How SSDs Fit in Different Data Center Applications

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NVM Solutions Group
Agenda

- SSD market momentum and drivers
- Placement in server/storage applications
- Application specific requirements and workload characteristics
- Proof points with SSDs in transaction processing, IT, virtualization
- Call to action
Strong SSD Momentum in the Market

Source: Gartner Q1'12

Worldwide SSD Unit Sales

We are here

Millions


165664.3000 122760.7000 82984.8500 49616.4600

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Millions

- 2008: 16,566,430
- 2009: 16,566,430
- 2010: 12,276,070
- 2011: 8,298,485
- 2012: 4,961,646
- 2013: 8,298,485
- 2014: 12,276,070
- 2015: 16,566,430

Source: Gartner Q1'12
Drivers Behind Data Center Storage

- **Architectural Changes** –
  - Big data
  - Cloud
  - Software innovation for caching, tiering

- **Server Side Innovations** -
  - De-duplication, compression
  - Thin-provisioning
  - Virtualization

- **Interface transitions**
  - SATA/SAS to PCIe
  - AHCI based to NVMe

- **SSD endurance and performance grades**
  - Endurance classes – high, medium, standard
  - Optimization for access – read intensive, write intensive, mixed workload
  - Different “out of the factory” spare area level
### SSD Placement in Server/Storage Application

<table>
<thead>
<tr>
<th>Usage</th>
<th>Applications</th>
<th>Compute (Servers)</th>
<th>External Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cache</td>
<td>IPDC Web 2.0</td>
<td>Persistent cache: (Block Cache, User space buffer cache)</td>
<td>Persistent Cache: (e.g. OS block, metadata, de-dupe)</td>
</tr>
<tr>
<td>(Low, Deterministic Latency, $/IOP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>IPDC web2.0 Volume</td>
<td>Hot Application Data (Web, Database, Email, Search, Videos, IPDC etc)</td>
<td>Hot Application Data</td>
</tr>
<tr>
<td>($/IOP/GB)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>($/TB, Watt/TB)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boot ($/GB)</td>
<td>All Server Application</td>
<td>Local boot data (Operating System, Hypervisor, SWAP, VM, Application Image)</td>
<td>Local boot Data:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Highest Requirements for Data Center SSDs

- **Data Integrity**
  - True End to End data protection
  - Power Loss Protection
  - Power loss cap self test
  - Protection of internal memory with ECC and parity

- **Predictable Performance**
  - IOPS variation needs to be within a narrow range
  - Latency outliers should be within a max value

- **High Endurance Requirement**
  - Two primary endurance evolving
    - Standard endurance 0.1-1 DWD
    - High endurance 10 DWD
# Data Center Application Workload Characteristics

<table>
<thead>
<tr>
<th>Applications</th>
<th>Transfer Size</th>
<th>% Random</th>
<th>% Read</th>
<th>Write. Endurance</th>
<th>Quality of service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media Streaming</td>
<td>64KB</td>
<td>Low</td>
<td>High</td>
<td>Med</td>
<td>Med</td>
</tr>
<tr>
<td>Web-server Logging</td>
<td>8KB</td>
<td>Low</td>
<td>Low</td>
<td>Med</td>
<td>Med</td>
</tr>
<tr>
<td>Search Engine</td>
<td>4KB/8KB/16KB</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Video-On-Demand</td>
<td>128KB</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Caching</td>
<td>512KB</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Decision Support</td>
<td>64KB</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Content Delivery Network</td>
<td>16KB/32KB</td>
<td>High</td>
<td>Mixed</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Database OLTP (On Line Transaction Processing)</td>
<td>4KB/8KB</td>
<td>High</td>
<td>Mixed</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

**Source:** Industry Standard Benchmarks and Customer Engagement Data

Patterns will vary for unique customers

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*Tuesday, August 21, 12*
SSDs For Virtual Storage in the Cloud

**Challenges**
- Reversed server to data store ratio (multiple VMs running on single array)
- Adding storage and cache is cost prohibitive

**Solutions**
- High Performance SSD 3x8 RAID5 meeting multiple VM random IOPS of ~100K w/ SW SAN solution

**Impact**
- Expanded performance at a lower cost >75% TCO reduction
  - 450 15K RPM HDDs vs. 24 Intel 710 SSDs
  - IT professional would spend $43K instead of $200K+
SSDs for Transaction Processing

- TPoX* (Transactional Processing over XML*) is an application-based benchmark that mimics a storage-bound online transaction procession over XML data for brokerage
- Intel® SSD 910 Series, reveals a replacement ratio of 1 to 180 with Standard Magnetic Drive Solutions
- 1 TB database can be compressed in one single PCIe card and meet the performance of 180 magnetic storage 15K RPM SAS drives

**PCIe SSD Based Solution**

**HDD Based Solution**

<table>
<thead>
<tr>
<th></th>
<th>PCIe SSD</th>
<th>Magnetic Storage 15K RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of drives</td>
<td>1</td>
<td>180</td>
</tr>
<tr>
<td>TPS score (steady-state run)</td>
<td>13,516</td>
<td>13,742</td>
</tr>
<tr>
<td>Latency (msec)</td>
<td>5.93</td>
<td>7.15</td>
</tr>
<tr>
<td>Drive Cost</td>
<td>3,859</td>
<td>59,000</td>
</tr>
<tr>
<td>Storage Subsystem Cost</td>
<td>X</td>
<td>14,000</td>
</tr>
</tbody>
</table>

Configuration: Intel® Xeon® Processor X5680 (3.33 GHz, 6.40 GT/s Intel® QPI) platforms with Intel® 7500 Chipset, 72GB (18x4GB), 800MHz DDR3 memory, SUSE SLES 11 SP1 operating system, DB2 9.7, and TPoX 2.0 using “M” factor scale (1 TB data size). Hitachi* HUS151P1 CLAR146 146GB SAS 15K RPM drives.

Transaction Processing And Importance of Latency QoS

- Transaction processing requires dense IO (Higher IOPS/GB)
- Systems tune to have no “storage bottleneck”
- No Mercy for latency outliers and occasional drops of IOPS

Acknowledgement: Terry Pricket, Jeff Smit, Intel SSG Lab
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Gain transactions by 24% by moving the latency from 90 msec to 20 msec

Acknowledgement: Terry Pricket, Jeff Smit, Intel SSG Lab
SSDs for IT Management Services

- Automatic Updates for IT security patches
- Managing Design Simulation database
- Swap operation for over-flow memory
- Benchmarking and proof points
Enterprise Patching and Security Compliance Performance Comparison

With 15K RPM Drive

Queue Depths

With SSDs deployed

Queue Depths

QD gets built up easily and the IO demand cannot be met

QD is never too deep, IO saturation maintained without it

Acknowledgement: Christian Black, Intel IT Architect
Are All SSDs Ready for Transaction Processing?
Are All SSDs Ready for Transaction Processing?

“Zero” IOPS!
Are All SSDs Ready for Transaction Processing?

“Zero” IOPS!

- RAID Array stalls and timeouts
- Higher drive counts to meet IO needs

100% Wr. 4KBRnd. Workload

Tuesday, August 21, 12
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1 sec max latency!
Are All SSDs Ready for Transaction Processing?

“Zero” IOPS!

RAID Array stalls and timeouts

Higher drive counts to meet IO needs

1 sec max latency!

Negative SLA impacts

Catastrophic for certain applications
Call to Action

- Ample opportunity for SSD proliferation within data center
- Innovate around applications needs
- Use faster interface and technology to unleash NAND backend bandwidth