

Potential Impact of Solid State Memory on Enterprise Storage and Server Solutions

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This presentation will analyze the factors that will affect the adoption and use of Solid State Drives in the enterprise. Wide adoption will depend on cost declines, but will also correlate to improvements in the entire infrastructure including HBAs, RAID Adapters, SAN, firmware, operating systems, middleware and applications. SSDs have the potential to be more than just another form of “disk.” The Flash storage attributes of latency, operations per second, power and reliability may transform enterprise computing. This presentation will explore those potential changes as well as the obstacles that must be overcome to get there.

What is Going to Happen with SSDs in the Enterprise?

- Many Technologies are adopted slowly in the Enterprise space
 - IB
 - iSCSI
- Will SSDs be added to the list, or will Enterprise HDDs (15K RPM) be displaced in a few years?

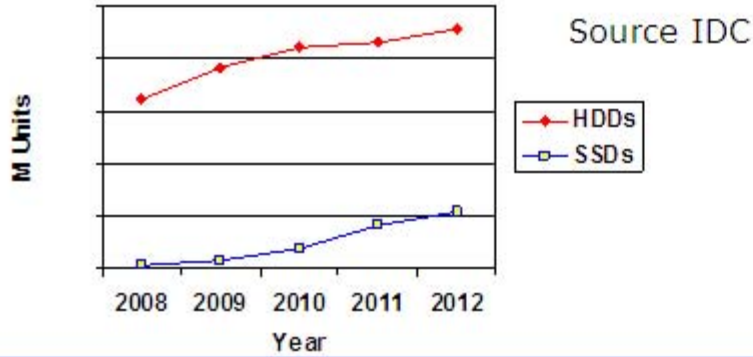
Important Considerations

- ❑ Performance
 - ❑ Read IOPs superior
 - ❑ Write IOPs and Sequential coming as Enterprise SSDs take shape
- ❑ Endurance
 - ❑ Will always need to be watched but. . .
 - ❑ Enterprise SSDs seem to be developing techniques to work around.
- ❑ Reliability
 - ❑ Would seem to have an advantage or can eventually have one
- ❑ Cost
 - ❑ With SLC, it may be difficult to get \$/GB there?
 - ❑ Can MLC be used in the enterprise to the extent necessary to allow for significant decreases in \$/GB
- ❑ Power Dissipation
 - ❑ Huge advantage and will only grow
- ❑ Flexibility to be used in other formfactors
 - ❑ PCIE or other types is a big advantage

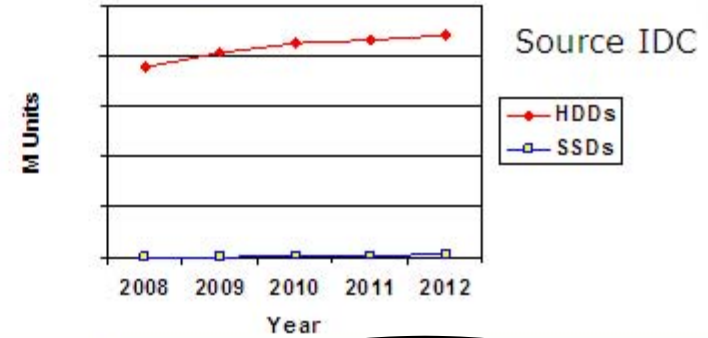
Projection Shapes



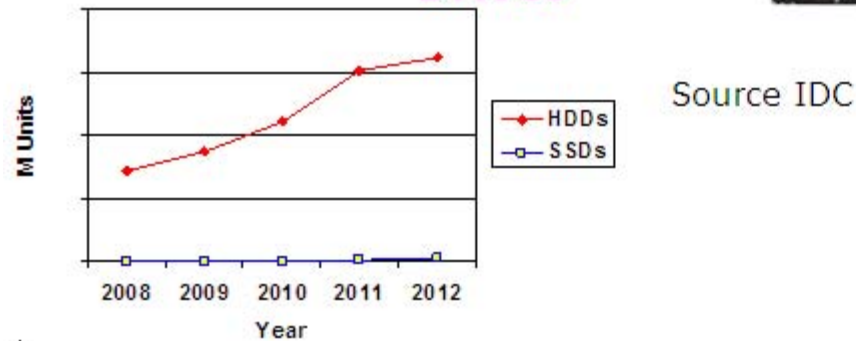
Notebook



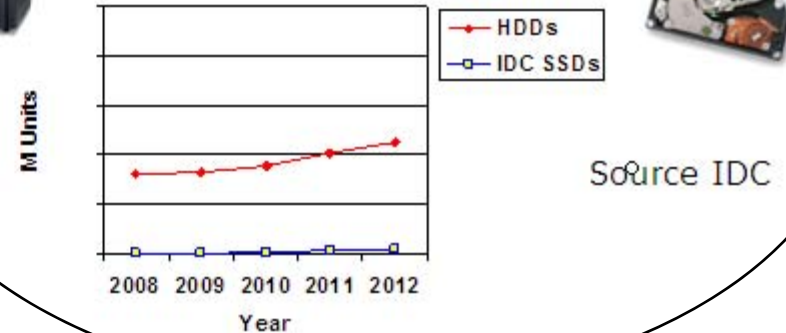
Desktop



Capacity Optimized Drives



Enterprise

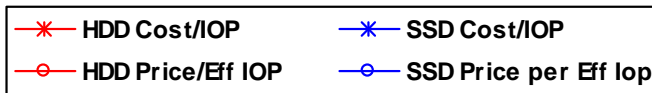
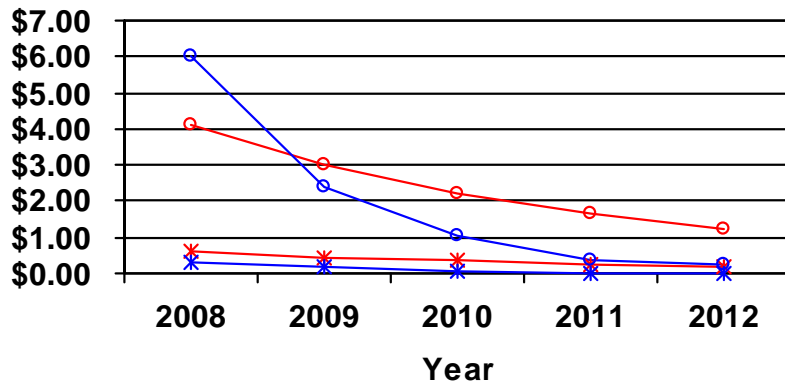


**But, Maybe, it can be more aggressive
than that??**

SSD and HDD Cost/Price per IOP comparison



High IOPS (10 to 25% of Enterprise Storage Totals)

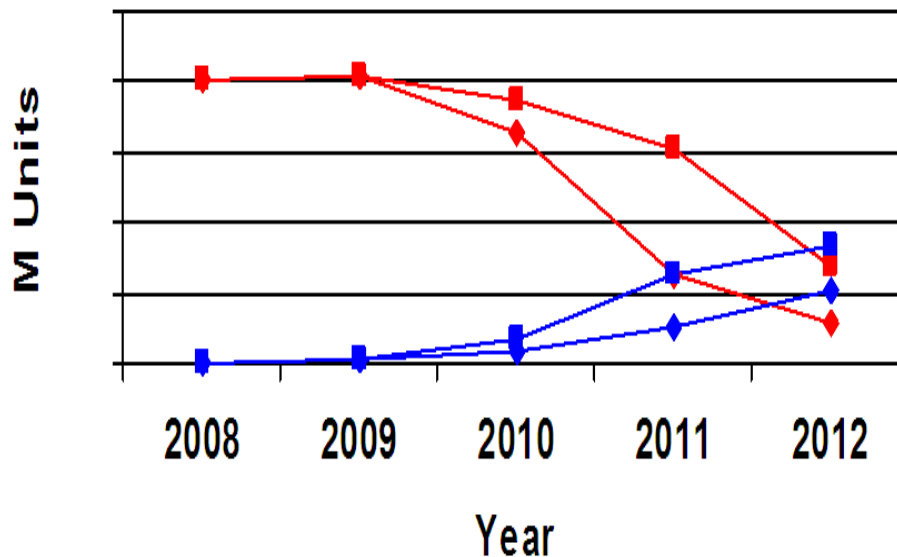


- Numbers are ballpark and meant to be only illustrative
- Shape and crossover points are key
- Price per Effective IOP takes into account infrastructure bottlenecks preventing all SSD IOPs to be used by system.
- Cost per IOP already crossed over
- Price per effective IOP will crossover for many systems next year. (Depends on server or Storage device.)

Possible SSD Adoption Rate vs. HDDs In High IOPs workloads



High IOPS (10 to 25% of Enterprise Storage Totals)



- 2008 would be early adopters
- 2009 is where price would result in adoption inflection points
- Latency to price crossover, if any would be due to lingering concerns with technology
- Multiple HDDs will be displaced with a single SSD
- However, new applications being enabled due to the order of magnitude performance improvement could offset it.

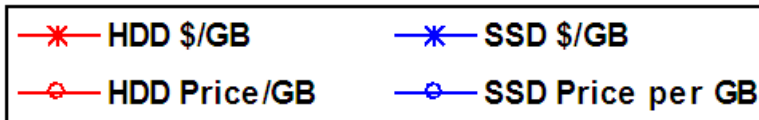
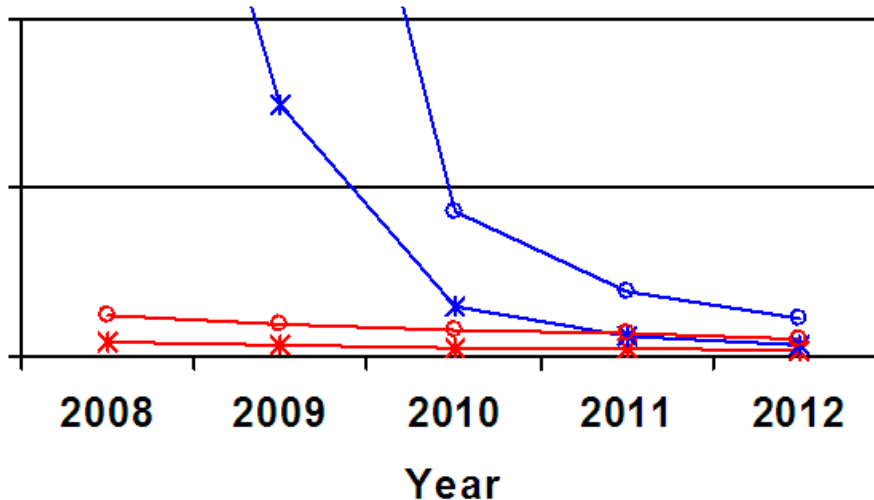
What about in the rest of the Enterprise Space?

\$/GB now the critical factor

\$/GB Comparisons



Other (RAS, etc)
 75% of Total



- Numbers are ballpark and meant to be only illustrative
- Will be a sharp takedown for SLC, But
- If MLC can come into enterprise than takedown even sharper
- Once price per \$GB reaches a 2 to 3X ratio, then the other properties of SSDs should allow for adoption in the non-High Ops applications

What is Best Usage Model in Enterprise

- ❑ SAN attached as today to accommodate ease of management and Sharing?
- ❑ Direct attached in Servers to take advantage of Low Latency?
 - ❑ But then how about the Clustering Fabric and Stack?

Stack Impediments

- ❑ For 50 years the industry have optimized around HDDs.
- ❑ SSDs will still require redundancy protection in Enterprise
- ❑ RAID controllers not designed today for the kind of performance SSDs can drive
- ❑ External Storage Latencies on Cache hits are superb, but Misses?
 - ❑ Who has cared when a disk takes ms?
- ❑ IO Model for SCSI and RAID sufficient?
- ❑ Drivers today tend to take a fair amount of instructions – who cares with disks
- ❑ Applications not really designed to be aware of different types of drives and optimized for them.

Ending Comments

- ❑ SSDs will almost certainly take off in the High IOPs space
- ❑ If \$/GB comes down enough, then further inroads into the Enterprise HDDs would occur
- ❑ Would 15K RPM drives survive?
- ❑ Stack improvements will certainly start but will likely take a long time
- ❑ Key applications
 - ❑ Search
 - ❑ Tiering
 - ❑ Databases
 - ❑ Data Warehousing
 - ❑ Email
 - ❑ etc