

1992 NASA GSFC Conference on Mass Storage Systems and Technologies

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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Todays 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.

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.
- Systems Integrators Face Grand Challenges in Adapting Technology to Meet Their Customers' Wide Variety of Needs. ***Business as Usual Will Not Work.***
- 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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