Server Based Storage
Faster... Economical... Reliable...

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Agenda

• Datacenter Growth and Management Decisions

• Server Based Storage

• Reference Materials

• Intel at the Flash Memory Summit
MEETING THE DEMAND FOR INTELLIGENT STORAGE
Cloud Computing Driven by:

More users, more devices, more data, more storage, more traffic...

55% Growth in Unstructured data (e-mail, video, images, social media etc.)

75% Growth in Public Cloud

670% Growth in Storage Capacity Shipped

>1000 Exabytes of Traffic

Forecast

1. IDC “The Internet Reaches Late Adolescence” Dec 2009, extrapolation by Intel for 2015
2. EG&G “Worldwide Device Estimates Year 2020 - Intel One Smart Network Work” forecast
3. IDC
Datacenter Growth and Management Decisions
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By 2015...

More Users  
1B more netizens

More Devices  
15B connected devices

More Data  
1,000 Exabytes traffic

Evolving Storage Paradigm

1. IDC “Server Workloads Forecast” 2009. 2.IDC “The Internet Reaches Late Adolescence” Dec 2009, extrapolation by Intel for 2015  
2. ECG “Worldwide Device Estimates Year 2020 - Intel One Smart Network Work” forecast  
Current Solution Methodology

- Scale out storage with HDD’s and systems
  - Expands storage with additional HDD’s in existing systems...
  - Alternative: Add additional storage subsystems
- Engineer ultimate component reliability
  - Use SAS drives for dual port redundancy and ultimate uptime reliability
- HDD over-provisioning
  - Increase HDD performance by trading capacity for rotational performance
- Add improved networking cards
  - Increasing bandwidth and network level performance
## Summary of Current Solutions

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale out HHD’s and systems</td>
<td>Addresses capacity, but adds power, heat</td>
</tr>
<tr>
<td>Ultimate component reliability</td>
<td>Burdens reliability cost on each server</td>
</tr>
<tr>
<td>HDD over provisioning</td>
<td>Underutilized drives and gobbles up space</td>
</tr>
<tr>
<td>Improved networking cards</td>
<td>Individual cards on systems do not improve performance significantly</td>
</tr>
<tr>
<td>New and faster servers</td>
<td>Commonly used as first approach to improve performance, but requires...</td>
</tr>
</tbody>
</table>

Smart choices must be made to remain competitive.
Other Issues to Consider

• Are server CPU’s fully utilized?
• Where are the current I/O performance bottlenecks?
  • Storage, Networking, Memory, System CPU’s?
• What is the appropriate socket and core configuration?
  • And the associated impact of software licensing?
• How much system memory is optimal?
• What is the workload and usage assumption?
• MTBF degradation due to increased infrastructure?
  • Not linear

Easy to overlook key issues that impact cost and performance
Server Based Storage
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Server Based Storage Advantages

• Industry moving to place primary storage inside servers
  • Reduces cost
  • Saves space
  • Improves performance and rebalances system I/O
  • Reduces thermal load & power demands
  • Reduces routing & switching overhead
  • Eliminates external storage subsystems
  • Minimizes storage management software diffusion
  • Reduces points of failure while increasing MTBF

• Takes advantage of existing hardware
  • SSD’s and faster NIC’s are enabling technologies

• Clustered servers used to provide fault tolerance
  • Different than Scale Out Storage
Another Way to Architect A Solution?  
Local Storage with SSDs

<table>
<thead>
<tr>
<th>REQUIREMENTS</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need more storage capacity</td>
<td>Add SSD’s and HDD’s to server enclosures to balance cost and performance</td>
</tr>
<tr>
<td>Increased performance</td>
<td>Add SSD’s to existing HDD configuration to deliver enhanced data caching and throughput</td>
</tr>
<tr>
<td>Limited space, power and air</td>
<td>Add storage to existing servers to increase overall data center efficiency</td>
</tr>
<tr>
<td>Need fastest possible storage</td>
<td>Add SSD’s to servers and use as primary storage</td>
</tr>
<tr>
<td>Simplify storage management software</td>
<td>Rely upon emerging converged enterprise software and Cloud</td>
</tr>
</tbody>
</table>
Server Based Storage

Achieves Greater Business Value

<table>
<thead>
<tr>
<th>Performance &amp; efficiency</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>Simplified management</td>
</tr>
</tbody>
</table>

Converged storage servers deliver a cost-effective storage platform

- **Storage Components**
  - Enclosure
  - Backplane
  - SATA/SAS Cables
  - IOC/HBA
  - Solid State Storage
  - Hard Disks

- **Server Components**
  - Server board
  - Server chipset
  - Server processor
  - Server memory
  - Network card
  - Power supply

Metadata Server

Application Server

Storage Server

Converged Storage Server
Solid State Advantage

• Server-based storage relies upon Solid State storage for hierarchical caching and performance acceleration
  • SSDs may also be configured for primary storage
  • Conventional HDDs provide lower-performance long term storage
• Capacity ratio of 1:10 is common
• Conventional 2.5” form factors offer the best removability
  • Hot plugability subject to hardware and software enabling and certification

SSD’s in Servers Offer Untapped Potential for Caching and Mainline Storage
SSD Datacenter Placement

Key Take-Aways

- SSDs displacing 15k HDDs
- 2.5” HDDs displaced 3.5”

Why?

- Reliability
- Performance
- Power savings
- Density

SSDs

- Reliability beyond mechanical hard drives
- Performance AND endurance for rigorous datacenter workloads
- Power savings multiplied beyond SSD to

Better, Faster, Cheaper and more Reliable
Cluster Configuration

• At least 3 to 4 servers required to support fault tolerance
  • Sometimes referred to as Network RAID
• Data is sent to JBOD drives based upon provisioning and data workload profiles
  • Ex: High bandwidth, low latency, directory data, archival, log files
• Drives within each server are not required to be the same capacity
• Data duplicated across server based upon real-time heuristic analysis and modeling
PCIe Add-In Option

- Add-in PCIe solutions may be used as conventional SSD form factor alternative
- Enables faster access to data
- Compact vs. conventional HDD + HBA
- Boosts storage performance vs. HDD’s

Form factor must be consistent with industry standards
Network Requirements

• At least one 10GbE port required to support bandwidth
• Dual 10GbE ports recommended for enhanced reliability
  • 1GbE does not offer enough bandwidth
• Used to transfer data between server cluster nodes
  • Also serves conventional LAN and WAN traffic
Simplify with Ethernet 10GbE

Source: Intel 10GbE ROI Calculator. This ROI calculator is a cost comparison for a highly virtualized solution, using multiple 1GbE connections versus a dual port 10GbE implementation. [http://www.event-management-online.de/LAD/calculator.aspx](http://www.event-management-online.de/LAD/calculator.aspx)
Solution Strategy

• Server based storage is emerging as an alternative to external storage subsystems

• Appropriate for many datacenter production environments
  • Cloud, virtualization, virtual desktop, decision support, etc.

• Not specifically designed to support big data usage models

• Consolidates hardware and software

• Reduces all major cost factors
Architectural Guidance

- Configurations of HDDs & SDDs balance cost and performance
  - SDD to HDD ratio contingent upon specific solution and workload
- Emerging PCIe add-in form factors can be used as alternative to conventional SSD form factors
- SAS ports no longer required to insure reliability
  - Fault tolerance via server clusters
  - SATA is acceptable and potentially optimal
- Embedded SATA ports offer lowest cost
- Add-in SATA RAID configured for JBOD
  - Software management console useful to monitor drive provisioning, health, status and performance
- Consumer-class drives may be acceptable for this architecture
  - But...requires understanding of workload...read to write ratios and performance requirements are key dependencies
Solid State Is Mainstream

Worldwide SSD Unit Sales

SSDs are Positioned for Strong Growth

Storage Tiering

1. Gartner Q1'12
Server Based Storage Summary

• Existing solutions for Data Center growth may create more problems than they solve.
• Multiple approaches can be used to address growing storage requirements while maximizing performance and reducing costs etc.
• Moving SSDs inside servers maximizes performance and increases reliability while reducing power and thermal load.

SSD momentum in the Enterprise will accelerate as strategies are updated.
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• Intel at the Flash Memory Summit
Reference Materials

- Intel Solid State Technology
  - www.intel.com/go/ssd

- Storage Networking Industry Association
  - www.snia.org
  - http://snia.org/forums/sssi/programs/twg

- Differentiated Storage Services
  - www.intel.com
  - Search for “Differentiated Storage Services”
Agenda

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• Intel at the Flash Memory Summit
Tuesday, Aug. 21

- **How SSDs Fit in Different Data Center Applications**, Tutorial A-11: Flash in Data Centers (Enterprise Storage Track) 8:30 a.m. to 11:25 a.m.
  - Tahmid Rahman, Technical Marketing Engineer

- **Server-Based Storage: Faster, Economical, Reliable**, Tutorial C-11: Enterprise SSDs (SSDs Track) 8:30 a.m. to 9:50 a.m.
  - Steve Mattos, Strategic Program Manager Storage Solutions

- **Merits and Methods of IO Traced Based Performance Benchmarking of SSDs**, Open Session 101-B: Mobile Applications (Applications Track) 8:30 a.m. to 9:50 a.m.
  - Harry Pon, NAND Product Development

- **The Transition to PCIe for Client SSDs**, Open Session 102-C: Standards (SSDs Track) 10:10 a.m. to 11:25 a.m.
  - Amber Huffman, Senior Principal Engineer

- **Write Atomicity and NVM Drive Design**, Tutorial B-11: Flash Memory-Based Architectures (Architectures Track) 10:10 a.m. to 11:25 a.m.
  - Andy Rudoff, Enterprise Storage Architect

- **Verification and Management of Endurance in NAND SSDs**, Tutorial C-12: SSD Technology (SSDs Track) 2:10 p.m. to 4:45 p.m.
  - Venkatesh Vasudevan, Director Quality and Reliability Engineering

- **Data Integrity on 20nm NAND SSDs**, Tutorial C-12: SSD Technology (SSDs Track) 2:10 p.m. to 4:45 p.m.
  - Robert Frickey, Product Development Engineer
Wed., Aug. 22

- **Which Way are We Headed?, Open Session 201-A: Future Storage Interfaces** (Interfaces Track) 8:30 a.m. to 9:40 a.m.
  - Jim Pappas, Director Initiative Marketing

- **Data Recovery Survival Tips and Realities, Open Session 201-B: Data Recovery of SSDs** (SSDs Track) 8:30 a.m. to 9:40 a.m.
  - David Blunden, Applications Engineer

- **Thunderbolt, Open Session 204-D (Interfaces Track)** 4:30 p.m. to 5:30 p.m.
  - Brett Branch, Software and Ecosystem Enabling
Thursday, Aug. 23

- **Industry Standards for PCIe SSD Storage, Session 301-A: PCIe Storage-1 (PCIe Storage Track) 8:30 a.m. to 9:40 a.m.**
  - Jim Pappas, Director Initiative Marketing

- **Exploitation of Rber Diversity over Dies to Improve ECC Performance in NAND Flash Drive, Session #301-B: SSD Technology (SSDs Track) 8:30 a.m. to 9:40 a.m.**
  - Ravi Motwani, ECC/DSP Architect

- **Intel Ultrabook Responsiveness and NVM Caching, Tutorial A-31 (Enterprise Storage Track) 8:30 a.m. to 10:50 a.m.**
  - Dale Juenemann, Storage Architect

- **Solid State Drives - From Disruptive to the New Normal, Open KEYNOTE 10: 2:00 p.m. to 2:30 p.m.**
  - Robert Crooke, Vice President/General Manager – Non-Volatile Memory Solutions Group

- **PCIe SSD Roundtable, Session 303-B: (PCIe Storage Track) 3:10 p.m. to 4:25 p.m.**
  - Mark Meyers, Server Platform Architect

- **Top Ten Things You Need to Know about Flash Memory Today, Open Session: 304-A: Closing Panel  4:40 p.m. to 6:00 p.m.**
  - Knut Grimsrud, Director Storage Architecture/Intel Fellow
Questions?
Thank You
Abstract

• Customers are demanding an alternative to expensive and slow external storage subsystems for workloads that maximize the performance of server hardware.

• In response, ecosystem solution providers are developing solutions that reduce the need for external storage subsystems while improving performance and throughput as well as reducing overall power consumption. These new solutions integrate hybrid drive configurations inside the server enclosure to offer the best characteristics of solid state drive (SSD) performance balanced against the low cost and capacity of conventional hard drives.

• This session outlines the detail behind this trend toward internal SSD storage, provides tips for system integration and offers guidance for building optimized server solutions. Tradeoffs of Enterprise versus Consumer class SSD’s will be discussed along with the latest trend in PCIe SSD’s.
Flash Memory Summit
Event Logistics

• Date: Tuesday, August 21.
• When: 8:30 to 9:50 or 10:10 to 11:25 (30 minute tutorial session)
• Where: Santa Clara Convention Center
## Program At-A-Glance

### Tuesday, August 21st

<table>
<thead>
<tr>
<th>Time</th>
<th>Enterprise Storage</th>
<th>Architectures</th>
<th>SSDs</th>
<th>Hardware</th>
<th>Applications</th>
<th>SSDs</th>
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</thead>
<tbody>
<tr>
<td>8:00-8:30am</td>
<td>Tutorial A-11</td>
<td>Tutorial B-11</td>
<td>Tutorial C-11</td>
<td>Session 101-A</td>
<td>Session 101-B</td>
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<td></td>
<td>Flash in Data Centers</td>
<td>Flash-Memory Based Architectures: A technical Discussion Part 1</td>
<td>SSDs</td>
<td>3D Flash: The Next Dimension</td>
<td>Mobile Applications OPEN</td>
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<td>8:30-9:50am</td>
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<tr>
<td>9:50-10:10am</td>
<td>Tutorial A-11</td>
<td>Tutorial B-11</td>
<td>Tutorial C-11</td>
<td>Session 102-A</td>
<td>Session 102-B</td>
<td></td>
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<td>Flash in Data Centers (cont.)</td>
<td>Flash Memory-Based Architectures: A Technical Discussion Part 1 (cont.)</td>
<td>SSDs</td>
<td>Flash Technology Trends</td>
<td>Consumer Applications OPEN</td>
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<td>10:10-11:25am</td>
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<tr>
<td>11:30am-Noon</td>
<td>OPEN - Keynote 1</td>
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<td>SSDs: Enabling the Next Wave of Growth in the PC Industry</td>
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<td>Lunch</td>
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<td>Noon-1:00pm</td>
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Flash Memory Summit

Friday, August 24, 12