Discover

It’s time to build a better enterprise. Together.
Please give me your feedback

**Session** DT4398  **Speaker** Pankaj Mehra

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Application-Visible Benefits
New HP PCIe Flash Workload Accelerators
Data Tier Drivers

- Flash technology accelerating data supply to the CPU for **analytics** and offering fast persistence for inexpensive transactions
- Context brokers exploiting favorable data:technology trends to gather and analyze big user data with scale-out iron

Across industries, businesses must process more new information deeper and faster than their competition.

- **App SLAs >** 10^3–5 **Infrastructure SLAs**
Application Acceleration 101

Transaction Velocity

- Write-ahead logging
  - Commit grain & speed
  - Out of the fault zone
- Checkpoints
  - Write consistency
  - Sparsity
- Read cache (write-thru)

Real-time Analytics Volume

- Scanning/loading
  - Large/extended memory
- Indexes & Buffers
  - High IOPS at low QD
- Mixed workload handling
  - Symmetric performance

Fast and flexible persistence: the magic potion for fault-tolerance, scalability and performance in online data stores.

P Mehra, S Fineberg
Parallel and Distributed Processing Symposium, 2004. Proceedings. 18th …
Application Acceleration and the Flash Memory Tier

Flash memory is solid state memory technology whose performance, cost, and endurance place it between DRAM and HDD.

- Directly benefits almost every subarea of application acceleration
Application Acceleration Offerings

SERVER FLASH AND SOFTWARE

ioMemory

FLASH APPLIANCES
Fusion-io pioneered Acceleration using In-Server PCIe Flash

**Flash As Disk**

- Host CPU
- App
- OS
- PCIe
- RAID Controller
- SAS
- SSD
- NAND
- DRAM

**Flash As Memory**

- Host CPU
- App
- OS
- PCIe
- Data path Controller
- NAND
- DRAM
From Fast Storage To Application Acceleration

Traditional Storage
- Fast storage
- Disk replacement
- Power efficiency

Workload Optimized
- Applications tuned to utilize flash
- Random I/O
- Solution optimized for Apps

Flash Aware Application Acceleration
- New paradigm
- Application specific optimizations
- Radically higher performance
- Improved reliability

Market Relevance

SSDs

ioMemory

HP PCIe Flash Workload Accelerators
Industry Leading Capacity

Previous ioMemory Capacities

Capacity of Industry’s Largest SSDs

Up to 6.4TB
Industry Leading Performance

HIGHEST
Write Performance in the Industry

2x Previous ioMemory Read Performance
Industry Leading Reliability

Fewer Points of Failure

Simple Physical Design

**STRONGEST** ECC using LDPC

$2^x$ Petabytes Written over Previous Generation

Lowest UBER for 2Ynm Flash
VE Line Enterprise
- Databases
- Server Virtualization
- Virtual Desktop Infrastructure
- Mixed Workloads

LE Line Hyperscale
- Hosting
- Web
- Big Data
- Verticals
VE Line Enterprise

- Databases
- Server Virtualization
- Virtual Desktop Infrastructure
- Mixed Workloads

330K 4K Random Read IOPS
375K 4K Random Write IOPS
2.7GB Read Bandwidth
2.2GB Write Bandwidth
15μs Write Latency
<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4K Random Read IOPS</td>
<td>215K</td>
</tr>
<tr>
<td>4K Random Write IOPS</td>
<td>300K</td>
</tr>
<tr>
<td>Read Bandwidth</td>
<td>2.6GB</td>
</tr>
<tr>
<td>Write Bandwidth</td>
<td>1.2GB</td>
</tr>
<tr>
<td>Write Latency</td>
<td>15μs</td>
</tr>
</tbody>
</table>
Which Line Best Fits Your Organization?

Enterprise — VE Line

Cannot afford downtime or to have server licenses sitting idle waiting for data

**Scale-up**
- High-end servers
- Lots of DRAM
- Storage arrays
- End-to-end H/A
- Full data mgmt

**Scale-up** Mission critical

Hyperscale — LE Line

No license cost
Minimal SLA

**Scale-out**
- Cheap servers
- Moderate DRAM
- DAS storage
- Crude replication
- Crude data mgmt

**Scale-out** Transient

Which Line Best Fits Your Organization?
## Capacity, Performance, and Endurance

### VE Line

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Storage</th>
<th>Capacity</th>
<th>R/W</th>
<th>Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 TB ioDrive</td>
<td>12 PBW</td>
<td>4K R/W 196K/320K</td>
<td>2.7GB Read/1.5GB Write</td>
<td></td>
</tr>
<tr>
<td>1.3 TB ioDrive</td>
<td>16 PBW</td>
<td>4K R/W 235K/370K</td>
<td>2.7GB Read/1.7GB Write</td>
<td></td>
</tr>
<tr>
<td>2.6 TB ioDrive</td>
<td>32 PBW</td>
<td>4K R/W 330K/375K</td>
<td>2.7GB Read/2.2GB Write</td>
<td></td>
</tr>
<tr>
<td>5.2 TB ioDrive</td>
<td>64 PBW</td>
<td>4K R/W 276K/375K</td>
<td>2.7GB Read/2.1GB Write</td>
<td></td>
</tr>
</tbody>
</table>

### LE Line

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Storage</th>
<th>Capacity</th>
<th>R/W</th>
<th>Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 TB ioScale</td>
<td>6 PBW</td>
<td>4K R/W 195K/285K</td>
<td>2.6GB Read/1.1GB Write</td>
<td></td>
</tr>
<tr>
<td>1.6 TB ioScale</td>
<td>8 PBW</td>
<td>4K R/W 195K/285K</td>
<td>2.6GB Read/1.1GB Write</td>
<td></td>
</tr>
<tr>
<td>3.2 TB ioScale</td>
<td>16 PBW</td>
<td>4K R/W 215K/300K</td>
<td>2.6GB Read/1.2GB Write</td>
<td></td>
</tr>
<tr>
<td>6.4 TB ioScale</td>
<td>32 PBW</td>
<td>4K R/W 180K/285K</td>
<td>2.6GB Read/1.2GB Write</td>
<td></td>
</tr>
</tbody>
</table>
"Adding the Fusion ioMemory platform to an existing SQL Server 2014 in-memory OLTP configuration can deliver up to 4x additional performance gains, building on our in-memory innovation…" Eron Kelly, General Manager, SQL Server Product Marketing, Microsoft
MySQL Success

DO MORE WITH MYSQL
DOUBLE USABLE CAPACITY WITH FLASH AWARE DATABASE COMPRESSION

Fusion-io Collaborates with Oracle to Double Usable Capacity for MySQL

New Flash-Aware NVM Compression Interface to Reduce Latency and Boost Usable Flash Memory Capacity by Up to 50% in the MySQL Database
Application Acceleration Technology
Application Acceleration Roadmap

1. Performance
   • Primary apps (DB)
   • Log, Compression, Savepoint

2. SAN Relief
   • Virtualized servers/desktops
   • Random read IOPS
   • Write vectoring

3. Memory Relief
   • Fast swap & sparse map at page grain

4. Comprehensive Application Acceleration with a Flash Memory tier

Persistent Memory
**Toward Better Application Acceleration**

**Applications do all the heavy lifting on HDDs and SSDs**

- 1 SSD I/O = 1 HDD I/O
- 2:1 compression at 80% throughput penalty
- Suboptimal utilization - 50+% of media density sacrificed for 20 DWPD
- Dependence on external RAID kills reliability at scale

**Applications work smarter on Fusion-io Atomic Series**

- 2x fewer I/Os keep data consistent
- 2½:1 compression at 10%
- Effective utilization - 10% overprovisioning for 12 DWPD
- Proven reliability at scale
Application Acceleration Roadmap

1. Performance
   • Primary apps (DB)
   • Log, Compression, Savepoint

2. SAN Relief
   • Virtualized servers/desktops
   • Random read IOPS
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3. Memory Relief
   • Fast swap & sparse map at page grain

4. Comprehensive Application Acceleration with a Flash Memory tier
Simple and Fast Consistency

- 2x
  - Throughput
  - Endurance

- 1/2
  - Latency

1. Performance
   - Primary apps (DB)
   - Log, Compress, Savepoint

Traditional MySQL Writes

MySQL with Atomic Writes
Performance with Atomic Writes

- Atomic writes at 99% of the performance of raw writes
- 2x flash device endurance improvement
Atomic Writes: Latency Improvement
2-4x Latency Improvement on Percona Server

Sysbench 99% latency OLTP workload
Fast and feasible compression

- Another 2x
  - Capacity
  - Endurance
- @ (10%)  
  - Performance

1. Performance
   - Primary apps (DB)
   - Log, Compress, Savepoint

SSD
Compression without Compromise (LinkBench)

- Uncompressed: 100% Transaction Rate
- Row Compression: 20% Compression Performance Penalty
- NVM Compression: 90%
Compression without Compromise (OLTP)

TPC-C like workload
MariaDB 10
1,000 warehouses - 75GB DRAM

New Order TX
MySQL uncompressed
MySQL compression
Fusion-io Compression

86% Transaction Increase
Application Acceleration Roadmap

1. Performance
   - Primary apps (DB)
   - Log – Index – Checkpoint

2. SAN Relief
   - Virtualized servers/desktops
   - Random read IOPS
   - Write vectoring

3. Memory Relief
   - Fast swap & sparse map at page grain

4. Comprehensive Application Acceleration with a Flash Memory tier
2. SAN Relief

- Virtualized servers/desktops
- Random read IOPS
- Write vectoring

- 10x desktops
- 5-30x performance for consolidated DB servers
Toward Greater Virtualization

Hypervisors work harder on HDDs and SSDs

▸ Suboptimal read caching uses block level dedup
▸ Overuse of WB caching risks SAN consistency
▸ Performance at the expense of risk

Hypervisors work smarter on Fusion-io Atomic Series

▸ Better use of read caches with file-level dedup
▸ Write vectoring keeps 80% of the writes from SAN
▸ Write through caching keeps SAN consistent
▸ Uncompromising performance
Offload Shared Storage by 90%
Consistent Low Latency Desktop Response
Application Acceleration Roadmap

1. Performance
   - Primary apps (DB)
   - Log – Index – Checkpoint

2. SAN Relief
   - Virtualized servers/desktops
   - Random read IOPS
   - Write vectoring

3. Memory Relief
   - Fast swap & sparse map at page grain

4. Comprehensive Application Acceleration with a Flash Memory tier

Persistent Memory
Persistent Memory Foundation

**Modules**

**Workloads**
- Transparent Acceleration and APIs

**NVM File System**
- Logical volume management
- Virtual Storage Services
- Persistent Memory Manager
- RDMA Layer
- Flash Translation Layer

**Features**

**Standards-based access**
- Flash-aware APIs and Transparent acceleration
- Accessed as Memory and Managed as Storage

**Uncommon value under common standards**
- Device-independent virtual storage services
  - Snapshots (memory & block)
  - Clones (memory & block)
  - Atomic writes
  - TRIM-compression
  - Memory logging (ACM)
  - Memory checkpointing
  - Memory metadata
3. Memory Relief

• Fast swap & sparse map at page grain

Originaly designed as a last resort to prevent OOM (out-of-memory) failures
• Never tuned for high-performance demand-paging
• Never tuned for multi-threaded apps

Tuned for flash (leverages characteristics)
• Simple and fast swap-out exploits fast random I/O
• Per-CPU reclaim → multi-threaded throughput
• Intelligent read-ahead on swap-in
3x Performance for Memory Hogs

≈2x improvement in page-out rate

≈3.5x improvement in page-in and out rate

≈3x reduction in load completion time
Memory Displacement for Big Data

MongoDB Throughput (operations/second)

Fusion-io and MongoDB: 
LESS MEMORY, MORE CONSISTENCY, BETTER EXPERIENCE.
1. Performance
   • Primary apps (DB)
   • Log – Index – Checkpoint

2. SAN Relief
   • Virtualized servers/desktops
   • Random read IOPS
   • Write vectoring

3. Memory Relief
   • Fast swap & sparse map
     at page grain

4. Comprehensive Application Acceleration
   with a Flash Memory tier

Application Acceleration Roadmap
Application Acceleration Reduces Server Sprawl

Useful Application Work per Server

- SSD (block)
- NVM File System
- Application-Transparent Acceleration
- Compression API
- Atomics API
- Index Optimization APIs (future)
- Log Optimization API
HP & Fusion-io, a better together story
## Fusion-io First Mover Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>ioMemory technology unveiled</td>
</tr>
<tr>
<td>2008</td>
<td>First products launched 1 million IOPS IBM Quicksilver Dell strategic investment</td>
</tr>
<tr>
<td>2009</td>
<td>HP, IBM OEMs Samsung strategic investment</td>
</tr>
<tr>
<td>2010</td>
<td>Dell OEM VSL introduced</td>
</tr>
<tr>
<td>2011</td>
<td>IPO on NYSE ioTurbine acquired ioDrive2 announced Supermicro OEM</td>
</tr>
<tr>
<td>2012</td>
<td>1 Billion IOPS 120+ channel and alliance partners ioFX Cisco, NetApp OEMs</td>
</tr>
<tr>
<td>2013</td>
<td>ioScale at Open Compute Summit NexGen acquired SAP Partnership Fujitsu, Quanta OEMs 5,000 customers</td>
</tr>
</tbody>
</table>
Future memory-semantic logging work, an HP-Fusion-io Collaboration

Contact your HP representative for details
Thank You
Fusion-io Accelerates

Databases
- Oracle
- MySQL
- SQL Server
- Sybase
- Ingres
- PostgreSQL
- IBM DB2
- Informix

Virtualization
- VMware
- XenDesktop 5
- KVM

Search
- Autonomy
- Lucene
- ORACLE Text
- LexisNexis

Analytics
- AccessData
- MarkLogic
- MongoDB

Big Data
- Hadoop
- SharePoint 2010
- Lotus

Collaboration
- Microsoft Exchange
- Microsoft SharePoint 2010
- IBM Lotus

HPC
- Fluent
- Magmasoft
- NX
- Nastran
- lustre
- IBM GPFS

Messaging
- IBM MQ

Workstation
- Autodesk
- SolidWorks
- Adobe

Development
- PERFORCE

Caching
- ArcSight
- Splunk

Security/Logging
- Varnish

Web
- LAMP
- Microsoft .NET
## Microsoft SQL Server 2014
### Atomic Series accelerates transactions

<table>
<thead>
<tr>
<th>Business Value</th>
<th>Key Performance Indicators</th>
<th>Enterprise-Class Disk Array with SQL Server 2014 In-Memory OLTP</th>
<th>ioDrive2 Duo 2.4TB with SQL Server 2014 In-Memory OLTP</th>
<th>Business Process Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve Customer Experience</td>
<td>User Transaction Wait Time (μ)</td>
<td>1329</td>
<td>117</td>
<td>91%</td>
</tr>
<tr>
<td>Server Customers</td>
<td>Transaction Throughput (MB/s)</td>
<td>42</td>
<td>172</td>
<td>75%</td>
</tr>
<tr>
<td>Improve Business Productivity</td>
<td>Total Transactions Processed (over 45 minutes)</td>
<td>6,362,883</td>
<td>28,328,639</td>
<td>77%</td>
</tr>
<tr>
<td>Deliver on Internal Server Level Agreements</td>
<td>Database Startup Time (sec)</td>
<td>222</td>
<td>72</td>
<td>308%</td>
</tr>
</tbody>
</table>