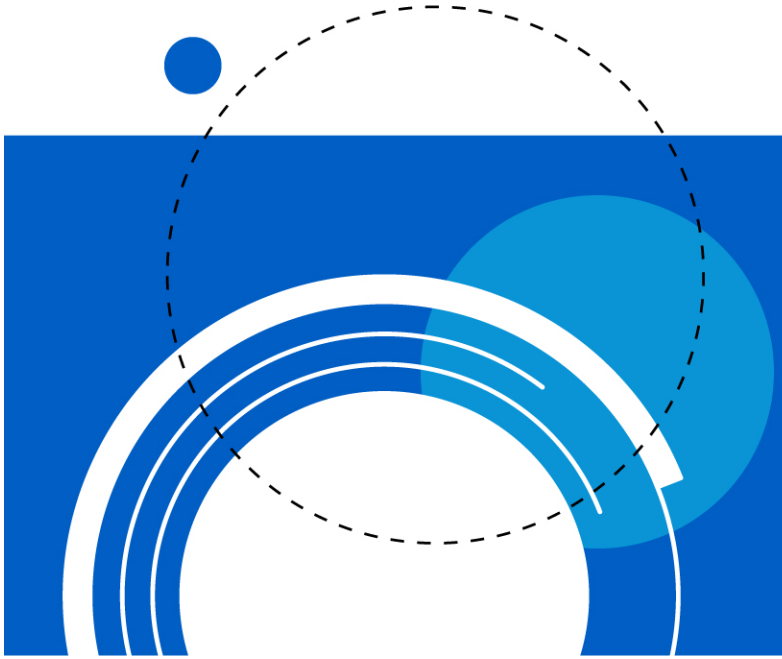


Hard Drive Directions

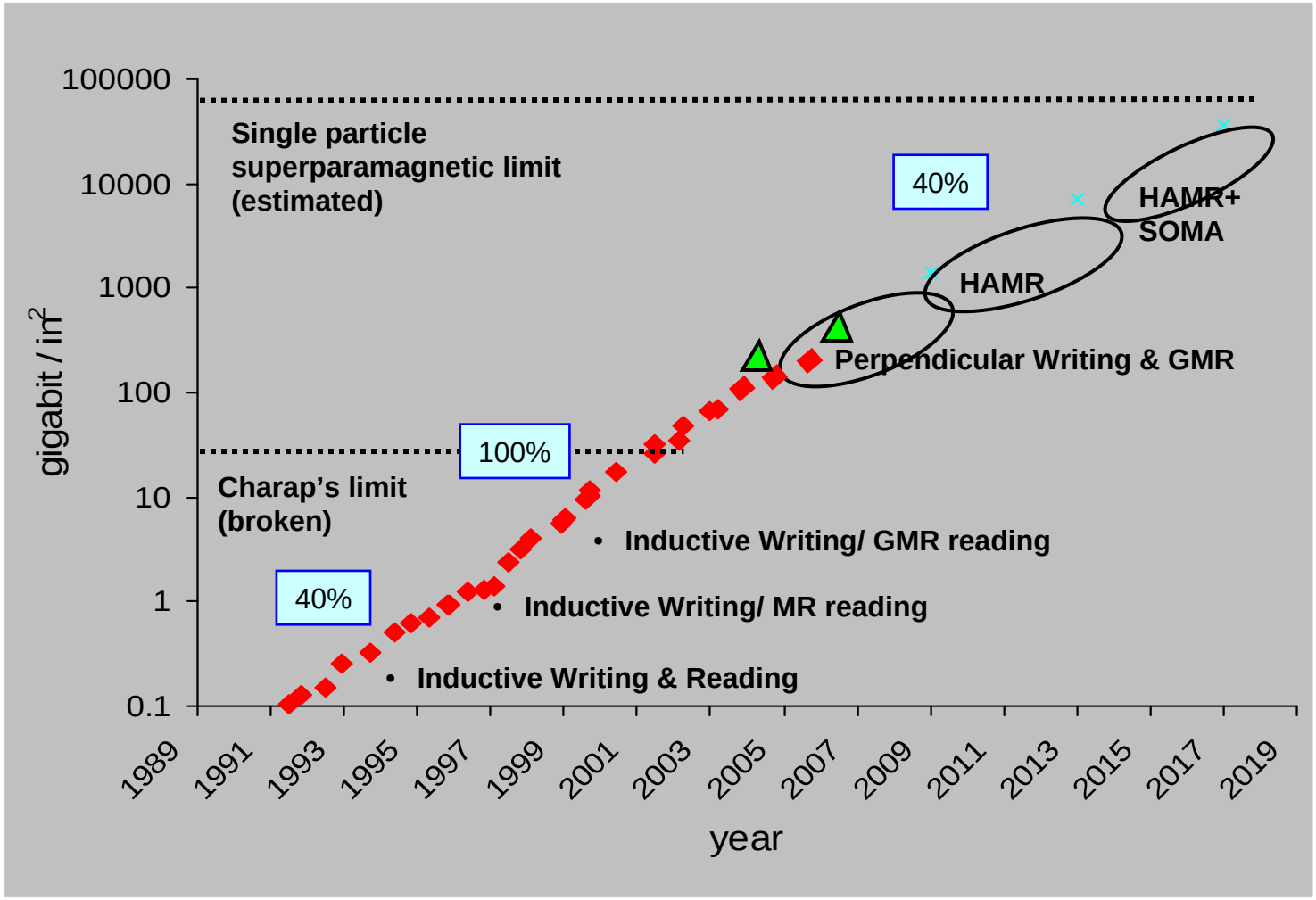
Dave Anderson

Seagate
We turn on ideas

Areal Density Growth

- Areal Density CAGR 40%
- Transfer Rate CAGR 20%

- Late 1990s – super paramagnetic limit demonstrated through modeling
- Perpendicular expected to extend to 0.5-1 Tb/in^2
- Additional innovations required at that point
  - heat-assisted recording
  - bit patterned media recording



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HDD Technology Trend

3.5 inch Consumer	2006	2009	2013
Drive Capacity (GB)	750	2,000	8,000
Number of Discs	4	3	3
Capacity (GB/disc)	187	670	2,670
Product Areal Density (Gbpsi)	133	500	1,800
Transfer Rate (Mb/sec)	930	2,000	5,000
RPM	7,200	7,200	10,000
Read Seek Time (ms)	8	7.2	6.5
3.5 inch Enterprise	**2006**	**2009**	**2013**
Drive Capacity (GB)	300	600	2,400
Number of Discs	4	4	4
Capacity (GB/disc)	75	150	600
Product Areal Density (Gbpsi)	108	250	1,000
Transfer Rate (Mb/sec)	975	2,000	4,000
RPM	15,000	15,000	15,000
Read Seek Time (ms)	3.7	3.3	2.8

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Solid State Disks

SSD Value Prop

Lower command latency

Access Density (IOPS/GB)

Power (IOPS/WATT)

Inhibitors to Broader Adoption

Price

Endurance concerns

Immature failure mode understanding

Industry Work Needed

Centralized standards activity

Performance standards

Endurance standards

Take Aways

SSD Enable Growth

SSD will co-exist with HDD

Industry Standards work needed

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Other Topics

Interfaces: Serial reigns!

- 6 Gbit SAS & SATA deployed in 2010
- FC continues for enterprise storage, but no 8 Gb/s on a drive
- SSD may lead to new (direct attached) interface thinking
- USB-3 will be considered as client drive interface
- PI will provide end to end integrity checking (SAS)

Power becoming an ever bigger issue

- Enterprise storage moving to 2.5”

Security will in or available on all drives

Form Factor transition?

- Laptops displacing desktops as mainstream client
- High capacity 3.5” drives based on low cost desktop market

Summary

- HDDs will continue to be primary storage in most systems
- SSD use more likely than higher RPM drives
- Power becoming more a important consideration
- Mainstream form factor trends bear watching

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