Qualification Process for Enterprise SSDs

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Storage Device Qualification
IBM has qualified several generations of SSDs across multiple products and form factors. The growth of the SSD Enterprise space will bring a wide variety of suppliers under consideration as candidates for qualification. This paper will discuss the process by which industry SSDs are qualified. Topics to be discussed include early joint qualification activity between IBM and the OEM, OEM qualification activity against an IBM supplied test plan, IBM Integration Test Cycle and IBM System Test cycles. These topics will include both industry standard qualification activities such as Safety and EMI/EMC Certifications as well as IBM specific activities. IBM specific test activities discussed would include Signal Integrity, Error Injection, Power, Thermal, and Performance testing. Recent qualification activities would now also include TCG/Encryption verification. A key factor for OEMs to consider is first-time data capture mechanisms to aid in quick resolution of problems. Discussion of the overall qualification process will provide a clear view of what is expected from OEM SSD suppliers looking to have their products qualified in an Enterprise product.
Agenda

- IBM Power SSD Product Offerings
- Qualification Stages
  - OEM Reliability Demonstration Test (RDT)
  - OEM Functional Test Cycle (FTC)
  - IBM Integration Test Cycle (ITC)
  - IBM System Test Cycle (STC)
- Industry Standard Testing
- IBM Specific Testing
- IBM/OEM Problem Resolution
IBM Power SSD Product Offerings

**MLC SSD 2.5” Form Factor**
- **Generation-1**
  - 200GB 2.5” SAS
  - 3Gb SAS
- **Generation-2**
  - 400GB 2.5” SAS
  - 6Gb SAS

**MLC SSD 1.8” Form Factor**
- **Generation-1**
  - 200GB 1.8” SATA
  - Bridge to 3Gb SAS
- **Generation-2**
  - 400GB 1.8” SATA
  - Bridge to 6Gb SAS
Qualification Stages

Power Systems Qualification Process / Schedule

Month 1 Month 2 Month 3 Month 4 Month 5 Month 6 Month 7 Month 8 Month 9 Month 10 Month 11 Month 12

FTC: 4-6 weeks
RDT: 6 weeks
ITC / SBT: 12 – 16 weeks
STR: 4 weeks
LNF: 8 weeks before SBT Exit
API: 4-6 weeks before STC
IRV: 4 weeks +
STC: 16 weeks

RDT – Reliability Demonstration Test – Performed at Supplier facility
FTC – Functional Test Cycle – Typically performed on Power Systems HW at Supplier facility
ITC – Integration Test Cycle – Performed by Power Systems Qualification Team
SBT – System Based Testing – Performed by Power Systems Qualification Team
STR – System Test Readiness – Owned & Performed by System Test Group
STC – System Test Cycle – Owned & Performed by System Test Group
IRV – Integration Reliability Verification – Owned & Performed by Power Systems Qualification Team

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OEM Reliability Demonstration Test (RDT)

- ~500 – 1,000 drives @ 1,000+ hrs
- Data Pattern
  - Randomly generated 4K compressed data pattern
- Work load
  - 80% - random
  - 20% - Sequential
- Read/Write Ratio
  - 50% Reads
  - 50% Writes
- Data Thru put
  - Total data throughput should be ~1 Terabyte per day on each Drive in this RDT.
- Power Cycles
  - 6 power on/off cycles performed per day, one every 4 hours
Qualification Stages

OEM Functional Test Cycle (FTC)

Month 1 Month 2 Month 3 Month 4 Month 5 Month 6 Month 7 Month 8 Month 9 Month 10 Month 11 Month 12

ITC / SBT 16 weeks
LNF 8 weeks before SBT Entry
STR: 4 weeks
STC: 16 weeks
IRV: 4 weeks +

FTC – Functional Test Cycle

Typically performed on Power Systems HW at Supplier Facility (~35 – 50 drives)

- Vital Product Data (VPD) / Log Verification
- System Configuration Runs / RAID Exercisers
- Good Path
  - Downloads
  - Formats
  - Protocol Testing
  - Change Definition
- Error Injection
  - Thermal
  - Abort Testing
  - ECC / PGList Testing

- Performance
- First Time Data Capture
  - Blink Light Verification
  - State Dump Verification
  - Bug List Verification
- Power
  - EPOW
  - Hot Plug Test
  - Backup Power Fall
  - Power Surge
Qualification Stages

IBM Integration Test Cycle (ITC) / System Base Testing (SBT)

Month 1  Month 2  Month 3  Month 4  Month 5  Month 6  Month 7  Month 8  Month 9  Month 10  Month 11  Month 12

ITC / SBT
12 – 16 weeks

STR:
4 weeks

LNF
8 weeks before SBT Exit

API:
4-6 weeks before STC

IRV:
4 weeks +

STC:
16 weeks

GA
2 weeks after STC exit

ITC - Integration Test Cycle / SBT – System Base Testing

Performed on Power Systems HW by Power Systems Qualification Team
(~200 drives per capacity)

- Vital Product Data (VPD) / Log Verification
- System Configuration Runs / RAID Exercisers
- Good Path
  - Downloads
  - Formats
  - Protocol Testing
  - Change Definition
- Bad Path RAID Testing
- Error Injection
  - Thermal
  - Abort Testing
  - ECG / FGList Testing

- Performance
- Simulated Customer Workloads
- First Time Data Capture
  - Blink Light Verification
  - State Dump Verification
  - Bug List Verification
- Power
  - EPOW
  - Hot Plug Test
  - Backup Power Fail
  - Power Surge
- Operating System Install / Boot / Compatibility
**IBM System Test Cycle (STC)**

**Qualification Stages**

- **FTC**: 4-6 weeks
- **ITC / SBT**: 12 – 16 weeks
- **LNF**: 8 weeks before SBT Exit
- **STR**: 4 weeks
- **API**: 4-6 weeks before STC
- **IRV**: 4 weeks +
- **STC**: 16 weeks
- **GA**: 2 weeks after STC exit

**STC - System Test Cycle**

Performed on New Power Systems by System Test

(≈200 drives per capacity)

Exercisers and Operating Systems

Official Test Cycle for New Machines prior to Announce / General Availability

- Expanded Testing on new Machine Type / Models
- Testing under Operating System
  - IBM I
  - AIX
  - Linux
  - Includes other IO (DVD, Tape, Optical)
Industry Standard Testing

- Safety Certification (OEM)
  - Confirm supplier met all required safety Certifications in IBM Purchase Specification

- System-Level EMI/EMC (IBM)
  - SSD is tested against EMI/EMC Industry Standard Specifications, in IBM Systems
IBM Specific Testing

- Signal Integrity
  - Jitter and Eye Measurements
  - Error Injection
    - Bad site handling to stress SSD error recovery (ECC)
    - Interface Errors (abort tag testing)
- Power
  - Repeated power drop and confirm data
  - Measure power draw on power up
  - Hot Plug Testing
  - Break backup circuit (SuperCap), power cycle and confirm failure detected and no unknown data loss
IBM Specific Testing (Cont)

- Thermal
  - Heat drive, confirm:
    - Warning message
    - Proper functionality (throttling)
- Performance
  - Measure performance in single drive and multi drive arrays, in IBM Systems, against known workloads (vary qdepth, transfer size, r/w percentage and cache utilization).
- Guardband
  - Temperature & Voltage corners
- Classical Testing
  - Power Line Disturbance, Lightning Strike, etc.
IBM Specific Testing (Cont)

- Encryption Testing
  - Confirm drives meet TCG specification and IBM Purchase Specification
    - Create Bands
    - Verify functionality with exercisers
  - Futures Specs TBD
Typical OEM Problems Discovered

- System Incompatibility
  - IBMi and AIX OS incompatibility
  - IBM unique SAS controller incompatibility
  - IBM unique FW requirement (NACA, Skip, etc)
  - Dual Initiator Issues
  - Power Cycle and Power Loss issues

- VPD Mismatch
  - Inquiry and Mode pages do not match IBM spec

-> Most of these issues can be prevented if OEMs test their devices using IBM HW/SW/OS
IBM/OEM Problem Resolution

• First Time Data Capture
  • Target is to gather sufficient first time data to identify root cause of problem event
    • Review data available from drive (log pages), state dump data to ensure drive is capturing sufficient data to debug most problems.
    • IBM will force a state dump and then ask supplier to tell us what was going on at the time of dump to confirm supplier captures enough data.
  • Gather statistical data to assess performance of drive anomalies
For More Information

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