



NAND Flash as a High Density Server Memory

David Flynn

The industry 20 years ago

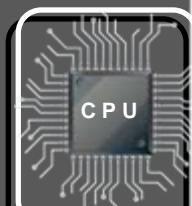


1987

Nanosecond (10E-9)

ACCESS DELAY IN TIME

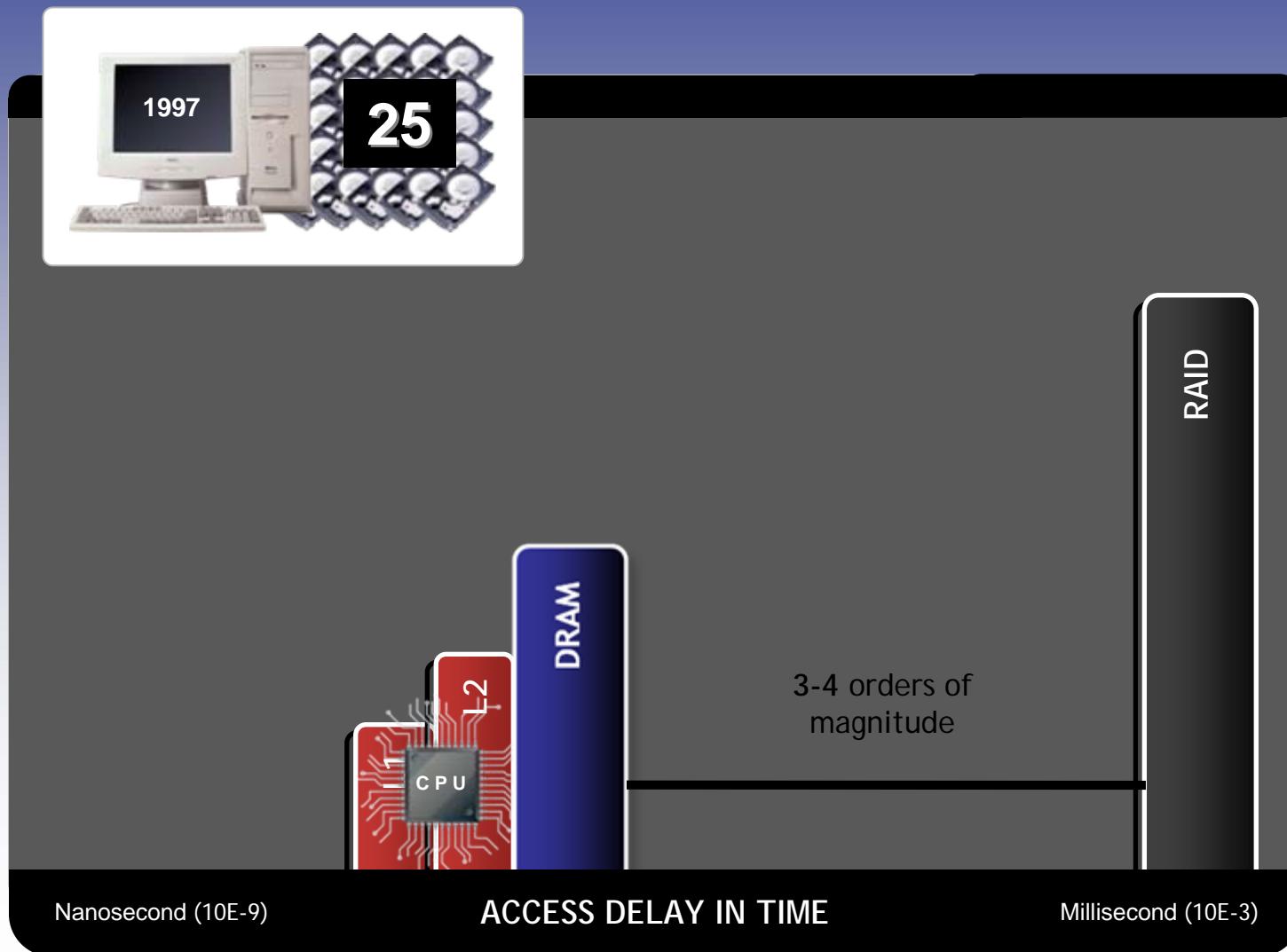
Millisecond (10E-3)



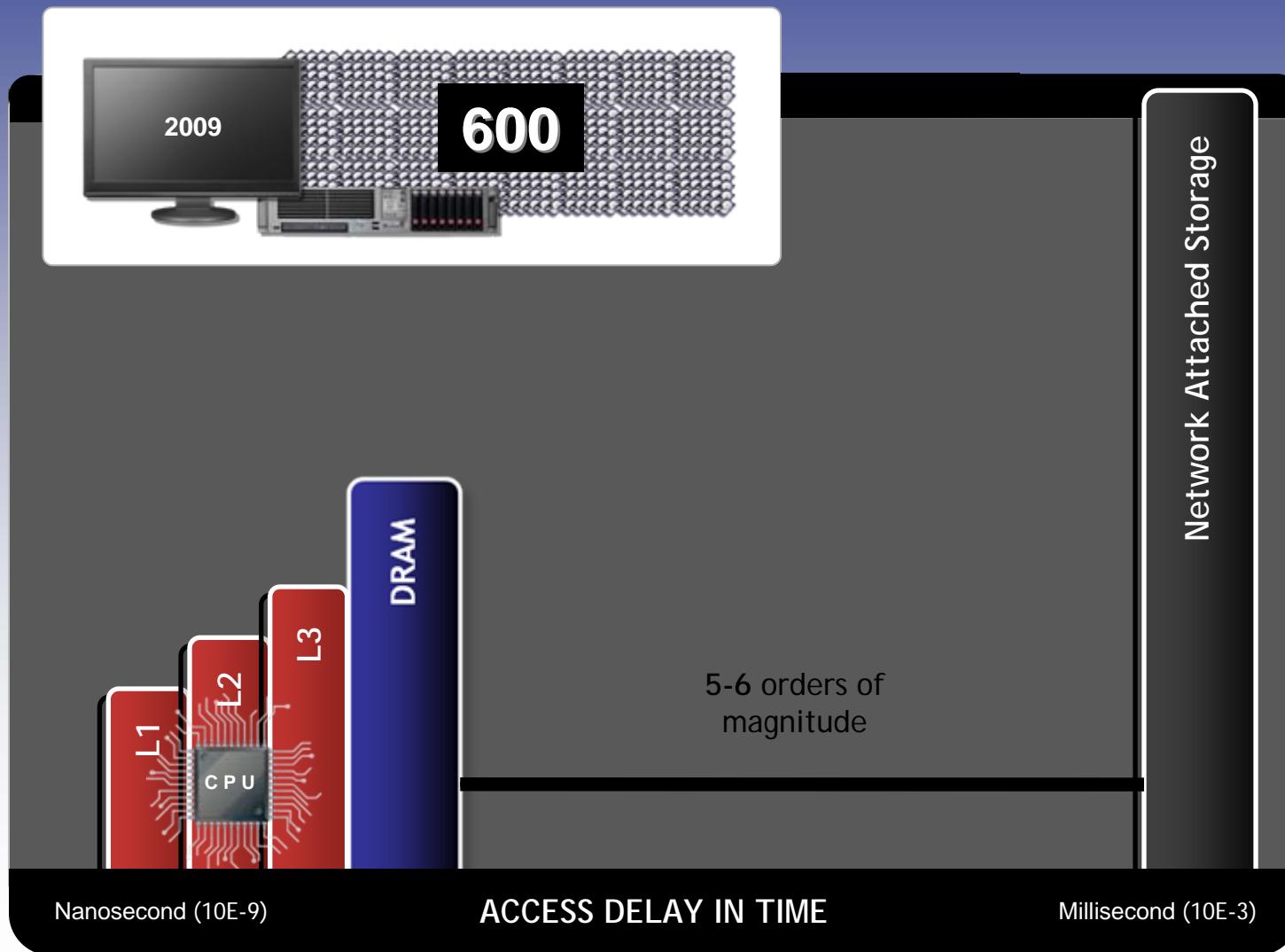
2-3 orders of magnitude

Disk Drive

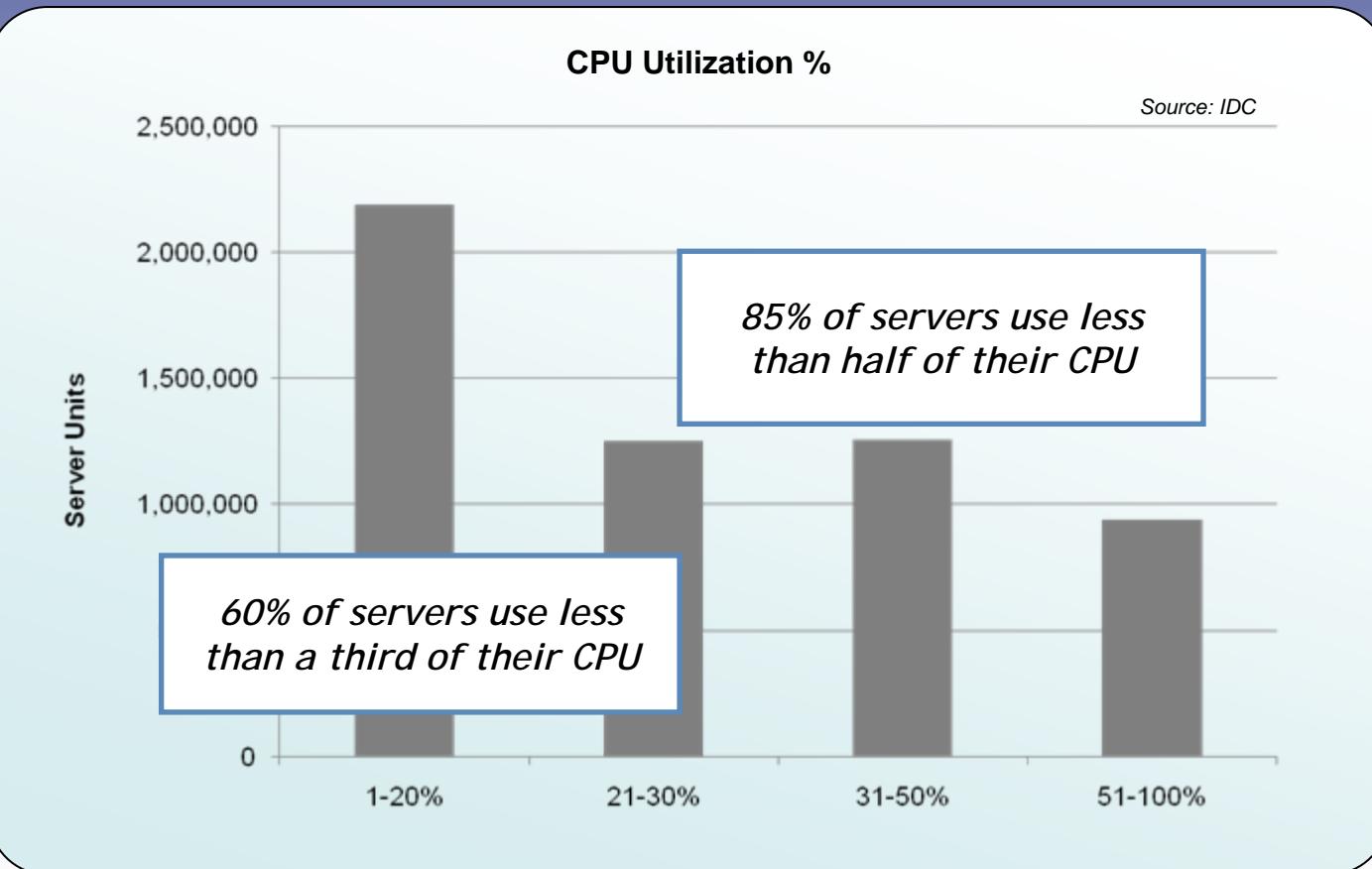
Where the industry went



Where the industry is today

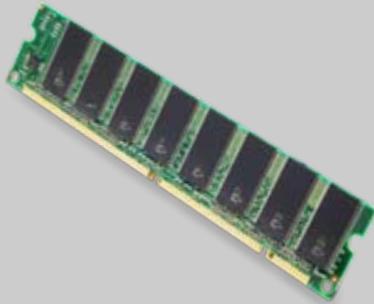


CPU Utilization



What's *really* Needed...

DRAM



Like

- Really fast
- Rarely fails

Don't Like

- Volatile
- Expensive
- Limited capacity

Disk



Like

- Non-volatile
- Cheap
- Large capacity

Don't Like

- Really slow
- Often fails

Need

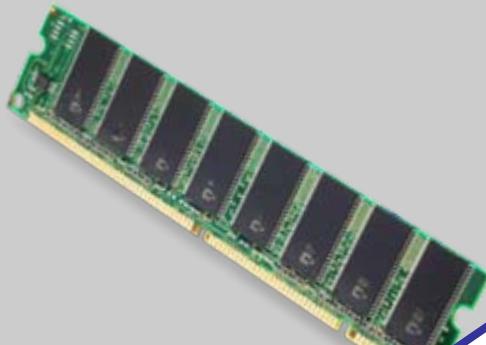


Want

- Non-volatile
- Really fast
- Large capacity
- Reasonable price
- Low energy
- Never fails

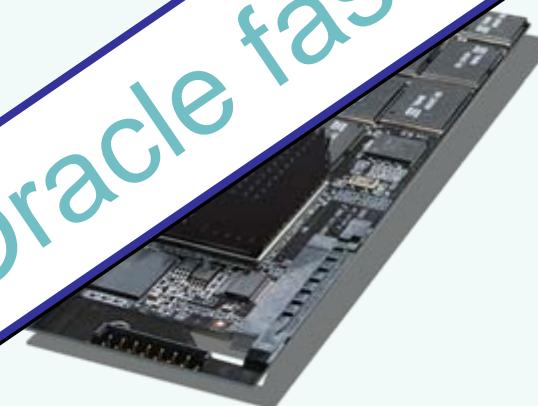
Compared to RAM

RAM



- 16 GB
- \$125 per GB
- 1.0 Watts per TB
- 39 bit & self healing

ioMemory



- 640 GB 40x
- \$25 per GB (list) 1/5th
- 10 Watts per TB 1/100th
- 39 bit & self healing
- Non-Volatile

ioMemory runs Oracle faster

ioMemory – Performs Better than DRAM

ioMemory

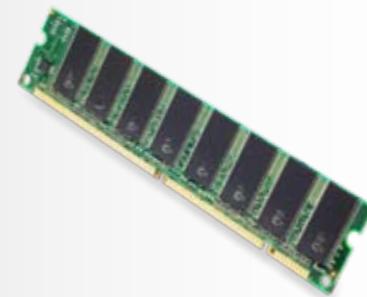
- Only moderate amounts of DRAM needed
- Enhances cache locality in CPU's L1, L2, L3 caches
- Non-volatile so it's usually indexed for speed of access
- Non-volatile so data is ready immediately
- ioMemory runs at full memory bandwidth
 - Data only goes across memory bus once (supplied from PCIe)
 - Does not waste CPU to move data (uses DMA engine)



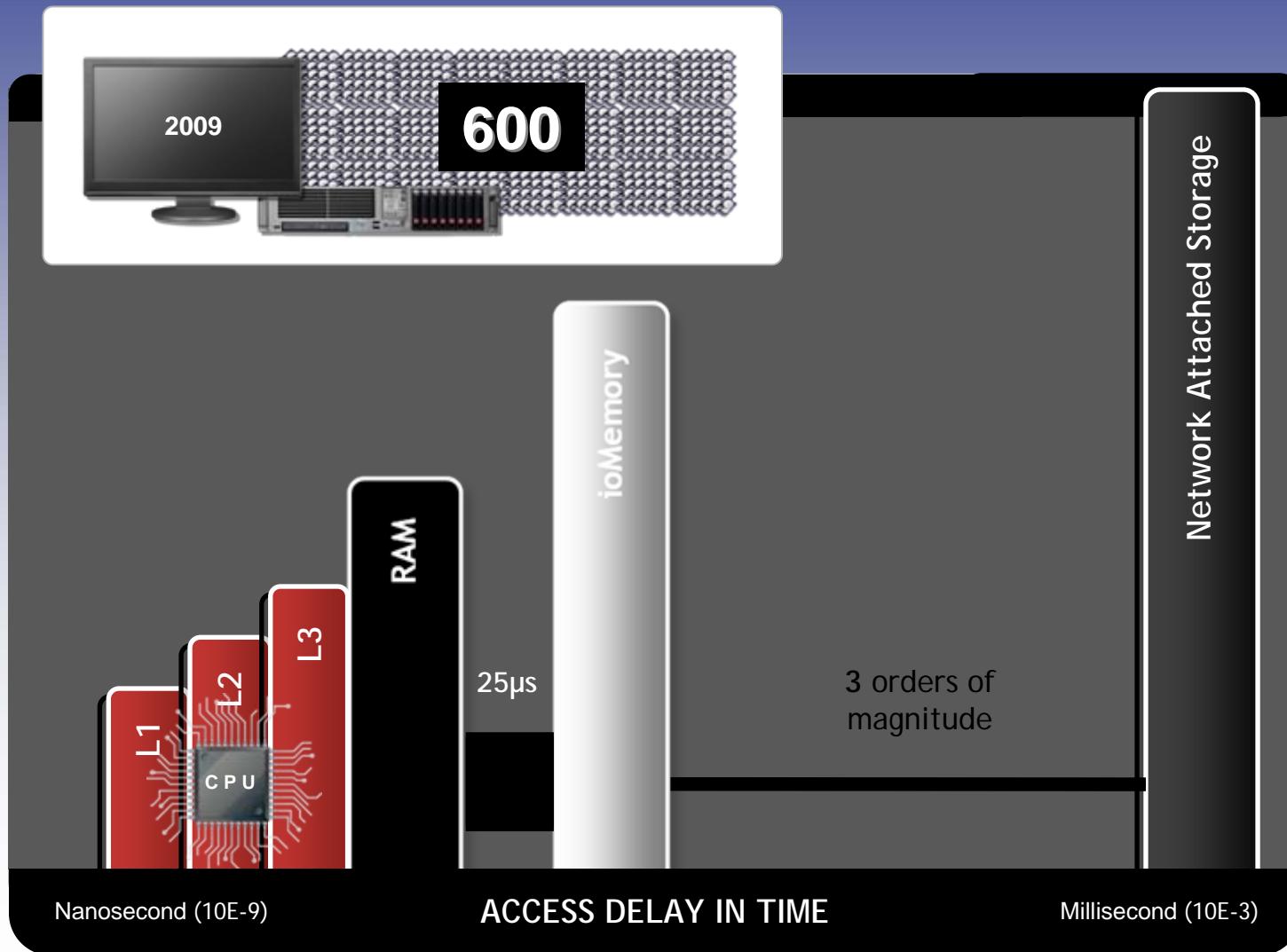
 FUSION-io

High-density DRAM

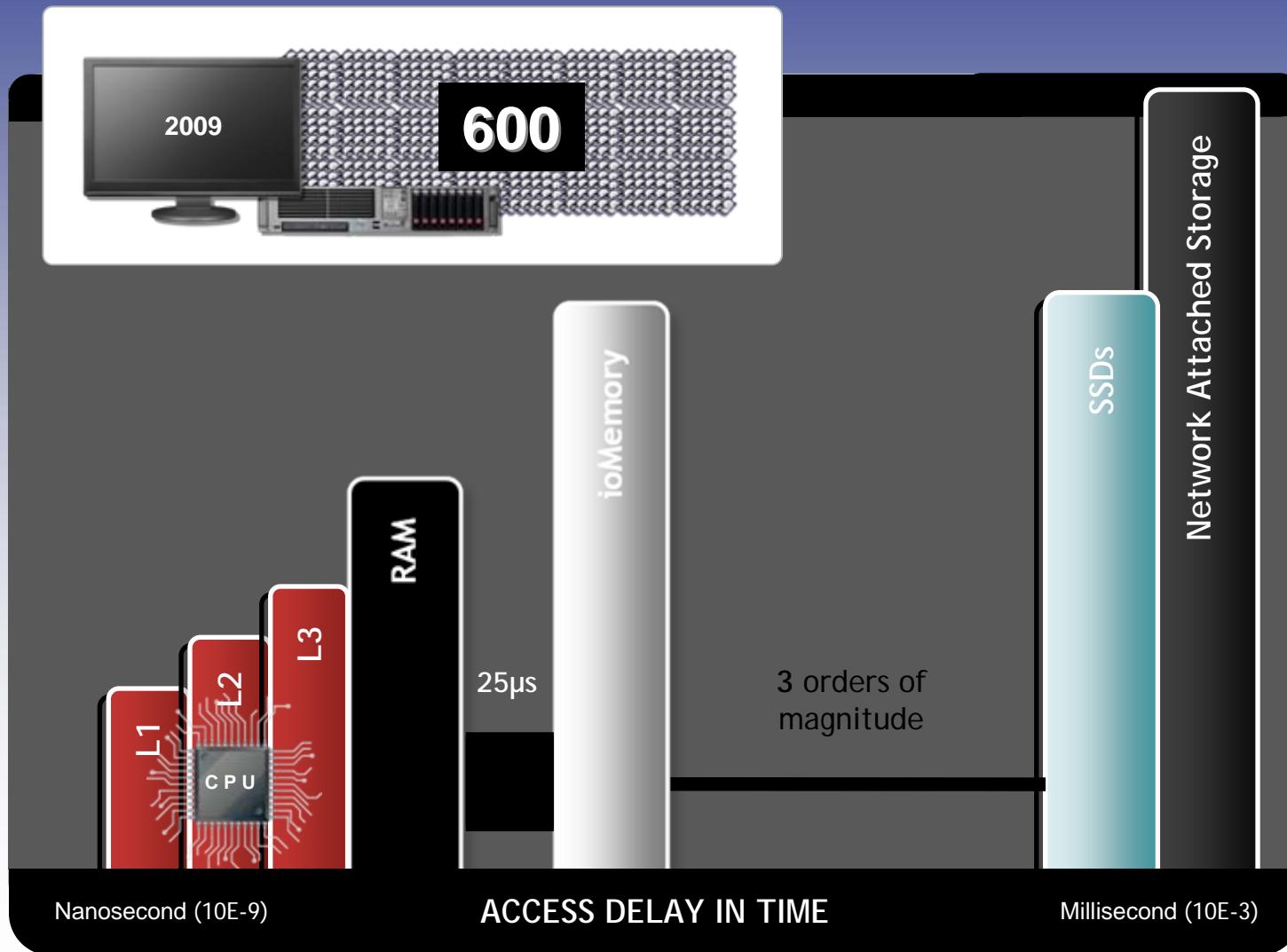
- Overloaded memory bus runs 30% slower
- Destroys the cache locality in CPU's L1, L2, L3 caches
- Volatile and changing so it's seldom indexed
- Takes hours to "warm-up" - load data into DRAM
- RAMDISK runs at $\frac{1}{2}$ memory bandwidth
 - A single I/O takes two transfers across the memory bus
 - The CPU must manually read from memory then write



ioMemory Maximizes Value Potential



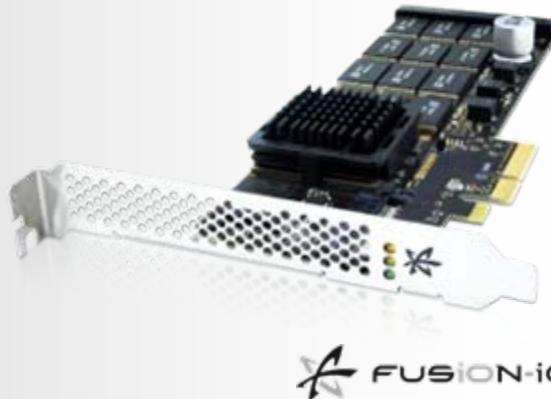
ioMemory Maximizes Value Potential



Alternative Approaches

ioMemory – A cheaper, higher density memory

- Each CPU core has independent parallel access
- Lower access latency increases application acceleration
- Less complexity, lower cost, less power, less space
- Complete solution soup-to-nuts software & hardware
- Self healing, no servicing required
- “Flashback Protection” chip-level redundancy

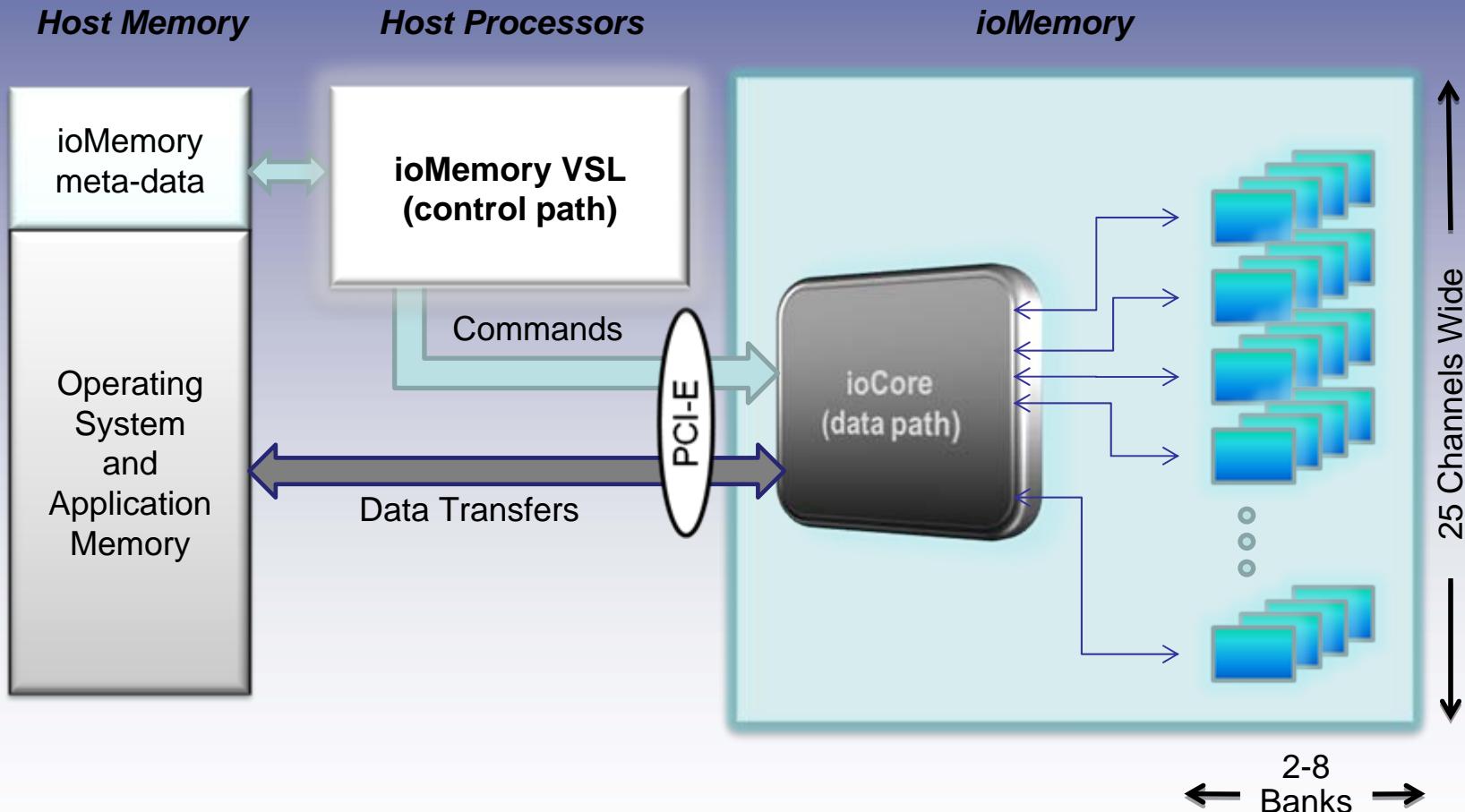


SSD – A more expensive, faster disk drive

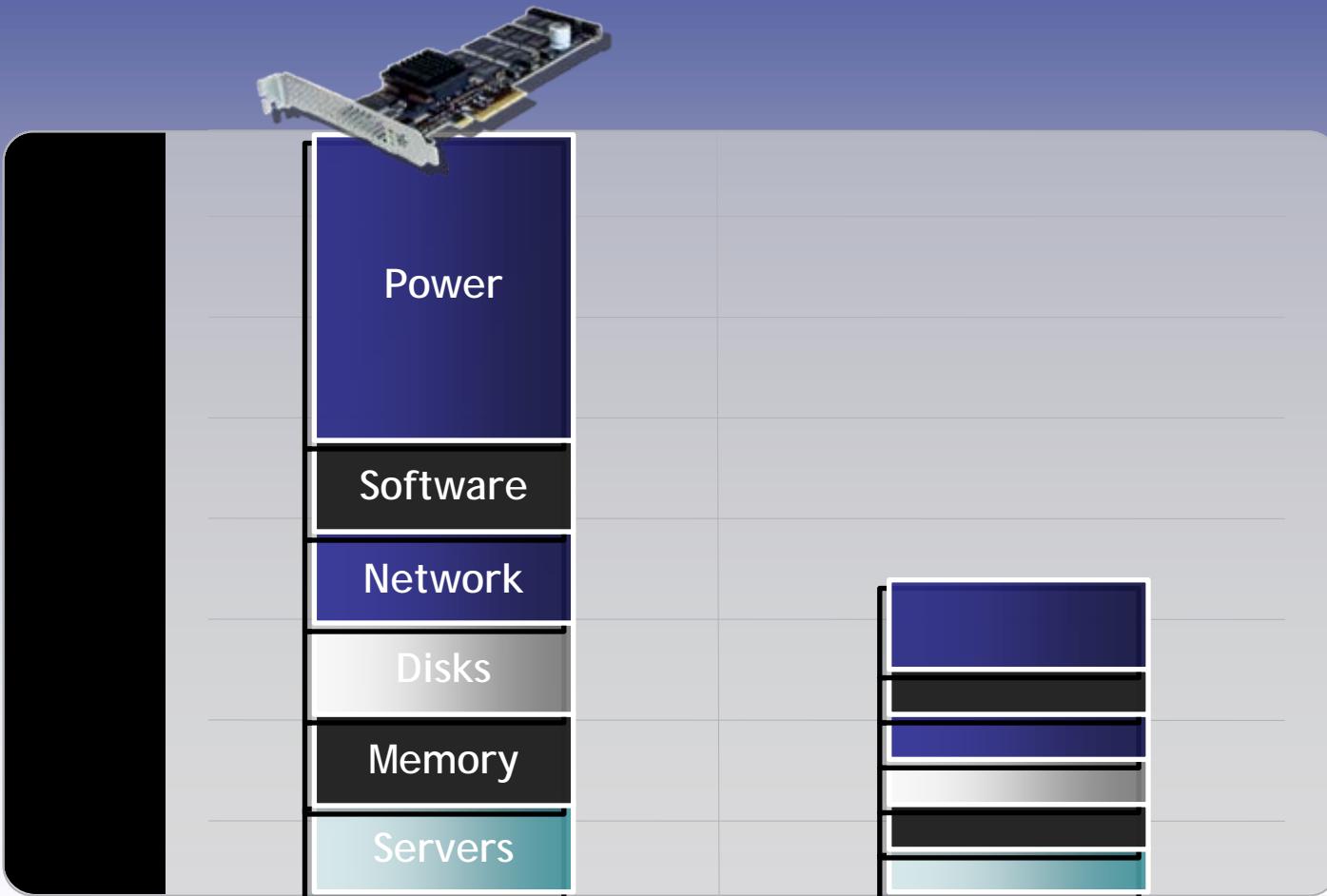
- Embedded CPU's serialize access
- RAID increases latency and batches completions
- RAID 1 or 5 sacrifices capacity and performance
- Major technologies from several different vendors
- Manual maintenance required to service failures
- Super-capacitors and embedded processors are prone to failures



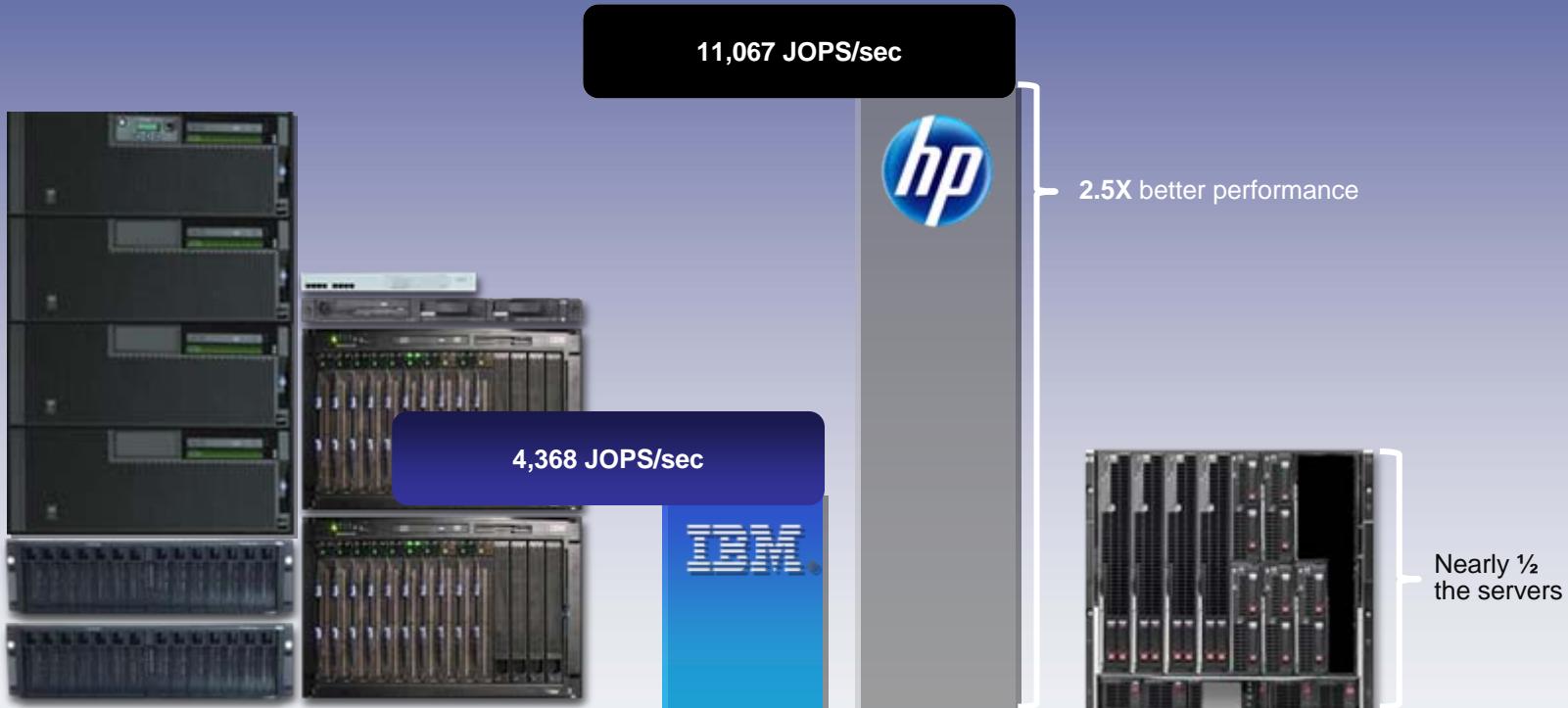
ioMemory Split-Path Architecture



ioMemory Consolidates...



HP & ioMemory jAppServer results



- WebSphere 6.1
- IBM HS20
- **40 cores, 40 chips**

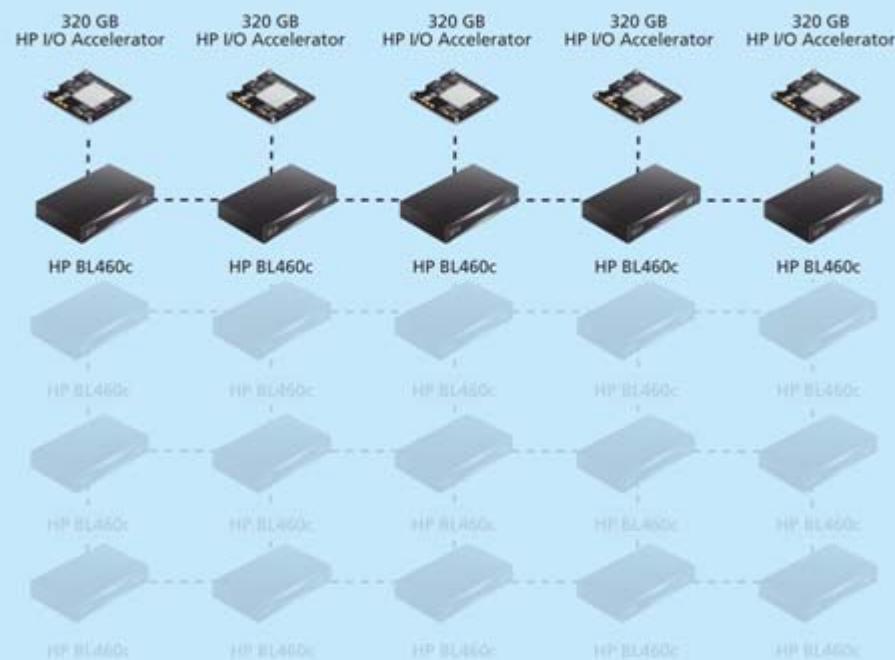
- Oracle Weblogic 10.3
- HP BL460c
- **24 cores, 6 chips**

Case Study

Answers.com®

The world's leading Q&A site

AFTER





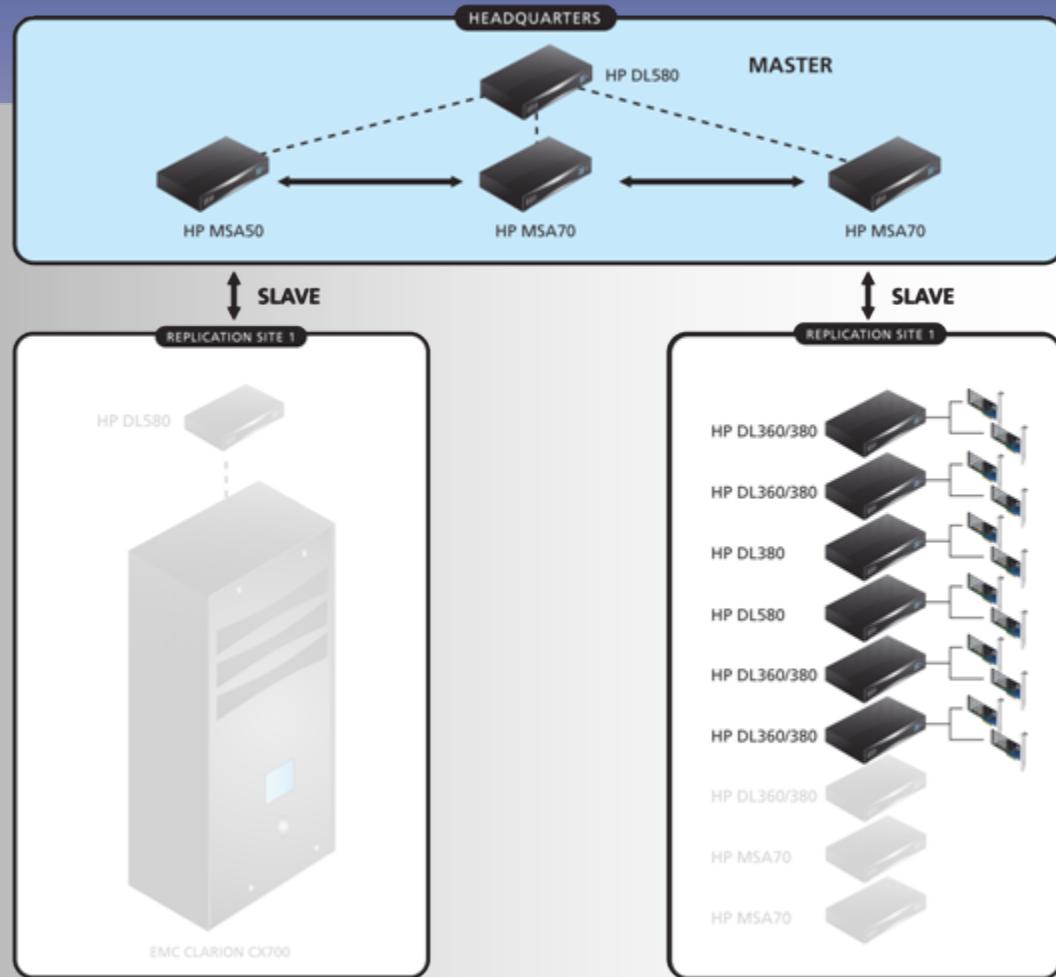
One of the world's fastest growing Webmonsters

- Over 900% more database queries per second
- Dramatically improved server replication for most current data
- Over 800% improvement to disaster recovery back-up time
- Cut server footprint, power costs, and IT overhead by 75%
- Full and immediate ROI on repurposed servers with
- Continued ROI on operational cost saving

Case Study



AFTER



Case Study

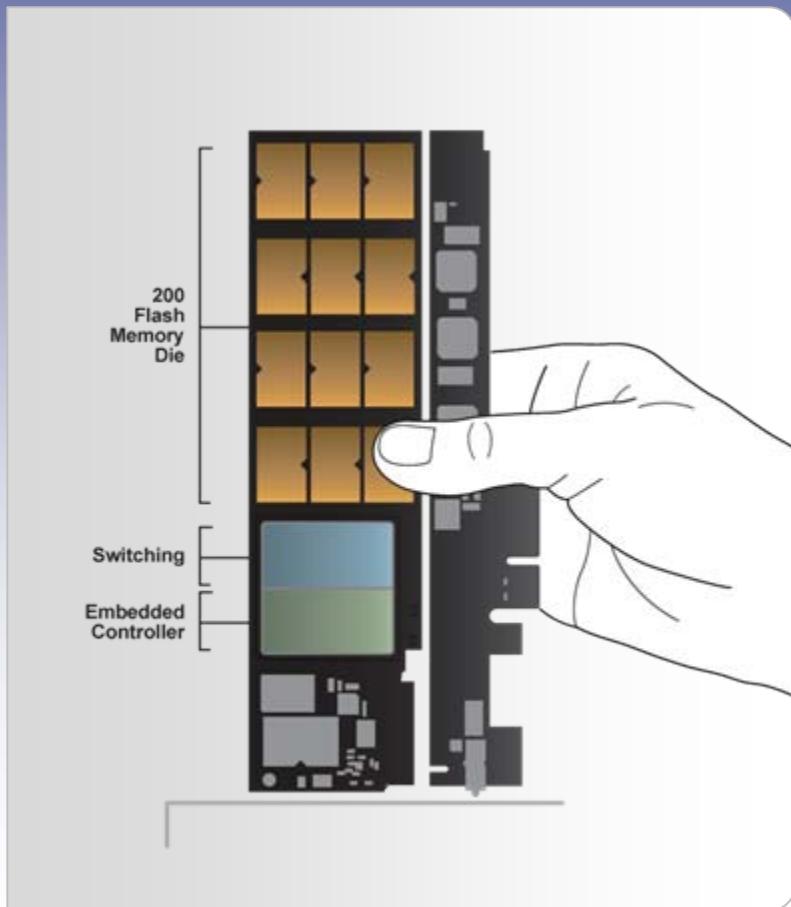


Internet security company that protects over 1 billion inboxes

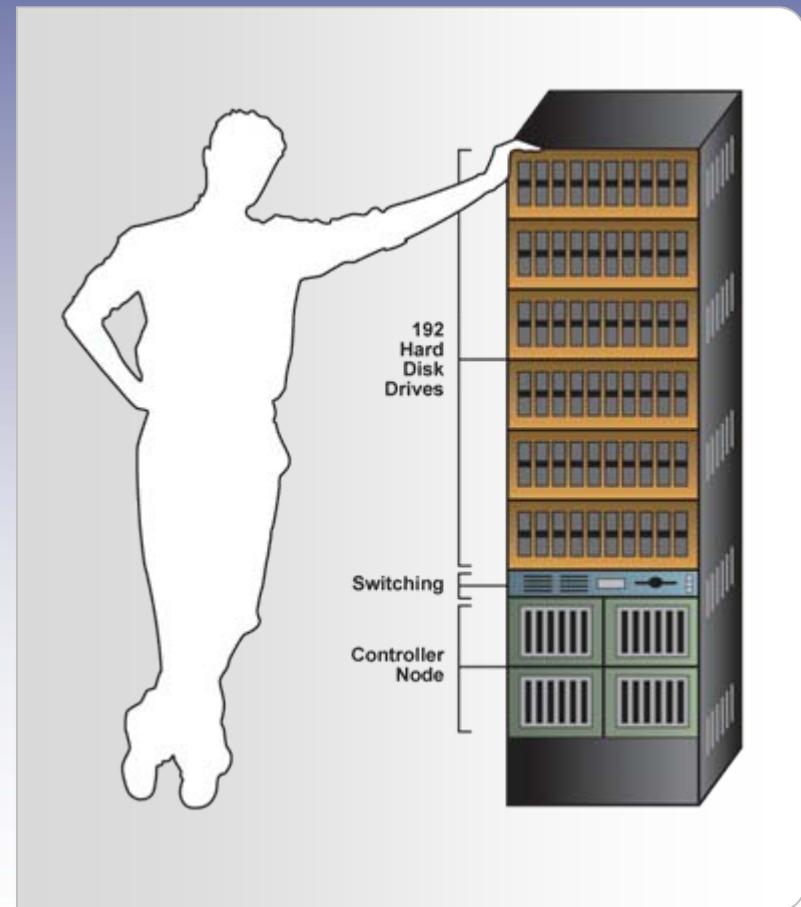
- 5x improvement to
 - Database replication performance
 - Data intensive query response
 - Analysis routines
- Eliminating 210 failure points from system
- Implemented full system redundancy
- Dramatically lowered power and cooling expenses

Disruption

By deploying ioMemory...



Cloudmark eliminated the need for this...



Other Customer Examples



Does a 30 to 1 server reduction for their reliable messaging system



HMO achieves a 200 HDD to 1 ioMemory reduction for their Data Warehouse



Department of Defense takes NASTRAN from 3-days to 6-hours



Stock exchange doubles the performance of their trading systems



FAST unstructured text search 2 min response times reduced to 0.2 seconds

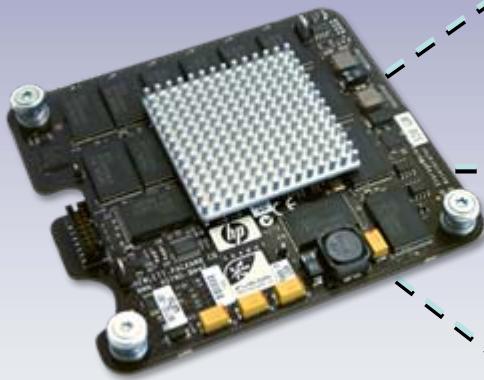


Dynamics NAV gets a 4x performance improvement

Customer Snapshot



Data-Intensive Applications for ioMemory



TRANSACTION PROCESSING

- 100x faster response time
- 10x the transactions per second



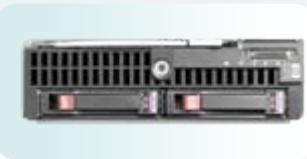
VIRTUALIZATION

- Host 4x more virtual machines
- Avoid service interrupts due to I/O contention
- Save or resume virtual machine states in seconds



APPLICATION SERVER

- 3-10x application acceleration
- “All-bladed”





Available from all major server vendors

The image displays three separate web browser windows side-by-side, each showing a different vendor's product page for solid-state storage solutions.

- Dell:** Shows search results for "FusionIO". It features two main product cards:
 - FusionIO 160 GB SLC PCIe IoDrive**: Status: Temporarily Out Of Stock. Manufacturer Part# FS1-001-001-03-0001. Dell Part# A2556172.
 - FusionIO 320 GB MLC PCIe IoDrive**: Status: Temporarily Out Of Stock. Manufacturer Part# FS1-001-021-03-0001. Dell Part# A2556176.A large circular callout highlights the first product card.
- HP:** Shows the "HP StorageWorks IO Accelerator for BladeSystem c-Class - Overview & Features" page. It includes a search bar and navigation links for HP Home, Products & Services, Support & Drivers, Solutions, and How to Buy.
- IBM:** Shows the "IBM Solid State Storage - PCIe Adapters" page. It includes a search bar and navigation links for Services, Products, Support & downloads, and My IBM. The page highlights the "Solid State SATA", "Solid State USB", and "Solid State PCIe Adapters" sections. It features a product image of a PCIe SSD adapter card and a detailed description of the technology.



Questions?



Thank You