Improved Drive Qualification Methods for Enterprise SSDs

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Abstract

Abstract: SSD suppliers are bringing improved products and new technologies, such as NVMe, to market at a breathtaking pace. How do we keep qualification procedures up-to-date? Enterprise OEMs must partner with SSD suppliers to accelerate the cycle time of drive qualifications, improving time-to-market. Joint Drive Qualification (JDQ) activities are essential and benefit both OEMs and SSD suppliers. Critical issues include determining test system requirements, sharing qualification drives, and developing common test strategies. In particular, we will discuss opportunities for OEMs to share their early, non-production systems and application specific test scripts with the drive suppliers and in turn, SSD supplier should look to share early-ship versions of their drives to the OEMs for the purpose of starting qualification activity earlier. This will result in shifting problem discovery and resolution earlier in the qualification process, which will lead to higher-quality product introductions, even in a fast-changing, competitive marketplace.

Agenda

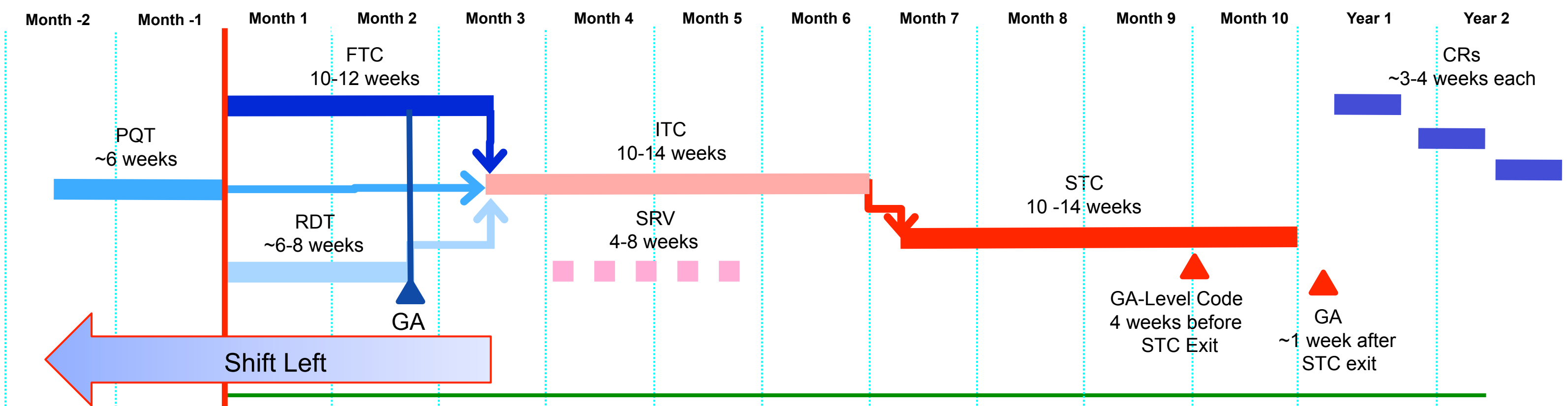
- Partnership Agreements - Enterprise OEM / SSD Supplier
- SSD Qualification Stages
  - SSD Supplier Activity – Joint Drive Qualification (JDQ)
    - Supplier Pre-Qual Test (PQT)
    - Reliability Demonstration Test (RDT)
    - Functional Test Cycle (FTC)
    - Code Regressions (CR)
  - Enterprise OEM Activity
    - Integration Test Cycle (ITC)
    - System Test Cycle (STC)
- Recent Experiences/Challenges

Partnership Agreements

- Enterprise OEM
  - Willingness to loan suppliers pre-production or early-production systems
    - Option for SSD Suppliers to purchase HW for long-term usage
  - Willingness to share custom in-house test scripts
    - Scripts need to be up-to-date and representative of OEM testing
  - Willingness to train SSD Supplier personnel in use of custom test scripts
- SSD Suppliers
  - Willingness to loan, share or sell pre-production drives
    - Engineering Samples & Qualification-Level Drives
  - Willingness to include OEM test scripts in SSD development cycle
    - Allows supplier to preview Qualification testing
  - Willingness to provide engineering personnel dedicated to OEM system usage/ testing
  - Willingness to provide debug tools with First Time Data Capture capability
- Both Enterprise OEMs / SSD Suppliers
  - Understanding that Shift-Left testing is on ‘early’ HW and FW and mistakes will be made prior to ‘Production-Level’ drives and systems

Qualification Process Model

(Not all stages required for every System/Drive – Stages may overlap – Stages may be shorter)



SSD Supplier Activity

PQT – Pre-Qual Test – Performed Prior to Qual Start at Supplier facility on OEM Systems (Preview FTC)

RDT – Reliability Demonstration Test – Performed at Supplier facility on supplier Test Equipment (Signifies end of Supplier Dev Cycle)

FTC – Functional Test Cycle – Performed at Supplier facility on OEM Systems

CR - Code Regressions – Performed at Supplier facility on OEM Systems (Post GA)

Qual Award

Enterprise OEM Activity

ITC – Integration Test Cycle – Performed by OEM Qualification Team

SRV – System Reliability Verification – Performed by OEM Qualification Team (Not typically used, Duplication of Supplier RDT)

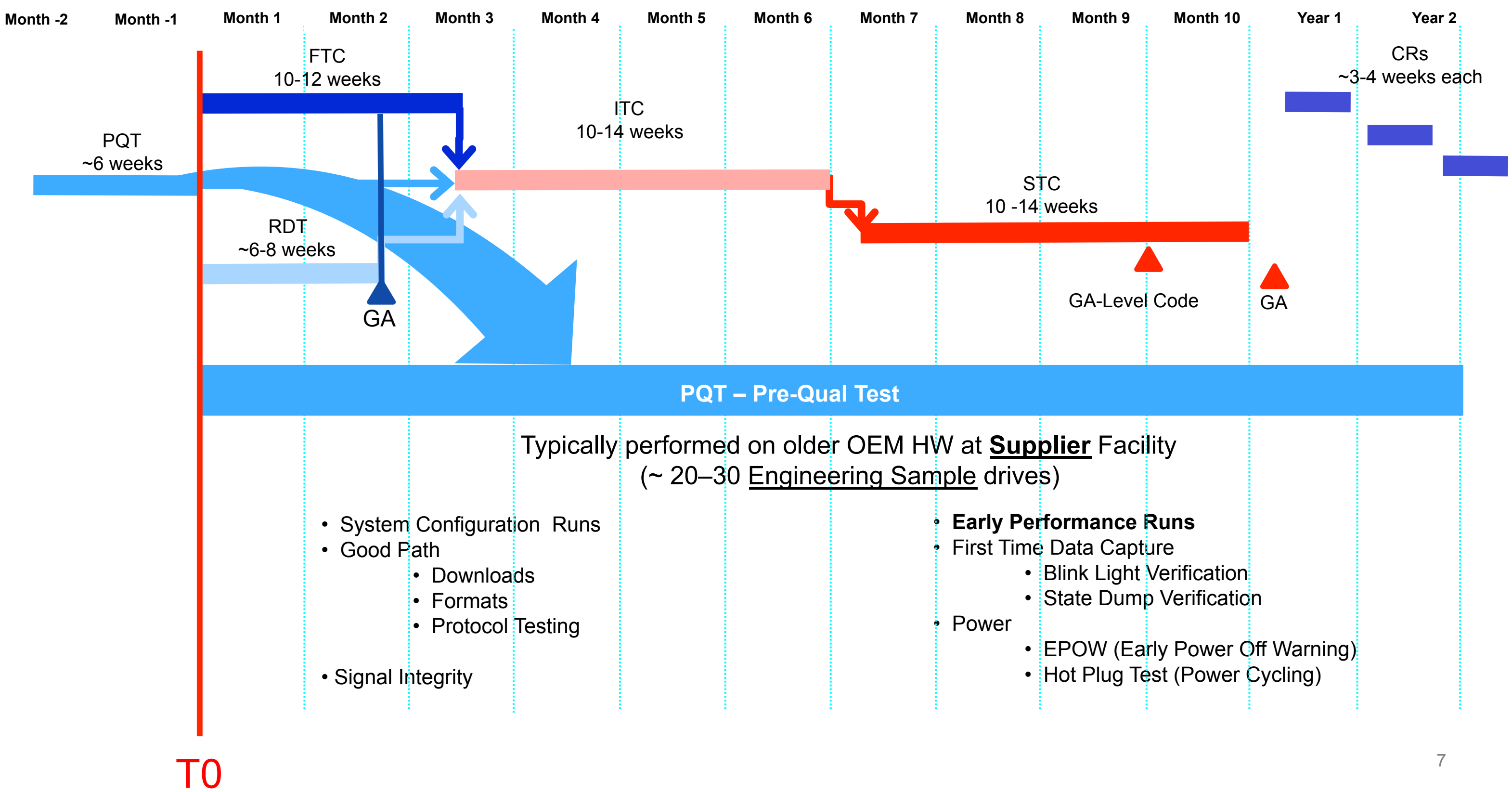
STC – System Test Cycle – Performed by OEM System Test Team

T0

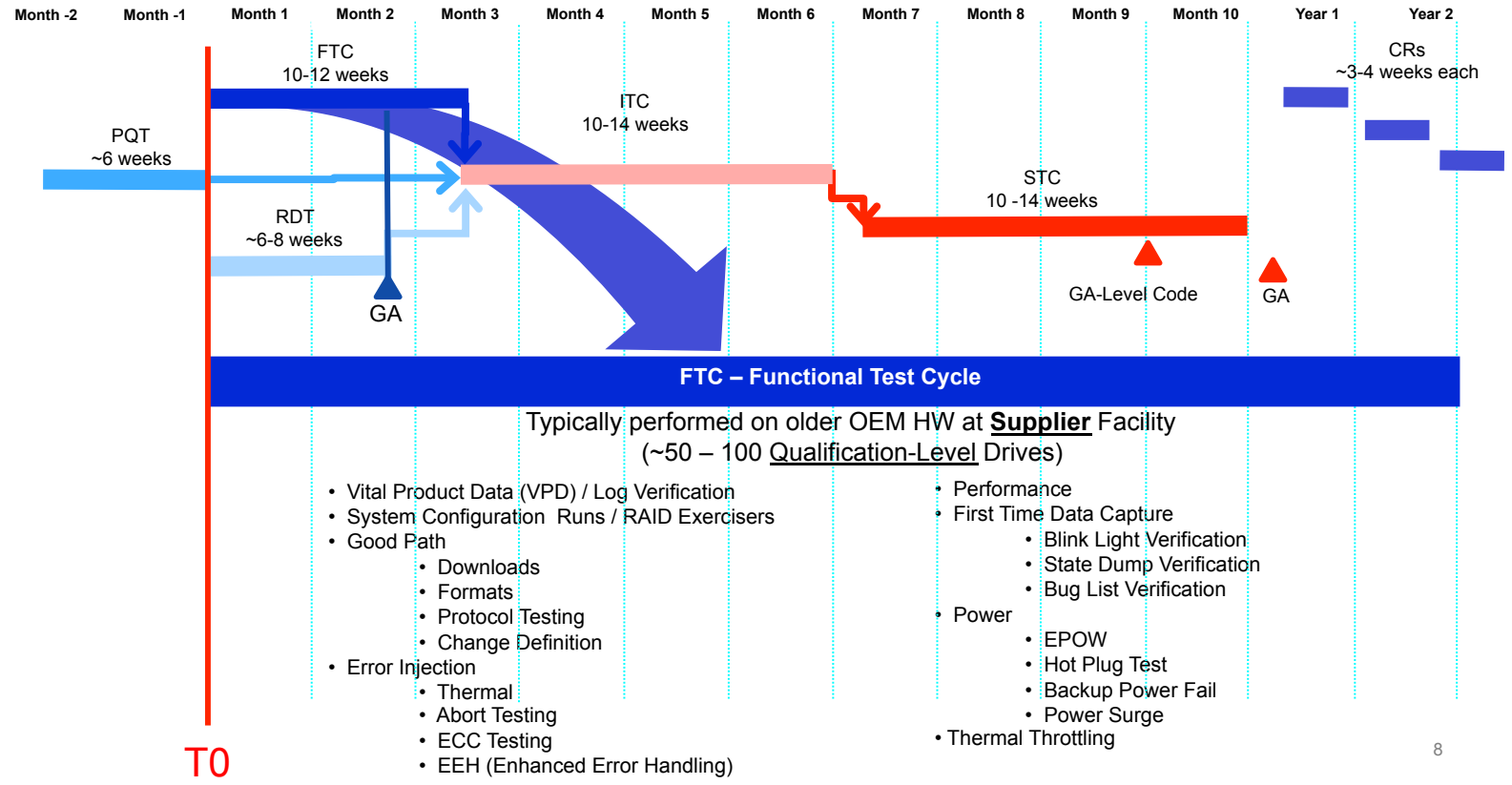
GA – General Availability (Product Ship Support)

SSD Supplier Activity

Supplier Pre-Qual Test (PQT) – Performed by SSD Supplier



Functional Test Cycle (FTC) – Performed by SSD Supplier



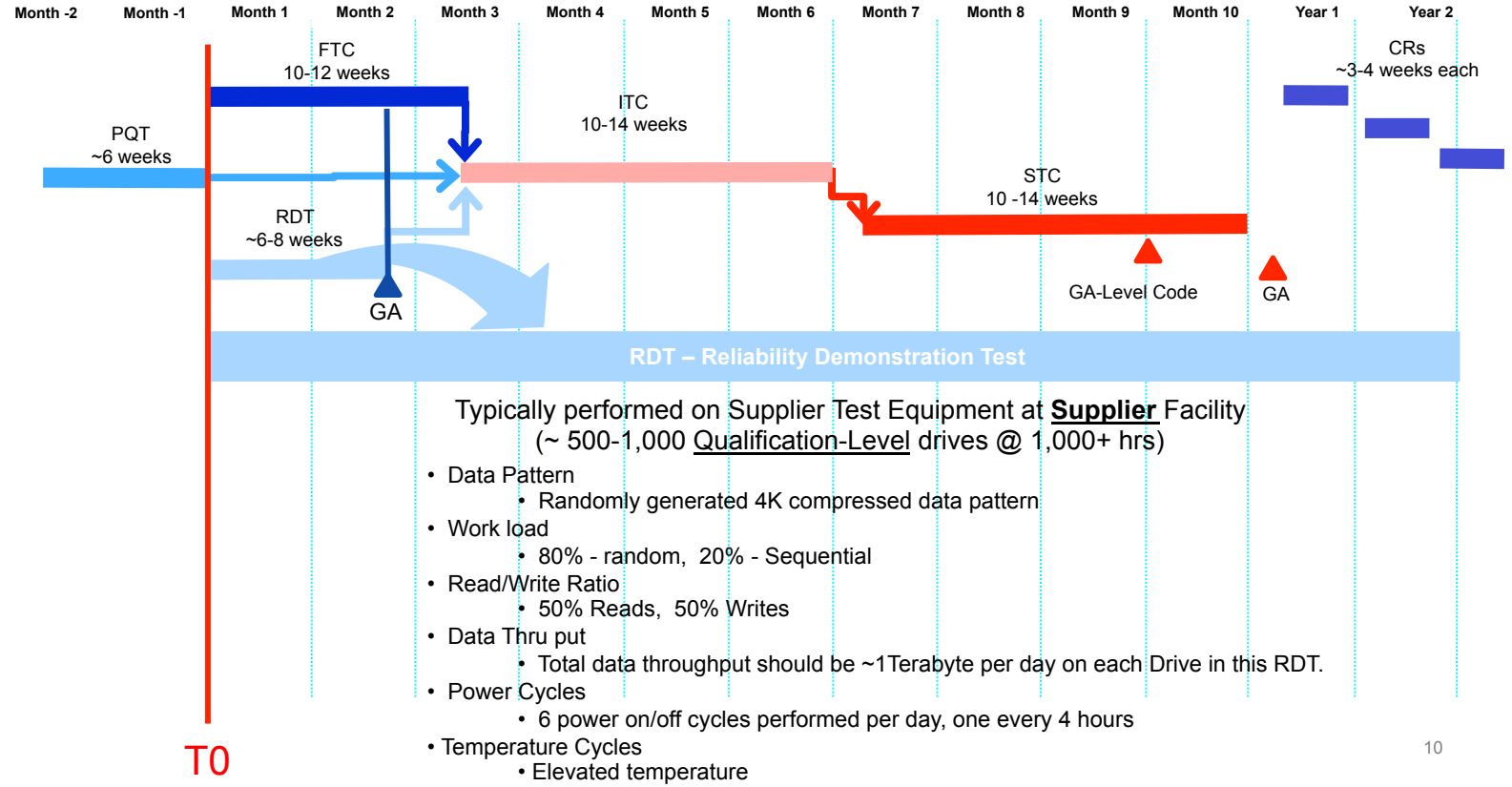
Typically performed on older OEM HW at **Supplier** Facility
(~50 – 100 Qualification-Level Drives)

- 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 Testing
  - EEH (Enhanced Error Handling)
- Performance
- First Time Data Capture
  - Blink Light Verification
  - State Dump Verification
  - Bug List Verification
- Power
  - EPOW
  - Hot Plug Test
  - Backup Power Fail
  - Power Surge
- Thermal Throttling

FTC Implementation

1. OEM provides Test Plan to supplier (Specific for each project)
    - OEM Systems HW/SW requirements included
        - Supplier may need to loan/purchase OEM HW prior to testing
2. Supplier Commitment for plan execution
    - Supplier: OEM Systems availability
    - Supplier: 'Drives under Test' availability, including unique OEM Firmware
    - Supplier: Staffing availability
    - Supplier: Detailed schedule for FTC Entry through FTC Exit
3. Supplier meets FTC Entry criteria and begins FTC execution
4. Scheduled Interim Checkpoints (3, 6, 9, 12 weeks)
    - OEM purchase of qualification drives based on FTC Checkpoints
        - FTC Checkpoint 1 (20% Complete) – PO's submitted to supplier for ITC-Level Drives
        - FTC Checkpoint 2 (50%) Complete – ITC Entry
        - FTC Checkpoint 3 (70% Complete) – PO's submitted to supplier for STC-Level Drives
        - FTC Exit/Chkpt 4 (95% Complete) - STC Entry
5. If Supplier not tracking to agreed upon FTC Schedule…
    - OEM/Supplier discuss project 'Go/No Go', based on FTC checkpoints

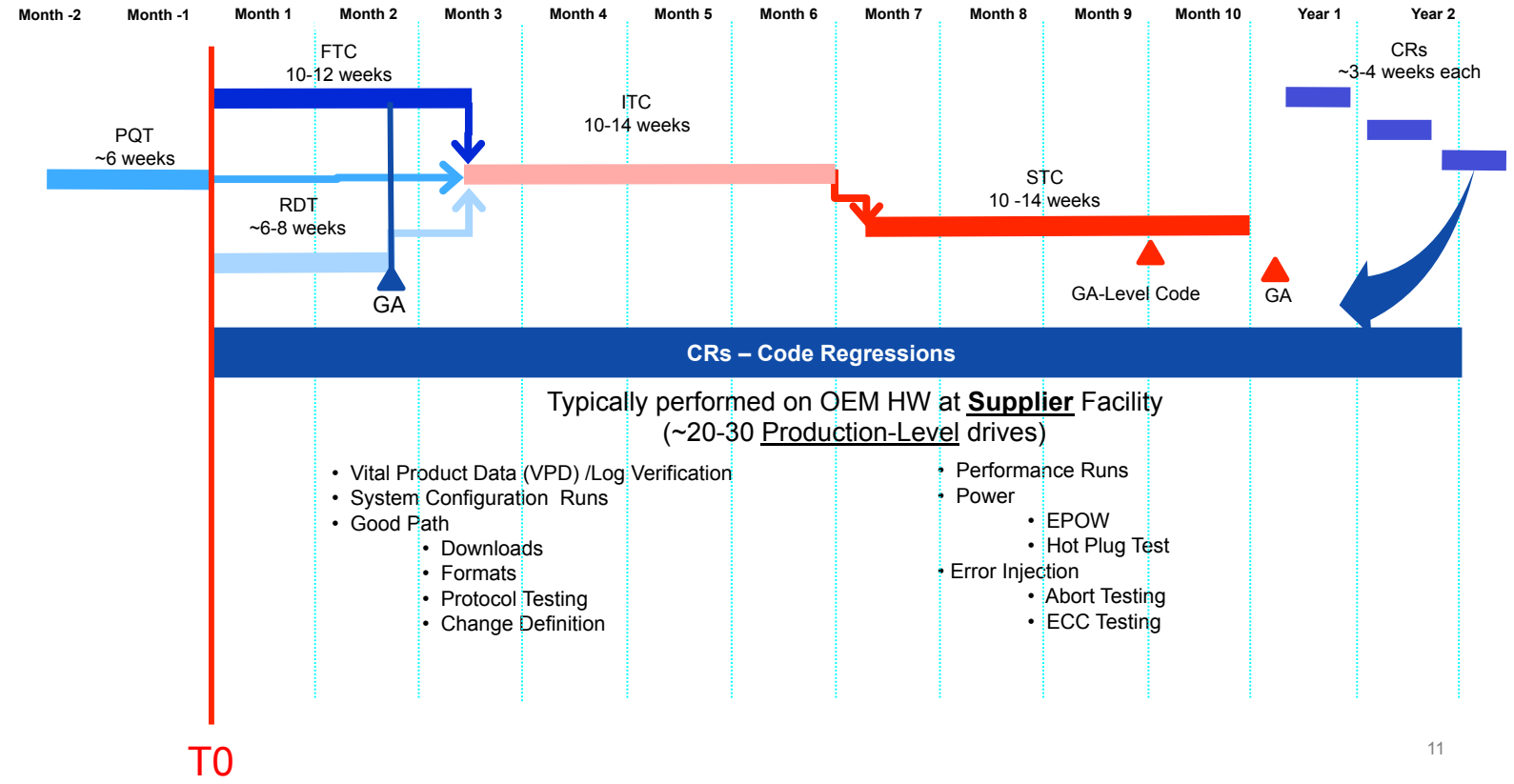
Reliability Demonstration Test (RDT) – Performed by SSD Supplier



Typically performed on Supplier Test Equipment at **Supplier** Facility
(~ 500-1,000 Qualification-Level 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 ~1Terabyte per day on each Drive in this RDT.
- Power Cycles
  - 6 power on/off cycles performed per day, one every 4 hours
- Temperature Cycles
  - Elevated temperature

Code Regressions (CRs) – Post GA, Performed by SSD Supplier

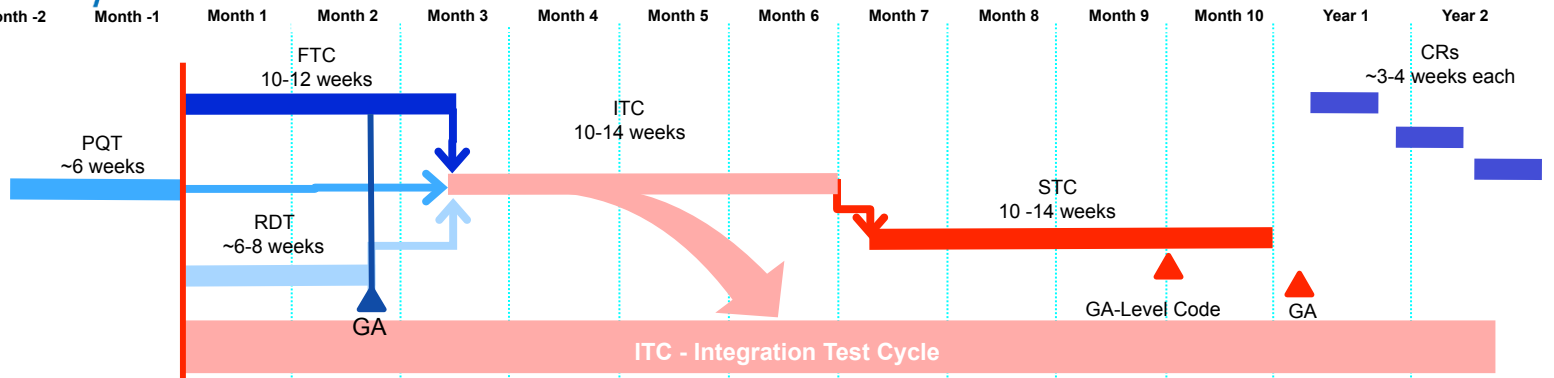


Code Regression (CR) Implementation

1. OEM provides CR Plan to supplier (Specific for each project)
    - OEM System HW/SW requirements included
2. Supplier Commitment for plan execution
    - Supplier: System availability
    - Supplier: Staffing availability
    - Supplier: 'Drives under Test' availability, including Regression code
    - Supplier: Detailed schedule for Code Regression
3. Supplier meets Entry criteria and begins CR execution
    - OEM reviews incremental results and provides feedback to supplier
4. Once supplier completes CR, OEM team moves new code to System Test
    - OEM/Supplier support any issues discovered in System Test
5. After System Test completes, OEM releases new code to the field

Enterprise OEM Activity

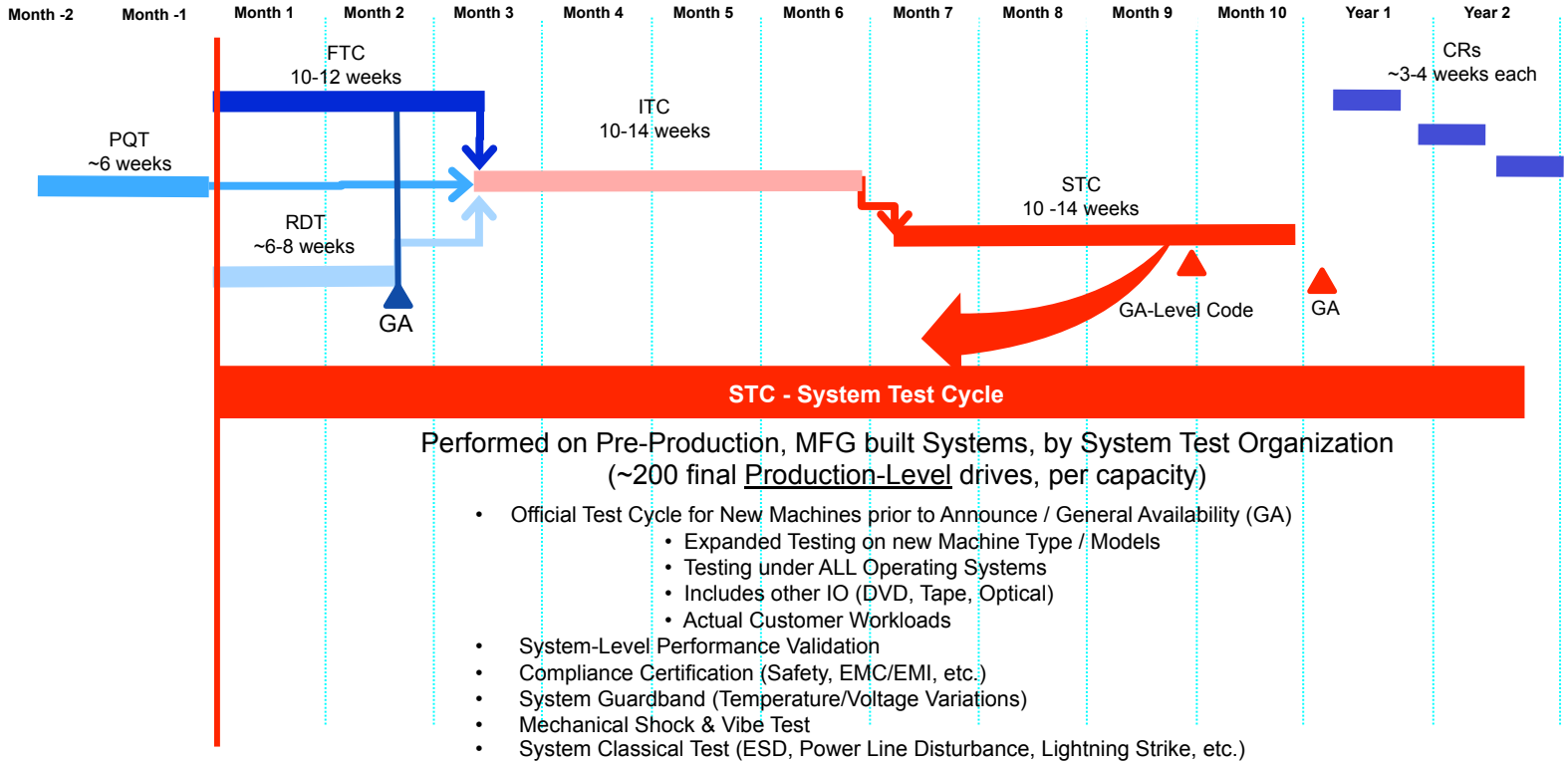
Integration Test Cycle (ITC) – Performed by OEM



Performed on Pre-Production, Development-Level, OEM System HW by OEM Qualification Team
(~100 Qualification-Level 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
  - ECC Testing
  - EEH
- Interoperability: New/Old Systems, Drawers & Drives
- Drive-Level Performance Validation
- 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
- Thermal Throttling
- Signal Integrity
- Operating System Install / Boot / Compatibility

System Test Cycle (STC) – Performed by OEM



Performed on Pre-Production, MFG built Systems, by System Test Organization
(~200 final Production-Level drives, per capacity)

- Official Test Cycle for New Machines prior to Announce / General Availability (GA)
  - Expanded Testing on new Machine Type / Models
  - Testing under ALL Operating Systems
  - Includes other IO (DVD, Tape, Optical)
  - Actual Customer Workloads
- System-Level Performance Validation
- Compliance Certification (Safety, EMC/EMI, etc.)
- System Guardband (Temperature/Voltage Variations)
- Mechanical Shock & Vibe Test
- System Classical Test (ESD, Power Line Disturbance, Lightning Strike, etc.)

Recent Experiences/Challenges

Typical Problems Discovered

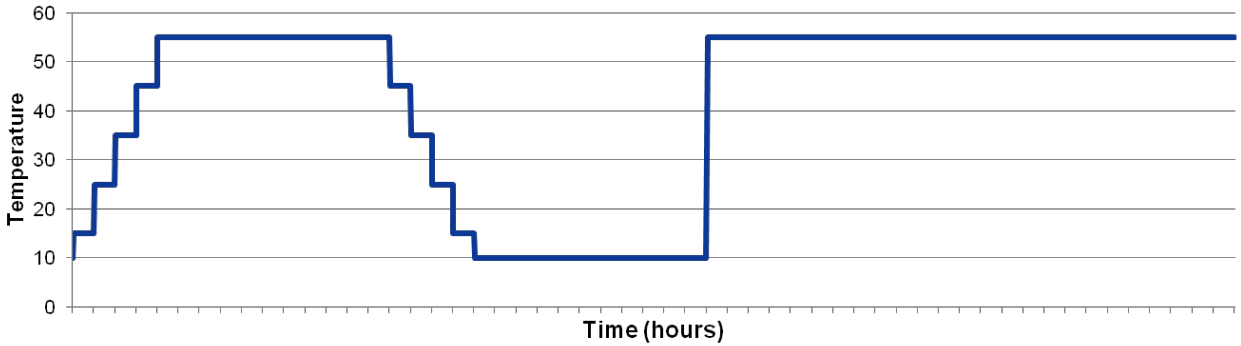
- System Incompatibility
  - OEM OS incompatibility
  - OEM I/O controller incompatibility
  - OEM unique FW requirements
  - Power Cycle and Power Loss issues
  - FW download failures
  - Bus error injection issues
- VPD Mismatch
  - Inquiry and Mode pages do not match OEM specification
- Performance mismatches
  - SSD not meeting stated SSD Supplier criteria on OEM Systems
  - SSD not matching performance of alternative source SSDs
- Thermal Issues
  - Drives running over temp in OEM Systems

For More Information

- Contact:
  - Jeff Fritzjunker, Manager, IBM Storage Device Qualification
    - jfritz@us.ibm.com
    - (507) 253-0058

Backup Charts

Reliability Demonstration Test (RDT) – Performed by Supplier



Reliability Demonstration Test – Sample Profile

Supplier Code Regression (CR) - Benefits

- Enterprise OEM Benefits
  - Earlier regression start date: Since SSD suppliers see the code several days before OEMs do, they can start test earlier.
  - Better test coverage: Although OEMs normally run a generic regression test plan, SSD suppliers know exactly what changed so they can modify/add test(s) to verify the fix.
- SSD Supplier Benefits
  - May find issues sooner and closer to the source (at supplier).
  - Fuller utilization of investment in OEM Systems hardware.
  - Closer alignment with OEM Qualifications.