

Invest in New Technologies or Divest in Market Share

**(Hard Disk Drive and Component Companies
Face a Critical Decision to Grow or Die)**

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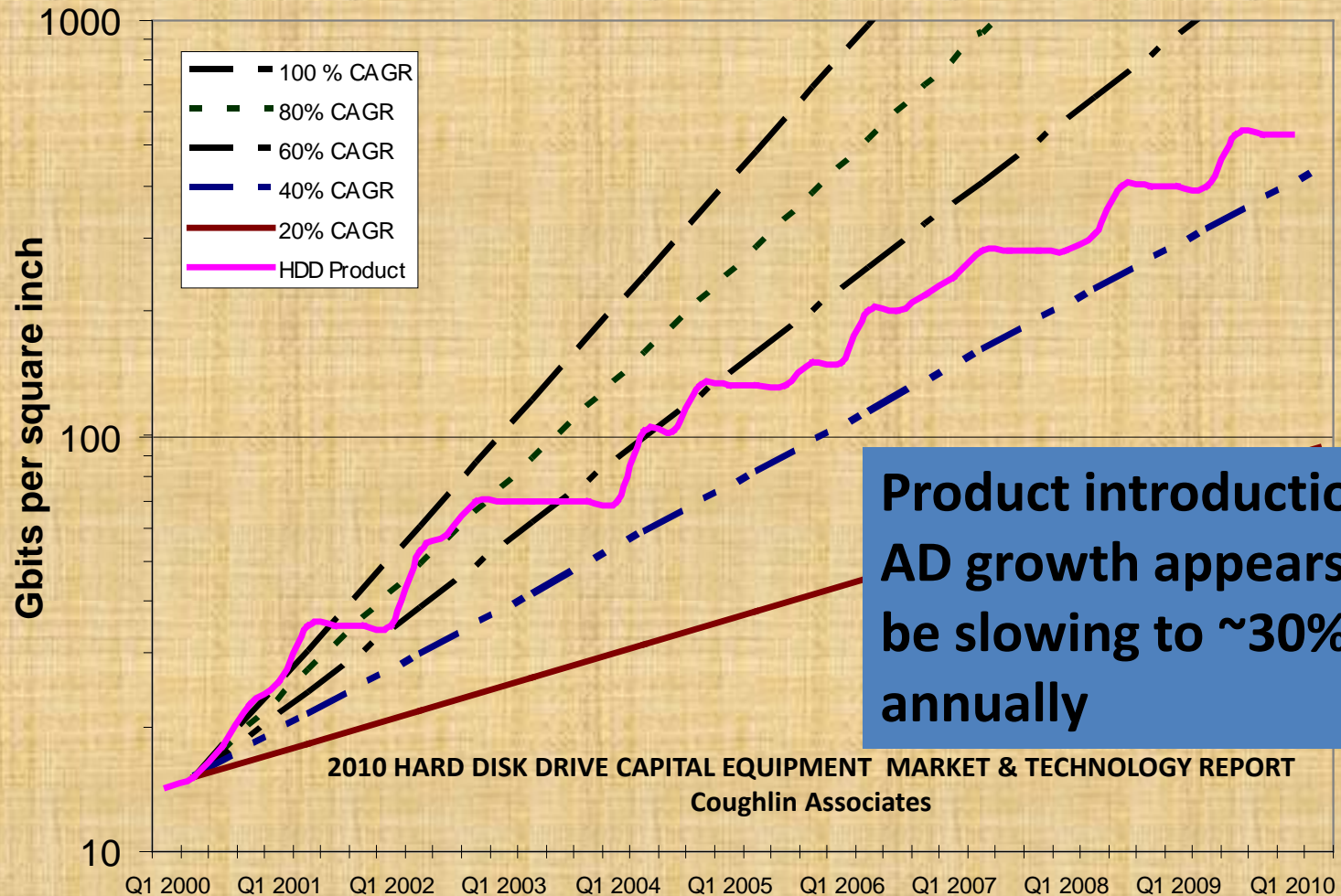
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Outline

- Slowing areal density growth
- Technology development and capital equipment spending
- HDDs vs. solid state storage--potential HDD revenue loss
- Joint development for AD growth
- New concepts for storage tiering and system architecture

Much of the data in this presentation is derived from the 2010 Hard Disk Drive Capital Equipment and Technology Report, Coughlin Associates, www.tomcoughlin.com

COMPARISON OF PRODUCT ANNOUNCEMENT TRENDS VS AREAL DENSITY GROWTH RATES.



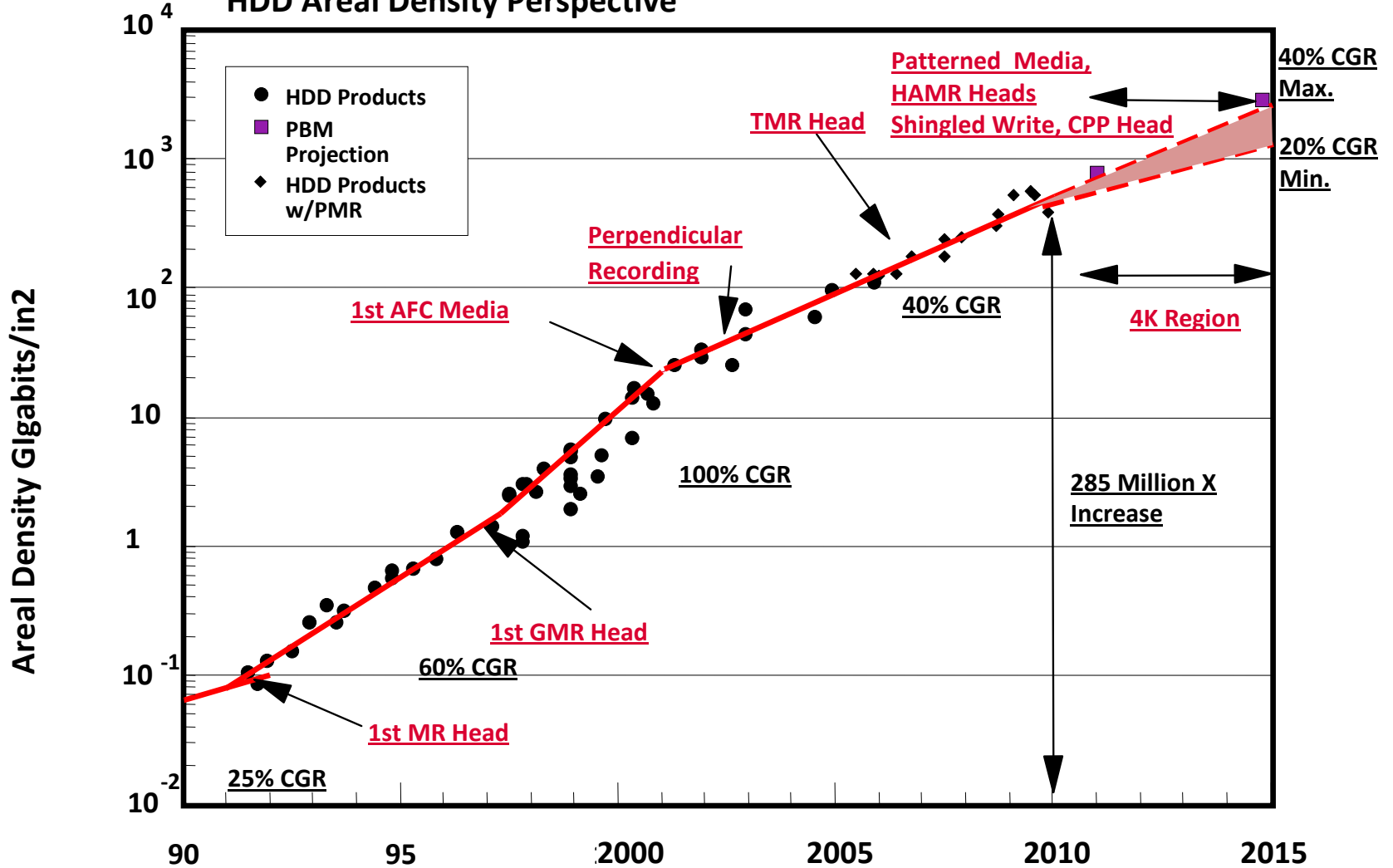
**Product introduction
AD growth appears to
be slowing to ~30%
annually**

2010 HARD DISK DRIVE CAPITAL EQUIPMENT MARKET & TECHNOLOGY REPORT
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HDD AREAL DENSITY GROWTH AND PROJECTIONS.

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HDD Areal Density Perspective

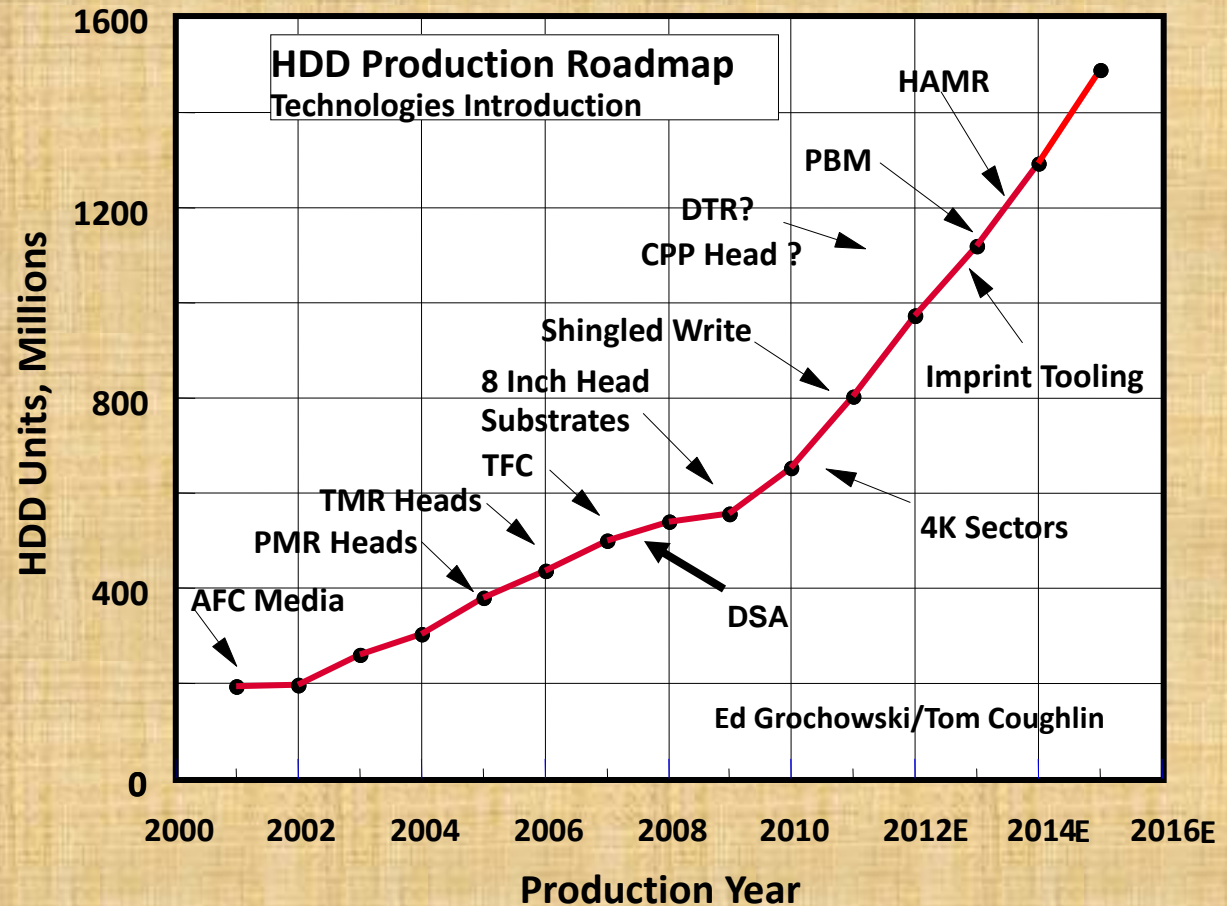


Production Year

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Technologies for Areal Density Growth

- Shingled Write
- Heat Assisted Magnetic Recording (HAMR)
- Patterned Media
- Dual Stage Actuators



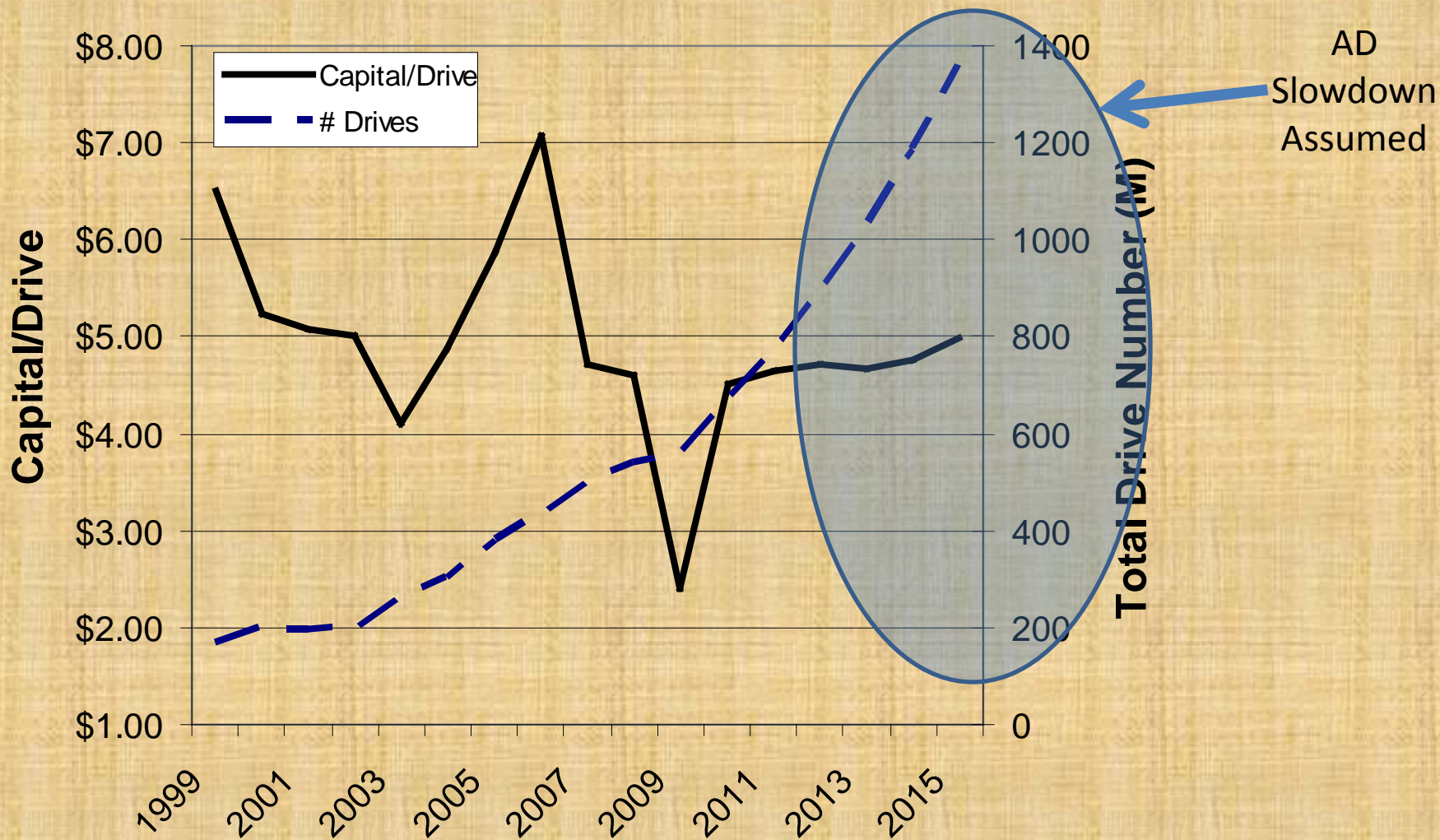
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HDD COMPANY REVENUE AND INDUSTRY CAPITAL EQUIPMENT SPENDING ESTIMATES (2007 TO 2015).

Year	Total HDD Est. Revenue	Total HDD Industry Capital Est. Equipment Spending	% Capital Equipment Spending/Revenue
2007	\$32.6 B	\$2.28 B	7.0%
2008	\$32.9 B	\$2.37 B	7.2%
2009	\$30.2 B	\$1.35 B	4.5%
2010	\$34.8 B	\$3.01 B	8.6%
2011	\$41.5 B	\$3.64 B	8.8%
2012	\$48.5 B	\$4.23 B	8.7%
2013	\$54.2 B	\$4.83 B	8.9%
2014	\$60.5 B	\$5.66 B	9.4%
2015	\$67.6 B	\$6.77 B	10.0%
Total (2007-2015)	\$402.7 B	\$34.14 B	8.1% (avg)

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CAPITAL EQUIPMENT SPENDING VS. NUMBER OF HARD DISK DRIVES TRENDS.

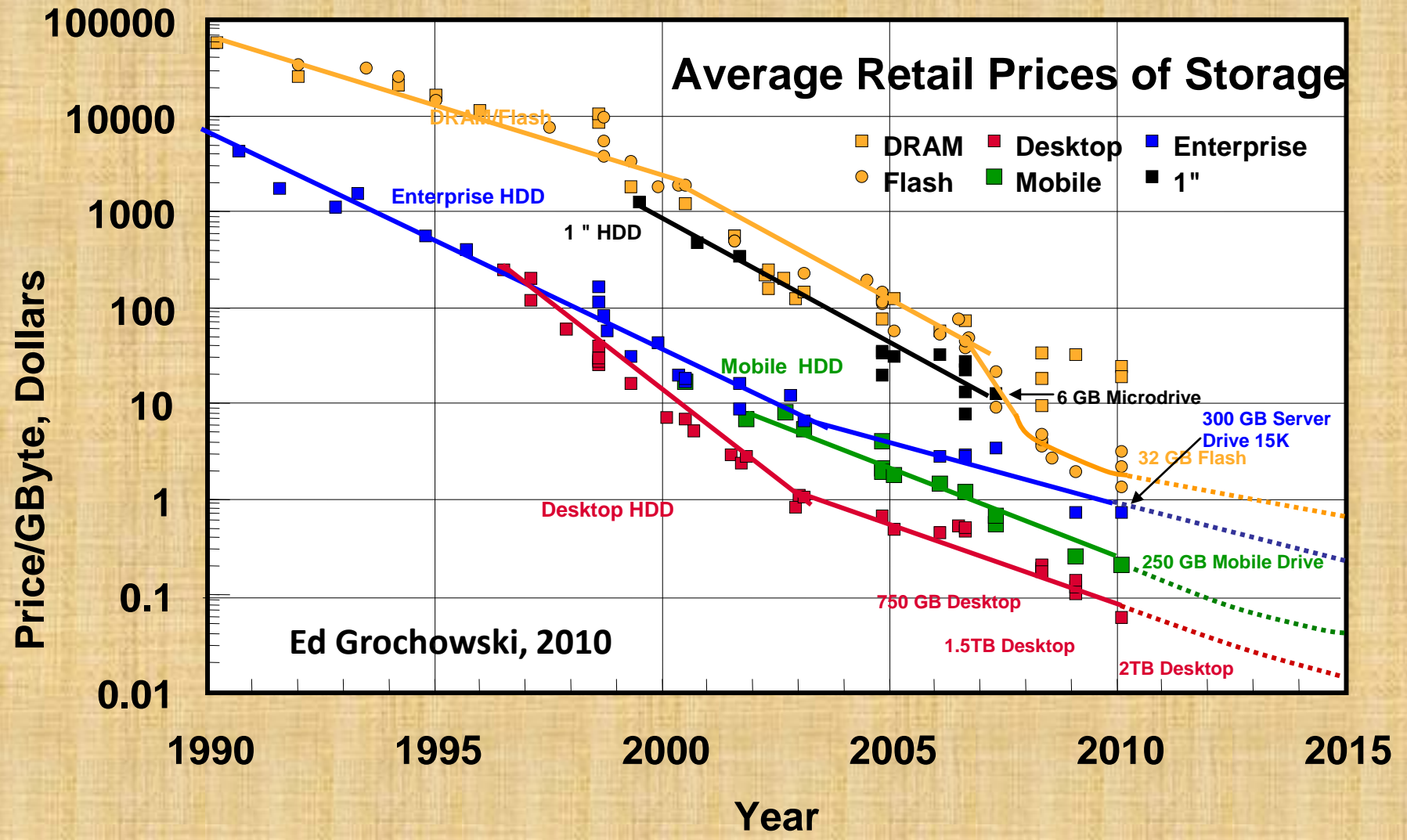


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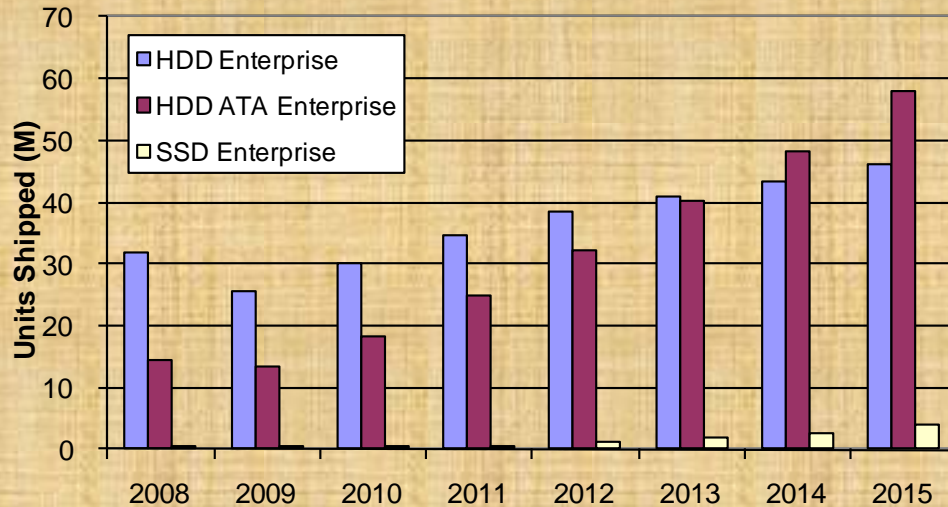
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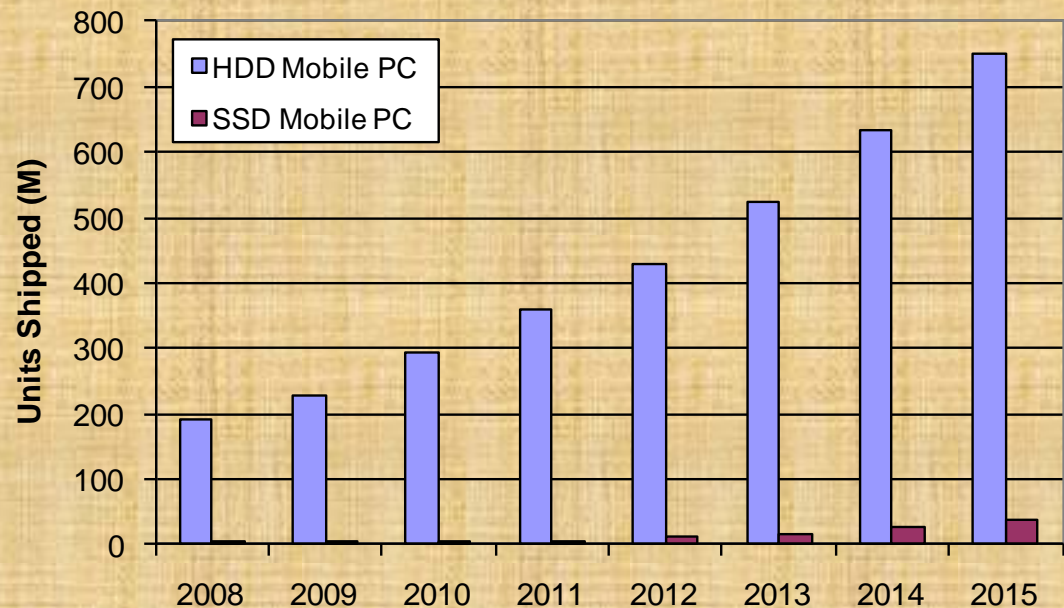
AVERAGE \$/GB FOR HDDS AND FLASH MEMORY.



Current Projections for HDDs and SSDs



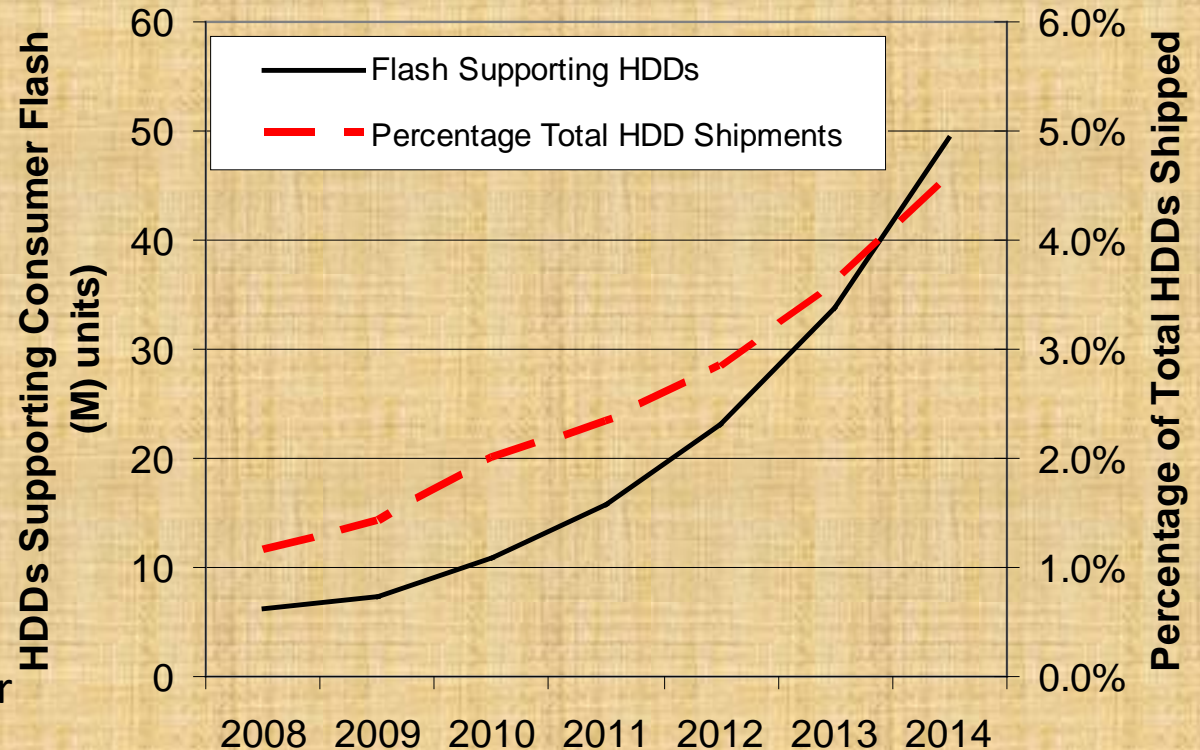
Mobile Computers



HDD Data—Coughlin Associates
 SSD Data—Objective Analysis

Historical Symbiotic Relationship Between Flash and HDDs

- Almost all consumer flash applications require HDDs
 - Music and video players
 - Cameras
- Consumer flash applications have created greater demand for HDDs
 - Downloads
 - Uploading photos and videos
 - Backup of Consumer Content



White Paper: Flash and HDD: Symbiosis or Survival of the Fittest? (Coughlin Associates & Objective Analysis, 2009)

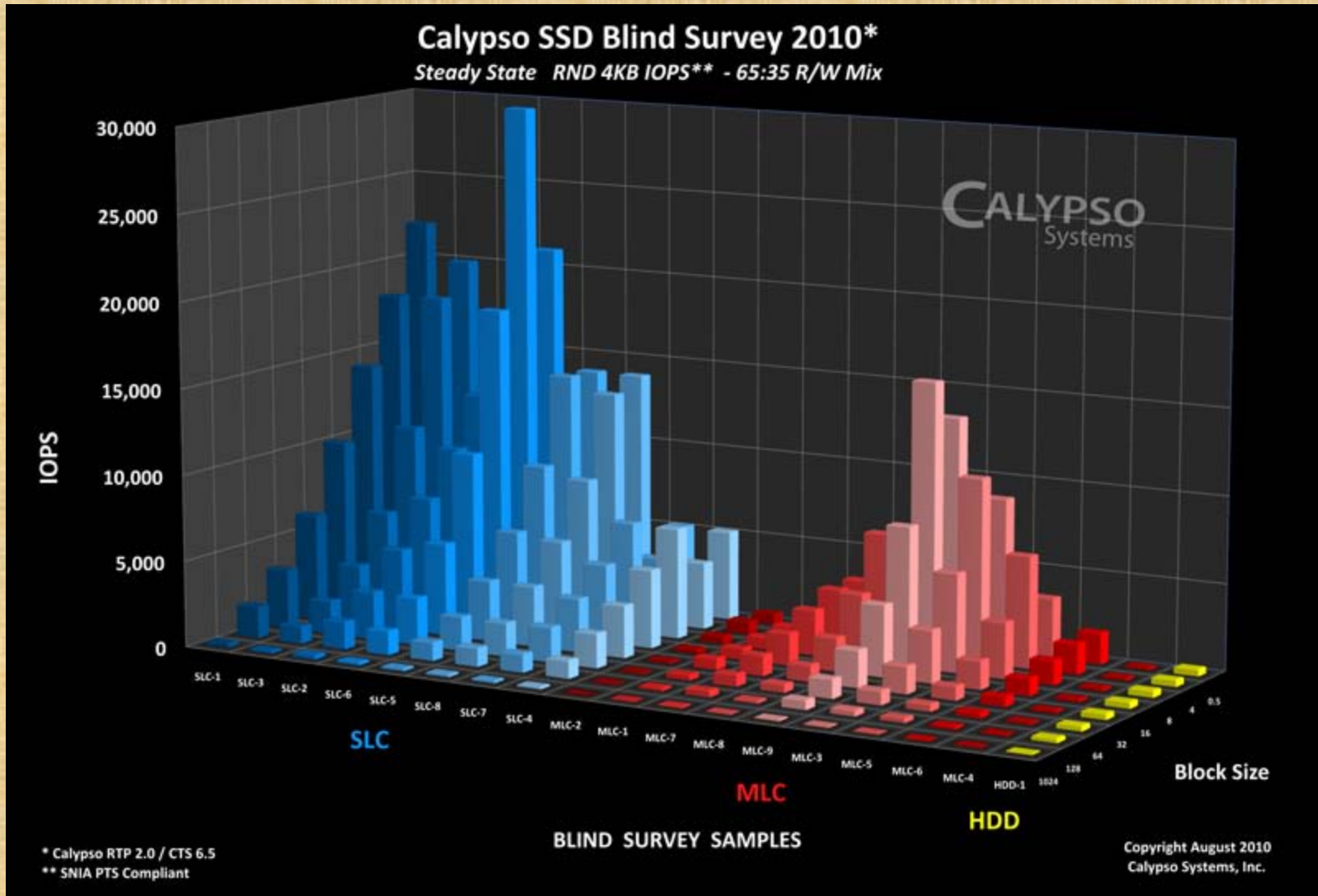
Historical HDD Losses to Flash Memory

- HDD were replaced in mobile A/V players for the most part
 - Compressed content could fit on a less expensive quantity of flash memory
 - Mobile use benefited from rugged a storage device
 - Killed 1-inch HDDs, 1.8-inch drives down considerably
- SSD's are being used as Tier 0 enterprise storage but also replacing some HDD arrays used to achieve performance at the expense of capacity
 - Expensive enterprise HDDs will be more vulnerable to flash memory replacement from \$/GB considerations if AD slows
- HDDs replaced by SSDs in remote caching operations, such as edge content delivery servers

Potential Loss of HDD Shipments

- There are read and possible write performance advantages with flash memory over HDD, depending upon the data traffic
- Advancing SSD and flash device controller technologies are making endurance and reliability issues less of a problem
- Still challenges to continue flash memory advances as feature size is reduced, but there are other solid state (SS) storage technologies in the wings
- HDDs face increasing competition from SS storage technologies and maintaining competitive \$/GB is critical to survival
- An extended period of low annual AD growth will hit potential HDD revenues
- It may be better to make apparently expensive capital equipment and technology investments to continue AD growth than lose that potential revenue (and market share)

SSD and HDD Steady State IOPS



Assumptions in Loss Estimate Calculation

HDD/Flash \$/GB Ratio

10.0
5.0
3.0
2.0
1.5
1.0
0.5
0.3

Reduction in HDD Demand

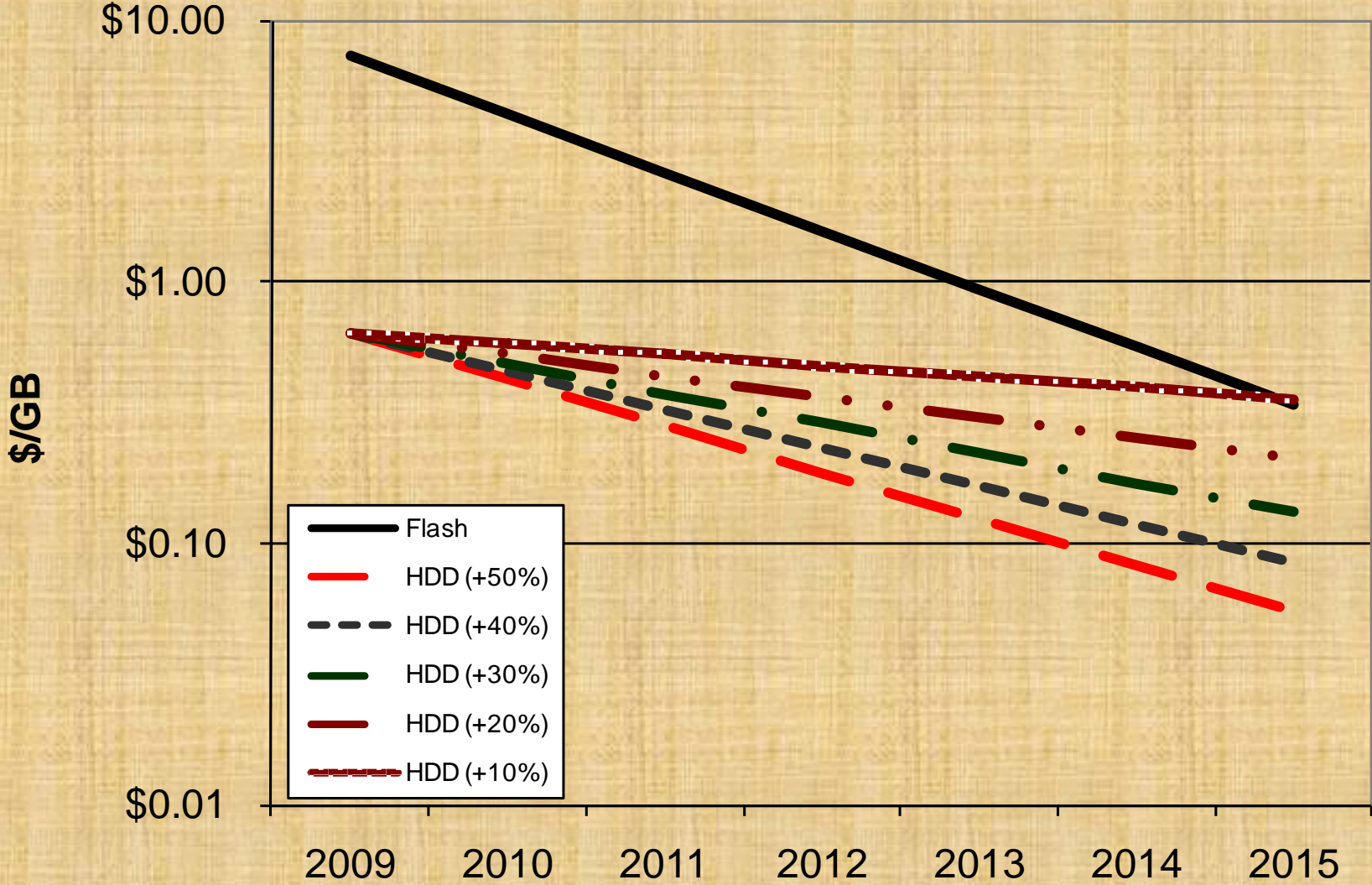
0
0.50%
10%
20%
30%
50%
70%
90%

**This may be optimistic!
Ultimately a 1:1 \$/GB
ratio could destroy
HDDs.**

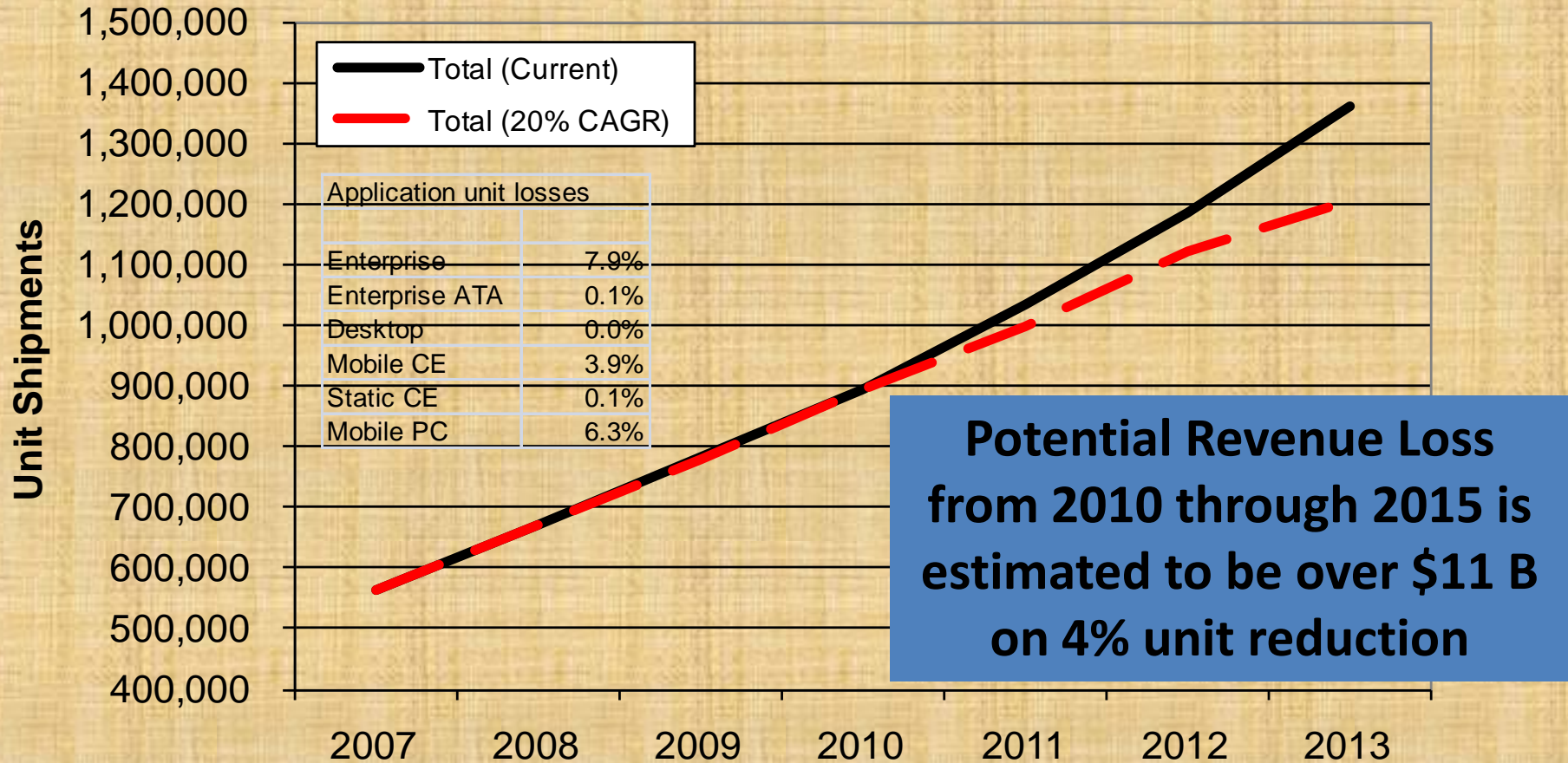
2009 SSD Numbers		2009 HDD Numbers	
Application	(\$/GB)	Application	(\$/GB)
Mobile Computer	\$5.73	Mobile Computer	\$0.32
Desktop Computer	\$5.73	Desktop Computer	\$0.10
Enterprise	\$7.24	Enterprise	\$0.63

- Assume 5% annual disk drive ASP decline from 2010 through 2015
- Assume 40% annual flash \$/GB decline from 2010 through 2015
- Assume 20% annual HDD AD increase from 2010 through 2015
- All losses calculated here are driven by \$/GB only, other factors are not considered through may be important for some applications
- Flash Pricing derived from information from Jim Handy, Objective Analysis

Enterprise \$/GB Trends vs HDD AD Growth



Estimated HDD Unit Shipment and Revenue Loss with 20% AD Growth from 2010-2015



HDD Companies and Suppliers Must Work Together to Enable AD Growth

- Storage Technology Alliance
 - Seagate, Western Digital, Hitachi GST and other HDD companies and equipment suppliers are to work together to enable the next generation of HDDs and maintain significant AD growth
 - By developing some common evaluation of technologies and perhaps production tools, industry technology growth can be accelerated
- Perhaps HDD companies should also work together on storage tiering and flash/HDD symbiosis (such as hybrid drives) as well, to make sure that HDDs stay relevant to the next generation of enterprise, computer and consumer devices

Conclusions

- HDD areal densities are slowing
- Technologies for extending areal density growth require significant technical and/or capital equipment investment
- Solid state storage increasingly offers reliable performance improvements and \$/GB decline in SS storage may continue
- HDD potential revenue will suffer if AD CAGR does not maintain reasonable levels (40% CAGR or so)
- The HDD industry must work together to implement these new technologies
- HDD companies must consider working together to embrace storage tiering and hybrid architectures for enterprise, computers and consumer applications

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Thanks

