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## **MAID for Archiving**

**Aloke Guha**

**COPAN Systems**

**1900 Pike Road, Longmont, CO 80501-6775, US**

**Phone:+01 303-532-0250 FAX: +01 303-532-0302**

**E-mail: aloke.guha@copansys.com**

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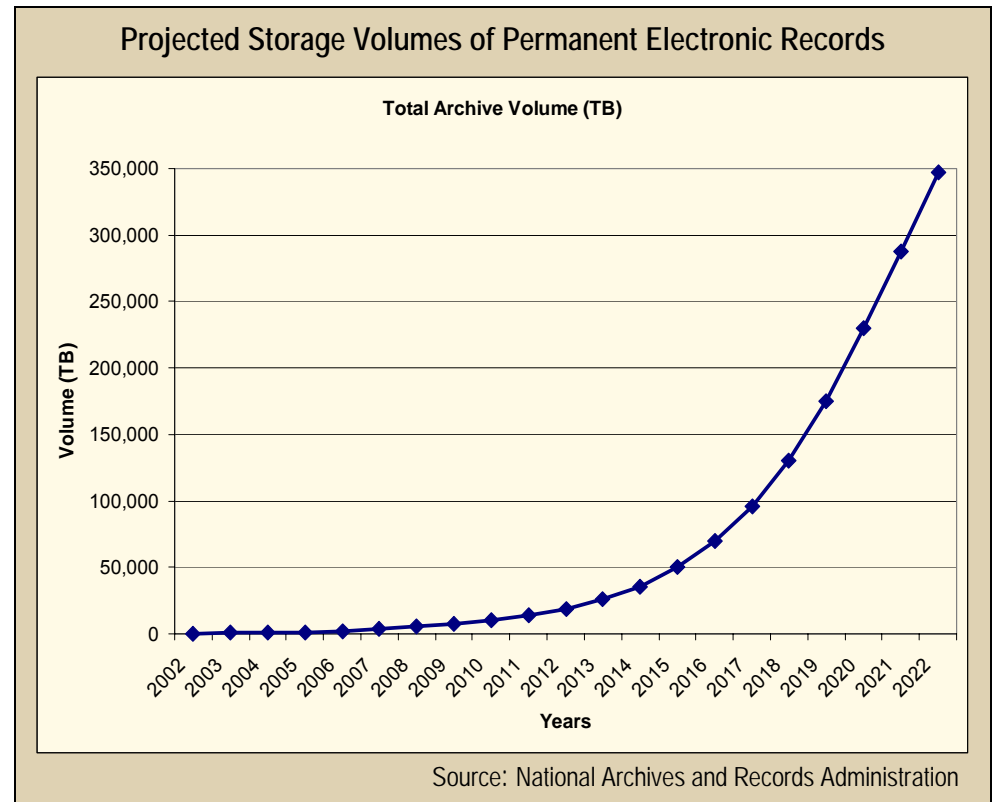
## Archive

- **Definition:** *An archive is a collection of data that is maintained as a long-term record of a business, an application, or an information state<sup>#</sup>*
- **Uses**
  - **Auditing, Regulatory, Analysis, Fixed Content, Reference Data**
- **Types**
  - **Active Archives:** frequent access to data, up to many times/day, many accesses to data within same data object
  - **Deep Archive:** long-term vaulted data that have very infrequent access, more tolerant of large latencies

<sup>#</sup>ILM Best Practices in Archiving and Tiered Storage for Email, SNIA Data Management Forum, Oct. 2004

# Archiving: More than Storage

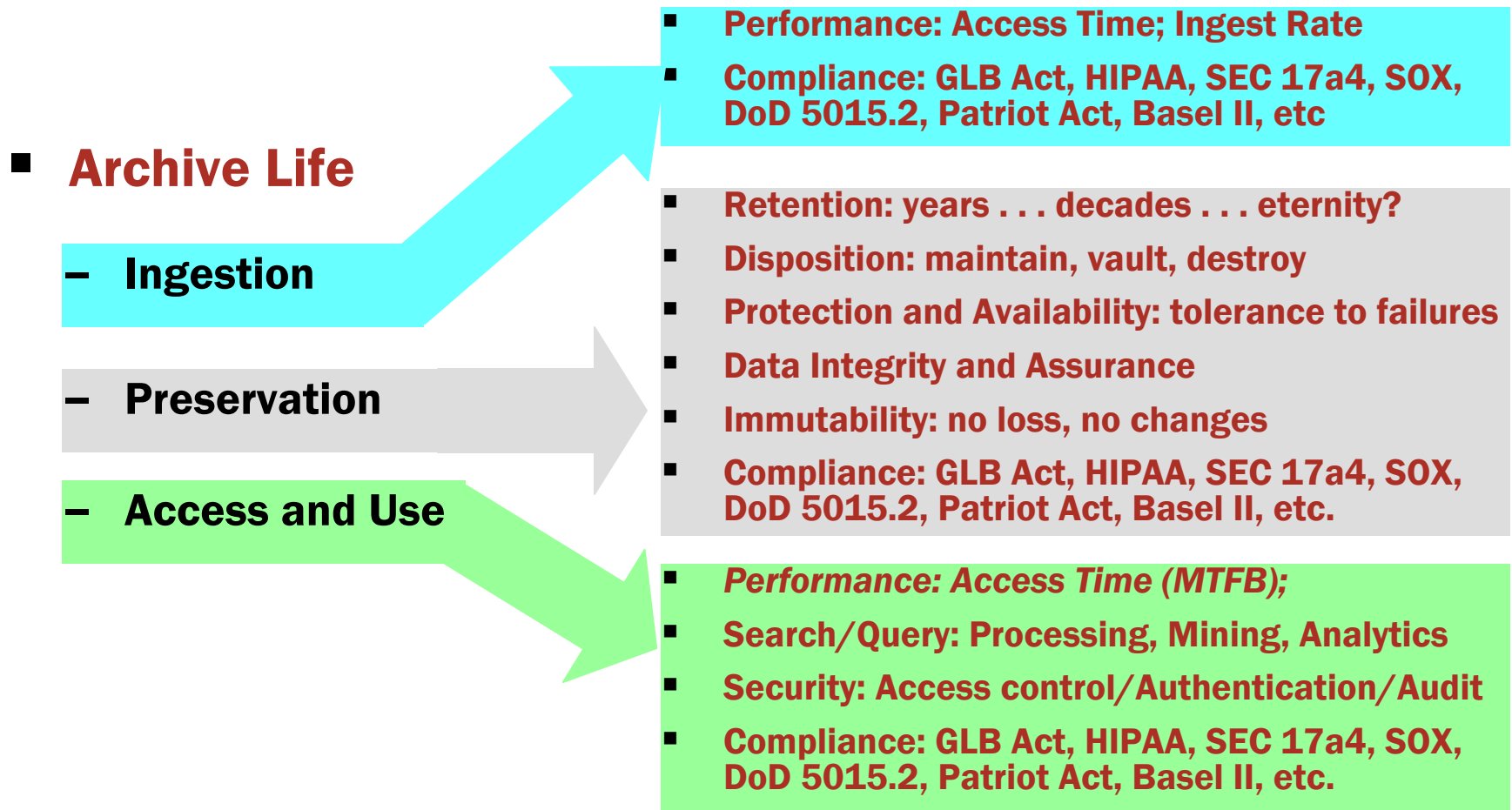
- **Archive Storage**
  - **Scale – growing capacity**
  - **Cost effective**
  
- **Archive Life . . . beyond storing bits**
  - **Ingestion – how data is entered**
  - **Preservation – maintenance and health of records<sup>#</sup>**
  - **Access and Use – how records are retrieved**



<sup>#</sup> K. Thibodeau, Building the Archives of the Future, Gartner PlanetStorage June 2005

<sup>#</sup> M. Smith, Eternal Bits, IEEE Spectrum, July 2005

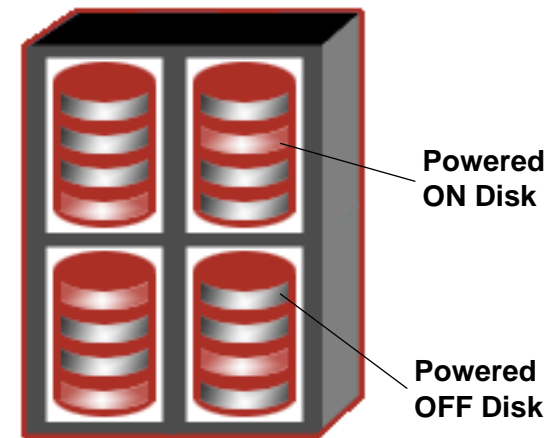
# Archiving: Attributes . . . More than Storage



*. . . and Cost-Effective and Scalable Storage*

## MAID: Power-Managed Storage System

- **Large # power-managed disks**
  - > 50% drives powered OFF
  - Power-cycling by policy
- **Scale, Cost, Service Life**
- **Lower System Cost/Drive**
  - 1/4 - 1/3 of typical RAID systems
  - Lower management cost
- **Extending MAID**
  - Performance and Scale
  - Reliability
  - Cost
- **Applicability**
  - Backup and Recovery
  - Long- Term Data: Archive



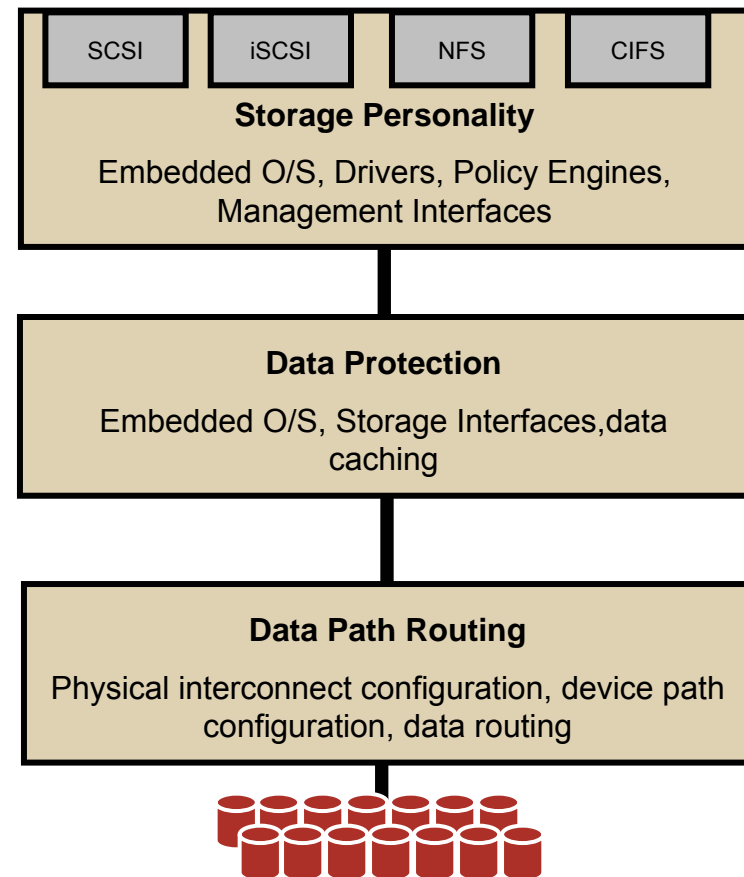
### SNIA Definition#

*“A storage system comprising an array of disk drives that are powered down individually or in groups when not required. MAID storage systems reduce the power consumed by a storage array.”*

# COPAN Architecture: 3-Tier MAID Architecture

*Three levels of processing separates functionality, simplifies management, scales performance w/ capacity*

- **Layer 2 – Storage Personality**
  - **Physical Domain (Revolution Controller)**
  - **Storage Network Protocols**
  - **Logical Volume/Block Management**
  - **Performance and Load Balancing**
  
- **Layer 1 – Data Protection**
  - **Physical Domain (Shelf Controller)**
  - **RAID Support and Caching**
  - **Power Management**
  - **Device Management**
  
- **Layer 0 – Data Path Routing**
  - **Physical Domain (Canister Controller)**
  - **Protocol Router**
  - **Monitoring of environmental parameter**



# Architecture: Tuned for Long-Term Data

Accessible, Retained and Protected

- **Architecture: 3-Tier MAID Architecture<sup>#</sup>**

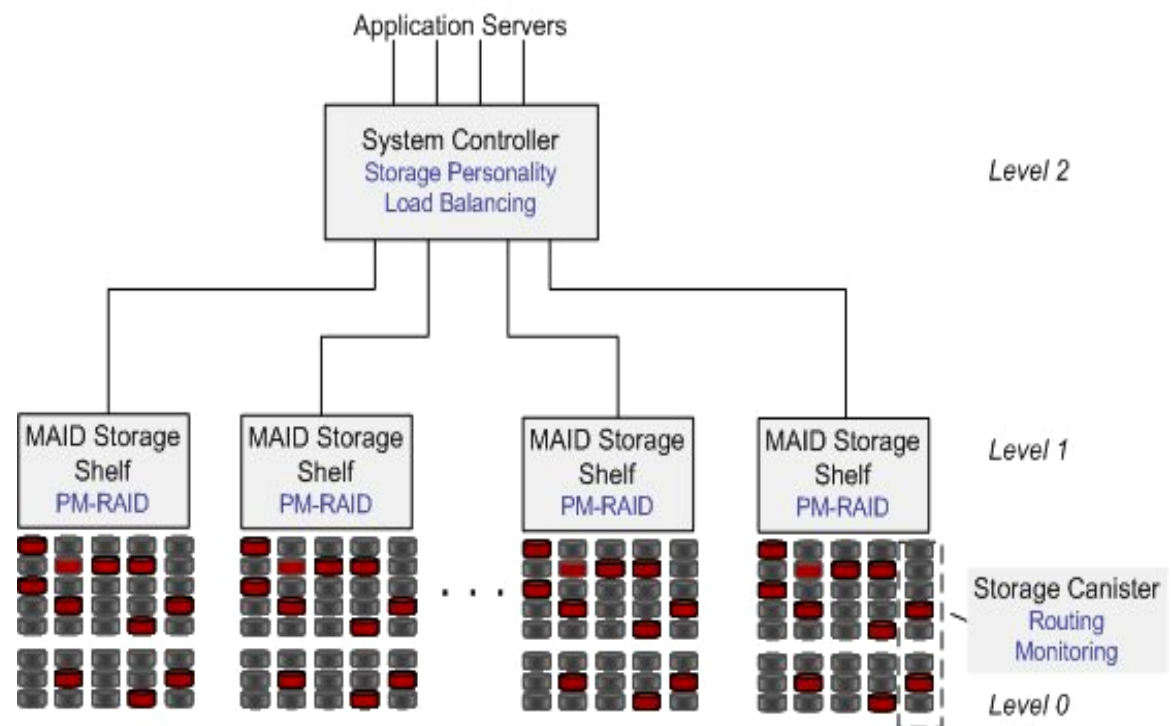
- Storage Density
- Scale
- Performance
- Serviceability
- Power/Cooling

- **Data Reliability**

- POWER MANAGED RAID™ Software

- **Data Retention**

- DISK AEROBICS™ Software



<sup>#</sup>A. Guha, A New Approach to Disk-Based Scalable Mass Storage System, IEEE Conf. Mass Storage Systems, April 2004

## COPAN's Revolution 200T

8 shelves/system  
8 canisters/shelf  
14 drives/canister

(896) 250 GB drives  
= **224 TB**  
**per system!**  
(uncompressed)

30"W x 48"D x 84"H  
(44U)

= 22TB/sq.ft.

4 –FC Connections

Performance

= 2.75TB / HR



### Three-Tier System Architecture

- Three levels of processing separate functionality
- Scale performance with capacity
- Simple management

### POWER MANAGED RAID™ Software

- RAID 5 data protection
- Drives spin only when necessary to meet application requirements
- <= 25% drives powered: extends service life

### DISK AEROBICS™ Software

- Predictive monitoring and management of drive health
- Periodically exercises and monitors non-powered on drives
- Proactively detecting possible drive failures before they occur

# MAID and Archiving

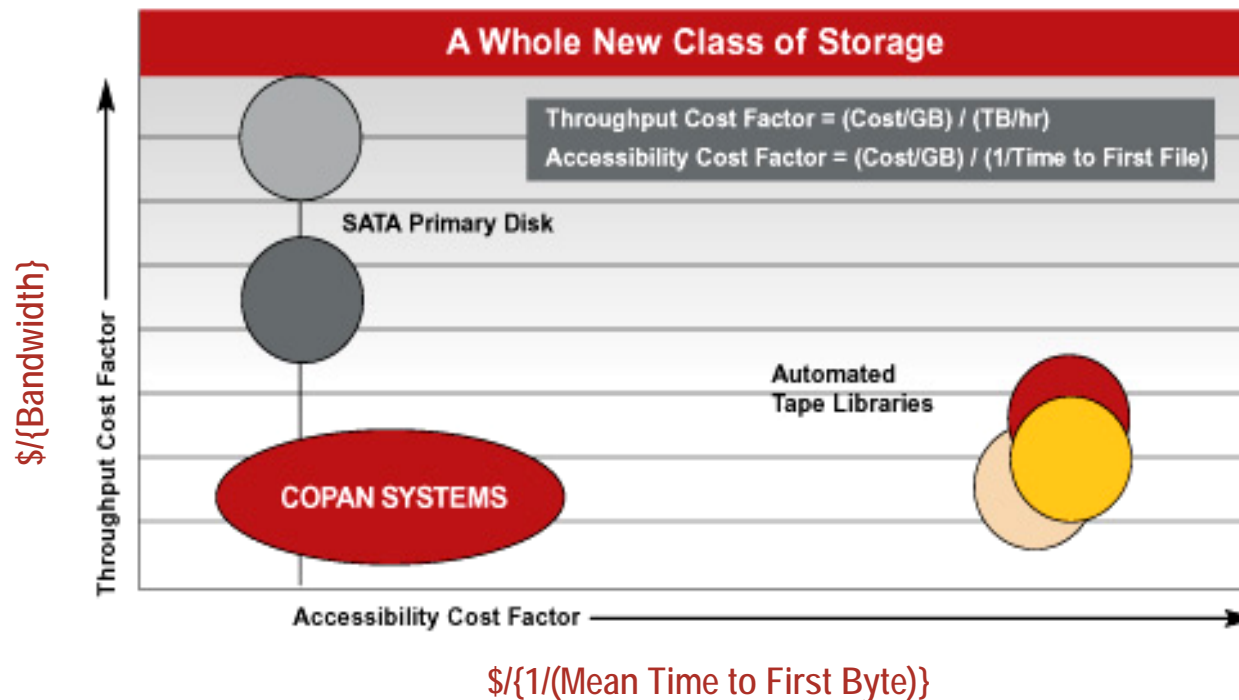
- **Scale and Capacity: Storage Density and Scale**
  - MAID Scale Optimized
  - Cost Optimized
- **Ingest: Data Transfer Rate, Latency**
  - Performance Tuned to Workload - Why "Burn" 100% drives for <25% Load
  - Process (Compliance): Logical Presentation - 3-Tier Architecture Control
- **Preservation**
  - Retention (Compliance): DISK AEROBICS™
  - Data and Storage Management
  - Data Integrity: DISK AEROBICS™ -- verify data within last 30 days
  - Cost-Effective Protected Data: POWER MANAGED RAID™
  - Immutability (Compliance): Read-Only – 3-Tier Architecture Control
- **Access and Use**
  - Performance: MTFB, Data Transfer Rate
  - Security: Access Control/Authent./Authorization – 3-Tier Architecture

## Storage Density and Scale

- **Storage density (drives/vol) driven by power duty-cycle (D)**
  - Density increases with decreasing temperature
  - Density increases with decreasing vibration
- **Interconnect options: # of drives vs. # of ports**
  - Cost of switching increases with # of ports per single switch
  - Multiple stages meets with cost and practical technology
- **Result**
  - 3-Tier interconnect: {#shelves s, #canisters c, #drive d/canister}
  - Optimization: {dim (s, c, d), Power/Cooling, Serviceability, Redundancy, Bandwidth, Processing/App Support} wrt Cost
  - 896 drives/cabinet: max 25% of user data online ( $D \leq 0.27$ )
    - 250 GB drives: 224 TB Uncompressed; 22.4 TB/sq ft
    - 500 GB drives: 448 TB Uncompressed; 44.8 TB/sq ft

## Ingest: Performance

- **Bandwidth: scales with multiple RAID engines**
  - Write rate/frame: 2.75 TB/hr (limited by # ports)
- **Access Time**
  - Average first time to access data on spin up: 0 (secs)
  - Subsequent (non-sequential) access to data: ~ 0 (ms)

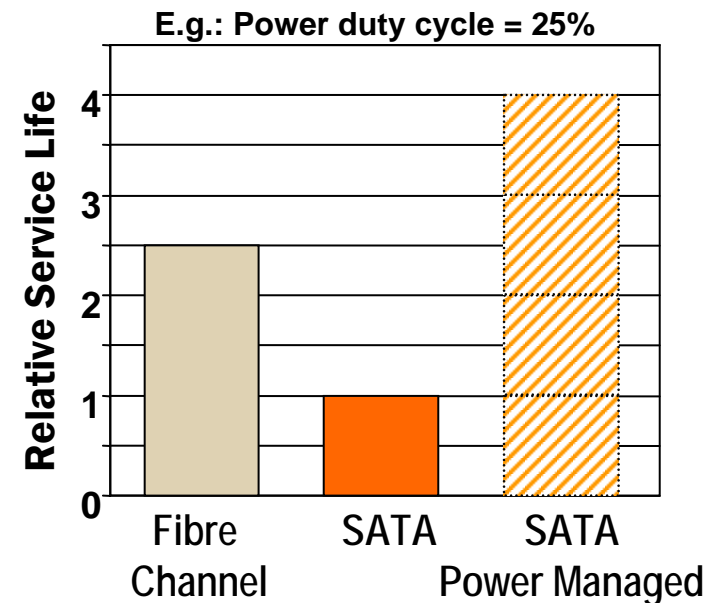


## Access and Use: Performance Close to Disk

- **Retrieve Rate**
  - Read rate/frame: 2.75 TB/hr (limited by # ports)
- **File Transaction Throughput**
  - Performance approaches that of standard disk
  - If locality/volume increases 100X => throughput increases 100X
- **Provides option of archive data processing not possible with tape**
  - Performance orders of magnitude higher than tape or tape+staging disk
  - Effectively on-line data for data mining, queries, etc.
- ***Most cost-effective solution for active archives!***

## COPAN MAID and Data Reliability

- **Effective drive service life**
  - Increases with decreasing duty ratio\*
- **Proactive monitoring: DISK AEROBICS™**
  - Proactive data recovery before drive failure
  - Rebuild data transparently
- **Increases data reliability**
- **Explicitly manage start stops**
  - ≤ 50K over service life
- **Exploit disk density for availability**
  - Spares to replenish failed drives
  - *Data Revitalization for long-term data*



**Revitalized Data + Drive Monitoring ⇒ Longer Data Retention**

# Disk and Data Reliability with MAID

## ■ Disk Reliability and Duty Cycle

- Decreasing POH: decreases annual failure rate (AFR), increases reliability
- Decreasing duty cycle: decreases AFR, increases reliability

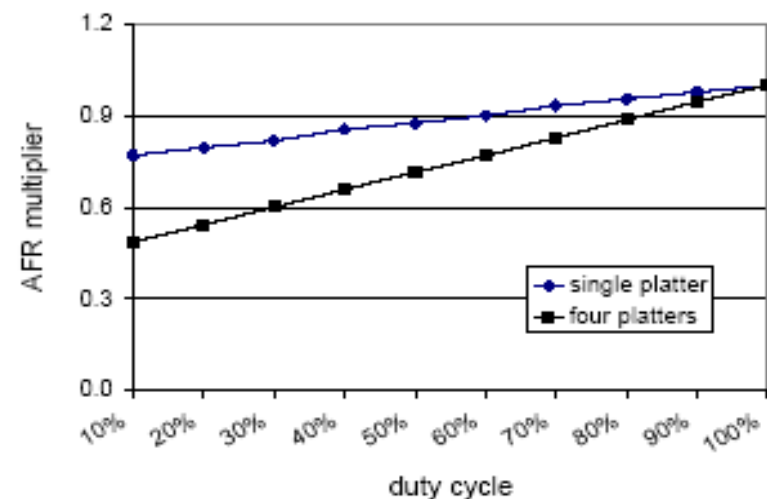
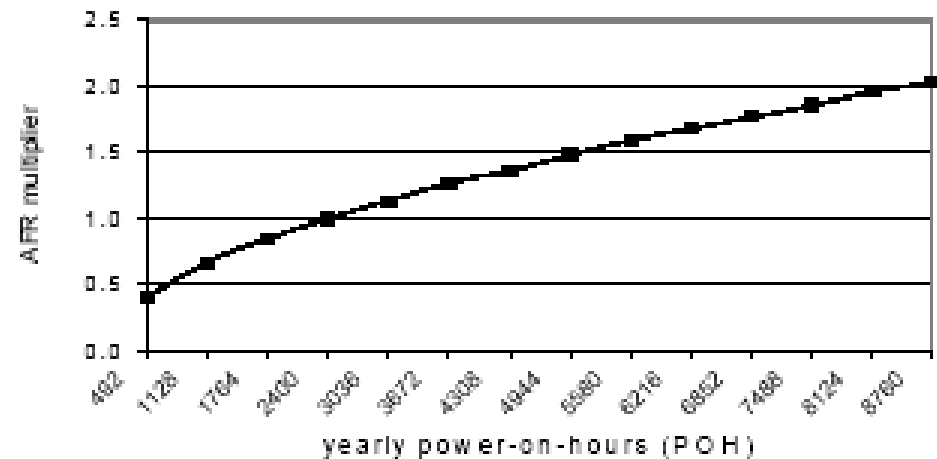
## ■ Archiving and Drive Reliability

- “Power-off archival storage stresses fewer spin motor bearing failure issues”

- “In disk drive archives, each drive should be periodically powered up in a MAID system, or mounted in a drive tester”

Hughes, Murray, “Reliability and Security of RAID Storage and D2D Archives Using SATA Disk Drives, ACM Trans. of Storage, Dec 2004

Anderson, et al, “More than an Interface: SCSI vs ATA”, 2nd Annual Conf. on File and Storage Tec, Mar 2003



## Conclusions

- **Archive needs go well beyond storing bits**
  - Ingest – Preserve – Access/Use
- **Tuned MAID Optimized for Archives**
  - Capacity Scale, Storage Density: MAID, 3-Tier Architecture
  - Ingest: Online Data Performance
  - Preservation: POWER MANAGED RAID™, DISK AEROBICS™, 3-Tier Architecture (Immutability)
  - Access/Use: Online Data Performance, 3-Tier Architecture (Data Processing)
- **Most Cost-Effective Solution of Active Archives!**



**Thank you**

<http://www.copansys.com>