HIGH DATA RATE
OPTICAL TAPE RECORDING

W.S. Oakley
LOTS TECHNOLOGY, Inc.

20 April 2001
NEED: SIGNIFICANTLY IMPROVED PERFORMANCE

- Data Rate, R/W (Faster)
- Time to Access Data (Less)
- Data Capacity (Greater)
- Life Cycle Costs (Lower)

- Standards
- Reliability
- Technology Stability
OPTICAL TAPE MEETS THE NEED

• **High Data Rates**  > 100 MB/sec.
  Multiple Parallel Bit Tracks & Fast Tape Speed
  (16 to 80 Bit Tracks; Write & Read @ 11.5 m/sec.)

• **High Data Capacity**  1 Terabyte per Cassette / Cartridge
  User Data, Native (Uncompressed)

• **Fast Data Access**  15 Sec. Avg. 1st Access Within 1 TB
  34 GB/sec., Due to High Data Density & Fast Tape
  (1.7 GigaBytes of Data per meter & 20 m/sec.)

• **High Reliability**  Non-Contact Recording
  No Head Wear, Very Low Media Wear

• **Low System Costs**
  Much Higher Capacity/Media Unit
  = Less Media, Smaller Robots, 90% Less Volume

• **Media Archival**  Now > 100 year
  Reusable Media Soon
LOTS Multi-beam Concept

532 nm Laser

Beamforming Hologram, 8xN Beams in 2D array

8xN Modulator Array

8xN Data Detectors

Focus & Track Servo

Focus & Track Servo

Objective Lens & Focus Track Actuator

8xN Simultaneous Bit Tracks per Group, & Multiple Groups Across Media Width

Moving Media

8xN Simultaneous Bit Tracks per Group, & Multiple Groups Across Media Width
BEAMFORMING HOLOGRAM

Single Collimated Beam Input, Multiple Collimated Outputs.

- All Beams Diffraction Limited
- Two Dimensional Array
- 8xN Beams, e.g for N = 4

Relative Beam Locations Fixed

All Beams In Same Focal Plane
Beam Forming Pattern

8 x 8 Array = 64 Beams

56.2 microns per group

2.5 microns

0.8 micron

7.125 degrees

8x8 Array @ 12.5 Mb/s. User Data Rate/bit Track (PPM 2,7) = 800 Mb/sec. for Group
Modulator Geometry
8 x 8 Array = 64 Beams

~ 2mm

HR Coating

Side View
Optical Modulation @ 12MHz provides PPM data at 16.7 Mbits/sec. per track, e.g. 64 tracks = 1069 Mbits/sec. ⇒ 800 Mbit/sec. User Data Rate (34% O.H.)
SYSTEM CONFIGURATION

- Track Group Selection by Periscope
- Tracking by Mirror Galvanometer

Non Contact Write & Read

Plan View

Optical Beams

Air Bearing
LOTS High Speed Tape Transport & Optical Servo System

- Provides Sub-Micron Tracking

Peak to Peak Tracking Error = ± 0.050 Microns
BASIC DRIVE FEATURES

25 - 100+ MB/sec. Data Rates
1 TeraByte User Capacity
600m of 13 Micron Thick Media
0.8 micron Track Spacing
PPM(2,7) encoding
20 m/sec. Access Tape Speed = 33.3 GB/sec.
No Head Wear & Essentially No Media Wear
Bi-Directional Serpentine Write/Read @ 11.5 m/sec.
~ 15,000 Bit Tracks across 12.7mm Media Width

DATA TRACK CONFIGURATIONS

16 data Tracks + Servo = 25 MB/s.
   x 800 Track Groups

or

64 data Tracks + Servo = 100 MB/s.
   x 200 Track Groups
### Media Parameters vs. Capacity

<table>
<thead>
<tr>
<th>‘3480’ or ‘DTF’</th>
<th>April 2001</th>
<th>Future</th>
<th>Access Rate GB/s.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media Thickness - microns</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Media Length - m</td>
<td>600</td>
<td>1100</td>
<td></td>
</tr>
<tr>
<td>Capacity, PPM(2,7) - TB</td>
<td>1.1</td>
<td>2.0</td>
<td>33*</td>
</tr>
<tr>
<td>Capacity, PWM - TB</td>
<td>1.75</td>
<td>3.2</td>
<td>53</td>
</tr>
<tr>
<td>Capacity, PRML - TB</td>
<td>2.5</td>
<td>4.5</td>
<td>80</td>
</tr>
<tr>
<td>Time to EOT @ 20 m/s - s</td>
<td>30</td>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

* 15 sec. Avg. to 1st Access in 1 TB, 10 sec. Avg. to Next Access in 1 TB
CURRENT PRODUCT STATUS

• Engineering Prototypes Operating
  Commercial Quality Recording
  Acceptable SNR & BER
  Reliable Tracking
  Satisfactory Wear Characteristics, Media & Drive
  Product Design in Progress

• NO Product Schedule Due to Funding Limitations