Solid State Storage
The Good, the Bad and the Ugly.

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Solid State Drives (SSDs)

Solid State Storage is the worst form of storage...
Solid State Drives (SSDs)

Solid State Storage is the worst form of storage, except for all the others.
Inside a Solid State Drive

NAND $$
Non-volatile Memory

Controller $$$$
• Wear Leveling
• Error Detection & Correction
• Bad Block Management
• Power Management

Interface $
SATA
SAS
FC
PCIe

Cache $
High performance SSDs use DRAM to accelerates data writes and prevents data loss due to power interruption

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• Wear Leveling
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NAND $$
Non-volatile Memory

Controller $$$$
### SSD Quality Grades

<table>
<thead>
<tr>
<th></th>
<th>Consumer</th>
<th>Enterprise MLC</th>
<th>Enterprise SLC</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Thumb Drives, Smart Phones, Tablets, Laptops/Desktops</td>
<td>Desktop, Direct Attached, Server Attached, Data Center</td>
<td>Data Center, Cloud, Financial, Government</td>
<td>-40C to +85C, Military, Transportation, Oil &amp; Gas</td>
</tr>
<tr>
<td>$/GB</td>
<td>$2</td>
<td>$5</td>
<td>$10</td>
<td>+$15</td>
</tr>
<tr>
<td>$ for 100GB</td>
<td>$100</td>
<td>$500</td>
<td>$1,000</td>
<td>$2,000</td>
</tr>
</tbody>
</table>
Most SSDs use the same memory.

NAND Manufacturing Market Share

- Samsung (Korea): 42%
- Toshiba (Japan): 28%
- Micron/Intel (Utah): 16%
- Hynix (Korea): 14%

Source: IHS Research 2011
How do memory manufacturers differentiate?

- Physically shrink the NAND
  - More chips per silicon wafer
  - Same voltage across a smaller floating gate
- Add more bits per NAND cell
  - Multi Level Cell NAND
  - More voltage across the gate

Requires more advanced SSD Controller technology = $$$. 
How do SSD manufacturers differentiate?

- **Memory Management** (Extending Life of SSD)
  - Extends the life of flash media to deliver enterprise-class endurance through advanced signal processing and adaptive flash management algorithms.

- **Error Management** (Extending Reliability of SSD)
  - A parity stripe inside the drive allows a RAID like capability to work to recover any lost data before an error has to be reported to the host. Given the shrinking geometries of the NAND, no SSD should ever be used that does not have this capability Bad Block Management.

- **Complimentary Software** (Providing Alternative Solutions)
  - Predicts most important data and moves it from HDD to SSD

* I did not mention speed and capacity.
Out of the gate, most any SSD can achieve fast read/write speeds. The quality is recognized after you’ve filled up the drive.

Why waste good money on engineers?
## SSD Power Advances

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Throttling</th>
<th>Reliability</th>
<th>Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per I/O, one SDD uses about the same power as 30 HDDs.</td>
<td>User controlled thresholds for speed and power consumption.</td>
<td>RAID on SSD allows for full chip failure.</td>
<td>10 Full Write &amp; Erase Cycles per day for 5 years.</td>
</tr>
</tbody>
</table>

$9,700 Upfront
16 Enterprise 500GB HDD

$4,900 Upfront
1 Enterprise SSD & 4 x 2TB HDDs

~4K IOPS
70/30 4K blocks
$3.90 / IO

~40K IOPS
70/30 4K blocks
$0.09 / IO

Objective: Accelerate Search
Accelerate
Database Queries
Web Searches
Reduce
User Wait Times
Power & Rackspace

- **$9,700 Upfront**
  - 16 Enterprise HDD at 80MB/s

- **$16,000 Upfront**
  - 4 Enterprise SSDs at 350MB/s

**Objective:** 1200MB/s Write Speed

- **Accelerate**
  - Database Queries
  - Web Searches
  - Audio/Video Recording
  - Office Applications
  - Replication/Backups

- **Reduce**
  - User Wait Times
  - Power per Transaction
  - Physical Footprint
  - Excess Drive Capacity
  - Cooling
Lessons from a roadside BBQ.

Price, Quality, Service.
Pick any two!
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