Long Term Archival Storage Using Holographic Data Storage

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Why Holographic Storage?

High capacity and performance
• Capacities from 300 GB to 1.6 TB
• Transfer rates to 120 MB/s
• Fast Replication (coming)

Unique formats possible because don’t have to spin

Long archival life
• 50+ years
• No special handling required
• No media wear issues

Robust content protection & security
• Write once archival media
• Drive & media security options

Random access to data
• Millisecond access; no need to restore data

Excellent Total Cost of Ownership (TCO)
• Low cost media
• Reduced migration frequency
## Competing Archive Technologies

<table>
<thead>
<tr>
<th>Tape</th>
<th>Hard Drives</th>
<th>CD/DVD</th>
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<tbody>
<tr>
<td><strong>Pros</strong></td>
<td><strong>Cons</strong></td>
<td><strong>Pros</strong></td>
</tr>
<tr>
<td>• High Capacity</td>
<td>• Media Reliability</td>
<td>• Good Media Archive Life</td>
</tr>
<tr>
<td>• High Transfer Rate</td>
<td>• High Capacity</td>
<td>• Low Cost/GB for device</td>
</tr>
<tr>
<td>• Low Cost Media</td>
<td>• Maintenance $</td>
<td>• Easy to use</td>
</tr>
<tr>
<td></td>
<td>• Slow Data Access</td>
<td>• Device Life</td>
</tr>
<tr>
<td></td>
<td>• Not True WORM</td>
<td>• 3-5 yrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not Archival Format</td>
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</table>

### Holographic Benefits

<table>
<thead>
<tr>
<th><strong>Pros</strong></th>
<th><strong>Cons</strong></th>
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<tbody>
<tr>
<td>• High Capacity = 300 to 1.6TB on a single disk</td>
<td>• New Technology</td>
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<tr>
<td>• Long Media Archive life = +50yrs (7 yrs. for tape &amp; hard drives)</td>
<td>• WORM only format at Introduction</td>
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<tr>
<td>• Millisecond Random Access to data (minutes for tape)</td>
<td>• Slower transfer rate than magnetic</td>
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<tr>
<td>• True WORM Format Protects Archive Data</td>
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<tr>
<td>• Low $/GB media competitive against tape and existing optical</td>
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<tr>
<td>• Highest Optical Transfer Rate</td>
<td></td>
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<td>• Low power requirements</td>
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</table>
Development Activities in HDS

United States
- Aprilis STK
- GE
- InPhase
  (IBM – not anymore)
- 3-4 Universities

Europe
- Bayer
- Thompson
- Datarius
- Fraunhofer Institute
- 3-4 Universities
- Few Small Companies

Korea
- Daewoo
- Samsung
- LG
- STK
- Many Universities
- Small Companies

India
- Moser Baer

Taiwan/China
- Singapore/
- Rest of Region
- ITRI
- DSI
- CMC
- Lite-on
- Many Universities

Japan
- Sony
- Panasonic
- Hitachi
- Maxell
- Alps
- Fujitsu
- NEC
- NTT
- Sharp
- Toshiba
- NHK
- Pioneer
- Pulstec
- Optware
- Daikin
- NEC
- Mitsubishi
- MKM
- Mitsui Chemical
- Konica Minolta
- Ashi Glass
- Memory-Tech
- Many Universities
Tapestry™ Product Roadmap

- **worm**
  - Gen 1: tapestry™ 300r, 300 GB @ 20 MB/sec
  - Gen 2: tapestry™ 800r, 800 GB @ 80 MB/sec
  - Gen 3: tapestry™ 1600r, 1.6 TB @ 120 MB/sec

- **rewritable**
  - Gen 1: tapestry™ 300rw, 300 GB @ 20 MB/sec
  - Gen 2: tapestry™ 800rw, 800 GB @ 80 MB/sec

- r-drive backward read compatible for 3 generations
- rw-drive backward read compatible with r-media
- 18 to 24 months between generations
tapestry™ 300r Drive

Capacity
- 300GB

Read/Write Performance
- transfer rate - 20MBps or 160 Mbps
- avg exposure per page- 1 millisecond
- avg seek time - 250 ms
- bit error rate (BER) \(< 10^{-18}\)
- 2GB buffer

Operational Characteristics
- looks like a drive letter
- drag and drop capabilities
- emulates MO WORM, LTO Tape
- interfaces:
  - SCSI Parallel 320
  - Fibre Channel
  - Gig-E, FTP