Storage Technologies for Today and Tomorrow

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Outline

• XENON Overview
• Storage Market Overview
• Storage Technology Roadmap
• New developments in hard disk drive technologies (HAMR, MAMR, BPM)
• Solid state storage (Flash, Phase Change, RRAM, MRAM)
• Exotic storage technologies
• "Software Defined Storage" Still Needs (and Sells) Smart Hardware
• Open discussion
XENON Systems – A History of High Performance Solutions

1998
Talstra Digital Video Network
Supplied Video Server equipment

2004
TataSky DTH India
Supplied Video Logging solution

2005
Thales Defence
Supplied Image Generators for the ASLV simulators

2009
CSIRO
(10th in Green500 ranking)
Supplied Australia’s first GPU Cluster (“Bragg”)

2011
Fox Broadcasting USA
Supplied Video Logging solution

2012
Fujitsu
Supplied Infiniband Network for Australia’s largest Supercomputer (“Rajin”)

2013
Digital Cinema Systems
Upgraded 150 Independent Cinemas in ANZ region

2014
University of Queensland FlashLite HPC cluster system for high data throughput

2015
Thales Defence
Delivered High Fidelity Solution for Australian Army Tiger Helicopter Simulator

2016
Oil Search
Deployed Intel® CAS to speed reservoir modeling

2017
The Walter and Eliza Hall Institute
Private Cloud for Next Generation Cancer, Disease & Medical Research

2011
Australian Stock Exchange (ASX)
Supplied Infiniband equipment

2015
Futuris
XENON drive high performance innovation

2016
Garvan Institute of Medical Research
NVMe solution that enables high data throughput

2017
NCI
Supercomputer dedicated to scientific research & technology innovation
Storage Market Overview

By 2020, ~70% of exabytes will still reside on HDDs.

By 2020, ~90% of data center exabytes will still reside on HDDs.

Ref: [wdc02]
HAMR Technology Breakdown
MAMR Breakthrough

Innovative Spin Torque Oscillator delivers Energy Assist and path for Areal Density Growth to 4Tb/\text{in}^2

Microwave Assisted Magnetic Recording (MAMR)

Heat Assisted Magnetic Recording (HAMR)

Shingled Magnetic Recording (SMR)

2D Magnetic Recording (TDMR)

Perpendicular Magnetic Recording (PMR)

MAMR has the same projected areal density potential as HAMR but without cost, reliability & complexity concerns

XENON
High Performance Computing
HAMR vs. MAMR

HAMR (Seagate)

- Manufacturability: Built over 40,000 HAMR drives; pilot volume in 2018, volume shipments of 20TB+ drives in 2019; drives are built on the same automated assembly line as current products
- Capacity: Achieved 2 Tbpsi areal density; 30% annual density growth on HAMR over past nine years
- Reliability: Tests proved single-head data transfers of over 2PB, exceeds real-world specifications
- Simplicity: HAMR is transparent to host; passed customer testing using standard code
- Cost: Supply chain fully established and ready to launch; projected cost-per-TB path beats legacy PMR technology

MAMR (WDC)

Why We Chose MAMR Over HAMR
Energy-Assisted Recording: Required for Writeability at High Track Densities

<table>
<thead>
<tr>
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<th>MAMR</th>
<th>HAMR</th>
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<tr>
<td>Complexity</td>
<td>Leverages current technology</td>
<td>New materials and supply chain changes</td>
</tr>
<tr>
<td>Reliability</td>
<td>No heat, similar to PMR</td>
<td>Heat dramatically degrades reliability</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Plug and Play</td>
<td>Host SW changes to manage wear leveling</td>
</tr>
<tr>
<td>Ready</td>
<td>Production in 2019</td>
<td>Unknown - cost &amp; reliability challenges</td>
</tr>
<tr>
<td>Manufacturability</td>
<td>Approaches PMR</td>
<td>Significantly higher than PMR</td>
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Delivering Next-Generation Technology
MAMR will be in production in CY19

- CY17: First MAMR HDD engineering samples for key customers
- CY18: First MAMR HDD engineering samples for key customers
- CY19: First production-level HDD using MAMR
- CY20: Formal MAMR technology announcement declaring that MAMR is our recording technology for the foreseeable future
Solid State Storage

[Diagram showing various storage technologies and their performance metrics.]

- ReRAM, XPoint, and STT MRAM promise to become less expensive than DRAM with similar performance.
- SRAM-style embedded MRAM could displace some SRAM cache.
- Some forms of ReRAM have been expected to eventually become cheaper than NAND flash.
Solid State Storage

- FeRAM (Toshiba 2009)
- MRAM (Motorola/Everspin 2009)
- RRAM (HP 2009)
- PCRAM (Samsung 2008)
- 3D XPoint (Intel 2017)
Solid State Storage Novelties

- Everspin 1GB MRAM NVMe SSD
- Open Channel SSD
- Seagate demo: NAND-Flash + MRAM
- IBM Flashsystem 9100

Everspin STT-MRAM benefits realized in IBM’s FlashCoreModule™
Exotic Storage Technologies

DNA

Racetrack

Nitrogen in Diamond

STORAGE LIMITS
Estimates based on bacterial genetics suggest that digital DNA could one day rival or exceed today’s storage technology.

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<th>Hard disk</th>
<th>Flash memory</th>
<th>Bacterial DNA</th>
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<tbody>
<tr>
<td>Read–write speed (μs per bit)</td>
<td>~3,000–5,000</td>
<td>~100</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Data retention (years)</td>
<td>&gt;10</td>
<td>&gt;10</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Power usage (watts per gigabyte)</td>
<td>~0.04</td>
<td>~0.01–0.04</td>
<td>&lt;10^{-10}</td>
</tr>
<tr>
<td>Data density (bits per cm²)</td>
<td>~10^{13}</td>
<td>~10^{16}</td>
<td>~10^{10}</td>
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WEIGHT OF DNA NEEDED TO STORE WORLD’S DATA

~1 kg
"Software Defined Storage" Still Needs (and Sells) Smart Hardware
Thank you!

Questions?

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XENON Systems – Who We Are

Australian company established in 1996.

Global Onsite hardware support and installation services in over 80 countries

Direct Relationship with all major component manufacturers to lower cost and speed up support

Subsidiaries:

- Mediaproxy
  Global leader in compliance logging and transport stream monitoring for broadcast and TV industries.

- XDT/Catapult
  Software for film and post production industries.

- XENOptics
  Fibre automation solutions for SDN in data centres

In-house technical ability to build low volume custom designed servers

Focused on innovation and investment in Research & Development

- Defence
- Education
- Broadcast

- Scientific / Academic Research
- Oil and Gas
- Cloud

- Finance
- Telecommunication