GLAST Large Area Telescope

LAT Flight Software

Post-Test Review
April 18, 2006

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Comments/Recommendations

- Forms available for recommendations
- Indicate recommended closure milestone
  - Required for acceptance
  - Δ-FQT
- Will review at end of PTR

Review Team

- Co-Chairs
  - Lowell Klaisner
  - Al Vernacchio

- Members
  - Erik Andrews
  - Tom Venator
  - Bernie Graf
  - Randy Worden
  - Jack Leibee
  - Shirley Savarino
  - David Dymm

Scope and Objectives

- FQT
  - Formal verification of core FSW
  - Ran 45 tests addressing 149/183 total requirements
- PTR Goals
  - Review test products to confirm tests successfully completed
  - Confirm requirements verified
  - Formally accept FSW B0-6-6

- ∆-FQT
  - Additional 12 tests will address remaining 34 requirements
  - Additional functionality: GRB detection and response, diagnostic functions associated with new filters, and software standards

Schedule

- ✓ 30 March : Test Readiness Review (TRR)
- ✓ 1-9 April : Script Dry Runs/Closure
- ✓ 11-14 April : FQT
- 18 April : Post Test Review (PTR)
- 1 May : GRB Detection Algorithm Requirements
- 1 June : Build V1-0-0 for ∆-FQT
- 8 - 9 June : ∆-FQT

FQT Personnel

- Test Director: Sergio Maldonado
- LAT SQE: Kelly Burlingham
- Test Conductors: Sergio Maldonado, Shantha Condamoor
- LAT FSW SE & GSFC witness: Mike DeKlotz
- GSFC SQE witness: Randy Worden

Test Report Summary

- All 45 tests passed, verifying the planned 149 of 183 total FSW requirements
- 40 passed with no or minor deviations for typos in test procedures
- 2 tests experienced network difficulties loading SW to the testbed
  - This is a known data flow lab issue, seeming to affect ~5-10% of test runs
  - These tests were rerun and completed successfully
- 1 test required rerun due to improper EGSE configuration
- 1 test required rerun due to operator input error
- 1 test had discrepancies between procedure document and script. These were resolved through examination of the script to confirm all required test cases were executed. (FSWTS-1)

SQE Assessment

- FQT runs
  - Validated configuration prior to test execution
  - Witnessed and approved test execution
- FSW-related Quality Documentation up to date
  - LAT-MD-00091 LAT Quality Manual
  - LAT-MD-00472 Corrective & Preventive Action
- Test Procedures are complete and in LATDocs, Test Scripts are in CVS and all are under CCB control
- Helped prepare final documentation package to include:
  - DID 335; Flight Software Requirements Specification
  - DID 336; Software Test Plan
  - DID 337; Software Test Procedures and Software Test Reports
  - DID 339; Software Management Plan
  - DID 340; Software/Algorithm Design Document
  - Version Description Document
  - Complete Code and Test Script Package
- Prepare archive of Quality Records
- Requirements Matrix has been verified

Requirements Verification

- Requirements to Test Matrix in Test Report
- Requirements Traceability
  - Audit of requirements flowdown from parent specifications to the FSW specification performed by LAT SE
    - All issues resolved
    - Traceability to parent requirements maintained in DOORS database

Document status

- See: http://www.slac.stanford.edu/exp/glast/flight/web/FSW_final_ptr.shtml

Document	LATDoc No.	Status
FSW Requirements Specification	SS-00399-06	Approved
FSW Software Management Plan	MD-00104-04	Approved
FSW Flight Unit Design Document	TD-07282-01	Draft complete
FSW Test Plan	TD-00786-04	-05 updates in approval process
FSW Test Procedures	See FSW Web site	Approved
FSW Test Report	TD-08126-01	Complete
Telecommand and Telemetry Formats	TD-02659	Autogenerated for each build.
LAT Configuration Management Plan	MD-00068	Approved
GLAST LAT Quality Manual	MD-00091	Approved
FSW – Instrument ICDs	See FSW Web site	Approved
FSW Build Procedure	TD-07275	Complete
FSW Maintenance Plan	TBS	To be delivered before final FSW post-test review
FSW-ISOC ICD	SS-05141	To be delivered before final FSW post-test review
FSW VDD	TD-07757	Complete
FSW User Guide	TD-07665	In approval process

Deliverables list

- In addition to the relevant documents, the following items are archived as part of the formal delivery
  - FSW code
  - Telecommand and telemetry .dbx files
  - Test scripts
  - Test input & output files

Summary

- All 45 planned tests run successfully
- FSW Test Team recommends formal acceptance of FSW B0-6-6 as verifying the identified subset of FSW requirements

Backup Slides

- FSW Design Overview
- Configuration Management
- Safety
- Issue resolution process
- Regression testing process
- NASA IV&V

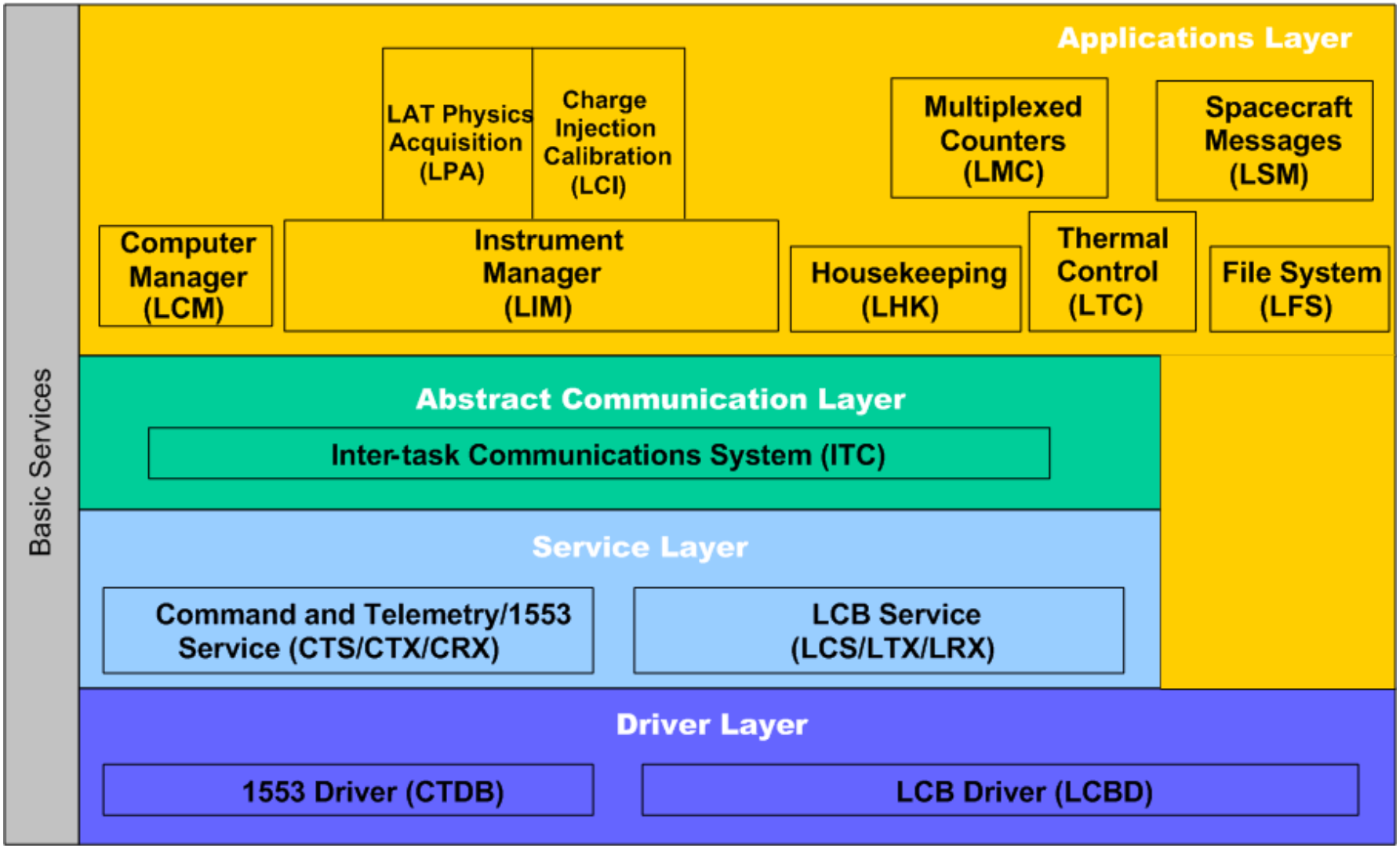
FSW Design: System Summary

- **FSW is a multi-CPU system that processes detector data delivered by the LAT Trigger and Dataflow System. Two classes of CPU are employed:**
  - **On the Spacecraft Interface Unit (SIU), FSW provides the command, control and configuration functions and:**
    - **Supports 1553 and discrete line hardware interfaces with the spacecraft**
    - **Manages collection and delivery of all instrument health and safety data**
    - **Makes adjustments to LAT thermal control**
    - **Performs transient monitoring and processes/responds to transient alerts**
    - **Manages operational modes**
    - **Manages the charge injection calibration process**
  - **On the Event Processing Units, FSW:**
    - **Filters data produced by the T&DF system**
    - **Collects EPU health and performance data**

FSW Design: System Summary (2)

- **Primary Boot**
  - Initialize CPU, cPCI bus, and other hardware in each crate
  - Provide boot shell interface for file and memory loads and reads
  - Send boot housekeeping telemetry
- **Secondary Boot**
  - Load RTOS, FSW application code libraries, and initialize
  - Once the SIU and EPUs have completed secondary boot, various Operational Modes are supported (e.g., PHYSICS, CALIBRATION, etc.)
- **Once secondary boot is complete, FSW operates under the VxWorks 5.5 RTOS:**
  - FSW runs as a collection of VxWork “tasks”, which are analogous to Unix processes, but share a common address space
    - Master and slave tasks
  - Tasks communicate within a CPU and between CPUs through a custom-built inter-task communications system
  - Task scheduling is performed using standard priority-based preemptive scheduling

FSW Design: Layer Architecture for Application Mode FSW



Configuration Management

- Hardware
  - Hardware database used to keep track of units/versions
    - All hardware units are assigned a GLAT# (bar coded)
    - GLAT# recorded in LAT-DS-03541
  - Each FPGA also has unique VHDL# (stored electronically)
    - HW version info available in diagnostic telemetry packet
- FSW and Test scripts
  - CMX
- Documents
  - LATDocs

Code Version Control

- **CMX (Test Procedures and Test Scripts)**
  - Command-line driven code management tool built on the CVS and CMT systems
  - Developed and maintained by the FSW Development Team
  - Tracks source files as they are checked in and out (with transaction logging)
  - Defines lists of files and file/versions within the library
  - Test Team engineers check out source files into private areas, modify them, test the changes then check them back in.

- **FMX (FSW Builds)**
  - Used by the Test Team to create “uploadable” builds, each defined by a specification file
  - FMX processes a list of FSW packages by version, then outputs encoded, compressed library and configuration files for upload
    - File numbers/IDs assigned automatically according to location in a random access database table
  - FMX also produces a startup and initialization file used by the secondary boot code to locate and load software modules during boot

Safety

- **FSW Safety**
  - **To date, no FSW component has been identified as safety critical by Project Management.**
  - **Should that situation change, the FSW Development Team will conduct a software safety program on the identified component that complies with NASA-STD-8719.13A,"NASA Software Safety Standard."**
- **Dataflow Laboratory and Testbed Safety**
  - **As discussed in individual QT procedure documents, test procedures follow the program requirements identified in the GLAST LAT System Safety Program Plan, LAT-MD-00078**
  - **SLAC Environmental Health and Safety Requirements:**
    - **An Area Hazards Analysis (AHA) for the Dataflow Laboratory, conforming EH&S requirements, has been prepared and approved**
    - **All members of the Test Team have completed Job Hazard Analysis and Mitigation (JHAM) forms for work related to FQT.**

Issue Resolution During FQT (1)

- FSW & EGSE
  - Issues reported in JIRA
  - Reviewed by FSW Test Team Lead
    - If valid, assigned to CCB
    - If not, closed with reason noted
  - For FSW issues
    - CCB rejects, approves, or identifies further action
    - If approved, CCB assigns to developer and specifies required level of regression testing
      - Changes unit tested prior to delivery to FSW Test Team
      - Test Team verifies changes, including regression testing
      - Test Team Lead marks issue “resolved”
      - “Resolved” issues reviewed and closed by CCB
  - For EGSE issues
    - CCB rejects or accepts
    - If accepts, NCR is created and JIRA item closed, referencing NCR

Issue Resolution During FQT (2)

- Test Scripts
  - Issues reported in JIRA
  - Reviewed by FSW Test Team Lead
    - If valid, assigned to CCB
    - If not, closed with reason noted
  - At CCB:
    - CCB rejects, approves, or identifies further action
    - If approved, CCB assigns to test engineer
      - Changes tested
      - Test Team Lead verifies changes
      - Test Team Lead marks issue “resolved”
      - “Resolved” issues reviewed and closed by CCB

Regression Testing

- **Regression testing prior to FQT:**
  - **Re-run all test scripts that can be run in batch mode (expected to be >90 % of scripts). Analysis of most of these scripts will only be looking for "PASS" vs. any other detailed analysis. FSW CCB may recommend detailed analysis of results for tests of FSW likely to be directly impacted by the change.**
  - **Run other test scripts if FSW CCB determines that related functionality could be impacted**
  - **Reporting – Informal, via email to FSW Manager, SE, SQA. In test report, identify any tests that required updates in order to run with the changed software. Summarize the changes needed for each test.**
- **Regression testing after FQT:**
  - **Approve any test procedure and script updates via FSW CCB**
  - **Re-run all test scripts that can be run in batch mode. Analysis of these scripts will only be looking for "PASS" vs. any other detailed analysis. FSW CCB may recommend detailed analysis of results for tests of FSW likely to be directly impacted by the change.**
  - **Run test scripts that require manual intervention if FSW CCB determines that related functionality could be impacted**
  - **Run new or changed tests formally, with an SQA witness**
  - **Reporting – Formal, via test report document**

NASA IV&V

- NASA IV&V involved in GLAST LAT for 3½ years
  - Performing Requirements, Implementation, Test Analysis
- Requirements Analysis Complete
  - IV&V comfortable with Revision 6 of FSW Specification SS-00399
- Implementation Analysis
  - Completed analysis of Build 0.6.1. High priority PBC package findings have been resolved with GPO/NRL
  - Per IV&V, "PBC code and associated design are excellent"
- Test Analysis Ongoing
  - Procedure analysis complete; issue resolution ongoing
  - Procedures/Plans: 1 issues remain open, 37 are resolved
  - Per IV&V, "Consistent and organized test procedures facilitate IV&V analysis. High responsiveness to IV&V findings. Both factors increase confidence in LAT mission assurance"
  - Ahead – test results analysis, issue resolution

Effective relationship between GPO/SLAC/IV&V