Session 101
Life Cycle Power Consumption
HDD Vs. SSD

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AGENDA

- Brief Description of HDD and SSD
- Major energy consuming steps
- Energy spent during the life of HDD and SSD
- Work load based power usage of HDD and SSD
- Directions for energy efficiency
- Concluding remarks
Description of HDD Vs. SSD

HDD

SSD

- **HDD Controller**
- **Dual CPU Core**
- **Read Channel**
- **Buffer Memory**
- **SATA Interface** (1.5 or 3.0 Gb/s)

- **SSD Controller**
- **Power Manager**
- **Buffer RAM**
- **NAND Interface**

- **Preamp**
- **Serial Interface, Read/Write Control**
- **VCM**
- **Serial Interface, Spindle/VCM Control**
- **POR**
- **+5V, -3V, +1.1V, +2.5V**

- **SOC**
- **RH SENSORS**
- **SHOCK SENSOR**

- **Page Buffer**

- **Controller**
- **Dual CPU Core**
- **Read Channel**
- **Buffer Memory**
- **SATA Interface** (1.5 or 3.0 Gb/s)
Energy Consumption in HDD Life

- Design Considerations
  - # of disks, rpm, disk diameter, data rate, css or lul, SOC line width, Seek profile, Helium or air, Spin up time trade off with starting power, work load management plan (firmware), power management strategy

- Key Components
  - Head, disk, motor, hda, soc, pcba

- Assembly & Test
  - Cleaning, servo pattern writing, burn in, tests

- Utilization
  - Duty cycle, seek profile, command execution path, background operations

- Data Recovery
  - Rework
  - Data transfer from one drive to another

- Recycling
  - Energy to convert drive into recycled product
Energy Consumption in SSD Life

- **Design Considerations**
  - # of Channels (buses) to NAND, Channel speed (40MB/s, 80MB/s, 133MB/s ...), # of NAND sharing a Channel, # of total NAND, Process technology (5x, 4x, 3x, 2x nm) for NAND manufacturing, Super-cap or battery backup, work load management plan (firmware), power management strategy

- **Key Components**
  - NAND, soc, pcba

- **Assembly & Test**
  - Multi-chip packaging of NAND dies, Multi-package stacking of NAND, tests

- **Utilization**
  - Duty cycle, hot / cold data management, command execution path, background operations, Preventive monitoring of NAND blocks, Bad block replacement, ECC

- **Data Recovery**
  - Rework
  - Data transfer from one drive to another

- **Recycling**
  - Energy to convert drive into recycled product
## Typical Energy Consumption

<table>
<thead>
<tr>
<th>Component</th>
<th>HDD (WH/unit)</th>
<th>SSD (WH/unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>360</td>
<td>150</td>
</tr>
<tr>
<td><strong>Key Components</strong></td>
<td></td>
<td></td>
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<tr>
<td>Head</td>
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<tr>
<td>Disk</td>
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<tr>
<td>Motor</td>
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<td>-</td>
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<tr>
<td>SOC</td>
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<td>-</td>
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<tr>
<td>Flash</td>
<td>-</td>
<td>200</td>
</tr>
<tr>
<td><strong>Assembly &amp; Test</strong></td>
<td>3100</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Recycling</strong></td>
<td>100k</td>
<td>100k</td>
</tr>
</tbody>
</table>

1 Horse power ~ 746 Watts
1 Watt Hour (WH) ~ 3600 Joules
Power consumption depends on workload and design.
Workload Based Power Usage (2)

SSD
TTR = ~1.3 seconds
Peak = 853mA

HDD
TTR = ~3.4 seconds
Peak = 786mA

Spin up/Power On

Idle Mode Power

Write Mode Power

Read Mode Power
With high IOPS and parallel processing in SSD
- Average power usage is much lower for SSD
- Instantaneous current draw can be high in SSD
- Operational power consumption is lower for SSD
Directions for Energy Efficiency

- **HDD**
  - Typically ~10% of system power
  - Higher areal density
  - ASIC wafer process line width & logic voltage
  - Low operating voltage
  - Lower rpm, data rate – trade off with performance
  - Duty cycle management
  - Resistance reduction (fewer disks, smaller disks, lower IR drop)

- **SSD**
  - Typically 5% of system power
  - Flash line width (higher density) & logic voltage
  - Lower operating voltage
  - Management of instantaneous current
  - Fewer components on PCBA