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
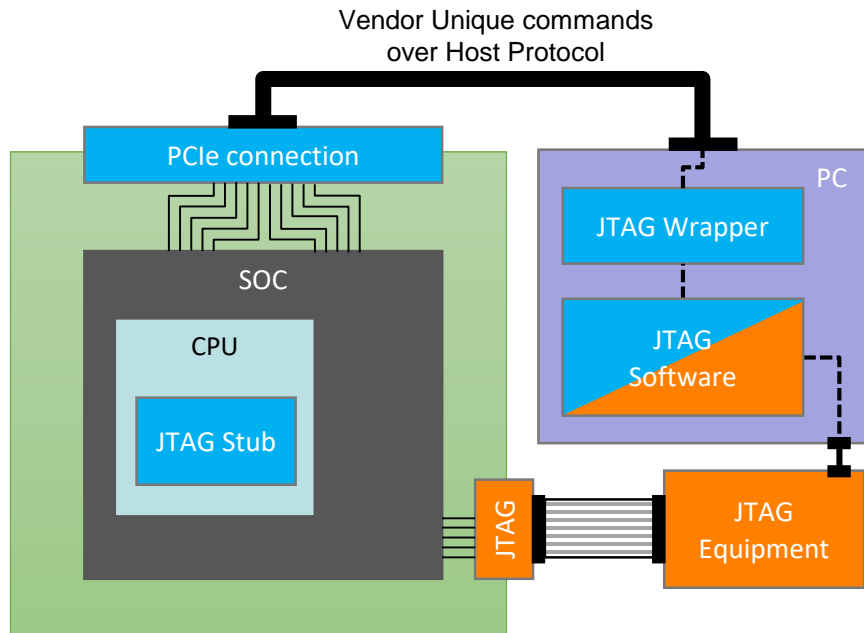   - Broken POSCAP

Crash Dump = Hard Failure
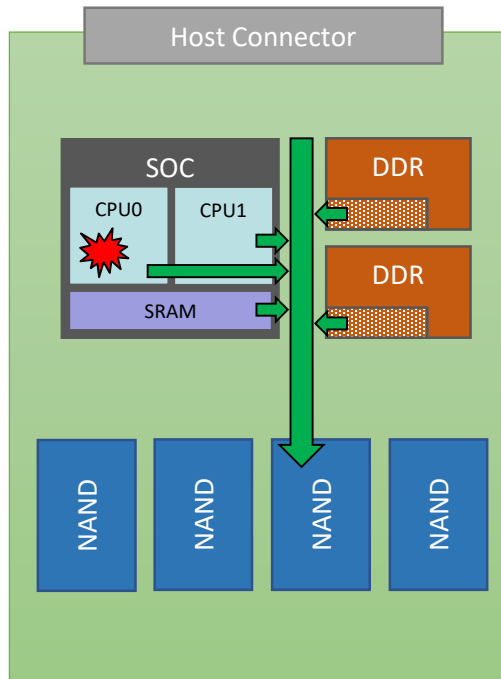
- <u>Trigger:</u>
  - ASSERT condition

- <u>Dump:</u>
  - CPUs TCM and Stack
  - SRAM and DRAM portions
  - SOC registers

- <u>Solution:</u>
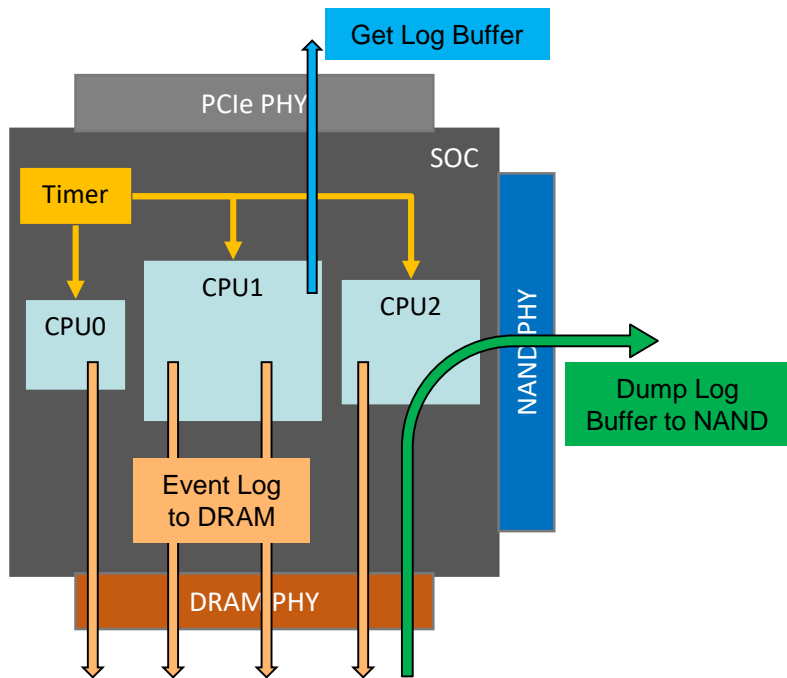 - Flush Dump to NAND & Reboot

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
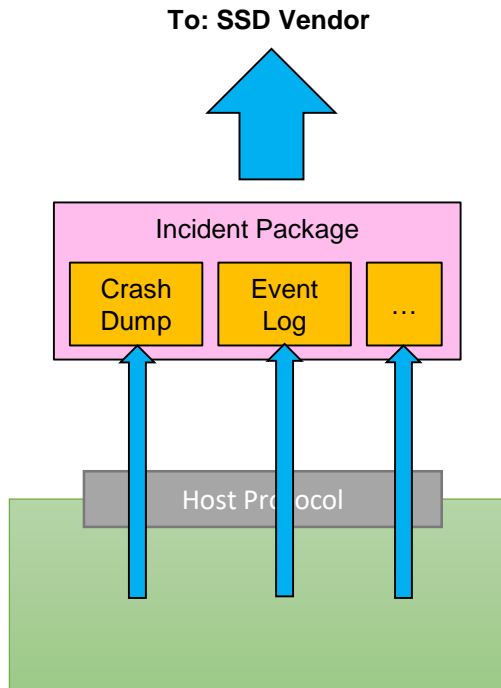
Vendor Unique Interface

- Implemented over Host Protocol

- Opens reach debug functionality of SSD

- Gently secured in production

- Has Protocol specific alternatives (Telemetry)

Incident Package

To: SSD Vendor

Incident Package

| Crash Dump | Event Log | ... |

Host Protocol

- 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