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Gravity Probe B Relativity Mission

MISSION OPERATIONS CENTER LAUNCH AND ACTIVATION PLAN
GRAVITY PROBE-B

S0629, Rev. B

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1 Scope

1.1 Purpose

This document describes the roles and responsibilities of the Gravity Probe-B (GP-B) team during the launch and activation phases of the mission. It also serves as the guide for implementing all the MOC pre-launch, launch and Initial Operations Checkout (IOC) operations for GP-B.

1.2 Related Documents

Mission Operations Plan (S0422)

GP-B Security Plan (LM/P480289A and S0369)

MOC Configuration Control of Pods (S0475)

MOC Configuration Control of IONet (S0476)

MOC Configuration Control of Science Net (S0477)

MOC Configuration Control of Firewall (S0502)

GP-B Launch Operations Go/No-Go Criteria (S0878)

GP-B Joint Operating Procedure for GP-B Launch Scrub Activities (P1054)

Launch Site Support Plan (K-ELV-14.011-BL-GPB)

MOC Configuration Management Plan (S0667)

MOC Mission Timeline Software Design (S0478)

Anomaly Resolution Plan (S0897)

GP-B Flight Rules (S0856)

Configuration Management Plan (S0667)

Flight Operations Handbook (LM086680)

Constraints and Restrictions Document (CARD)

Orbit Determination Interface Definition Document (S0505)

Detailed Mission Requirements (450-215-GP-B DMR)

MOC Logbook User's Guide (S0641A)

TCAD User's Guide (S0717B)

Mission Planning Timeline Products Guide (S0892)

1.3 Change Control

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
DRAFT	PRELIMINARY RELEASE	12/01
DRAFT REV. A	REVISION TO DRAFT FOR SIM 4 USE	7/8/02
FINAL REV. -	FINAL RELEASE FOR SIM 5 USE	6/13/03
FINAL REV. A	UPDATED FINAL RELEASE FOR SIM 7 USE	9/18/03
FINAL REV. B	UPDATED FINAL RELEASE FOR LAUNCH	3/26/04

2 Mission Overview

2.1 Pre-Launch Overview

During the pre-launch phase, the Gravity Probe B (GP-B) Space Vehicle (SV) will be transported from Sunnyvale, CA to Vandenberg Air Force Base (VAFB) at L – 75 days. During this time, the GP-B team will partially reside at VAFB and partially at the Mission Operations Center (MOC) at Stanford.

The Space Vehicle will be transported to the launch pad fifteen (15) days prior to launch. Upon arrival at the launch pad the SV will be lifted into the Mobile Service Tower (MST) and installed on the booster, a Boeing-made Delta II rocket. All required ground support equipment (GSE) will be installed in the MST at least one (1) day prior to SV arrival. Immediately after mating the SV to the booster (L-14), guard tank and GMA servicing will be performed. During this time the umbilical will be connected, and the first of several pre-launch Payload Health Checks will occur. The SV batteries will be installed and begin charging at this time as well, and several systems will be powered on, checked out and powered off again on day L-13. Day L-12 is dedicated to Boeing, allowing for their ordnance installation. The second guard tank and GMA servicing will occur on day L-11. Just prior to fairing installation (L-10), the sunshade soft cover will be removed and a walk-around inspection will be performed on the vehicle. Faring installation will occur on day L-9, at which time no work is allowed on the SV. The third guard tank and GMA servicing will be performed while Boeing prepares for the second stage propellant load on day L-8. Day L-7 is scheduled as a make-up day and will likely consist of guard tank work by the SV team and propellant loading preparations by the Boeing team. The second stage propellant will be loaded onto the booster on L-6, at which time no access will be granted to the SV. Days L-4 & L-5 will be used by the SV team for testing of the vehicle and on L-4 the fourth guard tank and GMA servicing will be performed. Range safety checks will be performed on Day L-3 as well as the loading of the first stage propellant onto the booster. The last two days consist of many events in final preparation for launch. Some of the main events are: installation of all pyro arm plugs onto the SV, installation of the thrust nullifier and the final guard tank and GMA servicing. At this point the SV SPC-Launch will be enabled, the SV will be switched to internal power and launch of GP-B will occur.

2.2 Launch and Orbit Insertion

The Gravity Probe B Space Vehicle is launched from VAFB on a Delta II into a 640-km altitude circular polar orbit. The launch vehicle (LV) also places the SV into its desired attitude and provides the desired roll rate.

The primary communications network for GP-B is the Ground Network (GN), a Wallops Flight Facility controlled suite of 11-m antenna dishes provided mostly at the poles. For GP-B, most GN passes are supported by GN stations in Svalbard, Norway (SGS) and

Poker Flats, Alaska (AGS). Wallops, Maryland (WGS) and to a much lesser extent McMurdo, Antarctica (MGS), due to its limited playback capability, will also be available GN stations. GN tracks will support either a 2.56 Mbps downlink in which the Solid State Recorder (SSR) data will be returned or a 32k realtime downlink. The playback data is stored at each GN station's Local Standard Autonomous File Server (LSAFS). Post-contact, the data is then sent to the Central SAFS (CSAFS) at Goddard Space Flight Center (GSFC), which then transfers the data to the MOC.

The Space Network (SN), consisting of several Tracking Data and Relay Satellites (TDRS), will provide secondary support. SN is based out of White Sands, NM at the White Sands Complex (WSC). SN supports a much lower data rate (1 kbps and 2 kbps) but can provide longer passes to allow for transmission of larger uplink files. During launch and early operations, substantial support from SN is expected (see Section 5, Space and Ground Network Coverage Support). GSFC controls both SN and GN; however, Data Services Management Center (DSMC) located at WSC covers all scheduling for both GN and SN.

The GP-B SV is launched with the flight computer on. A preloaded deployment sequence will count down to launch time and then reconfigure the flight software as required for flight. Early in the first second-stage burn, the LV payload fairing separates, triggering a signal that causes the GP-B deployment sequence to begin execution. One of the first events in this sequence is to power on the transmitter. Initial acquisition of GP-B telemetry is expected about 12 minutes after launch. While the second stage is firing, the GP-B Remotely Activated Valves (RAVs) are opened to allow helium to flow to the SV thrusters. The LV fires a circularization burn 63 minutes after launch. Shortly thereafter the SV is oriented toward the guide star by the LV, the solar arrays are deployed, and the LV initiates the roll rate for GP-B (0.1 rpm). The GP-B Attitude Reference Platform (ARP) is released and the SV begins attitude capture. Seventy-five minutes after launch, the SV is separated from the LV. The first GN pass occurs about this time as well, allowing for high rate data return if desired.

2.3 Initial Operations Checkout (IOC) Phase

After LV separation, the SV begins configuration for the science mission. The configuration phase is extensive and may take 40-90 days. Approximately 600 tasks, as defined in the Mission Timeline, must be accomplished during this phase to allow the science mission to begin. Most of the activities are payload tasks, but some spacecraft tasks interface with the payload and cannot occur until the payload is configured properly. Also during this phase, the orbit is trimmed to the correct plane. Because of the low thrust of the control system, this correction could nominally take as long as 60 days given a 3-sigma launch vehicle error. Completion of the IOC phase in a timely manner is critical because the limited lifetime of the helium will limit the science mission.

Significant activities during the IOC phase are payload activation, attitude control with telescope data, orbit trim, gyro spin up, spin axis alignment, low temperature bake-out, possible flux reduction and drag free operations.

2.4 Science Mission Phase

Because the goal during the science mission is to observe the gyro precession with minimal disturbances, commanding required during this phase is minimal. Although commanding will be scheduled on a daily basis to download the SSR data, sequences may run uninterrupted for several days to control science configuration. This phase is planned to be a very quiescent period for GP-B.

2.5 Calibration Mission Phase

After the science mission, there will be a calibration mission phase. During this period, disturbances are introduced into the system to observe their effect on the gyro precession and payload operations. This information will help in the characterization and calibration of the data gathered during the science mission. Development of the timeline for this phase may continue during the science mission.

3 GP-B Operations Organization

3.1 Operations Positions at MOC

The Mission Operations Center (MOC) Operations Organization during Launch and IOC is shown in Figure 3-1, Mission Operations Team Organization. Position roles and responsibilities of each of the functional groups are presented below.

3.1.1 Principal Investigator

Reports to: N/A
Responsibilities:
a) Responsible for the Program and all Mission Objectives.
b) Primary interface between the Program and the science community.
c) Coordinates efforts of Co-PI's and Co-Investigators
d) Approval authority for release of science data.

3.1.2 Program Management Team

Reports to: NASA Headquarters and MSFC Center Management, Principal Investigator
Responsibilities:
a) Overall mission responsibility.
b) Go/No Go Decision reporting at launch at VAFB.
c) Approval authority for top-level mission activities in general and major operations (i.e., gyro spin-up) in particular.

3.1.2.1 Stanford Program Manager

a) Manages facilities, ensures administrative support.
b) Ensures timely reporting of status and anomalies to Stanford management

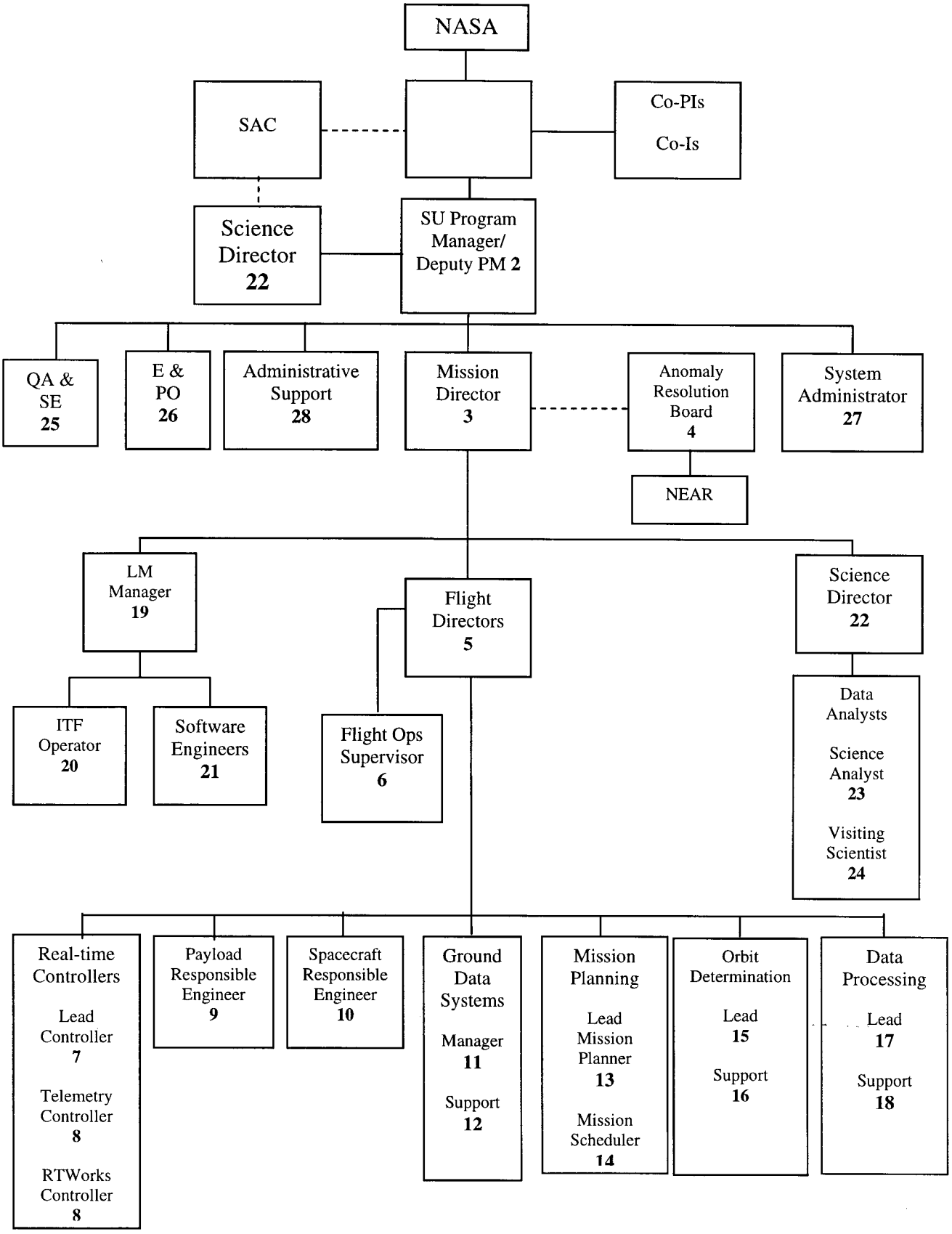

Figure 3-1, Mission Ops Team Organization

3.1.2.2 MSFC Program Management Representative

a) Responsible for go/no-go decision for launch.
b) Responsible for decisions impacting Level 1 or 2 requirements.
c) Responsible for interface with NASA HQ, including approval of any reports.
d) Ensures timely reporting of status and anomalies to NASA management.
e) Coordinates use of NASA assets in support of Program.

3.1.2.3 Lockheed Martin Program Manager

a) Ensures timely reporting of status and anomalies to Lockheed Martin management.
b) Coordinates for use of Lockheed martin assets in support of Program.

3.1.3 Mission Director

Reports to: Program Management Team (also a Team member)
Responsibilities:
a) Responsible for launch direction at MOC
b) Reports Ground Data Systems facilities' readiness status to VAFB
c) Go/ No Go Decision reporting for MOC at launch to PM.
d) Directs the Anomaly Review Board.
e) Approves and directs any changes to flight software
f) Coordinates day-to-day activities with FD and with Anomaly Board on resolving problems
g) Leads Daily All-Hands Meetings, reviewing IOC progress and plans
h) When in the MOC, MD directs through the FD, who leads all real-time activities.
i) Oversees execution and reports results to the FD during critical activities and anomaly recovery operations
j) Shifts are 12x7. If no change to PONG loads, could be 9x7 shift. On-call all other times.

3.1.4 Anomaly Resolution Board

Reports to: Mission Director (also a member of the Board)
Responsibilities:
a) Reviews all anomalies for disposition and/or recovery.
b) Activates specific Anomaly Resolution Teams specific to a given anomaly.
c) Approves and signs off generation, testing and implementation of recovery plan in ITF.
d) Serves as interface for personnel in New Engineering Analysis Room (NEAR).

3.1.5 Flight Director

Reports to: Mission Director
Responsibilities:
a) Leads flight team in real-time operations.
b) Directs all commanding activities
c) Polls appropriate team members for status and task verification

d) Ensures flight team follows timeline.
e) Makes decisions in real-time about responding to non-nominal operations.
f) Before each shift, ensures pass plans and procedures are signed off and available.
g) Reviews timeline and briefs MCT, Engineering Team, Science Team, and GSFC on daily activities.
h) Ensures that all flight command sequences are approved before transmission
i) Generates daily report on operations status, listing all anomalies in ground system, procedures, or flight system.
j) Leads shift handover briefings to review all upcoming activities with team.
k) Provides point-of-contact to support areas such as mission planning, scientists and other elements as necessary to coordinate any engineering efforts or deviations from operations baseline as needed to coordinate real-time operations.
l) Acts as MCT's point-of-contact to NASA, Stanford management, and other contractor subsystem engineers for coordination of the mission activities.
m) Collects Ground Data Systems readiness for launch status to MD.
n) Provides GDS and MOC status for MD's Daily Meeting.
o) Supports Lead Controller in adjustments to or requests for real-time changes to tracking schedule.
p) Interfaces with the GN and SN NOMs to work GDS problems
q) Declares spacecraft emergency, if necessary
r) During IOC, FD is present in the MOC for all real-time tracks

3.1.6 Flight Operations Supervisor

Reports to: Flight Director
Responsibilities:
a) This position is supplied from the Flight Director pool.
b) Maintains MCT work schedules to ensure adequate staffing for accepted operational baseline.
c) Supervises the real-time console personnel in order to support daily operations and ensures that real-time console personnel are advised and have necessary resources to execute GP-B operations.
d) Ensures Technical Analysts are notified and have scheduled support when necessary.
e) Attends the Daily All-Hands Meetings and Timeline review and sign-off meetings.
f) Provides communications and interface between real-time operations and management interfaces.
g) Ensures that pass plans and commanding sequences, timeline listings, and timeline displays are generated and signed off.
h) Generates daily Flight Operations Status Report for Flight Director.
i) Supports development of a training/certification plan for MCT real-time controllers and trains additional MCT members.
j) Ensures all real-time operations and offline operations (trend analysis, data reduction, limit check maintenance) are completed in a timely manner.
k) Evaluates operational procedures (pass plans, timeline listings, etc.) and monitors them for process improvement.

3.1.7 Lead Controller

Reports to: Flight Director
Responsibilities:

a) Prepares and Confirms POD readiness for supports
b) Prepares and confirms all necessary procedure readiness and signature approval for supports.
c) Understands the MCT ground system configuration, capabilities, and interfaces; performs troubleshooting as necessary.
d) Performs prime interface with the GN and SN network (voice and data) during supports.
e) Performs ground system parameter testing and analysis.
f) Performs prepass communication and data line checks to validate and/or confirm link integrity.
g) Responsible for pass plan generation and approval and executing all command sequences to vehicle.
h) Supports detailed procedure generation and testing for commanding.
i) Assists in operations acceptance testing of MOC software.
j) Coordinates configuration control of GP-B command procedures and telemetry displays.
k) Assists in GP-B telemetry and command database maintenance in the MOC.
l) Performs troubleshooting efforts as related to spacecraft performance and anomaly recovery in the ITF (not SV).
m) Provides technical and operational support to MCT on spacecraft and ground subsystems.
n) Coordinates nominal, contingency, and special operations of the spacecraft.
o) Coordinates and supports detailed procedure generation and testing for commanding during all mission phases.
p) Assists in analysis, subsystem trending, and spacecraft performance evaluation.
q) Generates periodic spacecraft and ground performance reports.
r) Assists in MOC database(s) configuration management.
s) Generates Post Pass Logs and other supporting files for pass archive
t) Assists in generation of post pass data reduction.

3.1.8 Telemetry Controller/RTWorks Controller

Reports to: Flight Director
Responsibilities:

a) Assists the Lead Controller with command validation checks (confirming the acceptance and execution of commands).
b) Performs real-time evaluation of spacecraft engineering parameters to ensure health and status is maintained, including verification of overall status with RTworks checker.
c) Assists in and verifies required stored commanding, ephemeris loads, and housekeeping activities via data dumps and other checks to ensure successful on-board storage.

d) Coordinates with the Lead Controller during all contacts to maintain real-time telemetry, command, and /or tracking operations.
e) Performs off-line telemetry performance trending, power analysis, plot generation, etc.
f) Maintains logbook documenting real-time spacecraft health and status.
g) Assists in generation of post pass data reduction.

3.1.9 Payload Responsible Engineer

Reports to: Flight Director
Responsibilities:
a) Monitors and reports on subsystem health and trending
b) Reviews subsystem data for performance.
c) Predicts subsystem performance as required.
d) Reviews real-time and post-processed data to verify timeline event execution and reports daily.
e) Responds to alarms and keeps out-of-limits (OOL) files up to date.
f) Supports Anomaly Resolution process and recommends corrective actions if required.
g) Approves command sequences for given subsystem.

3.1.10 Spacecraft Responsible Engineer

Reports to: Flight Director
Responsibilities:
a) Reviews subsystem data for performance.
b) Predicts subsystem performance as required.
c) Reports on trending performance.
d) Recommends corrective actions if required.
e) Approves command sequences forgiven subsystem.
f) Updates spacecraft parameters as required (orbit and mass trim).

3.1.11 Ground Data Systems Manager

Reports to: Flight Director
Responsibilities:
a) Coordinates hardware, software and voice interfaces with GSFC and IONet.
b) Ensures the MOC hardware, systems, software, and network are functioning and maintained under Configuration Control.
c) Ensures that all persons supporting ground data systems are trained and certified as required.

3.1.12 Ground Data Systems Support

Reports to: Ground Data Systems Manager
Responsibilities:
a) Supports all Ground Data Systems Functions.

3.1.13 Lead Mission Planner

Reports to: Flight Director
Responsibilities:

a) Works with Science Team and Mission Director to maintain mission timeline.
b) Schedules and verifies confirmation of requested contact support from GN and SN.
c) Updates and resolves contact changes and generates new timelines
d) Generates Predicts with STK for planning of mission tasks.
e) Generates GREAS timeline on weekly basis.
f) Generates GPS Coefficients.
g) Ensures that Command Generation is run, output files are approved, and that files are delivered to MCT for transmission.
h) Generates listings and graphic displays of scheduling activities and events.
i) Maintains configuration control of schedule and orbit prediction files.
j) Reviews command sequence load to ensure all scheduled activities have been included and than no constraints or restrictions will be violated.
k) Ensures that all persons supporting mission planning are trained and certified as required.

3.1.14 Mission Scheduler

Reports to: Lead Mission Planner
Responsibilities:

a) Plans and prepares SPC loads per instructions from the planning meetings.
b) Updates the MOC command database as required.
c) Generates Pass plans to control contact activities.
d) Assists in mission operations activities when/if needed.

3.1.15 Orbit Determination Lead

Reports to: Flight Director
Responsibilities:

a) Reviews current state of orbit determination before entering data in level 2 database.
b) Ensures delivery of ephemeris to science team.
c) Coordinates with GSFC / FDF and Boeing on launch trajectory data.
d) Coordinates with GSFC / FDF to evaluate performance of GPS.
e) Ensures delivery of ephemeris data to flight team for parameter generation (GPS, ATC sequences).
f) Computes required orbit trim thrust direction and duration.
g) Ensures that all persons supporting orbit determination are trained and certified as required.

3.1.16 Orbit Determination Support

Reports to: Orbit Determination Lead
Certification Required: Yes
Responsibilities:
a) Processes GPS and LR data for OD lead.
b) Schedules LR tracks.
c) Generates Parameter Generation orbit trim inputs.
d) Provides orbit solutions in STK format for Mission Planners.
e) Supports all Orbit Determination Functions.

3.1.17 Data Processing Lead

Reports to: Flight Director
Responsibilities:
a) Maintains the level 0 and level 1 database of SV telemetry.
b) Ensures that data products are delivered to customers per schedule.
c) Ensures data is backed up and archived as scheduled.
d) Ensures data is sent to NASA per Data Management Plan.
e) Works with MCT and science team to support special request data delivery.
f) Ensures that all persons supporting data processing are trained and certified as required.

3.1.18 Data Processing Support

Reports to: Data Processing Lead
Certification Required: Yes
Responsibilities:
a) Supports all Data Processing Functions.

3.1.19 LM Manager

Reports to: Mission Director
Responsibilities:
a) Ensures team provides analysis of Spacecraft performance.
b) Coordinates team to support anomaly detection and resolution.
c) Ensures team monitors and maintains FSW.
d) Ensures team monitors and maintains LM MOC software.
e) Coordinates team to develop command templates (spacecraft and payload) as required.
f) Ensures team maintains and operates the ITF.
g) Ensures team is trained and certified staff as required.
h) Responsible for LM personnel, contract(s), and resource issues.
i) Go/ No Go Decision reporting at launch.

3.1.20 LM ITF Operator(s)

Reports to: LM Manager
Responsibilities:
a) Ensures that the ITF is properly configured and functional.
b) Validates new Command Procedures and Templates.
c) Simulates Space Vehicle configuration for HW and SW diagnostics and anomalies.

3.1.21 LM FSW & Command Support

Reports to: LM Manager
Responsibilities:
a) Ensures all FSW configuration and performance.
b) Develops changes to FSW and validate changes.
c) Supports GrnRT and NRT SW.

3.1.22 Science Director

Reports to: Mission Director
Responsibilities:
a) Ensures Mission Timeline meets Science requirements.
b) Monitors Payload Performance.
c) Updates Payload on-board parameters when required.
d) Performs science data analysis and data reduction.
e) Archives science data.
f) Supports outreach and education on results of mission.
g) Coordinates visiting scientist requirements.

3.1.23 Science Analyst

Reports to: Science Director
Responsibilities:
a) Supports all Science Data Analysis functions.

3.1.24 Visiting Scientist

Reports to: Science Director
Responsibilities:
a) Supports all Science Data Analysis functions.

3.1.25 QA & SE

Reports to: Program Manager
Responsibilities:
a) QA provides formal control of software deliveries.
b) QA maintains document library.
c) QA verifies MOC configuration management.

d) QA tracks MCRs and MOC Action Items for closure.
e) SE tracks MOC D-logs for proper assignment and classification.
f) SE organizes and provides minutes for the Daily All-Hands Meeting.
g) SE gathers all functional groups' Daily Written Reports to assist in generation of the Daily Status Report for Management.
h) SE oversees anomaly tracking.

3.1.26 E & PO Manager

Reports to: Program Manager
Responsibilities:
a) Prepares and coordinates press releases and press packages.
b) Responsible for quality and form of data on public web page.
c) Supports design of GP-B posters, educational packages, etc.

3.1.27 System Administrator

Reports to: Program Manager
Responsibilities:
a) Maintains non-MOC and science computer systems and databases.

3.1.28 Administrator Support

Reports to: Program Manager
Responsibilities: Provides admin support to Mission Control Team as required.

3.2 Associated GP-B Personnel

3.2.1 MSFC role at the MOC at Launch/IOC

On launch day, the MSFC Program manager will be at Stanford University. He will have the final decision authority on the Program's readiness for launch, and communicate the Program's Go/No Go for launch either directly to the KSC Launch Manager over a voice loop from Stanford or through a designated representative at VAFB.

During IOC, the MSFC Program Management Representative will almost always be either the MSFC Program Manager, the Program Office Manager, or the MSFC Resident Manager. In the unusual event that the Program Manager, Program Office Manager and the Resident Manager are absent, the Program Manager will designate a representative. For mission monitoring, the MSFC Program Management Representative will normally use the MSFC office already located in the GP-B building. This office will have a speaker to monitor the MOC intercom, and an interactive line to a separate voice net for management that will be tied to the FD console in the MOC. There will also be the capability to monitor data at a Science terminal in this management area.

MSFC personnel will support IOC from the New Engineering Analysis Room (NEAR) and will function as a technical resource for the ARB. The ARB will include MSFC personnel in the NEAR as appropriate to respond to and resolve anomalies. The MSFC

personnel in the NEAR will have access to real-time vehicle data via Pod M and will have access to stored data via science terminals. Any concerns originating with MSFC personnel in the NEAR will be communicated through the NASA representative on the ARB. In addition to data access, the NEAR provides the team with a conference area and the capability to monitor all voice loops, with two-way communication over the ARB and NASA Management loops.

In addition there will be a team viewing area where the launch can be viewed on a TV monitor. After launch, this monitor will provide a view of the MOC to allow viewing (and intercom listen-only access) to the post-launch SV activation.

3.2.2 Related Operations Positions at VAFB

A number of teams will need to reside at VAFB during pre-launch activities: an EPS representative, the Dewar team, and the GMA team. In addition to these teams, the GP-B Payload Manager, the GP-B Spacecraft Manager, the Spacecraft Program Manager and the Spacecraft Mission Director will also be at VAFB through Launch. These management positions will all be seated in the Mission Director's Center (MDC) at VAFB.

3.2.3 Related Operations Positions at the ITF

The ITF will be staffed during launch in the event of a system failure at the MOC shortly after launch. Pod E at the MOC will be up and shadowing SV health and safety telemetry through pre-launch and launch phase activities. After launch, the ITF will be available to test out and verify newly developed procedures and templates as required, to assist in troubleshooting anomalies and developing contingencies, and to debug and test changes to flight software.

3.2.3.1 ITF Manager

The ITF manager is responsible for bringing up the Pod at the ITF to support shadowing and backup activities. He is also responsible for using the ITF to test any new sequences that are required after launch. It is the responsibility of the ITF manager to maintain configuration control of the ITF simulator and ground computers to allow for testing of sequences. If changes to the flight or ground system software are required, they are to be tested and verified in the ITF before transferring them to the MOC (or SV).

3.2.3.2 ITF Test Engineers

Test engineers will be available throughout IOC and, at a lower level, throughout the mission, to code new command templates and to run the ITF as required for testing and verification of these sequences.

3.2.3.3 Software Engineers

Throughout IOC, software engineers will be available at the ITF to support any required debugging of or changes to the flight software or LM ground software.

3.3 Support Organizations

3.3.1 GSFC

GSFC provides the network support to the GP-B Mission. The management interface coordinating this support is the CSOC Customer Services Representative (CSR). The CSR is responsible for coordinating with the GP-B Project to define their network requirements. The CSR ensures requirements are documented via the Detailed Mission Requirements (DMR) and all requirements are implemented and tested prior to launch.

GSFC also runs the GSFC Central SAFS used to store all GN data from the individual Ground Stations. (See Section 5.1, GN and SN Coverage for GP-B.)

3.3.2 Network Operations Managers (SN/GN)

The Network Operations Managers (NOMs) are responsible for providing the technical management of the network support. There is a NOM for the Space Network (S-NOM) and a NOM for the Ground Network (G-NOM). The NOMs support the pre-launch phase by coordinating the testing and ensuring the ground stations, networks and the Flight Dynamics Facility are ready for launch. The S-NOM and G-NOM will also provide on-console supporting during the pre-launch countdown and the first 24 hours of the mission. This on-line support is to coordinate/troubleshoot network issues during the critical phase of the mission.

3.3.3 Data Services Management Center (DSMC) / WSC Data Interface Service Capability (WDISC)

The NCC/WDISC resides at Whitesands Complex (WSC) and is essentially the front end processing for the SN. There are four PTPs, two primary PTPs and two secondary PTPs. Each PTP contains 3 boards used to receive the 1k or 2k real-time data on any given SN contact—one of three of these boards is used for forward link, and one of three is used for return link. Which of the PTPs/boards is used for any given contact is scheduled via SWSI. The 1k or 2k data downlinked on any given contact will be available for replay for 56 hours prior to being automatically cleaned off the WDISC server.

3.3.4 Flight Dynamics Facility (FDF)

FDF will provide initial orbit determination post-launch based on SN tracking data and will coordinate with the GP-B OD team via phone and fax. They will supply a launch vehicle Orbital Parameter Message upon separation. During the IOC period, they will continue to work with the GP-B team to confirm orbit determination and orbit trim maneuver performance. They will supply GN and SN acquisition data in support of GP-B throughout the mission. The FDF is also available to supply a back-up state vector if the need arises. Interfaces between FDF and the GP-B OD function (ODF) are defined in the Orbit Determination Interface Definition Document (OD IDD, S0505).

4 Facility Configurations

4.1 GP-B Facilities

The facilities used for GP-B on-orbit operations are spread out between Stanford facilities and Lockheed Martin facilities in Palo Alto. Main operations are conducted from the Mission Operations Center located in the Main GP-B Building on Stanford University campus. Several off-line support areas are located in other locations at Stanford and at LM Palo Alto as described in following sections. LM Palo Alto also contains the area that serves as the back-up MOC in the event that the primary MOC at Stanford should ever become unusable. Vandenberg Air Force Base facilities will be used for pre-launch and launch support activities according to the Launch Site Support Plan (K-ELV-14.011-BL-GPB).

4.1.1 Physical Layout of MOC Console Positions

The standard MOC layout is shown in Figure 4-1 below. (For differences in this layout during the pre-launch/launch phase, see Section 6.3, Pre-launch Staffing.) There are 2 identical Pods of computers in the MOC that control and monitor the Space Vehicle during real-time passes. These Pods are known as Pod-D and Pod-E. The minimum configuration for a Pod consists of 2 Sun workstations and an SGI workstation (units 1-3 in Figure 4-1). Nominally Pods have 3 other Sun workstations connected as well to provide additional displays. A 7th workstation has been added to each Pod to provide payload-driven RTWorks displays for gyro spin-up. The software for these displays runs on Sun machines, rather than the spacecraft displays, which run on the SGI.

Only one Pod is used to command the SV. Telemetry into that Pod, however, can be directed to other workstations or other Pods, allowing other display systems for monitoring subsystem health and safety. The Pod that does not have command authority is known as the shadowing Pod. In general, extra displays are driven off the shadowing Pod to prevent risk of shutting down the command Pod due to a problem on a display workstation. The Flight Director monitor, for instance, is driven off the shadowing Pod. There can be more than one Pod shadowing the control Pod.

When the Pods are not being used by the real-time system for commanding, they may be used as terminals to log on to either the MOC server or the Science server to run software located on these machines.

Each station in the MOC with Pod access will have an 8-voice line intercom system. One line will be reserved for formal communications within the flight team to formally track the timeline and tracking schedule. Other lines can be set up as one or more informal voice nets between team members as required for flight. The intercom connects to other areas in the GP-B work area, both in the main MOC building as well as in other buildings. There are four stations for Switching, Conferencing and Monitoring Arrangement (SCAMA) lines, the network voice circuit system controlled by GSFC Voice Control. These lines connect to the 4 GSFC voice lines, which can be allocated as needed for continuous voice communications. In general, one line connects to the GN, one to the SN. During launch, one will also connect to the team intercom at VAFB and

another will connect in a listen-only mode to the formal countdown. These four SCAMA lines will be patched into 4 of the 8 available MOC intercom voice loops. (See Section 7.3.1 for more on verbal communications and voice loops.)

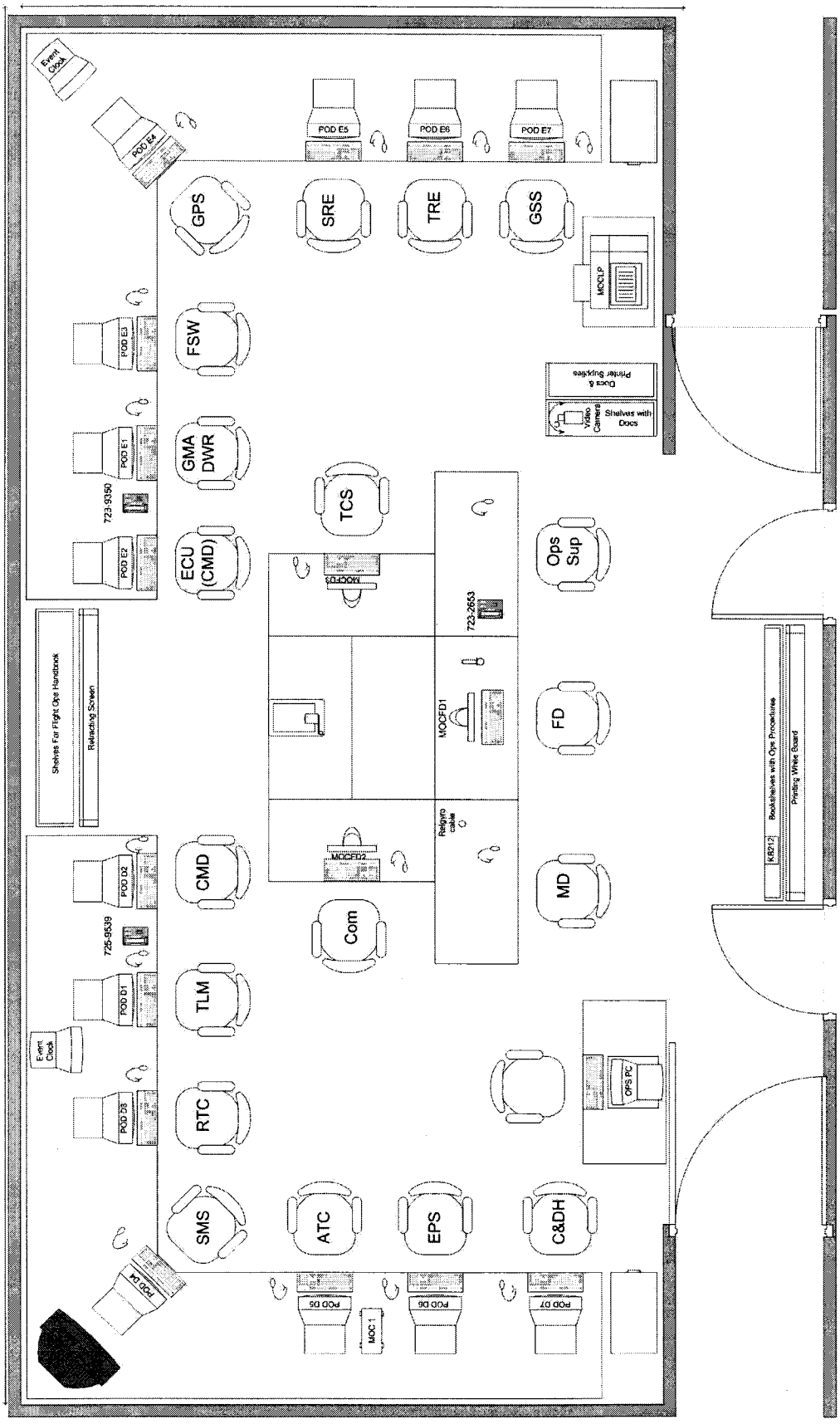
Event Clock
POD E4
POD E5
POD E6
POD E7
GPS
SRE
TRE
GSS
MOCLP
FSW
POD E3
Ducs & Printer Supplies
Video Camera
Shelves with Docs
GMA DWR
POD E1
723-9350
TCS
ECU (CMD)
POD E2
MOCFD3
Ops Sup
722-2653
Shelves For Flight Ops Handbook
Relaching Screen
MOCFD1
FD
Relgyro cable
CMD
POD D2
MOCFD2
MD
725-9539
Com
TLM
POD D1
Bookshelves with Ops Procedures
Printing White Board
K8212
Event Clock
RTC
POD D3
OPS PC
SMS
ATC
EPS
C&DH
POD D4
POD D5
POD D6
POD D7
MOC1

Figure 4-1, Stanford Mission Ops Center Layout

4.1.2 Off-line Operations Support Areas at Stanford

The GP-B building provides other areas for operations support. Off-line functions such as MOC system administration, mission planning and orbit determination have assigned offices as shown in Figure 4-2, Stanford GP-B Building & Other Location Layouts. Data processing is distributed throughout the building and into other buildings. All off-line support areas have intercom connections. An anomaly resolution area has also been established on the second floor of the GP-B building. This area has a full Pod setup known as Pod-J and an intercom.

Other Stanford off-line support areas for mission operations reside in End Station 3, HEPL and the Cypress Building. Offices with PC's and Science clients will be set up in End Station 3 for visiting subsystem engineers from LM to monitor and analyze their systems during IOC. End Station 3 also houses the NEAR, which includes an additional Science client, a two-terminal Pod (Pod-M) to allow engineers to observe real-time data from the space vehicle, a conference room, and capability to monitor all voice loops with two-way communication on the ARB and NASA Management loops. The NEAR also contains a wireless lan for internet connectivity.

The main conference room for team meetings will be the HEPL conference room, located in the building across the street from the MOC. The GP-B building first floor conference room, as shown in Figure 4-2, will be used for team meetings to review data as required. Cypress will contain additional off-line office space for visitors.

4.1.3 Off-line Operations Support Areas/Backup MOC at Lockheed Martin

The Integrated Test Facility (ITF) is an area in the LM complex in Palo Alto where there is an electrical mock-up of the SV and the ground computers required to run it. The ITF consists of engineering units or flight equivalent units for all the SV boxes including payload boxes, although not with the same level of redundancy as the vehicle itself. Pod-B is virtually identical to the Pods in the MOC and provides the telemetry and command interface with the ITF SV mock-up. Electronic simulators generate realistic telemetry where possible. A description of the ITF as well as the differences between the ITF and the actual SV is found in reference ITF Document.

As mentioned, Pod-B is used to drive the ITF and will be used during flight for template and procedure development and anomaly resolution. There is also another full Pod right next to the ITF, Pod-G, that shadows the MOC and is typically used as another off-line engineering analysis capability. However, in the event of any kind of emergency that prohibited use of the MOC at Stanford, primary operations would move to Pod-G for use as the backup Control Center.

4.1.4 Facilities for IOC Transients (MSFC, HQ, Science investigators, press, public)

The NASA management office on the first floor across from the GP-B conference room has data monitoring and intercom access. During IOC, when the GP-B first floor conference room is not in use for meetings, it will have intercom access that can be used as an additional monitoring area for visiting management. There will also be a few quiet off-line offices located in the Cypress building that have desks, phones and Internet access. Besides the NASA management offices just mentioned and shown in Figure 4-2 and those off-line areas located in Cypress, there are other facilities configured to support visitors and press for the launch phase.

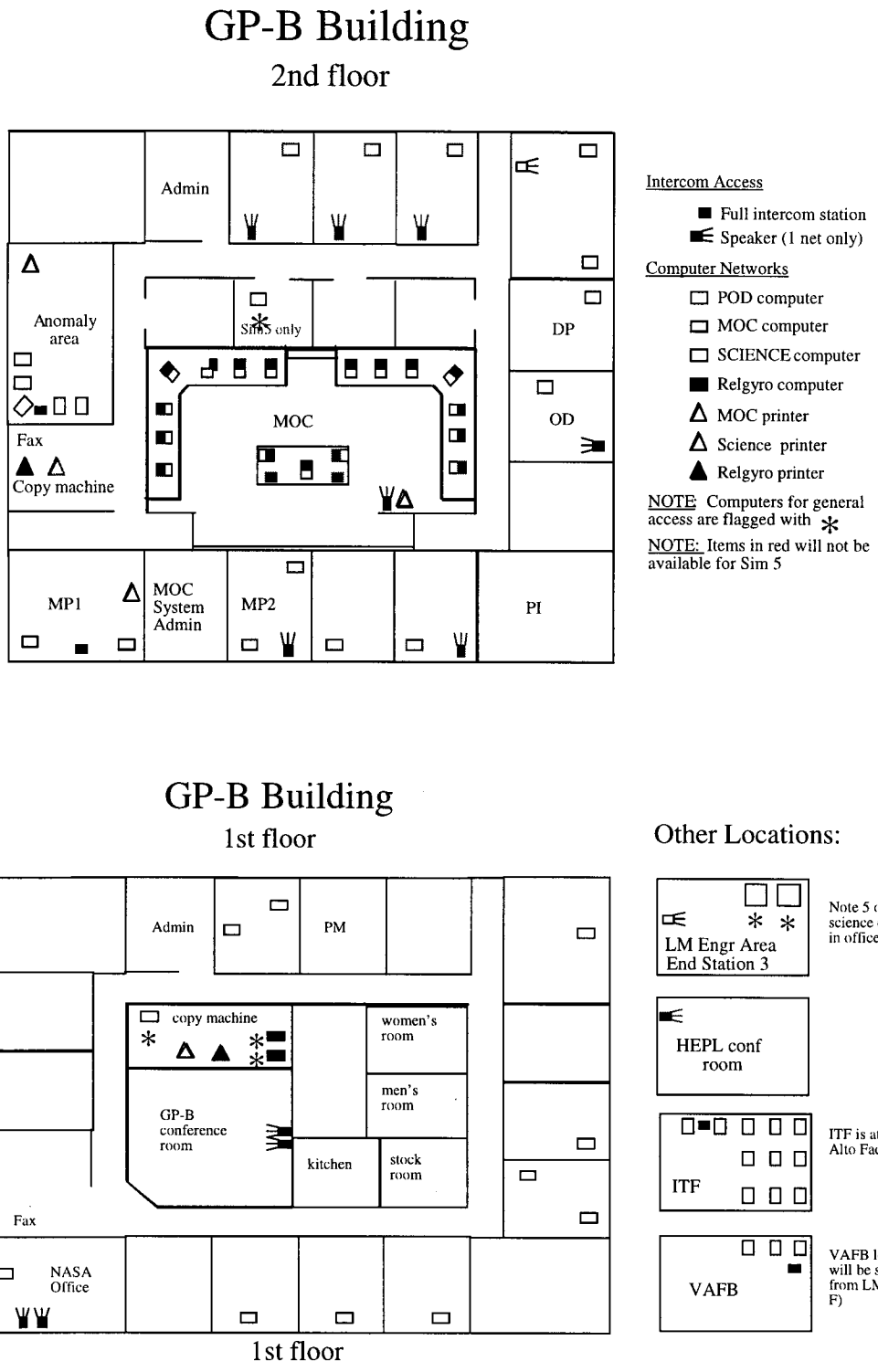

Figure 4-2, Stanford GP-B Building Floor Layouts

4.2 MOC Hardware/Software/Database Configuration Management

The MOC configuration is described in four documents. MOC Configuration Control of Pods (S0475) describes the hardware, system and software for the Pods. MOC Configuration Control of IONet (S0476) describes the hardware, system and software for the MOC net (IONet). MOC Configuration Control of Science Net (S0477) describes the hardware, system and software for the Science net. MOC Configuration Control of Firewall (S0502) describes the firewall configuration connecting these networks to the Stanford net. See the GP-B MOC Configuration Management Plan (S0667) for more details.

The GP-B flight database is managed by LM and delivered to the MOC with a configuration-controlled Version Description Document (VDD) describing all changes since the last delivery.

Procedures are maintained in notebooks in the MOC that are tracked and audited weekly. The GP-B Document Librarian maintains the formal versions of these procedures.

Discrepancy logs (D-logs) will be written for any ground or flight issue and tracked by SE. SE will disposition each D-log to one of the following: MOC Change Request (MCR), Software Change Request (SCR), MOC Action Item, Space Vehicle Anomaly Report (SAR), Timeline Change Request (TCR), or Engineering Change Order (ECO). (Reference Section 7.6 for details on where to obtain these forms.) D-logs are accessible electronically via TQSM, but can also be accessed via notebooks in each of the main areas (MOC for real-time, and the data processing and mission planning offices, as well as in the mailbox area).

4.3 Off-line Support Systems

Most of the GP-B staff has office computers connected directly to the Stanford net, called Relgyro, which provides e-mail and Internet access. General access computers are also supplied in the NASA offices, End Station-3 for engineering support personnel, and other off-line support areas for various personnel to access. There is also an internal GP-B website available via the Bastion Host that allows remote access to various products such as mission planning products, the GP-B logbook, documentation, data processing statuses, various reports and other products and forms. The secured internal website is located at https://gpbops1.private.net/ and is accessible by all personnel with relgyro accounts. There is also an external read-only website located at https://gpbops.stanford.edu that contains none of the interactive forms found at the gpbops1 site. The two sites are mirror images otherwise.

4.4 Physical and Network Security

All GP-B buildings are locked during off-hours, although from now through launch and IOC, the second floor where the MOC resides will be locked at all times. The MOC area has keypad-controlled access and also remains locked around the clock, seven days a week, throughout the entire mission. The second floor and MOC key codes will be

updated regularly. All computer areas with access to the MOC net are also locked 24/7. See the GP-B Security Plan (LM/P480289A) for more details.

4.4.1 GP-B Badging

Color-coded badges are now required by all GP-B personnel. Access levels are determined by the different color codes. The most access-allowed color is Green which indicates the wearer is allowed at console in the MOC. A Blue badge indicated the wearer may enter the MOC but is not console certified. A Yellow badge gives the wearer permission to be on the second floor of the GP-B building, but is not allowed into the MOC. A Red badge indicates only access to the first floor of the GP-B building. A Red badge may also indicate "ITAR-restricted" if this indication is noted on the front of the badge.

5 Space and Ground Network Coverage Support

5.1 GN and SN Coverage for GP-B

As mentioned in Section 2.2, Launch and Orbit Insertion, the GN provides a single Front End Processor (FEP) that can send commands and receive data, either 32k realtime data (VC0 data) or 2.56 Mb SSR playback data (VC1 and VC2 data). The SN has three boards per each of the four PTPs that essentially act as front end processors for the Space Network, known as WDISC (see Section 3.3.3, DSMC/WDISC). One of three PTP boards is used for the forward link, and another of the three is used for return link. The SN is capable of sending commands and receiving either 1k or 2k realtime (VC0) telemetry, but no playback data.

For the GN, each GN station stores GP-B playback data in its Local Standard Autonomous File Server (LSAFS). Post-contact, the data is then transferred to the Central SAFS at GSFC, where it is then transferred to the MOC via secure copy. Once the receipt of the playback transfer is verified at the MOC, a feature of secure copy, CSAFS e-mails a confirmation of file verification, name and file size to the ops account on relgyro.

5.2 SN and GN Coverage during the Operational Phases of GP-B

SN and GN coverage for each of the operational phases of GP-B is shown in Table 5-1. As shown, extensive tracking coverage is expected for the first day after launch. Agreements with GSFC provide 100 % coverage with TDRS/SA for the first 3 hours and 85 % coverage with TDRS/SA for the next 21 hours. Supplementing this SN coverage are several GN passes to allow for download of the SSR as required.

The SN also requires Local Oscillator Frequency (LOF) information, also shown in Table 5-1. The onboard transponder oscillator frequency can drift over time. The LOF measurements track this frequency to ensure the correct frequency is being used for SN supports.

Table 5-1, SN and GN Coverage by Operational Phase

Operational Phases	Duration	SN Services	GN Services	SN/GN Tracking Services
Launch & Early Orbit Phase (7 days)	Launch to L+24 hrs. (approx.)	**Link** **SA:** Near-continuous first 3 hrs. **SA:** 85% coverage for next 21 hrs. **MA:** Contingency to SA as needed	15 passes first day. (Every pass or once per 90 min. orbit)	**SN:** Minimum three coherent 10-min events per revolution. LOF – Three 5-minute one-way tracking service events per day per each transponder. **GN:** All passes non-coherent mode above 7 deg. elevation, first 12 hours.
	L+24 hrs. to L+7 days (approx.)	**Link** **SA:** 12 passes/day ~25 min each X 6 days **MA:** Contingency to SA as needed	~6 passes/day X 6 days. Roughly spread evenly throughout day.	**SN:** Eight coherent 25-min events, with minimum 10-min tracking per event. LOF – Two 5-minute one-way tracking service events per day per each transponder. **GN:** All passes non-coherent mode above 7 deg. Elevation.
IOC Phase (~90 Days)	L+7 days to L+90 days (approx.)	**Link** **SA:** 5 passes/day ~25 min each X 77 days **SA:** 10 passes/day ~25 min each X 12 days (4 gyros spin-up). **SA:** 1 pass/orbit ~25 min each X 1 day (orbit trim verification). **MA:** Contingency to SA as needed	~4 passes/day X 78 days. Roughly spread evenly throughout day. ~6 to 8 passes/day X 12 days (for 4 gyros X 3 days each).	**SN:** All passes coherent 25-min events, with minimum 10-min tracking per event. LOF – Five 5-minute one-way tracking service events per week per each transponder. **GN:** All passes non-coherent mode above 7 deg. Elevation.
Science Mission Phase (~12 Months)	L+3 months to L+15 months (approx.)	**Link** **SA:** 5 passes/day ~25 min each for the first 30 days, followed by 2 passes/day ~15 min each X 11 months. **MA:** Contingency to SA as needed	~3 to 4 passes/day X 12 months. Roughly spread evenly throughout day.	**SN:** Two coherent 20-min events, with minimum 10-min tracking per event. LOF – Five 5-minute one-way tracking service events per week per each transponder. **GN:** All passes non-coherent mode above 7 deg. Elevation.
Post-Science Phase (3 Months)	L+15 months to L+18 months (approx.) or depletion of cryogenics.	**Link** **SA:** 2 passes/day ~15 min each X 3 months. **MA:** Contingency to SA as needed	~4 passes/day X 3 months. Roughly spread evenly throughout day.	**SN:** Two coherent 20-min events, with minimum 10-min tracking per event. LOF – Five 5-minute one-way tracking service events per week per each transponder. **GN:** All passes non-coherent mode above 7 deg. Elevation.

6 Pre-launch and Launch Activities

6.1 Pre-Launch and Countdown Timelines

The Launch Terminal Countdown is included below. (This countdown may be subject to change, so reference the GP-B Countdown Schedule for the latest, most current version.)

T-minus (in minutes)	**Operations Description**
60-min built-in hold @ T-150	2nd stage HE/N2 sys press to 2500 psig Terminal countdown initiation & briefing Sound emergency evacuation klaxon
T-150	CSO clear missile hazard area RIFCA turn on 2nd stage HE/N2 tanks press 1st stage HE/N2 press
T-130	First stage fueling
T-100	C-band beacon checks Weather briefing
T-80	Air Cond high heat on LOX loading 7 decay checks
T-40	First stage HYD on
T-30	Auto slews RF link checks Water pumps on
20-min built-in hold @ T-20	
T-20	Command carrier on Destruct checks Top off HE/N2 Status checks Pressurize fuel tank
10-min built-in hold @ T-4 min	
T-4	S/C switch to internal Arm destruct S&A's S/C launch ready Launch

During pre-launch operations, Flight Director will coordinate procedure execution and verification with the VAFB team. Only pre-tested flight procedures will be used. All pre-launch data will be archived and treated as flight data. Countdown Status and Go/No go Polls will be taken as indicated in the go/no-go procedure. The go/no-go and

countdown procedure are documented in GP-B Launch Operations Go/No-Go Criteria (S0878).

6.2 Launch Commit Criteria

A number of go/no-go calls will be made in the decision to launch GP-B. In general, there are three main components of GP-B that monitor telemetry during pre-launch activity that must be polled for go/no-go: the MOC, communications/remote support, and the GP-B Space Vehicle. All individual system monitors considered as go/no-go Mandatory criteria must be "Go" for a go for launch. Details of the go/no-go criteria for each of these three areas are described in the GP-B Launch Operations Go/No-Go Criteria (S0878). The MOC Launch Director (a GP-B Mission Director located at the MOC) will distribute and track the pre-launch MOC go/no go procedure. This procedure contains the SV telemetry checks, the MOC systems and ground system interface hardware and software checks, and the GSFC GN, SN and FDF system checks. The Launch Director will make go/no-go calls for the MOC and report this to the GP-B Payload Manager (Stanford Program Manager), located at VAFB. The Spacecraft Manager and Spacecraft Program Manager will also be located at VAFB. These three individuals will provide Go/No-Go calls to the Spacecraft Mission Director (the MSFC Program Manager) at VAFB, who will in turn provide a Go/No-Go to the KSC NASA Launch Manager. The KSC NASA Launch Manager will make the final Go/No-Go call to the Boeing Mission Director, who makes the go/no-go call for the overall Launch Vehicle.

6.3 Pre-Launch Staffing and Facilities

A baseline schedule will be set each week to define who needs to be in the MOC and when during the pre-launch phase. These schedules will be posted to the GP-B internal website. Daily telecons between the Flight Director and VAFB will occur each morning to confirm/modify this schedule. For information on where personnel are located at VAFB, see the Launch Site Support Plan.

Prior to launch, the primary Pod used to command the SV will be Pod-E. Pod-D will be used for network data flows and checkouts. The layout depicted in Figure 4-1 will apply with the following caveats: at L – 17 hrs, secondary CMD and TLM personnel will take over Pode1 and Pode2 consoles with ECU and DWR moving to Pode6 and Pode7, respectively, until Launch + 10 minutes. At L – 17 hrs, CDH and EPS are required for status polling. At L – 4 hrs, CDH/FSW, EPS, TCS, DWR are staffed and CMD and TLM at Pod-D are required to begin data flow tests. ATC and COM are required to support at L – 1 hr. Positions for payload RE's will have to be negotiated for prelaunch/launch seating in the MOC. However, the MOC will be "locked" with no access allowed in or out at L - 45 minutes through L + 45 minutes. At one minute after launch, Pod-D will take over prime operations and Pod-E will be restarted in shadow mode. (Note that shadowing Pods that were monitoring Pod-E will need to restart in shadow mode to Pod D at this time.) At this point, the main layout illustrated in Figure 4-1 will apply. GPS, GSS, SRE and TRE will be required at L + 45 minutes if they are not already present to ensure they are ready to verify activations in the PONG002 load. For information

concerning when teams may be released from full-time staffing, see Section 7.1.1, Flight Team Staffing.

6.4 Launch Slip Activities

For GP-B only one launch attempt can occur in a twenty-four (24) hour period. Two attempts at a launch will be performed before the crew will stand down one day for guard tank and GMA servicing. The procedure performed in the event of a launch scrub differs depending on how far into the countdown the scrub occurs. For details of the different launch scrub scenarios, see the GP-B Joint Operating Procedure for GP-B Launch Scrub Activities (P1054). Also see the SV Launch Scrub (Power down) Procedure (GND 3.4.2.2.01). It is important to note that the procedures are adjusted as time passes and additional power-up operations are performed.

7 IOC Operations

7.1 IOC Staffing

7.1.1 Flight Team Staffing

The core flight team (Flight Director, Ops Supervisor, Lead Controller) positions will be staffed 24 hours a day through IOC, mainly with 8-hour shifts, such that no one is scheduled for more than 40 hours a week. The Telemetry Controller will be staffed 16x7. The schedule for shift staffing will be available on the internal GP-B website.

Engineers will supplement the flight team in the MOC according to a pre-arranged schedule that will follow the mission timeline. All subsystems will have Responsible Engineers (RE's) in the MOC for real-time pass supports for pre-launch status through various release times based on that particular subsystem's responsibilities. All subsystem RE's will monitor their subsystems for 72 hours from subsystem turn on (most are at launch). RE's will also ensure that their subsystem is stable and that the limit checking is correct. After their given release time, subsystem RE's with no expected activity may designate another RE or ops person to oversee their subsystem. Whenever a subsystem is initially activated or a special event is scheduled, however, successful operation of the system will be monitored and verified in real-time by the RE's sitting at a console in the MOC. If the activity occurred in the blind, it will be verified in the next scheduled contact or, if necessary, via the next processed playback. Routine operations can be analyzed off-line on a daily basis.

Many IOC activities will not need real-time support to verify successful completion, and in fact, many cannot be verified in real-time. RE's will report on the performance of these tasks at the Daily All-Hands Meeting. Required engineering support during IOC will be provided on the internal GP-B website.

The current table of MOC and off-line support staffing will be shown on the internal GP-B website. Backup persons with phone numbers will be identified for each critical position. A "final" staffing plan will be released before launch to cover the IOC period.

The staffing schedule will be reviewed and updates made and posted to the website on a weekly basis.

MOC personnel should arrive 30 minutes before their shift for shift handover. RE's should arrive at least 30 minutes before a real-time event in which they are required to verify execution to ensure they have the correct procedures and paperwork to support their verification. For more detail on handovers, see Section 7.3.1.2, Shift Handovers.

IOC will also be supported by engineers who will work in the NEAR as a resource of the ARB. These engineers will be available to assist in anomaly resolution at the discretion of the ARB and will also monitor specific vehicle subsystems during critical phases of IOC. Any concerns identified by the NEAR will be communicated through the ARB. A matrix identifying MSFC personnel who will be present in the NEAR is available online at the Virtual Resource Center (VRC).

7.1.2 On-Call Positions and Calling In Procedure

The on-call personnel schedule and contact information will be listed on the internal GP-B website. While on call, personnel should be accessible via pager or cell phone for close to immediate call-back. In the event an on-call person needs to actually come into the MOC, he/she should be in proximity enough to be able to arrive at the MOC within 3 hours of call-in.

IN THE EVENT AN ASSIGNED PERSON CANNOT BE ON CONSOLE OR ON-CALL FOR THEIR SCHEDULED SHIFT, he/she must call his/her backup, supervisor AND the Flight Director console (650) 723-2653. (Each position on the staffing schedule will have a prime and backup (on-call) person for each shift.)

If a person fails to show for their shift, the person going off shift will remain on duty until a backup person can be called in.

For some positions, full backups will not be available. In the event that a team or function is understaffed, the Ops Supervisor, FD or MOM will rearrange other staffing or reschedule deliverables as necessary to continue operations.

7.2 Daily Activity Schedule

The nominal daily schedule for operations on any given day during IOC is outlined in Table 7-1, Daily Schedule. This schedule shows standard main activities, meetings and reviews.

Table 7-1, Daily Schedule

Start	End	Description
1:00am	8:00am	Start of Pong Load – lasts 7 hours.
3:00am	3:15am	Last Playback from the Spacecraft to be included in 24 hour daily TACD Plot Set for RE review.
3:15am	5:15am	Worst Case amount of time required for SGS to push 8 hours of data to SAFS and MOC to retrieve data from SAFS.
5:15am	6:30am	Automated VC0 and VC1 and 2 Ingest into Sybase.
6:30am	8:00am	ScienceLP Printer dedicated to printing TCAD daily plot sets.
7:00am	7:30am	Graveshift handover briefing to Dayshift in the MOC.
8:00am	1:00am	Start of Ping Load – lasts 17 hours.
8:00am	NA	TCAD Daily Plot sets available to REs. REs must review this data to verify the last 24 hours of activities and subsystem health.
8:00am	NA	Mission Planning will distribute products for planned Pong (starting in 17 hours) and Ping (starting in 24 hours) loads. Products must be reviewed prior to 11:00 meeting and any problems must be corrected via completed TCRs brought to that meeting.
9:30am	10:00am	Recommended Meeting Time for each Functional Operations Group. Inputs to the Daily All Hands Finalized.
10:00am	11:00am	Daily All Hands Meeting led by Mission Director. Subsystem status briefings, timeline status, Science, MOC Status, and anomalies covered. Functional Group Status Reports and RE subsystem status reports handed to System Engineering.
11:00am	12:00pm	Daily Mission Planning Meeting. Attended by a Timeline Committee member, Mission Planning, relevant REs, and a realtime ops representative. Loads will either be signed off at this meeting or a TCR discussion will lead to rework.
12:00pm	NA	Orbit Determination delivers Instantaneous State Vector to Mission Planning.
1:30pm	NA	System Engineering completes Daily Status Report and delivers it to Mission Director.
2:00pm	NA	Mission Director finishes the Daily Status Report and sends it to the GPB Management Distribution.
3:00pm	3:30pm	Dayshift handover briefing to Swingshift in the MOC.
4:30pm	5:00pm	Mission Planning Sign-Off Meeting. All TCRs are resolved and all people required for products signoff attend.
5:00pm	6:00pm	Timeline Replanning Meeting. In the event the timeline needs more serious replanning, this meeting will determine the contents of the next ping/pong load; Run by Timeline Committee.
10:00pm	10:30pm	Operators restart the PODS to create new Oasis Run Directory, run data archiving scripts, and verify adequate disk space.
11:00pm	11:30pm	Swingshift handover briefing to Graveshift.

7.3 Communications and Reporting

7.3.1 Verbal Communications

It is of paramount importance that information flows between operations team members for successful mission operations. One major way this occurs is through consistent verbal communication. The verbal portion of communications begins with a proper handover between shifts from the off-going team to the on-coming team, both within a given position and between shifting teams. It continues with the verbal on-console reporting of significant events and activities, including unexpected observations and anomalies. It culminates with verbal verification of successful completion of planned activities, both in the real-time control room environment as well as off-line via post-processing analysis reporting in the Daily All-Hands meeting.

7.3.1.1 Voice Loops, Call Signs and Voice Protocol

The configuration for launch of the eight available voice loops is shown in Table 7.2, Voice Loop Configuration. Call signs for each functional group are shown in Table 7.3, GP-B Call Signs.

When calling a station over a voice loop, the protocol is as follows: (1) Identify the position you are calling, (2) identify who you are (by position), and (3) identify the loop you are calling on (e.g., "OD, Flight, on net-4). If a conversation is occurring on that loop, wait until the conversation has completed before beginning your call. If it is an emergency that can't wait, interrupt the conversation with a "Break Break" and wait for all talk to cease. In like manner, when having a conversation, you should immediately cease all talking if you hear a party announce "Break Break" on your loop.

Table 7-2, Voice Loop Configuration

Current	Launch	LEO	Nominal Ops	Stanford Circuit #
MOC	MOC	MOC	MOC	Internal
MGMT	MGMT	MGMT	MGMT	Internal
Net 3	Net 3	Net 3	Net 3	Internal
Net 4	Net 4	Net 4	Net 4	Internal
VAFB	VAFB	ITF1	ITF1	GSTN09204
(Request)	SN/GN	GN	GN	GSTN02707
(Request)	LM2	SN	SN	GSTN02808
DSMC	LM1	DSMC	DSMC	GSTN09103

Definitions for Table 7.2 are as follows:

Current = Now until L-17 hours.
Launch = L-17 hours to L+3
LEO = L+3 hours to L+24
Nominal OPS = L+24 On

MOC: MOC Operations Net. FD leads loop for operations.
MGMT: Management Loop. Internal Loops for management.
Net 3: Alternate Loop for discussions.
Net 4: Alternate Loop for discussions.
VAFB: GPB Team Net. MOC to VAFB Coordination Loop, includes Dewar Ops.
SN: Space Network. Only Pods 1 and 2 can talk on this Loop.
GN: Ground Network. Only Pods 1 and 2 can talk
SN/GN: Multiplexed Line with both SN and GN
LM1: Launch Monitor One. Defined by VAFB as Countdown Prime, Countdown Backup, and Weather.
LM2: Launch Monitor Two. Defined by VAFB as NLM -NASA Launch Manager.
DSMC: DSMC Scheduling. Only Used by Mission Planning.
ITF1: Integrated Test Facility. Connection to ITF at Lockheed Palo Alto.
Request: Requested Loop. These SCAMA circuits can be defined as needed.

Table 7-3, GP-B Call Signs

POSITION	CALL SIGN
Flight Director	"FLIGHT"
Mission Director	"MISSION DIRECTOR"
Command Controller	"COMMAND"
Telemetry Controller	"TELEMETRY"
Attitude Translation Control Subsystem RE	"A-T-C"
Command and Data Handling Subsystem RE	"C-&-D-H"
Communications Subsystem RE	"COMM"
Electrical Power Subsystem RE	"E-P-S"
Thermal Subsystem RE	"THERMAL"
Flight Software (FSW) Subsystem RE	"SOFTWARE"
Structures and Mechanisms RE	"MECHANISMS"

Safemode Subsystem RE	"S-M-E"
Electronics Control Unit Subsystem RE	"E-C-U"
Gas Management Assembly Subsystem RE	"G-M-A"
Global Positioning System RE	"G-P-S"
Gyroscope Suspension System RE	"G-S-S"
SQUID Readout Electronics RE	"S-R-E"
Telescope Readout Electronics RE	"T-R-E"
Dewar/Cryo Team	"DEWAR"
Mission Planning Team	"MISSION PLANNING"
Orbit Determination Team	"O-D"
Data Processing Team	"DATA"
Science Team	"SCIENCE"
Anomaly Resolution Board	"A-R-B"
New Engineering Analysis Room	"NEAR"
ITF Team	"I-T-F"
Management Teams	various
EXTERNAL INTERFACES	
MOC Command Controller	"G-P-B"
Svalbard Ground Station (SGS)	"NORWAY"
Alaska Ground Station (AGS)	"ALASKA"
Wallops Ground Station (WGS)	"WALLOPS"
McMurdo Ground Station (MGS)	"MCMURDO"
SKS (Commercial Ground Site at SGS/Norway)	"T-NOC"
PF-1 (Commercial Ground Site at Poker Flats)	"DataLynx"
GSFC Network Support	"COMM MANAGER"
Space Network (WSC)	"CSC-X" where x = 1 - 6

7.3.1.2 Shift Handovers

Shift handovers should occur within the last half hour to hour of the off-going shift. For example, since day shift is from 7:00 AM to 3:30 PM, evening shift should arrive at 2:30 – 3:00 PM, however long may be needed, for a given position to finish handover by 3:30 PM. In like manner, since evening (swing) shift runs from 3:00 PM to 11:30 PM, mid-shift should be in by 10:30 – 11:00 PM. Mid-shift is from 11:00 pm to 7:30 AM, so dayshift should be in between 6:30 – 7:00 AM.

Handover should begin with the oncoming position obtaining a printout of the logbook entries made since the last time that person was on console. (This means that if a person has been off for 3 days, they obtain the last 3 days worth of log entries.) All entries should be read with emphasis on that particular position's entries. All questions should be noted for discussion with the off-going position. Also, any pertaining reports or supporting data should be reviewed. During this time, the oncoming position should also monitor voice loop activity of current activities as possible. As on-going operations permit, a handover conversation should ensue between oncoming and off-going parties covering the following areas:

1.) Status of any applicable subsystems/spacecraft

2.) Any pertinent points of discussion or questions from the logbook

3.) Any anomalies and their statuses

4.) GN/SN upcoming schedule/briefing message review

5.) Timeline status, including both completed and upcoming activities

6.) Any outstanding actions to be worked by the up-coming shift

7.) Upcoming plans for the next shift that are off-nominal

8.) Known replanning activities

9.) Any applicable updated procedures or processes

The final stage of handover should be led over the voice loop by the oncoming Flight Director and consists of a "round-the-room" tag-up with each on-coming operator. This FD team tag-up will occur at 45 minutes after the handover hour (i.e., 7:45 AM, 3:45 PM, 11:45 PM). Each position will give a status of their area, any issues they are aware of and plans for that position for the next shift. Flight Director will finish the "round-the-room" with any big-picture information, areas not already covered and answer any outstanding questions. It would be best (but not mandatory) for the off-going operators to remain through this on-coming operator tag-up in order to answer any questions that may arise that weren't covered in the individual position's handovers. The off-going team member is released as long as any outstanding issues have been properly handed over and the oncoming shift is comfortable. The oncoming position should report to Flight Director that the handover for their position is complete.

In the special cases where the transfer of shifts occur between shifts that do not overlap (REs for instance), handovers should be worked by each team to ensure the incoming team is aware of the latest status as listed above.

7.3.1.3 Typical Pass Communications

During any given comm pass, before the pass begins, the Command Controller conducts a pre-pass briefing with the Flight Director if there are any special activities or commanding occurring during the upcoming pass. Otherwise, the pre-pass briefing with the ground station is sufficient. (See Procedure 3.4.3.8 of the Flight Ops Handbook (FOH) on pre-pass checklists for the detailed procedure and information on conducting these passes.) The Command Controller should announce over the voice loop when routine comm commands have been sent, and the Telemetry Controller and Command Controller should announce when lock with the return and forward link, respectively, have occurred. Once telemetry lock has been acquired, any applicable RE's should check the health of their subsystem, verify any timeline tasks that occurred during the previous LOS that they are able to verify through real-time telemetry and report all to the Flight Director via voice loop. Real-time events should also be reported immediately once they've been verified. If a critical event is beginning, reporting of the start of the event should be reported to FD via voice loop as well. Any anomalous situation should be reported immediately to FD, even if more investigation will be required to confirm identification of an actual anomaly. Statuses should be given at a reasonable interval in such situations, or as new pertinent information is discovered. (See Anomaly Resolution Plan, S0855.) Once a pass has completed, the Command Controller should announce LOS over the voice loop and conduct the post-pass briefing per Procedure 3.4.3.8 of the FOH.

7.3.1.4 Non-real-time Subsystem Event Verifications

As subsystem teams process incoming data, either real-time or playback, and confirm events, a status should be either reported to Flight Director if the position is on console, or put into the RE's Daily Report (See Section 7.3.3.2, Functional Group Daily Reports) for coverage at the Daily All-Hands meeting, typically held daily at 10 AM. (See next section for information on the All-Hands meeting.) RE's are responsible for verification of playback data events via TCAD once the processed data has been made available.

7.3.2 Meetings

7.3.2.1 Daily All-Hands Meetings

The Daily All-Hands Meeting will be held daily at 10 AM and cancelled when not required. (On launch day, the All-Hands meeting will likely occur in the afternoon due to logistics of telemetry receipt and analysis.)

The Daily All-Hands Meeting will have a fixed agenda (see Figure 7-1, Daily All-Hands Meeting, subject to future change), and will be run by the Mission Director and attended

by all teams. Systems Engineering will organize the meeting, which will take place in the HEPL Conference Room, and will also take minutes. Typically it will begin with an overall "big-picture" state of the vehicle, payload, and past day's activities. Each subsystem team should come prepared to give the overall indication that all the previous day's timeline tasks have been verified with only exceptions listed and discussed in detail. A Science representative should give a high-level status of science. Upon completion of the science status, the Ops Supervisor will follow up if necessary with a high-level MOC status covering facility, networks and data processing, and any other outstanding topics or issues needing discussion. Also, any existing anomalies should be statused by a representative of the Anomaly Resolution Board, and new anomalies should be introduced and detailed. The next 24 to 48 hours of planned activities should be highlighted at the end of the meeting. In addition, written status reports from each of the Functional Groups will be handed to System Engineering at this meeting to use to generate the Daily Status Report. The following teams will generate these written reports: each RE team, FD, MP, OD, DP, GDS, ARB and Science.

MEETING AGENDA ITEM	PRESENTER
Overall Space Vehicle Status	MD
Past 24 Hours Activity	T/L Committee
Spacecraft Subsystem Status (ATC, C&DH, Comm, EPS, Mechanisms, S/M, Thermal)	S/C RE's
Payload Subsystem Status (ECU, GPS, GSS, SRE, TRE)	P/L RE's
Science Status	Science Team
MOC/GDS Status	Ops Supervisor
Anomaly Status	ARB Rep
Today's Planned Activity	T/L Committee
Tomorrow's Planned Activity	T/L Committee
Closing Remarks	

Figure 7-1, Daily All-Hands Meeting Agenda

7.3.2.2 Daily Mission Planning Meeting

Directly following the Daily All-Hands Meeting in the HEPL Conference Room, a Daily Mission Planning Meeting will be held to review the next PONG and PING loads and any potential changes. This meeting will be attended by a Timeline Committee member,

Mission Planning, relevant RE's, and a real-time ops representative. Mission Planning will organize and run the meeting and take minutes. Loads will either be signed off at this meeting or a TCR discussion will lead to rework. In addition to review the next day's loads and signing off or discussing TCR's, the agenda will also consist of reviewing the next day's contact schedule and ensuring the appropriate RE staffing will be notified and present for all required timeline activities.

7.3.2.3 Mission Planning Sign-Off Meeting

If TCR's were brought to the Daily Mission Planning Meeting, a short sign-off meeting will occur no earlier than 4:30 PM upon verifying that all TCR's were correctly implemented in the load. (NOTE: This start time is flexible based on Mission Planning's work load. Meeting start is announced via a daily page to the participants.) The Timeline Committee, RE teams and a real-time ops representative will attend, and Mission Planning will run the meeting. In the event more serious replanning needs to take place, directly following the sign-off meeting, a Replanning meeting run by the Timeline Committee will take place to prepare for subsequent loads.

7.3.3 Written Communications

7.3.3.1 TQSM Logbook and Pass Logs

Within a typical day in mission operations, there can be up to 3 shifts. Some positions will staff less than 3 shifts on any given day. Yet in any case, there needs to be a smooth handover of information from one shift to the next shift, regardless of time in between. In order for this seamless transition to occur, a consistent, accurate and detailed log recording pertinent and necessary information must be kept. For GP-B, this log-keeping function will happen via the TQSM logbook. (See the TQSM User's Manual for detailed information pertaining to the use of this tool.)

Each flight controller will be expected to keep an electronic log of any significant event with the correct GMT timestamp of when the event occurred. Note that this time is NOT to be the time the entry was made into TQSM, but rather the time of occurrence of the event itself. At times, ops may be busy enough that an immediate logbook entry will not be practical, in which case it is CRUCIAL that a quick, hand-written note be taken of the time and topic so that later logbook entry of the event will be possible. Logbook entries should use standard nomenclature. Abbreviations and acronyms may be used; however, the text must be written in such a way that persons other than the originator can understand it. Types of information that should be captured in the logbook at a minimum are:

1.) Significant activities (start, stop and/or verification)

2.) The quality of telemetry received

3.) Any real-time commands that were executed

4.) Problems or delays encountered and their workarounds/solutions

5.) Any anomalous indications and observations

6.) Parameters approaching or out of normal or expected operating range

7.) Safe modes/malfunctions, their possible causes, and any action taken

8.) Any ground system problems encountered

9.) Any time a flight rule is implemented

10.) Notes worthy of communicating to future shifts

The TQSM logbook is electronic and available to staff from outside the MOC and off-site via the Internet.

Also within TQSM, there is an area for pass logs. The pass logs should be filled out for EVERY pass to capture actual AOS/LOS times and other pertinent information.

7.3.3.2 Functional Group Daily Reports

Each day prior to the Daily All-Hands Meeting, each functional group should prepare a written daily report giving the status of that area. Functional groups consist of RE subsystem teams (spacecraft and payload), Science, Mission Planning, Data Processing, Orbit Determination, Ground Data Systems, Timeline Committee, Anomaly Resolution Board, and Flight Director (via Ops Supervisor representing the real-time operations team). An electronic master of each functional group's written report, as well as an interactive version, is available on the GP-B internal website. The RE will sign this report to indicate verification of all covered tasks has been performed.

7.3.3.3 Daily Status Report

Following the Daily All-Hands Meeting, Systems Engineering will construct an overall GP-B Daily Status Report. This report will begin with a Big Picture Summary of overall S/V and P/L health and status, big events completed in the last 24 hours, big events planned for the next 24 hours. The next several sections will contain health and statuses of the individual spacecraft and payload subsystems taken from their Daily Reports and the statuses given at the All-Hands Meeting. Following these sections, a section will status the overall Ground Systems/Network health, Data Processing and Orbit Determination taken from their Daily Reports given at the All-Hands Meeting. Finally, all existing anomalies will be updated and statused, and all new anomaly reports opened in the last 24 hours will be listed. This report, once completed, will be automatically distributed to a predefined distribution that will include management, and it will also be posted to the internal GP-B website. The goal will be to have this report generated and distributed by 2 PM (PT) daily.

7.3.3.4 Mission Planning Summary Report

The Mission Planning Team will generate a Mission Planning Summary Report listing changes agreed to at the Mission Planning meeting. This report will also include any announcements of real-time event (GN/SN pass) changes. Mission Planning captures the TCRs in a summary report for SE to include in the Daily Status Report.

7.3.4 Media Relations

Press releases and other media relations shall be conducted in accordance with the GP-B Media Plan. Any press releases will be coordinated amongst the media representatives and management of NASA, Stanford University and Lockheed Martin. It is important to note here that no one shall talk to the press without proper training and PI approval! If any other team member is approached with questions relating to GP-B, they should direct that person to Public Affairs. Information regarding how to reach Public Affairs will be posted on the exterior doors of the GP-B building.

7.4 MOC Protocol

There are general rules of protocol that shall be followed by all personnel when entering the MOC. Some of these more general rules are listed below. There are also several other operational rules that must be well understood by all flight controllers concerning rules of ground operations to GP-B that are covered in the GP-B Flight Rules Document (S0856). It is essential that all flight controllers are familiar with the regulations listed in this Flight Rules Document.

7.4.1 Approval to Enter the MOC

ANY person entering the MOC shall approach the Flight Director for permission to enter before speaking to any other person or performing any task in the MOC. If the Flight Director is currently engaged in a discussion, either in person or via voice loop, the entering party should wait for a convenient moment to speak so as not to disrupt potential on-going activities. **On launch day, access to the MOC will be barred from Launch minus 45 minutes until Launch plus 45 minutes.**

7.4.2 Facility Maintenance

In the event that any maintenance—facility, hardware or software—needs to be performed in the MOC, FD approval must first be obtained. In special cases, the FD may require the action to be scheduled at a later time if critical activities are occurring. Criticality of activities versus maintenance will dictate prioritization, at FD discretion.

In like manner, any scheduled activities that may potentially influence any of the real-time ops systems, no matter how unlikely, must be coordinated and approved ahead of time with the FD to ensure no critical activities are scheduled for the same time.

7.4.3 Leaving Console during Shift

In the event a Flight Controller needs to leave console during shift, every attempt should be made to do so during an LOS period. Also, the controller should notify Flight Director and ask someone to monitor any voice loop calls for that position. Periods off console should be as brief as possible. *REMEMBER: Notify Flight Director whenever going off-console!*

7.4.4 Food/Drinks in MOC

Drinks are allowed in the MOC in MOC-approved cups only. These cups include MOC-issued approved mugs or any container that has either a cap or some kind of containment that makes it spill-proof. Food will be allowed in the MOC, but should not be eaten in close proximity of any computer equipment. All empty containers should be discarded external from the MOC since garbage pick-up doesn't occur in the control room. In the event that there are any VIP's scheduled to visit the MOC or any events requiring any kind of cameras (video or otherwise), console areas should be free of clutter, organized and no food or drink should be in view at all.

7.4.5 Moving Equipment in the MOC

It is essentially important that no one move any piece of equipment in the MOC, no matter how trivial the move may appear. Several sensitive connectors on the back of most equipment can be damaged by even the smallest shifts in equipment, resulting in the loss of equipment and costly repairs. Therefore, it is imperative that anyone wishing a piece of equipment moved, even if just a few inches, contact the Ground Data Systems Lead, Jeff Wade. He is the only person authorized to touch any equipment in the MOC or who can designate someone to do so.

7.4.6 Cell Phone Use in the MOC

If cell phones are brought into the MOC, they must be put in vibrate mode or turned off. No ringing cell phones will be tolerated during operations.

7.4.7 Red Ceiling Light in MOC Flashing

In the event that a critical event is occurring in the MOC that requires quiet and only key personnel, the red ceiling light in the MOC at the back of the room will be turned on and flashing. In this case, all non-essential personnel should exit the MOC and no non-essential personnel should re-enter while the red light is flashing unless an emergency requires entrance. The remaining personnel should maintain quiet when possible.

7.4.8 Pushing Displays from a Pod

Pushing displays to other consoles can only be done from a shadowing Pod, nominally Pod-E after launch. Such an activity performed from a primary Pod can result in the crashing of that Pod if the pushed displays are mistakenly closed.

7.4.9 Limit Changes in RTWorks

Any changes to limits in RTWorks must be authorized through Flight Director and implemented by the TLM Controller to manage the configuration of the limit file.

7.5 Operations Team Processes

7.5.1 Mission Planning Process

The overall mission planning process is depicted below in Figure 7-2, Mission Planning Process.

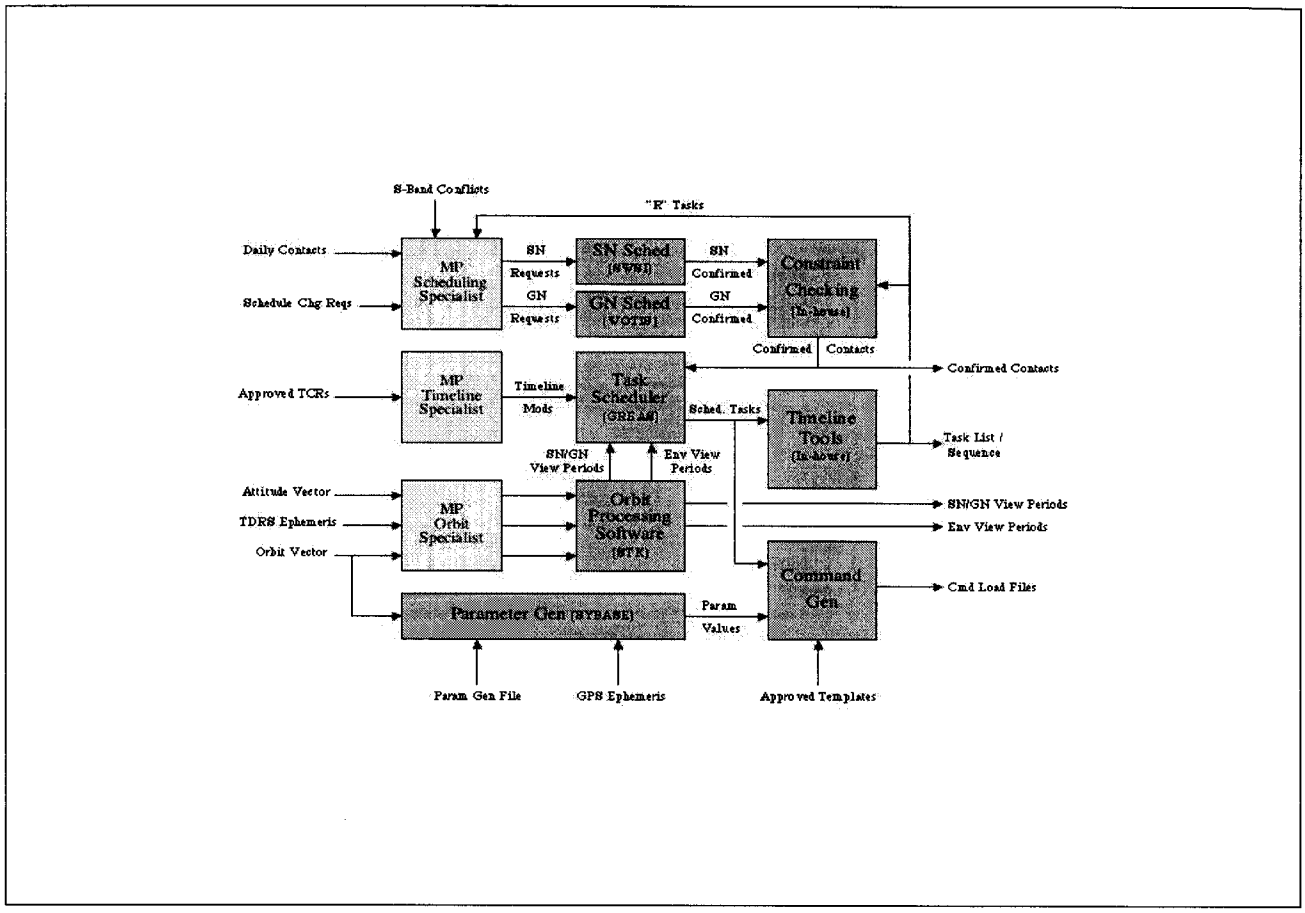

Figure 7-2, Mission Planning Process

Inputs and outputs into this mission planning process are described in the next two tables, Table 7-4, Mission Planning Receivables, and Table 7-5, Mission Planning Deliverables.

Table 7-4, Mission Planning Receivables

Input	Source	Frequency	Procedure	Verification
Approved TCR	Timeline Committee (MD, FD, RE)	As Needed	P0813, P0883	Tested
SCR	MD, FD, RE	As Needed	P0810	Tested
Param Gen Input	RE	As Needed	Flight Ops Procedures: 3.1.1.4, 3.2.1.5, 3.2.3.2, 3.2.3.3, 3.2.4.2, 3.2.4.3, 3.2.5.2, 3.2.5.3	Tested
Attitude Vector	ATC	As Needed	P0809	Tested
TDRS Ephemeris	GSFC OIG	Every 2 weeks or As Needed	P0809	Tested
Orbit Vector	OD	As Needed (IOC – probably 1-2 times/week) Weekly (Sci)	P0809, F.O.P. 3.1.1.3	Tested
GPS Ephemeris	Coast Guard NAVCEN	Weekly	P0884	Tested
Approved Templates	LM	As Available	P0948, P0815	Tested
DSN Blackout Periods	JPL	Weekly or As Needed	JPL MOU	Not Tested

Table 7-5, Mission Planning Deliverables

Output	Destination	Frequency	Procedure	Verification
Approved Load	PODs, www, hard copy distribution	Daily (IOC) / Weekly (Sci)	P0813, P0814	Tested
Task List / Sequence	www, hard copy distribution	Daily (IOC) / Weekly (Sci)	P0813, P0892	Tested
Confirmed Contacts	GREAS, www, DSN	Weekly or As Needed	P0811	Tested
SN/GN & Env View Periods	GREAS, www	Daily (IOC) / Weekly (Sci)	P0809, P0825	Tested

7.5.1.1 Sequence planning

Sequences will usually be built into two sequences. The first load is referred to as the PING load and is usually a 17-hour load that kicks off at 8 AM every day to run payload and science activities. The second load is referred to as the PONG load and is usually a 7-hour load that kicks off at 1 AM every day to run spacecraft (primarily attitude) activities. Primary staffing of both teams will be on day shift, since most spacecraft activities after launch day do not have to be monitored in real-time by the REs. Figure 7-3 below shows what is referred to as the Mission Planning "Day in the Life".

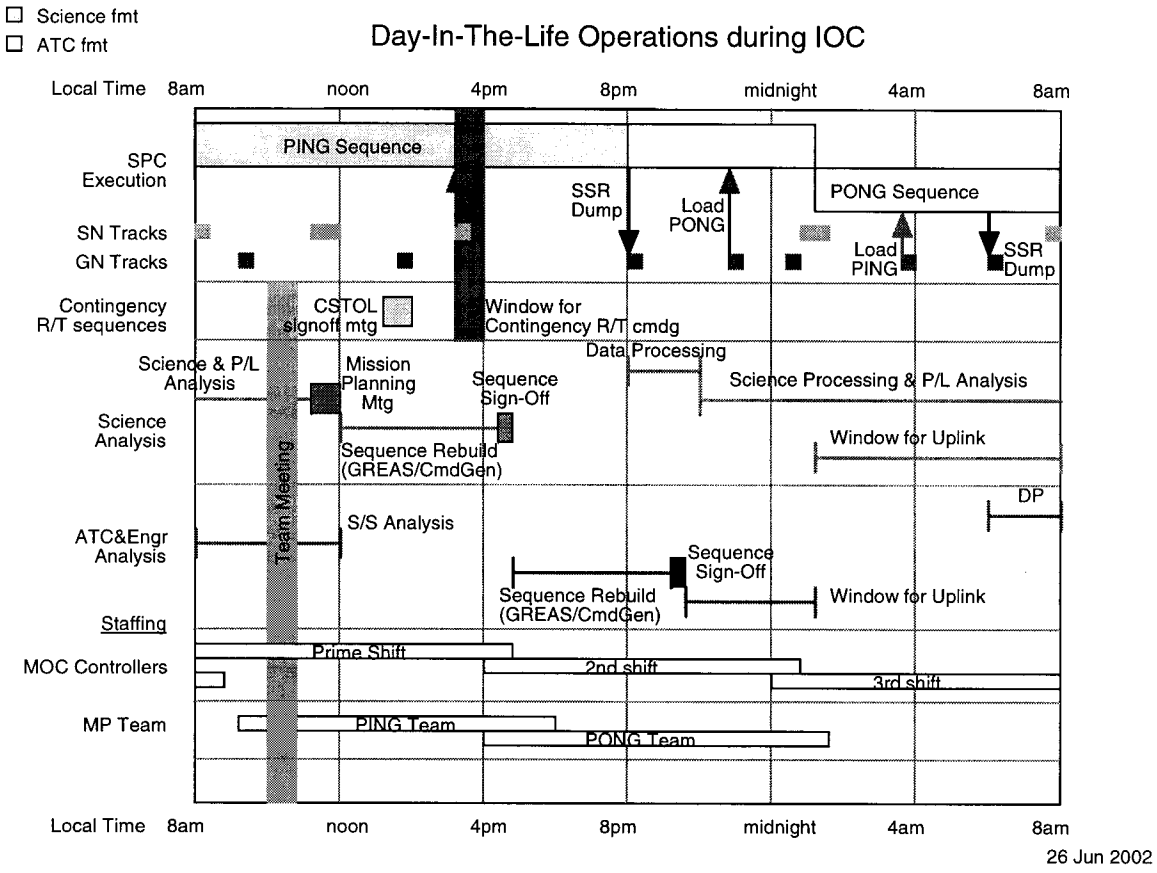

Figure 7-3, Day In the Life Operations During IOC

7.5.1.2 Mission Planning Product Distribution

Once a day, several mission planning products are generated and posted to the Mission Planning website on the internal GP-B webpage. (See Table 7-5, Mission Planning Deliverables.) The procedures that follow a given sequence will also be listed on the Mission Planning website. Each of these products is defined in S0892, the Mission Planning Timeline Products Guide, also posted at the Mission Planning website, which is located at https://gpbops.stanford.edu/.

7.5.2 Orbit Determination Process

The overall orbit determination process is depicted below in Figure 7-4, Orbit Determination Process.

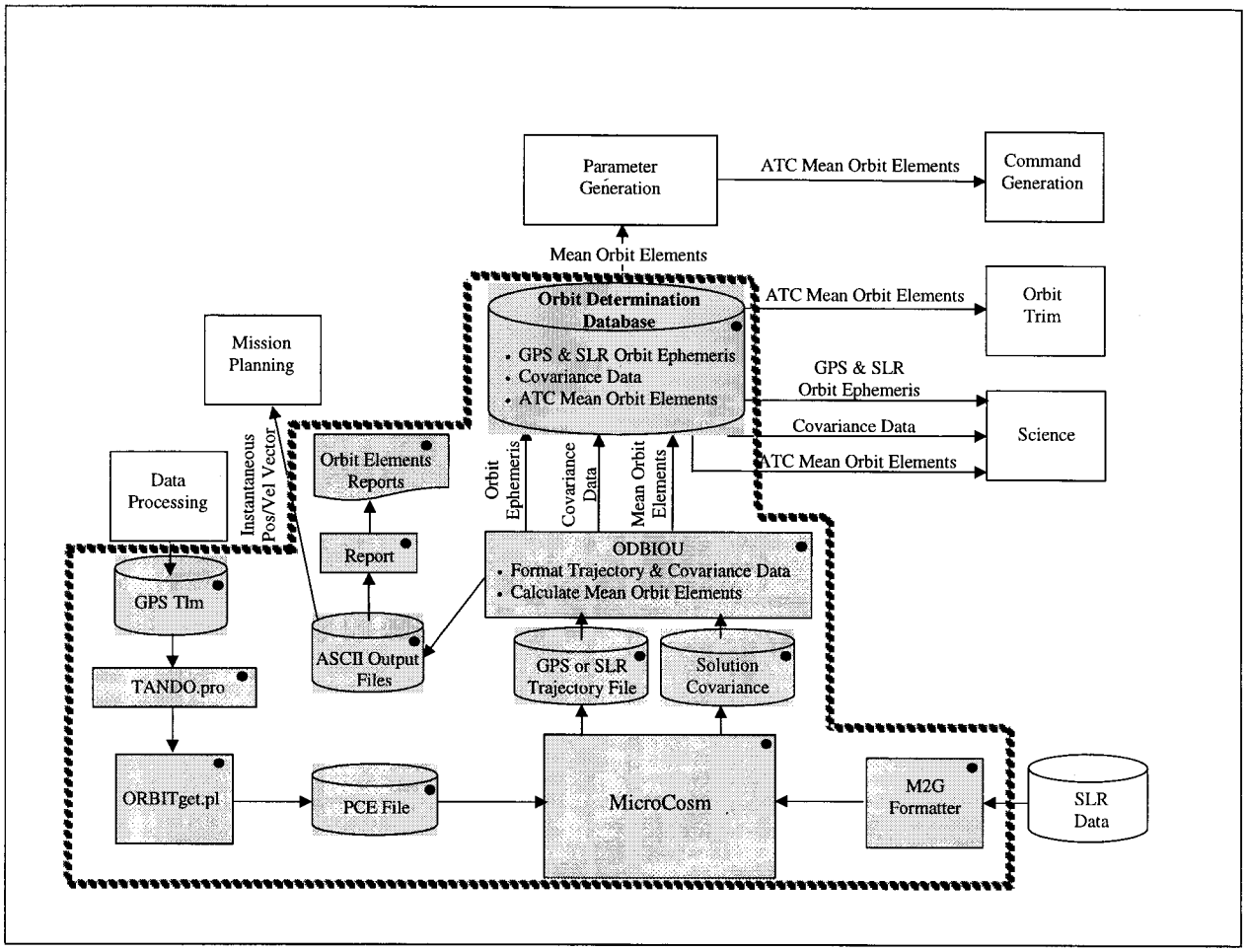

Figure 7-4, Orbit Determination Process

Inputs and outputs into this orbit determination process are described in the next two tables, Table 7-6, Orbit Determination Receivables, and Table 7-7, Orbit Determination Deliverables.

Table 7-6, Orbit Determination Receivables

Input	Source	Description	Mission Phase	Frequency	Relevant Procedure	Transmission Medium
GPS Telemetry Data	GP-B Data Processing	GPS Time, Position, Velocity Data	All	Daily (Within 4 hours of receipt)	P0664	Via DB
SLR Tracking Data	ILRS	Laser Ranging Data	All	Daily (Within 24 hours of receipt)	P0745	Internet / FTP
Launch Vehicle Separation Vector	Boeing / FDF	Post-Separation Orbit & Attitude State Vector	Launch	Within 30 min. of separation	S0505	Fax / e-mail Voice Backup
GPS Almanac Data	U.S. Coast Guard	GPS SV Orbit Information	All	Every 3 weeks	Mission Planning	Internet / FTP
Earth Orientation Parameter Files	IERS	Earth Rotation Modeling Data	All	Weekly	P0980	Internet / FTP
Solar & Geomagnetic Observation Files	NOAA	Solar & Geomagnetic Modeling Data	All	Weekly	P0980	Internet / FTP
Backup Orbit State Vector	FDF	Time, Position, Velocity Data	All	Daily, Twice a week, On request	P0664	Fax / e-mail Voice Backup

Table 7-7, Orbit Determination Deliverables

Output	Destination	Description	Mission Phase	Frequency	Relevant Procedure	Transmission Medium
Definitive Orbit Ephemeris	Science	UTC & Instantaneous ECI Position/Velocity in Cartesian Coordinates	IOC Science	Daily / On Request (IOC) Weekly (Sci)	P0664, P0745	Via OD Database
ATC Initialization Orbit State Vector	Param Gem / ATCS	Mean Modified Keplerian Elements	All	Weekly	P0664	Via OD Database
Science Processing State Vector	Science	"	Science	Weekly	P0664	Via OD Database
Orbit Trim Analysis State Vector	Orbit Trim	"	IOC	Daily	P0664	Via OD Database
GN/SN Backup Acquisition State Vector	FDF	UTC & Instantaneous ECI Position/Velocity in Cartesian Coordinates	All	Backup as needed	P0664	E-mail (fax backup)
SLR Backup Acquisition State Vector	ILRS Ops Center	"	Science	Backup as needed	P0664	E-mail (fax backup)
Mission Planning State Vector	Mission Planning	"	All	Weekly	P0664	Database
Orbit Trim Command Data	Mission Planning (Param Gen)	Start/Stop Time of Trim, command angle, sign & wedge angle	IOC	As needed (infrequent, e.g., 3 weeks)	P0985	Electronic File on Science Server

Orbit Determination generates mean and instantaneous vectors based on processing GPS data through the MicroCosm software. OD supplies the instantaneous vector to Mission Planning, who then inputs this vector into the Satellite Tool Kit (STK) software to generate view periods and the orbital events file (guide star valid/invalid, eclipse entrance/exit, SAA entrance/exit). The mean vector is supplied to the Science team for use in various analyses as well as to the Mission Planning team for use in the preparation of ATCS orbit vector commands. The OD function will also establish the direction and duration of orbit trim thrusting and supply Mission Planning with the input files used to prepare orbit trim commands. Orbit Determination external interfaces are defined in the Orbit Determination Interface Definition Document (S0505), and shown below in Figure 7-5, Orbit Determination Interfaces. OD statuses are posted on the internal GP-B website.

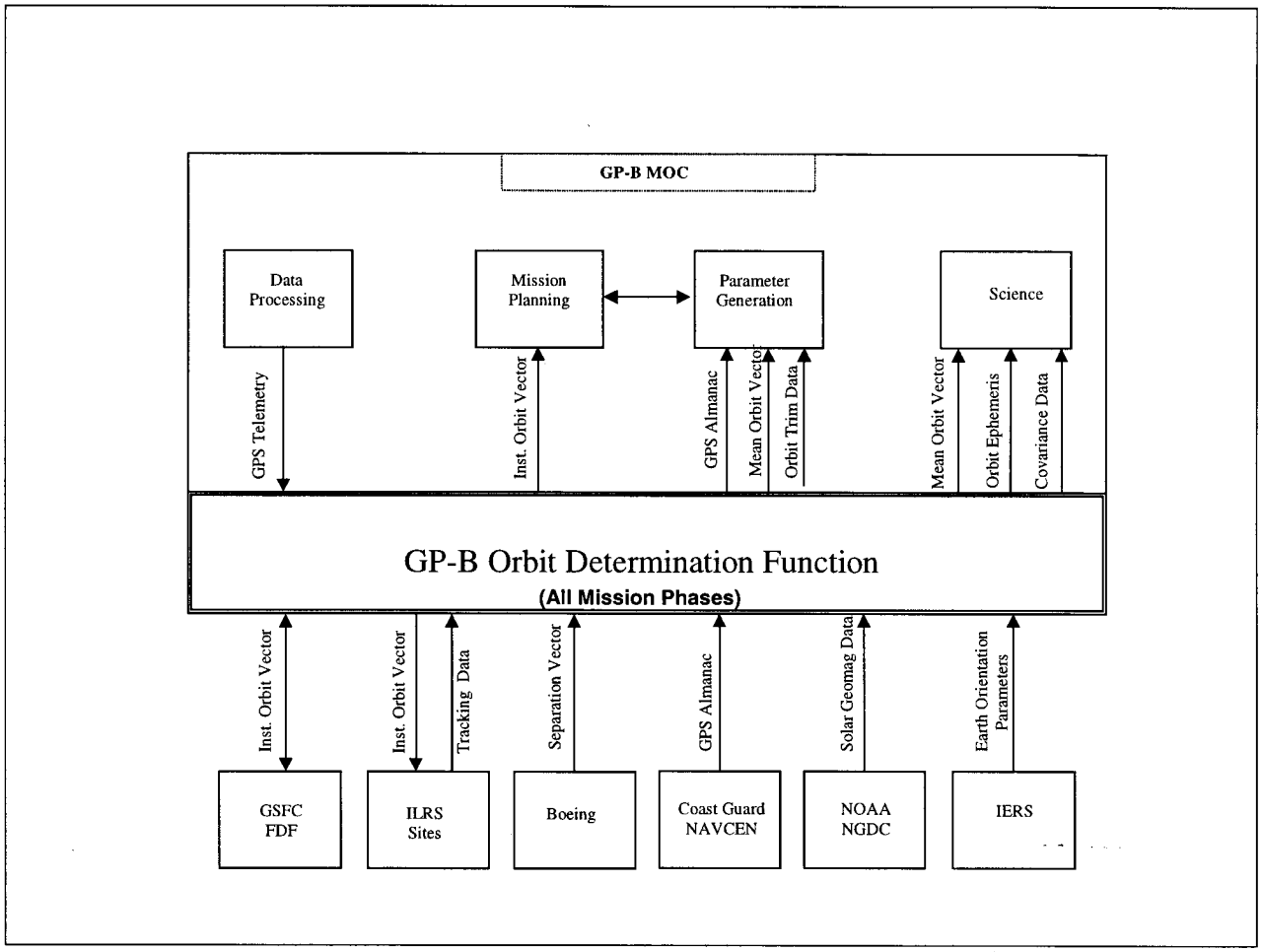

Figure 7-5, Orbit Determination Interfaces

7.5.3 Data Processing Process

The data processing data flow is depicted below in Figure 7-6, Data Processing Data Flow.

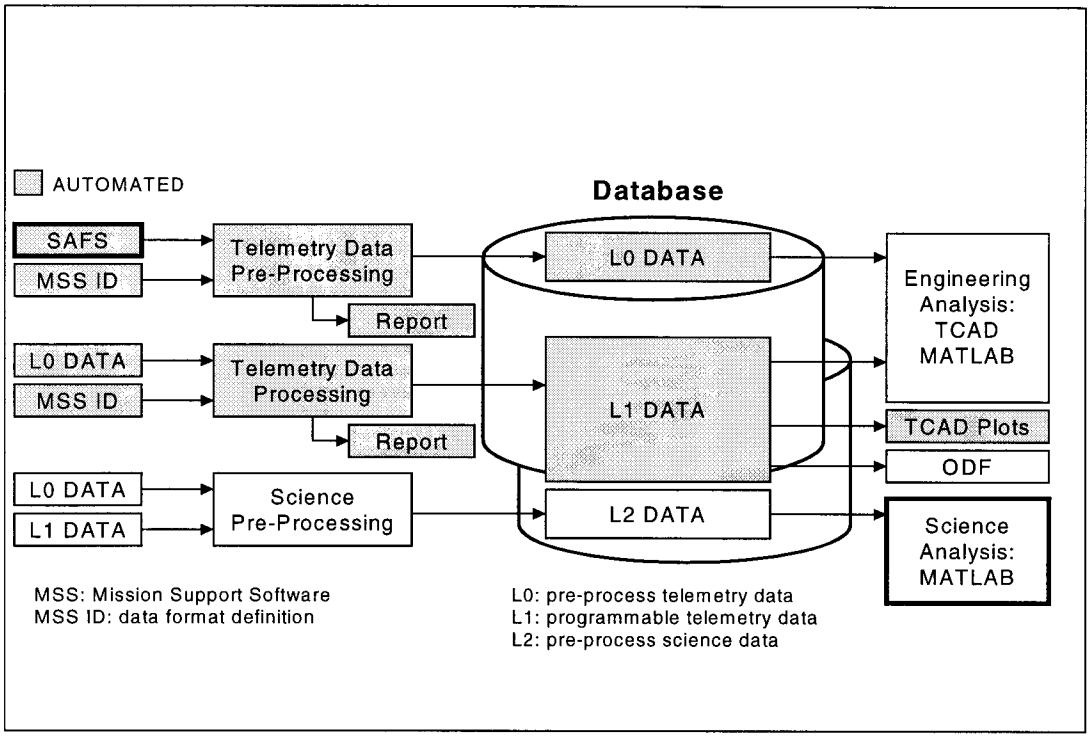

Figure 7-6, Data Processing Data Flow

Data Processing will routinely process data as it comes in and will post the processing status on the internal GP-B website. A daily set of plots covering the last 24 hours will be generated by 8 AM each morning for RE review prior to the 10 AM Daily All-Hands Meeting. (See Figure 7-2, Day in the Life Operations During IOC.) Data Processing also is responsible for the TQSM Logbook functions for all teams' usage. The receivables and deliverables for the data processing function are listed in the two following tables, Table 7-8 and Table 7-9 respectively:

Table 7-8, Data Processing Receivables

Input	Source	Description	Mission Phase	Frequency	Relevant Procedure	Transmission Medium
SAFS Data	Central SAFS	SV Telemetry data from SAFS	All	Every 4 hours	P0826	FTP
RT Ops Data	SV via	SV Realtime Pass Data	All	Every pass	P0826	IONET
Ground Test Data	LM	Data from SV ground testing	Pre-Launch	Per testing	P0953, P0826	IONET, Tape
ITF Data	LM	Data from ITF	All	As required	P0953, P0826	IONET, Tape
MSS DB	LM	Mission Support Software (MSS) database updates	All	As required	P0908	IONET, Tape
Limit Data	LM	New limit values for SV monitors	All	As required	P0826	IONET, Tape

Table 7-9, Data Processing Deliverables

Output	Destination	Description	Mission Phase	Frequency	Relevant Procedure	Transmission Medium
SAFS Data	GP-B Database	SV Telemetry data from SAFS	All	1 hr of receipt	P0826	Via MOC and Science Networks
RT Ops Data	GP-B Database	SV Realtime Pass Data	All	1 hr of receipt	P0826	Via MOC and Science Networks
Ground Test Data	GP-B Database	Data from SV ground testing	Pre-Launch	2 hrs of receipt	P0953, P0826	Via MOC and Science Networks
ITF Data	GP-B Database	Data from ITF	All	2 hrs of receipt	P0953, P0826	Via MOC and Science Networks
MSS DB	GP-B Database	Mission Support Software (MSS) database updates	All	1 hr of receipt	P0908	Via MOC and Science Networks
Limit Data	GP-B Database	New limit values for SV monitors	All	1 hr of receipt	P0826	Via MOC and Science Networks
TCAD Plots	GP-B Team	Hard copy plots of SV data	All	Once a day ~ 8 a.m. PST	S0717	Via DP Assistant to Team Mail Boxes

7.5.4 Real-Time Operations Process

The overall real-time process is depicted below in Figure 7-7, Real-Time Operations Process.

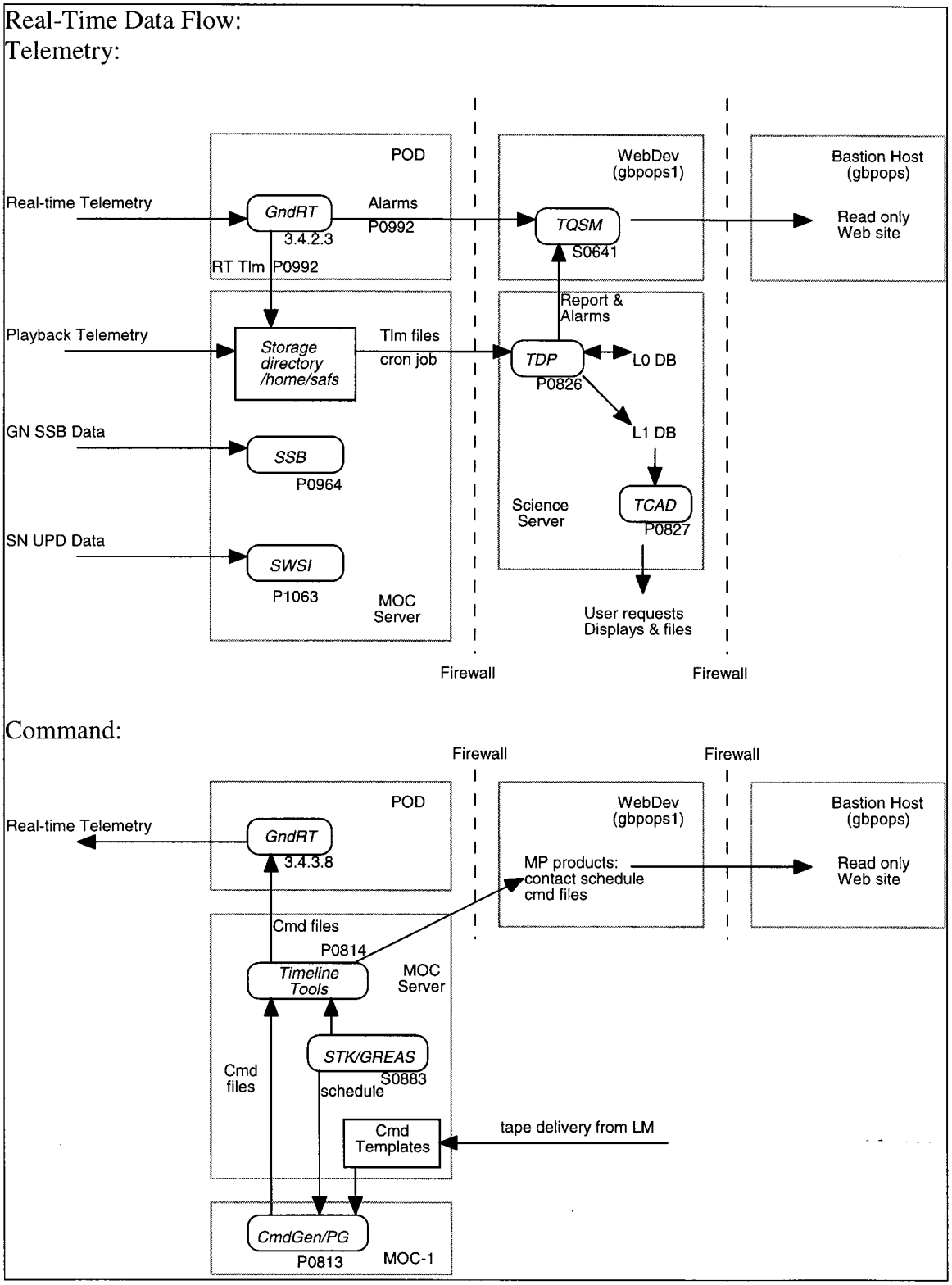

Figure 7-7, Real-Time Operations Process

The interfaces supporting the real-time operations function are listed in Tables 7-10, Real-Time Operations Interfaces.

Table 7-10, Real-time Operations Interfaces

From	To	Product description	Type	Transfer medium	Proc #
GndRT	SV	Cmd files: *.load	binary	IONet	3.4.3.8
GndRT	SV	CSTOL cmd files: *.prc	ascii	IONet	3.4.3.8
GndRT	SV	R/T cmds	hand typed	keyboard	3.3.4.3.08.1
SV	GndRT	Telemetry: *.tlm	binary	IONet	3.4.3.8
GndRT	TDP	Telemetry: Framex*.log	binary	electronic	P0992
GN	SSB	GN RF data: *.*GS	ascii	IONet	P0964
SN	SWSI	SN RF data: *.UPD	ascii	IONet	P1063
MP	FD/FOT	Contact schedule *.masrpt	ascii	electronic/paper	P0814
MP	FD/FOT	Approved load files: *.load, *.prc, *.tline, tv*.pdf	binary/ascii	electronic/paper	P0814
FD	Cmd	Pass plan checklists	paper	hand	P1061
RE/MD	FD	Pass plan change request (PPCR)	paper	electronic/paper	3.3.4.3.08.1
GSFC	FD	Briefing messages	ascii	email	N/A
RE	FD	Limit change requests	ascii	paper form	3.4.3.9
FD/FOT	FD/FOT	TQSM/Logbook entries	Sybase	electronic	P0999
GndRT	TQSM	Limit alarms: *.rtw	ascii	electronic	P0992
GndRT	TDP	Limit changes: *.rtw	ascii	electronic	P0992
FD	INFOtimer (TT)	Clock countdown file: latest	ascii	electronic	P1062
MP	FD/FOT	Scripts	ascii	electronic/paper	TBD

7.5.4.1 Pass Plan Checklists

Pre-passes, passes and post-passes will be guided by the real-time controller's Pass Plan Checklist (see Procedure 3.4.3.8 in the FOH). Each Pass Plan Checklist summarizes scheduling information about an individual contact (support facility, contact start/stop times, comm configuration, special commanding, etc.) The Flight Director will create and annotate the checklist to identify any loads or procedures to be transmitted during that contact. The real-time team will use the checklists to ensure health and safety checks are being performed on the S/V. The lead controllers will use the checklists both pre-pass and post-pass to interface with GSFC tracking station personnel as required to support real-time tracking and near term changes to tracking.

7.5.4.2 Real-time Commanding

Requests to send unplanned real-time commands must be documented in a Pass Plan Change Request (PPCR) according to Contingency Procedure 3.3.4.3.08.2. Once

generated, the PPCR must be signed off by the S/C lead, the P/L lead, the science lead, the Mission Director and provided to the Flight Director. The Flight Director will then coordinate with the Command Controller for execution of the PPCR.

7.5.4.3 Real-time Limit Checking

During every contact, the Telemetry Controllers will perform real-time limit checking according to Procedure 3.4.3.9 to ensure no limit violations have occurred. If any yellow or red limits have been violated, the appropriate subsystem RE will be contacted to correct the situation. Changes to limits in RTWorks must be coordinated through Flight Director and implemented by the TLM controller.

7.5.5 Science

The Science team will meet daily prior to the 10 AM Daily All-Hands Meeting to review analysis activities.

7.6 Products and Forms

7.6.1 Product Sign-off Lists and Process

All products will have documented procedures for sign-off. These include the mission timeline and changes to it, command load sequences and pass plans. Orbit determination deliveries to mission planning and science will have sign-off procedures. Copies of all delivered documents will be maintained by the producer in a fixed location.

MOC procedures and formal project documentation will be maintained in the MOC in notebooks along the back wall. Volume 1 of these notebooks contains a complete table of contents of all volumes. The project librarian also maintains formal copies. Documentation will be on-line as well at the GP-B Internal website.

The configuration management of the MOC will be documented and stored by the software manager in his office. Formal copies of these documents are also in the project library.

7.6.1.1 Product Distribution Lists and Schedules

All delivered products will have formal distribution lists as part of the procedure to generate these products. The form of distribution (electronic or hardcopy) will also be documented in the procedure. A distribution table (Table 7-11) is provided below, but may be subject to change. In such cases, the governing procedure's distribution takes precedence.

Table 7-11, Product Distribution

Team	Daily Plots	Load Packages	View Periods	Daily Status Report	MP Report	Activity Scripts
Msn Director		X	X	X	X	X
Flight Director		X	X	X	X	X
Ops Supervisor		X	X	X	X	X
Ops Controller		X		X		
Tlm Controller		X		X		
Spacecraft RE's:					X*	X*
ATC	X	X	X	X		
CDH	X	X	X	X		
COM	X	X	X	X		
EPS	X	X	X	X		
FSW	X	X	X	X		
Mech	X	X	X	X		
SM	X	X	X	X		
THER	X	X	X	X		
Payload RE's:					X*	X*
DWR	X	X	X	X		
ECU	X	X	X	X		
GPS	X	X	X	X		
GSS	X	X	X	X		
SRE	X	X	X	X		
TRE	X	X	X	X		
Science Team		X	X	X	X	X
MP Team		X		X		X
DP Team		X		X		
OD Team		X		X		
GDS Team		X		X		
ITF Team		X		X		
Mgmt Teams:		X		X		
SU		X		X		X
LM		X		X		X

MSFC		X		X		X
HQ		X		X		X
ARB/ART		X	X	X		X
NEAR		X	X	X		X
T/L Comm		X	X	X	X	X
Admin Team		X		X		

*** Only given to affected Subsystem RE Teams.**

7.6.1.2 Forms and Products Locations

Users can access several products and forms used for GP-B via the web. To aid this process, Table 7-12 provides a listing of common-use forms and products and their locations. (Note that the gpbops1 website listed below is the interactive website accessible from MOC or Science servers and is available to all relgyro users. The same information can be accessed externally in read-only mode by using https://gpbops.stanford.edu.)

Table 7-12, Product/Form Locations

Product or Form	Purpose/Use	Location
Timeline Change Requests (TCR)	Submit Timeline changes for upcoming loads	http://einstein.stanford.edu/private
Pass Plan Change Request (PPCR)	Request real-time commanding	Procedure 3.4.3.8 in the FOH
Software Change Request (SCR)	Request change to LM software	LM FMPro Database
MOC Change Request (MCR)	Request change to MOC H/W or SU S/W	Foxpro Database at Stanford on dbm drive
Engineering Change Order (ECO)	Request change to a released P-doc	Obtain from SU Documentation Librarian
Command Template and Procedure Change Request (CTPCR)	Request change to a Flight Procedure	LM FMPro Database
Discrepancy Log	Submit Problem report within MOC (hardware, software, facility, etc…)	Hardcopy forms found in D-log notebooks located in MOC and also in all off-line support offices. SE will maintain master D-log listing.
All Mission Planning Products	Contact schedule, .tline file, Taskviewer, PONGviewer, view periods, etc.	gpbops website

All Console Documentation	L&AP, ARP, FOH, Flt Rules, User's Guides, etc.	gpbops website
Daily Status Reports	Management Daily Status (see Section 7.3.3.3)	gpbops website
Personnel listing	All GP-B personnel	gpbops website
Staffing/Shifting Plan	Current Staffing plan at MOC	gpbops website
On-Call schedule/roster	Listing of current on-call personnel/schedule	gpbops website

7.7 State Tracking

7.7.1 Predicted State

The predicted state of the vehicle as it changes through IOC can be found through analysis of the timeline. Some functions are easy to track with software, but many are not. A state tracking Activity Script has been created that aids in the management of state changes and verifications. This script covers many but not all state changes. A new script is automatically generated with each new load and will be distributed to the team.

7.7.2 Status Boards

Status reports will be made available under the Reports section on the internal GP-B website for team access outside of MOC. Status boards will also be maintained by FD/OS in the MOC, and SE in the ARB Room. Some states are covered in Mission Planning products (formats, real-time events, ping/pong status).

7.8 Contingency Operations

7.8.1 Anomaly Resolution Board

Any position noticing an apparent off-nominal situation should immediately notify the Flight Director, even if more troubleshooting and investigation is needed to determine what the problem may be. If upon further investigation the Flight Director deems the event to be a true anomaly, FD will notify the Mission Director. The Mission Director will convene the Anomaly Resolution Board, who will be responsible for the assignment of a specific Anomaly Resolution Team (ART) to investigate that particular anomaly. Once the ART has developed a plan for recovery, the ARB will approve that plan for development. The ART will be responsible for generating, testing and verifying the recovery plan and associated contingency procedure in the ITF. When ready, the ARB will then approve implementation details of the contingency. Details of the anomaly identification and resolution process are fully documented in the GP-B Anomaly Resolution Plan (S0897).

7.8.2 Spacecraft Emergency

A "spacecraft emergency" has a very specific meaning according to SN and GN personnel that is worth noting here. They define a spacecraft emergency as "an operational condition that occurs when the health and welfare of the spacecraft is in grave danger, and the project will most likely need to request urgent operations to avoid of their spacecraft". The importance of realizing the networks' understanding of this term is due to the fact that during an actual spacecraft emergency, higher priority users of the network, even as high as NASA assets such as the Space Shuttle and ISS, may very well get bumped in order to provide emergency contacts. So this term should never be used lightly unless the definition above has been considered.

7.8.2.1 Process and Authority to Declare a Spacecraft Emergency

Notification may come from many sources leading to declaration of a spacecraft emergency by the Flight Director or Mission Director, but only they can declare an actual spacecraft emergency. Flight controller efforts will focus on combating damage and achieving stable conditions. Once the situation has been stabilized adequately to assure vehicle safety, a "hands-off" policy will be instituted requiring that all ground support equipment and voice data networks be preserved in the operational state and configuration existing at the time of the emergency until released by the FD or the chairman of the Investigation Board. Afterward, diagnosis and recovery will be determined and performed. Stabilization and recovery from the situation take precedence over operations. All information bearing on the emergency is privileged and non-releasable.

7.9 Transition to Science Mission Operations

In order to consider GP-B ready to transition from IOC to Science Mission operations, the Space Vehicle needs to be in a configuration ready to support that phase. This configuration consists of orbit trim having completed, the SRE reading gyroscope orientation (local space), the TRE functioning for guide star valid (distant space), GSS suspending 3 gyros at 220 Hz, and the ATC functioning nominally. The SRE should be exhibiting micro-Kelvin temperature control. One of the 3 suspended gyros should be drag free, with the spin direction toward the guide star and centered in the cavity. The ATC should be functioning in drag free mode, with pointing functioning nominally and the dewar temperature controlled.