492-MOC-001

# Gamma-Ray Large Area Space Telescope (GLAST) Project

# *Mission Operations Center Development Plan*

**Baseline**
**Version 1.2**

**August 16, 2004**

**GODDARD SPACE FLIGHT CENTER**
**GREENBELT, MARYLAND**

CHECK THE GLAST PROJECT WEBSITE AT
http://glast.gsfc.nasa.gov/project/cm/mcdl TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

# Document Approval

**Prepared by:**

| | |
|---|---|
| Doug Spiegel, Omitron<br>MOC Manager | Date |

**Approved by:**

| | |
|---|---|
| Ken Lehtonen, GSFC Code 581<br>GLAST Ground System/Ops Manager | Date |
| Dennis Small, GSFC Code 584<br>GLAST MOC Lead | Date |

**Concurrence:**

| | |
|---|---|
| George Sauble, Goldbelt Orca<br>MOC Program Director | Date |
| | Date |
| | Date |

# REVISION STATUS

This document is controlled by the GLAST MOC project. Changes require prior approval of the GLAST MOC Manager with concurrence of the GLAST MOC Lead.

| VERSION | DATE | CHANGED BY | DESCRIPTION |
|---|---|---|---|
| 0.01 | 07/31/03 | Doug Spiegel | Preliminary Document |
| 0.02 | 8/26/03 | Doug Spiegel | Revisions based on review comments |
| 0.03 | 10/20/03 | Doug Spiegel | Baseline Review version |
| 1.0 | 10/30/03 | Doug Spiegel | Baseline version, incorporated review comments |
| 1.1 | 04/01/04 | Doug Spiegel | Revisions to org chart, added section for QA |
| 1.2 | 08/11/04 | Doug Spiegel | Added Release Plan as appendix, other minor cleanup |

# TABLE OF CONTENTS

**1.0 INTRODUCTION** ..... **1**

1.1 PURPOSE ..... 1
1.2 SCOPE ..... 1
1.3 APPLICABLE DOCUMENTS ..... 1

**2.0 ORGANIZATION & RESPONSIBILITIES** ..... **2**

2.1 PROJECT ORGANIZATION ..... 2
2.2 DEVELOPMENT ORGANIZATION ..... 3
2.3 RF GROUND STATION PROVIDER ..... 4
2.4 TELEMETRY & COMMAND SOFTWARE PROVIDER ..... 4
2.5 SPACECRAFT VENDOR ..... 5
2.6 INSTRUMENT TEAMS ..... 5
2.7 INSTITUTIONAL SUPPORT ORGANIZATIONS ..... 5

**3.0 DEVELOPMENT METHODOLOGY** ..... **6**

3.1 REQUIREMENTS ANALYSIS ..... 6
3.2 SYSTEM DESIGN ..... 6
3.3 INTERFACE DEFINITION ..... 7
3.4 SOFTWARE DEVELOPMENT ..... 7
3.5 INTEGRATION ..... 8
3.6 TESTING ..... 8
3.7 SYSTEM DELIVERY & INSTALLATION ..... 8
3.8 DOCUMENTATION ..... 9
3.9 CONFIGURATION MANAGEMENT ..... 10
3.10 QUALITY ASSURANCE ..... 11
3.11 OPERATIONS PREPARATION ..... 11
3.12 TELEMETRY & COMMAND DATABASE ..... 12

**4.0 MANAGEMENT PLAN** ..... **13**

4.1 SCHEDULES ..... 13
4.2 STATUS REPORTING ..... 13
4.3 REVIEWS ..... 14
4.4 RISK MANAGEMENT ..... 14

**5.0 MAINTENANCE PLAN** ..... **15**

**6.0 TRANSITION PLAN** ..... **15**

**APPENDIX A – MOC BUILD PLAN** ..... **16**

**APPENDIX B – ACRONYM LIST** ..... **17**

# 1.0 INTRODUCTION

## *1.1 PURPOSE*

This Development Plan defines the approach and methodology for the development of the GLAST Mission Operations Center (MOC) and preparations for mission operations support.

## *1.2 SCOPE*

This document covers the approach to development of the MOC systems, network, development and operations facilities, and the testing, documentation, maintenance and control of those systems. This document does not address MOC design or operations concepts. In cases where applicable information is contained in a separate document, a reference is made to the specific document.

## *1.3 APPLICABLE DOCUMENTS*

The following documents contain information relevant to this plan:

- “GLAST Mission Operations Concept Document”, 433-OPS-0001, Revision A.
- “GLAST Project Plan”, 433-PLAN-0001.
- "GLAST Ground System Implementation Plan",433-PLAN-0016.
- "Statement Of Work for the GLAST Mission Operations Center and Mission Operations Support", 433-SOW-0003, Rev 1.
- "Mission Operations Agreement: GLAST Mission Operations Roles & Responsibilities".
- "GLAST Mission Systems Specification", 433-SPEC-0001.
- "GLAST Ground System Requirements Document", 433-RQMT-0006.
- “GLAST Ground System Mission Assurance Requirements Document”, 433-MAR-0004.
- “Project Service Level Agreement”, tbs.
- "GLAST Ground System Test Plan", tbs.
- "MOC Functional & Performance Requirements", 492-MOC-002.
- “MOC Design Specification”, 492-MOC-005.
- "MOC Test Plan", 492-MOC-007.
- “MOC Configuration Management Plan”, 492-MOC-006.
- “Flight Operations Manual”, 492-MOC-014.
- “Procedure and Proc Style Guide”, 492-MOC-004.

# 2.0 ORGANIZATION & RESPONSIBILITIES

## *2.1 PROJECT ORGANIZATION*

The GLAST Project is managed by the Goddard Space Flight Center (GSFC), Greenbelt, MD. The GLAST Project Office has overall project management responsibility to develop, deliver and operate the GLAST mission. The GLAST Project Scientist is Dr. Jonathan Ormes, who has overall responsibility for the accomplishment of the mission and meeting the science objectives. The GLAST Project Office is headed by Kevin Grady, Project Manager, and includes spacecraft and instrument management, systems engineering management, and ground system management. The ground system and mission operations are managed by Ken Lehtonen, GSFC Code 581, Ground System and Operations Manager (GSOM). The GLAST Mission Operation Center (MOC) Lead is Dennis Small, Code 584.The GLAST Ground System and Operations organization is depicted in Figure 2-1. Refer to the *GLAST Project Management Plan* for additional information. Details of the roles and responsibilities of the organizations involved in operations are described in the *Mission Operations Agreement: GLAST Mission Operations Roles & Responsibilities* document.

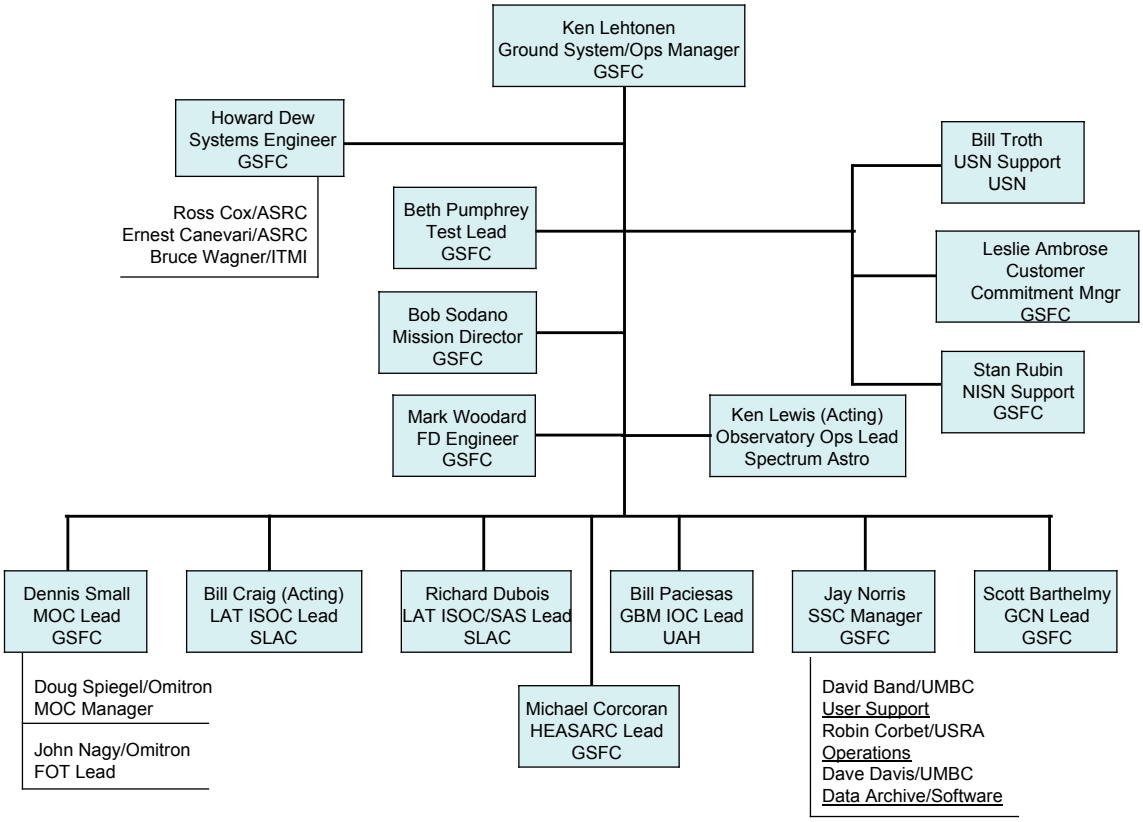


*Figure 2-1 GLAST Ground System & Operations Organization*

## 2.2 DEVELOPMENT ORGANIZATION

Goldbelt Orca and Omitron, Inc. are teamed as the contractor responsible for the design, implementation, testing, documentation, and delivery of the MOC systems and procedures. Goldbelt Orca and Omitron will also provide the Flight Operations Team (FOT) to support all pre-launch, launch and early orbit, and normal on-orbit operations activities. The FOT is an integrated subset of the MOC team. NASA is responsible for providing the MOC facility at GSFC in Greenbelt, MD. The Omitron MOC team is led by Doug Spiegel, MOC Manager. The MOC team's responsibilities are defined in the *Statement of Work for The GLAST Mission Operations Center and Mission Operations Support*.

The Orca/Omitron MOC team consists of system engineers, operations engineers and software developers that work closely together in all aspects of the definition, implementation, delivery, and operation and maintenance of the MOC. The system and operations engineers focus on development of concepts, requirements, architecture, interface specifications, software specifications, testing, and preparation for flight operations. The software developers focus on detailed design, implementation, and documentation of the software system. The MOC team organization is shown in Figure 2-2.

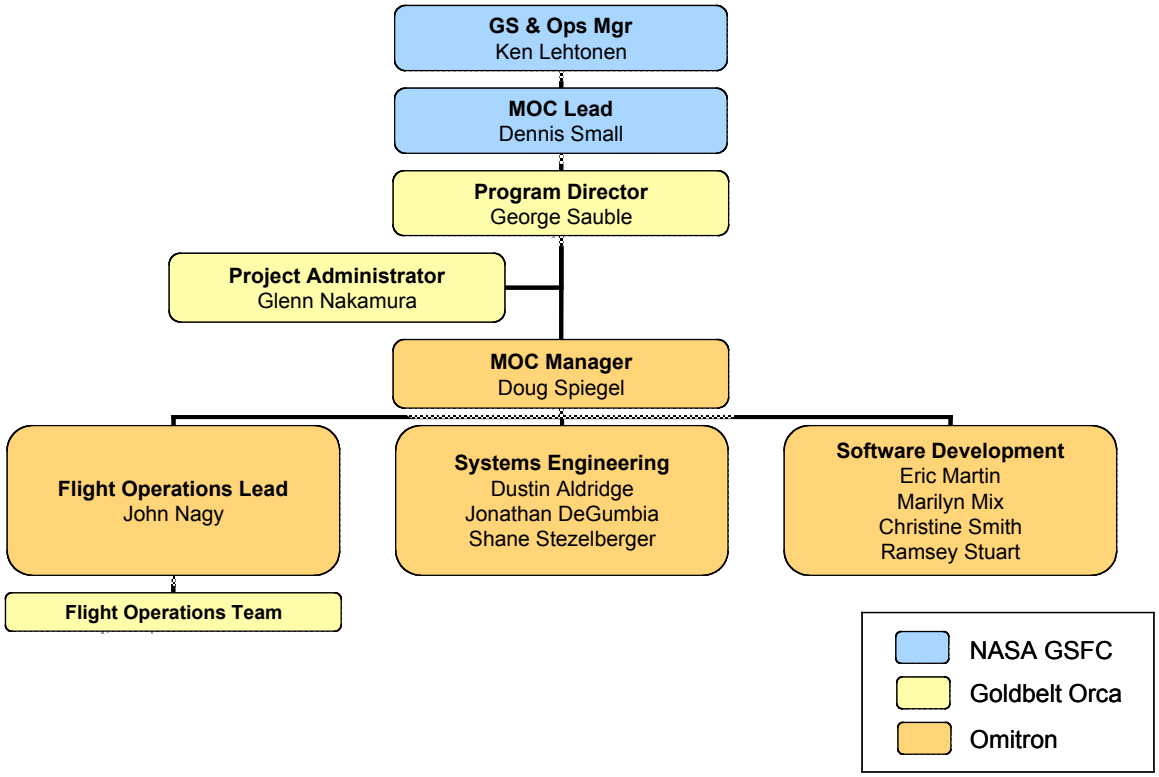


*Figure 2-2 MOC Team Organization*

### *2.3 RF GROUND STATION PROVIDER*

The primary RF services for telemetry and command communications with the GLAST Observatory are provided by the Space Network (SN) Tracking and Data Relay Satellite System (TDRSS). GLAST will utilize Ku-band for high-rate telemetry downlink and S-band for command uplink and telemetry downlink services. The MOC will interface with the TDRSS Demand Access System (DAS) for 24x7 alert messaging, and with the White Sands Complex (WSC) Data Interface Service Capability (WDISC) for scheduled forward and return link services. The MOC also interfaces with the GLAST Project-provided GLAST Front-End Processor (GFEP) at WSC for receipt of the Ku-band telemetry. The MOC schedules SN resources and receives status data from the Data Services Management Center (DSMC) via the SN Web Services Interface (SWSI). The MOC team interfaces with the SN to define the interface for the transport of telemetry and command data, status data, and scheduling SN resources. These items are documented in the *DAS to DAS Customers ICD*, the *NCCDS to MOC ICD*, the *GFEP to MOC ICD,* and the *SWSI Users Guide*.

The secondary RF services for GLAST are provided by Universal Space Network (USN), a commercial ground network provider. USN's South Point, Hawaii and Dongara, Australia ground stations will provide RF telemetry and command services via the USN Network Management Center (NMC), in Horsham, PA. The MOC team interfaces with USN to define the interface for transport of telemetry and command data, status data, and scheduling station resources. These items are documented in the *MOC to Backup Ground Station ICD*, developed by the MOC team.

### *2.4 TELEMETRY & COMMAND SOFTWARE PROVIDER*

The MOC utilizes the Integrated Test and Operations System (ITOS) telemetry and command system, a government-off-the-shelf (GOTS) product developed and maintained by GSFC Code 584. ITOS is used by the MOC team during spacecraft- and observatory-level I&T as well as for operations (note however that Spectrum Astro is using a different system, *AstroRT*, for all spacecraft and observatory I&T). The ITOS Development Team provides support to the project by making any mission-specific changes to ITOS, and to provide maintenance and support of the product. The requirements for the mission-specific changes to ITOS are maintained by the GLAST Mission Operation Center (MOC) Lead. The MOC team interfaces with the ITOS team to identify and schedule needed system changes and coordinate resolution of ITOS issues.

## *2.5 SPACECRAFT VENDOR*

Spectrum Astro of Gilbert, AZ is the spacecraft vendor and is responsible for development and integration of the spacecraft bus, observatory integration, launch processing, observatory commissioning and checkout, and sustaining engineering support for the on-orbit operations of the spacecraft. Spectrum Astro provides the spacecraft documentation, Telemetry and Command Database, and flight procedures to the MOC, and provides training on the spacecraft systems to the FOT. Spectrum Astro also delivers a MOC Training Simulator to the MOC team for use in ground system testing, proc development and validation, and FOT training. The MOC team interfaces with the Spectrum team on spacecraft and ground operations issues, testing, and operations plans. During normal operations, the MOC provides engineering data to Spectrum for analysis of spacecraft systems, and Spectrum performs flight software maintenance.

## *2.6 INSTRUMENT TEAMS*

The instrument teams are responsible for the development of the two instruments, delivery to observatory integration, and sustaining engineering. The Large Area Telescope (LAT) is being developed by the Stanford Linear Accelerator Center (SLAC) located in Stanford, CA. The GLAST Burst Monitor (GBM) is being developed by Marshall Space Flight Center with the University of Alabama-Huntsville. The MOC interfaces with the instrument teams on instrument operations issues, and coordination of flight software loads, the ITOS Database, flight procedures, STOL procedures (PROCs), and testing. The instrument teams provide analysis of instrument performance and flight software maintenance.

## *2.7 INSTITUTIONAL SUPPORT ORGANIZATIONS*

GSFC also provides support to the mission through the MOMS and NENS contracts for Space Network (SN) services, NASA Integrated Services Network (NISN) services, and Flight Dynamics Facility support services. The MOC team interfaces with the MOMS team on definition of requirements, testing, and operational support issues. The GSFC Code 451 Mission Manager for GLAST, Leslie Ambrose, is the primary point of contact. The MOMS services for GLAST are documented in the *Project Service Level Agreement*.

GSFC provides the Portable Spacecraft Simulator (PSS) for the GLAST project for use in testing the MOC systems and for testing the ground stations. The MOC team coordinates with the PSS developer to define GLAST requirements, specific needs of the tool, and on problem resolution. The MOC team receives releases of the PSS from the PSS team, tests the releases, and reports any discrepancies for resolution by the PSS team.

# 3.0 DEVELOPMENT METHODOLOGY

The approach for development of the MOC is described in the sections below including requirements analysis, system design, interface definition, software development, integration, testing, delivery, documentation, configuration management, and quality assurance. Preparation for mission operations is also discussed.

## *3.1 REQUIREMENTS ANALYSIS*

The MOC team performs requirements analysis by detailed review and assessment of the GLAST Project-level documents including the *Mission Systems Specification*, and the ground system-level documents including the *Ground System Requirements Document* and the *GDS Mission Assurance Requirements Document*. Detailed requirements are derived and documented in the *MOC Functional & Performance Requirements*, covering system, interface, performance, and functional requirements. This requirements document also includes a mapping to the GSRD requirements to establish traceability and identify the source each requirement was derived from.

In addition, the MOC team performs analysis of requirements and associated documentation on the spacecraft, the instruments, and external elements including the GSSC, SN/TDRSS systems (DAS, WDISC, SWSI, and NCC), the GLAST Front End Processor (GFEP), Universal Space Network, etc. This is augmented by attending reviews, participating in Technical Interface Meetings (TIMs), and consulting with the relevant groups.

## *3.2 SYSTEM DESIGN*

The MOC system design is specified in terms of the external interfaces, communications links, network and hardware architecture, software architecture, internal interfaces, and data products and flows. This information is documented in the *MOC Design Specification*. Detailed software process diagrams are developed along with a complete data dictionary defining all data elements. Data flow diagrams are developed to depict the flow of data through the system elements for each major system processing thread. Design walkthroughs are held within the MOC team for the data flow diagrams and all software component designs.

Trade studies are performed to assess alternative approaches, products or services and to determine the best fit for the GLAST MOC with respect to functionality, cost, performance, reliability, and maintenance. The results of trade studies are discussed with the GLAST MOC Lead and Ground System/Ops Manager, and documented for later reference. Prototyping of alternate products or approaches may be performed for areas deemed to be of high risk, or where additional insight is needed to finalize the system design.

### *3.3 INTERFACE DEFINITION*

The MOC interfaces to external elements are identified and defined in detail in Interface Control Documents (ICD). The ICD identifies all products exchanged between the interfacing elements, and defines the protocol for exchanging the data and their formats. Data rates and other information are included as appropriate. MOC external interfaces will also be summarized in the *MOC Design Specification* document.

Internal to the MOC, the data interfaces between the various software packages and components are defined and controlled in the *MOC Design Specification* document.

### *3.4 SOFTWARE DEVELOPMENT*

The MOC software is implemented in a series of builds, to incrementally build up and test the functionality of the MOC system. The build plan (appendix A) defines the allocation of software components to the designated builds. The MOC system is developed, integrated and tested in the MOC development lab at the Omitron facility, which consists of a network and hardware similar to the target MOC architecture. The MOC system consists of new software, COTS and GOTS products, and reused software with modifications. The software developers perform detailed analysis for each software component, and document the detailed design and any relevant notes, restrictions, or dependencies in online Software Development Folders (SDF). For new or modified software, the developers perform detailed design, implement the software following established coding standards, and develop and execute unit tests before proceeding to integration. Most new software is implemented using Perl scripts and Linux shell scripts, with some C and C++. A code walkthrough is held prior to execution of the unit test, in which the developer provides the code listing, design/implementation notes, and the unit test plan to the other team members for review. A walkthrough meeting is then scheduled to review the results and identify specific actions. The design and implementation notes, unit test plan and results, and code walkthrough minutes are captured in the SDF for that component.

COTS and GOTS products are installed in the development lab and configured for use with the GLAST MOC. Notes are compiled on the product configuration including instructions for setup and execution of the software, and captured in the SDF. Scripts are typically required to configure and startup the software, which are written by the developer and reviewed in a walkthrough. Product testing is performed to validate that the software is configured properly and performs the functionality required.

### *3.5 INTEGRATION*

As the software components for a given build complete code walkthroughs and unit tests, they are integrated into the system to prepare for system testing. An informal Build Integration Plan indicates the order in which components are integrated and the thread tests that verify that the integrated set of components accomplishes the necessary processing, and that the interfaces between them are working correctly. This activity is led by the developers with support from the testers.

### *3.6 TESTING*

The MOC team is responsible for testing the MOC system to ensure that all functional and performance requirements are met, and that the system is operationally usable. MOC testing is performed at the element level and then flows into the overall GLAST ground system test program for validation of all elements of the GLAST ground network, as specified in the *GLAST Ground System Test Plan*. MOC testing is specified in the *MOC Test Plan*, which provides a description of the test methodology, the planned test cases, and descriptions of each test. A Requirements Verification Matrix is developed to track the test coverage of all MOC Functional & Performance Requirements. A mapping of the test cases to the requirements is also included.

Testing for each build commences upon completion of software integration for that build. Regression testing is performed for each successive build or patch to verify that the prior build capabilities are functioning correctly and have not been adversely affected by the new software or changes. System testing is performed according to the test plan, executed by the testers and supported by the developers. The PSS, MTS, spacecraft hotbench simulator, and recorded data are used as test resources. Any discrepancies found are documented in Discrepancy Reports within the TrackGear system. After all tests have been executed, a final run-for-record (acceptance test) is executed and the results are summarized in a test report for that build. All relevant test scripts, PROCs, data files, etc. are archived in the online repository.

### *3.7 SYSTEM DELIVERY & INSTALLATION*

Upon completion of acceptance testing of each build, the MOC team will hold a Release Delivery Review (RDR) meeting with the GLAST Ground System/Ops Manager, GLAST MOC Lead, and a QA representative, to review the functionality of the build, summary of the test results, and description of any liens (DRs), workarounds, or other pertinent notes. The RDR will be held prior to installation of the build in the GSFC MOC. Following installation and checkout, a demonstration of the build's capabilities will be performed. The demonstrations are to be held in the GLAST MOC Facility at GSFC.

MOC development, integration and testing are performed in the Omitron development lab. There are two target environments for the MOC system: the Observatory I&T facility at Spectrum Astro, Gilbert AZ, and the operational MOC facility at GSFC. The MOC installation at the Observatory I&T facility consists of a subset of the MOC systems necessary to support spacecraft interface testing, proc development and validation, telemetry & command database check-out, and testing of the MOC system with the spacecraft hotbench and the actual spacecraft.

Prior to installation, a facility configuration is developed and any dependencies concerning physical space requirements, network connectivity, power, phone lines, etc. are provided to and coordinated with the party responsible for the facility. The installation process begins with setup of the hardware and network infrastructure, setup of accounts and associated administration tasks, installation of COTS and GOTS products, and installation of the MOC software. The system is then configured, followed by regression test. Data flow tests are conducted to validate connectivity to external interfaces. For the GLAST MOC, a facility installation and verification plan will be developed to describe all of the necessary steps. Facility readiness will be declared upon completion of the plan and acceptance by the GLAST MOC Lead.

### *3.8 DOCUMENTATION*

Documentation is prepared to describe the concepts, requirements, design and system information, and other system and operations aspects of the GLAST MOC. Documents are assigned an identification number and are tracked by version number and date. Table 3-1 lists the documents by title, identification number and entity responsible for control of the document. A status table is maintained to track the documents. Each document is assigned to a member of the MOC team as the responsible person for developing the document and handling updates for review comments and changes.

An online repository of the documentation is managed on a web server using the DocuShare document management system, and is accessible to all mission team members. The repository contains folders to categorize the information, including requirements, design data, ICDs, schedules, project management data, SDFs, testing info, operations info, reference documents, diagrams, TIM meeting notes, etc.

| Document | Doc. No. | CCB |
|---|---|---|
| GLAST Mission Operations Concept | 433-OPS-0001 | Project |
| Development Plan | 492-MOC-001 | Internal |
| MOC Functional & Performance Requirements | 492-MOC-002 | Ground System |
| DB Format & Naming Convention | 492-MOC-003 | Ground System |
| Procedure and Proc Style Guide | 492-MOC-004 | Ground System |

| | | |
|---|---|---|
| Design Spec | 492-MOC-005 | Internal |
| CM Plan | 492-MOC-006 | Internal |
| MOC Test Plan | 492-MOC-007 | Internal |
| Security Plan | 492-MOC-008 | Ground System |
| Operations Data Products ICD | 492-MOC-009 | Ground System |
| MOC-Backup Ground Station ICD | 492-MOC-010 | Ground System |
| Mission Ops Readiness Plan | 492-MOC-011 | Ground System |
| Training & Certification Plan | 492-MOC-012 | Internal |
| Sustaining Engineering Plan | 492-MOC-013 | Internal |
| Flight Ops Manual | 492-MOC-014 | Internal |
| Transition Plan | 492-MOC-015 | Ground System |

Table 3-1 MOC Documentation

### *3.9 CONFIGURATION MANAGEMENT*

All software, scripts, databases, documentation and parameter data files are maintained under configuration control. Configuration management (CM) is provided by the Configuration Control Board (CCB), either at the GLAST Project level, Ground System level, or internally at the MOC level. Ground System CM is described in the *GLAST Ground System Implementation Plan*, and the MOC CM is described in the *MOC CM Plan*. The operations concept is controlled at the Project CCB, and the ICDs, requirements, security plan, and operations readiness plan are controlled within the Ground System CCB; all other software and documentation is controlled internally within the MOC team. The CVS configuration management tool is used to manage the versions and track changes to the files. The MOC CM process and instructions for use of the CVS tool are contained in the online repository in the *MOC CM Plan*.

The GLAST Project and Ground System CCBs utilize a web-based configuration management system to manage and track documents. Documents are baselined in the CCB by submitting a Configuration Change Request (CCR) in the CM system. CCB members receive automatic notification via email, review the CCR and approve or disapprove the CCR, and enter comments regarding disposition of the CCR. The documents are loaded into the system and are linked from the CCR. Changes to baselined documents are handled in the same manner, in which a CCR is submitted along with the changes, reviewed and dispositioned by the CCB, and then baselined. The MOC Manager is a member of the Ground System CCB and is responsible for ensuring that all CCRs are reviewed and assessed for any impact to the MOC or mission operations.

Items controlled at the MOC level are maintained in the online repository. Discrepancy Reports (DR) are used to report and track all discrepancies of MOC software and data under configuration control. DRs are managed and tracked in the TrackGear system, which provides web access. The DR process is defined in the Standards and Procedures folder in the online repository.

### *3.10 QUALITY ASSURANCE*

The MOC team conducts design, code and test inspections as part of the normal development process. These inspections are conducted by peers within the MOC team, such that at least one other person than the author is independently reviewing the subject design, code or test plan. As described above, DRs are recorded and tracked for all MOC discrepancies. The MOC team also coordinates with the ground system QA Engineer, Dave Harmon, for independent QA of MOC processes and products. The quality assurance activities of the ground system are addressed in the *Ground System Mission Assurance Requirements Document*.

### *3.11 OPERATIONS PREPARATION*

Preparation for flight operations is an integral part of the development of the MOC. System Engineers and Operations Engineers bring an operations focus from the beginning of the project and continue throughout development and transition into operations. The System Engineers develop an *Operations Concept Document* to describe concepts for operation of the spacecraft and instruments, the roles of the organizations involved, and the concept for how people, systems and procedures come together to accomplish the requirements of the mission operations. The concepts are developed in conjunction with interfacing organizations including the spacecraft vendor, instrument teams, NASA, the GSSC, HEASARC, and the ground station providers.

The MOC team plays a key role in the development of operations products and preparation for flight operations. The roles and responsibilities of the various organizations involved are described in the *Mission Operations Agreement: GLAST Mission Operations Roles & Responsibilities*. The detailed plans for flight operations are documented in the *Flight Operations Manual*. The MOC team presents the operations plans at the Mission Operations Review (MOR) about one year prior to launch, and presents the status of readiness for flight operations at the Operational Readiness Review (ORR) about two months prior to launch.

The MOC team participates in regular discussions with the spacecraft and instrument teams to gain insight into the development of the spacecraft and instrument systems and flight software and to coordinate on resolution of issues. The GLAST Operations Working Group (GOWG) meets regularly to coordinate preparation for operations products of the spacecraft and instruments, including pre-launch verification, L&EO activation and checkout, and normal operations.

The MOC team develops detailed procedures for routine and contingency operations to define the steps necessary to accomplish all tasks needed to operate the observatory. The team participates in Observatory I&T to become

familiar with the spacecraft subsystems, instruments, operations procedures, and to checkout the MOC systems with the actual flight hardware. The MOC team develops and validates STOL PROCs, and coordinates review and signoff of the PROCs with the relevant spacecraft or instrument team. The MOC team develops the *Procedure and Proc Style Guide* for use by all team members to establish consistency in development of the operations procedures and ITOS STOL PROCs. The MOC team also develops the *Database Format and Naming Convention* document to establish the rules and guidelines for naming telemetry and command mnemonics and define database format and naming.

The MOC team is also an integral part of ground system-level testing, which includes the spacecraft interface tests (referred to as end-to-end tests on GLAST), ground readiness tests (GRTs), operations readiness tests (ORTs), and simulations. The ground system testing is defined in the *GLAST Ground System Test Plan*, developed by the GLAST Ground System Test Lead. Simulations include launch and early orbit, normal operations (day-in-the-life), and contingency operations, to exercise the procedures and demonstrate readiness of the personnel and systems. The simulations and overall operations readiness approach are described in the *Mission Operations Readiness Plan*.

The GLAST Flight Operations Team (FOT) shall be trained and certified for MOC operations. A *MOC Training & Certification Plan* will be developed, and will include certification requirements, training activities, and process description. Training shall include formal classroom training, reading assignments, hands-on MOC training and exercises, participation in I&T activities, and mission simulations.

### *3.12 TELEMETRY & COMMAND DATABASE*

The project telemetry and command database (T&C DB) specifies all spacecraft and instrument telemetry parameters and commands that are used by the ITOS system. Individual T&C DBs are developed for the spacecraft and each of the instruments by the development teams and validated during the respective I&T. These DBs are brought together in Observatory I&T to form the Observatory DB. Spectrum Astro provides deliveries of the Observatory DB to the MOC, in ITOS format. The MOC team adds ground system parameters to the DB to form the Project Data Base (PDB). The MOC inherits responsibility for the Observatory T&C DB after the Observatory 60-day check-out to maintain configuration control for on-orbit operations. Subsequent changes to T&C DB are accomplished through the CM process and validated prior to use in operations.

# 4.0 MANAGEMENT PLAN

## *4.1 SCHEDULES*

The MOC Manager maintains a detailed development schedule for all MOC system engineering, hardware, network, software, testing, documentation, and operations preparation activities. The detailed schedule identifies each task to be performed, the resources assigned, the dates for the activity, and any dependencies on other activities required. In addition, the MOC Manager supplies schedule inputs to the GLAST Project scheduler for inclusion in the integrated GLAST schedule. The MOC Manager tracks percent complete of each active task and monitors dates and resources usage.

The detailed schedule reflects the allocation of software components to MOC Builds as specified in the Build Plan (appendix A). The Build Plan lists the software components that comprise each build, and a mapping of functional items to builds. Key dependencies are also defined listing the required build number and capabilities needed.

## *4.2 STATUS REPORTING*

The MOC team participates in the regular GOWG meetings, chaired by the Ground System/Ops Manager. Status is provided to all ground system elements, and issues are discussed to develop a plan of action. The MOC team also participates in the Ground System/Ops Manager's weekly staff meetings. The MOC Manager provides a monthly status report highlighting significant accomplishments, plans for the next month, status of open issues/concerns, and identification of any risk items. The MOC team also holds weekly internal status meetings to coordinate tasks and monitor progress and issues. The MOC Manager maintains an action item list to track actions to closure, including assignee, due date, status, and comments for status/resolution.

Metrics are tracked throughout the development cycle, and reported to the GLAST MOC Lead. For the development of each MOC Build, development of new or modified software is tracked by the following:

- Number of modules total
- Number of modules coding complete
- Number of modules code walkthrough complete
- Number of modules unit testing complete

Testing of each Build is tracked by the following:

- Number of test cases total
- Number of test cases executed
- Number of test cases verified
- Number of DRs written

### *4.3 REVIEWS*

The MOC team participates in regular periodic reviews including the Monthly Status Review (MSR) with GLAST Project, and supports life-cycle Project reviews, including:

- System Requirements Review
- System Design Review
- Mission Operations Review
- Operational Readiness Review
- Flight Readiness Review

The MOC team develops and presents materials for the GLAST ground system reviews, and supports spacecraft and instrument reviews by assessing the materials and providing feedback from a ground system and operations perspective.

The MOC team also participates in element-level reviews including ground system and operations Peer Reviews, walkthroughs, and demos. Internally, the MOC team holds walkthroughs of requirements, design, code, test plans, and procedures.

### *4.4 RISK MANAGEMENT*

As a member of the ground system team, the MOC utilizes the GLAST Project Risk Management System, which allows any team member to submit or track risk items in the online system. Any risk items identified by the MOC team are elevated to the GSOM for determination of the appropriate action. At the direction of the GSOM, the MOC team will enter the risk items in the Risk Management System. MOC risk items are discussed and described in the monthly status report, and are also discussed at the GOWG status meetings. The MOC team periodically reviews all open risk items in the system to ensure proper coordination of issues between the ground system and the spacecraft and instruments.

## 5.0 MAINTENANCE PLAN

The MOC team is responsible for maintenance of the MOC systems for the life of the GLAST mission. Vendor maintenance contracts shall be maintained for all COTS hardware and software used in the MOC for the duration of the mission. Any new software developed by Goldbelt Orca/Omitron or modified GOTS products shall be maintained by Goldbelt Orca/Omitron programmers. System maintenance procedures shall be developed and included in the *MOC Sustaining Engineering Plan*, and will include periodic testing of backup GLAST ground systems. Patch releases will be developed and delivered as needed for bug fixes and critical new requirements.

External service providers shall have the responsibility for internal system maintenance on their facilities. External system maintenance plans and procedures shall be available for review and comment by MOC team, as required in the specific contract.

## 6.0 TRANSITION PLAN

The MOC team shall also develop and deliver a MOC Transition Plan to NASA. The document describes the contractor's approach and schedule for transitioning operations and sustaining engineering to a new contractor after two years of GLAST mission operations.

# APPENDIX A – MOC Build Plan

- Build 1 (Jan '05) – GRT#1, 2
  - DB Ingest - ITOS
  - TLM & CMD Processing - ITOS
  - Level 0 TLM Processing – ITOS
  - Flight Dynamics Processing – STK, STK Automation Release 1
  - Integrated Timeline and Command Load Generation - MPS Release 1
  - Event Logging
  - Attitude-dependent Contact Scheduling – Release 1
    - STK Scheduler

- Build 2 (July '05) – GRT#3, 4
  - Alert Handling
  - Level 0 Product Distribution (Fastcopy)
  - Timeline Monitoring Release 1
  - Flight Dynamics Processing Release 2
  - Attitude-dependent Contact Scheduling – Release 2
  - Science Input Processor
  - Contact Schedule Converter
  - System Automation – Real-time AMAC Release 1
  - System Automation – Offline AMAC Release 1
  - System Automation – DAS AMAC Release 1
  - MPS Release 2 – DB ingest (ITOS DBX files)

- Build 3 (Jan '06) – GRT# 5, 6, ETE#1, 2, 3
  - Attitude-dependent Contact Scheduling Release 3
  - System Automation – Real-time AMAC Release 2
  - System Automation – Offline AMAC Release 2
  - System Automation – DAS AMAC Release 2
  - GFEP Interface – Monitor and Control (??)
  - Frame Accounting
  - Timeline Monitoring Release 2
  - System Monitoring & Paging
  - Trending & Analysis
  - MOC Web Site

- Build 4 (July '06) – GRT#7, ETE#4, 5, 6
  - DR Cleanup
  - Late requirements/enhancements

# APPENDIX B – ACRONYM LIST

| | |
|---|---|
| CCB | Configuration Change Board |
| CCSDS | Consultative Committee for Space Data Systems |
| CMD | Command |
| COTS | Commercial Off-the-Shelf |
| CTV | Compatibility Test Van |
| DAS | Demand Access System |
| DSMC | Data Services Management Center |
| ETE | End-to-End test |
| ETR | Eastern Test Range |
| FDF | Flight Dynamics Facility |
| FOT | Flight Operations Team |
| GBM | GLAST Burst Monitor |
| GCN | GRB (Gamma Ray Burst) Coordinates Network |
| GFEP | GLAST Front End Processor |
| GI | Guest Investigator |
| GIOC | GBM Instrument Operations Center |
| GLAST | Gamma-ray Large Area Space Telescope |
| GN | Ground Network |
| GPS | Global Positioning System |
| GRB | Gamma Ray Burst |
| GSFC | Goddard Space Flight Center |
| GSOM | Ground System and Operations Manager |
| GSSC | GLAST Science Support Center |
| HEASARC | High Energy Astrophysics Science Archive Research Center |
| ICD | Interface Control Document |
| IOC | Instrument Operations Center |
| L&EO | Launch and Early Orbit |
| LAT | Large Area Telescope |
| LAT DPF | Large Area Telescope Data Processing Facility |
| LHEA | Laboratory for High Energy Astrophysics |
| LIOC | LAT Instrument Operations Center |
| MOC | Mission Operations Center |
| MOMS | Mission Operations and Maintenance Support |
| MSFC | Marshall Space Flight Center |
| NASA | National Aeronautics and Space Administration |
| NCC | Network Control Center |
| NENS | Near-Earth Networks Support |
| NORAD | North American Air Defense Command |
| NPG | NASA Policy and Guideline |
| PI | Principle Investigator |
| RF | Radio Frequency |
| RTS | Relative Time Sequence |
| SAA | South Atlantic Anomaly |

| | |
|---|---|
| SOH | State of Health |
| STDN | Spacecraft Tracking and Data Network |
| STOL | Spacecraft Test and Operation Language |
| SWSI | Space Network Web Services Interface |
| SWG | Science Working Group |
| TBD | To Be Determined |
| TBR | To Be Resolved |
| TCP/IP | Transmission Control Protocol / Internet Protocol |
| TDRSS | Tracking and Data Relay Satellite System |
| TLM | Telemetry |
| ToO | Target of Opportunity |
| USN | Universal Space Network |
| WDISC | WSC IP Data Interface Service Capability |
| WSC | White Sands Complex |