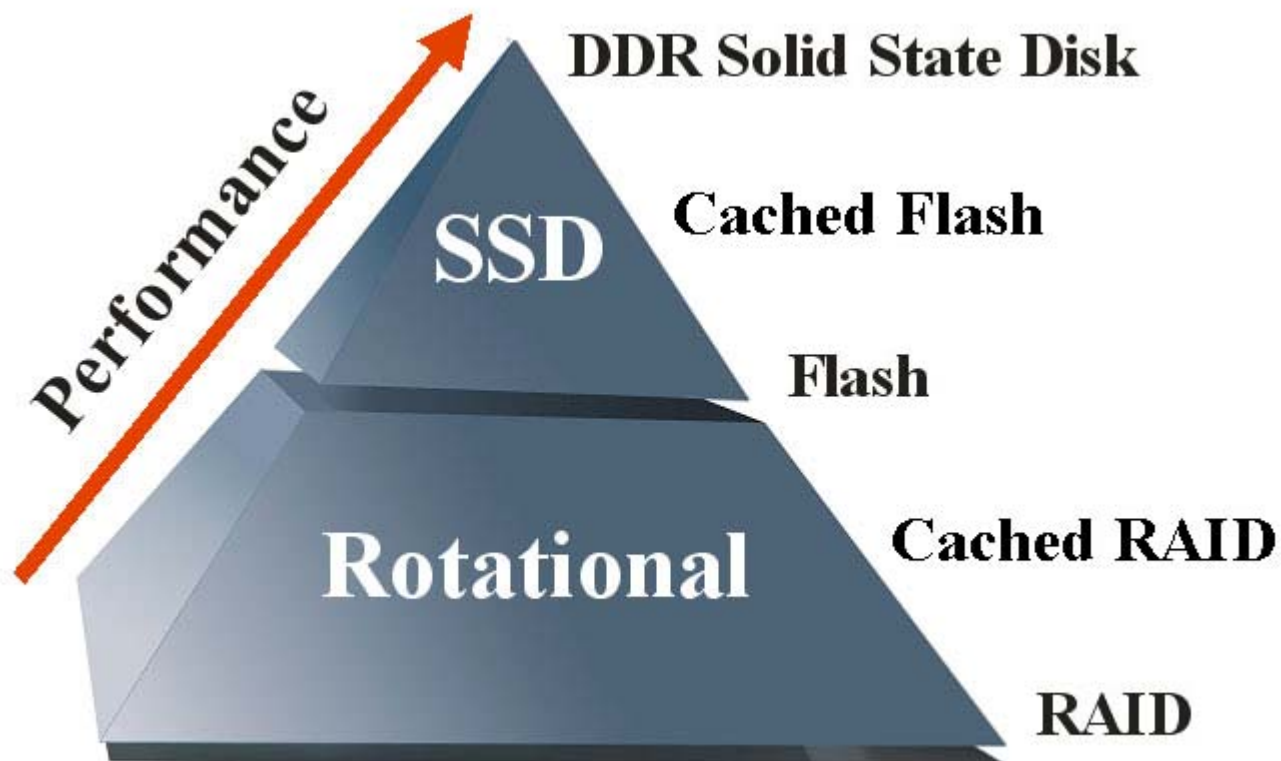
DDR RAM SSD

Killer Applications

- Write intensive OLTP environments
 - ◆ Heavy writes make these environments unsuitable for flash systems
 - ◆ Store transaction logs, temporary space, and undo segments on SSD
- Web transaction databases
 - ◆ Extreme concurrency
 - ◆ High read and write volumes
- Single-threaded applications
 - ◆ The ultimate latency sensitive application
 - ◆ Often found in the financial industry

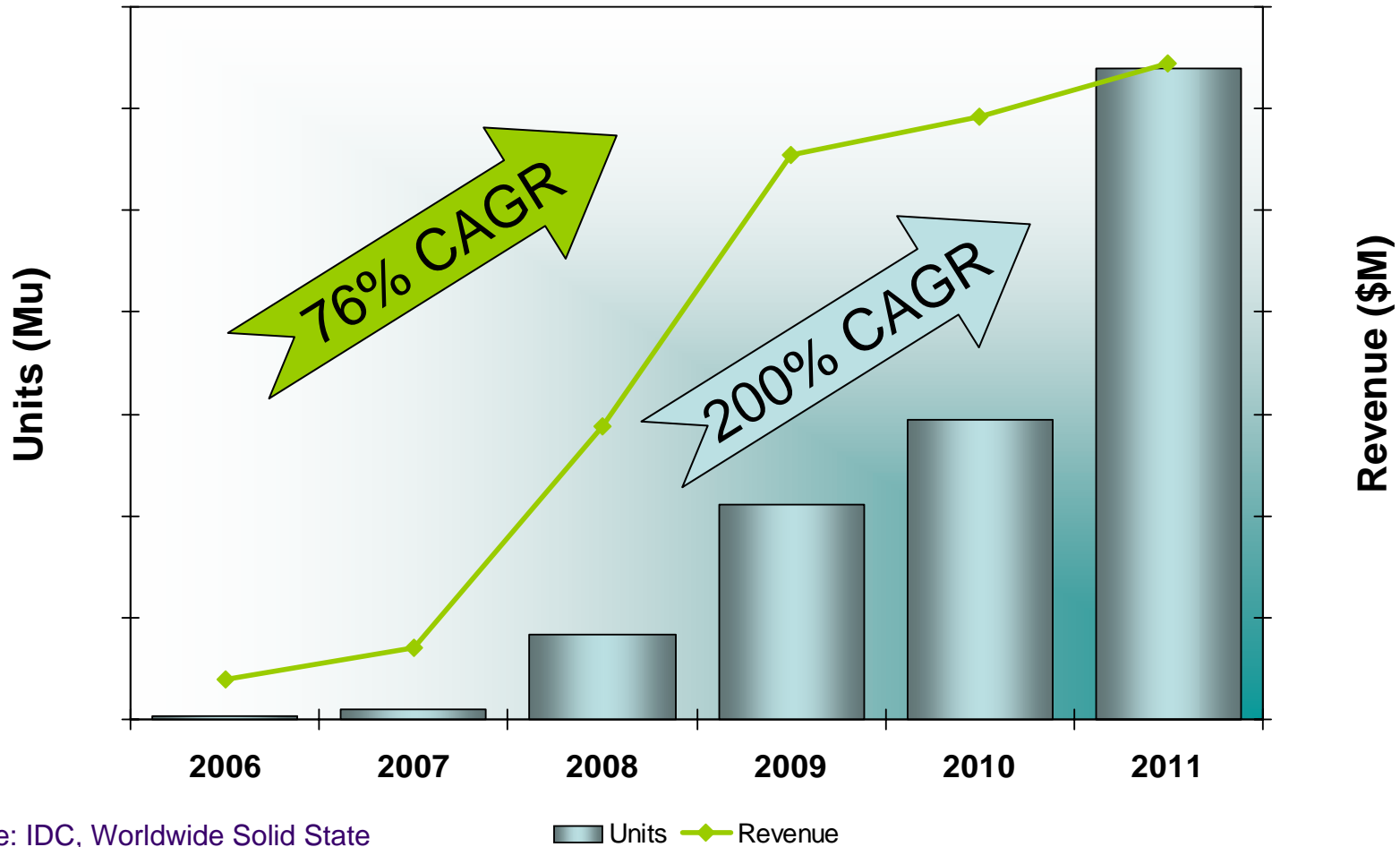
➤ Mission critical data warehousing

- ◆ When company profitability or lives are on the line, nothing is faster than a DDR RAM based solution
- ◆ Data Warehouses with simultaneous high ingest rates and high query rates



- Discussion of ILM is making people aware that different data has a different value at different times.
- Solid state disk sales are being driven by this awareness.
- Desired ILM features:
 - ◆ The ability to automatically migrate data between storage tiers based on frequency of data access.
 - Migrate data off SSD storage to lower cost storage.
 - Migrate data onto SSD storage from lower cost storage if frequency of access is high.
 - ◆ ILM software and hardware needs to have as little impact as possible on latency.

Enterprise SSD Market Set For Growth **SNIA**



Source: IDC, Worldwide Solid State Drive 2007-2011 Forecast and Analysis: Finding Space in the Expanding Digital Universe, Doc # 207739, July 2007.

Storage Performance Testing
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- Please send any questions or comments on this presentation to SNIA: trackstorage@snia.org

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