Current and Future Applications for Small Form Factor HDDs

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Director of Marketing

February 17, 2005
Fourth Era of HDD

1st era: Mainframe era
- 24”, 14”

2nd era: Minicomputer era
- 8”, 5.25”

3rd era: PC era
- 3.5”, 2.5”

4th era: Consumer era
- 3.5”, 2.5”, 1.8”, 1”

Source: Hitachi GST Estimate
The HDD evolution leads to acceptable Capacity, Price and Size for CE devices.

1956 RAMAC
- 5 Mbytes
- Fifty 24" disks, 1200 RPM
- 2000 bits/in²

48 years ago

2004

2.5” Mobile
- 80 GB 850 / 100 mW (idle/sleep)
- Two 2.5” disks, 5400 RPM
- 70 Gb/in²

Microdrive
- 4 GB 220mW / 43 mW (idle/standby)
- One 1” disk, 3600 RPM
- 56.5 Gb/in²

20 years ago

3380
- 1.2 GB >1000W
- Nine 14” disks, 3600 RPM
- 12 Mb/in²

25kg

1/1562 weight >3.3 capacity

16g

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New Applications for SFF HDDs

- Drive Miniaturization is enabling new handheld CE products

- Embedded Notebooks
- Personal Media Player
- Personal Audio (MP3) Players
- Removable Storage
- Ultraportable Notebooks
- Automotive Intelligence Systems / GPS
- Video Games
- Printers
- Desktop PC
- PVR/DVR
- Notebooks
- Mobile Phones
- PDAs
- Digital Video Cameras
- Digital Still Cameras
- Removable (CF)
- 3.5" Deskstar
- 2.5" Travelstar
- 1.8" Travelstar
- 1" Microdrive
- 2.5" Travelstar
- 3.5" Deskstar
Portable Consumer Digital Devices

Flash implementation in CE will continue to grow
HDD is an excellent choice for high capacity applications

<table>
<thead>
<tr>
<th>Storage Requirement</th>
</tr>
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<tbody>
<tr>
<td>32 MB</td>
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</tbody>
</table>

- MP3 player
- Handheld Game
- PDA
- Mobile phone
- Digital still camera
- Camcorders
- Video player
- With multi-functions
- Game Console
- Automotive
- MP3 jukebox
- Flash
- HDD

- MP3 player
- Handheld Game
- PDA
- Mobile phone
- Digital still camera
- Camcorders
- Video player
- With multi-functions
- Game Console
- Automotive
- MP3 jukebox
- Flash
- HDD
HDDs (1.0” and larger) have a sustainable capacity advantage over flash.
“Mikey”
- Smallest Microdrive
- Available in 2nd half of 2005
- Embedded version only:
  - PATA, CE-ATA, MMC-like
- 8 – 10 GB capacity
- Targeting small handheld products, including multimedia phones

“Slim”
- Smallest 1.8” hard drive
- Single disk and 2 disk versions
- 60 to 80 GB capacity
- Available in 2nd half of 2005
- Embedded version
  - PATA, CE-ATA (future)
- Targeting handheld audio and video products
Baby “Mikey” Features

- Reduced foot print (-20%) with 1” disk
  - Size 30mm x 40mm x 5mm
  - First size reduction of Microdrives in 5 years!
- Lighter weight
  - 2 grams lighter than current 4 GB drive
- Same 1.0” disk, higher capacity
  - 8 – 10 GB
- Low power electronics
  - Advanced semiconductor technology
  - Up to 40% less power than current 4GB drive
- Easy Integration with new embedded design
  - Supporting - IDE, CE-ATA, and ATA over MMC
  - ZIF connector
- Greater shock resistance
  - >100% improvement in operating shock
- Shipping in 2nd Half, 2005
1.8-inch Travelstar “Slim” Features

- **Reduced Size and Volume**
  - 54mm x 71mm x 5mm
  - 28% smaller by volume than current Hitachi 1.8” drive

- **Easy Integration with embedded design**
  - ZIF connector
  - Support for PATA and CE-ATA (future)

- **Single disk (5mm) and 2 disk (8mm) models**
  - 30 – 40 GB (single disk), 60 – 80 GB (two disk)

- **Greater shock robustness**
  - 10 – 20% improvement vs. to current Hitachi 1.8” drives

- **Low Power Electronics**
  - 10% - 20% reduction in power

- **Available in 2nd half 2005**
  - “Slim” 1.8-inch Travelstar®
  - 1.0-inch 4GB Microdrive®
  - 1.0-inch “Mikey,” the baby Microdrive®

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HDD Usage for Daily Life in the Near Future

10-20 HDDs per household in the near future

Automotive

- Car Navigation / Car Entertainment
- VRM (Vehicle Relationship Mgmt)
- Drive Data

Home

- Navigation system with music server
- Drive Data

PORTABLE

- Converged Device
- Mobile phone
- Mobile TV Camcorder
- PDA

Ubiquitous/Broadband Network

- Home Server
- Other iDVR appli.

1. Car Navigation / Car Entertainment
2. VRM (Vehicle Relationship Mgmt)
3. Drive Data
4. Home Server
5. Other iDVR appli.
6. Converged Device
7. Mobile phone
8. Mobile TV Camcorder
9. PDA
10. MP3 Player
11. DSC(SRL)
12. DVD/HDD Recorder
13. CATV
14. Web-TV
15. INTERNET

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Future Opportunity in Multimedia Phones

Small Microdrives ("Mikey") will be a key component for multimedia mobile phones.
Hitachi Commitment to CE

- “Mikey” and “Slim” hard disk drives represent major growth platforms for the coming years
  - Mikey delivers Microdrive capacity in a significantly smaller form factor
  - Slim delivers the world’s smallest 1.8” hard drive

- Hitachi is working with other industry leaders on a new interface standard, CE-ATA
  - Small hard drive interface standard optimized for use in CE devices
  - Collaborative effort with other hard drive makers, host companies, and silicon makers

- Hitachi has the most extensive product portfolio for Consumer Electronics OEMs, and is expanding production capacity to meet the market needs

- Hitachi has years of design and manufacturing experience with small hard drives, and is committed to deliver world class products
Thank You!
Consumer Electronics: Opportunities for Sub-2.5in. Hard Disk Drives

Will high demand continue or shift to flash?
Framing the Discussion on SFF HDDs

Product Dynamics
Competitive Positioning
Market Potential
# A Clear Dichotomy has Emerged

<table>
<thead>
<tr>
<th>High Capacity</th>
<th>Robust Mobility</th>
</tr>
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<tbody>
<tr>
<td><strong>$</strong></td>
<td><strong>$</strong></td>
</tr>
<tr>
<td><strong>Lowest $/GB</strong></td>
<td><strong>Highest $/GB</strong></td>
</tr>
<tr>
<td><strong>Form Factor</strong></td>
<td><strong>Form Factor</strong></td>
</tr>
<tr>
<td>3.5 inch</td>
<td>0.85 – 1.8 inch</td>
</tr>
<tr>
<td><strong>GB</strong></td>
<td><strong>GB</strong></td>
</tr>
<tr>
<td>40 – 500</td>
<td>2 – 60</td>
</tr>
<tr>
<td><strong>LxWxH</strong></td>
<td><strong>LxWxH</strong></td>
</tr>
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</table>
| 5.8” x 4.0” x 1.0” | 1.26”x0.94”x0.13”
| | 2.76”x2.13”x0.28” |
| **Power (Idle)** | **Power (Write)** |
| ~5.7 – 10 Watts | <1.0 to 1.4 Watts |
| **Shock** | **Shock** |
| NonOp 350G/225G | NonOp ~1500G |
| Operating ~55G | Op 1000G – 500G |

IDC
Analyze the Future
2.5” drives will grow aggressively with laptop PC growth and increased traction in desktop PC segment.

CE demand doubles from 20% of all units in 2005 to 40% in 2008.

CE market leads to highest growing demand for sub-2.5”.
Growing Importance of SFF HDDs

Revenue growth expected to mimic early adoption of 3.5” drives (i.e., revenue growing with units) as 2.5” and sub-2.5” combine for nearly 50% of the industry revenue by 2008.

Rapid decrease in 3.5” contribution to total industry revenue (85% in 2001 to 50% in 2008) highly related to enterprise-class drives.

Eventually current pricing dynamics will resume, even with smaller FF drives dominating the revenue contribution – balance supply/demand.
CE Market Opportunities for sub-2.5”

- **Compressed Audio Market**
  - Proven and high-growth
  - Apple’s flash iPod – new market or cannibalize existing
  - Converged devices – new market or cannibalize existing

- **Cell phones and Converged Devices**
  - Even small adoption rate yields significant growth
  - Applications driving *storage requirements still unclear*
  - Competition from flash significant – the capacity inflection point between HDD/Flash increases each year

- **Emerging opportunities**
  - Pocket storage applications
  - Digital cameras and camcorders
  - Automotive and telematics
<table>
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<tr>
<th>Flash Advantages</th>
<th>HDD Advantages</th>
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<tbody>
<tr>
<td>✓ Volume/GB</td>
<td>✓ Total Capacity</td>
</tr>
<tr>
<td>✓ Mass/GB</td>
<td>✓ $/GB</td>
</tr>
<tr>
<td>✓ Shock resistance</td>
<td>✓ Read/Write Speed</td>
</tr>
<tr>
<td>✓ Power Consumption</td>
<td>✓ No re-writing limits</td>
</tr>
</tbody>
</table>
$/GB – HDD pricing advantage is eroding

Flash vs 1.0” $/GB is 6:1 in 2004

Flash vs 1.0” $/GB is 3:1 in 2008

$/GB is not the sole criterion – capacity need and absolute cost

High capacity requirements are positive for HDDs
Context for Forecasting

Assumptions define the context of the forecast

**Examples** Favoring HDD Adoption:

1. Capacity requirements differentiate from flash
2. Applications like video streaming drive demand
3. Higher ASPs do not suppress adoption
4. Technology considerations:
   - ✓ Power consumption optimizations are sufficient
   - ✓ Shock resistance schemes are sufficient
5. Capabilities of 0.85” differentiate it from flash and 1.0”
Linear Growth with 3 Form Factors

Positive assumptions for 0.85” HDD
Assumes cell phone is key to 0.85” success
0.85” becomes second option for 1.0” markets
1.0” is second option for cell phone market
Modest adoption rate for HDDs in cell phones
Linear Growth with 2 Form Factors

Millions

HDD Units

2004 2005 2006 2007 2008 2009 2010

- Negative assumptions for 0.85” HDD
- Cost or capacity limitations yield to 1.0” HDD
- Demand for 0.85” rolls into 1.0” demand
- Maintain modest adoption rate for HDDs in cell phones
Exponential Growth - 2 Form Factors

Positive assumptions for applications that need HDDs

Positive assumptions for HDD technology and cost hurdles

Negative assumptions for Flash closing gaps with HDDs

High adoption rate for HDDs in cell phones
Exponential = Volume….but

![Graph showing exponential growth compared to linear growth. The graph illustrates that exponential growth far exceeds linear growth over time, highlighting the difference in growth rates.](image-url)
Final Thoughts

Future is bright for HDDs into many CE solutions – and has the potential to experience exponential growth

Profit not volume or share must be the industry focus

New technologies will be deployed as market requirements are defined – a critical step

- Storage requirements will dictate the appropriate storage medium

Most CE Designs integrating HDDs are for embedded HDDs – introducing various challenges and potential differences from the flash option – think through carefully

Glass media supply constraints cannot be allowed to damage CE opportunities for HDDs

Early growth led to insufficient manufacturing capacity - plans currently seem in line to meet near-term demand – maintain balance
Questions?

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