Data Storage and HAMR

Seagate Technology

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Overview

- Storage Business and Hard Drives
- Magnetic Recording Head Technology
- HAMR - The Future of Magnetic Recording
The Move Toward Mobility Is Shifting the Location of Data

In 2010, **62%** of the storage was shipped into the client market.

- **400 exabytes**
- **62%** shipped to **Consumer Electronics**
- **25%** shipped to **Client Compute**
- **25%** shipped to **Cloud Computing**
- **25%** shipped to **Tablets & Smartphones**

Location of Exabytes Shipped
The Move Toward Mobility Is Shifting the Location of Data

By 2020 that will dramatically shift to the cloud

Location of Exabytes Shipped

- Consumer Electronics
- Client Compute
- Cloud Computing
- Tablets & Smartphones

7 zettabytes

61% Consumer Electronics
31% Client Compute
25% Cloud Computing
62% Tablets & Smartphones
‘Connected’ Devices Drive Server Demand

~600 = 1 Server

~122 = 1 Server

and servers need storage
This Shift is *Highly Dependent* on Storage

The Market for Storage Devices

By 2020…

HDD: 1 billion units

and

SSDs: 200 million units
Higher areal density means more data on the same disk area. Areal density growth is critical for industry to keep up with the storage demand.
Seagate: Storage Leader

• Seagate is the world's leading provider of storage devices
  – Q1FY2013*: 58.1 million drives shipped; revenue of $3.7 billion

• Provides storage for enterprise, desktop, mobile computing, consumer electronics and retail markets
  – Builds hard disk, solid state hybrid and solid state drives
  – 41% overall market share
  – Broadest product offering in the industry—largest customer base

• Owns and vertically integrates critical technologies: heads and media

• Approximately 55,000** employees worldwide

* For first fiscal quarter ended September 28, 2012
** Includes interns and agency temps
Seagate Northern Ireland

- 1993 to current – 20 years contribution to Seagate’s vertical integrated manufacturing base.
- One of only 6 Recording Head Wafer Fabs in the world.
- 475,000 sq. ft., 87,000 sq ft cleanroom.
- 25% of world transducer T.A.M. supplied from Derry plant.
- 65% Seagate transducer volume, >500m wls (FY12).
- 40% of Seagate transducer development capacity.
- Notebook transducer product development responsibility. (supporting Science Park & Seagate Korea)
- Product Engineering Lead site for Seagate.
- 1330 employees.
  - 57 PhD, 75 Masters, 354 Degree level.
  - 55% employee base >10 years service.
Drive Component Overview

- **Wafer**: > 60,000 recording heads (UK)
- **Bar**: > 48 recording heads (Malaysia)
- **Slider**: = 1 recording head – >1.0M/day (Malaysia)
- **Head Gimbal Assembly (HGA)**: >100M/qtr (Thailand)
- **Head Stack Assembly (HSA)**: (Thailand)
- **Disk Drive**: > 30M/qtr (China)
- **Disk**: (Singapore)
Heat Assisted Magnetic Recording (HAMR)

Major Elements of HAMR HDD
- Optical Delivery
  - Every head needs a laser
  - Nanoplasmonic element
  - Waveguide
- Magnetic Field Source
- Magneto-Resistive Reader
- Media
  - Lubricant
  - Overcoat
  - Recording Layer
  - Heat Sink/Soft Underlayer
- Disk Substrate
- Mechanical Integration
- Servo
- Preamp
- Data Channel

Recording at or near Curie Temperature >450°C interface temperatures

Write Data by Lowering $K_u$ (temporarily raising Temperature)

High anisotropy media (recording layer)

Optical Delivery
- Every head needs a laser
- Nanoplasmonic element
- Waveguide

UK – > 500M heads per year

Magnetic Field Source

Magneto-Resistive Reader

Media
- Lubricant
- Overcoat
- Recording Layer
- Heat Sink/Soft Underlayer
- Disk Substrate

Mechanical Integration

Servo

Preamp

Data Channel
Heat-assisted magnetic recording by a near-field transducer with efficient optical energy transfer

**Wafer-scale integration of group III-V lasers on silicon using transfer printing of epitaxial layers**

John Justice*, Chris Bower², Matthew Meitl², Marcus B. Mooney³, Mark A. Gubbins³ and Brian Corbett*

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**Step 1:** Transfer semiconductor laser coupons from 4” GaAs to 8” ceramic or silicon wafer

**Step 2:** Use thin film processing to fabricate fully integrated laser on 8” ceramic or silicon wafer

**Step 3:** Etched facet process offers opportunity for fully wafer integrated laser.

**Step 4:** Massive parallel processing of on wafer lasers offers low cost and much higher throughput compared to current methods.

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Etched facet process offers opportunity for fully wafer integrated laser.

Massive parallel processing of on wafer lasers offers low cost and much higher throughput compared to current methods.
60TB HDDs possible with Next-Generation Storage Tech - Seagate.

It's increasingly rare for mechanical drives to make headlines, but Seagate is beating the PR drum over an advancement that promises to drastically increase the capacity of hard drives. The company has achieved a storage density of 1 terabit per square inch, about 55% more than today's 620 gigabits per square inch. More abstractly, Seagate says that's more bits per square inch than our Milky Way galaxy has stars, which astronomers estimate between 200 and 400 billion.

At 620Gb per square inch, current 3.5-inch HDDs peak at 3TB in capacity, while 2.5-inch drives max out at 750GB. The new tech will roughly double that to 6TB and 2TB when it arrives "later this decade" and it will lead to astronomical capacities of up to 60TB over the following 10 years. Seagate hit the milestone by using heat-assisted magnetic recording (HAMR), which the company hails as a next-generation successor to 2006's perpendicular magnetic recording (PMR).
ANSIN – Seagate/Queen’s Research Centre

- Seagate and Queen’s University Belfast co-funding collaborative research in a dedicated research lab at Queen’s - €11m investment.
  - Resource: Centre head (Prof. Robert Bowman), 3 Academics (part-time), 2 postdocs, 9 PhD students.
  - Technical projects on reader and writer technology as well as advanced HAMR head designs.
  - Seagate donated equipment: 3 x deposition systems, 2 x anneal ovens, 13 x Metrology tools
  - 450 m² laboratory

- Strategy
  - ANSIN collaboration with Seagate on technical topics
  - Seagate gains advanced material and design access

- Success to date
  - Start 12 people 2010 -> 30 people contracted for 2013
  - Seagate adoption of ANSIN advanced magnetic materials
  - 2 EU and 2 EPSRC funded projects
  - Joint projects with FEI and several N. Ireland companies
  - Seagate engagement in 2 EU funded projects.
Many areas of overlap exist between with recording head technology needs.
Conclusion

• Storage and Hard Drives will remain a key enabling technology.

• HAMR is the future of magnetic recording and Europe will be a key development and manufacturing base.

• Future recording head technology needs overlap with others in nanophotonics and integrated photonics.
Useful Links


