Developments in Media
“The Revival of Optical Storage”

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<table>
<thead>
<tr>
<th><strong>Alphabet Soup Definitions</strong></th>
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<tbody>
<tr>
<td>□ Disk  -&gt;  Magnetic Hard Disk Drive</td>
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<tr>
<td>□ Disc  -&gt;  Optical Storage Media</td>
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<tr>
<td>□ ODD   -&gt;  Optical Disc Drive</td>
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<tr>
<td>□ CD     -&gt;  Compact Disc</td>
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<td>□ DVD    -&gt;  Digital Versatile Disc</td>
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<tr>
<td>□ BD     -&gt;  Blu-ray Disc</td>
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<td>□ BDXL   -&gt;  Blu-ray Disc eXtra Large</td>
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<td>□ DOTS   -&gt;  Digital Optical Technology System</td>
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<td>□ WORM   -&gt;  Write Once, Read Many (true WORM)</td>
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<td>□ WORMED -&gt;  Write Once, Read Many, Eventually Delete</td>
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The first commercially available audio CD is **Billy Joel’s “52nd Street”** released in Japan on October 1st, 1982
- That’s almost 31 years ago

50 titles were also released on CD in those first early years including **Pink Floyd’s “Dark Side of the Moon”** in May of 1983

Still plays today on the latest devices supporting the newest formats
Research Emphasis on Extremely Long-term Data Preservation

- All Optical-based Technologies
  - 50 – 100 Yr. BDXL Media, *(100 & 128 GB)*
  - Next Gen Blu-ray, *(300 – 500 GB)*
  - Holographic Storage, *(1 – 12 TB)*
  - M-Disc – 1,000 year media, *(Blu-ray)*
    - DOTS – Digital Optical Technology System
    - Sapphire Hard Disc – 1M yrs
    - 5D Optical Nano-glass memory – 1M yrs
  - Quartz glass plate storage technology – 100M yrs

Hitachi areas of R&D
Optical Data Storage Benefits

- **Longevity**
  “Optical” recording has been used for over 10,000 years in human data recording history.

- **Compatibility**
  Since BD can be read on general purpose PCs with consumer devices, there is less possibility that media and data will be inaccessible due to obsolete devices.

- **Contactless**
  Since there is no contact with the media surface, there is less possibility of abrasion, scratch or other media wear.

- **Survivability**
  Only data stored on optical discs survived hurricane Katrina.
Optical Data Storage Benefit

☐ Beyond Speeds & Feeds – the Intangibles

- **Non-Magnetic**
  2 recording technologies are needed for a sound data preservation strategy, with magnetic recording being considered as one.

- **Ubiquitous**
  Several industries use optical devices which supports a mass volume industry and maintains compatibility. UHD?

- **Reliable**
  Since device and media are separated, reliability and replacement of devices doesn’t affect the reliability of media.

- **Green**
  Almost no electricity nor special environmental condition is needed to store media for a long time.
Not All Optical Media are Created Equal

- **Low-to-High – LTH low cost, organic dye based**
  - Dye Change Recording
    - **NOT FOR LONG TERM ARCHIVING!**
  - Gives Optical technology a bad name

- **High-to-Low – Normal Blu-ray characteristic**
  - Phase Change Recording using an in-organometallic compound
  - Basis for long-term optical archiving

- **True WORM Media not WORMED**
  - Hard concept to grasp
  - Other flaws

- **Zero-space race**

Long-term Data Preservation Strategies

☐ 321 == 3 copies, 2 sites and 1 other technology, *or visa versa*
☐ 322 == 3 copies, 2 sites and 2 technologies

☐ Several long-term data preservation strategists are coming to consensus that the 2 recoding technologies used today, hard disks and tape, are considered the same technology – magnetic
  ○ Similar vulnerabilities

☐ Long-term TCO is still a key goal
  ○ Life of the company
  ○ Life of the republic
  ○ Life that spans republics
Today, you can buy new standard drives that are compatible with media written over 30 years ago. This trend will continue due to markets for consumer and distribution driven volume.

#### Technology & Format Longevity – Mass Markets

- **Over 3 Active Decades**
- **Over 2 Active Decades**
- **Next Generation**

#### Capacity
- 5TB
- 2TB
- 200GB
- 50GB
- 1GB
- 0.5GB

#### Generation
- 1st Generation
- 2nd Generation
- 3rd Generation

#### Media Formats & Capacity
- **DVD**: 4.7GB, 8.5GB, 50GB
- **BD**: 50GB, 100GB, 200GB, 128GB, 256GB
- **BDXL**: 256GB, 200GB, 500GB, 400GB, 3.8TB
- **3.8TB BD**: Not to Scale

#### Historical Casualties
- **Laserdisc**
- **Magneto-optical**
- **Ultra Media Disc - UMD**
- **Ultra Density Optical - UDO**
- **HD DVD**

*Still exists, still supported*
Commercial optical storage is over 30 years old and still compatible today in modern mass produced equipment.

Attempting to break or elongate the migration cycle.

More R&D and investment is happening with optical storage technologies.

Enterprise archive media life in the 50, 100 to 1,000 year timeframe.

Different value proposition.

Careful, all media are not created equally.

Who here subscribes to the notion that magnetic recording with tape and disk, is the same technology?