Solid State Architectures in the Modern Data Center

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How SSDs are Changing Enterprise Storage

- Storage exploding in 2 ways
  - Volume of data exploding
  - Demand to analyze and find business value from all the data is exploding
- Storage tiers evolving to meet both needs
- SSD End Use is evolving
- The SAN is evolving
  - Automatic Tiering
Smarter Systems are Creating an Information Explosion

Every day, 15 petabytes of new information are being generated: 8x more than the information in all U.S. libraries

Coping with scale
- # of producers/consumers
- Size of objects
- Retention time

Internet of Things

Internet, Web 2.0

Distributed Computing

Data Center

Storage budgets up 1-5% in 20
Problem:
The Data center is facing the challenge to manage the explosion of information volume. The exponential growth of data implies higher cost on management, energy, floor space and capacity. Manual process to manage storage tiering cannot meet the demand anymore.

Solution: *EASY Tier*
Enable customers to manage the explosion of information volume by removing the complexity of the data placement management in storage systems.

- Transparent to applications: automated and concurrent data migration
- Fine grain data movement: adaptive sub-disk level data migration
- Maximize performance, cost, energy, storage utilization
- Automated storage configuring and provisioning
- Alignment with business, application and system policy
- Consistent with thin technology
- Integrated solution with storage management Software
**SSDs Superior in Price Performance – HDDs Superior $/GB**

- To get the same number of IOPs, SSDs are cheaper than HDDs
  - Especially considering infrastructure
- But capacity is much less
- RAID controllers to allow for all the IOPs and and will continue to appear

**HDDs and SSDs $/GB continuing to decline**

- SSDs driven by
  - Geometry shrinks
  - More MLC usage
- HDDs driven by
  - Continuing TPI reductions
  - More usage of Slower and cheaper HDDs

Ref: IDC Worldwide 2010 – 2015 Solid State Drive Forecast and Analysis by Jeff Janukowicz
Client Challenges with SSDs

- High performance (IO/Sec) but high cost ($/Gbyte)

- SSDs are more expensive than magnetic disks (Although prices dropping)
- The challenge – use them for the data that really needs the speed in IOPs/Sec
- Do not make management more complex
- Easy Tier makes the most use of the SSDs ($/IOP) for hot data and places colder data on HDDs ($/GB)
SSD Usage in the Enterprise
SSD End Usage is Evolving

External Storage

- MLC adoption increasing
- Easy Tier increasing dramatically
  - Multi Level tiers including SSDs, 15K and Nearline HDDs
  - Feature improvements will further increase adoption
- Some pure SSD boxes
  - Fairly uniform distribution of data
  - Response time critical
- With optimized external storage like DS8800, latencies even in the SAN are good.

Direct Attach

- MLC adoption increasing
- Easy Tier will play here in many ways
  - Within networks controlled by a RAID Controller pair
  - Within the server across disparate SSDs directly attached via PCIe or SAS.
- DAS does offer some reductions in latency and powerful use models
- Workload Optimized Systems
Endurance Questions

- Questions still linger about MLC

- MLC Endurance being addressed by one or more of the following
  - Use case restrictions (not desirable)
  - Write Mitigation
  - eMLC
  - SSD Controller endurance enhancements of Flash (Advanced Signal Processing)
  - Infrastructure throttling
  - Overprovisioning
How SSDs Accelerate Performance

- IOPs play to get more Transactions per second or to achieve similar transaction requirements with less cost.

- Higher Read Throughput or Scan Rate
  - Business Analytics
  - Data Warehousing

- Reduced and consistent Average Latency
  - Real time transaction processing with guaranteed response time
  - Requires reduced and manageable max latency

- Reduced batch windows to meet Service Level Agreements
Is there a return to Direct Attach

- Yes!
  - Cloud systems and providers like Yahoo, Amazon, Google, etc.
  - Caching or tiering in the Server for DAS HDDs or SAN
  - Servers with pure SSDs
    - Media Streaming
    - Analytics workloads
    - Financial analysis
- BUT, SAN is not going away
  - Converged networks
  - Server clustering
  - Ease of management
  - Replication and advanced functions
- They will be working together more
A word about FormFactors

- **External Storage**
  - Since HDDs and SSDs must coincide – common HDD formfactors with SAS and SATA will likely predominate

- **DAS**
  - PCIE Slots are available.
  - HDD and SSD form factors
  - 1.8” for density
  - Custom forfactors: SATA DIMMs, etc

- **Interfaces**
  - SCSI flavored is advantageous to make best use of common infrastructure
  - But PCIE and NVM will also likely grow since there are PCIE slots
  - 2.5” PCIE – Pros and Cons
Intelligent data placement EasyTier

Performance Improvement with minimal management

Automated Data Relocation

330% IOPS Improvement

300-400% more transactions
DB2 Brokerage Workload with Easy Tier: More Transactions with Less Response Time

Weighted Average RT (ms)

<table>
<thead>
<tr>
<th>Trade Activity</th>
<th>Lookup</th>
<th>Order</th>
<th>Update</th>
<th>Overall Transaction</th>
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<td>DS8800 Base</td>
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<td>13332</td>
<td>1169</td>
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<td>Easy Tier2</td>
<td>3441</td>
<td>198</td>
<td>5883</td>
<td>493</td>
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Benefit (%)

|                | 64.40% | 31.72% | 55.87% | 57.83% |
Flexible Configuration of Performance and Capacity with Auto-Rebalance

Before and After is Representative: Data Movement Accelerated to Reduce Test Time
At the application level, Easy Tier delivered:

- 341% more web server IOs per second
- 277% more Oracle OLTP IOs per second
- 69% more Exchange 2010 users
- 33% faster Exchange database read response times
- 43% faster Oracle OLTP IO response times

Conclusions

- Enterprise SSDs are starting to show significant growth
  - MLC is an important reason for that growth
- Clients need more than the underlying technology.
  - They need firmware and software to allow for tiering
  - They need applications which exploit it
- SSDs cheaper in terms of $/IOPs
  - Expect more infrastructure which exposes those IOPs to the client
- Various applications will exploit different performance attributes
- We are likely to see radical changes to the datacenter as more clients go to pure SSD solutions
  - DAS is very important for SSDs
  - But sharing and clustering of those DAS solutions is essential
  - But the SAN will also stay relevant especially with Easy Tier