Enterprise SSD Failure Analysis and Debug

Common Problems and Solutions

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Topics to cover

• Specifics of Enterprise SSD Failure Analysis
• Failure Symptoms and Root Causes
• Crash Dump
• JTAG Abstraction
• Event Tracking
• Vendor Unique Interface
• Incident Package
• Summary
Specifics of eSSD Failure Analysis

• Platform Diversity (OS, Chipsets, Adapters, Enclosures)
• Internal and Customer Qualifications last for at least a year
• Any field failure requires immediate explanations
• Inability to access customer environment / data centers
Failure Symptoms and Root Causes

- **Symptoms:**
  - Drive is not recognized
  - Command timeout
  - Performance degradation
  - SMART inconsistency
  - Boot up latency
  - Link issues
  - Unexpected command abort

- **Root Causes:**
  - Power Loss Recovery Bug
  - NAND Malfunction
  - DRAM Issues
  - Wrong Init Sequence
  - SMART Update Miss
  - Overheat
  - Broken POSCAP
Crash Dump = Hard Failure

- **Trigger:**
  - ASSERT condition

- **Dump:**
  - CPUs TCM and Stack
  - SRAM and DRAM portions
  - SOC registers

- **Solution:**
  - Flush Dump to NAND & Reboot
JTAG Abstraction over PCIe

- JTAG usage is simple
  - Memory / Register Read
  - View Stack Frame
  - Breakpoint Set
- It is not for Production
- Scaling JTAG equipment during massive sample Qualification is expensive
Event Tracking

• Every Failure is related to rear event (power on, link reset, NAND grown defect, overheat, buffer starvation)

• It is fine to log all corner case events with small meta information attached even in production

• SK Hynix owns US20190129774A1 patent related to the SSD Event Tracking in Firmware
Vendor Unique Interface

- Implemented over Host Protocol
- Opens reach debug functionality of SSD
- Gently secured in production
- Has Protocol specific alternatives (Telemetry)
To: SSD Vendor

• Gathers maximum from failed unit
• Available in Human Readable format
  • Drive to be self-descriptive
• Complete enough to withdraw the Drive
• Requires enhanced generation tool
  • Major Server OS and Drivers support
  • Support long Physical Connection chains
Summary

• Debug infrastructure support – high priority task
• It is good to enable debug features in production
• Fast Failure Analysis is greatly appreciated
• Phoenix Art: no matter what – keep the SSD alive