Small Satellite Research Laboratory

Franklin College of Arts and Sciences

UNIVERSITY OF GEORGIA

Mission Overview and Concept of Operations

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2018 SPOC CDR

Mission Overview

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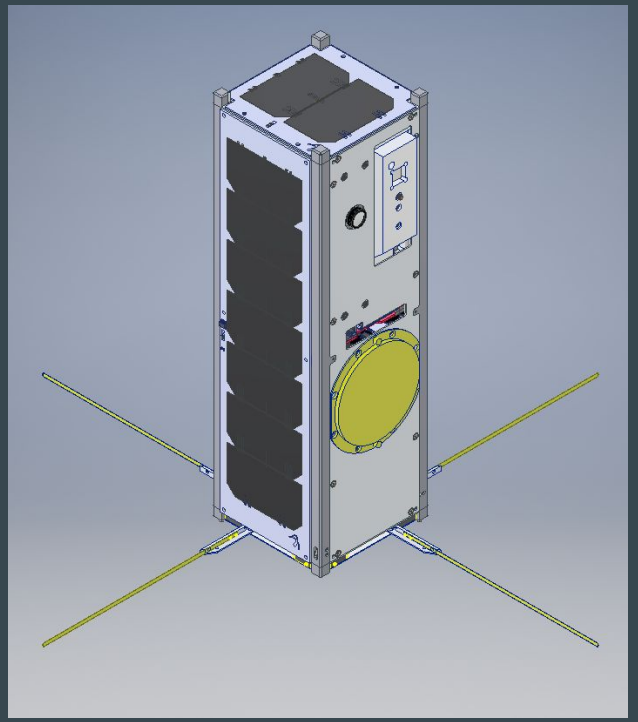
Spectral Ocean Color (SPOC) Satellite

The SPectral and Ocean Color (SPOC) Satellite shall acquire moderate resolution imagery across a wide range of spectral bands to monitor coastal ecosystems and ocean color. SPOC will acquire image data between 433 and 866 nm to monitor 1) coastal wetlands status, 2) estuarine water quality including wetland biophysical characteristics and phytoplankton dynamics, and 3) near-coastal ocean productivity. SPOC shall use multispectral remote sensing techniques to quantify vegetation health, primary productivity, ocean productivity, suspended sediments, and organic matter in coastal regions.



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Mission Objectives

- Acquire moderate resolution imagery of coastal ecosystems, ocean color
- Acquire image data between 433 and 866 nm
- Use multispectral image products to monitor status of coastal wetlands, including estuarine water quality and ocean productivity
- Train STEM students
  - Data transmission techniques
  - Georeference mapping
  - Photogrammetric processing
  - Community outreach
  - Aerospace design, testing, and manufacturing

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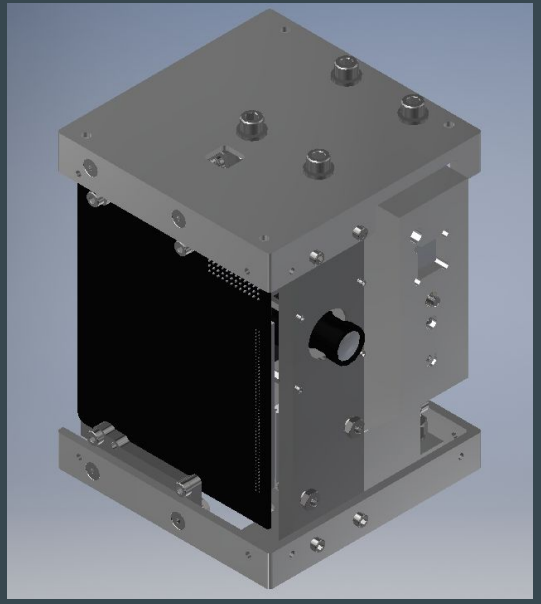
Success Criteria

Minimum	Full
Image one coastal target with spatial resolution 240m	Image the same coastal target 5 times with spatial resolution 150m
Acquire images with band spectral resolution of 50nm	Acquire images with band spectral resolution of 10nm
30 students involved for at least 2 semesters each over project lifetime	75 students involved for at least 2 semesters each over project lifetime
Give 5 community outreach presentations, mentor 2 local high school students, produce 5 space news/educational podcasts	Give 20 community outreach presentations, mentor 5 local high school students, produce 20 space news/educational podcasts, plus 10 instructional YouTube videos

Payload

Structure is based on Cloudland-designed HawkEye sensor, onboard SeaHawk mission (UNC Wilmington)



SPOCeye

- Pushbroom multispectral primary payload
- 16 adjustable bands
- 130 m GSD

Finderscope

- **Small 1km GSD imager**
- **Aid post data processing and acquire oblique satellite imagery**

Requirements

- Flow down from the mission statement
- Break into requirements for each subsystem
- Traced and must be verified prior to launch
- Under the Science Traceability Matrix

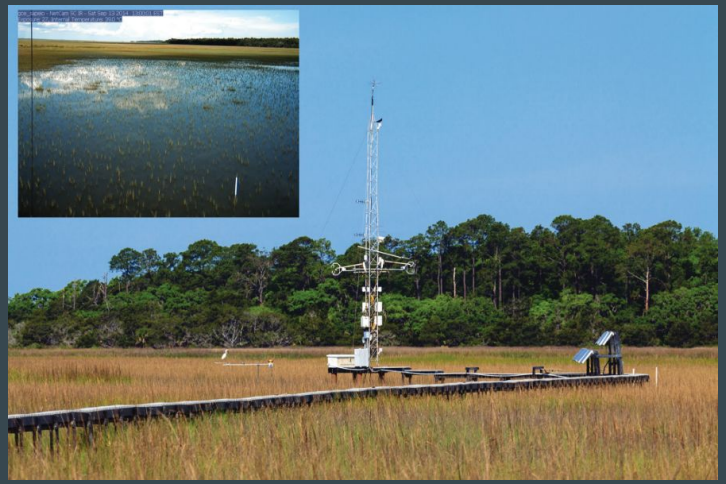
- OBC - 01
  - OBC shall log extracted telemetry from each subsystem via the satellite bus.

Target List

- Primary Targets:
  - Total Area ~606.7 km^2
  - Sites that have been preselected in order to fulfil the success criteria of the mission
- Secondary Targets:
  - Total Area ~1,004,494.782 km^2
  - Extended targets to image/scan should SPOC complete all success criteria for each primary target
- Tertiary Targets:
  - Experimental images/scans gathered for educational purposes, but does not have scientific merit
- Total Scan Area: ~5,253,788.03 km^2
- Will have margin to take multiple scans of primary targets to add temporal resolution

Experiments

- Obtain radiance values of all surface targets
- Calculate Remote Sensing Reflectance (Rrs)
  - over targets with in-situ downwelling radiation measurements
  - Estimated over other targets
- Near Coastal Ocean Productivity
  - Total Suspended Sediment (TSS)
  - Chlorophyll
  - Particulate Organic Carbon (POC)
- Wetland Biophysical Charactaristics
  - Normalized Difference Vegetation Index (NDVI)
  - Enhanced Vegetation Index (EVI)
- Other
  - Phycocyanin
  - Leaf Area Index (LAI)



Concept of Operations

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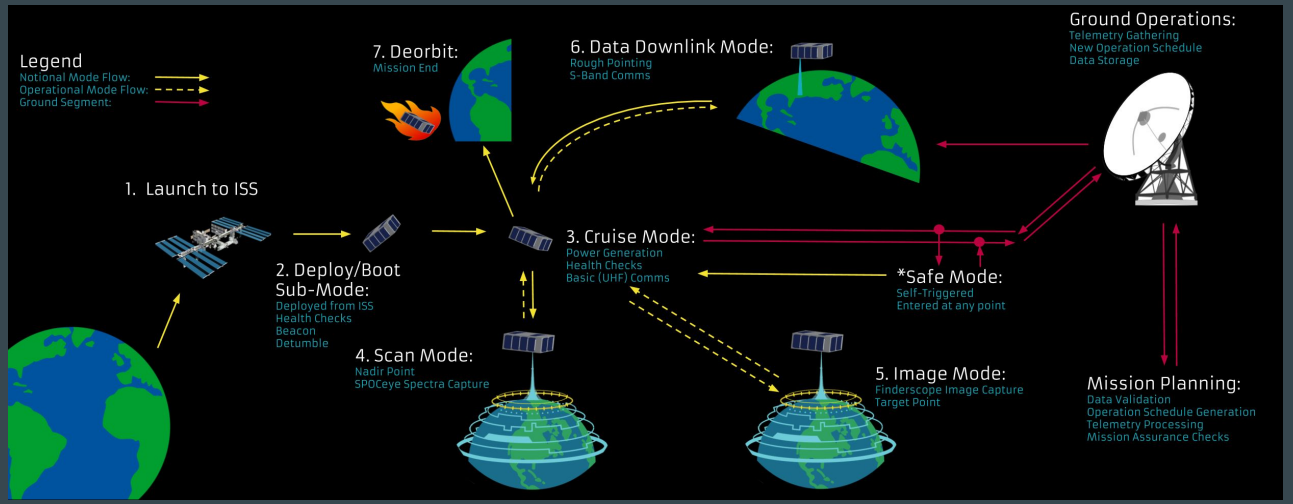
(CONOPS)

Overview

2 core principles:

1. Safe satellite operation

2. Acquisition of telemetry, payload, and end-product data to meet mission requirements



Automation

- Prolong operational lifetime
- Reduce number of required ground staff
- Acquisition of multispectral image data (payload boot, data acquisition, data handling, payload shutdown)
- Command/data handling (logger, monitor, scheduling, facilitation modules)
- Onboard error detection/correction; hardware watchdogs
- Uplink of operational schedules allows pseudo-autonomy
- Failsafe state: Ground intervention unavoidable. Automated processes cease, besides command/data handling

Flight Rules

A flight rule is a constraint that the mission operators place on the satellite or on operational procedures..

SFR-1 : Spacecraft cannot downlink data while in eclipse.

SFR-2 : Payload cannot look directly at sun

SFR-3 : Permission from Mission Director is required to manually transition into Safe Mode.

SFR-4 : Software updates may only occur if another pass occurs within 100 minutes.

SFR-5 : Weekly housekeeping “outage” passes must be open-ended and controlled by ground operations.

SFR-6 : Batteries shall not exceed 20% depth of discharge during operations

Modes

Transitions

Soft transition

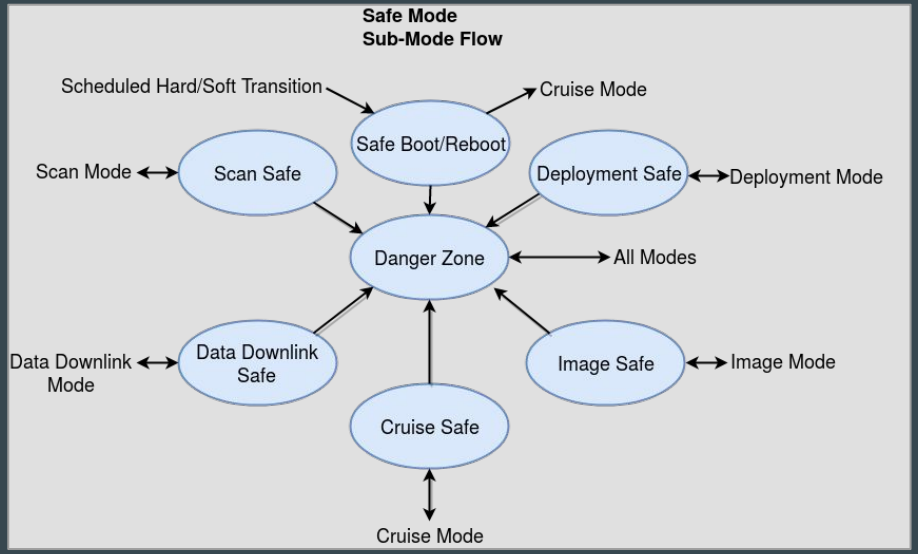
- Central command passed to core logic of current operational state
- No new tasks issued for current mode
- Wait for completion of in-progress tasks
- All nominal transitions are soft.

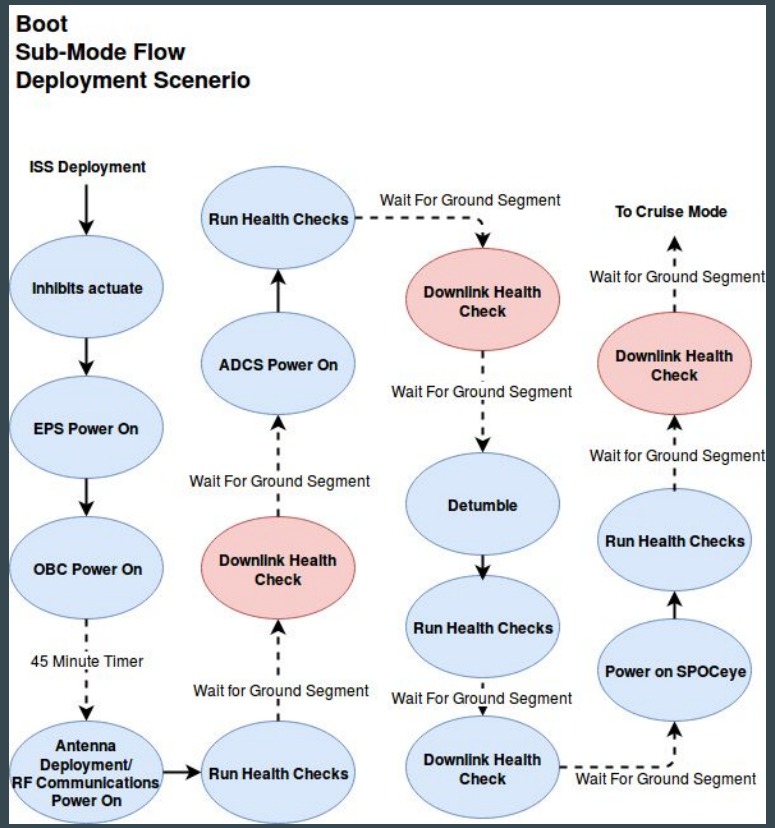
Hard transition

- Immediately end all processes and go to Safe Mode
- Do not wait for completion of any task

Safe Mode

Off-nominal, unique, or hazardous situations.





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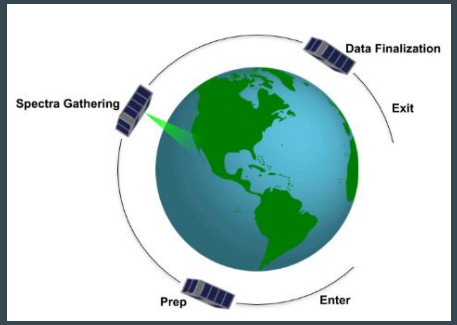
Scan Mode

Primary science mode; can run continuously for 30 minutes max.

Prep	Turn on all imagers and set configurations
Spectra Gathering	SPOCeye scans target; finderscope takes 3 images: ○ T_Area_Enter +5 seconds, ○ T_Nadir (or [T_Area_End - T_Area_Enter]/2, ○ T_Area_End -5 seconds
Data Finalization:	Move data to non-volatile onboard storage and post-process into bands



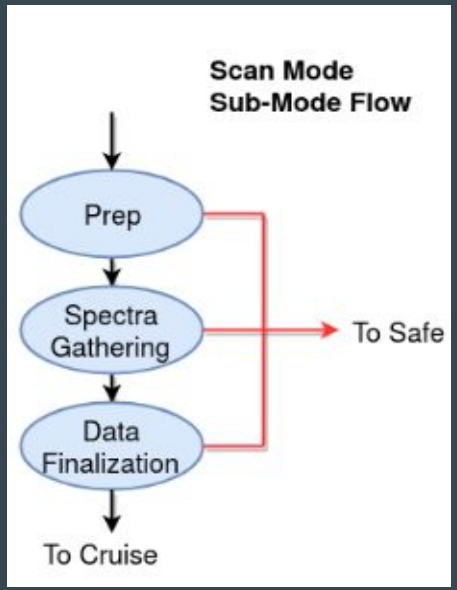
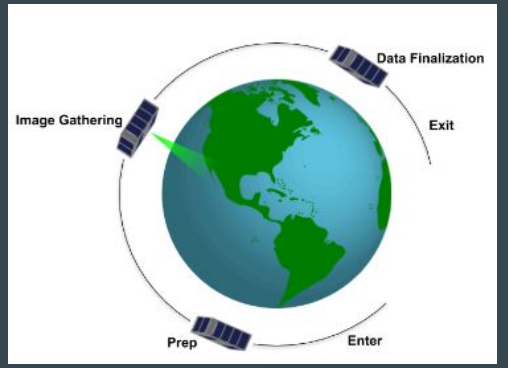
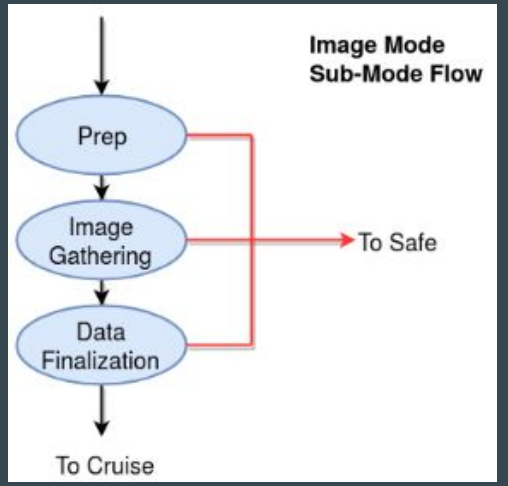


Image Mode

Optional mode for educational data. Allows the satellite to adjust to a commanded attitude.

Prep	Makes attitude adjustment; checks that finderscope is on and operational
Image Gathering	Tracks point and takes images
Data Finalization	Satellite returns to nadir; finderscope powers off

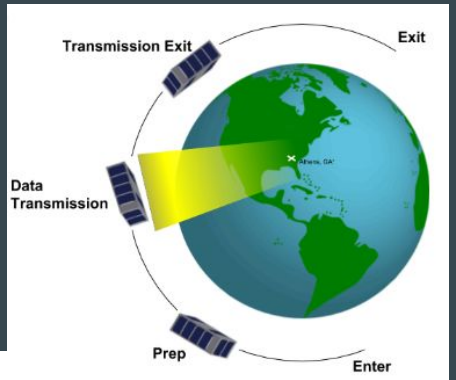


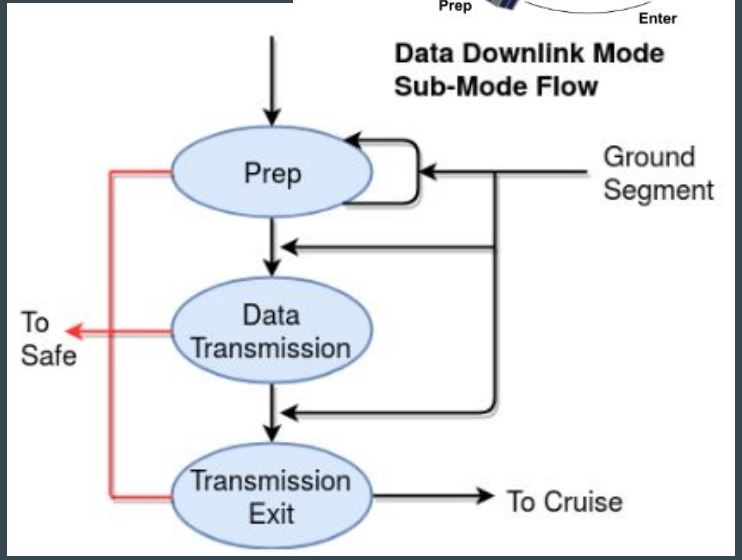


Data Downlink Mode

S-band downlink mode; entered via telecommand from the ground. Ground operators uplink next schedule.

Prep	Powers on transmitters and synchronizes with ground station
Data Transmission	Transfers RF packets
Transmission Exit	Powers down transmitters and deletes downlinked data





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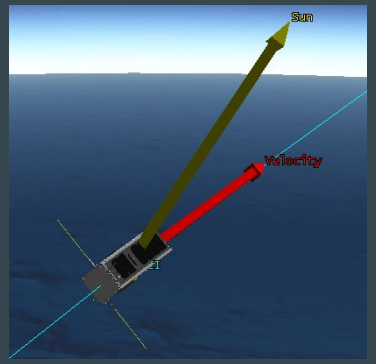
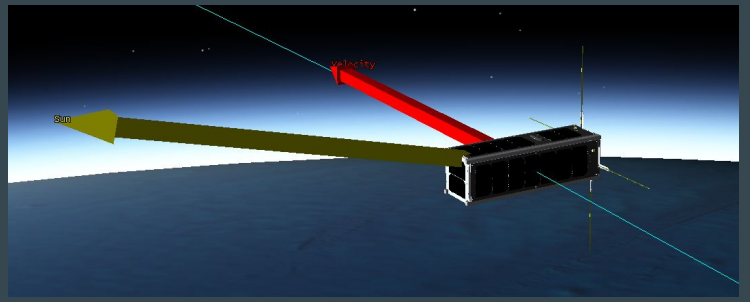
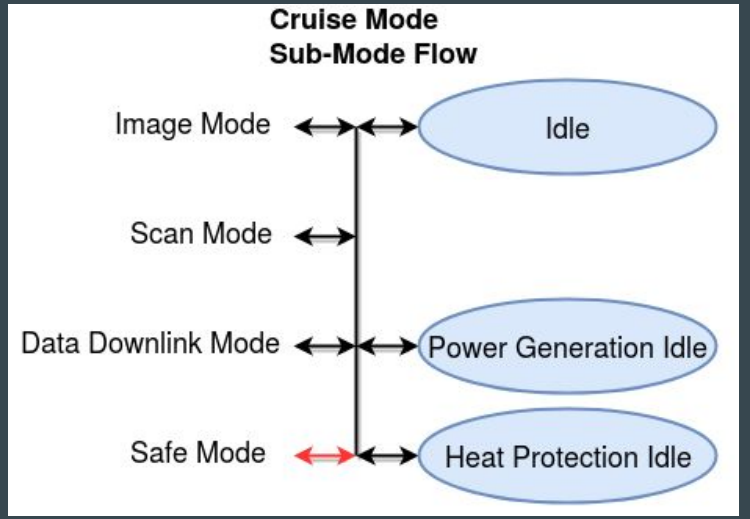
Cruise Mode

Nominal mode. Keeps satellite nadir-oriented.





Idle	Default. Satellite beacons unencrypted AX.25 GMSK packet every 30 seconds. Listens for ground control.
Power Generation Idle	Idle, but with special considerations to maximize power generation.
Heat Protection Idle	Idle, but with special considerations to maintain operational safety during prolonged Sun exposure.



Mission Operations

Commanding

- Operational schedules verified in spacecraft simulator; require approval of Mission Director
- Uplink schedule following predefined time sequence; allows automatic transitions between operations
- Critical command sets may require special approval before uplink
- Document both successful and failed command execution
- Encrypted uplink/downlink

Telemetry Monitoring

- Telemetry and event messages will be graphically and textually displayed
- Real-time monitoring with ground system display
- Analysis system provides quick access to historical and near-real-time telemetry
- Data can be retrieved from web interface

Routine Operations

"Routine": Performed continuously at consoles by mission operators

- Confirm successful command execution
- Monitor telemetry for precursors to anomalous behavior
- In case of behavioral anomaly, act to maintain operational safety
- Monitor ground system performance
- Create/test schedules

Housekeeping Operations

"Housekeeping": Performed regularly to maintain basic functionality

- Manage attitude, clock, and OBC
- Reconfigure subsystems outside of normal scheduled mode transitions
- Periodic payload calibration/maintenance
- Performed approximately weekly, during periodic "outage" times, probably within line of sight

Special Operations

- Extreme beta angle:
  - High: Orient Z+ face sunward to minimize heat risk during prolonged Sun exposure. (beta angle > 71 deg or < -71 deg)
  - Low: Orient X+ and Y+ panels toward Sun to maximize power generation during maximum eclipse. (beta angle between -5 and +5 deg)
- Fine sun sensor visibility:
  - 2 orthogonal sensors; which Z face sees prograde depends on the sign of the beta angle
  - Beta angle > 0: Z- face toward prograde
  - Beta angle < 0: Z+ face toward prograde
- Weekly OBC reboot

Anomaly Operations

In case of failure or degradation of system performance/nominal operations.

Level 0: No attention needed. Bright Ascension detects, logs, does not correct.

Level 1: Bright Ascension automatically detects, logs, corrects.

Level 2: Requires ground intervention. Safe Mode + Primary Boot Image

Level 3: Critical, rapid error resulting in OBC reboot. Safe Mode + Failsafe Image

Questions?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