
Grand Challenges in Mass Storage
"A System Integrator's Perspective"

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What are these Grand Challenges?

• Develop more Innovation in Approach
• Expand the I/O Barrier
• Achieve Increased Volumetric Efficiency & Incremental Cost Improvements
• Reinforce the "Weakest Link" - Software
• Implement Improved Architectures
• Minimize the Impact of "Self-Destructing" Technologies
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Our Definition of Mass Storage

• We Define Mass Storage as any Type of Storage System Exceeding 100 GBytes (0.1 TB) in Total Size (not off-line), Under the Control of a Centralized File Management Scheme

The Growing Importance of Systems Integrators

• Potential Systems Solutions are Becoming Increasingly Complex

• Open Systems Architectures Allow Multi-Vendor Solutions

• In-House Technical Staff are Tied Up Making the Current Technology Work on a Daily Basis

• In-House Technical Staff Members Have Difficulty Keeping Up with New and Alternative Technologies

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Today's High Performance Computing Environment

- A Hodge Podge of Many Different Types of CPU;
  - Vector
  - Scalar
  - Parallel & Massively Parallel
  - CISC
  - RISC
  - Visualization Engines

Today's High Performance Computing Environment (cont'd)

- Interconnection by Elaborate Networking Schemes;
  - HyperChannel
  - FDDI/CDDI & ATM
  - HiPPI
  - Ethernet & Token Ring
  - Kluge
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*Today's High Performance Computing Environment (cont'd)*

- Volumes of Bitfile Data are Being Produced at Rates Beyond our Wildest Hallucinations
- Local and Network Disk, and Tape Systems are Overwhelmed
- Dedicated and Intricate Software Schemes Have Been Developed to Manage Data
- The Growing Impact of Scientific Visualization
- New Fiscal Realities

*How do we Develop More Innovation in Approach?*

- To "Innovate" Requires Abandonment of Many Practices of the Past
  *"New Challenges Require New Thinking"*
- CPU Price/Performance Capabilities have become a "Double edged sword"
  *"Desktop Supercomputers with PC I/O Ports"*
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How do we Develop More Innovation in Approach? (cont'd)

- Mass Storage Solutions Require a Coordinated Effort by all Facets of the Data Center
  "Plugging in the latest-greatest box and software buys only short term results"

- Cost Factors Drive the Most Effective Solutions Today
  "Doing more with less has spawned innovative thinking across the board"

**Expanding the Input/Output Barrier**

- I/O Capabilities Must Begin to Keep Pace With Processor Speed
  Processor Power has increased 25% Per Year (CAGR), While I/O Rates Have Remained at .250 - 7 MB/s (with Few Exceptions) for Many Years.

- RAID, DASD-like devices, 19mm & 1/2" Helical Scan Tape, and Other New Storage Systems Cannot Achieve Their Potential w/o Solving the I/O Bottleneck.
  Operating System (O.S.) Software and Low-Bandwidth Peripheral Channels Must Undergo Significant Improvements to Meet the Challenges of the '90's
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*Expanding the Input/Output Barrier (cont'd)*

- HiPPI, FDDI, CDDI and ATM Offer Hope In Increasing the Bandwidth of Interconnecting Peripherals, But Do Not Solve the O.S. Software or I/O Channel Limitation Problems. 

*Direct Connection to High Bandwidth Internal Buses, and More Simplistic O.S. I/O Calls are Required.*

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**Achieving Volumetric Efficiency & Incremental Cost Improvements**

- Increasing Volumetric Efficiency of Storage Systems Reduces Operations and Transportation Costs Dramatically. 

*RAID, DASD-like Devices and Helical Scan Tape Provide Orders-of-Magnitude of More Storage Capacity per Square Foot With Increased Bandwidth Thrown in For Virtually No Cost!*

- DASD-like Devices and Helical Scan Tape Incrementally Reduce the $/MB of Capacity to a Fraction of More Traditional Devices, while also Providing More Capacity Per Unit Volume and Higher I/O Bandwidths. *Almost Like Having a "Free Lunch"*

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Reinforcing the "Weakest Link" - Software

- Hierarchical File Management Software Packages are Available From Many Manufacturers. All are Unique; Many are Proprietary; and Some Comply With Emerging Standards (IEEE MSRM 4.0, OSI, etc.)

**Those Developed by CPU Manufacturers Are The Most Mature (Cray, IBM, etc.)**

**Those Developed by Independents and Small Companies Offer the Most Features and Benefits (UniTree, EPOCH, E-Mass, etc.), but are also the Most Immature and Risky from a Business Perspective.**

Reinforcing the "Weakest Link" - Software (cont'd)

- The Newest IEEE Mass Storage Reference Model (Version 5.0) Potentially Provides the Means to Tame the Hierarchical File Management Software (FMS) Beast.

**Logical Layers and Task Partitioning Unbundles the Entire Package from one Provider. Key Segments Can be Provided from Developers with Specialized Expertise i.e. Security, PVR's, Bitfile Movers, etc.**

- Government Mandates (POSIX, GOSIP and OSI) Must be Tempered Against Established Practices and Protocols i.e. TCP/IP

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Implementing Improved/Advanced Hardware Architectures

- Dedicated File Server CPU's (Mainframe, Mini-Super, and Supercomputers) are Too Expensive and Inefficient to Solve Current and Future Mass Storage Requirements.

HiPPI, FDDI and ATM Fabrics Provide for Direct Interconnection of Source-to-Sink in Data Intensive Environments

- The "Redundant Array of Inexpensive/Independent Whatevers" Concept Can be Applied to Many Facets of the Data Center.
  e.g. Disk (RAID) and Tape (RAIT) Drives, Independent Computers (RAIC/Clustering), and Data Centers themselves (RAIR).

Minimizing the Impact of "Self-Destructing Technologies"

- Revolutionary Advances in Computer Technology have Produced a Nasty By-Product known as; "Self-Destructing Technology".

Pursuit of the latest, greatest technological solution for each new program has blinded many to the fact that a significant portion of the technology used in the last program has "self-destructed", while no one was paying attention.

- The Balance of Maturity in an Approach vs. Maintaining One's Technological Edge Produces Serious Conflicts in How to Proceed.
  i.e. Running the COTS Juggernaut

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Conclusions

• In Order to Survive into the Future, a New Order Must Emerge in the way we Develop and Manage Technology for Computing and Data Storage.


• Programs like EOSDIS will Force a New Paradigm on the Computer Marketplace. Manufacturers and Systems Integrators Should Not Ignore the Fate of the Dinosaur in Respect to Change.

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