SSD in Enterprise Storage

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Samsung Semiconductor, Inc.
New Dynamics in the Storage World
A.k.a. – What problem are we trying to solve?

Creating Content – Finding/Storing Content – Buying/Consuming Content
What Matters? ... BOTH Storage Performance and Storage Capacity
Storage Performance (IOmeter FileServer)

Clear, real-world Storage Performance
Our customers deserve clarity

Source – Storage Review.com
Squeeze the Balloon – Capacity, Power, Performance, Price

2.5” 15K rpm
76 GB, 8 w, 275 iops, $400

2.5” 10K rpm
146 GB, 9 w, 200 iops, $220

SSD 64GB
64 GB, 1 w, 800 iops, $750

3.5” 15K rpm
300 GB, 17.6 w, 260 iops, $600

3.5” 10K rpm
400 GB, 11 w, 200 iops, $400

3.5” 7200rpm
1000 GB, 7.6 w, 120 iops, $200

Samsung Storage...at the speed of imagination
Enterprise Storage: IOP/$ and GB/$

- **SSD (64G)**
  - 800iops/$750
  - 64GB/$750
- **3.5” 15Krpm**
  - 320iops/$350
  - 300GB/$350
  - 144GB/$420
- **2.5” 10Krpm**
  - 280iops/$300
  - 144GB/$300
- **3.5” 10K**
  - 220iops/$250
  - 400GB/$250
- **3.5” 7200 rpm (1TB)**
  - 120iops/$200
  - 1000GB/$200
Enterprise Storage: IOP/watt and GB/watt

800iops/1 watt
- SSD
  - 64GB/1 watt

380iops/7 watts
- 2.5” 15K rpm
  - 144GB/7 watts

320iops/16 watts
- 2.5” 10K rpm
  - 300GB/16 watts

220iops/11 watts
- 3.5” 10K rpm
  - 600/11

120iops/8 watts
- 3.5” 7200rpm (1TB)
  - 1000GB/8 watts

800iops/1 watt
- SSD
  - 64GB/1 watt
## Case Study

- **Internet Service Provider** - medical office software (real)
- Workload is mostly database – scheduling, billing, insurance claim processing. Very limited scanned documents
- 3,000 to 5,000 simultaneous users
- **Capacity:** **8.6 TB** - 60 drives – 15,000 rpm
- Storage Performance: **12,000** IOPs at typical Queue depth of 8

### Performance Optimized (PO)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP/watt</td>
<td>15.1</td>
<td>bad</td>
</tr>
<tr>
<td>IOP/$</td>
<td>0.29</td>
<td>bad</td>
</tr>
<tr>
<td>GB/watt</td>
<td>8.7</td>
<td>bad</td>
</tr>
<tr>
<td>GB/$</td>
<td>0.16</td>
<td>bad</td>
</tr>
<tr>
<td>TCO initial cost $</td>
<td>52,257</td>
<td>bad</td>
</tr>
<tr>
<td>TCO power $</td>
<td>4,892.43</td>
<td>bad</td>
</tr>
</tbody>
</table>

### SSD Optimized (PO)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP/watt</td>
<td>376.0</td>
<td>very good indeed</td>
</tr>
<tr>
<td>IOP/$</td>
<td>1.00</td>
<td>very good indeed</td>
</tr>
<tr>
<td>GB/watt</td>
<td>38.5</td>
<td>good</td>
</tr>
<tr>
<td>GB/$</td>
<td>0.10</td>
<td>bad</td>
</tr>
</tbody>
</table>

### SSD + 7200 1TB Optimized (PO + CO)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP/watt</td>
<td>28.4</td>
<td>good, 2x 15Krpm</td>
</tr>
<tr>
<td>IOP/$</td>
<td>0.31</td>
<td>OK, same as 15Krpm</td>
</tr>
<tr>
<td>GB/watt</td>
<td>83.5</td>
<td>very good indeed</td>
</tr>
<tr>
<td>GB/$</td>
<td>0.91</td>
<td>very good indeed</td>
</tr>
</tbody>
</table>

### TCO

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCO initial cost $</td>
<td>83,984</td>
<td>not so good</td>
</tr>
<tr>
<td>TCO power $</td>
<td>$1,100.80</td>
<td>good</td>
</tr>
</tbody>
</table>

#### Calculations:

- **15K rpm (PO)**
  - **IOP/watt:** 15.1 (bad)
  - **IOP/$:** 0.29 (bad)
  - **GB/watt:** 8.7 (bad)
  - **GB/$:** 0.16 (bad)
  - **TCO initial cost $:** $52,257 (bad)
  - **TCO power $:** $4,892.43 (bad)

- **SSD (PO)**
  - **IOP/watt:** 376.0 (very good indeed)
  - **IOP/$:** 1.00 (very good indeed)
  - **GB/watt:** 38.5 (good)
  - **GB/$:** 0.10 (bad)

- **SSD + 7200 1TB (PO + CO)**
  - **IOP/watt:** 28.4 (good, 2x 15Krpm)
  - **IOP/$:** 0.31 (OK, same as 15Krpm)
  - **GB/watt:** 83.5 (very good indeed)
  - **GB/$:** 0.91 (very good indeed)

**Note:**

- (PO) = Performance Optimized
- (CO) = Capacity Optimized
Conclusion

- **Enterprise SSD Drivers** –
  - User experience – business need to capture users (ad based), good user experience drives market share
  - Economics – the business need to deliver affordable performance **and** affordable capacity **and** low power

- **Enterprise SSD Enablers** –
  - PO/CO – performance optimized and capacity optimized storage with logic or processes to manage the hot data and cold data
  - SATA Enterprise adoption was the dress rehearsal for SSD adoption

- **Call to action** –
  - Be good to our customers through consistent use of KPC: IOP/$, IOP/watt, GB/$, GB/watt and simpler storage performance

SSD adoption drivers – User Experience, Economics and PO/CO
SSD(PO) adoption requires a bookend: 1TB 7200rpm (CO)
Web Advert Market

Google Sales Revenue - $16.6B in 2007

Source: NetRatings for SearchEngineWatch.com

- Google, 49.2%
- Yahoo, 23.8%
- MSN, 9.6%
- AOL, 6.3%
- Ask, 2.6%
- Others, 8.5%

Source – Google annual report 2007

Search MSS (000,000 per month)

Search MSS Growth (%)

Ad Imprints per week (39B)

Neilsen On-Line ad relevance June23-Jun29 2008