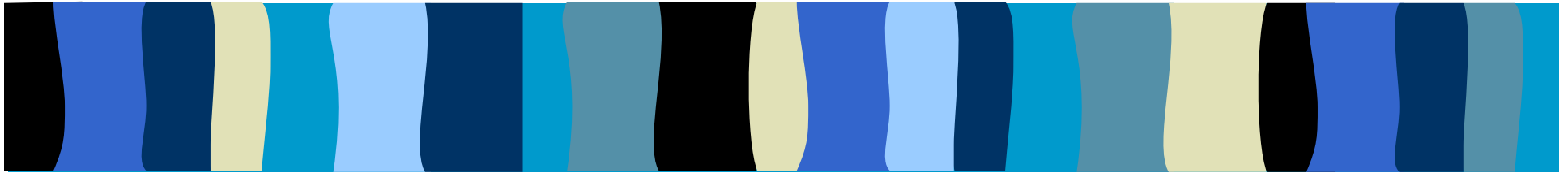


# TOWARDS IMPROVED TAPE STORAGE AND RETRIEVAL RESPONSE TIME



John Gnewek

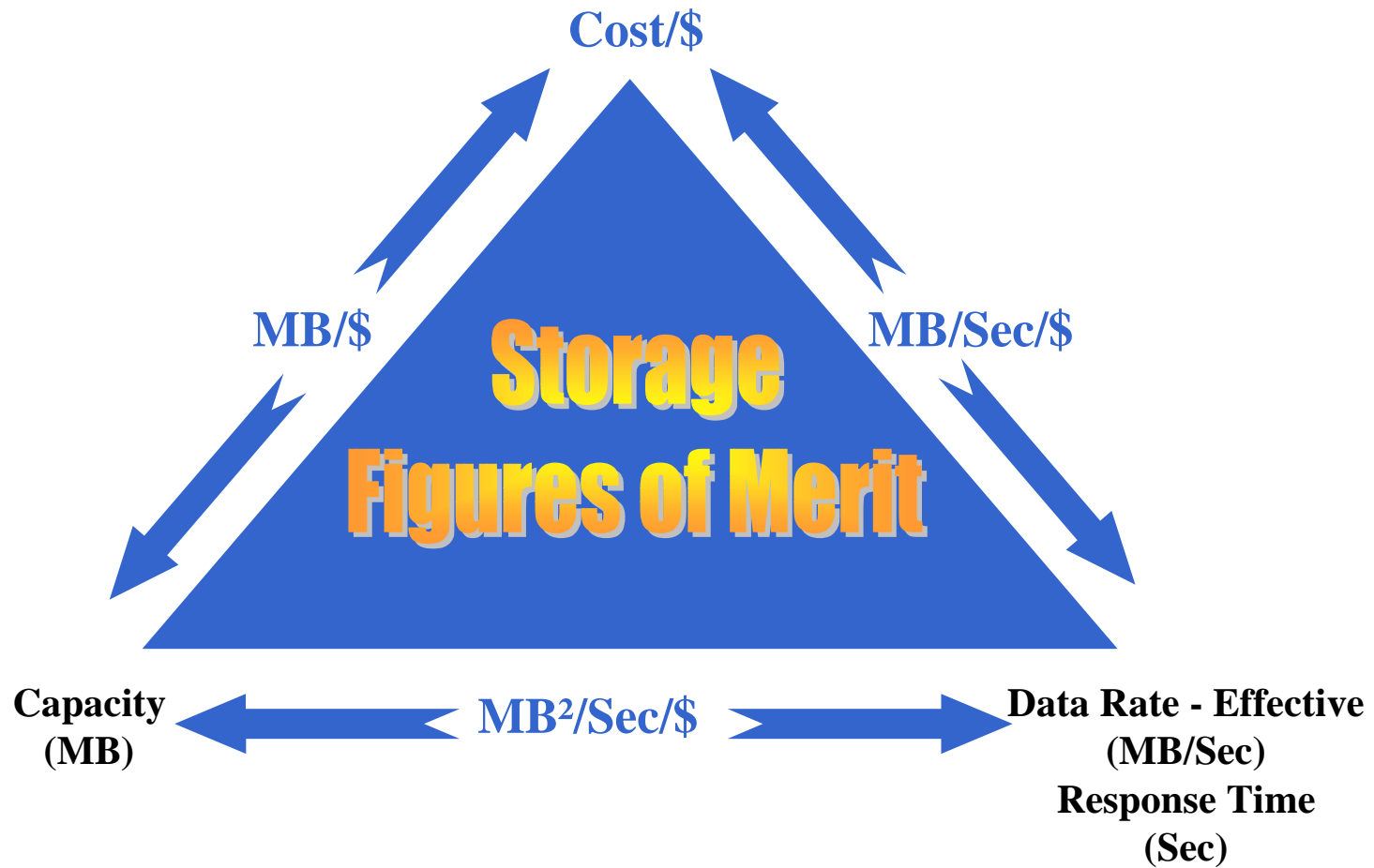


# RESPONSE TIME DESIGN FACTORS

- Mechanical
- Technology
- Cartridge Design
- Tape Format
- Data Organization
- Integrated Solutions

**INTEGRATED FIGURE OF MERIT**

# Storage Figures of Merit





# DEVELOP FIGURE OF MERIT “EFFECTIVE DATA RATE”

- Complete Cycle
- Clock Time
- Write or Read
- Write -- Sequential Appends
- Function of Object Size
- Application Dependent
- Values Total System
- Guides Development Priorities

# EFFECTIVE DATA RATE SEQUENCE OF OPERATIONS

## ■ Operation

- ✓ Cartridge Exchange
- ✓ Load
- ✓ Search
- ✓ Read
- ✓ Rewind
- ✓ Unload

## ■ Parameter

- ✓ AS
- ✓ LD
- ✓ C/2KV
- ✓ O/D
- ✓ C/2KV
- ✓ ULD

K=Recording density (MB/m)



# EQUATION:

$$EDR \equiv \frac{O}{\left[ AS + LD + \left( \frac{C}{K \bullet V} \right) + \frac{O}{D} + ULD \right]}$$

# HYPOTHETICAL DEVICE PARAMETERS

	A	B	C	D	E	F
AS SEC	8	8	8	8	8	8
LD SEC	20	<b>40</b>	5	10	15	<b>5</b>
ULD SEC	10	<b>15</b>	<b>5</b>	5	15	5
D MB/SEC	10	5	<b>2</b>	3	<b>12</b>	7
V M/SEC	5	4	10	<b>1</b>	4	<b>10</b>
K MB/M	<b>35</b>	60	35	80	<b>120</b>	35
C MB	10,000	40,000	<b>5,000</b>	20,000	<b>50,000</b>	5,000
DC \$	30,000	10,000	8,000	<b>8,000</b>	<b>80,000</b>	10,000
CC \$	<b>50</b>	<b>100</b>	50	50	100	50

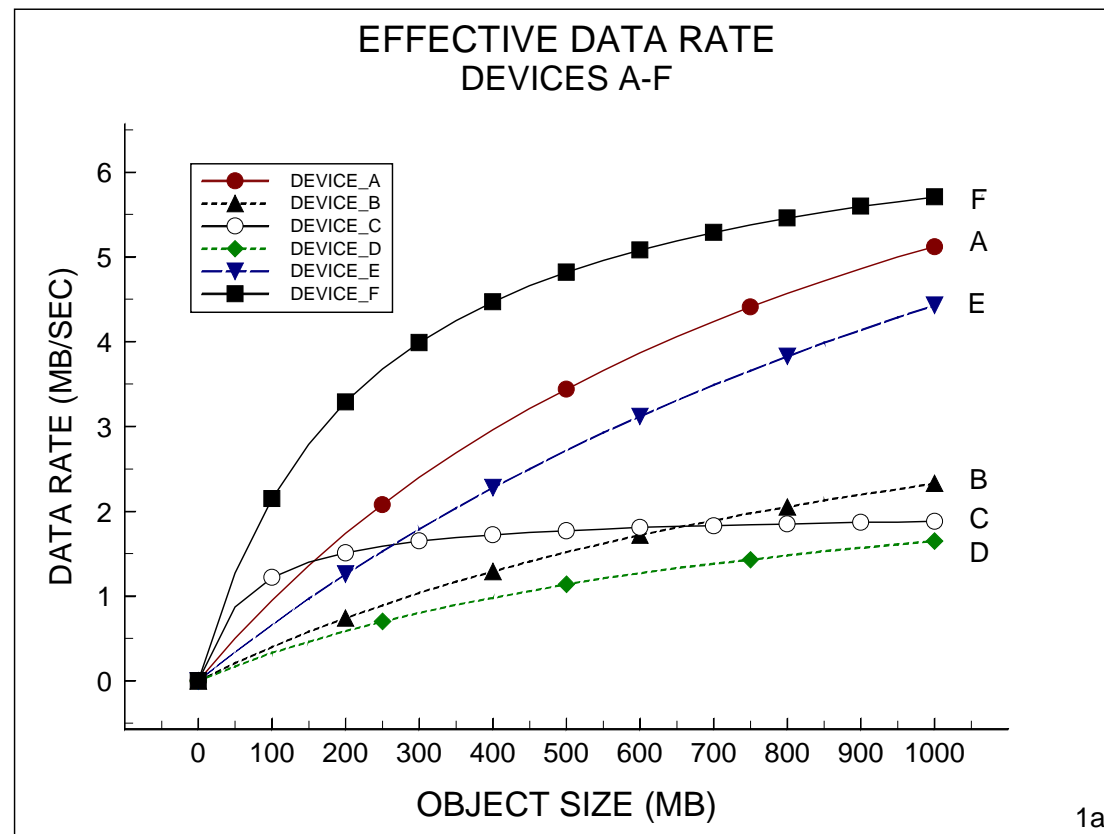


# FIGURES OF MERIT

- Effective Data Rate
  - Drive/Accessor Only -- No Cost
- Price-Performance Data Rate
  - Effective Data Rate + Drive Cost
- Storage FOM
  - Effective Data Rate With:
    - **Drive/Media/Automation Cost**
  - Input: + Aggregate Data Rate  
+ Library Capacity

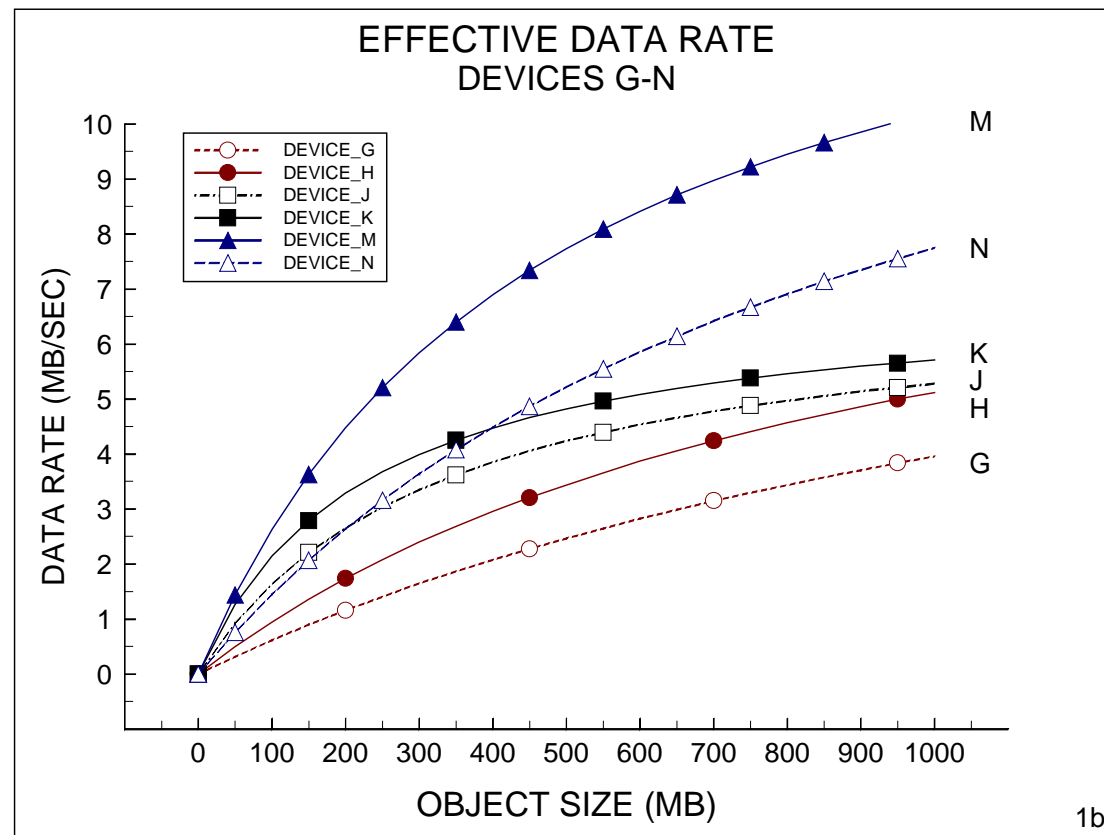


# EFFECTIVE DATA RATE DEVICES A-F

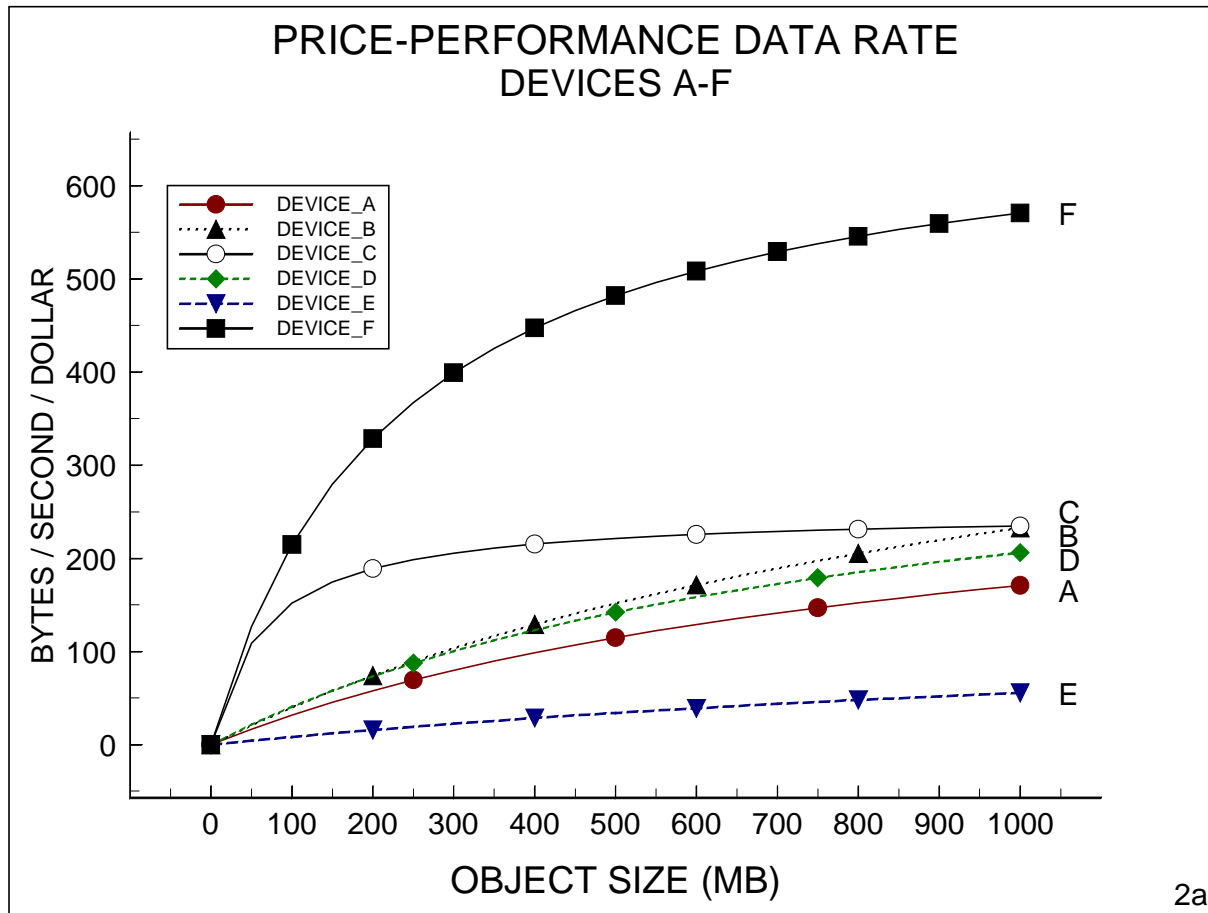


1a

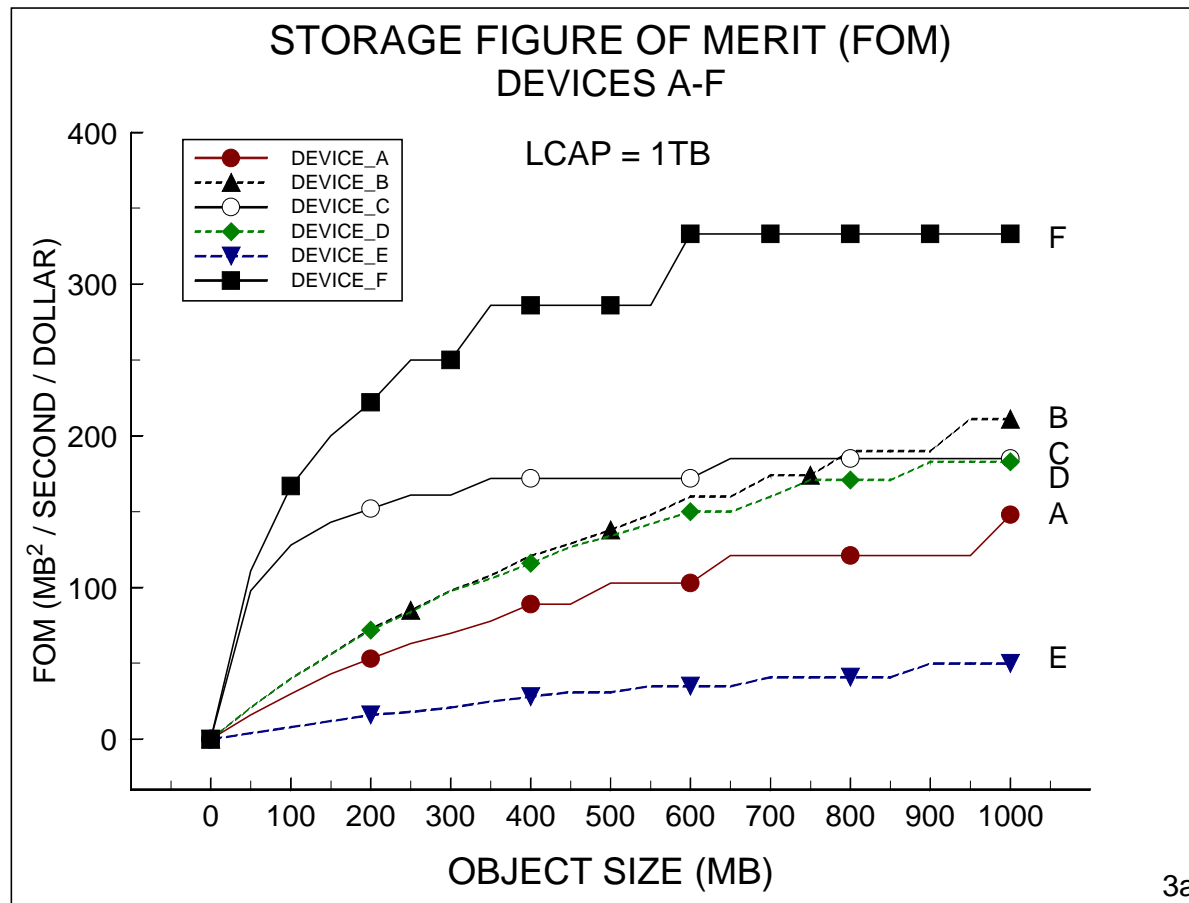
# EFFECTIVE DATA RATE DEVICES G-N



# PRICE PERFORMANCE DATA RATE DEVICES A-F

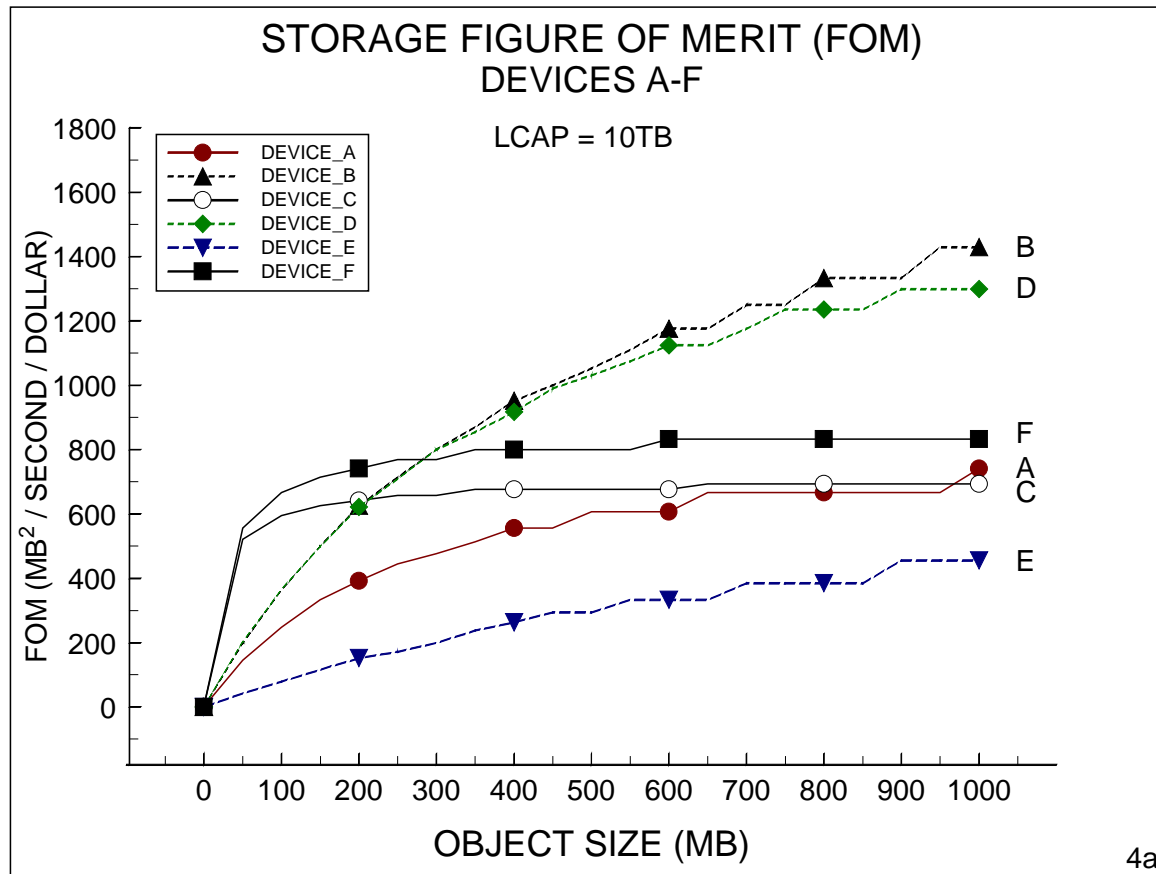


# STORAGE FIGURE OF MERIT (FOM) DEVICES A-F



3a

# STORAGE FIGURE OF MERIT (FOM) DEVICES A-F





# CARTRIDGE DESIGN

## AVERAGE SEARCH DISTANCE

### ■ Single Reel

- From Bot
  - $\frac{1}{2}$  Length
- Random Within
  - $\frac{1}{3}$  Length

### ■ Mid-Point 2 Reel

- From Bot
  - $\frac{1}{4}$  Length
- Random Within
  - $\frac{1}{3}$  Length



# DATA ORGANIZATION

## ■ Collocation

- Improved Read Response Time
- Fewer Cartridge Mounts Upon Retrieval
- More Cartridge Mounts During Write
- “Effective Data Rate” Metric Applies

## ■ Non-Sequential Retrieval

- Serpentine Longitudinal Tape Format
- Logical to Physical Mapping Intelligence
- Sequence Optimization (B. Hillyer)

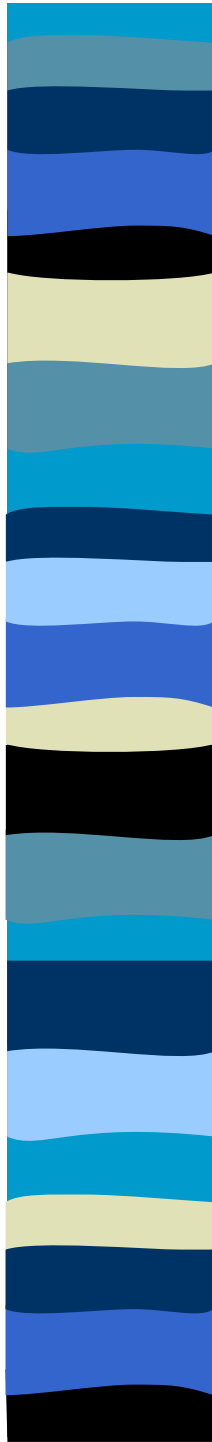


# TAPE FORMAT

- Serpentine Longitudinal
  - **Precise Track Following Servo**
  - **Precise Thin Film Write Width**
  - **No Overwritten Tracks**
- Logical - Physical Bot
- Independently Addressable Tape 'Wraps'
  - Multiple Logical Bot Possible



# SCHEMATIC OF TRACK LAYOUT FOR A TRACK-FOLLOWING SERVO



	Tape Tracks	
	Wraps	
→	41	8 →
→	39	6 →
→	37	4 →
→	35	2 →
→	33	0 →
←	32	1 ←
←	34	3 ←
←	36	5 ←
←	38	7 ←
←	40	9 ←

Precise Track Following -- No overwritten tracks -- 32 Sets of 4 Track Partitions



# ADDITIONAL FACTORS

- Data Reliability
- System Availability
- Footprint / Environmentals
- Total Cost of Ownership
  - Maintenance
  - Migration of Data
  - Modular Growth