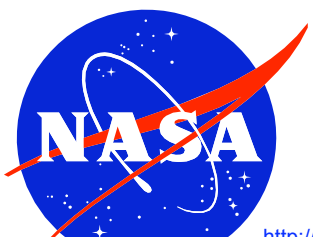
INITIAL DRAFT

GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT

GROUND SYSTEM TEST PLAN

August 20, 2004



GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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NASA Goddard Space Flight Center

Greenbelt, Maryland

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GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT GROUND SYSTEM TEST PLAN

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CHANGE RECORD PAGE

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OPEN ITEMS

This table lists the items that remain open as of the publication of this version of the document. As they are closed the resolutions will be incorporated into the body of the document.

ISSUE #	AFFECTED AREA	DESCRIPTION
1		
2		

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose

The objective of the *Gamma-ray Large Area Space Telescope (GLAST) Ground System Test Plan* is to document the testing methodology used to verify that the GLAST Ground Data System is ready to support the GLAST Mission.

The following sections describe the series of tests, the management approach, data analysis, level of participation, and the discrepancy tracking system that will be used to demonstrate the ground system's operational readiness. The final ground system readiness determination will be achieved through a series of ground system readiness tests, radio frequency (RF) compatibility tests, and end-to-end (ETE) tests. In addition, the testing methodology will be used to verify and validate requirements in the *GLAST Ground System Requirements Document (GSRD)*. For each test the methodology will dictate how the test will be performed, the high-level objectives of the test, and the definition of the methods used for verification and validation of testing.

1.2 Scope

The scope of this test plan includes an Overview of the Ground System Elements and Interfaces, Ground Readiness Management Approach, Test Plan, and Roles and Responsibilities of test participants. The Test Plan

This test plan does not include detailed descriptions or matrices for each test. The final detailed test plan (script) developed for each verification test will be added as an appendix to this document. The GSTL is responsible for developing and maintaining a *Ground System Requirements Validation Matrix* of the specific requirements to be tested and their status during the Ground Readiness Test (GRT) testing and an *ETE Functionality Matrix* for the ETE testing. Updated reports will be provided to the GLAST Project Team on a regular basis.

Ground System testing is limited to verifying the functionality and performance of the Ground System as defined in the GLAST GSRD and to validate all interfaces. For external interfaces such as with the spacecraft, Ground System testing is limited to validating the Ground System has properly implemented the interface as specified in the appropriate interface control document (ICD). The *ETE Functionality Matrix* will be used to verify requirements for ETE testing. The ETE tests will not verify functionality or performance of the external system itself. If problems are detected, an appropriate anomaly report will be generated. Ground system testing will not verify the readiness of operations personnel or products (e.g., command PROCs or T&C database) to support the mission. Operations readiness will be specified in the *Mission Operations Readiness Plan* and will be verified by a series of operational simulations. The ground system implementation team's responsibility is to ensure that the system is able to support operational readiness activities. The GLAST Ground System Test Program will verify the readiness of the GLAST Ground System to support the mission.

The GLAST Ground System Test Plan is controlled and managed by the GLAST Ground System and Operations Configuration Control Board (CCB).

2.0 GROUND SYSTEM OVERVIEW

This section provides a brief overview of the GLAST Ground System, its major components, and the responsibilities of each component. The GLAST Ground System will provide the following list of functions for the mission.

- Radio Frequency (RF) Communications with the Spacecraft
- Spacecraft Monitoring and Control
- Instrument Monitoring and Control
- Gamma Ray Burst (GRB) alert notification
- Mission Planning
- Science Data Processing
- Science Data Archive and Distribution
- Orbit Management

These functions are performed by existing and new facilities. Figure 2-1 depicts the GLAST Ground System Mission Architecture. The following sections describe each of the major ground system components.

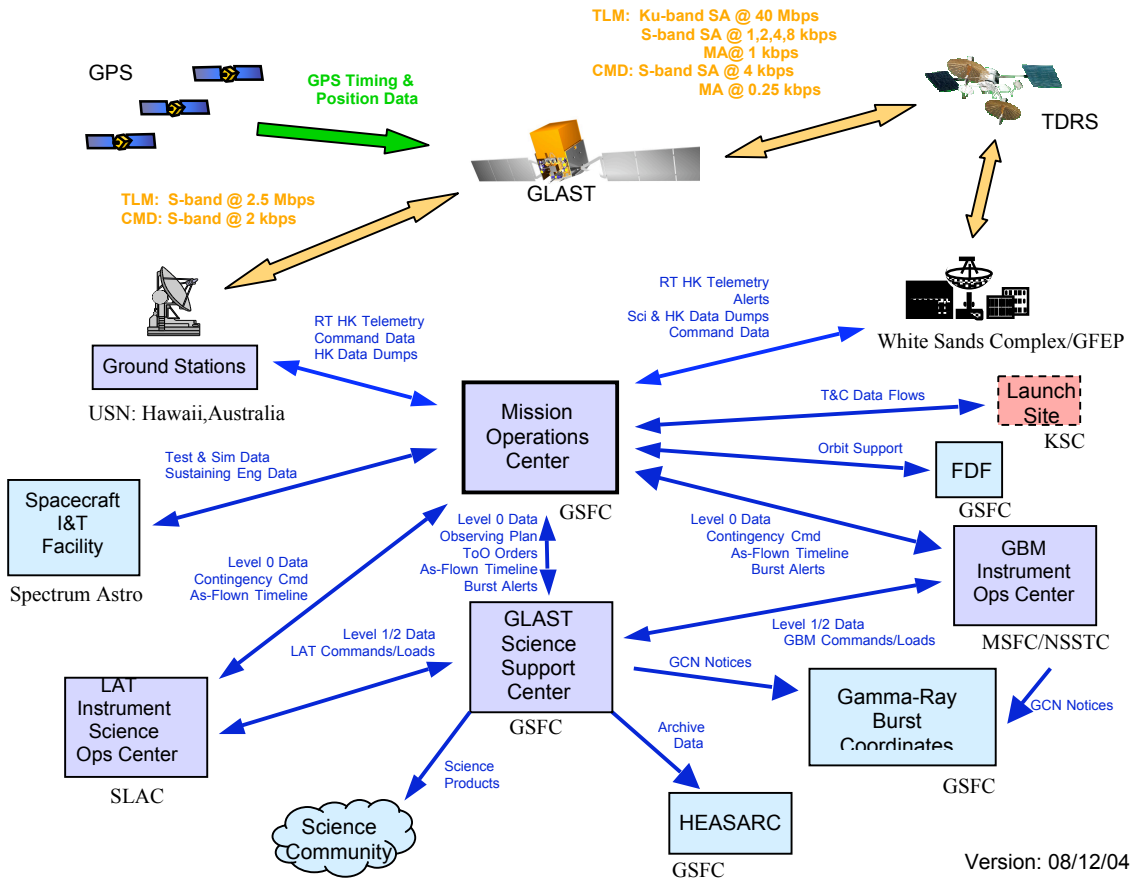


Figure 2-1: GLAST Mission Architecture

2.1 Space Network (SN)

The Space Network (SN) consists of the Tracking and Data Relay Satellite System (TDRSS), the White Sands Complex (WSC) in New Mexico, the Network Control Center (NCC), the Demand Access System (DAS), White Sands Complex Data Interface Service Capability (WDISC), and the SN Web Services Interface (SWSI).

The SN Ku-band services provide the principle space-to-ground RF communications with the GLAST spacecraft. The TDRSS DAS provides near continuous Multiple Access (MA) S-band downlink coverage for low-rate telemetry. This service provides the downlink of low-rate State of Health (SOH) data in support of contingency operations, Launch and Early-Orbit Operations (L&EO), and GRB alerts to the ground when not in a Ku-band or ground station contact. TDRSS S-Band Single Access (SSA) service will be used as a backup and contingency in the event that TDRSS MA and/or DAS services are unavailable.

Quick response commanding is available via TDRSS MA forward service at 250 bps for contingency or L&EO support, and uplinking of Target of Opportunity (ToO) Orders from the GLAST Science Support Center (GSSC). This is scheduled through and provided by SWSI.

Responsibilities: The Consolidated Spacecraft Operations Contract (CSOC) or the CSOC replacement contract will be responsible for providing the SN services for the GLAST Project.

2.2 Ground Station Support

Universal Space Network (USN) ground stations are to provide additional space-to-ground RF communications with the GLAST spacecraft. They will support simultaneous S-band science data acquisition at 2.25 Mbps and S-band command functions at 2 Kbps. The ground stations will uplink spacecraft commands received from the MOC. In addition, they will provide real-time or S-band telemetry and pass statistics to the MOC during each pass. They also collect solid state recorder (SSR) dump data during each pass and transfer it to the MOC following the pass.

Responsibilities: After L&EO, support will be on an as needed basis.

2.3 GLAST Mission Operations Center (MOC)

The GLAST Mission Operations Center (MOC), located at Goddard Space Flight Center (GSFC), will operate the GLAST satellite and instruments. It supports pre-launch operations, launch and 60-day checkout, normal and contingency operations. The MOC performs all spacecraft and instrument mission planning, commanding, monitoring, and Quick-look Level-0 data processing and delivery to the GSSC and Instrument Operations Center (IOC). The MOC forwards burst alert telemetry to the Burst Alert Processor (BAP) collocated in the MOC and the GBM Instrument Operations Center (GIOC). The BAP will reformat the Large Area Telescope

(LAT) and GLAST Burst Monitor (GBM) burst alert telemetry packets into GRB Coordinates Network (GCN) Notices and immediately sends them to the GCN. The MOC also implements ToO inputs from the science team or science community.

Responsibilities: Goldbelt Orca/Omitron has responsibility for implementing and operating the MOC and overall mission operations.

2.4 GSSC

The GLAST Science Support Center (GSSC) assists the science community in the scientific analysis of GLAST data. The GSSC has the lead role in integrating GLAST science analysis tools into a complete package. The GSSC collects information about the calibration of the instruments and makes it available to the science community. In addition, the GSSC maintains documentation of the GLAST data and analysis techniques for use by the science community. The GSSC also evaluates instrument commanding provided by the IOTs to determine their impact on the science timeline and assists the project scientist in the evaluation of ToO Requests.

Responsibilities: GSFC's Laboratory for High Energy Astrophysics is responsible for the GSSC.

2.5 GCN

The GCN distributes location and light curve information for GRBs that has been detected by spacecraft capable of detecting GRBs. It distributes this information to interested members of the science community. The rapid dissemination of GLAST alerts and finder fields will enable ground observatories and operators of other spacecraft to plan correlative observations. The GCN is an existing system with sufficient capacity to support GLAST.

Responsibilities: GSFC's Laboratory for High Energy Astrophysics is responsible for the GCN.

2.6 High Energy Astrophysics Science Archive Research Center (HEASARC)

The High Energy Astrophysics Science Archive Research Center (HEASARC) will be the permanent archive for GLAST data products, calibration data and documentation. All data products will be placed in the HEASARC and mirror archives in the United Kingdom and Italy. Data will be archived during the life of the mission.

Responsibilities: GSFC's Laboratory for High Energy Astrophysics is responsible for the HEASARC.

2.7 Flight Dynamics Facility (FDF)

For the first week of the mission, the Flight Dynamics Facility (FDF), located at GSFC, provides orbit determination support to the MOC. The data is derived from current TDRSS tracking data services. The FDF provides orbit products to the MOC as defined in the GLAST Project Service Level Agreement (PSLA).

Once FDF support is completed, GLAST orbit determination will be performed by the MOC using North American Air Defense Command (NORAD) provided two-line elements (TLEs). NORAD under its own resources tracks everything in low Earth orbit, including the GLAST satellite. National Aeronautics and Space Administration (NASA)/GSFC continually receives the latest NORAD "satellite catalog" of up-to-date satellite state vectors in the form of two-line elements. NASA/GSFC Orbital Information Group (OIG) publishes these elements on the World Wide Web (WWW). Once updated orbit information is obtained, the MOC will provide updated state vectors to the ground stations and the SN.

Responsibilities: Mission Operations and Mission Services (MOMS) is responsible for operating and managing the FDF.

2.8 Flight Software Maintenance

The Flight Software Maintenance function supports maintenance of the software for the Spacecraft and all the instruments. This includes analyzing software problems, generating and verifying software updates, maintaining the on-board images, as well as providing these products to the MOC.

Responsibilities: Spectrum Astro, in Gilbert, AZ (pending contract negotiations), is expected to be responsible for providing software maintenance for the Spacecraft and flight software. The Stanford Linear Accelerator Center (SLAC) is responsible for providing software maintenance for the LAT science instrument. Marshall Space Flight Center (MSFC) is responsible for providing maintenance for the GBM science instrument.

3.0 GROUND READINESS MANAGEMENT APPROACH

The ground system management will define verification so as to be consistent with the Mission System Specifications (MSS). The MSS's definition of verification is "The process of proving that the implementation satisfies the requirement." The central question is whether the system has been built correctly.

To show requirement compliance the MSS uses the following list of methods and definitions.

- **Analysis** – Predicted performance using calculations to show compliance with specified performance.
- **Demonstration** – Observed compliance of functional operation or behavior with that specified.
- **Inspection** – Visual proof of existence of specified characteristics or properties.
- **Test** – Measurement of performance to show compliance with specified performance.

The *Ground System Requirements Validation Matrix* will include the verification method for each requirement. This matrix is controlled by the Ground System Configuration Control Board (CCB).

3.1 Ground Readiness Test Team (GRTT)

The Ground Readiness Test Team (GRTT) is responsible for developing the specific tests and testing scripts to verify all ground system requirements to ensure mission readiness. The Ground System Test Lead (GSTL) chairs the GRTT meeting and is responsible for developing the Ground System Test Plan, coordinating the ground system mission readiness tests, discrepancy management, and tracking and reporting on the state of mission readiness. Members of the GRTT include representation from Spectrum Astro, the Flight Operations Team (FOT), the Instrument Teams, the GSSC, and the GLAST Project Team.

The GSTL holds regularly scheduled meetings with the GRTT to review test requirements, resources, schedule, action items, discrepancies, and to identify problem areas. Prior to conducting a test the GRTT will develop the detailed test script and briefing message. The GSTL will hold pretest meetings for all involved personnel to review the test script and briefing message. A formal pretest briefing notification will be provided to the GRTT and GLAST Project Team for each formal ground system test.

During the test all discrepancies and variations to the test script will be appropriately documented. Upon completion of a test, the GRTT will generate a formal Test Report documenting the test results. The test reports will be available for the GLAST project.

3.2 Roles and Responsibilities

Ground Readiness Test Team (GRTT) – The Ground Readiness Test Team (GRTT) is responsible for developing the specific tests and detailed testing scripts that will verify all ground system requirements as listed in the GLAST Ground System Requirements Document (GSRD) and ensure mission readiness. Ground system testing is carried out by the GRTT and is comprised of the following people or groups.

Ground System Test Lead (GSTL) – The Ground System Test Lead (GSTL) (Beth Pumphrey/GSFC Code 586) is responsible for the following activities:

- Chairperson for the GRTT meetings
- Administers the Ground System Test Program
- Develops and maintains the appropriate test program documentation
- Controls the GLAST Ground System Test Plan
- Maintains the Test Verification Matrix
- Schedules resources as necessary for individual tests
- Coordinates the ETE testing

Ground System Engineers – The Ground System Engineers will be responsible for the following activities.

- Assists the Ground System/Operations Manager (GSOM) in the technical management of the ground system development effort
- Chairs the GLAST Ground System Discrepancy Review Board (DRB) once the ground system testing begins
- Develops and maintains the Ground System Verification Matrix
- Ensures the Ground System is ready to meet test readiness objectives
- Maintains the Mission Operations Center (MOC) to Observatory Checklist for ETE testing

Spacecraft Contractor – Spectrum Astro is the spacecraft contractor and is responsible for implementing the spacecraft and delivering it to NASA on-orbit within launch +60 days. Delivery to NASA is predicated on validation of spacecraft functionality and bus-to-instrument interfaces. Nominally they would also provide sustaining engineering support for the spacecraft after launch +60 days pending contract negotiations with NASA.

Flight Operations Team (FOT)– The contractor, **Goldbelt Orca/Omitron,** is responsible for implementing the MOC to support pre-launch, launch, early orbit, and normal operational activities. In addition, they are responsible for providing flight operations support that will include responsibility for planning, documenting, and execution (from the MOC) of the ETE

tests and ground readiness tests. Omitron will provide implementation and Flight Operations Team (FOT) support.

Instrument Operations Teams (IOTs)– These teams are responsible for implementing the GLAST instruments, including the flight software. In addition, they provide instrument sustaining engineering support for the life of the mission. The SLAC provides LAT support and the University of Alabama Huntsville (UAH) provides GBM support.

GLAST Science Support Center (GSSC) – The GLAST Science Support Center (GSSC) is responsible for providing GLAST data, analysis software, and documentation to users. In addition, the GSSC will support the Guest Investigator (GI) program. During nominal operations, the GSSC will provide the science timeline to the MOC.

NASA (GLAST Project) – NASA provides overall support for end-to-end ground system implementation, test activities, and mission (science and flight) operations.

3.3 Ground System Requirements Tracking

The GSTL is responsible for creating the *Ground System Requirements Validation Matrix* and the *ETE Functionality Matrix*. These two matrices include all ground system test requirements, interfaces, objectives, resources, and results. This information is derived from the GRTT and the GLAST GSRD

The matrices are used by the GRTT to develop detailed testing approaches, readiness criteria, and test scripts.

3.4 Discrepancy Management

This section will briefly describe the discrepancy management approach to be used by the GLAST ground system. Discrepancy management refers to the process to be used to document, prioritize, track, and close out anomalies that have been detected in the Ground System. These anomalies may be detected during element development, element-level acceptance testing, ground system testing, or operations activities.

At the element level, each element will manage it's own discrepancies internally, although the Ground System/Operations Manager (GSOM) will have full visibility into the discrepancy system. While no specific discrepancy management approach will be dictated, the approach must provide for the ability to document and prioritize each detected anomaly.

At the Ground System level, discrepancies discovered during testing will be recorded and managed through the Discrepancy Management System that will be developed for the MOC. This system will have categories for discrepancies associated with the Ground Readiness Tests, End-to-End Tests, and RF tests. The Discrepancy Management System will be based on the Spacecraft Emergency Response System (SERS) or equivalent system.

The ground system Discrepancy Review Board (DRB) will disposition all DR's, allocating the proper criticality based on the criticality of the associated functionality. The DRB is responsible for the evaluation and tracking of the individual system anomalies and associated repairs. Problems that are considered essential to supporting launch and early orbit activation will be categorized as "launch critical", and will thus receive the appropriate level of priority by the development team. The DRB will be chaired by the Ground System Engineer, and will be made up of representatives from each of the Ground System elements and appropriate operations personnel. The GRTT and DRB will work closely together, but essentially will serve two different purposes: the GRTT will primarily plan and analyze tests, while the DRB will evaluate and track individual system anomalies and associated repairs.

4.0 TEST PLAN

GLAST Ground System Readiness Testing is completed during the project's pre-launch operations phase. The Test Plan describes the series of tests that will demonstrate the ground system's operational readiness to support the GLAST mission. In addition, it identifies the configuration, target dates, a lien list (if any), and team members responsible for implementation, as appropriate.

The GRTT is responsible for developing the detailed test scripts of each ground system test to ensure that all GLAST Ground System Requirements have been appropriately tested and that the ground system is ready to support the GLAST Mission. The GRTT is an interdisciplinary team that includes members from NASA, Spectrum Astro, instrument teams, GSSC, and the FOT. The following table is an overview of the GLAST Ground System Mission Readiness Testing Schedule. The dates and schedule identified in the following chart and subsequent sections are estimates. Time allocations include setup and contingency time. Test durations may be adjusted as required in order to complete test objectives. As testing progresses, updates will be made and maintained by the Observatory Integration & Test (I&T) Manager. Further definition and explanation on each test is provided in subsequent sections of this document.

The test schedule has been coordinated with all element build capabilities to ensure compatibility with the test objectives. Table 4-1 indicates which element builds are available for each test. All elements will be using their launch builds for testing for GRT 6 and all subsequent testing.

Table 4-1 – Test Dates and Release Support Schedule

Test	Build/Release			
	MOC	LAT ISOC	GBM IOC	GSSC
GRT 1	1	-	-	2
GRT 2	1	1	1.2	2
GRT 3	1	1	1.3	3
GRT 4	2	2	2.1	4
GRT 5	2	2	2.2	4
ETE 1	2	3	2.2	4
GRT 6	3	3	2.2	4
ETE 2	3	3	2.2	4
GRT 7	3	3	2.2	4
ETE 3	3	3	2.2	4
ETE 4	4	3	2.2	4
ETE 5	4	3	2.2	4

The GRTT has several simulator tools that will be used in the execution of the *Ground System Test Plan*. Table 4.2 provides an overview of the simulators that will be used by the GRTT to validate the GLAST Ground System.

Table 4-2 GLAST Simulators used for Ground System Verification.

Simulator	Provider	Use	Date Available
Portable Spacecraft Simulator (PSS)	GSFC Code 584	Initial MOC testing, Ground System testing	October 2004
MOC Training Simulator	Spectrum Astro	FOT Training, Ops Simulations, Ops Product development and Test	September 2005
Spacecraft HotBench	Spectrum Astro	For activities requiring spacecraft high fidelity simulator support (e.g., proc validation, selected contingency simulations)	Limited availability during S/C I&T
Software Development and Maintenance Simulator (SDMS)	Spectrum Astro	Flight software maintenance	September 2005

The MOC system will be located at the operational GSFC MOC facility in a launch support configuration for the ETE tests. This will ensure that any problems that may result from the different network connections are detected prior to launch. Similarly, a position has been established that all of the formal operations simulations must be conducted from the actual GSFC MOC facility. Preliminary S/C Interface Testing will be supported using the MOC system located at Spectrum Astro.

The GSTL will generate and maintain a *Ground System Requirements Validation Matrix*. The *Ground System Requirements Validation Matrix* will be the primary vehicle to record specifically what will be tested (i.e. the test requirements), when it will be tested, and the status of each of the test requirements at any given time. The GRTT will play an integral part in reviewing the requirements matrix and keeping it up to date with actual test status and progress. Up-to-date versions of the *Requirements Verification Matrix* will be maintained on the GLAST Ground System Web Site to ensure that the team has ready access to the information and the information being accessed is current.

The GLAST Ground System development will be completed upon customer acceptance, which nominally occurs at the Operational Readiness Review (ORR). A complete ETE demonstration of the system's capabilities will be provided through a series of tests that will be performed as

part of the operational readiness testing. The acceptance criteria will include specific tests to be executed, requirements to be satisfied by each test that will be specified in the Ground System Verification Plan, and the results to be provided to the project. Acceptance of the system will be documented in the minutes of the ORR.

4.1 Element Acceptance Testing

The purpose of Element Acceptance Testing is to verify functionality and performance of the individual elements that comprise the GLAST Ground System. Additionally, testing will demonstrate interface compatibility between elements. Element level testing must be completed as a pre-requisite to a GRT.

A structured, incremental approach is used for ground system testing, verification, and readiness. This includes a modular build strategy for ground system development where each build or module is integrated and tested. Build or module testability is determined during design and code walkthroughs. Module testing confirms satisfaction of design requirements. A system acceptance test plan ensures quality assurance by placing emphasis on the integrity of the delivered modules and the associated user documentation, and adherence to standards. Acceptance testing ensures the readiness of the operational system.

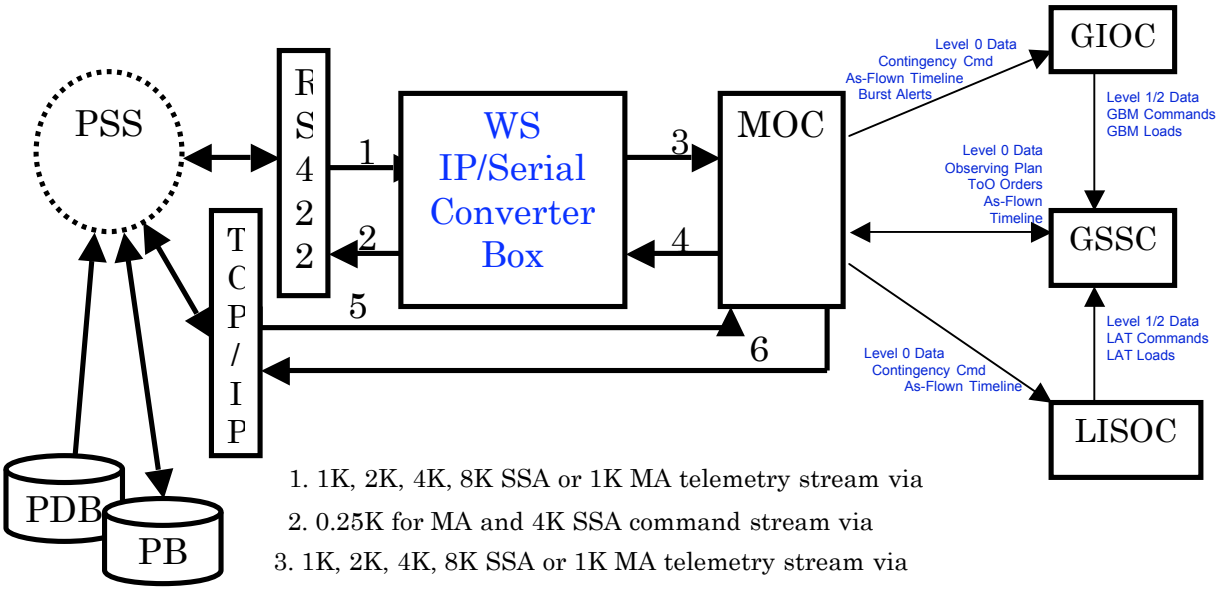
The main drivers for the element-level testing are the element-level requirement documents and the ICDs. The element-level testing for each build will ensure that it is ready to support the more formal ground system tests that will follow after delivery.

Responsibilities: Element testing is generally organized and conducted independently with GRTT assistance provided as required. GRTT-level visibility into testing process, progress, and results will be provided by each element team.

4.2 Ground Readiness Testing

The purpose of ground readiness testing is to validate the ground system interfaces, data flows, performance and major functionality of the GLAST ground system. This will be accomplished through a series of seven ground-system oriented tests using the simulators or recorded data. The objective is to have all functionality tested by the first 6 tests and to use the final test for regression testing. GRTs will serve as the prerequisite to the End-to-End Tests where appropriate.

Testing configurations will vary and may include a combination of the Portable Spacecraft Simulator (PSS), the MOC, the IOCs, and the GSSC as shown in Figure 4.2-1.



1. 1K, 2K, 4K, 8K SSA or 1K MA telemetry stream via
2. 0.25K for MA and 4K SSA command stream via
3. 1K, 2K, 4K, 8K SSA or 1K MA telemetry stream via
4. 0.25K for MA and 4K SSA command stream via

OR

5. 1K, 2K, 4K, 8K SSA or 1K MA telemetry stream via TCP/IP with IP
6. 0.25K for MA and 4K SSA command stream via TCP/IP with IP

Figure 4.2-1: GRT Configuration

4.2.1 Ground Readiness Test 1 (GRT #1)

GRT #1 (Basic Command and Telemetry to PSS Connectivity)

Participants

- MOC, FOT, WSC, SAI, IOTs, GSSC, NASCOM/NISN

Pre-Test

- MOC to ingest T&C Database from Spectrum Astro
- MOC to ingest partial T&C Database from IOTs
- Perform CCB and CM control of T&C Database
  - MOC, PSS and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Black phone schedule of WSC resources
- Briefing messages
- Install PSS and perform connectivity check with GSFC
- Perform connectivity check with GSSC
- EGSE required – PSS, BitAlyzer

Test Objectives

- MOC will verify proper handling of GLAST T&C database
  - Requires sufficient observatory and instrument telemetry to fill 151 HK stream and 2.5 MB playback
- Real-time (RT) T&C data flow between MOC and a S/C simulator and instrument data from WSC to MOC
  - Real-time S-Band data from the PSS
  - MOC to decom subset of all data types
  - MOC to send NOOP commands to the PSS
    - Capture and compare bits at PSS
- Dump S-Band HK data
  - Dump HK partition of the PSS
- MOC to create Level-0 file of observatory HK data
  - MOC Archive of level-0 data
- MOC to transfer Level-0 HK data files to GSSC (GSSC to ingest)
  - Full HK Level-0 data file transfer
    - Notifications, acknowledgements and dispositions
    - Ensure delivery to proper directories
  - GSSC ingest HK Level-0 data into archive
  - GSSC sends re-transmission request to MOC

Post Test

- Test Director Summary
  - Brief synopsis of test within 24-hours of execution
- Summary report
  - Data received and status
  - Problems encountered
- Cleanup Archive

Target Date: 02/15/05

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #1 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 1 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Schedule TDRSS with NCC	- 2 weeks	CSOC	

Dependency	Due (delta to test)	Responsibility	Comments
Operations Support during Test • SN Services at WSC • MOC • Network connections	GRT #1	 CSOC Omitron NISN	
Document and Report on test results	GRT #1 + 1 week	GSTL	

4.2.2 Ground Readiness Test 2 (GRT #2)

Participants
- MOC, FOT, WSC, SAI, IOTs, GSSC, FDF, NASCOM/NISN

Pre-Test
- MOC to generate PDB
  - MOC to ingest T&C Database from Spectrum Astro
  - MOC to ingest T&C Database from IOTs
- Perform CCB and CM control of T&C Database
  - MOC, PSS, IOTs and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Basic planning & scheduling (P&S) S-Band activities with WSC
  - Schedule WSC resources using SWSI
- Briefing messages
- FDF to provide orbital products to the MOC for distribution as required
- MOC to distribute FD products
- EGSE required – PSS, BitAlyzer

Test Objectives
- Regression Test GRT#1 T&C flows
- Basic S-Band planning and scheduling with WSC
- Flow S-band data from PSS through TDRSS
  - Flow RT HK data
  - Dump HK SSR partition on PSS
- P&S plans from IOC's to GSSC
  - Ingest commands and memory loads from IOCs
  - Full file transfer

- Plans/activities to MOC from GSSC
  - Pre-Planned Science Timelines
  - GSSC to send timelines and memory loads to MOC
  - Full file transfer
- MOC builds and uplinks simple stored command loads to simulator (PSS)
  - Instrument Memory Loads and Commands (LAT and GBM)
- Flow RT HK data to LAT ISOC
  - Real-Time Housekeeping Data
- MOC to transfer Level-0 HK to GBM and LAT
  - Level-0, Notifications, Acknowledgements and Dispositions
  - Ensure files are sent to the proper directories
- FDF to perform DOWD

Post Test

- Test Director Summary
  - Brief synopsis of test within 24-hours of execution
- Summary report
  - Data received and status
  - Problems encountered
- Cleanup Archive

Target Date: 4/15/05

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #2 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 1 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
GSSC Established and linked to MOC	- 4 weeks	Omitron & CSOC	
IOCs Established and linked to GSSC and MOC	- 4 weeks	Omitron & CSOC	
Schedule TDRSS with NCC	- 2 weeks	CSOC	
Operations Support during Test • SN Services at WSC • MOC	GRT #2	 CSOC Omitron	
Document and Report on test results	GRT #1 + 1 week	GSTL	

4.2.3 Ground Readiness Test 3 (GRT #3)

Participants
- MOC, FOT, WSC, SAI, LISOC, GIOC, IOTs, GSSC, FDF, NASCOM/NISN

Pre-Test
- MOC to generate PDB
  - MOC to ingest T&C Database from Spectrum Astro
  - MOC to ingest T&C Database from IOTs
- Perform CCB and CM control of T&C Database
  - MOC, PSS, IOTs and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Basic planning & scheduling (P&S) S-Band activities with WSC
  - Schedule WSC resources using SWSI
  - GSSC and MOC exchange contact and request schedules for TDRSS
- Briefing messages
- FDF to provide orbital products to the MOC for distribution as required
- GSSC and IOCs to ingest FD products from the MOC
- EGSE required – PSS, BitAlyzer

Test Objectives
- Regression Test GRT#2 T&C flows
- S-Band Burst Alert and Housekeeping Telemetry flows through TDRSS
  - Generated by simulator, sent through TDRSS via SOC at Goddard
  - MOC forwards Burst Alert's to the Burst Alert Processors (BAPs), which forwards to the GCN
  - GSSC to support BAP Operations
- GSSC integrates IOC commands/memory loads into timeline
- MOC ingests science timeline from the GSSC
- MOC delivers integrated observatory timeline to GSSC
  - GSSC ingests integrated observatory timeline from MOC
- Commanding through TDRSS (to the simulator)
- GFEP and Ku-Band basic T&C flows
  - Flow RT HK data
  - Command through S-Band
- Level-0 data processing performed on science data
- IOCs process Science Level-0 into Level-1 products

Post Test
- Test Director Summary
  - Brief synopsis of test within 24-hours of execution
- Summary report
  - Data received and status

  - Problems encountered
  - Cleanup Archive
- Evaluate planning timeline exchange between MOC, GSSC and IOCs and execution

Target Date: 6/15/05

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #3 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 1 installed and tested in MOC	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
GSSC Established and linked to MOC	- 4 weeks	Omitron & CSOC	
IOCs Established and linked to GSSC and MOC	- 4 weeks	Omitron & CSOC	
Operations Support during Test • SN Services at WSC • MOC	GRT #3	 CSOC Omitron	
Document and Report on test results	GRT #3 + 1 week	GSTL	

4.2.4 Ground Readiness Test 4 (GRT #4)

Participants

- MOC, FOT, USN, Wallops, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN

Pre-Test

- MOC to generate PDB
  - MOC to ingest T&C Database from Spectrum Astro
    - Including Instrument T&C Database
  - MOC to distribute PDB to all participants
- Perform CCB and CM control of T&C Database
  - MOC, PSS, IOTs and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Basic planning & scheduling (P&S) S-Band activities USN, Wallops
- Briefing messages
- FDF to provide orbital products to the MOC for distribution as required
- MOC to distribute FD products for ingest by all test participants
  - EGSE required – PSS, BitAlyzer

Test Objectives

- Main focus is T&C data flows to/from the ground stations
  - RT S-Band Hk
  - S-Band command
- Planning and Scheduling with USN and Wallops
  - Ingest timelines, memory loads into GSSC databases (no impact on ground scheduling)
- Spacecraft and instrument housekeeping data
- S-band burst alerts through the Ground Stations
- S-band HK recorder dumps
- Level-0 processing of S-Band HK dump data
- MOC sends Level-0 HK data to IOC's
- IOCs perform ingest of HK data level-0 files
- MOC sends Level-0 HK data to GSSC
- MOC provides burst alert data to GBM IOC and to BAP
  - BAP sends GCN notice to GCN

Post Test

- Test Director Summary
  - Brief synopsis of test within 24-hours of execution
- Summary report
  - Data received and status
  - Problems encountered
- Cleanup Archive

Target Date: 9/1/05

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #4 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Recorded data from I&T provided	-8 weeks	Spectrum Astro	
Draft Test Script	- 6 weeks	GRTT	
MOC Build 4 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
GSSC to HEASARC and Instrument Teams interface Checkout	- 3 weeks	GSSC	
Operations Support during Test • USN • GSSC • MOC • GIOC • LISOC	GRT #4	Omitron GSSC, HEASARC, Instrument Teams	
Document and Report on test results	GRT #4 + 1 week	GSTL	

4.2.5 Ground Readiness Test 5 (GRT #5)

Participants

- MOC, FOT, WSC, USN, Wallops, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN

Pre-Test

- MOC to generate PDB
  - MOC to ingest T&C Database from Spectrum Astro
    - Including Instrument T&C Database
  - MOC to distribute PDB to all participants
- Perform CCB and CM control of T&C Database
  - MOC, PSS, IOTs and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Planning & scheduling (P&S) Ku and S-Band activities with WSC
  - Schedule WSC resources using SWSI
  - GSSC and MOC exchange contact and request schedules for TDRSS
- Briefing messages
- FDF to provide orbital products to the MOC for distribution as required
- GSSC and IOCs to ingest FD products from the MOC
- More complex P&S among IOC's, GSSC and MOC
  - Bring in supporting spacecraft and instrument memory loads
- EGSE required – PSS, BitAlyzer, Data Challenge Science Data

Test Objectives

- Flow Ku –Band data from WSC to MOC
  - Dump Science SSR partition on PSS
  - Flow instrument Science data from Data Challenges through PSS to MOC
- MOC to send KU band level-0 files to the IOCs
  - Need simulated science data to be processed by IOC algorithms
- Level 1 and Level 2 processing sent to GSSC from IOCs
- GSSC to ingest Level 1,2 data from IOCs
  - Full file transfer
  - Ingest into databases
- Burst alerts on Ku-band
  - BAP and GBM IOCs send GCN notices to the GCN
- Diagnostic data on Ku-band
- IOCs send instrument engineering command requests directly to MOC

Post Test

- MOC generate as-flown timeline and send to GSSC
- GSSC Ingest as-flown timeline from MOC and compare versus science timeline
- LAT IOC sends GCN notices to the GCN
- Test Director Summary

  - Brief synopsis of test within 24-hours of execution
- Summary report
  - Data received and status
  - Problems encountered
- Cleanup Archive

Target Date: 11/15/05

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #5 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 2 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Schedule TDRSS with NCC	- 2 weeks	CSOC	
Operations Support during Test • USN • GSSC • MOC • GIOC • LISOC	GRT #5	 Omitron GSSC, HEASARC, Instrument Teams	
Document and Report on test results	GRT #5 + 1 week	GSTL	

4.2.6 Ground Readiness Test 6 (GRT #6) – Contingency Operations

Participants

- MOC, FOT, WSC, USN, Wallops, KSC, SAI, LISOC, GIOC, IOTs, GSSC, FDF, GCN, NASCOM/NISN

Pre-Test

- MOC to generate PDB
- MOC to ingest T&C Database from Spectrum Astro
  - MOC to ingest T&C Database from IOTs
  - MOC to distribute PDB to all participants
- Perform CCB and CM control of T&C Database
  - MOC, PSS, IOTs and GSSC to have identical PDB
  - Observatory Telemetry and Command Database Updates
- Basic planning & scheduling (P&S) Ku and S-Band activities with WSC
  - Schedule WSC resources using SWSI
  - GSSC and MOC exchange contact and request schedules for TDRSS
- Basic planning & scheduling (P&S) S-Band activities USN, Wallops, KSC
- Briefing messages
- FDF provide orbital products to the MOC
- GSSC and IOCs to ingest FDF products from the MOC
- EGSE required – PSS, BitAlyzer, Data Challenge Science Data

Test Objectives

- Similar to GRT#5 with contingencies added
  - Cleanup and Regression Testing
- GSSC to Operate backup Level 0 pipelines
  - GSSC processes Level-0 into Level-1 and 2 products
  - Compare with IOC processing
- ToO Operations
  - GSSC to Create ToO order
  - GSSC to send ToO order to MOC
  - GSSC and MOC exchange notifications
  - MOC perform real-time TDRSS scheduling
  - MOC to transmit ToO commands to PSS via TDRSS
- Red limit alarm and burst alert notification paging
- MOC failover scenarios
  - User notification of anomalies
- Contingency S-Band dumps at Ground Stations

Post Test

- MOC generate anomaly reports
  - Note: Anomalies will be data losses and NOT spacecraft related
- GSSC ingest anomaly reports from MOC

  - Full file transfer
  - Ingest into database
- Summary report of data received and status
- Cleanup Archive

Target Date: 3/15/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #6 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 3 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Completion of ETE #1	- 4 weeks	GRTT	
Schedule TDRSS with NCC	- 2 weeks	CSOC	
Operations Support during Test • USN • GSSC • MOC • GIOC • LISOC	GRT #6	Omitron GSSC, HEASARC, Instrument Teams	
Document and Report on test results	GRT #6 + 1 week	GSTL	

4.2.7 Ground Readiness Test 7 (GRT #7) – Clean-up/Regression Testing

- Clean-up/regression testing
- Autonomous Operations

Target Date: 5/15/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the GRT #7 test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
MOC Build 3 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Completion of ETE #2	- 4 weeks	GRTT	
Schedule TDRSS with NCC	- 2 weeks	CSOC	
Operations Support during Test • USN • GSSC • MOC • GIOC • LISOC	GRT #7	Omitron GSSC, HEASARC, Instrument Teams	
Document and Report on test results	GRT #7 + 1 week	GSTL	

4.3 *End-To-End (ETE) Testing*

The GLAST project will perform a series of 5 end-to-end tests (approximately 2 days in length each) between the MOC and the observatory. The objective of the initial tests will be to verify the interface compatibility between the MOC workstations at GSFC and the GLAST Observatory. As the systems mature the end-to-end test will become more operational in nature and include additional ground system elements including contingency scenarios. An ETE test may be run via a hardline or RF interface between the observatory and the MOC. While all ETE tests are planned to be run using the MOC located at GSFC, preliminary testing to prepare for the actual test may be conducted using the MOC workstations located at the spacecraft I&T facility. These tests will validate data exchanges including telemetry, memory dumps, Solid State Recorder (SSR) operations, commands, command loads, and memory loads, at a minimum. The primary interfaces are defined in the Spacecraft/MOC ICD. All PROCs used for ETE testing will be under Ground System CM control and will be validated prior to using with the observatory.

The test metrics will be maintained in the "MOC to observatory Checklist for ETE tests." The purpose of the checklist is to ensure the compatibility of the MOC functionality with the observatory has been tested. Those MSS requirements that span the Ground System and the Observatory and cannot be adequately verified during a GRT or Observatory Testing will be performed during ETEs. (Note: This is to be a small subset of all of the MSS requirements, This checklist will be maintained by the ground system engineers.

Spectrum Astro will lead testing in terms of approving which activities can and should be performed with the observatory. They will provide personnel at the I&T facility to support testing and to ensure observatory health and safety.

Spectrum's primary responsibilities during test execution will include: observatory setup (i.e. placing the observatory in the expected initial test configuration), maintaining observatory health and safety during testing, capturing all command and telemetry data, and safing the observatory prior to the conclusion of the test. Test support will be provided through the Observatory Operations Lead, who will act as the liaison between Spectrum and the Ground System Team for ETE Testing. Spectrum Astro shall provide input for the overall test report.

The spacecraft vendor in conjunction with the FOT and IOTs will participate in the review of test scripts and the approval of all products generated by the FOT and IOTs to be used during the test. This will include ascertaining which PROCs should be executed against the spacecraft, signing off on PROCs before they are used in the test and reviewing the test script.

The FOT is responsible for developing the test products, verifying products against the The FOT is responsible for developing the test products, verifying products against the simulators, validation of PROCs against the HotBench, planning and developing the test script, executing

the test from the MOC, capturing all command and telemetry data sent or received at the MOC, denoting all test script deltas, and writing a final test report. The FOT will execute the test script from the MOC under direction of the Ground System Test Lead. The FOT will capture the command log and data received at the MOC, denote all test script deltas.

The Instrument teams are responsible for supporting their respective instruments during testing and will provide support through the IOC Leads. The IOTs in conjunction with the FOT and Spectrum will determine the instrument configuration and interfaces required to meet the objectives of the test. The IOTs will approve all operational products to be used with the instruments including all loads, PROCs and the scripts to ensure the instrument is properly operated and provide operational products as required to meet the test objectives. The IOTs will also provide an assessment of instrument performance to be included in the test report.

The IOTs will provide personnel at the Spectrum I&T Facility whenever their respective instruments are powered on and at the MOC whenever instrument commands are being executed from the MOC to monitor instrument operations and provide operational expertise.

The End-to-End testing configurations may vary and may include a combination of the GLAST observatory, the MOC, the IOCs, and the GSSC as shown in Figure 4.3-1

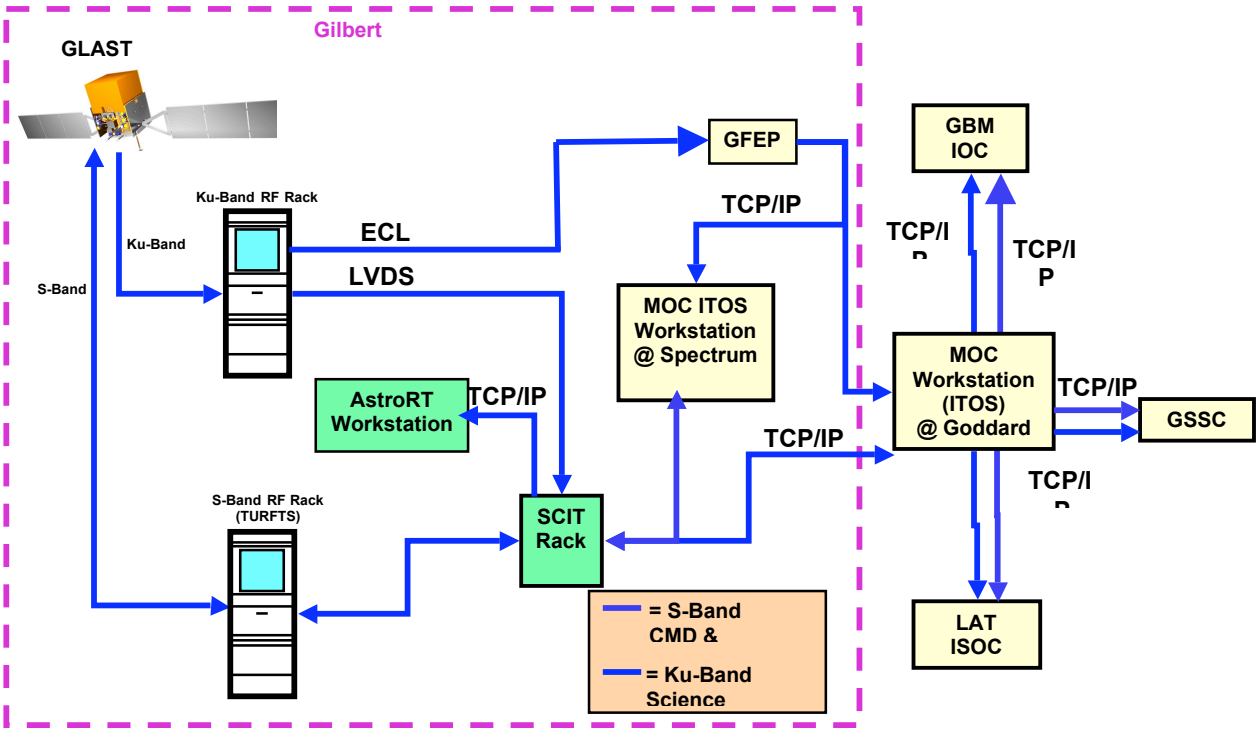


Figure 4.3-1: End-to-End Test Configuration

4.3.1 End-to-End Test 1 (ETE #1)

End-to-End Test 1 (ETE #1) will verify the basic observatory command and telemetry capabilities between the observatory and the MOC. The observatory at the Spectrum Astro I&T facility will be used during ETE #1. This test is will verify the following:

- RT Observatory HK telemetry – all rates, SN and GN
- Use TDRSS link, Ku and S-band data
- Use CTV and/or RF Suitcase to handle GN interface
- RT spacecraft and instrument commanding – all rates and types
- SSR operations
- Instrument science data being generated
- Stored command loads (ATS & RTS)
- Simple spacecraft and instrument commands
- Basic diagnostic data
- Provide Level 0 files to IOC's (post-test)
- IOC's generate Level 1 data products and provide to GSSC

Target Date: 2/8/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during ETE #1, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
HotBench & Integrated Instruments delivered to Spectrum Astro	- 4 weeks	Spectrum Astro & Instrument Teams	
MOC Build 2 installed and tested	-3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
HotBench/MOC Interface Checkout	- 1 week	Spectrum Astro/Omitron	
Operating HotBench and conducting ETE #1 Tests	ETE #1	Omitron	
Document and Report on test results	ETE #1 + 1 week	GSTL	

4.3.2 End-to-End Test 2 (ETE #2)

End-to-End Test 2 (ETE #2) continues to validate the observatory and its interface to the MOC. ETE #2 may re-validate the objectives of ETE #1 as well as to verify memory loads, memory dumps, stored command loads, and burst alert telemetry. ETE #2 includes:

- ETE-1 plus…
- Memory/FSW load uplink (S/C and instruments)
- Tables and FSW patches
- Memory dumps (S/C and instruments)
- Tables and FSW patches
- Stored command loads, more complex than ETE-1
- S/C and instrument commands
- Observatory timeline/load input IOC's to GSSC to MOC
- RT Observatory HK TLM packets to LAT IOC
- Burst alert telemetry (MOC-BAP-GCN FE)

Target Date: 5/4/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during ETE #2, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Procs and T&C Database	-12 weeks	Spectrum Astro	
Draft Test Script	- 6 weeks	GRTT	
Spacecraft in Spectrum Astro I&T Facility	- 3 weeks	Spectrum Astro	
MOC Build 3 installed and tested	- 3 weeks	Omitron	
Spacecraft T & C Database	-2 weeks	Spectrum Astro	
Final Test Script including Procs	- 2 weeks	GRTT	
Spacecraft/MOC Interface Checkout	- 1 week	Spectrum Astro/Omitron	
Operations During ETE #2 • Spacecraft • MOC	ETE #2	Spectrum Astro & Omitron	
Document and Report on test results	ETE #2 + 1 week	GSTL	

4.3.3 End-to-End Test 3 (ETE #3)

End-to-End Test 3 (ETE #3) begins to verify basic observatory operations. ETE #3 may re-validate the objectives of ETE #1 and ETE #2. It will also verify ARs, ToO commanding, ATC buffer handover, getting burst alert telemetry to the GIOC BAP, clock management, and orbit determination. This test includes:

- ETE-1&2 plus…
- Autonomous Repoints (AR's)
- TOO commanding
- ATC buffer handover
- Burst Alert telemetry to GIOC BAP
- Clock management
- Orbit determination (FDF-MOC)
  - Tracking data from SN to FDF
  - GPS orbit data from MOC to FDF
  - Ephemeris loads to S/C (S/C and TDRSS)

Target Date: 6/15/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during ETE #3, the completion time, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
ETE #1 Completed	- 4 weeks	GRTT	
ETE #2 Completed	- 4 weeks	GRTT	
Integrated Observatory (Spacecraft & Instruments) in Spectrum Astro I& T Facility	- 3 weeks	Spectrum Astro	
MOC Build 3 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Observatory/MOC Interface Checkout	- 1 week	Spectrum Astro/Omitron	
Operations During ETE #3 Test • Observatory • MOC	ETE #3	Spectrum Astro & Omitron	

Dependency	Due (delta to test)	Responsibility	Comments
Document and Report on test results	ETE #3 + 1 week	GSTL	

4.3.4 End-to-End Test 4 (ETE #4)

End-to-End Test 4 (ETE #4) incorporates more advanced observatory operations. ETE #4 may re-validate the objectives of the previous ETE tests. It will also verify LEO timeline segments, spacecraft unique operations, subsystem failovers, and more advanced FSW patches. This test includes:

- ETE-1 thru 3 plus…
- L&EO Timeline segments (e.g., subsystem activation)
- Spacecraft-unique operations (not simulated adequately by HotBench)
- Subsystem failovers (e.g., A to B-side CPU)
- More advanced/complex FSW patches/updates

Target Date: 8/24/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during ETE #4, the completion time, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Draft Test Script	- 6 weeks	GRTT	
Integrated Observatory in Spectrum Astro I&T Facility	- 2 weeks	Spectrum Astro	
ETE #3 Completed	- 4 weeks	GRTT	
MOC Build 4 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Observatory/MOC Interface Checkout	- 1 week	Spectrum Astro / Omitron	
Flight Software Load Capability Checkout	- 1 week	Spectrum Astro	
Operations During ETE #4 • Observatory • MOC	ETE #4	Spectrum Astro & Omitron	
Document and Report on test results	ETE #4 + 1 week	GSTL	

4.3.5 End-to-End Test 5 (ETE #5)

End-to-End Test 5 (ETE #5) will regression test and test additional contingencies. ETE #5 may re-validate the objectives of the previous ETE tests including regression testing for ground system updates, new and revised procs, FSW updates, and T&C database updates. This test includes:

- ETE-1 thru 4 plus…
- Last check before S/C ship for items such as:
  - Ground system fixes/enhancements
  - Revised/new PROC's
  - FSW updates
  - T&C database updates

Target Date: 10/16/06

Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during ETE #5, the completion time, and the responsible party.

Dependency	Due (delta to test)	Responsibility	Comments
Draft Test Script	- 6 weeks	GRTT	
Integrated Observatory in Spectrum Astro I&T Facility	- 2 weeks	Spectrum Astro	
ETE #4 Completed	- 4 weeks	GRTT	
MOC Build 4 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Observatory/MOC Interface Checkout	- 1 week	Spectrum Astro / Omitron	
Flight Software Load Capability Checkout	- 1 week	Spectrum Astro	
Operations During ETE #5 • Observatory • MOC	ETE #5	Spectrum Astro & Omitron	
Document and Report on test results	ETE #5 + 1 week	GSTL	

4.4 RF Testing

RF testing validates the compatibility between the Spacecraft and the RF system. It is comprised of 4 tests (each test 5 days in length) that verify all aspects of the RF interfaces and forward and return links. These tests assess the spacecraft RF interface compatibility with the Ground Stations and TDRSS, measure the telemetry values at the ground stations' receivers, and verify the spacecraft command receiver operations

All RF testing will be conducted while the spacecraft is in the I&T facility at Spectrum Astro. An RF suitcase will be used to simulate the different ground stations. The RF suitcases will be verified using the HotBench and/or PSS prior to testing with the spacecraft. The Simulations Operations Center (SOC) at GSFC and the Compatibility Test Van (CTV) will be used to communicate with TDRSS and the Space Network (SN) at the White Sands Complex (WSC), and forward data to the MOC. The GLAST Front End Processor (GFEP) will be located at WSC and will be used for the Ku-band processing. Spectrum Astro will execute the RF tests in conjunction with CTV support. The MOC workstations located at Spectrum may also receive the test data. These workstations will be for FOT monitoring purposes only.

RF compatibility between the spacecraft and the USN ground stations will also be performed. USN will provide a RF suitcase that will simulate the Commercial Ground Stations. The RF Suitcase will receive data from the RF transponder on the spacecraft and process it in accordance

with the signed ICD. Then, the data will be transmitted to the MOC via the TCP/IP port on the back end of the RF Suitcase. Prior to testing with the spacecraft, verification of the RF Suitcase will be conducted using the Hot Bench and/or PSS.

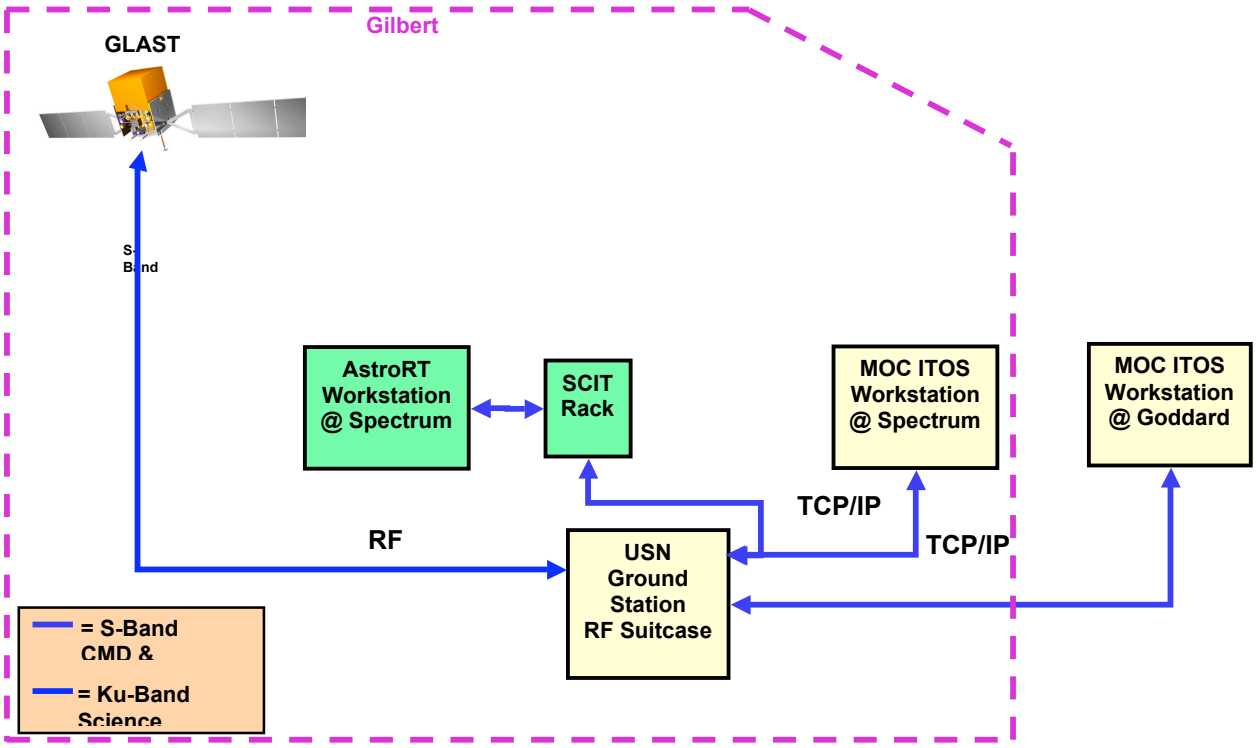
4.4.1 RF Test – USN Ground Station

The USN Ground Station testing verifies the compatibility between the spacecraft and the USN ground stations. The USN provides a RF suitcase that simulates an USN Ground Station. The RF Suitcase receives data from the RF transponder on the spacecraft and processes it in accordance with the specifications in the signed USN RF ICD. The TCP/IP port on the back end of the RF Suitcase then transmits the data to the MOC. This is the first test of the packaging of data as spelled out in the ICD. An attempt to simulate antenna switching during the test will be made. This portion of the test is to validate that the signal lock is maintained or that specified measures are taken prior to the antenna switch to alert the MOC.

Target Date: TBD

INITIAL DRAFT

Configuration: The RF Suitcase and the spacecraft are located in the Spectrum Astro I&T facility in close proximity to one another. The spacecraft sends a RF signal to the RF port on the RF Suitcase. The RF Suitcase processes the signal and sends it by TCP/IP to the MOC by hardline.



Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the USN test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
USN RF Test Script	- 12 weeks	USN	
Draft Test Script	- 6 weeks	GRTT	
MOC Build 2 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Spacecraft/MOC Interface Checkout	- 1 week	Spectrum Astro/Omitron	
Provide RF Suitcase to MOC	- 6 weeks	USN	
RF Suitcase /HotBench interface checkout	- 4 week	USN and Spectrum	
RF Suitcase / Spacecraft Interface checkout	- 2 weeks	USN and Spectrum	

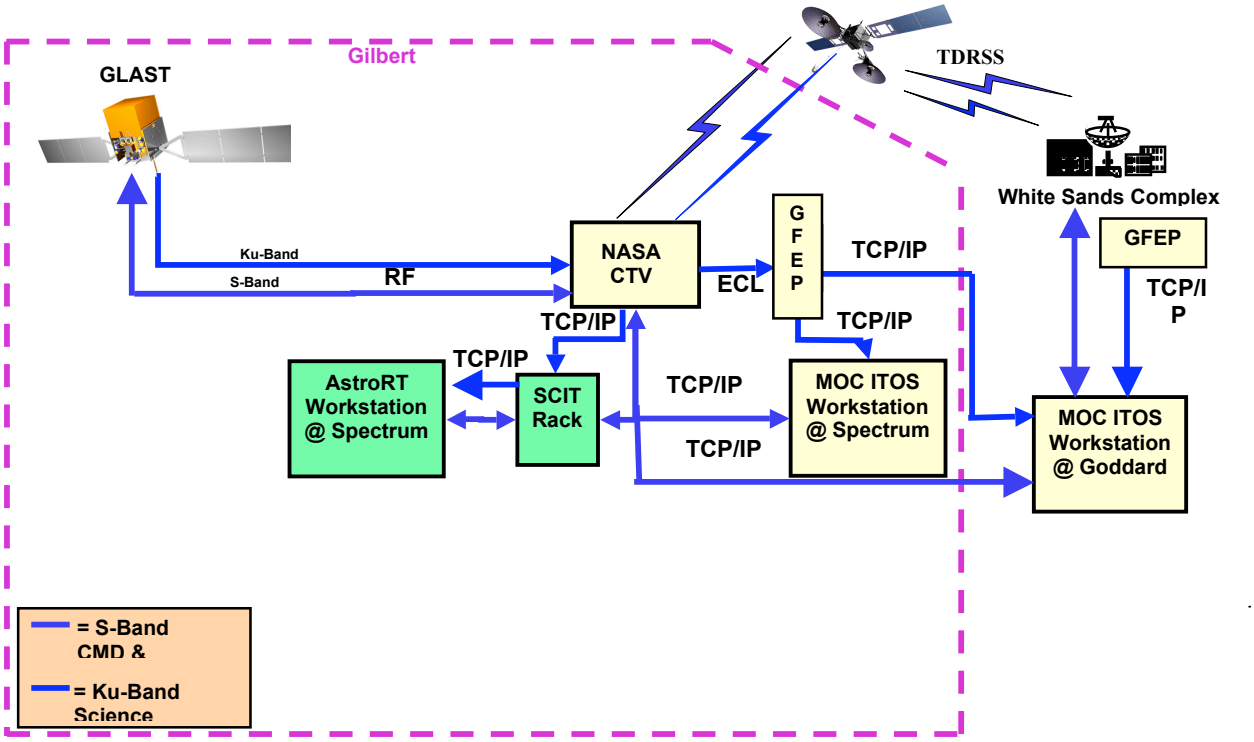
RF Suitcase / MOC interface checkout	- 2 weeks	USN and Omitron	
Operations During USN GS Test • RF Suitcase • MOC	USN GS Test	USN Omitron / Spectrum	
Document and Report on test results	USN GS Test + 1 week	GSTL	

4.4.3 RF Test – TDRSS

The TDRSS RF test verifies the spacecraft RF data interface compatibility and data flow by using the CTV and Simulations Operations Center (SOC) at GSFC to communicate with TDRS and the Space Network's (SN) Demand Access System (DAS) at the White Sands Complex (WSC) and forward to the MOC. The GLAST Front End Processor located at WSC will be used for the KU-band processing. All valid data rates are tested (1kbs, 2kbs, 4kbs, and 8 kbps) and a detailed frequency analysis is conducted. The TDRSS testing takes place in the I&T facility at Spectrum Astro. The CTV will be used to characterize the Spacecraft's transponder performance and interface. Additionally, the test analyzes the link and signal lock with WSC.

Target Date: TBD

Configuration: The spacecraft sends a RF signal to the CTV. The signal is then processed by the CTV and sent to WSC via TDRSS.



Dependencies/ Responsibilities: The following table defines the tasks that must be completed prior to and during the TDRSS test, the time required, and the responsible party.

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
CTV Test Script	- 12 weeks	CSOC/Bldg 25	
Draft Test Script	- 6 weeks	GRTT	
Spacecraft in Spectrum Astro I&T Facility	- 3 weeks	Spectrum Astro	
MOC Build 2 installed and tested	- 3 weeks	Omitron	
Final Test Script	- 2 weeks	GRTT	
Spacecraft/MOC Interface Checkout	- 1 week	Spectrum Astro/Omitron	
CTV links to Spacecraft and TDRSS/WSC available	- 3 weeks	CSOC	

Dependency	**Due** (delta to test)	**Responsibility**	**Comments**
Spacecraft / CTV Interface Checkout	- 2 weeks	CSOC / Spectrum Astro	
Operations during TDRSS Test • CTV Equipment • MOC • Spacecraft	TDRSS test	CSOC Omitron Spectrum	
Document and Report on test results	TDRSS test + 1 week	GSTL	

4.5 Operational Simulations

The Operational Simulations are designed to ensure the launch readiness of the operations personnel, products (e.g., procs), and processes. They include activities such as L&EO, day-in-the-life, and contingency rehearsals. The MOC shall be used for all of the Operations Simulations. The Operational Simulations will occur from approximately May 2006 to launch. The "Mission Operations Readiness Plan" will specify the details of these simulations.

4.6 Launch Site Compatibility Testing

Launch Site Compatibility testing verifies that neither shipping nor launch-site processing has impacted communications between the Observatory and the Ground System. Several data flows are conducted while the Observatory is in Hanger AE at KSC including:

- TDRSS Data Flow (August 2006)
    - Telemetry data from Observatory to MOC
    - Command data from MOC to Observatory
    - Burst Alerts from Observatory to MOC and GCN

- USN Data Flow (August 2006)
    - CTV or Spectrum Astro test equipment to verify Observatory / MOC interface
    - Communication occurs via 2.25Mbps RF interface

Additionally, a revalidation of the operational readiness of the link between the MOC and the USN Ground Station will be conducted. This does not involve the launch site or the actual Observatory. This data flow includes:

- Simulated and recorded Observatory telemetry
- Command data from MOC to USN
- Quick-look Level-0 data from MOC to GSSC
- Higher level data products from GSSC to HEASARC and Instrument Teams

APPENDIX A – ACRONYM LIST

ACS	Attitude and Control System
APIDs	Application Identifications
ATS	Absolute Time Sequence
AZ	Arizona
BAPs	Burst Alert Processors
C&DH	Command & Data Handling
CCSDS	Consultative Committee for Space Data Systems
CMD	Command
COP-1	Command Operation Procedure - 1
COTS	Commercial-Off-The-Shelf
CTV	Compatibility Test Van
DAS	Demand Access System
DRB	Discrepancy Review Board
E/PO	Education and Public Outreach
ETE	End-To-End
ETR	Eastern Test Range
EU	Engineering Unit
FDF	Flight Dynamics Facility
FITS	Flexible Imaging Transport and System
FoM	Figure of Merit
FOT	Flight Operations Team
FSW	Flight Software
GBM	GLAST Burst Monitor
GCN	GRB Coordinates Network
GIOC	GBM Instrument Operations Center
GLAST	Gamma ray Large Area Space Telescope
GN	Ground Network
GOTS	Government-Off-The-Shelf
GPS	Global Positioning System
GRB	Gamma-Ray Burst
GSFC	Goddard Space Flight Center
GSSC	GLAST Science Support Center
HEASARC	High Energy Astrophysics Science Archive Research Center
HK	Housekeeping
I&T	Integration & Test
ICD	Interface Control Document
IM	Instrument Module
IOC	Instrument Operations Center
IP	Internet Protocol
IR	Infrared
ISAC	Italian GLAST Archive Center

IT	Information Technology
ITOS	Integrated Test and Operations System
Kbps	kilobits per second
KSC	Kennedy Space Center
L-0	Level Zero
LAT	Large Area Telescope
L&EO	Launch and Early Orbit
LIOC	LAT Instrument Operation Center
m	meter
MA	Multiple Access
Mbps	Million bits per second
msec	millisecond
MOC	Mission Operations Center
MOMS	Mission Operations and Mission Services
MSFC	Marshall Space Flight Center
MSM	Mission Systems Manager
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NCR	Non Conformance Reporting System
NENS	Near-Earth Network Services Contract
NISN	NASA Integrated Services Network
NORAD	North American Air Defense Command
OGIP	Office of Guest Investigator Program
PB	Playback
PCM	Pulse Code Modulation
PDB	Project Database
PDMP	Project Data Management Plan
PDR	Preliminary Design Review
PI	Principal Investigator
PM	Project Manager
PTP	Programmable Telemetry Processor
RF	Radio Frequency
RS	Reed-Solomon
RT	Real-Time
RTS	Relative Time Sequence
S/C	Spacecraft
sec	second
SERS	Spacecraft Emergency Response System
SLAC	Stanford Linear Accelerator Center
SN	Space Network
SOC	Simulations Ops Center
SOH	State of Health
SOT	Science Operations Team
SRD	System Requirements Document
SSR	Solid State Recorder

STDN	Spacecraft Tracking and Data Network
STK	Satellite Tool Kit
STOL	Spacecraft Test & Operations Language
SWG	Science Working Group
SWSI	SN Web Services Interface
T&C	Telemetry and Command
TBD	To Be Determined
TCS	Thermal Control System
TDRSS	Tracking and Data Relay Satellite
TLE	Two-Line Element
TLM	Telemetry
ToO	Target of Opportunity
UPS	Uninterruptible Power Supply
U.S.	United States
USN	Universal Space Network
UTC	Universal Time Coordinated
VC	Virtual Channel
WDISC	White Sands Complex Data Interface Service Capability
WSC	White Sands Complex
WWW	World Wide Web

APPENDIX B – GLAST GRTT Points of Contact

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INITIAL DRAFT

Name	System	Organization	Phone	Email
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	RFSOC			