Using Track-Following Servos on Next Generation Tape Drives

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Fujitsu Limited

- Among the top five largest computer companies
  - Japan - Fujitsu Ltd
  - USA - Amdahl
  - Europe - ICL Group
- More than $37.7 billion in sales
- Employs 180,000 people
- Operations in over 100 countries
Linear Tape Recording Basics

Tape Movement

Recording Head

- Write Element
- Read Element
Needed Improvements in Tape Technology

- Greater media area
  - Thinner tape
- Higher bit density
  - Higher coercivity media
  - Improved modulation codes
  - "Predictive" signal decoding
- Higher track density
  - Servo Track-following
Track Density Comparison

Large Potential Capacity Growth Enabled by Increasing Track Density
Challenge to Increasing Track Density: Vertical Tape Movement

Recorded Track Below Read Head

Poor Data Recovery

- Write Element
- Read Element
Track-following Technology

- **Write Element**
- **Read Element**
- **Servo Element**

**Head Moves to Follow Servo Track**
3590 Magstar™

Fujitsu M8100
- 10GB Capacity
- 13.5 MB/sec

3 Redundant Servo Tracks

Magstar is a trademark of IBM
High Performance Tape Format

- Announced November '97
  - Formed by HP, IBM, and Seagate
- Open format specification
  - Compliance tested
- Evolutionary technical roadmap
  - Products available this year

More information:
- www.lto-technology.com
### Linear Tape Open

#### Ultrium Roadmap

<table>
<thead>
<tr>
<th>Generation</th>
<th>Capacity Native</th>
<th>Capacity Compressed*</th>
<th>Transfer Rate Native</th>
<th>Transfer Rate Compressed*</th>
<th>Recording Method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation 1</td>
<td>100GB</td>
<td>200GB</td>
<td>10-20MB/s</td>
<td>20-40MB/s</td>
<td>RLL 1, 7</td>
<td>MP</td>
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<tr>
<td>Generation 2</td>
<td>200GB</td>
<td>400GB</td>
<td>20-40MB/s</td>
<td>40-80MB/s</td>
<td>PRML</td>
<td>MP</td>
</tr>
<tr>
<td>Generation 3</td>
<td>400GB</td>
<td>800GB</td>
<td>40-80MB/s</td>
<td>80-160MB/s</td>
<td>PRML</td>
<td>MP</td>
</tr>
<tr>
<td>Generation 4</td>
<td>800GB</td>
<td>1.6TB</td>
<td>80-160MB/s</td>
<td>160-320MB/s</td>
<td>PRML</td>
<td>Thin Film</td>
</tr>
</tbody>
</table>

*Assumes 2:1 compression ratio
Linear Tape Open

Ultrium
- 384 tracks
- Time-base Servo
- Powerful ECC
- Dynamic Rewrite
- Cartridge Memory

2 Redundant Servo Tracks
SuperDLT

SDLT

- 100GB Capacity
- Revolutionary Technical Roadmap
  - Pivoting Optical Servo
  - PRML
  - Reflective-bonded Media
- ? Servo Redundancy
- More information:
  - www.dlttape.com
Choosing Next Generation Tape

Look for:

- Most tape area
  - Widest and longest tape

- Track-following Servo
  - Redundant servo sensors

- Evolutionary Technical Roadmap
  - Lower risk of reliability problems

- Multiple manufacturers
  - Ensure competitive pricing