Industrial Embedded Technology for an Interconnected World
Can You See Inside Your SSD?

Scott Phillips
Director, Product Marketing at Virtium
Limited visibility into how SSD is functioning
Standard SMART data is limited and often cryptic
Managing NAND reliability and endurance is tricky

- Application workload affects SSD usage acceleration (+/-), which impacts SSD available life
- Temperature affects reliability, endurance, and data retention
Why is it Happening?

Fundamental NAND architecture requires careful management

Planar NAND Flash Cell Structure

Temperature Effects on NAND Flash Data Retention
Why is it Happening?

NAND data structure requires even more management
What to do About it

Provide ability to see what is happening inside the SSD

- Monitor workload and effects on SSD (e.g. life remaining)
- View usage acceleration impacts
- Develop “Smarter” SMART attributes
- View temperature vs. errors

Virtium’s vtView SSD Dashboard
Provide tools to optimize and control SSD operation

**Optimize for Performance**
- Firmware for specific application workloads

**Optimize for Endurance**
- Overprovisioning to lengthen available SSD life

**Optimize for Reliability**
- Built-in protection for high temp and power-loss

**Optimize for Power**
- Balance power and performance requirements

**Proactive Notification**
- Suggested maintenance, workload optimization
Data Alignment

- Understand the application’s data transfer patterns
- Try to coalesce host data into larger files that are aligned on 4/8/16K page boundaries

Smaller, unaligned data causes increase in SSD usage acceleration, which in turn increases latency and wears the SSD more rapidly
**SSD Endurance Tips**

### Overprovisioning
- Selecting the right SSD configuration requires knowledge of application workload
- Smaller, random data benefits greatly
- Larger, sequential data benefits marginally

### Effects of over-provisioning on SSD endurance and performance

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<tr>
<td><strong>Operating with Virtium Over Provisioning (OP)</strong></td>
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**Example:**
- **Write 1K Pages:**
  - Avoid whole block erase cycle to update only two pages in the block
  - Map new data to removed block in over-provisioning (OP) area
  - Eliminate two-operation cycles
  - During idle time (no host operation), perform garbage collection to manage available space and pre-erase OP blocks

- **Write Large Block:**
  - Avoids whole block erase cycle
  - Improves write performance

**Effects:**
- Write Amplification Factor
  - Write to OP
  - Write to NAND
  - Example:
    - 2.07

**Endurance:**
- NAND Write Cycles
  - 100K
  - Example:
    - NAND Write Cycles
    - OP: 100K
    - NAND: 100K
    - Example:
      - OP: 100K / NAND: 100K
      - Example:
        - 1.00

**Total Endurance:**
- NAND Write Cycles
  - 100K
  - Example:
    - NAND Write Cycles
    - OP: 100K
    - NAND: 100K
    - Example:
      - OP: 100K / NAND: 100K
      - Example:
        - 1.00

**Efficiency:**
- NAND Write Cycles
  - 100K
  - Example:
    - NAND Write Cycles
    - OP: 100K
    - NAND: 100K
    - Example:
      - OP: 100K / NAND: 100K
      - Example:
        - 1.00
Data protection during power loss

- In-flight data as well as firmware metadata at risk during power loss

![Diagram of voltage ramp down technique to save data during unexpected power loss]

$\Delta t$ determines by:
- RAM buffer cache size
- NAND write time
- Number of SSD channel

$\Delta t$ defines number of Capacitors and pre-charge voltage level

$\Delta t$ using capacitors pre-charge up to 20V
Preconditioning

- Shows SSD’s true “steady-state” performance
- **Goal**: Write to drives until a steady-state write pattern is achieved
- **Methodology**: Multiple full drive capacity writes with random, 4K, unaligned data

* Refer to JEDEC for published SSD benchmarking guidelines
“Software-defined storage” is coming.

IP still required to effectively manage storage block.

SoC

FPGA
Will You be Ready?

Align storage needs with value-added capabilities

- Not enough to rely on “integrators” providing lowest cost
- Align with suppliers providing expertise and value-add technology:
  - Firmware development and flash management expertise
  - Software tools to monitor/manage SSD
  - Flexibility to adapt SSD to application workloads and environmental conditions
It’s a Wrap!

For more information, go to:

http://www.virtium.com/resources/product-collateral/
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