Mission Operations Concept

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Operations concept Document

- **September 7, 2000 version available at:**
- **http://glastproject.gsfc.nasa.gov/engn.htm**

Target Of Opportunity Options

- **Level of optimization of initial TOO observation**
  - Handle TOO similar to burst detected onboard
    - Simple command to spacecraft for fixed duration observation
    - Spacecraft points in default direction during any earth occultation
    - Ground operators have option to develop more sophisticated observation during the initial fixed duration observation
    - Onboard process will have to check for occultation
  - Optimize initial observation
    - Design start time, duration, and any occulted pointing direction prior to commanding observation
- **MOC Staffing for command uplink**
  - Require operator to command TOO from MOC
    - Requires additional time (~ 1 hour?) for MOC operator to get to MOC when MOC is not staffed
  - Unstaffed commanding
    - Requires additional tools and processes in MOC and communications systems
    - Requires change to GSFC operations culture

TOO Timeline Guesstimate

	Optimized, Unstaffed Commanding	Optimized, Staffed Commanding	Unoptimized, Unstaffed Commanding	Unoptimized, Staffed Commanding
Generate Activity by PS or designee	45	30	5	5
MOC operator gets to MOC	0	60	0	60
Generate Commands from activity	5	30	5	5
Schedule Uplink	5	5	5	5
Send command and observe TOO	10	10	10	10
Total	65 minutes	135 minutes	25 minutes	85 minutes

Uplink scheduling at least 5 minutes; could be longer
Observe TOO time depends on distance to slew and visibility of target - could be shorter
SRD Requirement is 6 hours (4 hour goal)

Target Of Opportunity Frequency

- **Assumes TOOs will occur once per month after year one and less often in the first year**
- **More frequent TOOs could be a burden on the ops staffing as currently planned and might require a change in approach**
- **(chart reconstructed after the fact)**

Baseline Telemetry Downlink

- **[Pass timeline showing that there is enough time to dump the X-band data twice during a normal contact. This redundancy should reduce the amount of data loss. Assumes 300 kbps average rate from LAT]**
- **[Timeline showing passes for a typical day. Plenty of opportunities to recover data if a pass is missed; In addition, should be able to arrange ground stations so that data is not loss if the primary station is out for an extended period of time (hours)]**
- **[Current baseline is robust; Could increase average LAT data rate to ~750 kbps with only slight increase of data loss. Increases beyond 750 kbps would require more contacts per day and could drive ops costs in other ways.]**

- **[Reconstructed after the fact]**

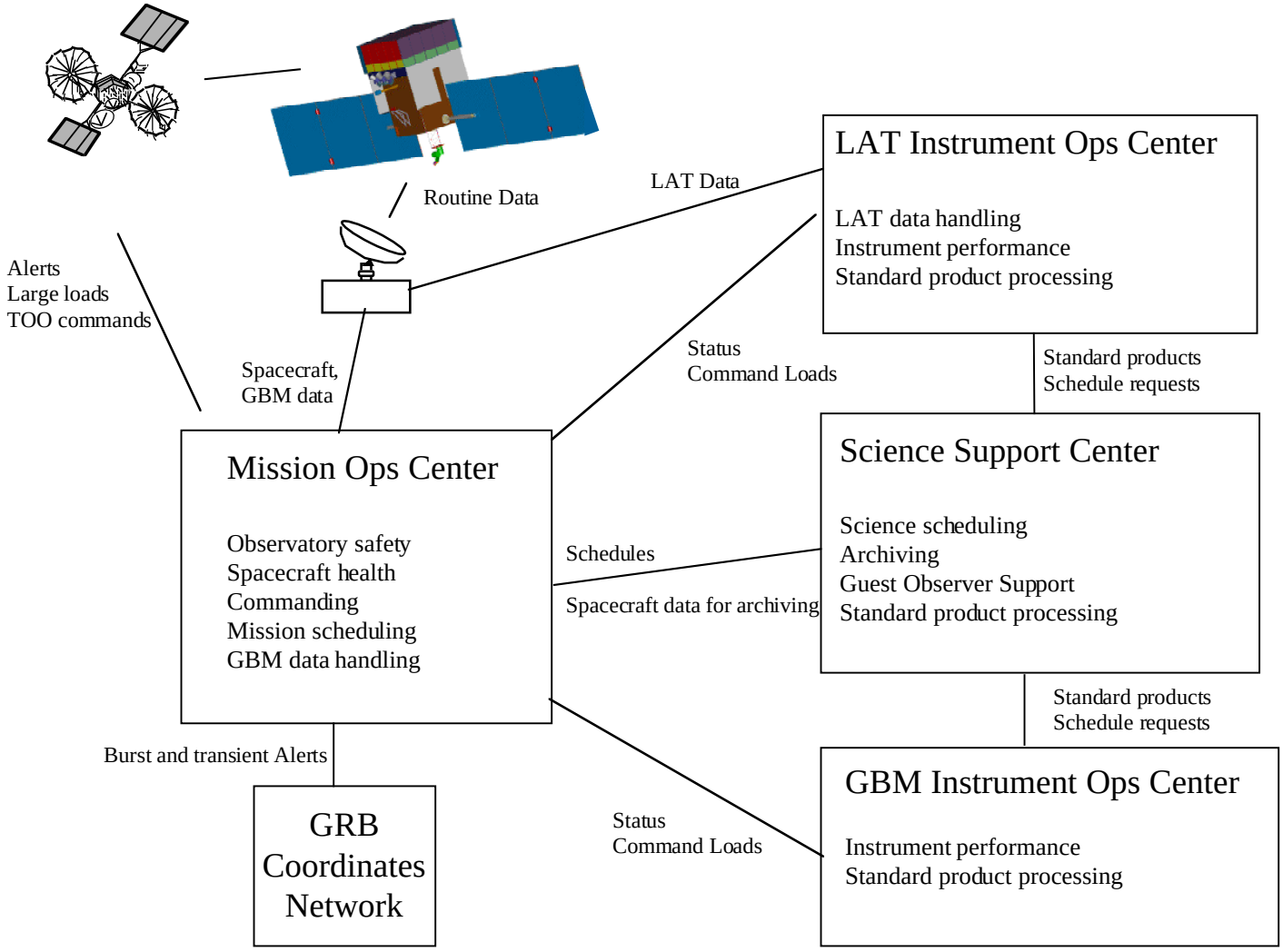
Operations Drivers

- **Routine operations**
  - All-sky survey for first year
  - Pointed observations in subsequent years
  - Minimal pointing constraints
- **Real time operations**
  - Gamma ray burst alert
    - Autonomous interruption of current observation and/or slew of spacecraft for selected bursts; observe burst for 5 hours and return to interrupted operation
  - Transient detection alert
  - Anomaly alert
  - Targets of opportunity
- **Modest downlink volumes**
  - ~28 Gbits per day
- **South Atlantic Anomaly**
  - No instrument operations ~15% of the time

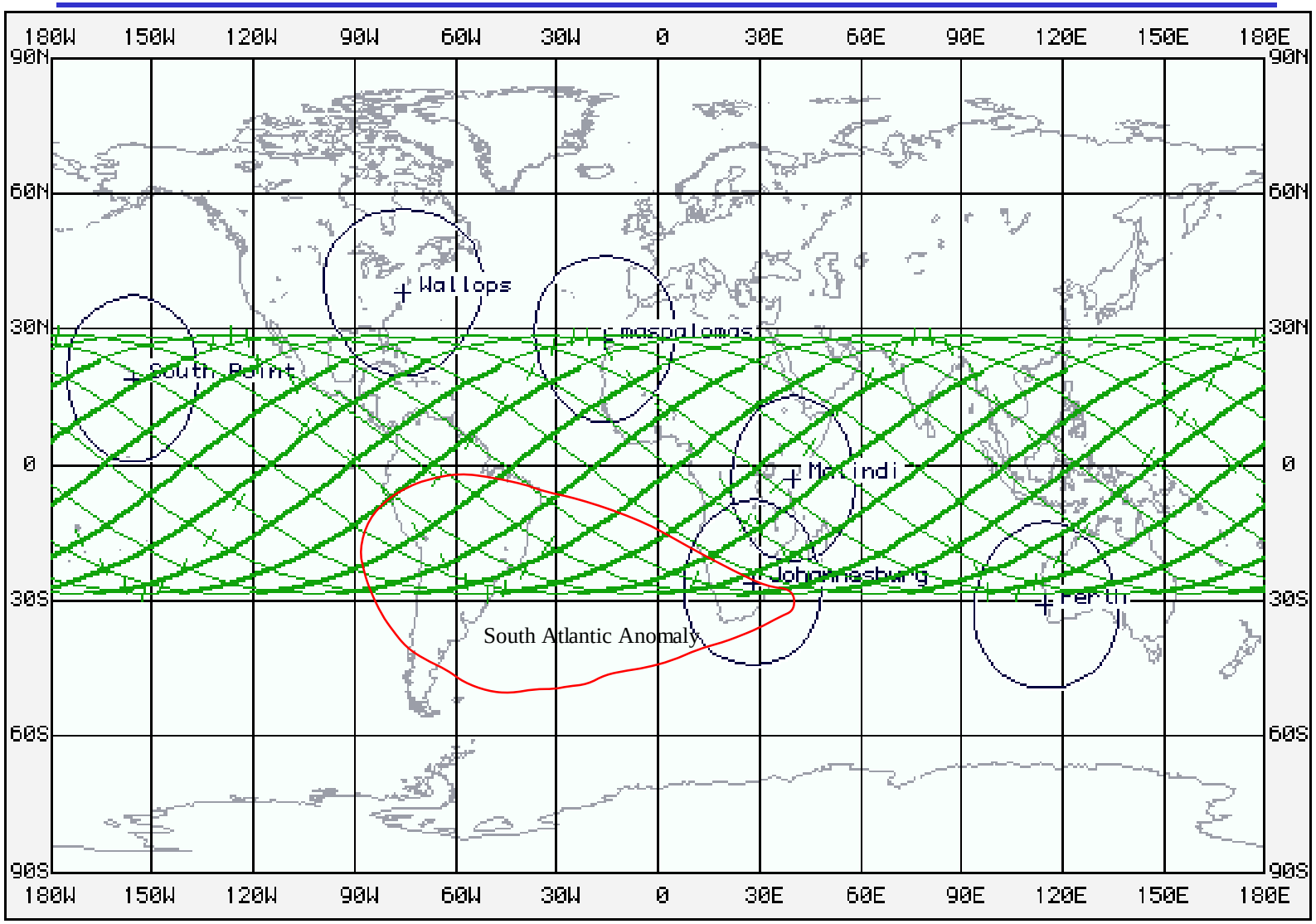
Operations Drivers (continued)

- **Long lifetime - 5 year requirement, 10 year goal**
- **Data Release**
  - Transients released immediately
  - Sky survey data available 3 months after completion
  - Guest observers have 3 months to validate data
  - Other data available within 2 weeks

Reference Architecture



550 km 28.5° Circular Orbit



Space/Ground Communications

- **Onboard instrument processing significantly reduces LAT data volume**
  - 300 kbps average LAT data rate
  - GBM ~ 5 kbps
- **One contact per day through ground station for bulk science data**
  - ~28 Gbits
  - Solid State Recorded sized for 36 hours of data
- **Ground Station Network**
  - 11 meter X/S band antennas
  - Expect to have multiple opportunities per day for routine contact

Space/Ground Communications

- **Alerts through TDRSS Multiple Access System**
  - Demand access service provides 100% coverage
  - Supports requirements for 5 second end-to-end delay
  - 1 kbps
- **Large software loads for LAT (1 Mbyte or larger) thought Single Access service at 4 kbps**
- **Target of Opportunity commands through MA or SA Forward service at 250 bps**
- **TDRSS also used to during launch and early orbit and anomaly resolution**

Routine Operations

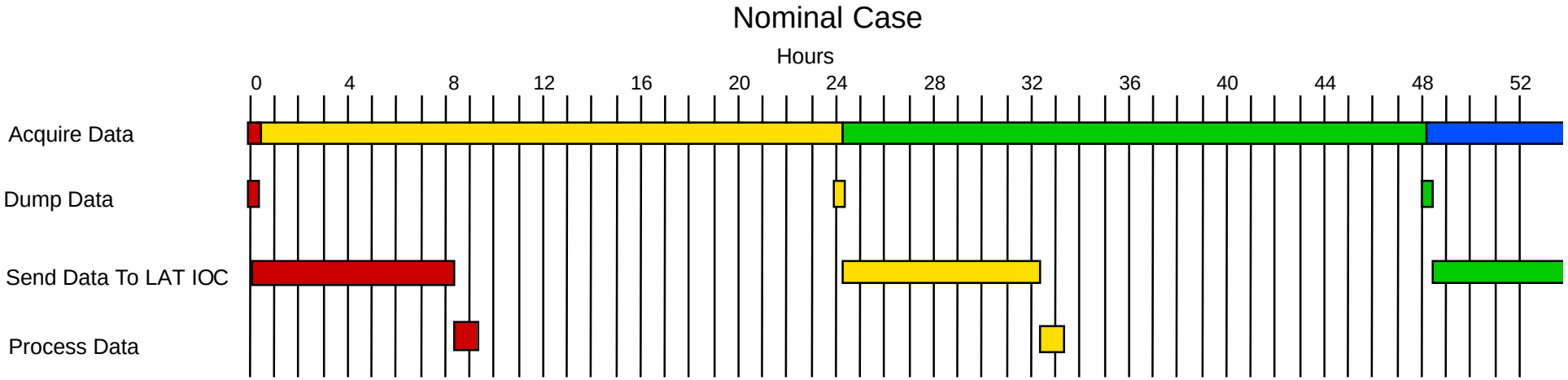
- **Scheduling**
  - Ground station scheduling
    - Ground station provider schedules within GLAST specified window
  - Sky survey
    - SSC may adjust scan pattern periodically
  - Targets
    - Selected about once per year
    - Most will be long exposures - weeks to months
    - Two target mode - inertial pointing and pointed scan
      - Pointed scan keeps target within 30 degrees of instrument center
  - Instrument Activities
    - Instrument activities scheduled through the SSC
- **Commanding**
  - All commands are through the Mission Operations Center
  - Command loads once or twice per week
  - Instrument loads provided by IOCs

Routine Operations (continued)

- **Health and Safety Telemetry**
  - Mission Operations Center responsible for observatory safety and spacecraft health
  - Instrument Operation Centers responsible for instrument health
  - Spacecraft provider will be responsible for sustaining engineering for at least a few years
- **Science Data Processing**
  - Instrument Operations Center generate standard products
  - SSC also generates some standard products
  - SSC responsible for archiving data for duration of mission
    - Archive transferred to HEASARC by the end of the mission

Data Delivery Delays

- **Oldest data delivered to the LAT IOC can be 24 to 50 hours old**
- **Onboard detection and use of TDRSS alert service for transients with time scales of a day or less**



Data Loss

- At least 98% of the data generated by the instruments is required to be delivered to the Instrument Operations Centers
- 2% data loss limits allows low cost operations
- Primary sources of data loss are problems during operations
  - Ground station hardware/software hiccups
  - Misconfigurations
  - Inconsistent information among the spacecraft, MOC, and ground station
- Large losses of data (e.g., a full pass) will be recovered
- Modest losses (e.g., less than a minute of downlink) will not be recovered if an additional contact would be required
- 2% loss allowance will be averaged over a month

Special Operations

- **Launch and early orbit**
  - TDRSS used to monitor critical events
  - Additional ground station contacts
  - Spacecraft checkout, instrument checkout, and the exercise of the survey, inertial pointing, and pointed scan observation mode
  - Nominal operations shall begin 30-60 days from launch
- **End of mission**
  - Controlled reentry (TBR)
- **Targets of Opportunity**
  - Observation of a short term phenomenon discovered by another observatory that is interesting enough to interrupt planned GLAST observations
  - Determination made by project scientist (or designee)
  - Observation will begin within hours of determination
  - TDRSS Forward link will be used to command new observation
  - Frequency expected to be less than once per month

Special Operations (continued)

- **Anomalies and Safe Mode Recovery**
  - Spacecraft notifies Mission Operations Center via TDRSS demand access service
- **Software loads**
  - Large software loads to the LAT will be done through TDRSS
- **LAT raw data mode**
  - Onboard software filters will be disabled, significantly increasing data rate
  - Extra contact will be scheduled to dump solid state recorder

Staffing

- **SSC and IOCs expected to be staffed 8 hours per day/5 days per week for normal operations**
- **MOC staffing depends on selection of MOC provider**
  - If unstaffed:
    - MOC staff will be on call in the event of a safety alert from the spacecraft or the MOC
    - Unstaffed commanding for targets of opportunity will be explored
- **Additional staffing for launch and initial checkout**
  - MOC expected to be staffed around the clock through spacecraft checkout
  - IOCs will be staffed around the clock to support instrument checkout