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Joint Polar Satellite System (JPSS) Ground System Concept of Operations

NOAA / NASA

Goddard Space Flight Center Greenbelt, Maryland

Joint Polar Satellite System (JPSS)
Ground System Concept of Operations

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Preface

This document is under JPSS Ground Segment (GS) configuration control. Once this document is approved, JPSS approved changes are handled in accordance with Class I and Class II change control requirements as described in the JPSS Configuration Management Procedures, and changes to this document shall be made by complete revision.

Any questions should be addressed to:

JPSS Configuration Management Office
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Change History Log

Revision	Effective Date	Description of Changes (Reference the CCR & CCB/ERB Approve Date)
Rev-	Oct 18, 2012	This version incorporates 474-CCR-12-0640 which was approved by the JPSS Ground ERB on the effective date shown.
A	Feb 14, 2013	This version incorporates 474-CCR-13-0831 which was approved by the JPSS Ground ERB on the effective date shown.
B	May 31, 2013	This version incorporates 474-CCR-14-1042 which was approved by JPSS Ground ERB on the effective date shown.
C	Dec 19, 2013	This version incorporates 474-CCR-13-1370, and 474-CCR-14-1510 which was approved by JPSS Ground ERB on the effective date shown.
D	May 25, 2016	This version incorporates 474-CCR-14-2110, 474-CCR-14-2168, 474-CCR-15-2277, 474-CCR-15-2657, 474-CCR-15-2755 and 474-CCR-15-2939 which was approved by JPSS Ground ERB on the effective date shown.
E	Feb 08, 2019	This version incorporates 474-CCR-16-3049, 474-CCR-17-3250, 474-CCR-17-3316, 474-CCR-16-3402, 474-CCR-16-3578, 474-CCR-18-3861 and 474-CCR-18-4048 which was approved by JPSS Ground ERB on the effective date shown.

Table of TBDs/TBRs/TBSs

TBx	Type	ID	Text	Action
1	TBD	CON_205	**DoD Weather Satellite Follow-On Program (TBD)**	Remain TBD until a materiel development decision is finalized by the DoD (Block 4 timeframe).
2	TBD	CON_206	The DoD had originally planned to complement the JPSS program missions in the early morning orbit in what was called the Defense Weather Satellite System (DWSS). The 2012 FY Defense Appropriations Act terminated this program and the DoD was directed to revisit the basic requirements and schedules for a follow-on program to DMSP. The expected need dates for the new DoD system remains TBD, but will be targeted to replace the last two DMSP satellites currently awaiting launch. The JPSS Ground System will remain a viable option/alternative for any future DoD Weather Satellite Follow-On (WSF) Program, but remains TBD until a material development decision is finalized by the DoD.	Remain TBD until a materiel development decision is finalized by the DoD (Block 4 timeframe).
3	TBR	CON_413	JPSS provides a variety of environmental observations from the 1325 LTAN orbit. The users depend on DoD's WSF satellites (TBD) to provide data from the 1730 LTAN orbit and on EUMETSAT's Metop and Metop-SG satellites to provide data from the 2130 LTAN orbit. Together these satellites enable many observations to be refreshed at four-hour intervals. Additionally, the JPSS Ground System acquires and pre-processes data from JAXA's Global Change Observation Mission (GCOM) - Water (GCOM-W). JPSS, DoD (TBR), and GCOM-W carries an instrument complement consisting of the VIIRS, CrIS, ATMS, OMPS, CERES/RBI, and AMSR-2 instruments as shown in Table 3.3-1. These instruments are described briefly below:	Remain TBR until a materiel development decision is finalized by the DoD (Block 4 timeframe).

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1 INTRODUCTION

The Joint Polar Satellite System (JPSS) is the National Oceanic and Atmospheric Administration's (NOAA) next-generation operational Earth observation program that acquires and distributes global environmental data primarily from multiple polar-orbiting satellites. The program plays a critical role in NOAA's mission to understand and predict changes in weather, climate, oceans and coasts, and the space environment, which support the Nation's economy and protect lives and property. The first JPSS satellite mission, the Suomi National Polar-orbiting Partnership (S-NPP) satellite, successfully launched in October 2011. S-NPP, along with the legacy NOAA Polar Operational Environmental Satellites (POES), provides continuous environmental observations. Two JPSS satellites will follow S-NPP: JPSS-1, planned for launch in fiscal year (FY) 2017, with JPSS-2 to follow in FY2021. In the future, the JPSS Polar Follow-On (PFO) provides for two additional missions, JPSS-3 and JPSS-4, as follow-on to the JPSS-2 mission to extend the JPSS Program lifecycle out to 2038.

In addition to the JPSS Program's own satellites operating in the 1330 (±10) Local Time of the Ascending Node (LTAN) orbit, NOAA also leverages mission partner assets for complete global coverage. These partner assets include the Department of Defense (DoD) Defense Meteorological Satellite Program (DMSP) operational weather satellites (in the 1730 - 1930 LTAN orbit), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Meteorological Operational (Metop) satellites (in the 2130 LTAN orbit) and the Japanese Aerospace Exploration Agency (JAXA) Global Change Observation Mission-Water (GCOM-W) satellite (in the 1330 LTAN orbit). JPSS routes Metop data from McMurdo Station, Antarctica to the EUMETSAT facility in Darmstadt, Germany and EUMETSAT, in turn, provides Metop data to NOAA. For GCOM, JPSS routes the GCOM-W data from Svalbard, Norway to the NOAA Satellite Operations Facility (NSOF) in Suitland, MD, processes GCOM-W data and delivers GCOM-W products to the JPSS users who have JAXA permissions.

Additionally, the JPSS Program provides data acquisition and routing support to the DMSP and the WindSat Coriolis Program. JPSS routes DMSP data from McMurdo Station to the 557^{th} Weather Wing at Offutt Air Force Base in Omaha, NE. After processing, the 557^{th} releases the DMSP data for public consumption over the Internet via the National Centers for Environment Information (NCEI) in Boulder, CO. The JPSS Program provides data routing support to the National Science Foundation (NSF), as well as the National Aeronautics and Space Administration (NASA) Space Communications and Navigation (SCaN)-supported missions, which include the Earth Observing System (EOS). As part of the agreements for the use of McMurdo Station, JPSS provides communications/network services for the NSF between McMurdo Station, Antarctica and Centennial, Colorado.

As a multi-mission ground infrastructure, the JPSS Ground System supports the heterogeneous constellation of the before-mentioned polar-orbiting satellites both within and outside the JPSS Program through a comprehensive set of services as listed in Table 1-1.

Table: 1-1 JPSS Ground System Services

Service	Description
Enterprise Management and Ground Operations	Provides mission management, mission operations, ground operations, contingency management and system sustainment
Flight Operations	Provides launch support and early orbit operations, telemetry and commanding, orbital operations, mission data playback, payload support, flight software upgrade, flight vehicle simulation, and disposal at the end of mission life
Data Acquisition	Provides space/ground communications for acquiring mission data
Data Routing	Provides routing of telemetry, mission and/or operations data through JPSS' global data network
Data Product Generation	Provides the processing of mission data to generate and distribute raw, sensor, environmental, and ancillary data products
Data Product Calibration and Validation	Provides calibration and validation of the data products
Field Terminal Support	Provides development and operational support to the Field Terminal customers

1.1 Purpose

The purpose of the JPSS Ground System Concept of Operations (ConOps) is to describe how planned system functions and operations will accomplish the assigned missions under nominal operations as well as anomaly conditions. The ConOps also serves as a verification and validation reference for the system design and later a template for the development of mission operation plans and test plans.

This ConOps is a JPSS Level 3 Ground Project controlled document and a companion document to the JPSS Ground System Requirements Document (GSRD) and Architecture Description Document (ADD). An integral part of the model-based JPSS Ground System design, the ConOps not only describes planned operations, but also in many cases directly identifies the requirements of the JPSS Ground System (in GSRD) as well as its core component, the JPSS Common Ground System (CGS) (in CGS Requirements). It ensures the completeness and coherency of the system architecture.

At the JPSS program level, the JPSS System Architecture and Concept of Operations (SACO) document (470-00029) describes the overall JPSS program system operations concept, including both space and ground aspects, in response to the JPSS Level 1 requirements. Each JPSS mission (e.g. JPSS-1, JPSS-2) provides a mission ConOps, which describes end-to-end mission operations, including required ground support. The JPSS Ground System ConOps responds to the SACO and mission ConOps by defining the required functions and operations, in more details, as common services and support that will be referenced by all mission ConOps for their ground system configuration and operations. This notional relationship is illustrated in Figure 1.1-1.

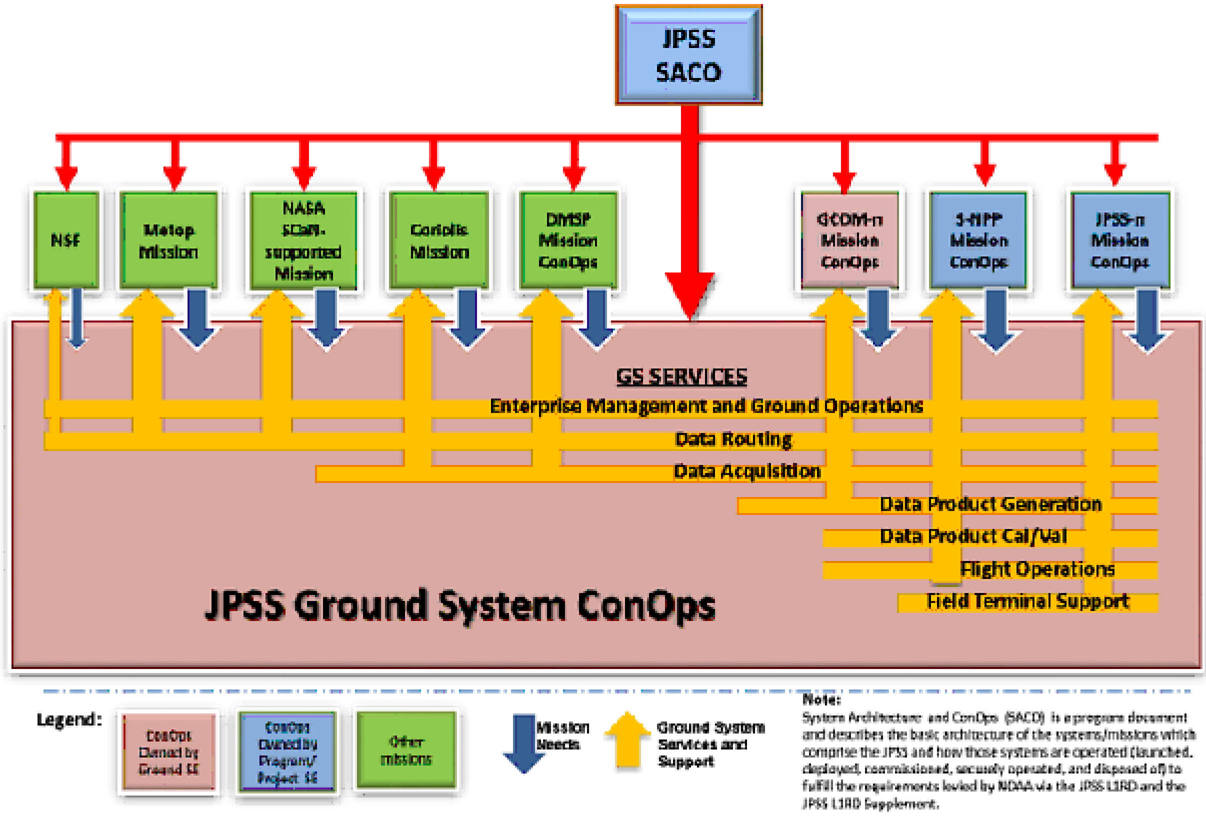


Figure: 1.1-1 Notional Relationship between JPSS Ground System ConOps and Mission ConOps

This document is not intended to be a requirements document nor a procurement specification. The information contained within is intended to describe the desired attributes and operational scenarios of the planned JPSS Ground System.

1.2 Scope

The JPSS Ground System ConOps is based on the JPSS Program Level 1 Requirement Document (L1RD) and JPSS SACO document. The scope of the JPSS Ground System ConOps includes all major functions and operations necessary to support the missions as required by the L1RD, as well as the interfaces with external entities that directly provide information to, or receive information from, the JPSS Ground System. Furthermore, the ConOps presents concepts and operational approaches for meeting key system performance requirements.

While describing functional scenarios at the top level of the JPSS Ground System, these scenarios do not intend to cover every possible event and configuration that may occur but to serve as a basis for future decomposition at lower level design and operations planning activities.

Due to the National Polar-Orbiting Environmental Satellite System (NPOESS) heritage of the JPSS program, major segments of JPSS Ground System are already in operation. Therefore certain physical attributes and implementation approaches as described reflect existing reality, while some others are omitted to permit the potential design and implementation improvements.

1.3 Mission and Project Objectives

The primary missions of NOAA are Science, Service, and Stewardship: for a weather ready nation, healthy oceans, climate adaptation and mitigation and resilient coastal communities and economies. Polar environmental satellites provide timely global observations from space that are used for numerous applications. NOAA requires a global and continuous/enduring space-based capability in polar or low-Earth orbit to provide for:

- Weather situational awareness and forecasting - Data from instruments in polar orbits are the main source for numerical weather forecasting, which uses mathematical models of the atmosphere and oceans to predict the weather based on current conditions. Data from satellites in polar orbits constitutes approximately 85% of all the input data to the National Centers for Environmental Prediction's global models. In addition, visible imagery from polar satellites is the primary situational awareness observation source for NOAA weather warning services in the Alaskan Region.
- Environmental monitoring - Data from instruments in polar orbits are used to monitor the environment including, for example, the health of ecosystems, drought conditions, operational ozone monitoring for treaty compliance and UV forecast, volcanic ash for transportation, floods, oil spills, the state of oceans.
- Climate monitoring - Data from instruments in mid-morning and afternoon polar sun-synchronous orbits have provided more than 30 years of continuous global observations that have allowed scientists to monitor the climate. These records and products are critical to climate modelers, scientists, and decision makers concerned with advancing climate change understanding, prediction, mitigation and adaptation strategies and policies.
- Data collection - Polar-orbiting satellites carry data collection instruments that relay *in situ* data and observations from remote transmitters. These instruments relay temperature and salinity readings from ocean buoys, which allow for the monitoring of the ocean and other data from remote, unmanned stations. These instruments are also used to track wildlife.
- Search and rescue - Polar-orbiting satellites carry search and rescue instruments that relay distress signals from aviators, mariners or land-based users in distress.

Subsequently, the objective of the JPSS Ground System is to manage a fleet of polar-orbiting environment sensing satellites and to acquire, route, process and distribute operational weather and climate data collected from polar orbiting sensors to meet the above stated mission objectives.

1.4 Background

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) program started in 1994 as a joint polar-orbiting environment satellite program among NOAA, DoD, and NASA. The Office of Science and Technology Policy (OSTP) restructured NPOESS in 2010 to transition the program to NOAA and DoD to manage separate but complementary programs. NOAA, through NASA as its acquisition agent, procures the afternoon (1330) orbit satellites under the JPSS program. DoD independently procures satellites for the early morning (1730)

orbit. Furthermore, assets from international partners, including JAXA's GCOM-W satellites in the 1330 orbit, complement the environmental observations along with EUMETSAT's Metop satellites in the 2130 LTAN orbit. These polar-orbiting satellites will be supported, in varying degrees, by a shared ground system, the JPSS Ground System, the data products of which are shared by all agencies for civil, military, and scientific purposes.

The JPSS Program provides operational continuity for environmental observation into the future that is currently provided by NOAA POES, DoD DMSP, and NASA EOS. Figure 1-1 illustrates these and EUMETSAT polar environmental satellite systems; and in contrast, Figure 1-2 shows a greatly consolidated system in JPSS era.

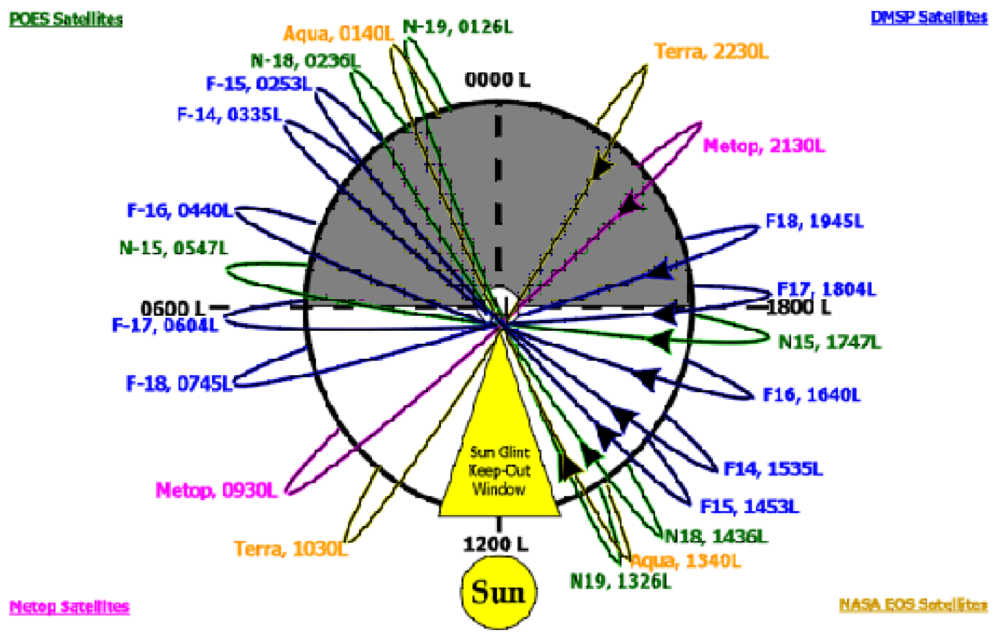


Figure: 1.4-1 Current NOAA POES, NASA EOS, DoD DMSP and EUMETSAT Polar Environmental Satellite Systems

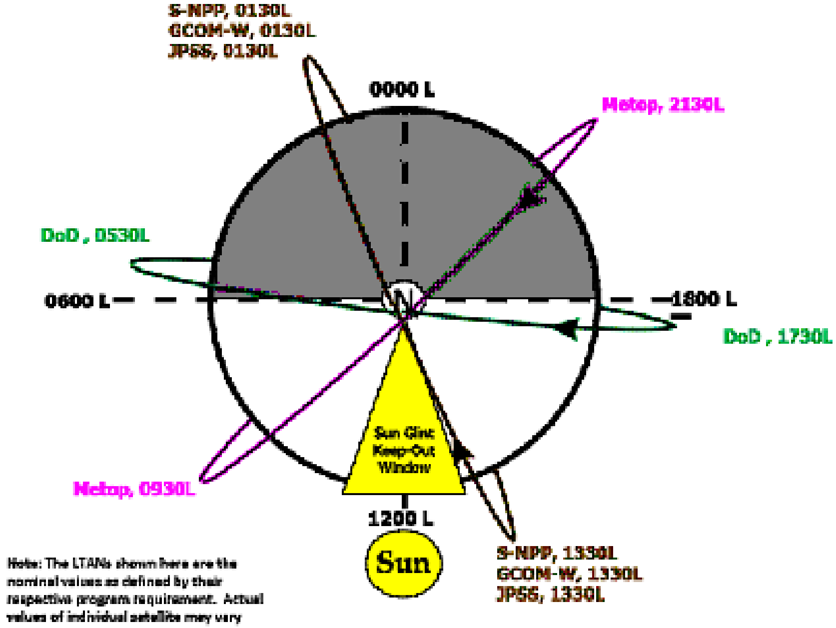


Figure: 1.4-2 Polar Environmental Satellite Systems in JPSS Era

The JPSS is a NOAA program that is predominately acquired through NASA. As such, NOAA defines requirements using their established management structure and provides funding and requirements to NASA which is responsible for acquiring and integrating the system. NOAA has partnered with NASA to implement the JPSS Program, using NASA's space acquisition expertise and acquisition authority. NASA is the acquisition agent for the flight systems (e.g., satellites, instruments and launch vehicles) and components of the ground segment (e.g., space/ground communications; ground network; tracking, telemetry, and control system; data processing system; and field terminal support). NOAA is the acquisition agent for components of the ground segment (e.g., data exploitation; product distribution and access; data archive and dissemination; facility upgrades) and is responsible for operations, science, and infrastructure. Once a satellite has been successfully launched and commissioned, the operational responsibility will be transferred from the NASA JPSS Program Office to the NOAA Office of Satellite and Product Operations (OSPO).

The major performance improvements brought on by the evolution from the POES, DMSP, and S-NPP to the JPSS can be summarized as the following:

- Significantly more accurate spatial and spectral observations enabled by the next generation sensor suite first demonstrated on S-NPP
- Timely results with significantly reduced data latency, down from 180 minutes for POES and from 140 minutes for S-NPP to 80 minutes for JPSS-1/2/3/4
- Robust operations with alternate ground stations and communication networks, mission control centers, and data processing facilities (POES, S-NPP, and DMSP already have this capability)
- Service-oriented shared resources to reduce overall cost

1.5 JPSS Ground System Block Evolution

The JPSS Ground System is required to support JPSS missions through FY2025. Over this long time span, the system supports the current missions, as well as prepares to support future missions for which the definitions and requirements are still evolving. Therefore it is essential that the Ground System be flexible and adaptable to evolve along with advancing technologies and future missions.

The JPSS Ground Project plans to evolve the Ground System in implementation Blocks. With the release of each Block, the Ground System rolls out new capabilities, security enhancements, technology refreshes, and reliability improvements. Table 1-2 provides a summary of notional JPSS Ground System Implementation Blocks. Missions listed for a particular block are the missions newly added in that timeframe.

Table: 1.5-1 JPSS Ground System Implementation Blocks

Block	Mission	Transition To Operations (TTO) Date	Contents	Note
0	Coriolis/WindSat, POES, SCaN-supported missions	Ongoing	Coriolis/WindSat, POES, SCaN-supported missions support from Svalbard	
1.0	S-NPP	Ongoing	S-NPP support	
1.1	Metop	04/2011	Metop-A support from McMurdo Station, SCaN-supported missions support from Svalbard	
1.1	DMSP	02/2012	DMSP support from McMurdo Station	
1.2	GCOM-W1	Ongoing	System patches, upgrades and enhancement; Stop-Gap Mission Management Center (MMC) capability; GCOM-W1 support; security updates; 557th Weather Wing will receive products from NESDIS IDPS and decommissioning hardware at 557th Weather Wing; GZIP compression to data consumers implemented.	
TRANSITION TO JPSS TECH BASELINE				
2.0	JPSS-1	01/2016	JPSS-1 mission support, GCOM-W1 full capability, hardware and COTS upgrades, software fixes, separate operation configurations, failover capabilities at Consolidated Backup at Fairmont, WV, and situational awareness. Alternate Common Ground System (ACGS), extended polar station operations, services, data delivery to the Naval Oceanographic Office (NAVOCEANO) and Fleet Numerical Meteorology and Oceanography Center (FNMOC), full security requirement compliance	In time to support JPSS-1 Integration and Test (I&T) In the Block 2.0 timeframe the 557th Weather Wing will receive JPSS data products from NOAA Environmental Satellite Processing Center (ESPC).
2.1	n/a	JPSS-1 Launch + 9 months	Fleet ground management (remote planning); situational awareness (state of service, centralized reporting/monitoring); IDPS modularity (primary vs. non-primary product ordering); phased implementation of IDPS XML management; data quality monitoring; data exfiltration tool	
2.2	JPSS-2	2019	JPSS-2 integration and test support (JCT-1, JCT-2), JPSS-2 RDR generation, Path to NIST 800-53 V4 compliance	
3.0	JPSS-2	2020	JPSS-2 JCT support, launch and operations; tech refresh; domain name change; move email server out of NOAA 5042; data processing mods for MUPs	
3.X	Metop-SG	TBD	TBD - may include EUMETSAT-SG support, McMurdo communications upgrade, SGSS interface; Data-driven SMD acquisition; McMurdo communications upgrade; Metop-SG cross-support, Data-driven T&C Ops, Asset management (CAMDb) Ops transition	
	End of Program	2025		

The current deployed operational JPSS Ground System supporting S-NPP, GCOM-W1, Metop, POES, Coriolis/WindSat, DMSP, and NSF, as well as SCaN-supported mission operations, is dubbed Block 1.0 through Block 1.2. The design and development of these JPSS Ground System capabilities are based on the heritage NPOESS technical baseline with minor evolution to improve robustness, operability, security, and performance.

Starting with Block 2.0 the JPSS Ground System development is being fully revised to reflect the JPSS Program requirements flow-down and fundamental changes in mission set, roles and

responsibilities, and required capabilities. As a result, Block 2.0 represents a point of departure from the NPOESS technical baseline and the arrival of JPSS Ground System technical baseline.

The deployment and transition to operation of the Block 2.0 JPSS Ground System will directly support the JPSS-1 mission with significant enhancement to meet stringent requirements associated with operational weather missions. It will also re-baseline the current JPSS Ground System with a full complement of refreshed hardware systems, and serve as the foundation for future needs for the JPSS Program mission set. Additional capabilities for remote mission planning, situational awareness, and data processing modularity will be deployed as Block 2.1 approximately nine months after JPSS-1 launch.

The development of Block 2.2 JPSS Ground System is aimed at supporting integration and testing of the JPSS-2 spacecraft. It will be ready in January 2019 to support the first JPSS-2 compatibility test at the Ground System support facility in Riverdale, MD, and later be fully deployed to support the second compatibility test at NOAA's facility in Suitland, MD. In addition, as resources allow, Block 2.2 will enhance the system security posture by implementing NIST 800-53 V4.

1.6 Document Organization

The JPSS Ground System ConOps is organized in the following sections:

Section 1	Provides the introduction, as reference material only.
Section 2	Lists the parent, applicable and information documents.
Section 3	Provides an overview of the system, including the context, interfaces, architecture and other system characteristics.
Section 4	Presents organizational roles and responsibilities involved in the system operations and sustainment.
Section 5	Describes types of JPSS Ground System services and support provided to each mission. It also presents high-level timelines in system operations to exemplify operation rhythms and cycles. Moreover, it provides overview to special topics such as the sensor constellation operations, utilization of multiple processing environments, situational awareness, and operations product development.
Section 6	Provides a set of major operational scenarios that detail operational threads through the system architecture to depict how major activities are accomplished under nominal and non-nominal conditions. Each scenario focuses on a specific area of operations. The activities and actions called out in the threads directly tie the ConOps to the system architecture and requirements.
Section 7	Presents a set of system-level Technical Performance Measures (TPMs) along with a summary of performance analysis for data availability, data latency and operational availability.
Appendix A	The first table includes an Effectivity Matrix that maps applicable scenarios to individual missions. The second table provides traces to the children Operations Concept (OpsCon).

Appendix B	Includes key system parameters in a set of tables and diagrams for quick references. Among these parameters are mission data rates and volumes, data production and distribution volumes, network bandwidth allocations, ground station resources and the missions they support, etc.
Appendix C	Provides an eRooms link to a set of ConOps to Requirement mapping files. Note that these mapping files are not under the JPSS Ground CM control and provided for information only.

This document includes many large architectural diagrams (e.g. OV-5b views) that have been reduced in size in order to fit in this publication. In cases where small font sizes make them unreadable, please reference the original high resolution version of the same diagram in the JPSS Ground System Architecture Description Document (474-00333).

2 RELATED DOCUMENTS

The latest JPSS documents can be obtained from URL: https://jpssmis.gsfc.nasa.gov/frontmenu_dsp.cfm. JPSS Project documents have a document number starting with 470, 472 or 474 indicating the governing Configuration Control Board (CCB) (Program, Flight, or Ground) that has the control authority of the document.

2.1 Parent Documents

The following reference document(s) is (are) the Parent Document(s) from which this document has been derived. Any modification to a Parent Document will be reviewed to identify the impact upon this document. In the event of a conflict between a Parent Document and the content of this document, the JPSS Program Configuration Change Board has the final authority for conflict resolution.

Document Number	Title
470-REF-00031	JPSS Level 1 Requirements Document - Final Signed, Version
470-REF-00032	JPSS Level 1 Requirements Supplement - Final, Version
470-00029	JPSS Program System Architecture and Concept of Operations

2.2 Applicable Documents

The following document(s) is (are) the Applicable Document(s) from which this document has been derived. Any modification to an Applicable Document will be reviewed to identify the impact upon this document. In the event of conflict between an Applicable Document and the content of this document, the JPSS Program Configuration Change Board has the final authority for conflict resolution.

Document Number	Title
GPR 7123.1A	Systems Engineering, Goddard Procedural Requirements
470-REF-00033	Memorandum of Understanding (MOU) between NOAA and JAXA in relation to the Cooperation for the Global Observation Mission-1 Water (GCOM-W1)
470-REF-00219	Memorandum of Understanding (MOU) between the Space Communications and Navigation Office of the Human Exploration and Operations Mission Directorate of the NASA and the JPSS Program Office of NOAA Regarding Polar Telecommunications Services
474-00188	McMurdo Station Antarctica Data Communications Services Program Service Level Agreement (PSLA)
470-00053	JPSS Verification and Validation Plan
470-REF-00059	NOAA/NASA JPSS Management Control Plan (MCP)
470-00001	JPSS System Engineering Management Plan (SEMP)

2.3 Information Documents

The following documents are referenced herein and amplify or clarify the information presented in this document. These documents are not binding on the content of this document.

Document Number	Title
470-00067	JPSS Ground System Requirements Document

Document Number	Title
470-00094	Joint Polar Satellite System (JPSS) Ground System (GS) Security Requirements Document (GSSRD)
474-00333	JPSS Ground System Architecture Description Document
470-00019	JPSS-1 Mission System Specification
470-00020	JPSS-1 Mission Concept of Operations
470-00072	JPSS 2/3/4 Multi Mission Concept of Operations
470-00101	JPSS Multi Mission System Specification
429-99-02-02	S-NPP Mission System and Operations Concept
474-00167	JPSS Common Ground System (CGS) Requirements Document
474-00005	JPSS GRAVITE Requirements Specification
474-00194	JPSS FVTS Requirements Specification
474-00262	JPSS FTS Requirements Document
474-00585	JPSS AGS Level 3 Requirements
474-00790	JPSS Ground System Network Adaptor Box (NAB) Specification
470-00041	Joint Polar Satellite System (JPSS) Program Lexicon
CCSDS 732.0-B-2	AOS Space Link Data Protocol
CCSDS 911.1-B-3	Space Link Extension - Return All Frames Service Specification
CCSDS 911.2-B-2	Space Link Extension - Return Channel Frames Service Specification
NIST SP 800-53 r4	NIST Special Publication 800-53: Security and Privacy Controls for Federal Information Systems and Organizations

3 SYSTEM OVERVIEW

3.1 Overview of JPSS-Supported Missions

The JPSS Ground System provides fleet management, mission planning and scheduling, satellite control, data acquisition, routing, processing, product generation and distribution, and system sustainment functions to an array of satellites and users, as depicted in the Figure *JPSS Ground System Context Diagram*. The context diagram identifies all primary external entities to which the JPSS Ground System provides various levels of services or attains data for the services. All interfaces to and from the JPSS Ground System pass through a security layer, which is in effect around the JPSS Ground System. This security layer is in the form of access controls, user/device identification/authentication, and authorization by using certificates/credentials to authorized users/machines, etc.

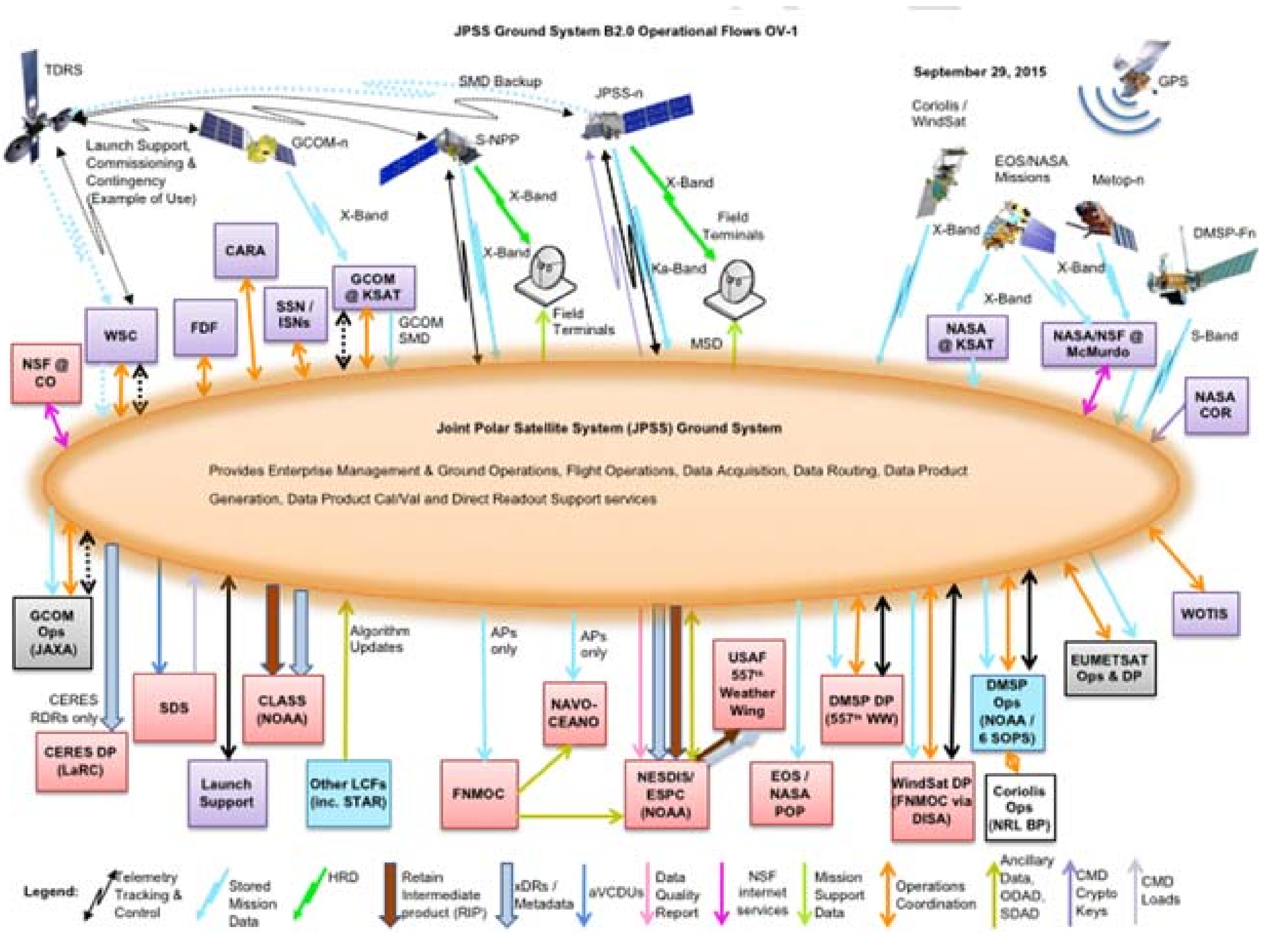


Figure: 3.1-1 JPSS Ground System Context Diagram

3.2 External Interfaces

The JPSS Ground System interacts with many external entities that can be classified as either space-based assets such as satellites or ground-based assets such as users and supporting organizations. The definitions of polar-orbiting missions interfacing with the JPSS Ground

System are described in Section 3.2.1; and the definitions of ground-based assets interfacing with the JPSS Ground System are described in Section 3.2.2.

3.2.1 Polar-orbiting Missions

As a shared ground system, the JPSS Ground System is required to support operations of many polar-orbiting observation missions, each of which is described briefly below. Table 3.2.1-1 summarizes the support provided by the JPSS Ground System.

Table: 3.2.1-1 Summary of Missions Supported by the JPSS Ground System and Their Required Services

	NSF	Coriolis/ WindSat	SCaN Supported Missions	S-NPP	JPSS	GCOM	DMSP	Metop
Launch Date	n/a	Operational	Operational	Operational	JPSS-1: FY 2018 JPSS-2: FY 2022 JPSS-3: FY 2026 JPSS-4: FY 2031	W1: Operational	Operational	B: Operational C: 2016
Support Date	Current	Current	Current	Current	JPSS-1: 2015 JPSS-2: 2019	W1: Current W2: TBD	Current	2011
Mission Planning	No	No	No	Yes	Yes	No	No	No
Spacecraft Control	No	No	No	Yes	Yes	No	No	No
Satellite Command and Telemetry	No	No	No	Yes	Yes	No	No	No
Mission Data Acquisition	No	Yes	No	Yes	Yes	Yes	Yes	No
Data Routing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data Processing	No	No	No	xDR-level	xDR-level (JPSS-1/2/3/4)	RDR-level	No	No
Product Distribution	No	No	No	Yes	xDR-level (JPSS-1) RDR to GRAVITE only (JPSS-2) (B2.2)	Yes	No	No
Cal/Val	No	No	No	Yes	Yes	No	No	No

	NSF	Coriolis/ WindSat	SCaN Supported Missions	S-NPP	JPSS	GCOM	DMSP	Metop
Downlink Data Rate (Mbps)	n/a	25.6 or 51.2	Vary	300	Direct: 300 TDRSS (J1): 150 TDRSS (JPSS-2/3/4): 150/300)	W1: 10	2.66/2.66/1	70
Raw Data Volume (GB/day)	See Note 1	Occasional support	See Note 2	10	JPSS-1: 110 JPSS-2/3/4: 115	W1: 1.6	6	21
Daily Product Data Volume (GB/day)	n/a	n/a	n/a	~2,400 (with compression)	JPSS-1: ~2,700 (with compression)	W1: 1.6	n/a	n/a
Data Latency (for at least 95% of the data processed)	n/a	n/a	n/a	≤ 140 minutes (JPSS GS allocation)	≤ 80 minutes (JPSS GS allocation)	≤114 minutes (RDR) < 12 minutes (JPSS GS allocation)	n/a	n/a
Field Terminal Support	No	No	No	Yes	Yes	No	No	No

Note 1: Under the agreement for sharing the satellite link at McMurdo Station, NSF has fixed 10 Mbps bandwidth allocation for outbound and 18 Mbps for inbound.
Note 2: Under the agreement for sharing the communication network linking Continental United States (CONUS) to Svalbard and McMurdo Station, NASA SCaN has a fixed 1 Mbps bandwidth allocation for outbound and 0.5 Mbps for inbound at McMurdo Station; and a fixed 150 Mbps bandwidth allocation for outbound at Svalbard.
Note 3: xDRs include Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), and Environment Data Records (EDRs). There are also Intermediate Products (IPs) that are generated during xDR production and may be delivered along with the xDRs.

3.2.1.1 Suomi NPP

The Suomi NPP (S-NPP) was intended to provide an opportunity to demonstrate and validate new instruments, algorithms, and pre-operational processing capabilities prior to the first JPSS flight. However due to the change of circumstances, it is now used operationally to fill the gap between NOAA-19 and JPSS-1. It carries a suite of instruments including: Visible-Infrared Imager Radiometer Suite (VIIRS), Cross-Track Infrared Sounder (CrIS), the Advanced Technology Microwave Sounder (ATMS), Ozone Mapping Profiler Suite (OMPS), and Clouds and the Earth's Radiant Energy System (CERES). Successfully launched on October 28, 2011, S-NPP is currently operating in the 1325 LTAN polar orbit.

The JPSS Ground System supports S-NPP with mission planning, spacecraft control, satellite command and telemetry, mission data acquisition, and routing. The mission data are processed into Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), Intermediate Products (IPs), and Environment Data Records (EDRs). Collectively these data products are called xDRs. The S-NPP xDRs along with metadata are delivered to operational users defined in Section 3.2.2 as well as NOAA's Comprehensive Large Array-data Stewardship System (CLASS) for archival storage. The data latency is within 140 minutes from the time of onboard observation to the time when the xDRs are made available to the users.

The JPSS Ground System supports the S-NPP Cal/Val activities during its Intensive Cal/Val (ICV) period post launch as well as full mission operations through its mission life. In addition, S-NPP broadcasts High Rate Data (HRD) with its X-band antenna. The JPSS Ground System makes algorithm and software as well as operational support available to the JPSS field terminal support customers who receive and process the S-NPP direct broadcasts.

3.2.1.2 JPSS

JPSS-1 is a polar-orbiting sun-synchronous satellite in the 1325 LTAN orbit and JPSS-2/3/4 are planned to follow suit. JPSS-1 carries VIIRS, CrIS, ATMS, OMPS -Nadir and CERES instruments. JPSS-2/3/4 will have a similar set of instruments with an addition of OMPS-Limb and the replacement of CERES with Radiation Budget Instrument (RBI), which is a placeholder for an instrument of opportunity. JPSS-1 launched in FY 2018, and will be followed by JPSS-2 around the FY 2022 timeframe. JPSS-3 and JPSS-4 are planned to launch in FY2026 and FY2031, respectively.

The JPSS Ground System supports JPSS-1/2/3/4 with mission planning, spacecraft control, satellite command and telemetry, mission data acquisition, and routing. The mission data are processed into xDRs. The JPSS xDRs along with metadata are delivered to the operational users as well as NOAA's CLASS for archival storage. The data latency (for the primary satellite in the fleet) is within 80 minutes from the time of onboard observation to the time when the xDRs are made available to the users.

The JPSS Ground System supports the JPSS-1/2/3/4 Cal/Val activities during the ICV period as well as through each satellite's mission life. In addition, JPSS-1/2/3/4 missions provide a direct broadcast to the JPSS field terminal support customers with X-band HRD. The JPSS Ground System makes algorithm and software as well as operational support available to the JPSS field terminal support customers who receive and process the JPSS direct broadcasts.

3.2.1.3 GCOM

GCOM is an Earth observation program by the JAXA. GCOM-W (Water) is a series of GCOM polar orbiting satellites dedicated to monitoring water-related targets including precipitation, water vapor, sea surface wind speed, sea surface temperature, soil moisture, and snow depth. The mission instrument onboard GCOM-W is the Advanced Microwave Scanning Radiometer 2 (AMSR-2). The first satellite in this series, GCOM-W1 was successfully launched in May, 2012.

The JPSS Ground System supports GCOM missions with mission data routing, processing and distribution. The mission data is processed into RDRs. The GCOM RDRs are delivered to the NESDIS/ESPC for higher level product generation as well as NOAA's CLASS for archival storage. The data latency is 114 minutes from the time of observation to RDR delivery, with 12 minutes allocated to the JPSS Ground System.

3.2.1.4 DoD Weather Satellite Follow-On Program (TBD)

The DoD had originally planned to complement the JPSS program missions in the early morning orbit in what was called the Defense Weather Satellite System (DWSS). The 2012 FY Defense Appropriations Act terminated this program and the DoD was directed to revisit the basic requirements and schedules for a follow-on program to DMSP. The expected need dates for the new DoD system remains TBD, but will be targeted to replace the last two DMSP satellites currently awaiting launch. The JPSS Ground System will remain a viable option/alternative for any future DoD Weather Satellite Follow-On (WSF) Program, but remains TBD until a material development decision is finalized by the DoD.

3.2.1.5 DMSP

DMSP is DoD's current polar-orbiting sun-synchronous satellites monitoring meteorological, oceanographic, and solar-terrestrial physics.

In order to significantly reduce DMSP's data latency, the JPSS Ground System supports DMSP missions by providing data acquisition and routing at the McMurdo ground station in Antarctica. Mission data is not processed, but routed to DMSP Service Delivery Points at the 557th Weather Wing using the JPSS Wide Area Network (WAN).

3.2.1.6 Metop

The Metop-A is Europe's first polar-orbiting satellite dedicated to operational meteorology, and is the European contribution to the Initial Joint Polar-Orbiting Operational Satellite System (IJPS). It carries a payload of eight instruments for observing the planet and flies in the 0930 Local Time Descending Node (LTDN) polar orbit. Metop-B succeeded Metop-A in calendar year (CY) 2012 and was succeeded by Metop-C in CY2018.

In order to significantly reduce Metop data latency, the JPSS Ground System supports Metop missions by providing data routing at the McMurdo Station in Antarctica, with NASA providing data acquisition. Mission data are not processed, but forwarded to the Metop Service Delivery Point at Darmstadt, Germany using the JPSS WAN.

3.2.1.7 Coriolis/WindSat

The JPSS Ground System supports Coriolis/WindSat with its assets at the Svalbard ground station to acquire and route its mission data to the Coriolis Service Delivery Point at NOAA Satellite Operations Facility (NSOF).

3.2.1.8 SCaN-Supported Missions

The JPSS Ground System supports SCaN-supported missions, including the EOS missions, by routing their mission data between either Svalbard, Norway or McMurdo Station, Antarctica and the SCaN Service Delivery Point at the NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland.

3.2.1.9 National Science Foundation (NSF)

The National Science Foundation (NSF) operates the United States Antarctic Program (USAP), including the operation of the McMurdo site. The JPSS Ground System supports NSF by routing NSF data between the NSF McMurdo station and the NSF USAP Service Delivery Point in Centennial, Colorado.

3.2.2 Data Consumers

The JPSS Ground System provides operational Low-Earth Orbiting (LEO) environmental satellite data and services to a wide array of users worldwide. The user community in general includes all components of NOAA that perform analysis and forecasting of weather, climate, oceans and coasts, as well as interagency, international, and private users. However for the purpose of defining the system, the term 'Users' refers to the immediate recipients of JPSS data who develop value-added products and services for the others. These immediate users are described in the following sections.

3.2.2.1 Operational Users

The operational users are the ones who use environmental data products for near real-time operations, examples of which include short-term weather forecasting, storm tracking, and disaster management. Timing is essential to operational applications. JPSS operational users include NOAA’s National Environmental Satellite, Data and Information Service (NESDIS) Environmental Satellite Processing Center (ESPC), Fleet Numerical Meteorology and Oceanography Center (FNMOC), and Naval Oceanographic Office (NAVOCEANO).

In order to meet stringent data latency requirements of the operational users, a data processing facility is co-located at ESPC to produce data products for local consumption. FNMOC and NAVOCEANO receive mission data (Application Packets) directly from the JPSS Ground System.

3.2.2.1.1 Environmental Satellite Processing Center (ESPC)

Located in Suitland, Maryland, the primary ESPC data processing and distribution site is at NSOF and is operated by the NESDIS OSPO. The ESPC receives all xDRs along with metadata and quality reports from the JPSS Ground System. It produces GCOM-W1 SDRs and EDRs from the RDRs received from the JPSS Ground System. The ESPC provides data and products

derived from JPSS xDRs to NOAA's operational and climate communities and to other civilian customers.

3.2.2.1.2 557th Weather Wing

Located on Offutt Air Force Base (AFB) in Bellevue, NE, the 557th Weather Wing is the global operations center of Air Force Weather. The center provides worldwide weather support to Air Force and Army war fighters, unified commands, national programs, and the National Command Authorities. The JPSS Ground System delivers to 557th Weather Wing the DMSP mission data captured at the McMurdo Station.

3.2.2.1.3 Fleet Numerical Meteorology and Oceanography Center (FNMOC)

Located in Monterey, CA, FNMOC is the principal global Numerical Weather Prediction (NWP) center within the DoD. In particular, FNMOC is well known for its long and productive track record of implementing, evaluating, operating, maintaining and improving complex NWP models specifically to meet the needs of DoD.

FNMOC receives subscribed JPSS data (Application Packets). FNMOC uses JPSS VIIRS data, Feature Track Wind products as one example, input into the global atmospheric 4 Dimensional Variational Analysis (4DVAR) data assimilation scheme (NAVDAS-AR) for use by the Navy Global Environmental Model (NAVGEM). The VIIRS data is also utilized to create enhanced Navy unique imagery and EDRs such as dust depictions, low clouds and fog, snow cover, fire products, contrail detection, and day/night time reflective property imagery. The CrIS, ATMS, OMPS, and Microwave Imagery Sounder (MIS) data provides temperature, moisture, and aerosol data at various levels within the atmosphere. These data are utilized by the models to give key environmental parameters over the ocean enabling Naval Aviation Weather Forecasting, Ship Fleet Operations, Intelligence, Surveillance and Reconnaissance assets, and Maritime Weather Forecasting capabilities to avoid tropical cyclones and areas of convective activity.

3.2.2.1.4 Naval Oceanographic Office (NAVOCEANO)

Located at Stennis Space Center, Mississippi, NAVOCEANO is primarily responsible for the collection, processing, and distribution of oceanographic, hydrographic, and other geophysical data and products to all elements of DoD and to civilian users as appropriate. NAVOCEANO is one of the Navy's processing facilities for NOAA polar-orbiting satellite data and is nationally recognized for satellite-derived global sea-surface temperature and satellite altimeter-derived sea-surface topography and wave height.

NAVOCEANO receives subscribed JPSS data (Application Packets). NAVOCEANO uses VIIRS/CrIS data to augment its global satellite sea surface temperature products that are input to ocean analyses and circulation models supporting ship routing and Anti-Submarine Warfare (ASW). VIIRS imagery also supports both the routing and ASW in the mapping of ocean fronts and eddies in near real-time. VIIRS and OMPS data are used to generate littoral Navy Ocean Color products supporting mine warfare and special ops.

3.2.2.2 Climate Users

The climate users are the ones who use environmental data products for long-term climate/environmental change studies and research, for which data latency is not critical. JPSS climate users include NOAA's National Centers for Environmental Information (NCEI) and NASA's Science Data Segment (SDS).

3.2.2.2.1 NOAA National Centers for Environmental Information (NCEI)

NOAA NCEI archives JPSS data products using the CLASS archival storage. CLASS is a web-based digital library of real-time and historical satellite environmental data. Through CLASS, the climate user community can search and access data products generated by the JPSS Ground System as well as data from existing satellites (e.g., Geostationary Operational Environmental Satellite (GOES), POES, etc.).

JPSS xDRs, ancillary data, auxiliary data, and metadata are delivered to CLASS at NSOF. The JPSS data processing software and documentation are also stored in CLASS.

3.2.2.2.2 Science Data Segment (SDS)

NASA's Science Data Segment is a distributed research system with the primary presence located at Goddard Space Flight Center (GSFC). The primary role of the SDS is to support the NASA requirements for JPSS mission data. The SDS will make data quality assessments and algorithm improvements developed by the NASA Science Team available to the JPSS Science Team and the JPSS Program. The SDS will interface with the JPSS Ground System for rapid access to the JPSS mission data especially those needed to produce data products from the NASA provided instruments.

The JPSS Ground System delivers all S-NPP and JPSS Stored Mission Data (SMD) to the SDS delivery points at NSOF and CBU.

As part of its research results, the SDS may generate work requests and recommendations for instrument calibration and algorithm enhancements.

3.2.2.3 Field Terminal Support Customers

The Field Terminal (FT) community refers to users who use their own equipment, including FTs, to acquire and to process space-borne real-time data over its Field of View (FOV) for immediate generation of products to support regional operations. This community includes diversified entities such as NOAA, Air Force, Army, Navy, Marine Corps, civilian, national and international governments as well as commercial and private organizations. Their applications can be either operational or long-term science research.

The JPSS Program supports the FT community by broadcasting sensor data continuously in real-time from satellites such as S-NPP and JPSS-1/2/3/4. Further, the JPSS Ground System makes data processing software and documentation available to the JPSS Field Terminal Support (FTS) customers so they can use their own hardware to receive HRD broadcast and to produce data products. In addition, the JPSS Ground System makes Mission Support Data (MSD) available to the FTS customers in order for them to acquire satellite signals and generate high quality products.

It should be noted that the JPSS program is not responsible for developing or testing any field terminals.

3.2.2.4 Data Acquisition and Routing Users

3.2.2.4.1 FNMOC

Blossom Point Field Site provides simultaneous tracking and data acquisition, health and status monitoring, and command and control for Coriolis/WindSat, and FNMOC is responsible for processing the WindSat data.

3.2.2.4.2 Defense Weather Satellite Division

The Defense Weather Satellite Division (DWSD) of Space and Missiles Command (SMC) is responsible for the DMSP satellites. The JPSS S-band receptors at McMurdo receive mission data from the DMSP satellites. DMSP mission data is relayed to the DMSP Service Delivery Point (SDP) at the 557th Weather Wing for data processing (the 557th Weather Wing forwards DMSP data to DMSP SOCC at NSOF to support flight operations). DMSP mission data is not processed by the JPSS Ground System.

3.2.2.4.3 EUMETSAT

The McMurdo Station, managed by NASA, acquires mission data from the EUMETSAT owned and operated Metop satellites. Metop data is then relayed via JPSS WAN to the EUMETSAT Metop SDP for further processing. Metop data is not processed by the JPSS Ground System.

3.2.2.4.4 NSF USAP

The NSF USAP McMurdo station uses the JPSS WAN to route data to and from the NSF USAP WAN in CONUS in support of its day-to-day operations and scientific investigations.

3.2.3 Data Providers

The operations of the JPSS Ground System rely on a number of data providers for satellite control, data processing and security.

3.2.3.1 GSFC Flight Dynamics Facility

The JPSS Ground System uses services provided by GSFC Flight Dynamics Facility (FDF) for launch and early orbit operations and for supporting contingency operations.

3.2.3.2 GSFC Conjunction Assessment and Risk Analysis Team

The JPSS Ground System uses services provided by GSFC Conjunction Assessment and Risk Analysis (CARA) team for conjunction assessment throughout the JPSS mission operations.

3.2.3.3 Ancillary Data Providers

Ancillary data refers to the data provided by external sources that are required in JPSS mission operations and data processing. Examples of ancillary data include Global Forecast System (GFS) from National Center for Environmental Prediction (NCEP); NAVGEM and Navy

Aerosol Analysis and Prediction System (NAAPS) from FNMOC; Correlative Truth Data from various sources, etc. Some of the ancillary data are fairly static and are updated infrequently; while the others are dynamic and are updated in hours. NESDIS ESPC acquires the ancillary data and makes it available to the JPSS Ground System.

3.2.3.4 JAXA

JAXA develops and operates GCOM-W satellites and their instruments. JAXA provides operational data such as contact schedules through Kongsberg Satellite Services (KSAT) and documentation to support science data pre-processing.

3.2.3.5 Key Management Authority

The JPSS satellites encrypt command uplinks for security. The Key Management Authority (KMA) approves the encryption schemes to be used; sanctions encryption/decryption equipment to be deployed; and provisions and controls the Cryptographic Keys for operations as required by the selected encryption schemes. For S-NPP, KMA is the National Security Agency (NSA). For JPSS-1/2/3/4, KMA is the NASA Central Office of Record (COR).

3.3 JPSS Instruments and Environmental Data Products

JPSS provides a variety of environmental observations from the 1325 LTAN orbit. The users depend on DoD's WSF satellites (TBD) to provide data from the 1730 LTAN orbit and on EUMETSAT's Metop and Metop-SG satellites to provide data from the 2130 LTAN orbit. Together these satellites enable many observations to be refreshed at four-hour intervals. Additionally, the JPSS Ground System acquires and pre-processes data from JAXA's Global Change Observation Mission (GCOM) - Water (GCOM-W).

JPSS, DoD (TBR), and GCOM-W carries an instrument complement consisting of the VIIRS, CrIS, ATMS, OMPS, CERES/RBI, and AMSR-2 instruments as shown in Table 3.3-1. These instruments are described briefly below:

Table: 3.3-1 Environmental Observation Instrument Complements on JPSS and Partner Polar Environment Satellites

	S-NPP	JPSS-1	JPSS-2/3/4	GCOM-W
The Visible Infrared Imaging Radiometer Suite (VIIRS)	Yes	Yes	Yes	No
The Cross-track Infrared Sounder (CrIS)	Yes	Yes	Yes	No
The Advanced Technology Microwave Sounder (ATMS)	Yes	Yes	Yes	No
The Ozone Mapping Profiler Suite Nadir (OMPS-N)	Yes	Yes	Yes	No
OMPS Limb (OMPS-L)	Yes	No	Yes*	No
The Clouds and the Earth's Radiant Energy System (CERES)	Yes	Yes	No	No
Radiation Budget Instrument (RBI)	No	No	No**	No
The Advanced Microwave Scanning Radiometer-2 (AMSR-2)	No	No	No	Yes

* OMPS-L will be included only if provided by NASA

** RBI is a placeholder for an instrument of opportunity.

VIIRS - The Visible Infrared Imaging Radiometer Suite (VIIRS) is used to obtain measurements of the Earth's oceans, land surface and atmosphere to make a wide range of EDR's. VIIRS Imagery EDRs at six selected bands for latitudes greater than 60-degree North in the Alaskan region are identified as JPSS Key Performance Parameters (KPP). VIIRS combines the radiometric accuracy of the AVHRR currently flown on the NOAA POES with the high (0.65 km) spatial resolution of the Operational Line-scan System (OLS) flown on the DoD DMSP. It provides imagery of clouds under sunlit conditions in about a dozen visible channels (or frequency bands), as well as provide coverage in a number of infrared channels for night and day cloud imaging applications.

CrIS - The Crosstrack Infrared Sounder (CrIS), with the ATMS, forms the Crosstrack Infrared and Microwave Sounding Suite (CrIMSS) to provide moisture, temperature, and pressure profile data. The CrIS SDR is identified as one of the KPPs required for JPSS. CrIS collects upwelling infrared spectra at very high spectral resolution, and with excellent radiometric precision. These data are then merged with microwave data from ATMS to construct highly accurate temperature, and moisture profiles of the earth's atmosphere and pressure profiles of the earth's surface. Initially running with limited spectral resolution, CrIS has been operating in the full spectral resolution mode since 2014.

ATMS - The Advanced Technology Microwave Sounder (ATMS) is a companion sensor with CrIS for producing the CrIMSS products, which is generated by the NESDIS ESPC. The ATMS TDR is identified as one of the KPPs required for JPSS. ATMS is the functional-equivalent follow-on to the Advanced Microwave Sounding Unit (AMSU-A) and the Microwave Humidity Sounder (MHS) but with improved sampling and coverage.

OMPS - The Ozone Mapping and Profiler Suite (OMPS) carries on a long tradition of space borne measurements of ozone beginning in 1970 with the Nimbus 4 satellite and continuing with the Solar Backscatter Ultraviolet (SBUV and SBUV/2) and Total Ozone Mapping Spectrometer (TOMS) instruments on various NASA, NOAA, and international satellites. It maps the total column amount of ozone and determines the densities of ozone in the atmospheric layers. The ozone values are derived from the ratio measurements of the solar backscattered ultraviolet radiance and the limb radiance to the solar irradiance impinging on the top of the earth atmosphere. OMPS is composed of two sensors, Nadir viewing the nadir and Limb viewing earth limb.

CERES - The Clouds and the Earth's Radiant Energy System (CERES) instrument produces radiation data and cloud data. The radiation data is provided as fluxes at the top of the Earth's atmosphere, at the Earth's surface, and as flux divergences within the atmosphere. Cloud data are provided in terms of measured area coverage, altitude condensed water density, and short-wave (SW) and long-wave (LW) optical depths. A part of NASA EOS program, CERES was first launched in 1997 aboard NASA's Tropical Rainfall Measurement Mission (TRMM), then continues observation on the EOS Terra and Aqua observatories.

RBI – The Radiation Budget Instrument (RBI) is the next generation, follow-on to the CERES instrument. It will provide measurement of reflected sunlight and thermal radiation emitted by Earth. It will collect upwelling Earth radiance over a wide spectral range and capture three spectral bands: SW (reflected solar energy), LW (emitted Earth energy), and total (independent

check of the other two bands). Note: RBI is not a part of J-2/3/4, however, RBI is a placeholder for an instrument of opportunity.

AMSR-2 - The Advanced Microwave Scanning Radiometer (AMSR-2) continues the legacy of AMSR-E that provided continuous observation onboard NASA's EOS Aqua satellite from 2002 to 2011. It observes water-related targets including precipitation, water vapor, sea surface wind speed, sea surface temperature, soil moisture, snow depth.

Collectively, these missions and their instruments are designed to fulfill the RDR, SDR and EDR requirements specified in the NOAA L1RD and the L1RD Supplement. These EDRs are broken out by mission and sensor in Figure 3.3-1. Note that this figure includes all products generated by the JPSS Program. The JPSS Ground System generates all APs, RDRs, TDRs, and a part of the SDRs and EDRs.

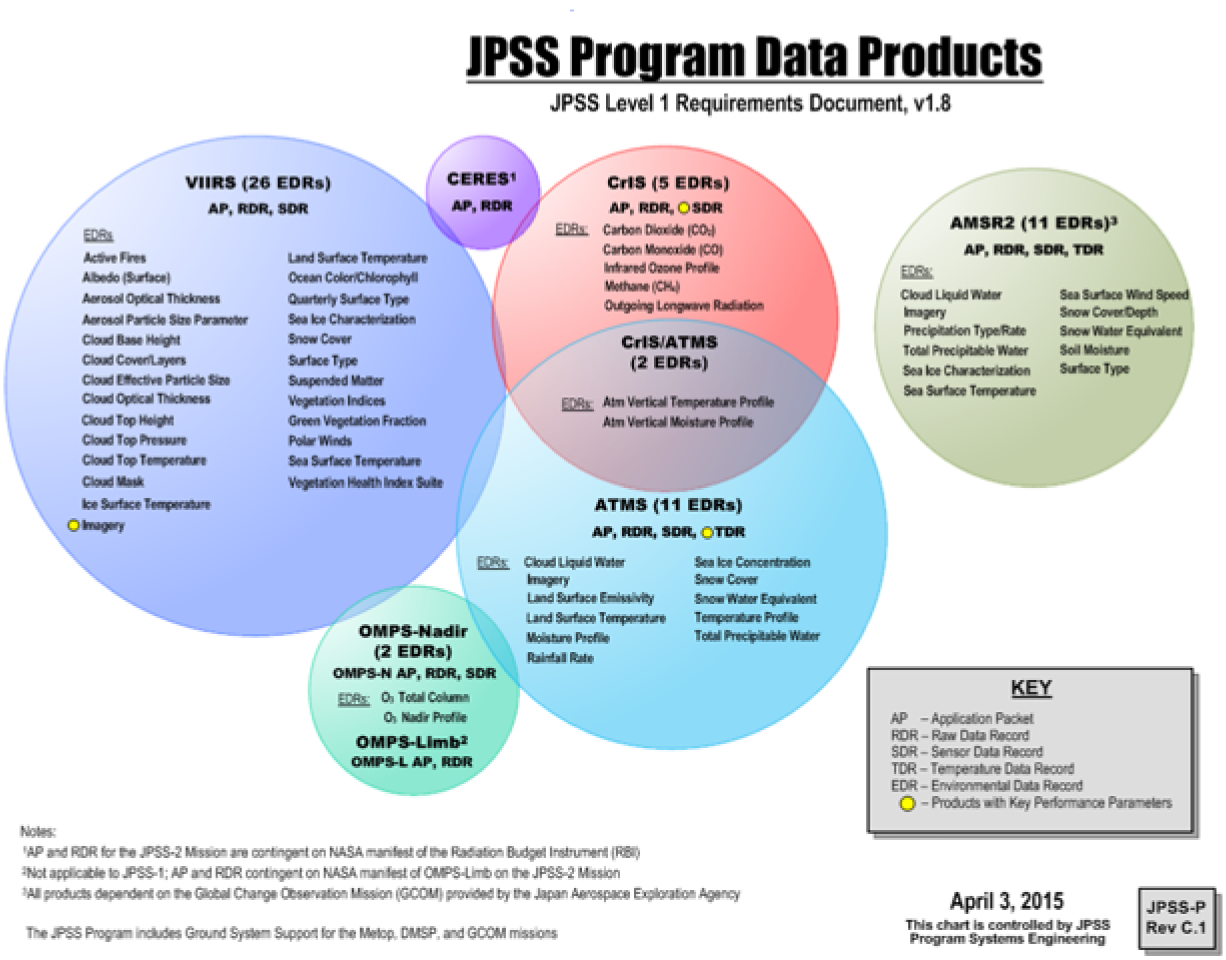


Figure: 3.3-1 JPSS Environmental Data Records (EDRs)

In order to produce the required EDRs, the JPSS Ground System acquires and processes down linked mission data, and produces RDRs, SDRs and TDRs. RDRs contain full-resolution, digital sensor data, time-referenced and locatable in earth coordinates with absolute radiometric and

geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data should be unprocessed with the following exceptions: Time Delay and Integration (TDI), detector array non-uniformity correction (i.e., offset and responsively equalization), and lossless data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data are retained and communicated to the ground without lossy compression.

SDRs are data records produced when an algorithm is used to convert RDRs to geolocated, calibrated detected fluxes with associated ephemeris data. The existence of the SDRs provides an intermediate step between the EDRs and the raw data. Full resolution sensor data are time referenced, earth (GEO) located (or orbit-located for in-situ measurements), and calibrated by applying the ancillary information including radiometric and geometric calibration coefficients and georeferencing parameters such as platform ephemeris. These data are processed to sensor units (e.g., radar backscatter cross section, brightness temperature, radiance, etc.). Calibration, ephemeris, and any other ancillary data necessary to convert the sensor units back to sensor raw data (counts) are included.

EDRs are data records produced when an algorithm is used to convert SDRs to geophysical parameters (including ancillary parameters, e.g., cloud clear radiation, etc.). EDRs are generally produced by applying an appropriate set of algorithms to SDRs.

3.4 Ground System Architecture

The JPSS Ground System architecture provides a high-level view of how the Concept of Operations (ConOps) and requirements are met, organized and related. The Figure *JPSS Ground System Architecture* illustrates a conceptual view of the JPSS Ground System functional capabilities and interconnectivity organized in Nodes. A Node is a collection of functions to achieve specific goals.

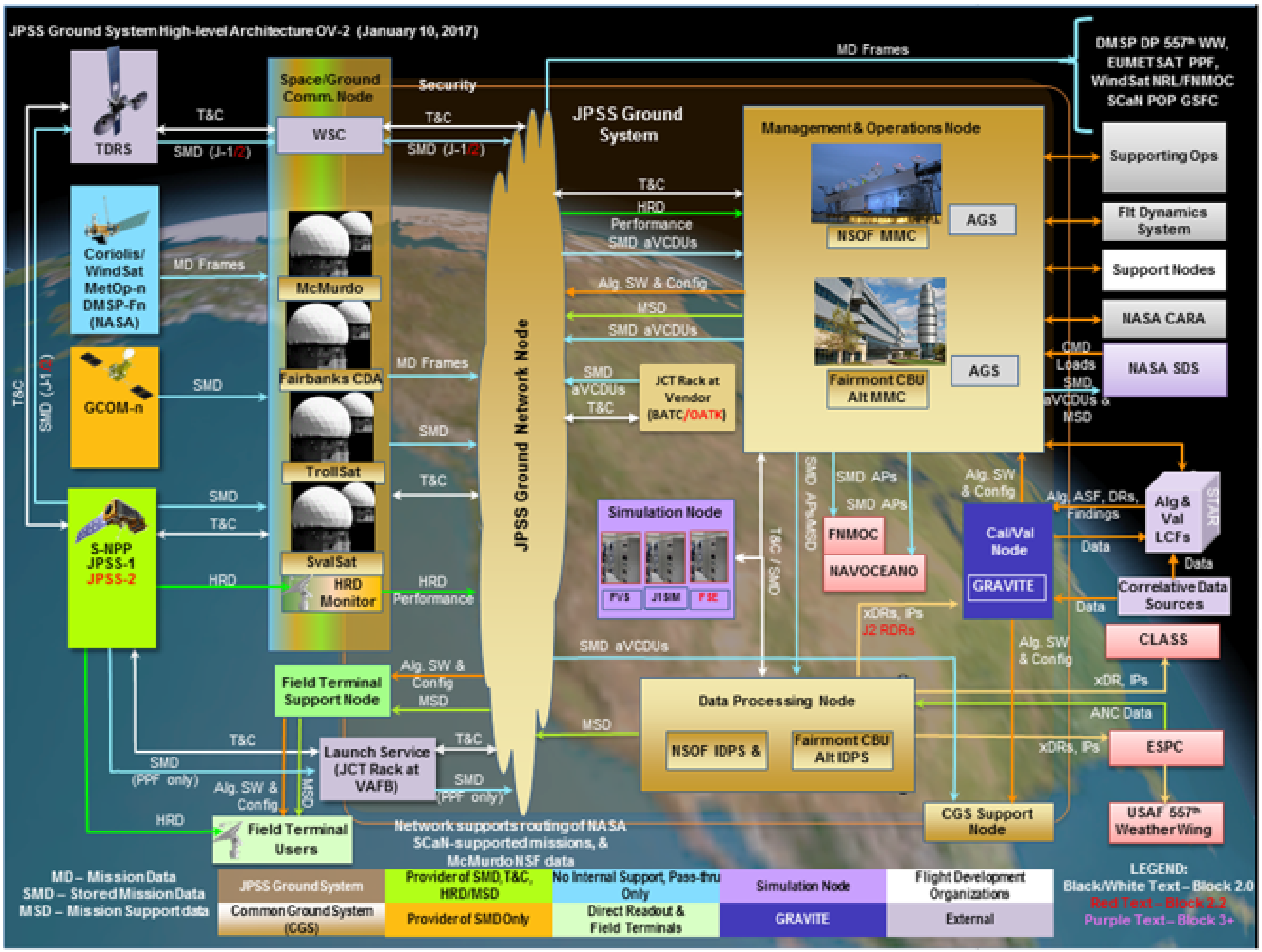


Figure: 3.4-1 JPSS Ground System Architecture

3.4.1 JPSS Ground System

The JPSS Ground System is composed of eight functional nodes: the Space/Ground Communications Node, the Ground Network Node, the Management and Operations Node, the Data Processing Node, the Common Ground System (CGS) Support Node, the Simulation Node, the Calibration/Validation Node, and the Field Terminal Support Node.

The CGS consists of the Space/Ground Communications Node, the Ground Network Node, the Management and Operations Node, the Data Processing Node, and the CGS Support Node.

These Nodes are described in the following sections.

3.4.2 Space/Ground Communications Node

The Space/Ground Communications Node (SGCN) is distributed around the globe. The Node provides the Radio Frequency (RF) uplink and downlink communications between the ground and spacecraft to support telemetry and commanding operations as well as mission data operations. Some of the assets used to provide Space/Ground Communications are owned and

dedicated to the JPSS Program, while others are provided by other Government agencies or commercial entities.

The primary communications are provided by Kongsberg Satellite Services (KSAT) Svalbard Satellite Station (SvalSat) located in Svalbard, Norway, and the McMurdo Station S/Ka-band receptor site in Antarctica. Alternate communications are provided via the NOAA Fairbanks Command and Data Acquisition Station (FCDAS) in Fairbanks, Alaska, and KSAT Troll Satellite Station (TrollSat) located in Jutulsessen, Antarctica. The JPSS Ground System also leverages ground station assets in McMurdo Station, Antarctica to support Data Acquisition and Data Routing services to missions such as Metop, DMSP, and NASA missions supported by SCaN.

Additionally, the SvalSat location provides monitoring capability for the X-band HRD Direct Broadcast of the S-NPP and JPSS satellites.

The White Sands Complex (WSC) is used to provide access to the Tracking and Data Relay Satellite System (TDRSS) for T&C communications when Svalbard and Fairbanks are not available or in view. For JPSS-1/2/3/4, WSC/TDRSS can be used to provide alternate Stored Mission Data (SMD) downlink.

3.4.3 Ground Network Node

The JPSS Ground Network Node (GNN) is used to support communications among all ground system entities, including the Space/Ground Communications Node, the Management and Operations Node (MON), the Data Processing Node, and the CGS Support Node. It consists of AT&T Multi-Protocol Label Switching (MPLS) Wide-Area Network (WAN) and specific Points of Presence (PoP) and Service Delivery Points (SDP) located at each site. For some missions, such as DMSP, Metop, SCaN-supported missions, and Coriolis/WindSat, the Ground Network Node provides data routing from the Space/Ground Communications Node to the non-JPSS Data Processing Node at their respective destinations.

The GNN acquires and delivers the mission data and the mission support data for the JPSS Ground System. The GNN carries command from the MON to SGCN and telemetry and SMD from the SGCN to MON. The mission support data service includes acquisition of ancillary data used for data processing and orbit operations, as well as distributing ancillary and auxiliary data to authorized users throughout the JPSS Ground System and external-interfacing partners.

3.4.4 Management and Operations Node

The Management and Operations Node (MON) commands the spacecraft and ensures proper operation of the JPSS spacecraft and ground assets. The MON provides the mission planning and scheduling, flight operations, telemetry and commanding, orbit and attitude management, ground operations, alarms, warnings and events processing, and trending and analysis. The MON also provides the infrastructure for enterprise management as well as monitoring for the security events within the system.

The MON also provides central SMD distribution capability. It receives SMD from SGCN, filters out duplicates, and distributes SMD to the data processing centers, including the Data

Processing Node (DPN), FNMOC, NAVOCEANO, and SDS, as well as other users within MON.

The MON functionality is provided by the MMC. The primary MMC is located in Suitland, MD at the NSOF. The alternate MMC is located at the NOAA Fairmont, WV Consolidated Backup (CBU) facility. A Stop-Gap MMC is provided at the CGS vendor location in Aurora, CO for S-NPP prior to the deployment of the alternate MMC. The primary purpose of this Stop-Gap MMC is to maintain the health and safety of the satellite.

3.4.5 Data Processing Node

The Data Processing Node (DPN) processes mission data into raw, sensor and environmental data products. Currently NOAA has JPSS-provided DPN implementations to minimize WAN communications utilization. The Fleet Numerical Meteorology and Oceanography Center (FNMOC) and Naval Oceanographic Office (NAVOCEANO) will receive technical support to implement their own DPNs. The NOAA DPN distributes data products to ESPC, the Comprehensive Large Array-Data Stewardship System (CLASS), and the Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE).

The primary NOAA DPN is located in Suitland, MD at the NSOF. The alternate NOAA DPN is located at the NOAA Fairmont, WV CBU facility. The alternate NOAA DPN is only responsible for data flows to ESPC and CLASS.

3.4.6 Common Ground System Support Node

The JPSS Ground System is an evolving capability that will be in multiple concurrent lifecycles for the various missions being supported. As such, the ground system needs to be capable of developing capabilities for new missions and capabilities, while integrating, testing and validating releases to support launches and updates to existing missions; all the while supporting mission operations for the on-orbit satellites. The Common Ground System Support Node provides the functionality needed to support these activities.

3.4.7 Simulation Node

The JPSS Ground System's Simulation Node provides satellite and ground system simulators to support mission operations as well as integration, test and verification of new capabilities to be fielded. The Flight Vehicle Test Suite (FVTS) performs the functions of the Simulation Node.

The FVTS consists of the Flight Vehicle Simulator (FVS), Command and Telemetry Simulator (CTSIM), the JPSS-1 Simulator (J1Sim) and the JPSS-2/3/4 Flight Segment Emulator (FSE). In addition, there are Ground Link Simulator (GLS) and Simulator Control (SimCtrl) Infrastructure that are shared by J1Sim and FSE for their simulation operations. The FVS supports S-NPP satellite simulation, with CTSIM serving as a backup with limited functionality. J1Sim supports JPSS-1 satellite simulation; and FSE is shared by JPSS-2/3/4 for their simulations.

3.4.8 Calibration/Validation Node

The JPSS Ground System's Calibration/Validation Node maintains the existing science algorithms, maintains the algorithm calibration and develops new algorithms as needed for the science mission.

The Calibration/Validation Node relies on the GRAVITE system for the JPSS Ground System-embedded computing resources and also on external Local Computing Facilities (LCF) to support the science maintenance role.

3.4.9 Field Terminal Support Node

The S-NPP and JPSS satellites include a High-Rate Data (HRD) antenna that continuously downlinks sensed data as the data are collected. Such a downlink is often referred to as a Direct Broadcast (DB). The JPSS Ground Project has defined, specific support for end user (Direct Broadcast Community) processing of DB data from the JPSS-managed satellites. The Field Terminal Support (FTS) node will support the DB community by providing software, documentation, and periodic updates using a web portal. The FTS web portal will also provide the necessary hardware and software specifications, ancillary and auxiliary data needed for processing the broadcasts, as well as making orbital data available to assist the DB community in locating the satellites of interest. With their own equipment and the above-provided information, the DB community can capture and process the HRD content and generate data products, such as RDRs, SDRs, and a subset of EDRs. In addition, the JPSS Ground System will provide equipment at the Svalbard Ground Station, which will monitor the quality of the direct broadcast link and make the HRD Monitoring report available on the web portal.

3.4.10 Continuity of Operations

With Block 2.0, the JPSS Ground System will be compliant with U.S. Government continuity of operations policy, providing diversely located backup capabilities to deal with long-term outages of facilities and equipment. The current plan is to provide backup capabilities to critical Management and Operations Node functions as well as Data Processing Node functions. There will be backup Simulation Node capabilities to support the critical Management and Operations Node functions.

3.4.11 Security

The Federal Information Security Management Act (FISMA) of 2002 mandates that federal information processing systems maintain a security program and control guidelines that are commensurate with the level of risk of which the information system operates. As such, the JPSS Ground System employs a security program aimed at mitigating the risks to which the JPSS Ground System is exposed. In addition, the JPSS Ground System must meet the NOAA Level 1 requirements that the JPSS Ground System will also develop and maintain, to the fullest extent, the controls of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-53, Recommended Security Controls for Federal Information Systems and Organizations. The JPSS Ground System Security Requirements Document (GSSRD) applies through Block 2.1 and derives its requirements from the NIST SP 800-53 Rev 3; and enhances the requirements based on Department of Commerce IT SPP, NOAA IT Security Policies, National Environmental Satellite, Data, and Information Service (NESDIS) policies and Office of Satellite and Product Operations (OSPO) Policies and Procedures. From Block 2.2 onwards, the Lifecycle System Security Requirements Documentation (LSSRD) derives requirements from NIST SP800-53 Rev 4 as well as the updated versions of the IT SPP, NOAA, NESDIS and OSPO policies and procedures described above. The LSSRD is a non-verifiable master list of

the security requirements; the verifiable requirements drawn from the LSSRD as applicable to each component system of the JPSS Ground System and are constitute a security volume to each component system's Level 3 Specification. The objective of the ground security is to be fully compliant with FISMA 2002 and NOAA IT Security Policies prior to launch of and during operations of JPSS-1.

3.4.12 Support Nodes Managed by Flight Project

To support JPSS-managed missions such as S-NPP, JPSS-1/2/3/4, there are two support nodes that are managed under the JPSS Flight Project: the Instrument Support Node (ISN) and Spacecraft Support Node (SSN). These support nodes are outside of the JPSS Ground System but interact with the Ground System nodes under various scenarios.

The Instrument Support Node includes the infrastructure utilized by the Instrument Science Team (IST) to perform their tasks. The ISN also includes the Instrument Vendors, the Flight Project Instrument Manager, the Instrument Science Lead as well as relevant system and discipline engineers from the Flight project. The ISN maintains and updates the instrument flight software as needed, as well as managing some of the flight instrument tables. It also provides anomaly investigation support, as needed.

Similarly the Spacecraft Support Node includes the infrastructure to support spacecraft sustainment operations. SSN includes the Flight Project Observatory Manager, spacecraft vendors, as well as relevant system and discipline engineers from the Flight project. The SSN maintains and updates the spacecraft flight software and tables. It also provides anomaly investigation support, as needed.

4 JPSS ENTERPRISE ROLES AND RESPONSIBILITIES

The JPSS Enterprise involves a federation of many organizations whose roles and responsibilities vary during different phases of operations. Figure 4-1 illustrates a notional organizational relationship. NOAA/NASA JPSS Management Control Plan (MCP) and derived Project Management Plans document the roles and responsibilities of these organizations.

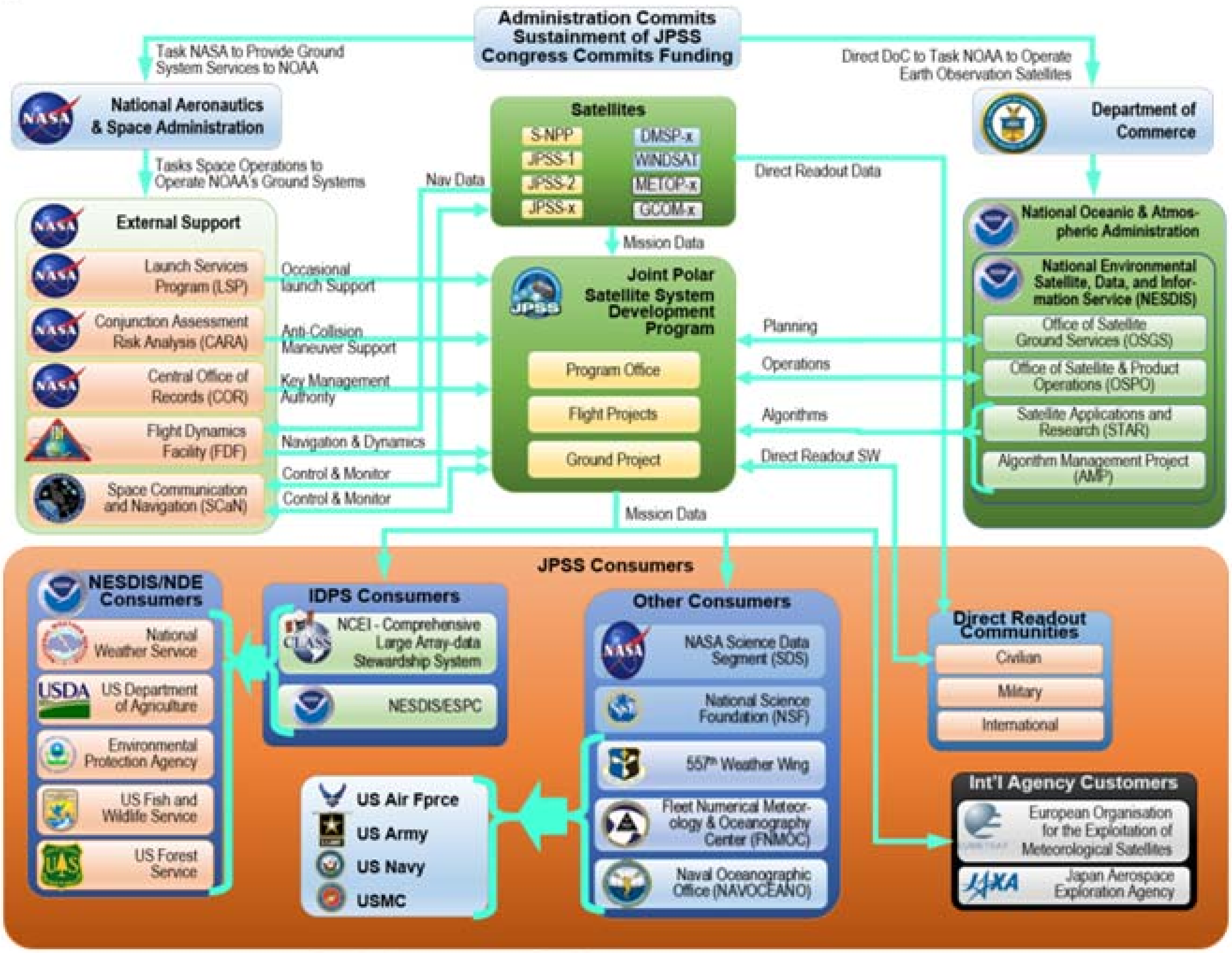


Figure: 4-1 JPSS Notional Organizational Relationship

4.1 JPSS Ground Project

The JPSS Ground Project has the following responsibilities:

- Provide Mission Operations system engineering
- Support satellite compatibility integration and testing
- Manage mission compatibility and readiness tests
- Support pre-launch integration and testing at launch sites.

- Support launch and early orbit operations.
- Support spacecraft activation and commissioning until the operational responsibility is transitioned from the Flight Project to the Ground Project.
- Manage full or partial mission operations until the operational responsibility is fully transitioned from the Ground Project to NOAA OSPO.
- Provide mission operations support.
- Implement algorithms provided by AMP/STAR within the Ground System to meet JPSS requirements.
- Provide JPSS Ground System sustainment until the sustainment responsibility is transitioned from the Ground Project to NOAA OSPO.
- Provide JPSS Ground System CCB, ERB, and CM

4.2 Stakeholders

As the owner of the requirements, NOAA manages the JPSS Program stakeholder relationships. The development of requirements to support the primary stakeholders within the weather and climate communities is managed by the JPSS Program Scientist. The following are the major categories of stakeholders for the JPSS Program:

- Operational Users – This category includes all NOAA and DoD users who will use data for critical functions such as weather forecasting, identifying and tracking severe weather events, climate analysis, and monitoring the health of the Nation's oceans and coastal areas. In addition, there are other interagency, international and private users.
- Mission Partners - This category includes other organizations within NESDIS and external components required to complete the JPSS mission. NESDIS components include OSPO that is responsible for command and control and data processing functions and customer liaison, NOAA's Office of Satellite Ground Services (OSGS) is responsible for development and sustainment of downstream data processing, and STAR is responsible for algorithm development and maintenance. A complete list of NESDIS stakeholders is contained in the NOAA JPSS Implementation Plan. JPSS coordinates with DoD on the development, deployment, and sustainment of the CGS. External components include those providing data to the JPSS Program and include EUMETSAT and JAXA.
- Long Term Archive - This category includes NOAA data centers responsible for the long-term archive of S-NPP and JPSS data.

The primary forum to ensure user stakeholder advocacy will be the Environmental Satellite Users Group (ESUG) which will have an executive council composed of senior leaders from NOAA, NASA, DoD and EUMETSAT; a user constituency group; and technical advisors. The objectives of the ESUG are to provide a forum for user cooperative interaction which enables collaboration on the analysis of satellite capabilities, assists the user community in evaluating operational utility of current satellite capabilities and in determining operational impacts of proposed changes in capabilities.

4.3 NOAA Office of Satellite and Product Operations

The NOAA OSPO has the following responsibilities:

- Participate in ground system reviews for design, development, implementation, integration, testing, and transition to operations
- Participate in developing operations transition plans and training operational crews
- Participate in training and mission simulations, Ground System integration and testing (I&T)
- Serve as a member of the Technical Evaluation Team for the Ground Project Approval on Mission Ops Products.
- Manage JPSS mission operations once transitioned from the JPSS Ground Project, including the mission management and enterprise management systems
- Generate and provide augmented products and other services to NOAA and other NOAA partners
- Provide 24/7 user help desk for JPSS ground system product generation and distribution services to operational users
- Coordinate with the JPSS direct broadcast community to communicate changes in broadcast services.
- Manage the JPSS backup facility and its operation
- Produce and disseminate environmental data products (see Section 4.4. for more details)

4.4 NOAA OSPO Environmental Satellite Processing Center

NOAA OSPO's Environmental Satellite Processing Center (ESPC) receives JPSS data products, produces high-level products and disseminates them to NOAA users. ESPC has the following responsibility:

- Request and receive JPSS data products from the JPSS Ground System.
- Generate GCOM-W1 SDRs and EDRs from the RDRs delivered by the JPSS Ground System.
- Produce and distribute JPSS data products to ESPC registered operational users.
- Acquire ancillary data and make it available to the JPSS Ground System.

4.5 NOAA Algorithm Management Project (AMP)

The NOAA Algorithm Management Project (AMP) has the following responsibilities:

- Oversee development and maintenance of the algorithms and related Calibration/Validation (Cal/Val) activities
- Submit algorithm change requests to the Ground Project

- Verify science performance requirements at Level-2
- Coordinate with the system developers/integrators for implementation of the algorithms

4.6 NOAA Center for Satellite Applications and Research (STAR)

NOAA's STAR has the following responsibilities:

- Lead the algorithms and validation teams
- Develop algorithms and perform Cal/Val of data products
- Lead the science efforts in terms of advising JPSS technically on the best path forward
- Maintain all algorithms for the mission life-time
- Perform algorithm and data product testing
- Receive JPSS data products and perform long-term monitoring of the data products
- Provide European Centre for Medium-range Weather Forecasts (ECMWF) forecast data to the JPSS Ground System

4.7 NOAA National Centers for Environmental Information (NCEI)

The NOAA NCEI has the following responsibilities:

- Receive, archive and disseminate JPSS data products.

4.8 NOAA National Weather Service

The NOAA National Weather Service (NWS) has the following responsibilities:

- Provide ancillary data to the JPSS Ground System as an alternate source for data processing.

4.9 DoD Data Centers

The DoD Data Centers at FNMOC and NAVOCEANO have the following responsibilities:

- Provide network connectivity between the DoD Data Centers (FNMOC and NAVOCEANO) and NSOF/CBU
- FNMOC and NAVOCEANO request and receive JPSS/GCOM-W1 data (Application Packets) from the JPSS Ground System
- FNMOC distributes two ancillary data sets (NAVGEM and NAAPS) to the NOAA NESDIS

4.10 Direct Readout Communities

The Direct Readout Communities, as the customers of the JPSS Field Terminal Support have the following responsibilities:

- Receive and process the real-time JPSS satellite data that is directly broadcasted**.**

4.11 Spacecraft and Instrument Vendors

The spacecraft and instrument vendors have the following responsibilities:

- Provide sustainment of flight software and flight vehicle simulators.
- Support anomaly investigations.

4.12 National Security Agency

The National Security Agency (NSA) has the following responsibilities:

- Oversee the management of the S-NPP encryption keys.
- Provide the S-NPP spacecraft command encryption keys as required by the selected encryption schemes.

4.13 Science Data Segment

The Science Data Segment (SDS) has the following responsibilities:

- Receive, process, and disseminate S-NPP and JPSS data to NASA science teams.
- Provide assessment of S-NPP and JPSS derived measurements.
- Process S-NPP and JPSS-2/3/4 OMPS-Limb data.
- Support the CERES and RBI instrument operations.

4.14 NASA Flight Dynamics Facility

The NASA Flight Dynamics Facility (FDF) has the following responsibilities:

- Provide orbit analysis support during launch and early orbit, and contingency operations.

4.15 NASA Langley Research Center

The NASA Langley Research Center (LaRC) has the following responsibilities:

- Manage the operations and calibrations of CERES instrument.
- Process CERES data; and generate and distribute CERES data products.
- Manage the operations and calibrations of RBI instrument.
- Process RBI data; and generate and distribute RBI data products.

4.16 Kongsberg Satellite Services

The Kongsberg Satellite Services (KSAT) has the following responsibilities:

- Coordinate schedules with JAXA for GCOM-W1 support.
- Coordinate schedules with the JPSS Ground System for Coriolis, S-NPP, GCOM-W1, JPSS-1/2/3/4 support.

- Provide T&C and SMD supports to the JPSS missions from the Troll ground station located in Jutulsessen, Antarctica upon service request.
- Receive and forward GCOM-W1 mission data to JAXA.
- Receive and forward GCOM-W1 mission data to the JPSS Ground System.

4.17 NASA Earth Observing System Data and Information System

The NASA Earth Observing System Data and Information System (EOSDIS) has the following responsibilities:

- Provide ancillary data to the JPSS Ground System for data processing.

4.18 JPSS Science Investigators

The JPSS Science Investigators (SIs) have the following responsibilities:

- Assist calibrations of JPSS instruments.
- Assist calibrations and validations of JPSS data products.

4.19 NASA Space Network

The NASA Space Network (SN) has the following responsibilities:

- Schedule SN resources upon the JPSS Ground System requests
- Provide T&C communication support and status
- Provide SMD downlink support and status

4.20 NASA Conjunction Assessment Risk Analysis Team

The NASA Conjunction Assessment and Risk Analysis (CARA) team has the following responsibilities:

- Support conjunction assessment throughout the JPSS mission operations.

4.21 Blossom Point Tracking Facility

Navy's Blossom Point Tracking Facility supports Coriolis/WindSat satellite and has the following responsibility:

- Provide simultaneous tracking and data acquisition, health and status monitoring, and command and control

4.22 Fleet Numerical Meteorology and Oceanography Center

FNMOC processes Coriolis/WindSat data and has the following responsibilities:

- Receive Coriolis/WindSat data from the JPSS Ground System.
- Receive, process, and disseminate DMSP data to DoD and other government agencies.

- Distribute two ancillary data sets (NAVGEM and NAAPS) to the NOAA NESDIS as input into JPSS EDR algorithms.

4.23 DMSP Satellite Operational Control Center

The DMSP Satellite Operational Control Center (SOCC) co-located at NSOF operates DMSP satellites and has the following responsibilities:

- Coordinates schedules with the JPSS Ground System for the DMSP support.

4.24 557th Weather Wing

The 557th Weather Wing processes DMSP data and has the following responsibilities:

- Receive, process, and disseminate DMSP data to DoD and other government agencies.

4.25 NASA Near Earth Network

The NASA Near Earth Network (NEN) has the following responsibilities:

- Coordinate schedules with EUMETSAT MCC for Metop support
- Acquire and forward Metop data to JPSS WAN for routing to EUMETSAT Central Application Facility (CAF)

4.26 EUMETSAT Mission Control Center

The EUMETSAT Mission Control Center (MCC) operates Metop satellites and has the following responsibilities:

- Coordinates schedules with NASA NEN for Metop support.

4.27 EUMETSAT Central Application Facility

The EUMETSAT Central Application Facility (CAF) processes Metop data and has the following responsibilities:

- Receive, process and disseminate Metop data.

4.28 Air Force Space Command

The Air Force Space Command (AFSPC) has the following responsibilities:

- Produce DoD requirements for the JPSS Ground System to provide mission operations, communications and data processing services to the future DoD WSF missions.

4.29 National Science Foundation

The National Science Foundation (NSF) provides facility and infrastructure support at McMurdo, and shares satellite communications with JPSS. It has the following responsibilities:

- The NSF provides the infrastructure, infrastructure maintenance, and utility services for the McMurdo site
- Maintain Black Island Microwave Relay and Earth Station

- Receive, process and disseminate NSF data.

4.30 NASA Space Communications and Navigation

The NASA Space Communications and Navigation (SCaN) provides communication support from polar sites to a large number of NASA missions, including the Earth Observation System (EOS) missions. It shares a Wide Area Network (WAN) with JPSS to transmit mission data between CONUS and the polar sites (Svalbard and McMurdo). SCaN has the following responsibilities:

- Provide the mission data of the SCaN supported missions to the Service Entry Point of the JPSS Ground System.
- Receive the mission data of the SCaN supported missions from the Service Delivery Point of the JPSS Ground System.

4.31 Japanese Aerospace Exploration Agency

The Japanese Aerospace Exploration Agency (JAXA) receives GCOM-W1 Stored Mission Data from KSAT Svalbard ground station under an agreement between NOAA, JAXA and KSAT. JAXA has the following responsibilities:

- Retrieve GCOM-W1 SMD from KSAT ground station at Svalbard, Norway.

4.32 NASA Central Office of Record

The NASA Central Office of Record (COR), with its Electronic Key Management System (EKMS), serves as the Key Management Authority (KMA) for JPSS-1/2/3/4. NASA COR EKMS has the following responsibilities:

- Provide operational command encryption keys
- Provide test command encryption keys

4.33 NOAA Office of Satellite Ground Services

In the NOAA NESDIS, the Office of Satellite Ground Services (OSGS) leads the consolidated development and sustainment of all NOAA NESDIS ground systems, leverages common ground services, and guides the development of an enterprise ground architecture. For the JPSS Ground System Block 2, the NOAA OSGS has the following responsibilities:

- Participate in system verification and validation efforts
- Participate in life cycle reviews

5 CONCEPT OF OPERATIONS

5.1 JPSS Ground System Services

As a shared common ground infrastructure, the JPSS Ground System supports not only missions of today but also that of tomorrow, whose details are yet to be defined. Even the needs of today's missions may change over time, some planned and some not. This reality demands a modular, flexible and adaptable ground system that can evolve affordably with the missions and their needs. Such a system is more service-oriented, providing a suite of services with well-defined interfaces, allowing new missions to be plugged in with minimum customization. Based on this philosophy, the JPSS Ground System provides seven mission services in order to meet the varying needs of polar orbiting environmental missions. They are:

- Enterprise Management and Ground Operations
- Flight Operations
- Data Acquisition
- Data Routing
- Data Product Generation
- Data Product Calibration and Validation (Cal/Val)
- Field Terminal Support

These services are described in the following sections. Also Table 5.1-1 shows how each of these services are supported by the JPSS Ground System Nodes that are introduced in Section 3.4.

Table: 5.1-1 JPSS Ground System Services and Architectural Nodes

Service Node	Enterprise Manageme nt & Ground Operations	Flight Operations	Data Acquisition	Data Routing	Data Product Generation	Data Product Cal/Val	Field Terminal Support
Management & Operations	x	x	x	x	x	x	x
Space/Ground Communications	x	x	x				
Ground Network	x	x		x			
Data Processing	x				x		
Cal/Val	x					x	
Simulation	x	x					
Field Terminal Support	x		x				x
CGS Support	x						

5.1.1 Enterprise Management and Ground Operations Service

Through the Enterprise Management and Ground Operations service, the JPSS Ground System provides mission management and mission operations capabilities necessary for every supported

mission. This includes mission planning and scheduling, ground system equipment control, monitoring and management, service level situational awareness, status report and trending, and system maintenance, upgrade and sustainment for long-term support. In order to provide robust services to the operational users, the service also includes extensive support for anomaly resolution as well as the ability to continue operations even under catastrophic conditions.

5.1.2 Flight Operations Service

Through the Flight Operations service, the JPSS Ground System provides a full suite of capabilities for operating a satellite through its entire mission life cycle. More specifically, the Flight Operation service provides for each mission:

- Pre-launch support
- Launch and early orbit operations
- Sensor activation and commissioning
- Satellite health and safety
- Flight vehicle simulation
- Orbit operations
- Telemetry and commanding
- Instrument calibration and support
- Mission data operations
- Flight Software Updates
- Command encryption support
- Satellite disposal

5.1.3 Data Acquisition Service

Through the Data Acquisition service, the JPSS Ground System provides its users the space to ground wideband communication capability to acquire the mission data from their satellites. This service allows the users to take advantage of strategically located JPSS ground stations (i.e. at Svalbard and McMurdo polar sites) to significantly reduce data latency and increase data availability.

The service point for data acquisition is an antenna for acquiring RF signal on the one end and a serial interface for baseband data on the other. The downlink RF supported includes S-, X- and Ka- band. The details are specified in the mission requirements or in individual Service Level Agreements (SLAs) or equivalent between the JPSS Program and user mission/agency.

Due to the nature of space missions and potential conflicts of resources, schedule coordination is required for the service through electronic and voice communications. Such coordination may be done through the JPSS scheduling system, or through existing external scheduling systems based on JPSS provided scheduling data. In addition, the service status and reports (including antenna status) as well as anomaly reporting and resolution are supported. The details should be

specified in individual Operations Agreements (OAs) or equivalent between the JPSS Program and user mission/agency.

Due to the extremely harsh Antarctic conditions and limited access to the McMurdo Station receptor sites, there is a potential long delay in restoring the function of a failed receptor. Therefore only one of the two receptors is designated for operational use, while the other is reserved as the backup. This means the resource availability for mission planning is based on a single receptor, not both. In case of a scheduling conflict, the JPSS spacecraft contacts have schedule priority over DMSP for the McMurdo Station receptor. Note that the two receptors will rotate on a monthly basis for the operational use to prevent deterioration due to the harsh environment.

5.1.4 Data Routing Service

Through the Data Routing service, the JPSS Ground System receives user's mission data from a service entry point, performs no or minimum data processing, then routes the data through JPSS ground network to mission's service delivery point(s). This service allows the users to take advantage of strategically located JPSS global data network connectivity (i.e. from the Svalbard and McMurdo polar sites to CONUS) to significantly reduce data latency and increase data availability.

The service entry point for data ingest can be a serial interface or a network interface for user's mission data and the service delivery point can be a network interface. In some cases, the data is routed directly through the network; while in other cases, the data is preprocessed at the receiving site before being routed to its delivery point(s). The network bandwidth is pre-allocated and guaranteed for the service. The details are specified in the mission requirements or in individual Service Level Agreements (SLAs) or equivalent between the JPSS Program and user mission/agency.

Because of the nature of network operations, schedule coordination is typically not required for the service. However the service status and reports as well as anomaly reporting and resolution are supported. The details should be specified in individual Operations Agreements (OAs) or equivalent between the JPSS Program and user mission/agency.

5.1.5 Data Product Generation Service

Through the Data Product Generation service, the JPSS Ground System receives user's mission data from a service entry point, processes the data into the environmental data products per JPSS data processing specifications, then delivers the data products to the users. The level of processing depends on user's requirements, ranging from the Raw Data Records to the Environmental Data Records. The mission data is stored locally at the Data Processing Node for a limited time, allowing data product repair and retransmission.

Data processing performance such as data latency and data availability also varies from user to user based on the mission requirements or as identified in individual Service Level Agreements (SLAs) or equivalent between the JPSS Program and user mission/agency.

5.1.6 Data Product Calibration/Validation Service

Through the Data Product Calibration/Validation service, the JPSS Ground System provides the capability to monitor data product quality, maintain calibration and validate environmental data products. The goal of Calibration and Validation operations is to establish and maintain the performance of these data products to the level specified in the JPSS data processing specifications.

5.1.7 Field Terminal Support Service

Through the Field Terminal Support service, the JPSS Ground System makes available to the Field Terminal (FT) user community data processing algorithms, software, and documentation so that these users can produce the high quality data products in their own environment using mission data acquired through direct broadcast from the S-NPP and JPSS satellites.

Further the JPSS Ground System supports the FT operations by making available to the FTS customers timely mission support data, including but not limited to satellite Two-Line Elements (TLEs), mission plans and schedules, spacecraft and instrument events and status, anomaly notifications, processing coefficients and data quality threshold tables.

5.2 JPSS Missions

This section describes missions that have been or plan to be supported by the JPSS Ground System through the services described in the previous section. Table 5.2-1 provides a summary of these missions and the services provided to each of the missions.

Table: 5.2-1 JPSS Supported Missions and Provided Services

Service Mission	Enterprise Management & Ground Operations	Flight Operations	Data Acquisition	Data Routing	Data Product Generation	Data Product Cal/Val	Field Terminal Support
SCaN-supported missions (e.g., EOS)	x			x			
Coriolis/WindSat	x		x	x			
DMSP	x		x	x			
Metop	x			x			
NSF	x			x			
GCOM-W	x		x	x	x		
S-NPP	x	x	x	x	x	x	x
JPSS	x	x	x	x	x	x	x

5.2.1 Coriolis/WindSat

Coriolis is a joint Navy/NPOESS satellite designed to measure ocean surface wind speed and direction from space using a polarimetric radiometer. It has been operating in a sun-synchronous, 830-km, 98.7-degree, and 1800 LTAN orbit since 2002. In addition to its tactical downlink to the Navy fleet, it also has an S-band downlink for Telemetry, Tracking, & Command (TT&C) and an X-band for Stored Mission Data (SMD).

In the past, the Air Force Research, Development, Test & Evaluation Support Complex (AF RSC) operated the Coriolis satellite. The Naval Research Laboratory Blossom Point facility now operates the Coriolis satellite and coordinates schedules through the DMSP Satellite Operations Control Center (SOCC).

The JPSS Ground System provides Data Acquisition and Data Routing services to the Coriolis/WindSat mission. The DMSP SOCC mission planners schedule Coriolis satellite contacts, which use the JPSS Ground System assets at the Svalbard ground station, around S-NPP and JPSS-1/2/3/4 scheduled contacts. During the scheduled contacts, the JPSS Ground System equipment at the Svalbard ground station acquires and routes the Coriolis/WindSat mission data to FNMOC through the Coriolis Service Delivery Point at the NSOF.

Figure: 5.2.1-1 WindSat Sensor for Coriolis

5.2.2 SCaN-Supported Missions

Under the Memorandum of Understanding (MOU) between the SCaN Office of the Human Exploration and Operations Mission Directorate of NASA and the JPSS Program Office of NOAA, the JPSS Ground System provides the Data Routing service to the SCaN-supported missions from both Svalbard and McMurdo ground stations to the continental United States (CONUS).

At Svalbard, the main mission supported under this arrangement is the NASA EOS, which consists of a coordinated series of polar-orbiting satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. The JPSS Ground System

receives the EOS mission data, acquired by a Kongsberg Satellite Services (KSAT) antenna, from the NASA Service Entry Point at Svalbard, transports the data across its Svalbard-to-CONUS ground network, and delivers it to the NASA Service Delivery Point at the Goddard Space Flight Center (GSFC). The EOS mission data being transported is transparent to the JPSS Ground System and no higher-level data processing or transformation is required on the part of the JPSS Ground System. The total bandwidth allocation for this service is 150 Mbps. At McMurdo Station the JPSS Ground System provides the Data Routing service to a group of low-rate NASA missions using its McMurdo Multi-mission Communication System (MMCS), a communication infrastructure shared among NSF, NOAA, and the United States Air Force (USAF). The JPSS Ground System receives the NASA mission data, acquired by NASA's MG1 antenna, from NASA Service Entry Point at McMurdo Station, transports the data across the MMCS and the JPSS Wide Area Network (WAN), and delivers it to the NASA Service Delivery Point at GSFC. The NASA mission data being transported is transparent to the JPSS Ground System and no higher-level data processing or transformation is required on the part of the JPSS Ground System. The total outbound bandwidth allocation for this service is 1 Mbps. Moreover, the JPSS Ground System provides 512 Kbps inbound telecommunication service through the same route for NASA applications.

These network services are provided with stringent performance requirements and 24x7 support as specified in the MOU. Routine status reports are provided to NASA.

NASA's GSFC operates the EOS satellites, such as the Aqua satellite shown in the figure below, and the NASA portion of the network; and coordinates any operational issues with the JPSS Ground System Mission Operations Team (MOT).

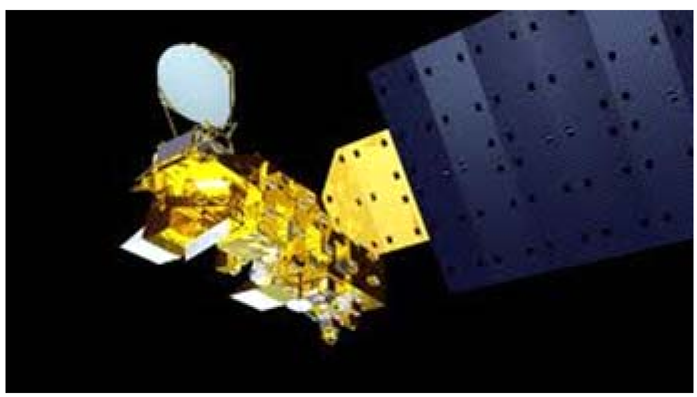


Figure: 5.2.2-1 EOS Aqua Satellite

5.2.3 Metop

Metop-A was Europe's first polar-orbiting weather satellite with a suite of instruments for observing the planet. It operated in a sun-synchronous, 817-km, 98.7-degree, and 2130 LTAN orbit since 2006. Metop-B succeeded Metop-A in calendar year (CY) 2012 and will be succeeded by Metop-C in CY2018.

Based on agreements among NOAA, NASA, and EUMETSAT, the JPSS Ground System provides the Data Routing service to the Metop mission. Metop-B X-band SMD downlink at 70 Mbps is acquired by NASA's MG1 antenna at McMurdo Station, Antarctica. The acquired SMD

is transferred to a EUMETSAT front-end processor where frame-level processing is performed. The processed Metop frames are then passed to the JPSS data network through its service point at McMurdo Station; and are forwarded through the MMCS using Transmission Control Protocol/Internet Protocol (TCP/IP)-based communication protocol to the EUMETSAT Polar System (EPS) Central Site in Darmstadt for processing. This added data access in the southern hemisphere complements EUMETSAT's primary access and control point out of Svalbard and enables the Metop mission to cut its data latency by nearly 40 percent.

The operation coordination for the Metop support is conducted between JPSS Ground System and the Metop Operations Center at EUMETSAT.

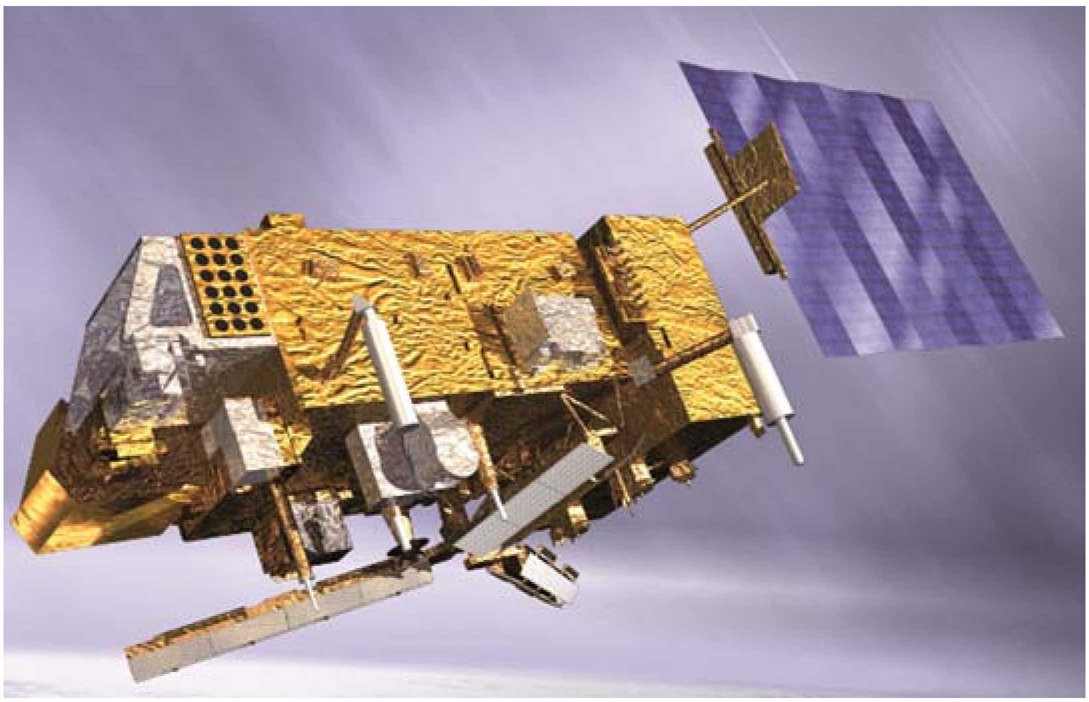


Figure: 5.2.3-1 Metop-B Satellite

5.2.4 DMSP

The DoD DMSP Program consists of polar-orbiting satellites providing the U.S. military with critical and continuous environmental information for planning and conducting military operations worldwide. The satellites have been operating at an altitude of 830km since the 1960s.

DMSP satellites use S-band links at 1.024 Mbps to provide meteorological data in real time to Air Force, Army, Navy, and Marine Corps tactical ground stations and Navy ships worldwide. DMSP satellites also use S-band links at 2.66 Mbps to transmit SMD to one of eight ground stations located near Fairbanks, AK; New Boston, NH; Thule Air Force Base, Greenland; Kaena Point, HI; Vandenberg AFB, CA; RAF Oakhanger, England; Guam; and Antarctica. From these ground stations, data are relayed via Domestic Satellite communications (DOMSAT) to the 557th Weather Wing and to Fleet Numerical Meteorology and Oceanography Center (FNMOC) for processing.

The DMSP satellites are operated by DMSP SOCC at NSOF, Suitland, MD and as a backup, by 6th Space Operations Squadron at Schriever AFB, CO.

The JPSS Ground System provides Data Acquisition and Data Routing services to the DMSP mission. Based on DMSP support requests, the JPSS Ground System schedules and configures its resources at the McMurdo ground station in Antarctica. During the scheduled contacts, DMSP S-band SMD downlink is acquired by JPSS dual-band (S and Ka) receptors at McMurdo and then forwarded via JPSS ground network to the DMSP Service Delivery Point at the 557th Weather Wing for processing. This added data access in the southern hemisphere enables the DMSP mission to reduce its data latency by nearly 40%.

During a Continuity of Operations (COOP) event when the NOAA NSOF facility cannot support both JPSS and DMSP operations, JPSS will move its operations to the Consolidated Backup (CBU) facility in Fairmont, West Virginia. The JPSS mission scheduler will establish contact with the DMSP backup SOCC at Schriever AFB, CO to coordinate DMSP contact schedule and provide continued support to the DMSP operations.

Figure: 5.2.4-1 DMSP Satellite

5.2.5 NSF

McMurdo Station, Antarctica provides an ideal southern polar downlink site that can reduce data latency for polar-orbiting satellites such as Metop and DMSP by up to 40%, and enables JPSS-1 and JPSS-2 to meet their 80 minute data latency requirement.

The NSF operates the United States Antarctic Program (USAP), including the operation of the McMurdo site. Under the Memorandum of Agreement (MOA) between NASA, NSF, and USAF, NSF receives access to JPSS high-speed satellite data communications in exchange for facilitating and hosting the JPSS polar-orbiting satellite earth station at McMurdo Station and providing Antarctic satellite communications earth station resources. NSF operates the Black Island Telecommunications Facility (BITF) that is the major communications transmission and receiving site for the United States Antarctic Program. It also operates the Black Island satellite

communication earth station that establishes the link with the Optus D1 telecommunication satellite, which is a part of the JPSS communications network.

The JPSS Ground System provides the Data Routing service to NSF with its ground data network. NSF mission data are routed between the NSF McMurdo Local Area Network (LAN) and the NSF Centennial, Colorado Communications Service Entry/Delivery Point, which is the hub for the NSF USAP WAN.

NSF provides the JPSS Ground System telecommunication and satellite communication services that bridge McMurdo to Belrose, Australia, where the JPSS ground network has a Point of Presence (PoP). The NSF operates the satellite communication earth station that establishes the link with Optus D1 telecommunication satellite providing bi-directional communications between Black Island and Australia.

Based on the current agreement, NSF (McMurdo) network bandwidth allocation is 18 Mbps inbound and 10 Mbps outbound.

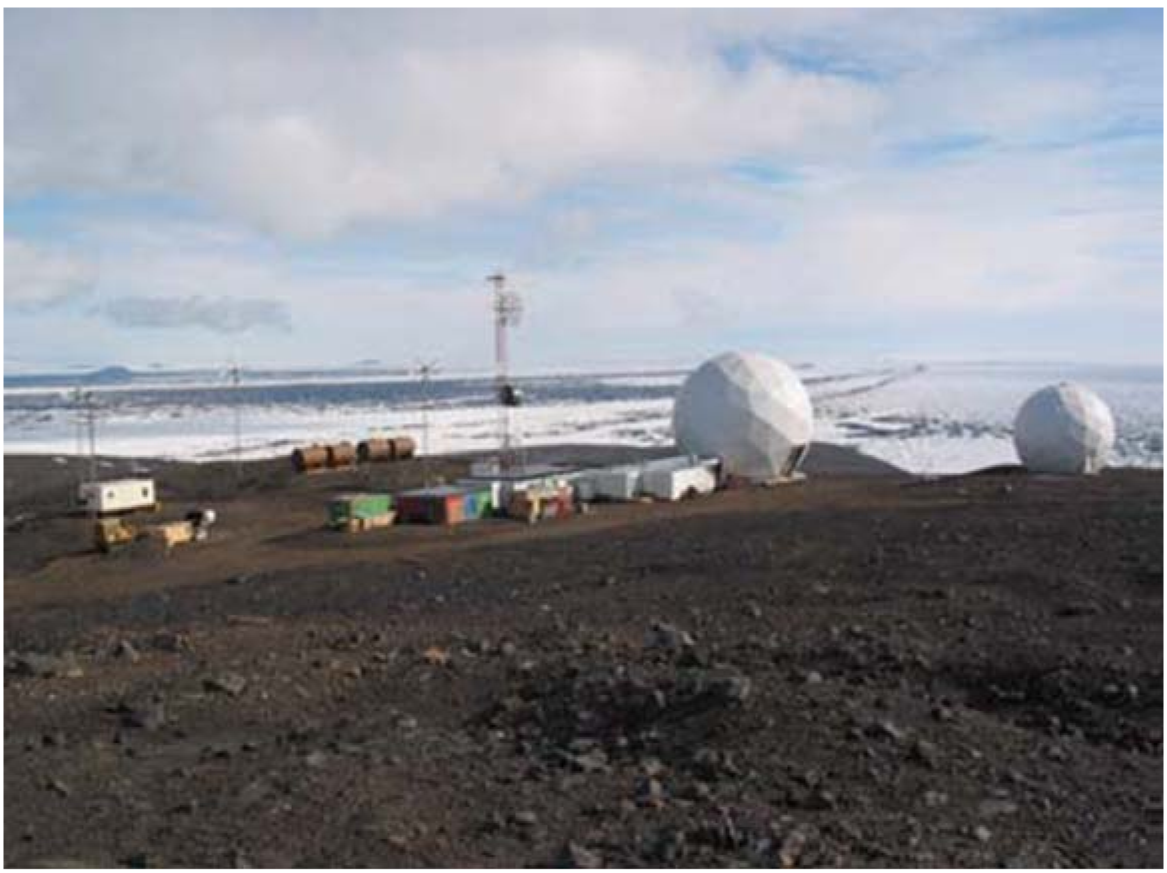


Figure: 5.2.5-1 NSF Black Island Communication Facility

5.2.6 GCOM-W1

GCOM-W1 is a JAXA satellite. Equipped with an Advanced Microwave Scanning Radiometer 2 (AMSR2), it is designed to measure water-related targets including precipitation, water vapor, sea surface wind speed, sea surface temperature, soil moisture, snow depth, etc. GCOM-W1 was

successfully launched on May 18, 2012 into a sun-synchronous, 700-km, 98.7-degree, 1330 LTAN orbit, also known as the A-Train.

The GCOM-W1 satellite is operated by JAXA out of its Tsukuba Space Center in Japan. Under agreements between NOAA, NASA, JAXA, and KSAT, the KSAT facilities at Svalbard, Norway are contracted by the JPSS Ground Project to provide SMD support to GCOM-W1. Globally observed mission data are transmitted using an X-band link at 20 Msps (Mega-symbols per second) 10 Megabits per second (Mbps) every pass. During each pass, mission data from two revolutions (98.8 minutes x 2) are transmitted to increase data availability. Soon after the pass is over, the mission data are then sorted by Application Process (AP) Identifier (APID) and made available to JAXA.

Under agreements between NOAA, NASA, JAXA, and KSAT, the JPSS Ground System performs Data Routing and Data Product Generation services for the GCOM-W1 mission data for NOAA. During a pass, the mission data are acquired by KSAT at Svalbard ground station, and forwarded to the JPSS ground equipment co-located at the Svalbard ground station. The Virtual Channel Data Unit (VCDUs) are extracted and forwarded to the JPSS SMD Hub (JSH) in CONUS. JSH extracts GCOM-W1 Application Packets (APs) and forwards them to the JPSS Data Processing Node, where the sensor data are extracted and processed to generate the Raw Data Records (RDRs) for delivery. NOAA will generate Sensor Data Records (SDRs) and Environmental Data Records (EDRs) from the GCOM-W1 RDRs. The GCOM-W1 APs are also made available to FNMOC and NAVOCEANO.

Schedule coordination for GCOM-W1 support is conducted between the JPSS Ground System and KSAT as KSAT receives all GCOM-W1 ground contact information, including Two-Line Elements (TLEs), from JAXA. KSAT will provide post-pass reports for contact status and data statistics. Anomaly reporting and resolutions are also handled through KSAT. The JPSS Ground System is not involved in mission planning, spacecraft housekeeping and safety, or telemetry and commanding of GCOM-W1 mission operations. However, it monitors the spacecraft and sensor status distributed by JAXA.

Figure: 5.2.6-1 GCOM-W1 Satellite

For a broad view of GCOM-W1 operations, see JPSS GCOM-W1 Support Mission ConOps document. For more in-depth view of GCOM-W1 operations, see the operational threads later in this document.

5.2.7 GCOM-W2

Reserved

5.2.8 Suomi NPP

The S-NPP satellite is NOAA's primary operational polar-orbiting weather mission and a climate data measurement continuity mission. Successfully launched on October 28, 2011, it has been operating in a sun-synchronous, 824-km, 98.7-degree, and 1325 LTAN orbit. The instrument complement on S-NPP includes: the Visible Infrared Imager/Radiometer Suite (VIIRS), the Cross-Track Infrared Sounder (CrIS), the Advanced Technology Microwave Sounder (ATMS), the Ozone Mapping Profiler Suite (OMPS), and the Clouds and the Earth's Radiant Energy System (CERES).

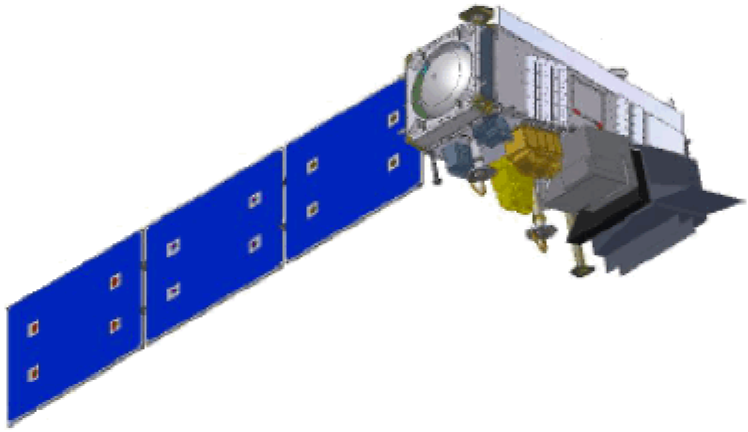


Figure: 5.2.8-1 S-NPP Satellite

In March 2012, the JPSS Program assumed, from the NPOESS Preparatory Project (NPP), full operational responsibilities for the newly-designated Suomi National Polar-orbiting Partnership (S-NPP) mission. As such, the JPSS Ground System provided the full suite of services to the S-NPP mission. This encompassed all aspects of operations necessary to keep the S-NPP spacecraft and payload safe, healthy and functional; and to maintain smooth ground operations to acquire, route, process science mission data for S-NPP Data Records (xDRs) and deliver within specifications. In February 2013 the Operations Management of the S-NPP satellite was transitioned to the National Oceanic and Atmospheric Administration's Office of Satellite and Product Operations. This limited first phase (of three) transition included 24-hour/7-day mission operations and anomaly support for the flight and data processing. The entire mission is planned for transition after JPSS-1 launch plus one year. JPSS Program remains responsible for the bulk of the S-NPP mission including ground system maintenance, sustainment and configuration control.

The JPSS Ground System plans mission activities and schedules based on spacecraft and payload housekeeping needs, science observation tasks and ground resource availabilities. It generates command loads based on the mission plan and verifies the load on the S-NPP Flight Vehicle Simulator (FVS). S-NPP uses the Svalbard ground station as its primary ground station (with Fairbanks Command and Data Acquisition Site (FCDAS) as a limited alternate site) for Telemetry and Command (T&C) and SMD retrieval operations with contact on every orbital revolution. During a pass, commanding is routinely uplinked and telemetry down linked via S-band links. The telemetry is analyzed and trended by mission operations personnel for health and safety. The T&C operation is also available through NASA's Space Network (SN) and its Tracking and Data Relay Satellite (TDRS) System (TDRSS) for secondary support.

Orbital analysis is carried out by mission operations. Orbit maneuvers are performed when needed to maintain the desired orbit position and satellite orientation. Collision Avoidance (CA) analysis is conducted with NASA's Conjunction Assessment Risk Analysis (CARA) on a daily basis. Risk Mitigation Maneuvers (RMM) are planned and performed when necessary to avoid collision with other space objects.

Once per orbit, the SMD is downlinked via a 300 Mbps X-band link and acquired by a JPSS X-band antenna at Svalbard. The SMD is preprocessed into annotated VCDUs (aVCDUs) and

routed to JSH in CONUS. JSH relays the aVCDUs to the NASA SDS in near real-time. It also extracts S-NPP Application Packets (APs) and forwards them to the JPSS Data Processing Nodes, where it is fully processed into S-NPP data products (xDRs) for delivery and archival. The S-NPP APs are also made available to FNMOC and NAVOCEANO. The data product quality is monitored and trended. Sensor calibration and product validation are performed routinely to ensure the data quality is within specifications. In addition to the primary SMD receiving site at Svalbard, S-NPP also uses NOAA FCDAS as an additional site for the SMD operations.

The JPSS Ground System provides data accounting capability for tracking data latency and data availability for the S-NPP mission. In the event a data loss is detected, retransmission can be initiated to recover the data either from upstream data storage on the ground or from the Mass Data Storage (MDS) onboard S-NPP. The MDS can store up to five orbits of data and data can be retransmitted within the next four orbits since its original transmission.

S-NPP is capable of broadcasting observation data in real-time continuously around the globe. The observation data are transmitted via a 15 Mbps X-band link, also known as High Rate Data (HRD). Properly equipped, users on the ground who are within the view of satellite can receive and process the observation data for their local applications. The JPSS Ground System provides these Field Terminal customers with data processing algorithms and software, as well as operational support such as distribution of orbital elements, mission status and notices.

Nominally all mission operations are conducted at the Mission Management Center (MMC) located at the NSOF. However, as an operational mission, the continuity of operations is critical to the S-NPP mission success. A limited alternate mission operation facility (Stop-Gap Mission Management Center-SGMMC) is available in Aurora, CO to support basic T&C operations and will be superseded by a full mission backup center in Fairmont, WV to support T&C and essential mission data processing operations. In the event the MMC at NSOF is unavailable, S-NPP operations can be transferred to an alternate facility within hours to minimize operational impacts.

During the S-NPP prime mission life (five years), the JPSS Program will perform system sustainment for both flight and ground assets in coordination with spacecraft, instrument and ground factories. The flight software, including calibration tables, and spacecraft database will be upgraded as needed. Ground hardware and software, including algorithms, will also go through upgrades to enhance security, reliability, functionality, and performance. The JPSS Ground System is designed with redundant strings so that minimum downtime is required for major hardware and software upgrades.

At the end of the S-NPP mission, the JPSS Ground System will support generation and execution of the S-NPP de-orbit plan for its orderly disposal.

5.2.9 JPSS-1

The JPSS Program is responsible for the development and operations of a series of polar-orbiting Earth observing satellites. The first of this series, JPSS-1 is very similar to S-NPP, carrying nearly the same complement of instruments and operating in the same polar orbit. Built by Ball Aerospace and Technologies Corporation (BATC), and launched in FY2017 to provide operational continuity with the S-NPP mission.

Figure: 5.2.9-1 JPSS-1 Satellite

The JPSS Ground System provides the full suite of services to the JPSS-1 mission from its development to its disposal. This encompasses all aspects of operations necessary to support satellite integration and test (I&T), pre-launch checkout, and launch and early orbit operations, to support instrument activation and commissioning, to keep JPSS-1 spacecraft and payload safe, healthy and functional; and to maintain smooth ground operations to acquire, route, process mission data for JPSS data products (xDRs) generation and delivery within specifications.

During the satellite development, the JPSS Ground System supports satellite I&T through a series of compatibility tests, checking out interfaces and the commanding of spacecraft. When the satellite is transported to the launch site, the JPSS Ground System supports pre-launch integration and testing, and participates in the final-countdown. During the launch and early orbit, the JPSS Ground System will track the spacecraft, establish T&C contacts, activate the spacecraft and check out its health and functionality. Once the spacecraft is deemed operational, the instrument activation will begin, leading to a set of commissioning activities. Following the commissioning intensive instrument and data calibration and validation continues until all data products are certified to be operational.

The JPSS Ground System plans mission activities and schedules based on spacecraft and payload housekeeping needs, science observation tasks and ground resource availabilities. It generates command loads based on the mission plan and verifies the load on J1Sim. Similar to S-NPP, JPSS-1 uses the Svalbard ground station as its primary ground station for T&C operations with contact on every revolution. During a pass, the MOT checks spacecraft health and safety through real-time and back-orbit telemetry. Command loads are routinely uplinked once a week to cover a two-week period. The telemetry is analyzed and trended. The T&C operation is available through NASA's SN when contacts are needed outside of the nominal polar contact schedule, as well as for contingency operations. If the Svalbard ground station is not available for an extended period, NOAA's FCDAS ground station can be used as an alternate site for the T&C operations as well.

Mission orbital maintenance and analysis is carried out by the MOT. Orbit maneuvers and attitude calibration are performed when needed to maintain the desired orbit position and satellite orientations. CA analysis is conducted in conjunction with NASA's CARA on a daily basis. CA maneuvers are planned and performed when necessary to avoid collision with other space objects.

Unlike S-NPP, JPSS-1 uses the JPSS Ka-band receptors at Svalbard, Fairbanks, McMurdo Station, and Troll for its mission data acquisition. The Troll Satellite Station (TrollSat) operated by KSAT is located at Jutulsessen, Antarctica. These four locations for receptors provide opportunities for two SMD contacts during each orbit, significantly reducing data latency to less than 80 minutes compared to less than 140 minutes for S-NPP. During each contact, the SMD is down linked via a 300 Mbps Ka-band link and acquired by a JPSS Ka-band receptor. The SMD is preprocessed into aVCDUs and routed to JSH in CONUS. JSH relays the aVCDUs to the NASA SDS in near real-time. It also extracts JPSS-1 APs and forwards them to the Data Processing Nodes at the NSOF and CBU, where it is fully processed into JPSS data products (xDRs) for delivery to the ESPC and to the archival storage at the Comprehensive Large Array-Data Stewardship System (CLASS). The JPSS mission data (Application Packets) are also made available to FNMOC and NAVOCEANO from the JPSS primary and backup operations centers for their data processing. The data product quality is monitored continuously in near real-time and trended over long period. Sensor calibration and product validation are performed routinely to ensure the data quality is within specifications.

In addition to using the SMD receiving sites at Svalbard, Fairbanks, Troll, and McMurdo, JPSS-1 also utilizes the NASA SN as a contingency for transmitting SMD to the JPSS Ground System. Utilizing TDRS during anomalies for data acquisition maintains data product latency performance in case of polar ground station or satellite nadir Ka antenna failure.

The JPSS Ground System provides full data accounting capability for tracking data latency and data availability for the JPSS-1 mission. In the event a data loss is detected, retransmission can be initiated to recover the data from upstream data storage on the ground, most likely at the ground receiving sites since there are two copies of data, one at each site. In a rare case when the data never reaches the ground, retransmission from the JPSS-1 MDS can be commanded by the MOT. The JPSS-1 MDS can store at least five orbits of data so that the data can be retransmitted within the next four orbits after its original transmission.

The JPSS-1 is capable of broadcasting observation data in real-time continuously around the globe. The observation data are transmitted via a 15 Mbps X-band link, also known as HRD. Properly equipped, users on the ground within the view of satellite can receive and process the observation data for their local applications. The JPSS Ground System provides these Field Terminal customers with data processing algorithms and software, as well as operational support such as distribution of orbital elements, mission status and notices.

Nominally all mission management operations operate out of the MMC located at NOAA NSOF. However as an operational mission, the continuity of operations is critical to JPSS-1 mission success. Therefore an alternate mission operations facility is in Fairmont, WV to support T&C as well as essential mission data processing operations. In case the MMC at NSOF is unavailable, the JPSS-1 operations can be transferred to the alternate facility within hours to minimize operational impacts.

During the JPSS-1 mission life, the JPSS Ground System will perform system sustainment for both flight and ground assets in coordination with spacecraft, instrument and ground factories. The flight software, including calibration tables, and spacecraft database will be upgraded as needed. Ground hardware and software, including algorithms, will also go through upgrades to enhance security, reliability, functionality, and performance. The JPSS Ground System is designed with redundant strings so that minimum downtime is required for major hardware and software upgrades.

JPSS-1 satellite handover from NASA (MOST) to NOAA (OSPO) occurs at launch plus 90 days following the successful completion of an Operational Acceptance Review (OAR) to be held at the NSOF around launch plus 85 days. This review will demonstrate compliance of the satellite (spacecraft, instruments, and flight software) to requirements and demonstrate readiness to proceed with transfer of satellite operations from NASA to NOAA. Once this transition is completed, OSPO will provide 24-hour/7-day mission operations and anomaly support for the flight and data processing for the JPSS-1 satellite. The JPSS Ground System will be formally transitioned to NOAA in February 2019, at which point OSPO will assume responsibility for operations and maintenance and the Office of Satellite Ground Services (OSGS) will assume responsibility for sustainment and configuration control of the JPSS Ground System. When JPSS-1 reaches the end of its mission life, the JPSS Ground System will support the generation and execution of the JPSS-1 de-orbit plan for its orderly disposal.

5.2.10 DoD Weather Satellite Follow-On Program

The DoD Weather Satellite Follow-on (WSF) program is planned to complement the JPSS in the early morning orbit and replace DMSP. The expected need date for the new DoD system remains TBD. Further details of the projected follow-on system are under development. The JPSS Ground System will remain a viable option/alternative for any future DoD WSF program, but its exact roles and responsibilities remain TBD until the DoD finalizes a Material Development Decision.

5.2.11 JPSS-2/3/4

Following JPSS-1, the JPSS Program continues the development and operations of additional polar-orbiting Earth observing satellites, JPSS-2, and JPSS-3 and JPSS-4. These satellites are planned to be identical. They are similar to JPSS-1, operating in the same polar orbit and carrying a similar complement of instruments with some adjustments to its instrument manifest by adding OMPS-Limb and replacing CERES with RBI. Built by the Orbital ATK, JPSS-2 is scheduled for launch in FY2021 to continue the legacy of S-NPP and JPSS-1.

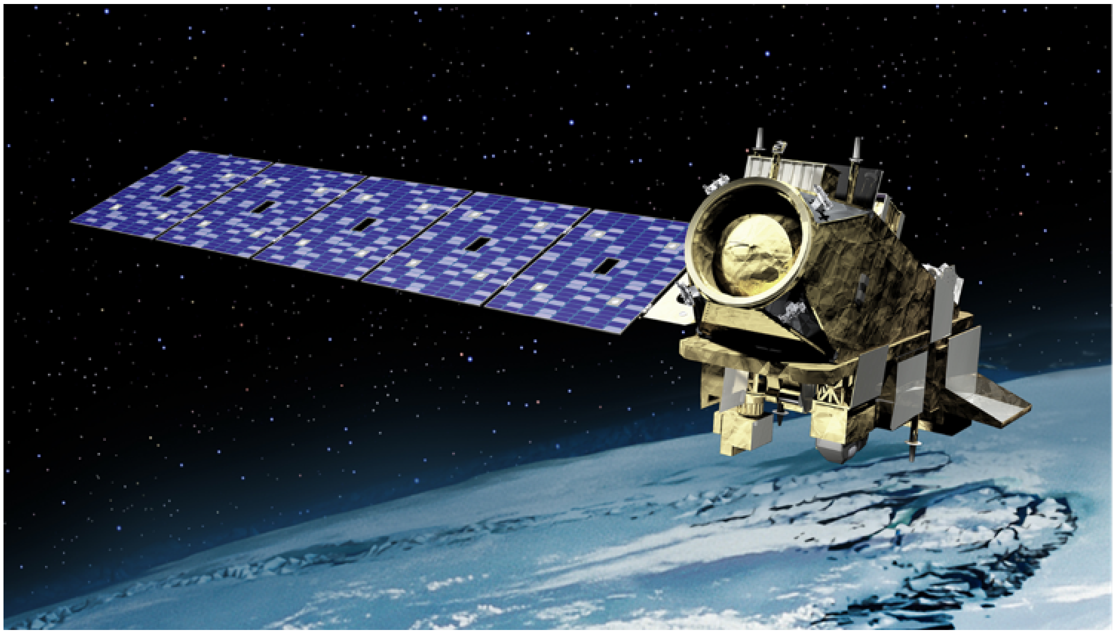


Figure: 5.2.11-1 JPSS-2 Satellite

The JPSS Ground System provides the full suite of services to the JPSS-2/3/4 missions from its development to its disposal. This encompasses all aspects of operations necessary to support satellite integration and test (I&T), pre-launch checkout, and launch and early orbit operations, to support instrument activation and commissioning, to keep JPSS-2/3/4 spacecraft and payload safe, healthy and functional; and to maintain smooth ground operations to acquire, route, process mission data for JPSS Mission Unique Products (MUPs) generation and delivery within specifications.

During the satellite development, the JPSS Ground System supports satellite I&T through a series of compatibility tests, checking out interfaces and the commanding of spacecraft. When the satellite is transported to the launch site, the JPSS Ground System supports pre-launch integration and testing, and participates in the final-countdown. During the launch and early orbit, the JPSS Ground System will track the spacecraft, establish T&C contacts, activate the spacecraft and check out its health and functionality. Once the spacecraft is deemed operational, the instrument activation will begin, leading to a set of commissioning activities. Following the commissioning intensive instrument and data calibration and validation continues until all data products are certified to be operational.

The JPSS Ground System plans mission activities and schedules based on spacecraft and payload housekeeping needs, science observation tasks and ground resource availabilities. It generates command loads based on the mission plan and verifies the load on FSE. Similar to JPSS-1, JPSS-2/3/4 use the Svalbard ground station as its primary ground station for T&C operations with contact on every revolution. During a pass, the MOT checks spacecraft health and safety through real-time and back-orbit telemetry. Command loads are routinely uplinked once a week to cover a 2-week period. The telemetry is analyzed and trended. The T&C operation is available through NASA's SN when contacts are needed outside of the nominal polar contact schedule, as well as for contingency operations. If the Svalbard ground station is not available,

NOAA's FCDAS ground station and KSAT's Troll ground station can be used as alternate sites for the T&C operations.

Mission orbital maintenance and analysis is carried out by the MOT. Orbit maneuvers and attitude calibration are performed when needed to maintain the desired orbit position and satellite orientations. CA analysis is conducted in conjunction with NASA's CARA on a daily basis. CA maneuvers are planned and performed when necessary to avoid collision with other space objects.

JPSS-2/3/4 use the JPSS Ka-band receptors at Svalbard and JPSS Ka-band receptors at McMurdo as primary means for their mission data acquisition. In this configuration, one Svalbard contact and one McMurdo contact are scheduled in each orbit for SMD acquisition, ensuring data latency of 80 minutes or less. In addition, FCDAS, and Troll ground stations, as well as TDRSS, all have Ka-band receiving capabilities. The FCDAS can be used as an alternate to Svalbard, while Troll can be used as an alternate to McMurdo. TDRSS can be used as a contingency option during anomaly situations and is used during Launch and Early Orbit activities.

During each contact, the SMD is downlinked through Ka-band link at 300 Mbps to either a polar ground station or via TDRSS in the case of contingency operations. The SMD is preprocessed into annotated VCDUs (aVCDUs) and routed to JSH in CONUS. JSH relays the aVCDUs to the NASA SDS in near real-time. It also removes duplicates, then extracts APs and forwards them to the Data Processing Nodes at the NSOF and CBU, where it is fully processed into JPSS MUPs for delivery to the ESPC and to the archival storage at the Comprehensive Large Array-Data Stewardship System (CLASS). The JPSS mission data (APs) are also made available to FNMOC and NAVOCEANO from the JPSS primary and backup operations centers for their data processing. The data product quality is monitored continuously in near real-time and trended over long period. Sensor calibration and product validation are performed routinely to ensure the data quality is within specifications.

The JPSS Ground System provides full data accounting capability for tracking data latency and data availability for the JPSS-2/3/4 missions. In the event a data loss is detected, retransmission can be initiated to recover the data from upstream data storage on the ground, most likely at the ground receiving sites. In a rare case when the data never reaches the ground, retransmission from the JPSS-2/3/4 onboard mass data storage can be commanded by the MOT. The JPSS-2/3/4 onboard mass data storage can store at least 8 hours of data so that the data can be retransmitted within the next 6 hours after its original transmission.

The JPSS-2/3/4 is capable of broadcasting observation data in real-time continuously around the globe. The observation data are transmitted at 25 Mbps via an X-band link, also known as HRD. Properly equipped, users on the ground within the view of satellite can receive and process the observation data for their local applications. The JPSS Ground System provides these Field Terminal customers with data processing algorithms and software, as well as operational support such as distribution of orbital elements, mission status and notices.

Nominally all mission management operations operate out of the MMC located at NOAA NSOF. However as an operational mission, the continuity of operations is critical to JPSS-2/3/4 mission success. Therefore an alternate mission operations facility is in Fairmont, WV to support T&C as well as essential mission data processing operations. In case the MMC at NSOF is

unavailable, the JPSS-2/3/4 operations can be transferred to the alternate facility within hours to minimize operational impacts.

During the JPSS-2/3/4 mission life, the JPSS Ground System will perform system sustainment for both flight and ground assets in coordination with spacecraft, instrument and ground factories. The flight software, including calibration tables, and spacecraft database will be upgraded as needed. Ground hardware and software, including algorithms, will also go through upgrades to maintain and enhance security, reliability, functionality, and performance. The JPSS Ground System is designed with redundant strings so that minimum downtime is required for major hardware and software upgrades.

JPSS-2/3/4 satellite handover from NASA (MOST) to NOAA (OSPO) occurs, respectively, at launch plus 90 days following the successful completion of an Operational Acceptance Review (OAR) to be held at the NSOF around launch plus 85 days. This review will demonstrate compliance of the satellite (spacecraft, instruments, and flight software) to requirements and demonstrate readiness to proceed with transfer of satellite operations from NASA to NOAA. Once this transition is completed, OSPO will provide 24-hour/7-day mission operations and anomaly support for the flight and data processing for the JPSS-2/3/4 satellite.

When each of the JPSS-2/3/4 satellite reaches the end of its mission life, the JPSS Ground System will support the generation and execution of the appropriate JPSS de-orbit plan for its orderly disposal.

5.3 Multi-Mission Operations

The JPSS Ground System is designed to support a fleet of heterogeneous polar-orbiting satellites with varying levels of operational requirements. For a specific mission, its operational needs will also change over its mission lifecycle, from initial checkout to commissioning, becoming operational, to transitioning to secondary, until its decommissioning and disposal. This may occur not only at satellite level, but also at sensor level. Since the resource is always limited, it is essential for the management to prioritize the mission's needs based on overall JPSS program goals and objectives, and provide clear guidance to the MOT for mission planning, resource deconfliction, and daily operations. The JPSS Ground System provides capabilities to facilitate deconfliction and prioritization throughout fleet operations from conjunction analysis, planning and scheduling to data routing, processing and product delivery.

5.3.1 Nominal Week-in-the-life

All mission activities, including onboard operations such as routine observation and non-routine orbit maneuvers and ground operations such as station maintenance and system upgrades, are referred to as tasks. The tasks are requested through a computerized system, reviewed and approved by appropriate operation authorities depending on its level of complexity and interdependency with other tasks. Only approved tasks are entered into the mission scheduling system.

To schedule mission and system activities, the JPSS MOT routinely performs the following operations:

- Receives event and ephemeris products from orbit operations.

- Schedules approved mission tasks.
- Schedules contact times for routine T&C and SMD downlink.
- Monitors the availability of space and ground resources.
- Conducts conjunction analysis to identify resource conflicts among JPSS missions and with other non-JPSS missions.
- Resolves conflicts based on the management guidance and through coordination with non-JPSS missions.
- Generates implementation products for each mission.
- Aggregates Ground Contact Schedules (GCS) of all missions into a Master Schedule (MS) for the JPSS Ground System, including its antenna, network, data processing resources. The Master Schedule illustrates from individual resource (e.g. SG-4 antenna at Svalbard) perspective all activities from all missions that will bear on the resource over the scheduled period.
- Distributes the schedule products.
- Assesses the Mission schedule performance with a weekly scheduling evaluation.
- Generates Mission Notices for the mission and system activities.

5.3.2 Nominal Day-in-the-life

With the mission and system schedules and implementation products, the MOT conducts daily operations. A typical routine ‘day-in-the-life’ of the JPSS-managed mission operations involves the following group of activities, which are instrumental in meeting the mission objectives:

1. Generate Stored Command and Operational Table Loads
2. Perform Mission Planning Activities (Schedule Contacts)
3. Routine Contact Activities
    a. Prepare for Scheduled Contacts
    b. Acquisition of Signal (AOS) & Verify Command Path/Telemetry
    c. Uplink Stored Command & Operational Table Loads (as-needed)
    d. Observe Satellite Performance using Real-time Telemetry
    e. Downlink stored mission data & back-orbit telemetry
    f. Terminate Contact at Loss of Signal (LOS)
4. Stored Mission Data (SMD) Handling & Transport
5. Data Product Processing & Distribution
6. Data Archive
7. Direct Broadcast (HRD)

8. Trending and Performance Monitoring (Satellite & Ground System)
9. Trending and Performance Monitoring of Product Quality

See Mission Concept of Operations documents for more information on a specific mission.

5.3.3 Sensor Constellation Operations

An important aspect of JPSS multi-mission operations is the Sensor Constellation Operations (SCO). The sensor constellation refers to a set of spacecraft carrying a near identical set of sensors operating in a near identical orbit. For example, S-NPP, JPSS-1 and JPSS-2 will constitute a sensor constellation as their payloads are nearly identical and their orbits are planned to be within a small range of the sun-synchronous, 824km, 98.7 degree, 1325 LTAN orbit. This section discusses two unique aspects of the constellation operations: flying satellites in close proximity and processing mission data from multiple sets of sensors.

5.3.3.1 Constellation Flying

The S-NPP, JPSS-1/2/3/4 series of spacecraft fly in a constellation known as the J-Train. S-NPP and JPSS-1/2/3/4 have similar orbital positioning requirements. S-NPP and JPSS-1 will nominally be 1/2 orbit (50.75 minutes) apart along-track at 824km and 1325 LTAN. They also have a specified ground track accuracy of ±20km, translating into ±43 seconds equatorial crossing variability. The JPSS Ground System is responsible for maintaining the individual spacecraft orbital positioning as well as the separation between the spacecraft.

Flying S-NPP and JPSS-1 in 1/2 orbit orbital separation, as shown in Figure 5.3.3-1, will yield significant science benefits because of maximized sensor swath overlap. They include:

- Better global coverage, especially of higher spatial resolution pixels/field-of-views.
- Both ATMS/CrIS footprint growth minimized.
- VIIRS footprint size growth minimized as the edge of scan on JPSS-1 would be near nadir for the S-NPP follow up.
  - All composited imagery and derived products will be 750 m to 1 km for M-bands (and 375 to ~ 500 m for I-bands)

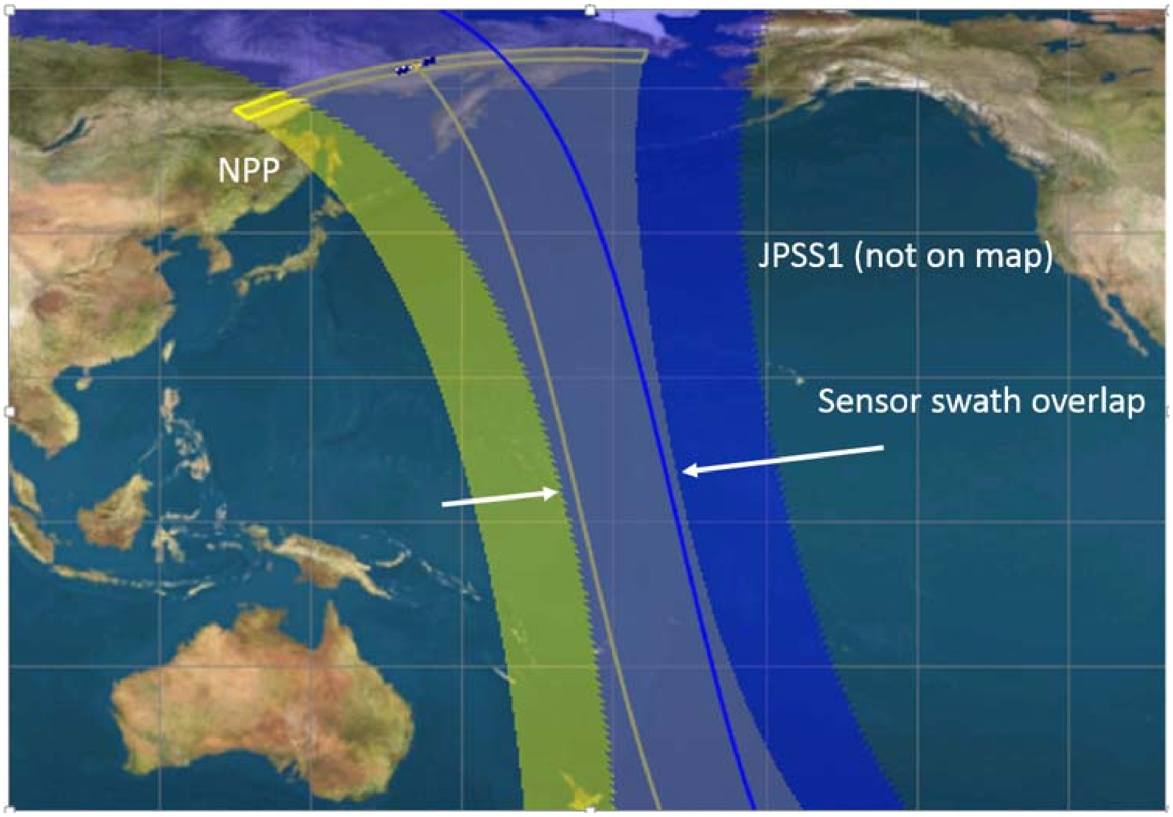


Figure: 5.3.3-1 Nominal JPSS-1 and S-NPP Contacts at Svalbard and McMurdo

The operations of the J-Train spacecraft can place additional demands on the ground infrastructure (antennas, back-end equipment and network communications resources) and the mission operations team in support of simultaneous T&C contacts and SMD contacts. Svalbard is the primary T&C ground station for S-NPP, JPSS-1/2/3/4 with its every orbit visibility and dedicated X/S-band antenna. During JPSS-1/2/3/4 launch and early orbit operations when a JPSS-1/2/3/4 satellite flies in its transition orbit with sufficient angular separation from another JPSS satellite, there may be simultaneous T&C contacts of both JPSS satellites at Svalbard. Svalbard is also the only available ground station with every orbit visibility for S-NPP SMD downlink at X-band. JPSS-1 will nominally downlink SMD twice per orbit using the Svalbard and McMurdo Ka-band receptors. By 1/2 orbit phasing between them, S-NPP and JPSS-1 will have near simultaneous SMD downlink (S-NPP at Svalbard and JPSS-1 at McMurdo) and processing (at NSOF and CBU) once each orbit. Figure 5.3.3-2 shows the timeline for nominal JPSS-1 and S-NPP contacts at Svalbard and McMurdo.

The FCDAS at Fairbanks, AK and Troll in Antarctica are available as alternate Ka/X/S-band ground stations in case of anomalies at Svalbard or McMurdo but their visibility to the J-Train spacecraft is limited to about 10 of 14 orbits per day. TDRSS provides full orbit visibility for T&C contacts on a scheduled basis, but the data rates are limited for telemetry and command return and forward links. JPSS-1 will have the capability to downlink SMD through TDRSS via Ka-band multiple times per orbit should a ground or spacecraft anomaly occur that prevent normal SMD downlink.

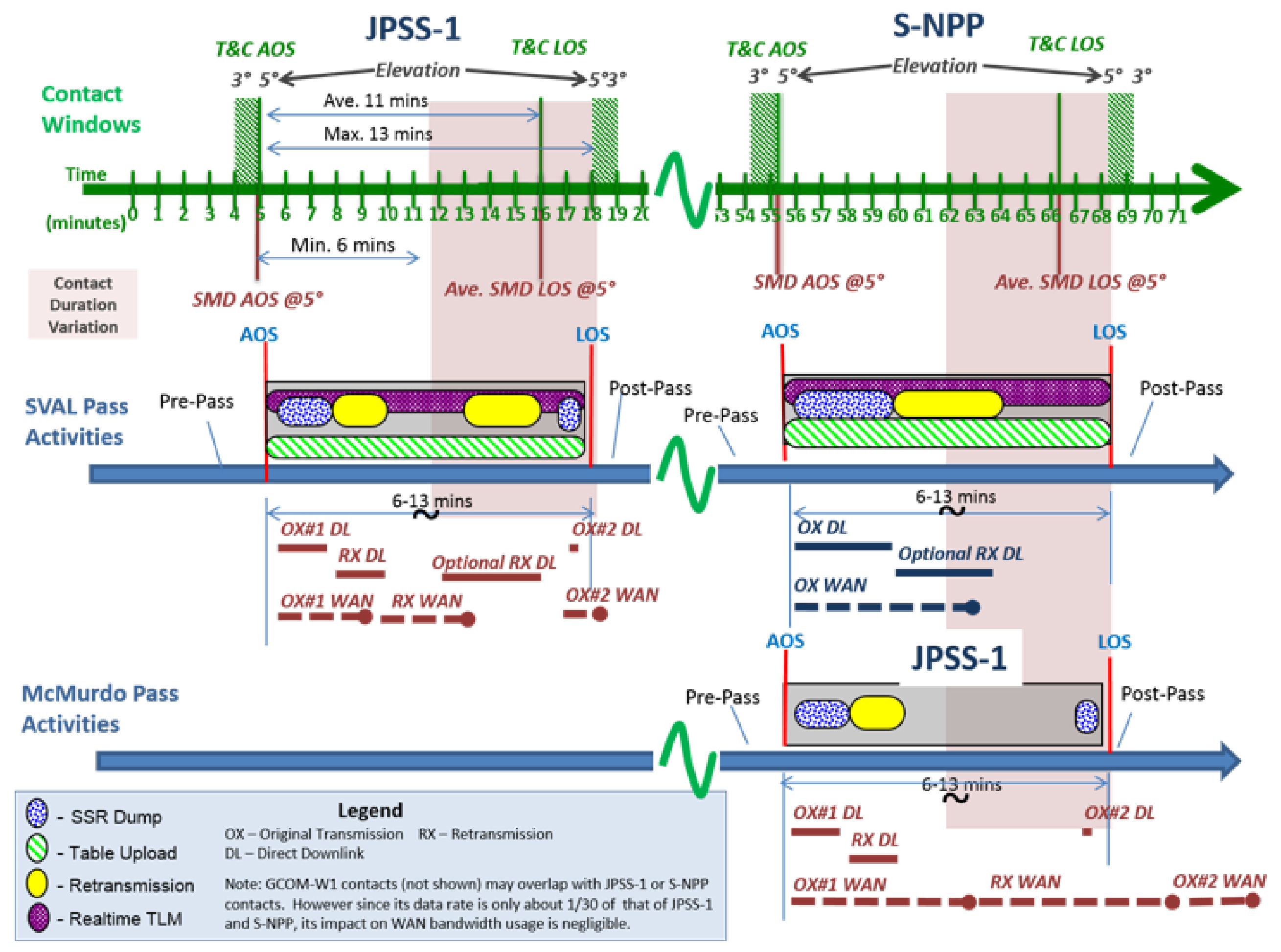


Figure: 5.3.3-2 Nominal JPSS-1 and S-NPP Contacts at Svalbard and McMurdo

5.3.3.2 Constellation Data Processing

The data processing of sensor constellation can be categorized into three phases: Transition, Concurrency, and Failover. The Transition phase focuses on the time period during which S-NPP is operational, and JPSS-1 has just completed Activation and Checkout. The Concurrence phase focuses on the time period during which JPSS-1 is operational after completing Intensive Calibration and Validation (ICV), and S-NPP is still functioning to some useful capacity. The Failover phase addresses the time period when some JPSS-1 functionality has been lost or significantly degraded. Figure 5.3.3-3 illustrates notional timeframes for the three phases.

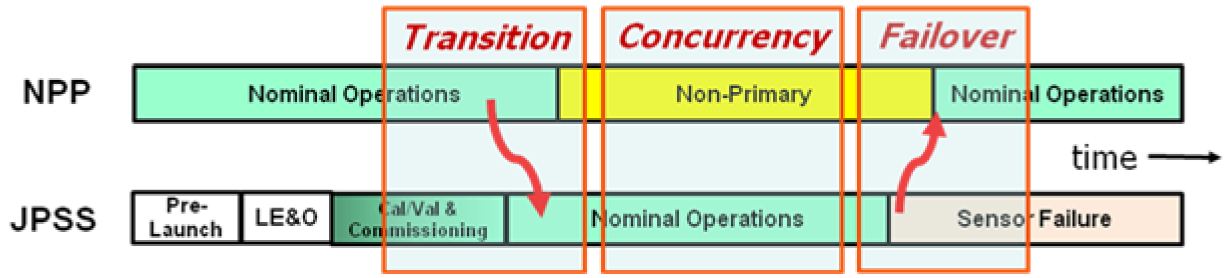


Figure: 5.3.3-3 Notional timeline for Transition, Concurrency and Failover

While these satellites are designed to supersede the existing one with the new, it is very likely, or even desirable, that there will be an extended overlap among these satellites beyond the initial transition period. The key attributes of the SCO can be summarized as the following:

- S-NPP and JPSS-1 will comprise a constellation in 1325 LTAN, similar to the A-Train, with managed orbital separation between satellites
- JPSS-1 leads S-NPP by 1/2 orbit (50.75 minutes) of along-track separation in the same LTAN mission orbit. When JPSS-2 is launched, it will lead JPSS-1 by 1/2 orbit of along-track separation in the same LTAN mission orbit with S-NPP moved to a position ¼ orbit from JPSS-1.
- Sensors do not get turned off if at least marginally operational
- There is only one complete set of operational data products to which the system data availability and latency requirements apply
- NOAA is responsible for identifying the operational EDR set through their standing Satellite Products and Services Review Board (SPSRB) process (based on data product team recommendations)
- The sensors from which the operational TDRs/SDRs are produced are referred to as primary sensors; primary sensors may reside on different spacecraft
- At a minimum, all Raw Data Records (RDRs) are produced for data from non-primary sensors; Housekeeping (HK) data from non-primary sensors need to be extracted from the Stored Mission Data (SMD) and delivered to the MMC for monitoring and trending
- SDRs are periodically produced for non-primary sensors to support routine calibration activities. This enables a more timely transition from non-primary to primary status in case of primary sensor anomaly
- The JPSS Ground System makes one complete set of operational data products and all RDRs from non-primary sensors available to its data consumers (The Application Packets to FNMOC and NAVOCEANO; and VCDUs to SDS). These products are also made available to CLASS for archival storage.
- Additional data products are generated from RDRs of non-primary sensors on a best effort basis and distributed based on a NOAA-defined priority when the system resources are available. Production of the non-primary products can be enabled or

disabled by spacecraft/sensor depending on available processing capacity and anomaly conditions.

Section 6.5.1, the Stored Mission Data Handling thread, provides a more detailed description of sensor constellation data processing concept.

5.3.4 JPSS Multi Mission System Robustness

Reserved [B2.2]

The JPSS multi mission system robustness concept implements the necessary elements for mandatory compliance with the NOAA NESDIS Policy for Continuity of Operational Polar Orbiting Environmental Satellite Observations. The purpose of this policy is to ensure continuity of polar satellite data and prevent a weather satellite data gap. As per the policy, JPSS will implement a robust satellite architecture, starting with the JPSS-2 mission, which provides continuity of sounding and imaging environmental data, and is operationally fault tolerant for the sounding data, as follows:

- Maintain on-orbit a primary and secondary source of microwave sounding and infrared sounding data, co-manifested with visible-infrared and UV imagery/radiometry instruments in the afternoon sun-synchronous orbit
- Develop and maintain on-ground a tertiary asset carrying at least microwave sounding and infrared sounding to return to a “two failures to a gap” condition for sounding, if a failure occurs
- Manifest the full complement of instruments designed to fly on the same mission as the sounders, unless precluded by an urgent need to launch a sounder contingency mission before the other manifested instruments can be ready

Compliance with the first condition of the NESDIS policy (maintain on-orbit a primary and secondary source of microwave & infrared sounding and imaging/radiometry) is established with the on-orbit operations of the JPSS-2 and JPSS-1 satellites and nominal instrument manifest. Compliance with the second condition (operational readiness of an on-ground tertiary asset containing at least the microwave & infrared sounders in response to an on-orbit failure associated with the availability of two sets of microwave/infrared sounder data) is accomplished with the development of a JPSS-3 contingency mission capability. This capability requires the accelerated readiness of the JPSS-3 spacecraft and microwave & infrared sounding instruments, which upon completion of integration can be placed into ground storage and available for launch within 12 months of an on-orbit failure with the primary or secondary sounding data assets.

This capability implies that the implementation of the JPSS-3 mission has two options: one using the full instrument complement, and another using only the microwave & infrared sounding instruments. Compliance with the third condition (baseline the full instrument complement for the JPSS-3/4 missions, but maintain the flexibility to reduce the manifest to contain the microwave & infrared sounders, at a minimum) is accomplished through flexible spacecraft and instrument schedule and integration plans, and requirements to replace a nominal mission instrument with the structural/thermal/mass elements necessary to support launch and mission operations with a reduced mission instrument complement, as appropriate.

Though the implementation of the NESDIS policy is focused on the JPSS Flight Segment elements, the JPSS Ground System is required to support both the operations of on-orbit assets and integration and testing of on-ground assets.

Table 5.3.4-1 provides the launch planning dates and launch readiness dates for the JPSS-2/3/4 missions, including the two implementation options for the JPSS-3 mission (Full Instrument Complement –or- Contingency Mission Complement with only the microwave and infrared sounding instruments). The decision to implement the Contingency Mission, with reduced instrument complement, will be made by NOAA to support the LRD of May 2023.

Table: 5.3.4-1 JPSS-2/3/4 Mission Robustness Capabilities

Mission	Instrument Complement	Launch Planning Date	Launch Readiness Date
JPSS-2	Full	07/2021	N/A
JPSS-3 Option 1: Contingency Mission	Microwave/Infrared Sounders Only	N/A	05/2023
JPSS-3 Option 2: Full Mission	Full	07/2026	01/2024
JPSS-4	Full	07/2031	04/2026

5.3.5 Radio Frequency Interference between JPSS Satellites during Orbit Attainment Phase

JPSS-1 is in the same orbit plane of S-NPP but at an altitude of 814 km, 10 km below that of S-NPP. JPSS-1 was gradually raised to its final orbit and position with ½ orbit separation from S-NPP. During that period, JPSS-1 flew close to but underneath S-NPP for some time. Since both satellites use identical S-band communication design and share the same S-band frequency, Radio Frequency Interference (RFI) becomes an issue. RF analysis shows that when both satellites fly within 24 degree of each other (relative to a ground-based antenna), their command and telemetry communications may be compromised. This RFI issue will get severe when JPSS-2 launches as it will have twice the chances to run close to other JPSS satellites (i.e., S-NPP and JPSS-1). Similar situation exists for JPSS-3 and JPSS-4 during their orbit attainment period.

The RFI mitigations that the MOT may choose to ensure satellite health and safety include the following:

- Provide the new satellite priority access to the Svalbard ground station during its most critical time in the spacecraft activation and instrument activation phases (for example, from Launch to Launch+5 (L+5) days for spacecraft activation; and from L+10 to L+15 days for instrument activation).
- Use alternate ground stations, including FCDAS and Troll, to support other satellites so that each mission will maintain T&C contact once per orbit. However it should be noted that once a day, there is a period of about three orbits when both FCDAS and Troll are not in view of S-NPP and JPSS satellites, leaving Svalbard the only available T&C site for dumping back-orbit telemetry.
- Use NASA Space Network for critical T&C needs through real-time commanding and telemetry.

- Schedule two shorter back-to-back T&C contacts at the Svalbard ground station with at least 5 minutes duration each.

5.4 Processing String Description & Utilization

The JPSS Ground System utilizes two-tier redundancy to support system upgrades and to ensure continuity of operations. The first tier is through the internal redundancy of the Space/Ground Communication Node (SGCN), the Ground Network Node (GNN), the Management and Operations Node (MON), and the Data Processing Node (DPN). The internal redundancy is achieved by the deployment of redundant servers, power supplies, disk drives, routers, switches, and firewalls. When a single unit fails, the mission operations automatically fail over to the redundant unit without interruption. Sufficient spares exist on site to replace the failed unit. The failed unit is either repaired or replaced per the maintenance agreement with unit's vendor.

The second tier of redundancy is provided by the deployment of redundant processing strings for the JSH, MON and DPN. It should be noted that while JSH is a part of MON performing SMD aggregation, buffering and distribution functions, it is listed as a separate entity for the purpose of string utilization discussion. As shown in Figure 5.4-1, an "A" and a "B" string are deployed at NSOF along with an Integration & Test (I&T) string. A "C" string is deployed at the Consolidated Back-Up (CBU) facility. Each of the "A", "B", and "C" strings is a physically separate collection of hardware and software resources capable of supporting full mission operations, including the support to all JPSS missions. Each of these operations-capable processing strings consists of built-in redundancy as described above to withstand a single failure in the system; and meets the required operational availability. The "C" string at CBU is normally operated by the operations staff at NSOF. The fact that it is located at a remote site should be transparent to the operators unless a physical inspection or intervention is required.

Figure 5.4-1 is intended to show string components in default configuration. As such it shows associated connections but not all possible ones. The components in physical strings may be cross-strapped to form a logical string in anomaly or other special situations. See Section 5.4.3 for more information.

The MON in each string is configured with three independent slots, each of which is capable of performing control, commanding and telemetry functions for a mission in a given mode (OPS or Test). Thus each string can support up to three different missions concurrently in the OPS mode, or two missions: the first one in the OPS mode, and the second one in both OPS and Test mode, respectively. Test mode is typically used to conduct simulations for load verification or anomaly resolution support.

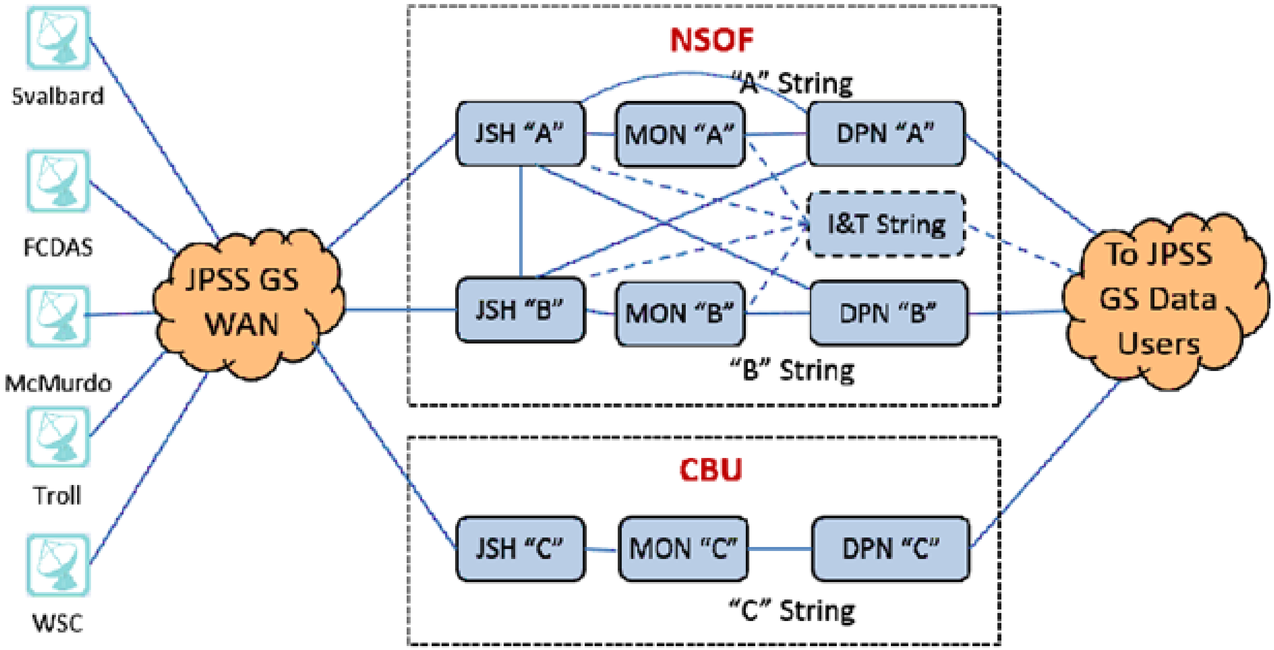


Figure: 5.4-1 JPSS Ground System Processing Strings

The "A" string is generally used for mission operations; and the "B" string for backups, upgrades, maintenance, mission testing and training. The "C" string is primarily designed to provide the Continuity of Operations (COOP) capability in case of a COOP event at NSOF. The COOP is defined as efforts to ensure that primary mission-essential functions continue to be performed during a wide range of emergencies, including localized acts of nature, accidents, and technological or attack-related emergencies. In a COOP event, the JPSS CGS is required to be able to support JPSS mission operations from CBU continuously for at least 30 days.

The I&T string located at NSOF provides limited MON and DPN processing capabilities; and is not capable of supporting mission operations. The I&T string is only used to validate loads, verify simple patches, and provide an initial test of new configuration of DPN at NSOF through the Integration, Test, and Check-Out (ITCO) process prior to moving this configuration to one of the operations-capable processing strings for full validation.

Each operations-capable string may perform one or more of the following activities:

1. **Primary Operations (Ops)**: supports all of the functions of the MON and DPN including planning and scheduling mission operations, monitoring satellite telemetry, commanding the satellite, processing science data to create JPSS data products, and delivering the products to the JPSS users. A string performing this activity is called an operational string.
2. **Backup Ops**: Allows the string to take over operations from the operational string quickly if the operational string were to fail. A string performing this activity is called a backup string. In this activity, the string ingests the same TLM and mission data as the operational string does, performs the same processing, and produces the same products. The main differences are that the commanding is disabled and the product distribution

disabled. In addition, there are certain MON functions such as planning and scheduling of mission operations, orbit operations, and management of ground system resources can only be done on the operational string. As result, some data needs to be synchronized periodically from the operational string to the backup string. This close synchronization ensures a smooth and rapid transition of operations to the backup string at the moment of notice in the event of failure on the operational string.

3. **Parallel Ops**: In the Parallel Ops, a string is used to validate new software and/or hardware releases, and/or new configurations without interrupting ongoing operations before deploying this new configuration to operations. The string ingests the same TLM and/or mission data as the operational string does, performs the same processing, and produces the same products as called for by the specific test. The commanding and/or data distribution may be temporarily enabled for validations. If a string running the Parallel Ops were required to take over operations, this string would be re-configured to fall-back to the last known working hardware and software configuration before assuming an operational role.
4. **Test**: In the Test activity, a string is used to perform extensive test activities in support of mission integrations and mission rehearsals. The string may or may not be in the same configuration as the operational string, depending on the need of tests. The test activity also encompasses "on the job" training; anomaly resolution; and development of new spacecraft activities before moving them into operations. In addition, the Simulation activity is an important part of test. In the Simulation activity, a string is connected to FVS, J1Sim, or FSE (B2.2) simulators. This can be used for operational purposes such as checking a command load prior to performing to the operational satellite or non-operational purposes such as training. Note that the hardware-based high fidelity simulators, i.e., one FVS for S-NPP and one J1Sim-EDU for JPSS-1, are only located at NSOF.

For example, String A may support concurrently the S-NPP Primary Operations in its slot A1, the S-NPP Simulation in slot A2, and the JPSS-1 Backup Operations in slot A3.

In addition to the MON and DPN strings, there are other elements that are shared by both MON and DPN strings. They are referred to as the Common. The Common elements, compartmentalized for increased security, include the Internet De-Militarized Zone (IDMZ), the Mission De-Militarized Zone (MDMZ) (including the Mission Support Data Server (MSDS)), the CGS Common Services (CCS) (including the JSH strings), and the Security Enclave.

The IDMZ provides isolation of data flow going out of and into CGS from and to JPSS external interface. MDMZ provides isolated data environment for sharing mission data among different JPSS sites and environments. The CGS Common Services contains the common functionality to support multiple environments such as CGS configuration management, Enterprise Management infrastructure, SFTP service, domain control, etc. Finally the Service Enclave provides security data collection, repository, and management across the system.

To ensure the continuity of mission-essential functions, there should be at least one string running the Backup operations at all time. When the primary operating environment suffers a complete failure, the time-critical functions will be transitioned to the backup operating environment within 5 minutes. Such time-critical functions include satellite command, control,

and data product production and distribution. The transition is considered complete when the system is available for mission operations and capable of delivering data products.

The transition of non-time-critical functions should be completed within 90 minutes of initiation of the transition. This includes all primary operation environment functions other than the ones categorized as the time-critical functions. Typically all system functions can be restored within 30 minutes with the exception of enterprise reporting.

5.4.1 Representative String Utilization Scenarios

While it is not practical to list all possible scenarios to use the strings, Table 5.4.1-1 provides a summary of the most representative string utilization scenarios. Details of these scenarios are provided in the tables and diagrams that follow. As examples, these scenarios don't list all missions running on the operational string, rather just major missions such as S-NPP, GCOM-W1 (GW1) and/or JPSS-1 (J1). In the following tables and discussions, String X refers to a collection of JSH X, MON X and DPN X.

Table: 5.4.1-1 String Utilization Scenario Examples

No.	Scenario	Purpose
1	Nominal Operations	Nominal system operations to support all JPSS missions
2	JPSS-1 Pre-Launch Mission Testing	Prior to JPSS-1 launch, JPSS Compatibility Tests (JCTs), Operational Readiness Exercises (OREs), and Mission Rehearsals (MRs) were performed.
2a	JPSS-1 Pre-Launch Testing - End-to-end system test	Prior to the JPSS-1 launch, MOST conducted an end-to-end system test, involving external users. To mimic the real mission operations, the test was conducted on the operational string, running both operational S-NPP and GCOM-W1 data as well as JPSS-1 test data.
3	JPSS-1 Launch, Early Orbit and Activation (LEO&A)	Ensure a dedicated string is available to support JPSS-1 until it is in its operating orbit and initial check out of the satellite and the instruments are complete. This will isolate the S-NPP and GCOM-W1 mission operations from potential disturbances of JPSS-1 LEO&A operations.
4	System Upgrade	Support nominal operations while validating the system software and hardware upgrades on a separate string through ITCO.
5	Operations Transition from B1.2 to B2.0	Transition the Operations from the B1.2 system to the B2.0 system after the successful B2.0 Operations Based Site Acceptance Test (OB SAT), Ground Project Acceptance Test (GPAT) and the Operations Readiness Review (ORR). The transition will take place in multiple steps.
6	COOP	The operations are transitioned from NSOF to CBU due to a catastrophic failure at NSOF such as an extended power outage.

No.	Scenario	Purpose
7	Transition between A and B strings	a) With B string running Backup Ops b) With B string not running Backup Ops
8	JPSS-2 Pre-Launch Mission Testing (B2.2)	Prior to JPSS-2 launch, JPSS Compatibility Tests (JCTs), Operational Readiness Exercises (OREs), and Mission Rehearsals (MRs) will be performed.

Table 5.4.1-2 describes the roles each string plays during the Nominal Operations; and Figure 5.4.1-1 depicts the data flow through the strings.

Table: 5.4.1-2 Nominal Operations

Environment	Activities
A String	**Primary Ops** - to provide dedicated support to the J2/J1/S-NPP/GW1 operations.
B String	**Backup Ops** - to provide backup to the operational string in case of a failure. It ingests J2/J1/S-NPP/GW1 mission data, performs telemetry processing and product generation but no commanding and product distribution. MON B is closely synchronized with MON A. The Data Analysis Report (DAR) file generated by DPN A is copied to DPN B daily. *In case of an A String failure, the time-critical operations on A can transition to B within 5 min.* **Test** - Alternately B can be used to validate loads and databases, test patches, and support anomaly resolutions.
C String	**Backup Ops** - to provide backup to the operational string in case of a COOP event. It ingests J2/J1/S-NPP/GW1 mission data, performs telemetry processing and product generation but no commanding and product distribution. MON C is closely synchronized with MON A. The DAR file generated by DPN A is copied to DPN C daily.
I&T	**Test** - To validate command and table loads, databases; to validate Ops products; and to test patches.
Notes	1. All strings run on a common operational baseline. 2. Tiles on DPN are backed up weekly, with optional daily update. 3. Nominally DPN C at CBU acquires the ancillary data from the ESPC PDA at CBU for its data production. If the ESPC PDA at CBU is unavailable due to maintenance or testing, the DPN C may connect to the ESPC PDA at NSOF for the ancillary data.

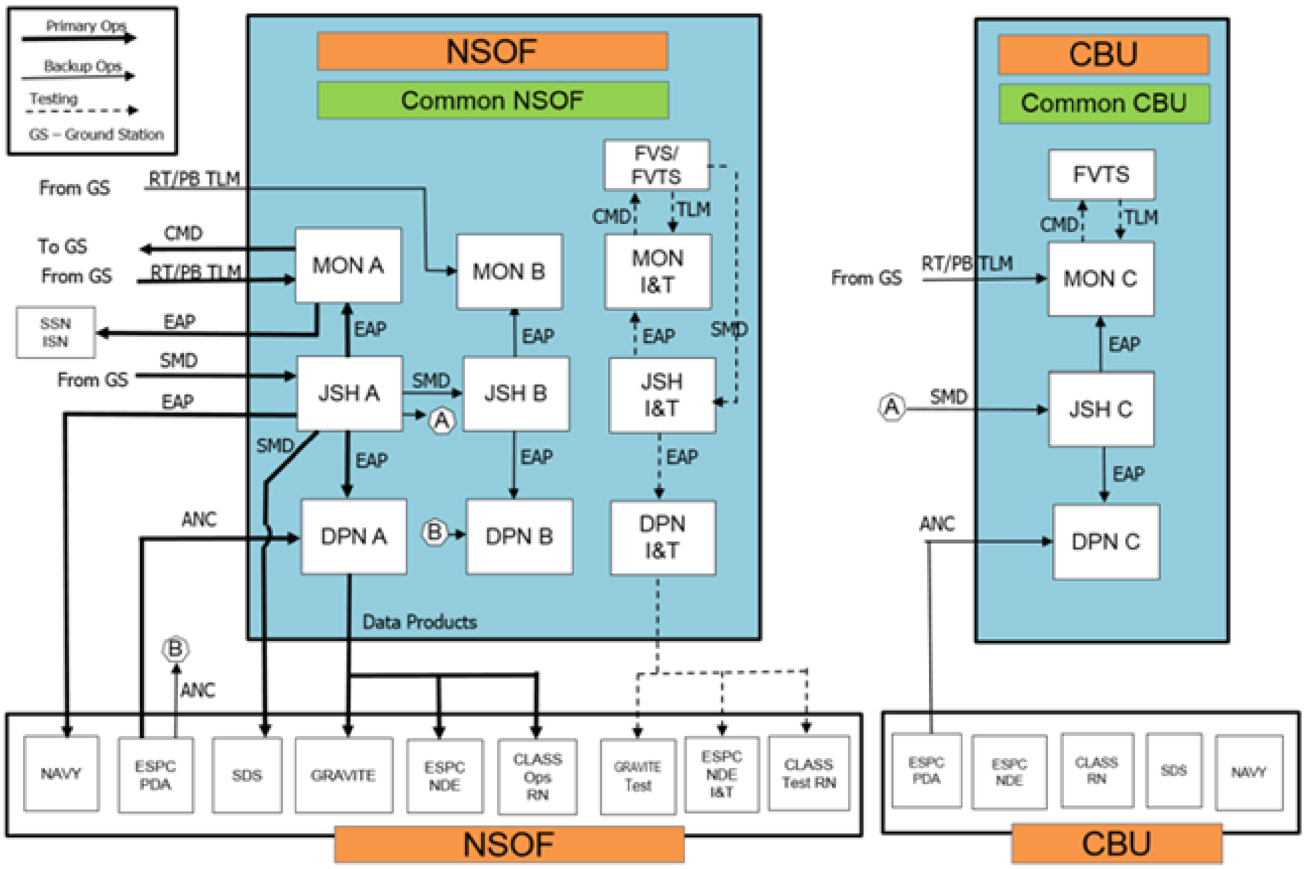


Figure: 5.4.1-1 Nominal Operations Data Flow

Table 5.4.1-3 describes the roles each string plays during JPSS-1 Pre-Launch Mission Testing; and Figure 5.4.1-2 depicts the data flows through the strings.

Table: 5.4.1-3 JPSS-1 Pre-Launch Mission Testing

Environment	Activities
A String	**Primary Ops** - to provide dedicated support to the S-NPP/GW1 operations
B String	**Test**- to perform the J1 pre-launch testing. The B String receives J1 test data to check out the end-to-end data flow, and performs J1 Commanding and Telemetry (C&T) testing using the J1Sim. The B String may also ingest S-NPP/GW1 data to test multi-mission scenarios. *In case of an A String failure, the MON operations on A can be transitioned to the B String using the S-NPP baseline on B. MON and DPN can be transitioned independently. The tiles from the operational DPN may be loaded to the B String DPN on a weekly basis.*
C String	**Backup Ops** - to provide backup to the operational string in case of a COOP event. It ingests S-NPP and GW1 mission data, performs telemetry processing and product generation but no commanding and product distribution. Its MON is closely synchronized with the operational string.

Environment	Activities
	In case of a MON A failure, the operations on MON A may be transition to MON C, which is operated from NSOF.
I&T	**Test -** To validate command and table loads, databases; validate Ops products; and to test patches. May also be used to support J1 testing
Notes	The operational baselines for S-NPP and J1 may diverge during this period so that frequent updates for J1 will not interfere with the S-NPP operations. The baseline updates for the J1 mission can be tested and run on the B String. The S-NPP baseline remains on the B String to support transition in case of failure. The diverged baselines will be merged into the common operational baseline prior to the launch.

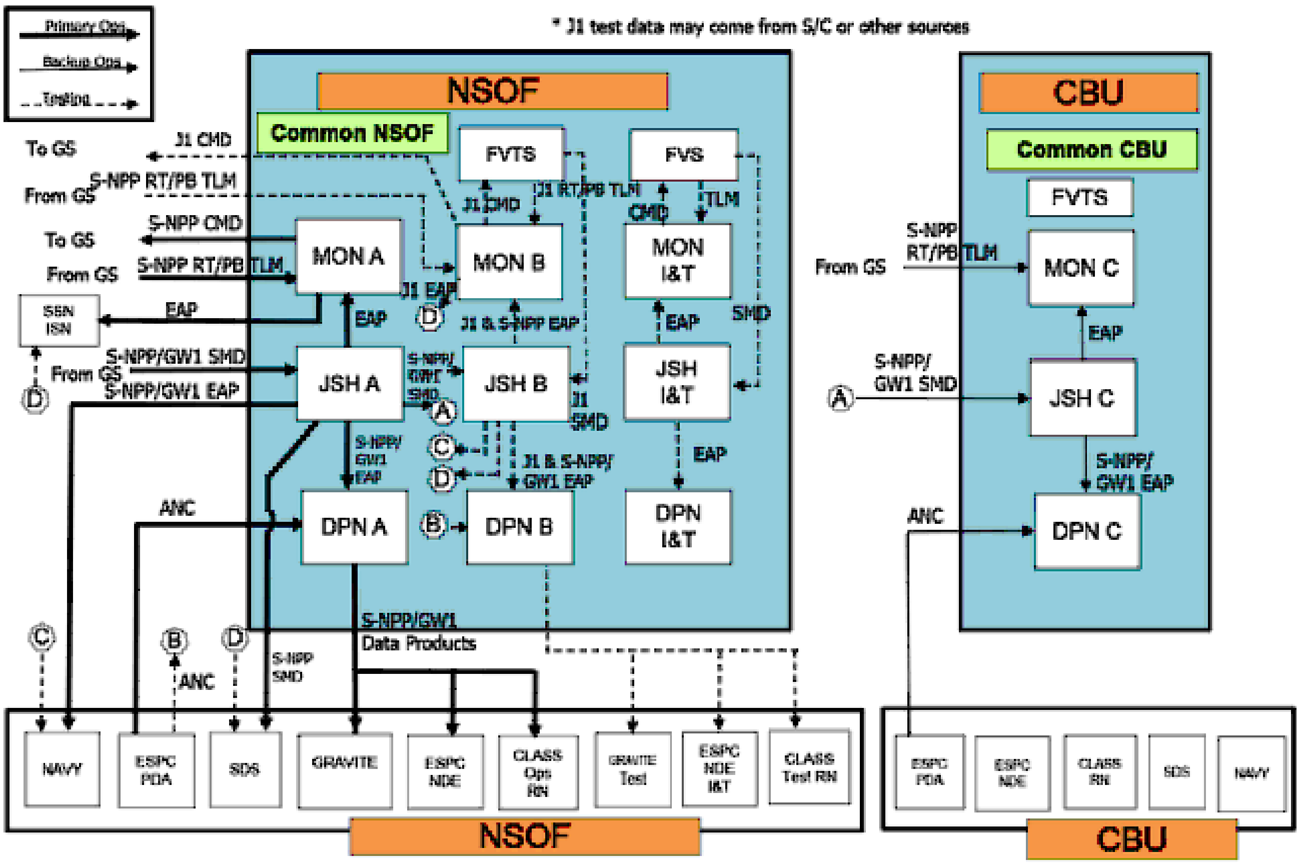


Figure: 5.4.1-2 JPSS-1 Pre-Launch Mission Testing Data Flows

Table 5.4.1-4 describes the roles each string plays during JPSS-1 Pre-Launch End-To-End system testing; and Figure 5.4.1-3 depicts the data flows through the strings.

Table: 5.4.1-4 JPSS-1 Pre-launch End-To-End System Testing

Environment	Activities
A String	**Primary Ops/Test -** to conduct S-NPP/GW1 operations; and to perform the J1 end-to-end testing using simulated data. Products of all missions are delivered to the users: the S-NPP/GW1 products marked as Operational; and the J1 products as Test.

Environment	Activities
B String	**Backup Ops/Test -** In case of an A String failure, the S-NPP/GW1 operations on A can be transitioned to the B String using the S-NPP baseline on B. MON and DPN can be transitioned independently.
C String	**Backup Ops/Test -** to provide backup to the operational string in case of a COOP event. It ingests S-NPP and GW1 mission data, performs telemetry processing and product generation but no commanding and product distribution. MON C is closely synchronized with MON A. The DAR file generated by DPN A is copied to DPN C daily. *In case of a MON A failure, the operations on MON A may be transition to MON C, which is operated from NSOF.*
I&T	**Test -** To validate command and table loads, databases; validate Ops products; and to test patches.
Notes	1. All strings run on a common operational baseline. 2. Both operational and test data (clearly marked) products are delivered to user's operational system as part of this end-to-end test, which may last up to a week. 3. After the test, the ops needs to be transitioned to B String so that A String can be cleaned up (of test data).

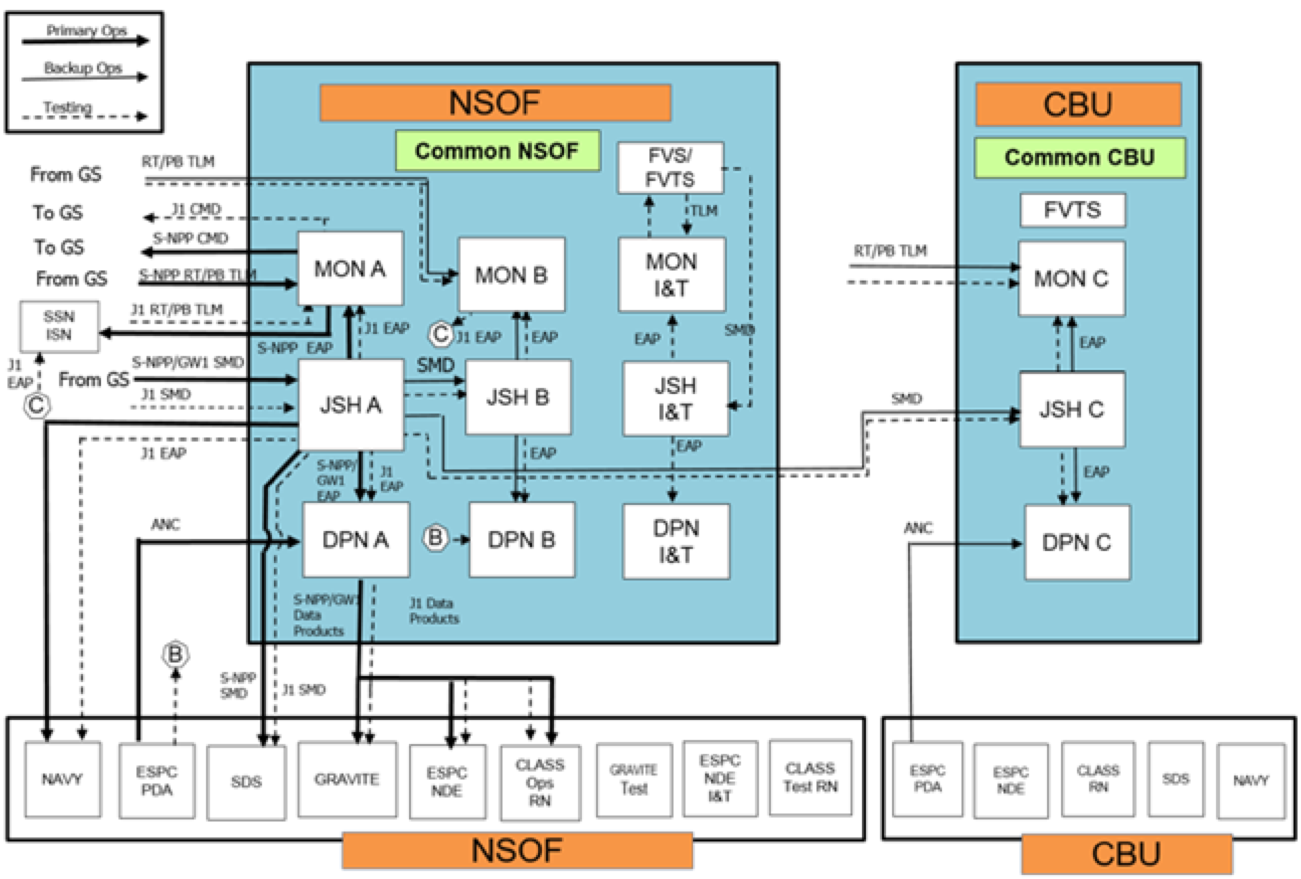


Figure: 5.4.1-3 JPSS-1 Pre-launch End-To-End System Testing Data Flows

Table 5.4.1-5 describes the roles each string plays during JPSS-1 Launch, Early Orbit & Activation (LEO&A) operations; and Figure 5.4.1-4 depicts the data flows through the strings.

Table: 5.4.1-5 JPSS-1 LEO&A Operations

Environment	Activities
A String	**Primary Ops -** MON A provides support to the S-NPP/GW1 operations. JSH A delivers EAPs to FNMOC and NAVOCEANO. DPN A processes and delivers all S-NPP/GW1 data products to the users. *In case of MON B failure, the J1 operations on B can be transitioned to A.*
B String	**Primary Ops -** MON B performs the J1 LEO&A operations. J1 EAP is forwarded by JSH B to DPN B for processing. No routine J1 product output to the users during this period. *In case of an A String failure, the MON operations on A can be transitioned to the B String to support the S-NPP operations. The DPN operations on A can also be transitioned to the B String to support all S-NPP/GW1 and J1 data product generation and delivery.*
C String	**Backup Ops -** to provide backup to A and B in case of a COOP event. It ingests S-NPP/GW1 and J1 mission data, performs telemetry processing and product generation but no commanding and product distribution. MON C is closely synchronized with the MON A and MON B. The DAR file generated by DPN A is copied to DPN C daily. *In case of a MON A or B failure, the operations on MON A and B can be transitioned to MON C, which is operated from NSOF.*
I&T	**Test -** To validate command and table loads, databases; validate Ops products; and to test patches.
Notes	1. All strings normally run on a common operational baseline. But String B may take emergency patch independent of Strings A and C. *2. For a given mission, Commanding can only be conducted from one site, either NSOF or CBU.* 3. In this configuration, ground station resources are pre-allocated to each string so that mission planning and scheduling for each mission can be conducted independently for each mission. Frequent data sync among the strings allows view of individual mission plan on all strings. 4. This configuration ensures isolation of J1 Ops from that of S-NPP, thus minimizing potential impacts on S-NPP operations.

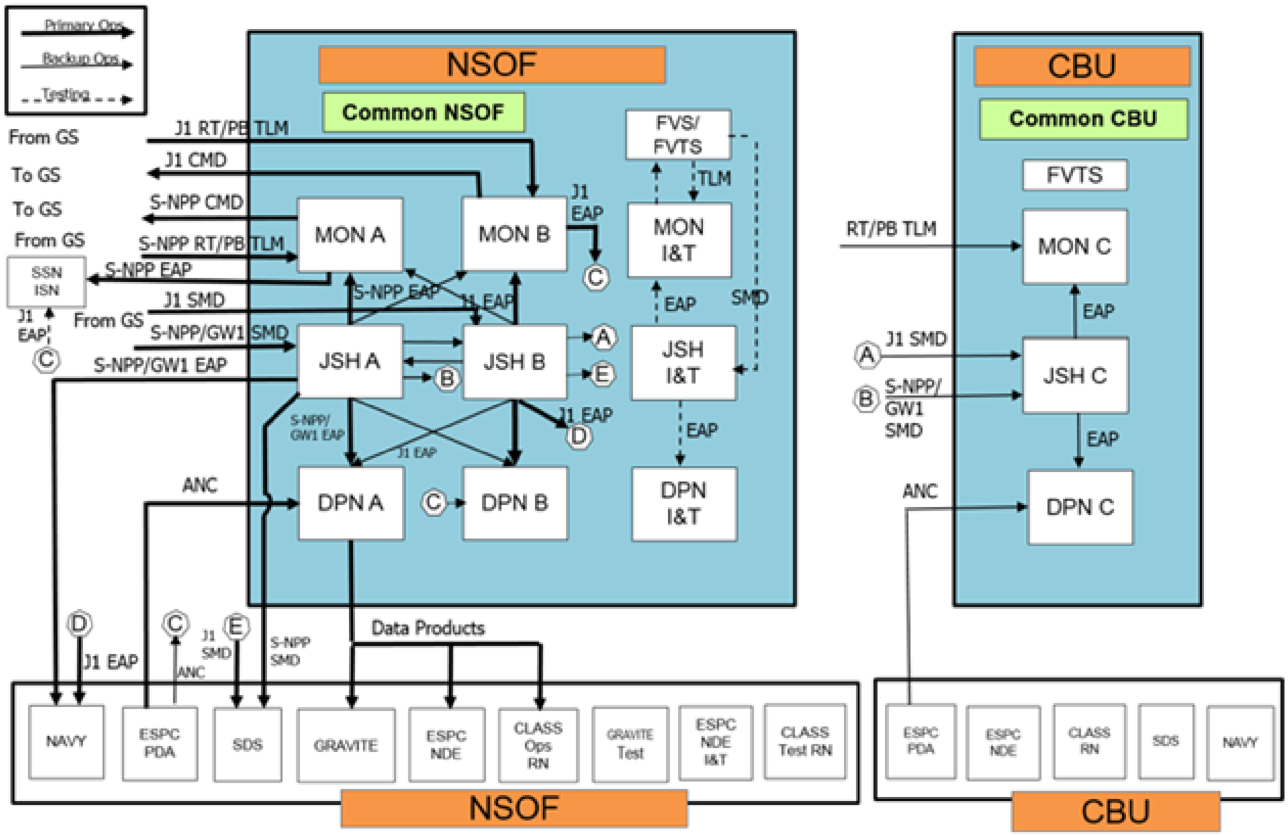


Figure: 5.4.1-4 JPSS-1 LEO&A operations Data Flows

Table 5.4.1-6 describes the roles each string plays during a Major System Upgrade; and Figure 5.4.1-4 depicts the data flows through the strings.

Table: 5.4.1-6 Major System Upgrade

Environment	Activities
A String	**Primary Ops -** to provide dedicated support to the S-NPP, GW1, J1 and J2 operations.
B String	**Parallel Ops -** to verify and certify the new system HW/SW releases. Run full ITCO. The test period depends on the contents of release, but typically takes up to two weeks. Commanding and data distribution may be temporarily enabled for full validation.
C String	**Backup Ops -** to provide backup to the operational strings in case of a COOP event. It ingests S-NPP, GW1, J1 and J2 mission data, performs telemetry processing and product generation but no commanding and product distribution. Its MON is closely synchronized with the MONs on the A String. *In case of an A String failure, the operations on A can be transitioned to C, which is operated from NSOF, to support the nominal operations. JSH, MON, and DPN can transition independently.*
I&T	**Test -** to verify the new release first before it is moved to the B String; to validate loads and databases; and to test patches.

Environment	Activities
Notes	The new releases should be fully tested on the factory string and I&T string before be moved to the B String. Once the ITCO is complete, the B String will be configured as the Operational string and the A String will run Backup ops for a period of time. The upgrade will continue on the A String followed by the C String. Test scope may be adjusted for limited releases, e.g., single SI (SOTC, STA, CLG, etc.)

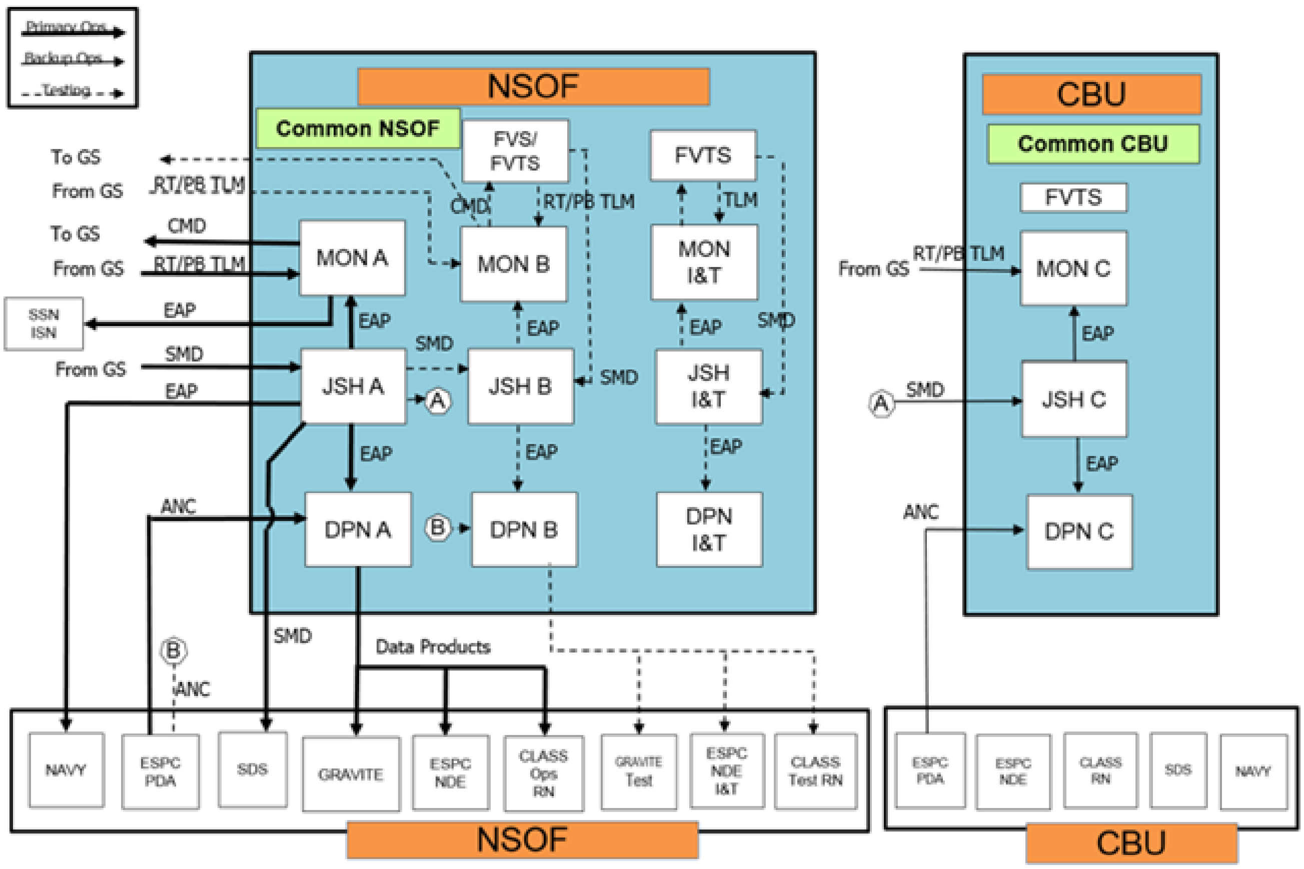


Figure: 5.4.1-5 Major System Upgrade Data Flows

Table 5.4.1-7 describes the roles each string plays during the Operation Transition from B1.2 to B2.0; and Figures 5.4.1-6 through 5.4.1-9 depict the data flows through the strings. The Transition To Operations (TTO) follows the successful completion of Block 2.0 L3AT/GPAT/GSAT (LG2) activities, Operations Readiness Review (ORR) preparation activities, and ORR. TTO will take around 30-45 days. Transition of all key mission elements and their customers to Block 2.0 expected occur up to TTO +90 days.

Table: 5.4.1-7 Operations Transition from B1.2 to B2.0

Environment	Step 1	Step 2	Step 3	Step 4
B1.2 String	**Primary Ops -** provide dedicated support to the S-NPP and GW1 operations until B2.0 TTO	**Backup Ops -** after the primary S-NPP and GW1 operations are transitioned to the B String, serves as the backup	**Backup Ops -** continue to serve as the backup to the B String	
B String	**Operational Readiness Activities** – Run shadow and parallel ops to demonstrate operations readiness.	**Primary Ops -** provide dedicated support to the S-NPP and GW1 operations from B2.0 TTO	**Primary Ops -** provide dedicated support to the S-NPP and GW1 operations.	**Primary Ops -** provide dedicated support to the S-NPP and GW1 operations.
A String	**Test -** support J1 testing activities.	**Test -** support J1 testing activities.	**Test** – support J1 testing activities. **Parallel Ops** – Run parallel ops to demonstrate operations readiness.	**Test** – support J1 testing activities
C String	**Test** – ORR prep test activities and backup to support J1 testing activities	**Backup Ops** – serve as the backup to the B String	**Backup Ops** – serve as the backup to the B String	**Backup Ops** – serve as the backup to the B String
I&T	**Test -** to validate loads and databases; to validate ops products; and to test patches.	**Test -** to validate loads and databases; to validate ops products; and to test patches.	**Test -** to validate loads and databases; to validate ops products; and to test patches.	**Test -** to validate loads and databases; to validate ops products; and to test patches.

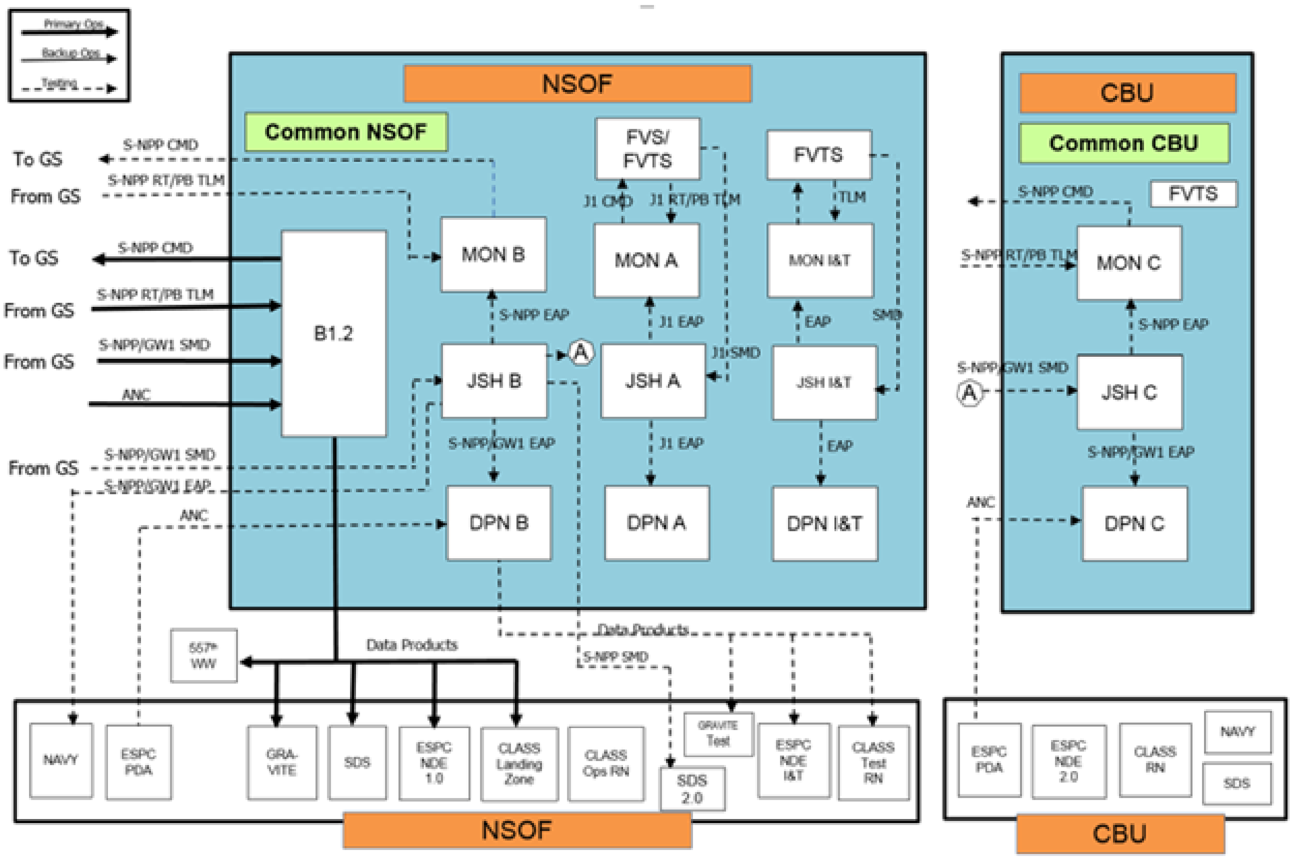


Figure: 5.4.1-6 Operations Transition from B1.2 to B2.0 - Step 1 Data Flow

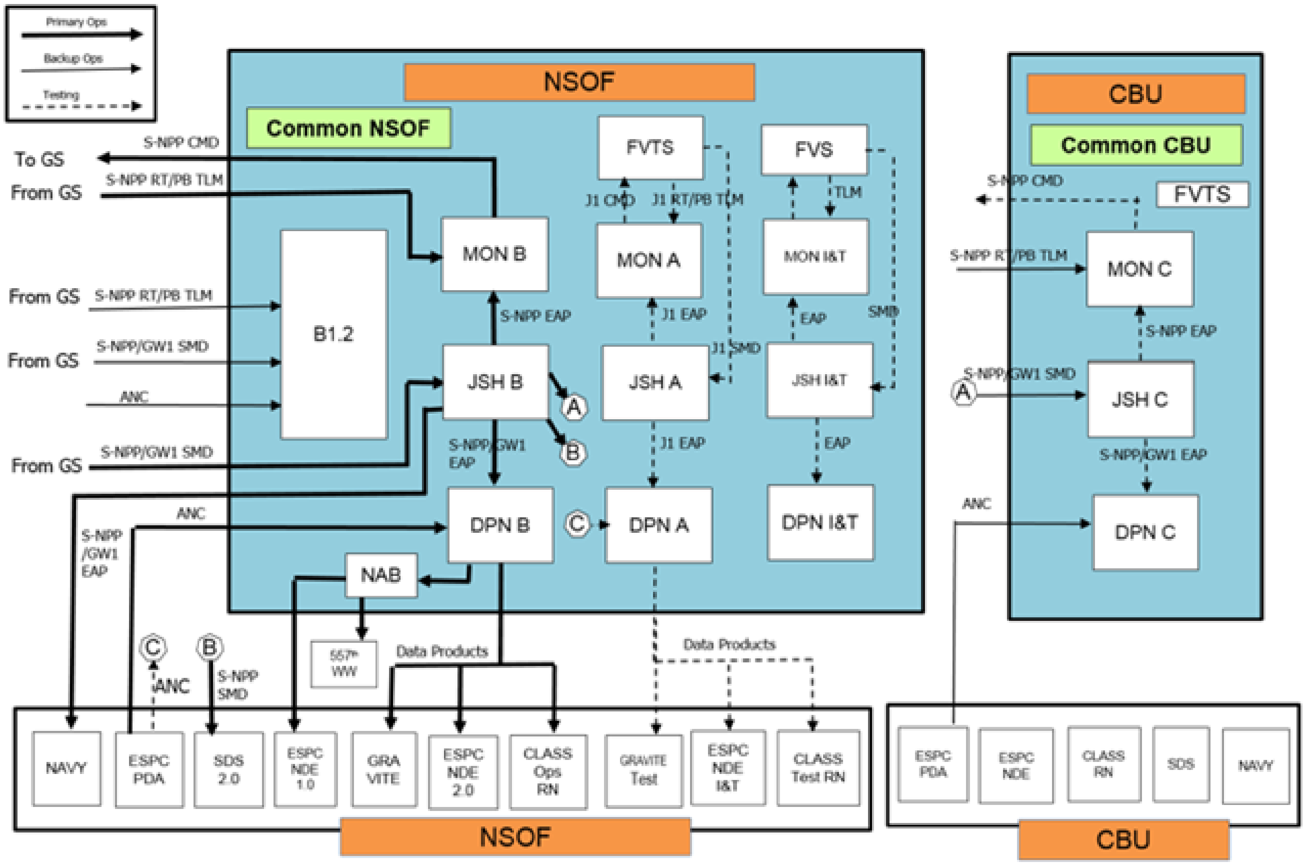


Figure: 5.4.1-7 Operations Transition from B1.2 to B2.0 - Step 2 Data Flow

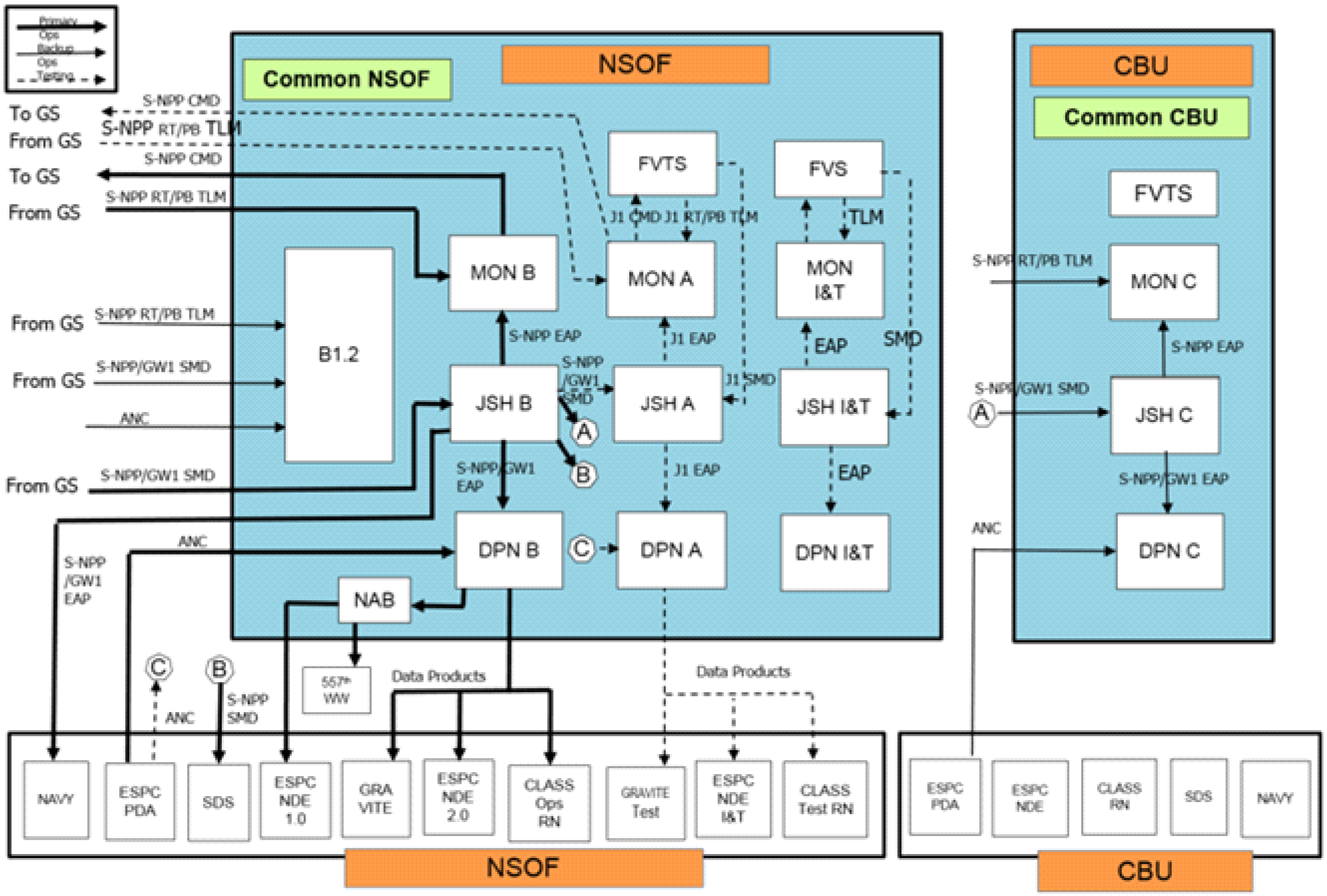


Figure: 5.4.1-8 Operations Transition from B1.2 to B2.0 - Step 3 Data Flow

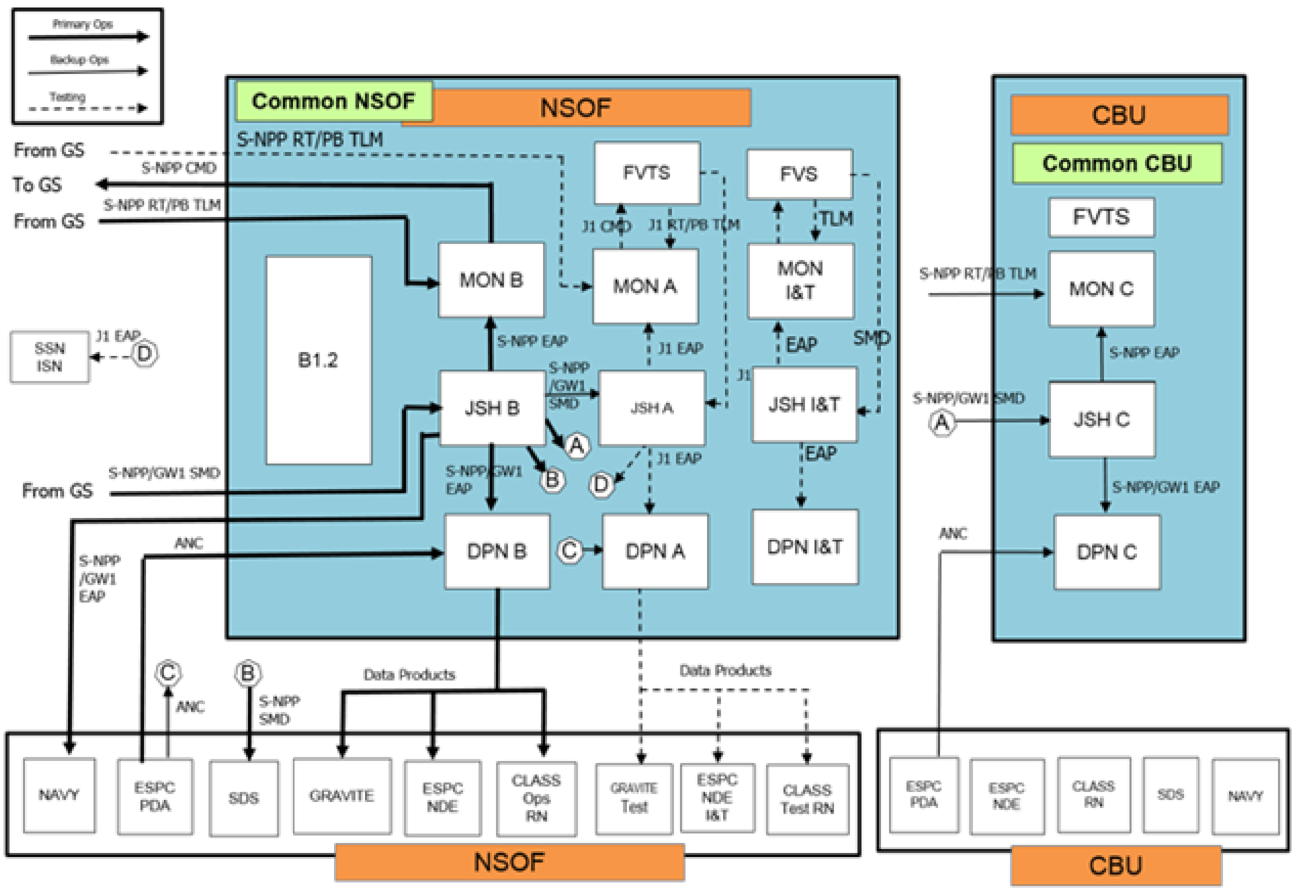


Figure: 5.4.1-9 Operations Transition from B1.2 to B2.0 - Step 4 Data Flow

Table 5.4.1-8 describes the roles each string plays during Continuity of Operations (COOP) when the mission operations are transitioned to the CBU facility in Fairmont West Virginia; and Figures 5.4.1-10 and 5.4.1-11 depicts the data flows through the strings.

Table: 5.4.1-8 Continuity of Operations

String	Activity
A String	**Down** Once NSOF operability is restored, run Parallel Ops in preparation of transition the operations from CBU back to NSOF
B String	**Down**
C String	**Primary Ops** – Once the transition is complete, resume S-NPP, GW1, J1, and J2 mission operations. Data products are distributed to FNMOC, NAVOCEANO, SDS, ESPC, and CLASS. Once stabilized, recover any missing data from the ground stations and perform recovery processing while conducting current operations.

String	Activity
Notes	This could be a planned transition, like in a proficiency exercise; or a unplanned transition, like in a real COOP event or when ESPC has to go to CBU. When DPN transitions to CBU, ESPC and CLASS need to transition as well, as DPN C only delivers to the ESPC and CLASS at CBU *During COOP, GRAVITE may acquire data products from CLASS.*

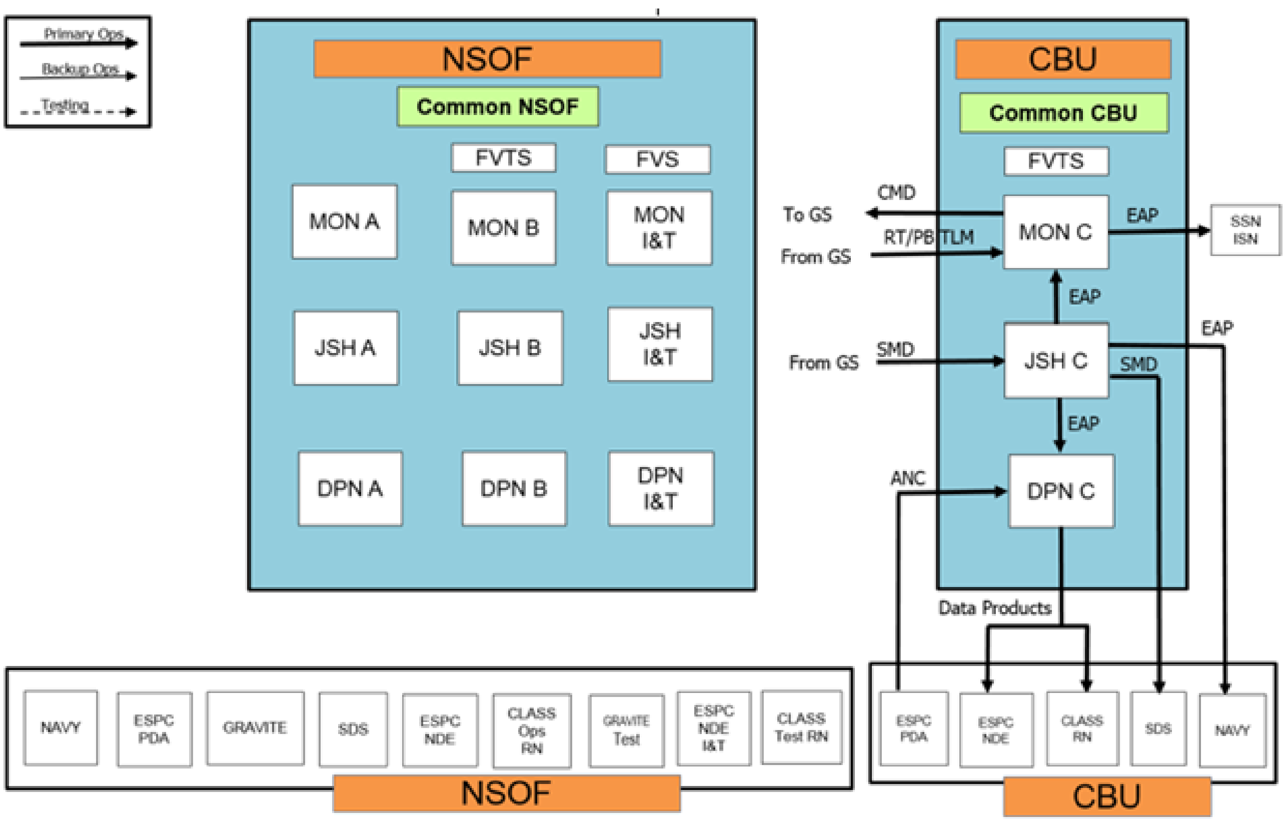


Figure: 5.4.1-10 COOP Data Flow

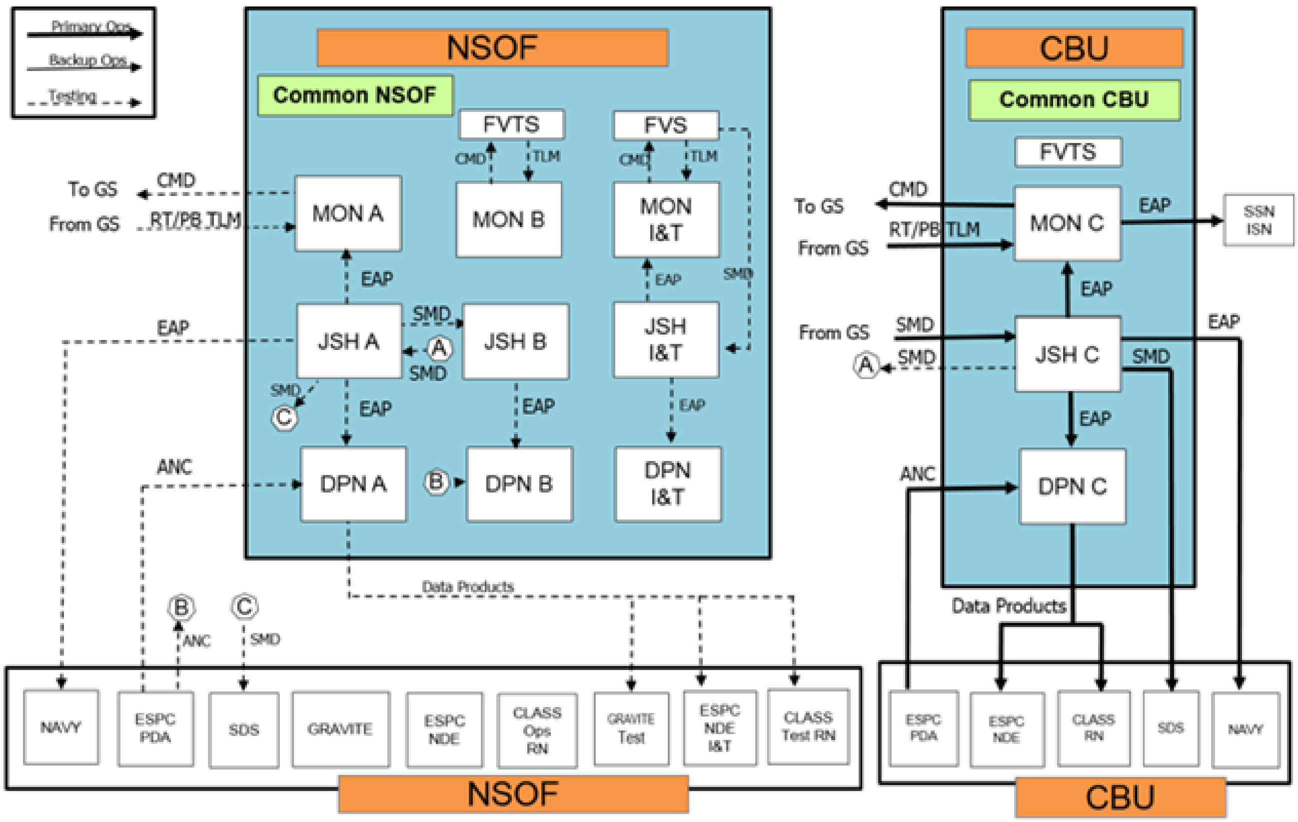


Figure: 5.4.1-11 COOP Data Flow in Preparation to Transition Back to NSOF

Table 5.4.1-9 and 5.4.1-10 describe the activity each string plays during transitions between the A and B strings.

Table: 5.4.1-9 Transition from A to B when B Runs Backup Ops

Environment	Activities
A String	**Down in 3 cases:** MON only, DPN only, Both MON and DPN **Primary Ops** - if only MON or DPN is transitioned.
B String	**Primary Ops** - to support S-NPP, GW1, J1 and J2 nominal operations. Depending on the failure, either MON or DPN or both are transitioned.
C String	**Backup Ops (COOP)** - to provide backup to the operational strings in case of a NSOF infrastructure failure. It ingests S-NPP, GW1, J1 and J2 mission data, performs telemetry processing and product generation but no commanding and product distribution. Its MON is closely synchronized with the MON on the Operational String (A or B). The DAR file generated by the Primary Ops DPN is copied to DPN C.
Notes	This is an unplanned transition. Because B had been running backup ops, the configuration and operational data on both strings should be closely synchronized. The transition of time-critical functions completes within 5 minutes and that of remaining functions within 90 minutes.

Table: 5.4.1-10 Transition from A to B when B not running Backup Ops

Environment	Activities
A String	**Down in 3 cases:** MON only, DPN only, Both MON and DPN **Primary Ops** - if only MON or DPN transitioned.
B String	**Primary Ops** - B is started on a short notice to support S-NPP, GW1, J1 and J2 nominal operations. Depending on the failure, the transition can be only MON, only DPN, or both. If DPN is transitioned to the B String, the tiles needs be uploaded to the B string from the backup data storage before the operation resumes.
C String	**Backup Ops (COOP)** - to provide backup to the operational strings in case of a NSOF infrastructure failure. It ingests S-NPP, GW1, J1 and J2 mission data, performs telemetry processing and product generation but no commanding and product distribution. Its MON is closely synchronized with MON on the A String if only DPN is transitioned, or MON on the B string otherwise.
Notes	This is an unplanned transition without B running backup ops. Critical operational data has to be uploaded before the operations can commence on the B String. The transition time vary depending on the state of B string prior to the transition.

Table 5.4.1-11 describes the roles each string plays during JPSS-2 (J2) Pre-Launch Mission Testing; and Figure 5.4.1-12 depicts the data flows through the strings.

Table: 5.4.1-11 JPSS-2 Pre-Launch Mission Testing

Environment	Activities
A String	**Primary Ops -** to provide dedicated support to the J1/S-NPP/GW1 operations
B String	**Test**- to perform the J2 pre-launch testing. The B String receives J2 test data to check out the end-to-end data flow, and performs J2 Commanding and Telemetry (C&T) testing using J2 FSE. The B String may also ingest J1/S-NPP/GW1 data to test multi-mission scenarios. *In case of an A String failure, the MON operations on A can be transitioned to the B String using the J1/S-NPP baseline on B. MON and DPN can be transitioned independently. The tiles from the operational DPN may be loaded to the B String DPN on a weekly basis.*
C String	**Backup Ops** - to provide backup to the operational string in case of a COOP event. It ingests J1, S-NPP and GW1 mission data, performs telemetry processing and product generation but no commanding and product distribution. Its MON is closely synchronized with the operational string. *In case of a MON A failure, the operations on MON A may be transition to MON C, which is operated from NSOF.*
I&T	**Test** - To validate command and table loads, databases; validate Ops products; and to test patches. May also be used to support J2 testing
Notes	The operational baselines for J1/S-NPP and J2 may diverge during this period so that frequent updates for J2 will not interfere with the J1/S-NPP operations. The baseline updates for the J2 mission can be tested and run

Environment	Activities
	on the B String. The J1/S-NPP baseline remains on the B String to support transition in case of failure. The diverged baselines will be merged into the common operational baseline prior to the launch.

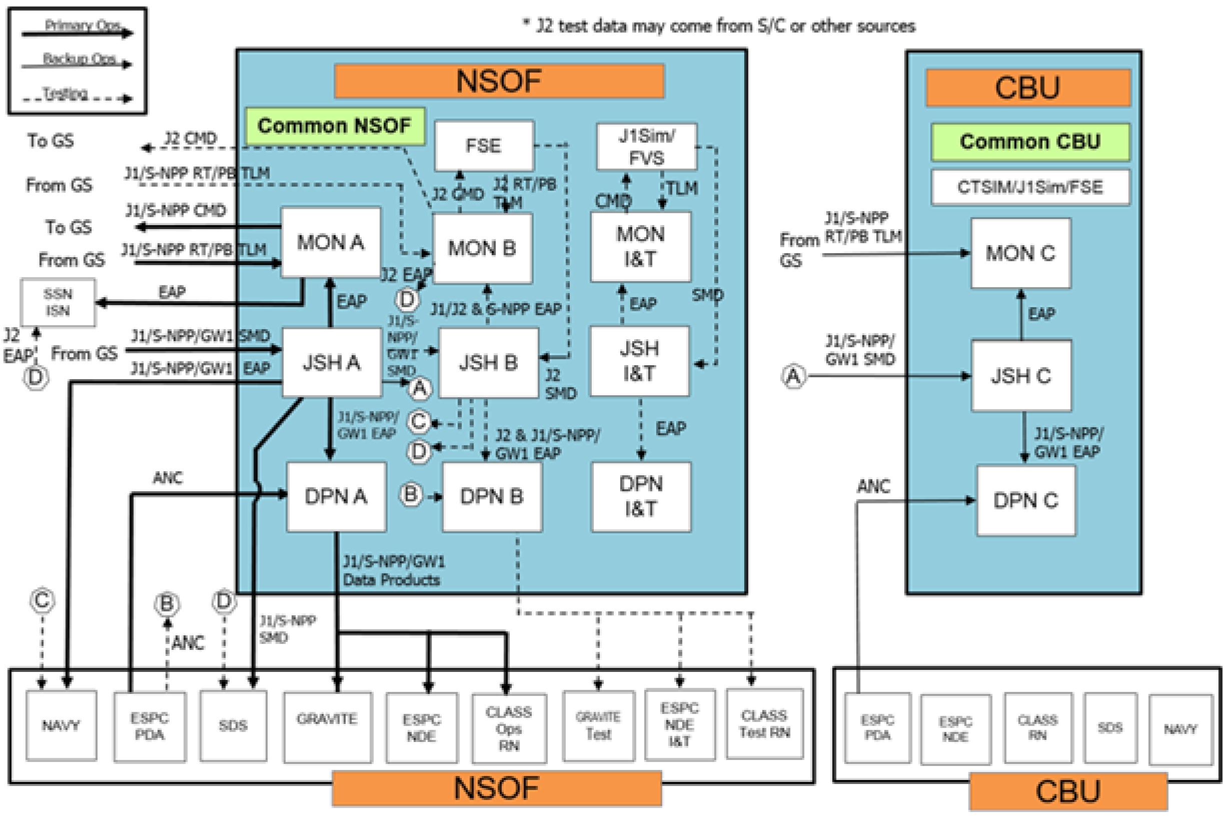


Figure: 5.4.1-12 JPSS-2 Pre-Launch Mission Testing Data Flows

5.4.2 Data Distribution during Transitions

5.4.2.1 Data distribution during transition between DPN A and B

Assumptions:

- Each string has a unique set of URLs for user's making requests
- All users are supported
- Users are notified the DPN transitions via mission notices
- The transition time to be configured is based on the observation time, not "wall clock" time. It should always be later than the"wall clock" time at the time of configuration
- The product starting time is the earliest observation time of its data; while the product ending time is the latest observation time of its data

- Based on the configured mode, the primary DPN string generates products marked as "OPS" and the backup DPN generates products marked as "POP". Both types of products are equally valid for delivery as operational products
- Users have set up separate Landing Zone (LZ) for each DPN string
- While DPN A to B transition is described below, transition from DPN B to A is the same except change of direction and role

Planned DPN Transition from A to B

- Needed after software upgrades
- DPN A is running at the time of transition and will continue running until it is safe to stop it
- DPN A supports deliveries for products with the ending time before the transition time
- DPN B supports deliveries for products with the starting time after the transition time
- Products with starting time before and ending time after the transition time will be delivered from both DPN A (marked as OPS) and B (marked as POP), as illustrated in Figure: Planned DPN Transition
- DPN A will stay up for at least 24 hours and may stay up to 7 days of transition to support product repairs and redeliveries.
- Reject any request for products not supported after the transition and notify the user
- Support delayed deliveries (e.g., to CLASS)

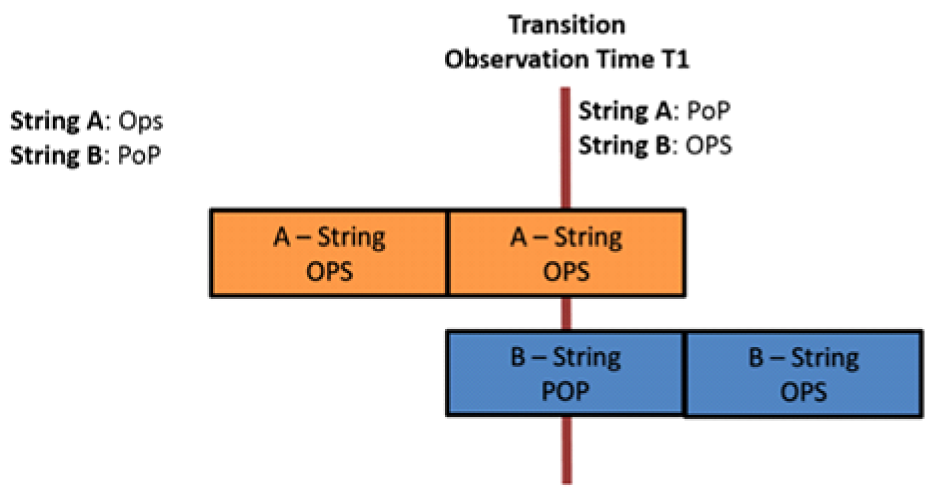


Figure: 5.4.2-1 Product Delivery during Planned DPN Transition

Unplanned DPN Transition from A to B

- DPN A stopped processing and cannot be brought back online in a timely manner
- DPN B may need to set up Tiles and data delivery requests; and reprocess the data if not running Backup (Parallel) Ops

- DPN B supports delivery requests for products with the selected starting time before the outage to ensure there is no data gap
- Different request times may be set for different users
- Duplicate data may be included in the delivery to ensure there is no data gap

5.4.2.2 Data distribution during transition due to COOP

Assumptions:

- DPN C has been running as a Backup with products marked as "POP" (delivery disabled)
- DPN C has a unique set of URLs for user's making requests
- Only DPN users who have presence at CBU are supported, i.e. ESPC, CLASS
- SDS, FNMOC and NAVOCEANO will receive data from JSH C
- Other users may acquire data from CLASS
- Users are notified the DPN transitions via mission notices
- Predefined requests are loaded in DPN C
- Transition is coordinated with mission partners, including ESPC and CLASS

COOP Transition from NSOF DPN A to CBU DPN C, as illustrated by Figure: Unplanned DPN Transitions

- NSOF suffers a catastrophic failure
- DPN stops product generation and delivery at observation time T1
- DPN C continues product generation with products marked as POP
- DPN C is transitioned from POP to OPS mode at observation time T2, after which it begins generating products marked as OPS
- DPN C product delivery is enabled from observation time T1 or earlier once ESPC and/or CLASS are ready
- From the requested observation time T1 DPN C delivers products generated before its transition and marked as POP till the delivery reaches its transition time (T2), from which it delivers products generated after the transition and marked as OPS
- Different delivery request times may be set for different users
- Users can make ad-hoc requests from DPN C by observation time
- Duplicate data may be included in the delivery to ensure there is no data gap

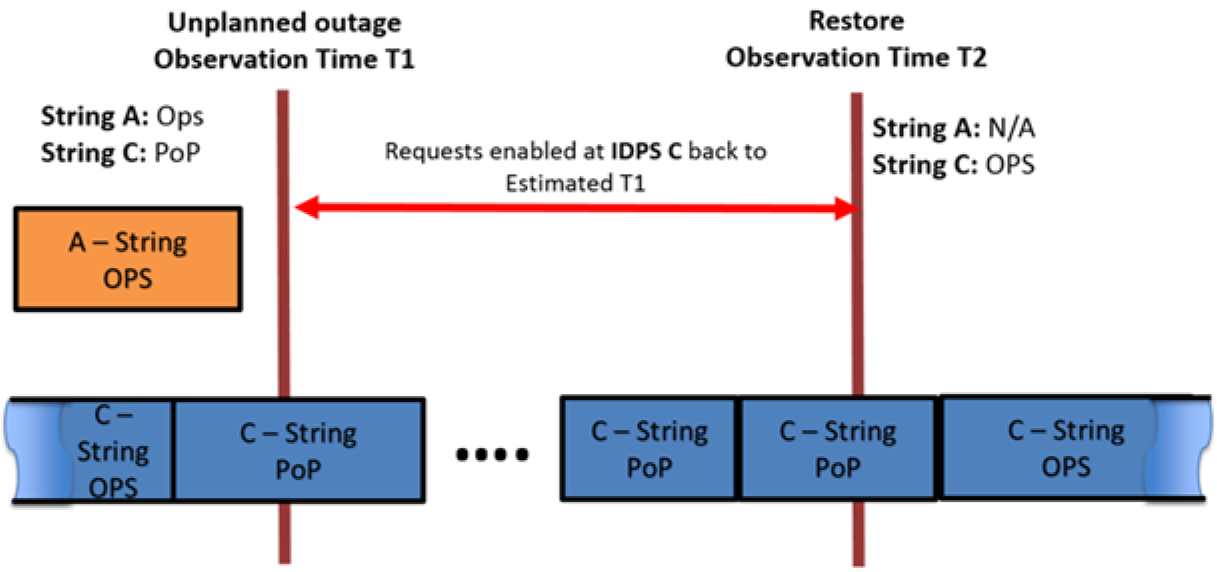


Figure: 5.4.2-2 Unplanned DPN Transition

Planned Transition from CBU to NSOF

- NSOF is restored
- DPN A and B have been running Parallel Ops for several days to build up their data archive
- A planned transition from DPN C to DPN A similar to Planned A to B, if ESPC and CLASS at CBU are kept up for 24 hours after the transition
- Otherwise no reach back to DPN C once ESPC and CLASS are transitioned to NSOF. All requests for the past data will be serviced by DPN A
- CLASS can have different transition time for its delayed delivery

5.4.3 Independent Transitions of String Components

For the purpose of operations transitions, MON, JSH and DPN are not dependent of each other. As such, they can be transitioned independently. However for the consideration of data latency, it is recommended that, if needed, DPN and JSH are transitioned together from NSOF to CBU and back. In summary:

For transitions between A and B at NSOF:

- JSH is capable of transitioning independently from MON and DPN
- MON is capable of transitioning independently from DPN and JSH
- DPN is capable of transitioning independently from MON and JSH

For example, a logical string after transition may consist of MON A, JSH B and DPN B.

For transitions between NSOF to CBU:

- MON is capable of transitioning between NSOF and CBU independently from DPN and JSH
- DPN and JSH are capable of transitioning together between NSOF and CBU independently from MON
  - This may be needed if ESPC has to transition from NSOF to CBU

For example, a logical string after transition may consist of MON C, JSH A, and DPN B.

5.4.4 Independent Transitions of Common Components

As introduced in Section 5.4, The IDMZ, MDMZ, CCS and Security Enclave are considered the Common components shared by the processing strings. The Common at NSOF is shared by String A and String B; while the Common at CBU is used by String C. The Common can be transitioned between the NSOF and CBU independent of the strings. However care has to be taken when the primary controls are split to both NSOF and CBU sites (e.g., S-NPP and JPSS-1 ops on A-string at NSOF and JPSS-2 ops on C-string at CBU). Since only one IDMZ (either at NSOF or at CBU) can be active, the operations products generated by MM, OO, and CLG at the site where IDMZ is not active cannot be transmitted to external parties automatically. Instead MOT needs to manually move these files to the other site so that they can be transmitted to the external parties through the active IDMZ. Note that inbound data (e.g., schedule request) through the active IDMZ is automatically synchronized to the other site thus no special action is required. The FTS will have access to the IDMZ when Common is transitioned to CBU (outside of COOP occasions). This allows FTS to provide necessary information to the direct readout community no matter where operations is functioning.

In addition, when the primary controls are split to both NSOF and CBU sites, the ground station equipment are also divided into two sets, one controlled by string and the other by the other string. The status of one set of equipment is only available to the site that controls that set of equipment and not available to the other site automatically.

Like JSH, the MSD Server (MSDS), a part of MDMZ, has A and B at NSOF and C at CBU. The operations of MSDS can be transitioned independently from that of Common, JSH, MON, and DPN.

5.5 Transition of Operations to NOAA

Following the commissioning of S-NPP, JPSS Ground Project assumed full responsibility for mission operations from the NPOESS Preparatory Project. The S-NPP Mission Operations Manager managed the operations that were performed by a joint MOT staffed with both JPSS Ground and NOAA OSPO personnel.

The transition of operations to NOAA OSPO occurs in a phased approach. For the S-NPP mission, at approximately Launch+12 months, day to day C3S and IDPS operations were assumed by OSPO personnel, predominately 24x7 operations positions. Then at Launch+15 months, the operations management was assumed by OSPO, with the operations support positions fully staffed and managed by the JPSS Ground Project. The Satellite Control Authority was transferred to the NOAA OSPO, but mission requirement satisfaction responsibility was

retained by NASA Science Missions Directorate (SMD) and the Mission Management function is retained by JPSS Program and Ground/Flight Projects.

For the JPSS-1 and JPSS-2 missions, NOAA OSPO takes responsibility for mission operations at Launch+90 days (reference JPSS PID – Program Implementation Document, Table B-1). The sustainment handover to NOAA/NESDIS OSGS will occur in February 2019, and the maintenance handover to OSPO will occur in February 2019 (references JPSS Transition Framework).

5.6 System Sustainment

In the JPSS Program, the Ground Project manages the sustainment of the Ground System while the Flight Project manages that of space systems for the S-NPP and JPSS Missions.

The Flight Project provides the space sustainment through the arrangement of Post Delivery Support (PDS) with the spacecraft and instrument vendors. These space system support entities work with the MOT closely to coordinate the sustainment activities.

The ground sustainment activities include:

- Delivering periodic Maintenance Releases that correct defects, address usability issues, or functionally enhance the system for custom software, COTS hardware and software. The sustainment plans the content of each delivery, coordinates and obtains the required approvals, implements corrective actions, and performs factory testing
- Managing all issues, anomalies and/or required changes
- Supporting anomaly resolution
- Maintaining the operational baseline and configuration files
- Sharing the support responsibility for COTS hardware and software maintenance and warranty management with the O&S Helpdesk in Indianapolis, where the Centralized Logistic Management (CLM) function is performed
- Providing updates to JPSS Ground System asset and sustainability information
- Supporting maintenance of vendor agreements
- Updating user guides and training materials for hardware and software
- Updating segment documents
- Providing “Tech refreshes” of deployed equipment that has reached end of life
- Coordinating returns to vendor for failure analysis, repair and verification

The CGS Support Node provides the CGS sustainment.

5.7 Situational Awareness and Data Accountability

The JPSS Ground System is used to provide satellite management, space ground communications, data processing, and data routing to several important domestic and international operational environmental observation missions. Because the JPSS Ground System

is critical to the success of these missions, it must have a very high operational availability. In order to achieve that high availability improved situational awareness is required to identify problems quickly so they can be resolved before mission performance is affected.

The JPSS Ground System supports situational awareness by providing a set of system capabilities for real-time monitoring and comprehensive reporting of the State-of-Health of all JPSS resources, including all terrestrial and space assets. The ground system must also maintain awareness of the availability of assets for scheduling. Detailed status information is necessary to accomplish these objectives.

The following three types of status information are required to meet the JPSS objectives described in the above paragraphs.

State of Health (SOH): SOH information consists of hardware and software status for the equipment and software running at the JPSS Ground System nodes (i.e. the Ground Station, Ground Network, the Data Processing, and Mission Management) as well at the telemetry based status from the spacecraft supported by JPSS.

Configuration: Configuration information consists of a listing of the specific hardware, software, and firmware versions and serial numbers for all of the equipment in the JPSS Ground System. Compatibility checks should be made to ensure that all of the closely coupled equipment, software, and firmware are at the compatible versions.

Mission Performance: Mission performance information provides status on whether or not the JPSS Ground System is providing complete and high quality data to its end users. This information consists of the following two types of data:

- **Data Accountability & Delivery:** This includes monitoring of items such as processing throughput performance and data presence or absence. It includes system level technical performance parameters such as data latency and data availability.
- **Data Quality Assurance:** This category includes selected quality related metrics on the delivered data products. These metrics range from statistics on individual data product granules to summary level information or trending over long periods of time.

Additional information on SOH and configuration information can be found in the System Status /Situational Awareness section of this document (Section 6.2.3); and additional information on mission performance information can be found in the SMD Handling (Section 6.5.1), Data Quality Assurance (Section 6.5.3), and Data Accounting & Recovery (Section 6.5.2).

The following two approaches are employed to identify the key status information that can affect system performance in time to take effective corrective action.

Data Thresholds and Filtering: For each status item, thresholds are established for out of tolerance conditions. Typically three levels are used: Normal, Warning, or Alarm. These status levels are used in conjunction with filters to limit the amount of information that a situational awareness screen would display. These filters are used to limit both the types of status information and the system area(s) that are being displayed. For example, only alarms from the network node could be displayed at one time.

Data Summary: An approach for providing system status and situational awareness information is also used to ensure that the service affecting information is provided quickly as possible to the appropriate operator. As shown in Figure 5.7-1, local operators for each node of external element would see information about their area; and the status for that local area would also be forwarded up to the M&O node for overall monitoring of the JPSS mission status. In addition, filter setting for the JPSS mission status would be set to higher thresholds for alarms to further ensure that only the critical service affecting faults were reported the M&O node.

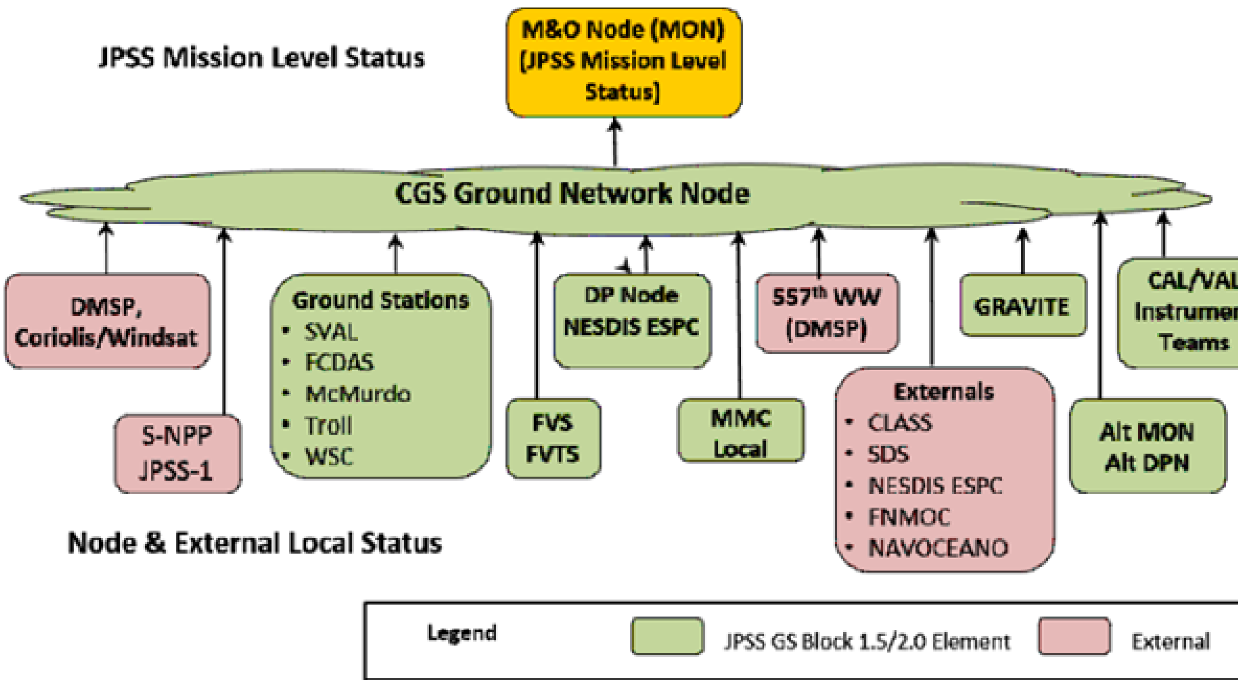


Figure: 5.7-1 JPSS Situational Awareness Reporting Structure

Logs for all of the situational awareness status information are maintained at both the local and the M&O level. These logs are searchable and maintained for the life of the mission.

The last aspect of situational awareness is the dissemination of information to the appropriate level within mission operations and to external customers. The general approach for information dissemination is the following:

Local Issues: Status for local node issues that can be handled at the local node should only be reported in real-time to the local node, but logged for possible problem investigations or trend analysis.

Service Affecting issues: As problems become more severe and either affect multiple nodes or affect mission performance, then the reporting in real-time needs to include the mission level M&O and potentially external users if their data is affected by these more severe problems.

Additional information on situational awareness information dissemination can be found in the System Status/Situational Awareness section of this document.

5.8 Operations Product Development

Operations (OPS) products, including operational flight and ground procedures (Procs), comprise mission task in support of mission activities. Procs support scripted commanding of the spacecraft components (bus and instruments) and ground equipment that support routine operational activities such as telemetry and SMD downlink during contacts, as well as infrequent activities such as spacecraft bus and instrument table loads. Telemetry (TLM) pages are created to provide status and configuration of the spacecraft bus and instruments as well as ground equipment related to specific tasks. This section provides an overview of a development environment supporting OPS product development. The environment consists of flight simulators and a partial ground system, known as Mini-C3S, along with various development tools. It enables operations engineers to develop, test, and validate the operational procedures with high degree of confidence.

5.8.1 Roles and Responsibilities

OPS product development is the responsibility of the various teams within the JPSS Ground Project, including MOST, MST and the Ground SEIT, with support from NOAA/OSPO.

- MST and the Ground SEIT develops and verifies new and revised Ground OPS Products, including JPSS-1 required ones.
- MST develops and verifies revised Flight OPS Products.
- MOST develops and validates new mission F-Procs, i.e., JPSS-1 F-Procs for Blk 2.0.
- Includes integration and validation of nested ground Procs (G-Procs)
- MOST validates the new and revised Ground and Flight OPS Products.
- MOST, working with NOAA/OSPO, makes the OPS Products ready for operations.
- The FVTS team integrates, certifies and deploys flight simulator units.
- The CGS Developer develops, integrates, certifies and deploys Mini-C3S units.
- The CGS Developer SEIT configuration manages Mini-C3S units prior to transition to the operations environment.
- The Deployed System Manager manages Mini-C3S units at NSOF after transition to the operations environment.

5.8.2 Assumptions and Constraints

The following assumptions and constraints apply to the OPS Product development process and support environments.

- The Mini-C3S is used as a tool to validate operational products.
- The J1Sim, FSE (B2.2) and FVS simulator units are considered operational tools.

5.8.3 OPS Product Development Tool Sets

The OPS product development environment consists of four Tool Sets (TS) that are built on top of each other progressively with increased fidelity. These Tool Sets will be deployed in phases to support development framework and product maturation. The key components supporting product development and simulation environments are listed below.

Command and Telemetry Data Base (C&T DB): The C&T DB is generated by the spacecraft vendor. It specifies the command and telemetry formats of the spacecraft and instruments and the valid ranges of the command parameters and telemetry values. The C&T DB as well as the derived telemetry and ground equipment control & status databases constitute the Validation database (DB) used to validate flight and ground equipment commands and status (telemetry) formats and parameter ranges.

ProcPad: ProcPad is Microsoft Windows Operating Systems based text editor with the ability to provide a cursory level of syntax and limit checking. It is the primary tool used in the initial development of Procs.

PSS: The Portable Satellite Simulator (PSS) is a low fidelity satellite simulator that can execute in conjunction with the Command Authentication Tool (CAT) to support early checkout of Procs beyond the syntax and limit checking performed by ProcPad. It accepts command input and provides telemetry output via the CAT. The telemetry is read from canned telemetry files and, with a few exceptions, reflects spacecraft changes expected by command input only if scripted in the canned telemetry file or modified in real-time by the user.

Figure 5.8.3-1 illustrates typical usages of ProcPad, PSS and CAT in early Procs development in conjunction with the C&T DB.

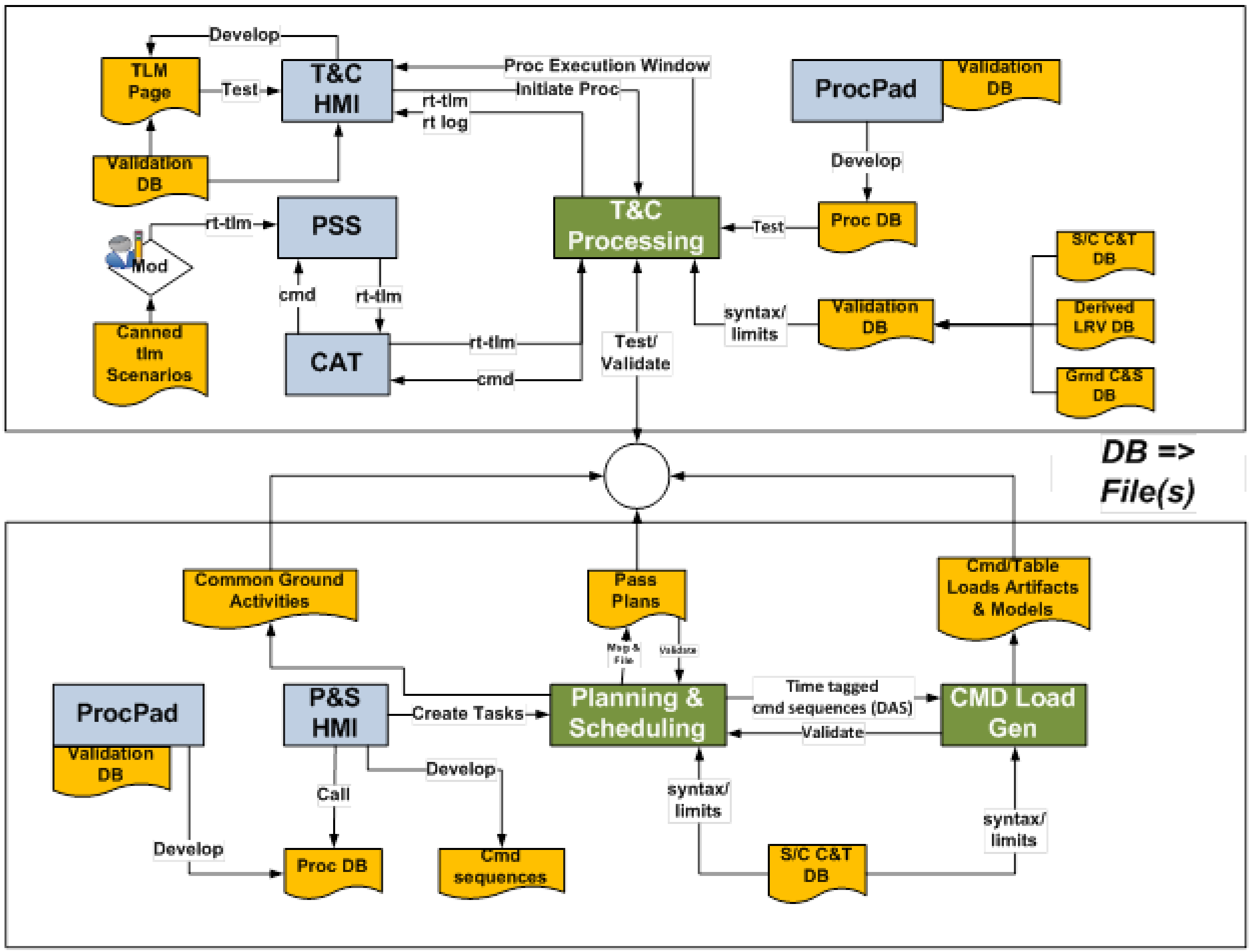


Figure: 5.8.3-1 Product Development and Checkout Flow with PSS/CAT

Flight Vehicle Simulator (FVS): The FVS is an S-NPP simulator in use for Proc validation. It is a high fidelity HW simulator that is supported within the Blk 2.0 architecture with a translator to accommodate the SLE protocol migration from Blk 1.x to Blk 2.x and beyond. The only instance of the FVS is located at the NSOF.

JPSS-1 Simulator (J1Sim): J1Sim is an integrated suite of HW, SW, and configurations that provide simulation of JPSS-1 flight (Spacecraft and Instruments) and ground station equipment. J1Sim also includes a simulation control component that supports the management of the simulation configuration. Flight simulations can be either through a J1Sim/OPS Simulator or a J1Sim/EDU Simulator depending on the needs. While the EDU has hardware based interfaces and can perform encryption; the OPS can simulate both sides and has greater anomaly capabilities. The EDU is required for flight validation prior to Flight Proc (F-Proc) acceptance for operational use.

Flight System Emulator (FSE) (B2.2): FSE is an integrated suite of HW, SW, and configurations that provide medium to high fidelity simulation of JPSS-2/3/4 flight (Spacecraft and Instruments) and ground station equipment. FSE also includes a simulation control component that supports the management of the simulation configuration.

Mini-C3S: The Mini-C3S can be deployed with one or more FVTS simulator units to support the interaction of C3S HW and SW that is similar to operational HW and SW. It consists of those functional components of the C3S used to interact with the spacecraft, including T&C processing, command encryption, command load generation, telemetry analysis, SMD reception and processing, planning and scheduling, equipment status & control, HMI clients, and infrastructure support. The Mini-C3S has three independent strings that can support up to three simultaneous FVTS/OPS or EDU Sims. The Mini-C3S also provides the functionality capable of supporting JCT events using the actual spacecraft in lieu of FVTS. The Mini-C3S also supports simulations using the S-NPP FVS, including encrypted commanding if an S-NPP command encryption capability is added to a Mini-C3S string. Any combination of mission instances can be simulated in the three independent strings, including three instances of the same mission (i.e., JPSS-1) depending upon the FVTS mission simulator units availability.

Mini-C3S with Enhanced Product Development Environment: The Mini-C3S can be enhanced with the addition of PSS/CAT, T&C processing, planning & scheduling, command load generation SW instances and HW infrastructure that provides an environment for initial Proc, TLM Page and Mission Task development and checkout. It is possible to link up to three independent PSS simulations for a specific mission to a single T&C processing instance. The enhanced Mini-C3S configuration provides a flexible environment for focused product development activities as well as continued interaction with the FVTS Sim environments and/or JCT support.

The Tool Sets are constructed using the above components to create environments that support OPS Product development, integration & test, and validation.

Tool Set #1 (TS1): TS1 is ProcPad with an integrated C&T DB that is installed on product developer workstations. The number of simultaneous developers is essentially unlimited.

Tool Set #2 (TS2): TS2 is comprised of a standard Mini-C3S augmented with an Enhanced Product Development Environment as described above with components integrated with a Validation DB. Microsoft Office products are installed supporting various aspects of Proc, Page and Task development and checkout. The number of simultaneous developers is limited by the number of workstations with PSS/CAT installed and the number of T&C and P&S processing instances available in the enhanced product development area. Simultaneous interactions with FVTS or JCT interfaces are limited to three.

Tool Set #3 (TS3): TS3 is a Mini-C3S (such as TS2) or C3S operations or I&T string environment augmented by one or more FVTS OPS Sim units. TS3 can connect to as many as three FVTS OPS Sim units simultaneously. If a C3S operational or I&T string are used for FVTS connectivity only a single instance of the same mission (i.e., JPSS-1) can be active at a time. Three unique missions can be active simultaneously. Offline product development activities (non-FVTS Sims) have similar capacity as indicated for TS2.

Tool Set #4 (TS4): TS4 is similar to TS3 except that a high fidelity FVTS EDU and/or S-NPP FVS is connected to the Mini-C3S or C3S operations or I&T string. TS4 can support all phases of the OPS Product lifecycle including development, integration & test and validation. Only the Mini-C3S string(s) connected to high fidelity simulators (i.e., FVTS EDU or S-NPP FVS) support validation activities.

Table 5.8.3-1 summarizes how these Tool Sets can be used to support the development of various OPS products over their development lifecycles.

Table: 5.8.3-1 Tool Sets vs. OPS Product Development Maturity

Product	Initial Development	Full Development	Integration & Test	Validation
Ground Procs	MST Environment	MST Environment	TS2, TS3, TS4 (when integrated with flight Procs)	TS4 (when integrated with flight Procs)
Flight Procs (S-NPP & J1)	TS1, TS2, TS3, TS4	TS2, TS3, TS4	TS2, TS3, TS4	TS4
TLM Pages	TS1, TS2, TS3, TS4	TS2, TS3, TS4	TS2, TS3, TS4	TS4
MM Tasks	TS2, TS3, TS4	TS2, TS3, TS4	TS2, TS3, TS4	TS4

5.8.4 Related ConOps Threads

The Flight Vehicle Simulation thread (GS-NML-080) provides additional detail regarding flight simulation capabilities. The Launch Readiness Support thread (GS-MAD-110) provides additional detail for activities related to launch readiness activities leading up to launch. In addition to the OPS Product validation identified during the development lifecycle, mission rehearsals and JCT events provide additional validation of the various flight and flight support OPS products prior to launch and operations. The Mission Planning and Scheduling thread (GS-NML-020) provides additional detail regarding operational planning and scheduling activities and supporting tasks.

6 JPSS GROUND SYSTEM OPERATIONAL THREADS

6.1 Overview

Section 6 presents a series of operational threads defining the details of JPSS Ground System concept of operations. These threads are grouped into Subsections based on the services they support. Table 6.1-1 shows the mapping among the Ground System services and the operational threads.

Each thread begins with a general description of the thread, providing a context and background information for the operations to be described. Through a Primary Interface Diagram and associated descriptive tables, the thread identifies primary interfaces and actors, both internal and external, which are significant to the operations. Assumptions and pre-conditions to the operational flow are provided in order to understand the dependencies and entry points. The operational flows are illustrated in standard DoDAF OV-5b views, the details of which are described in text tables with sequenced actions performed by a set of activities at various system nodes. These activities and actions form a basis on which system architecture and requirements are derived and synchronized. Besides main threads, alternate threads may be included to describe alternative paths or non-nominal conditions. Expected states after the thread execution are described as post conditions. For references, a list of related threads is included at the end of each thread.

The operational threads are developed to cover both Ground System (level 2) and Common Ground System (level 3) level of details. Some lower level details are included in the notes to capture specific project needs and to provide guidance for the development. In the scheme of an integrated system design, these threads serve as parents to the lower level operations concept threads. This follow-down traceability is documented in a list of children threads included in each thread with a summary list in Appendix A-2.

The multi-mission support capabilities of JPSS Ground System will be phased in over time. As such, it is envisioned that this document will evolve with each development/deployment phase. The revisions for Blocks 2.0 and 2.1 are focused on establishing the JPSS Ground System technical baseline based on the S-NPP, GCOM-W1, and JPSS-1 missions. The revision for Block 2.2 adds more details for supporting JPSS-2/3/4 missions. More details on other missions (e.g., EUMETSAT Metop-SG missions) will be added in the future revisions.

The JPSS Ground System provides varying level of services to a variety of missions. Appendix A-1 contains a Mission Effectivity Matrix that maps applicable threads to individual missions.

Table 6.1-2 summarizes all operational threads with a brief description for each.

Table: 6.1-1 JPSS Ground System Operational Threads Mapping to Services

Service Thread (Subsection)	Enterprise Management & Ground Operations	Flight Operations	Data Acquisition	Data Routing	Data Product Generation	Data Product Cal/Val	Field Terminal Support
Fleet Ground Management (6.2.1)	x	x					
Mission Planning and Scheduling (6.2.2)	x	x	x				
System Status/Situational Awareness (6.2.3)	x						
Ground Operations (6.2.4)	x						
Integrated Support (6.2.5)	x						
System Maintenance and Upgrade (6.2.6)	x						
Continuity of Operations (6.2.7)	x						
System Fault Analysis (6.2.8)	x						
Security (6.2.9)	x						
Launch Readiness Support (6.3.1)		x					
Launch & Early Orbit (6.3.2)		x					
Telemetry and Command (6.3.3)		x					
Space Operations (6.3.4)		x					
Space Network Support (6.3.5)		x					
Orbit Maintenance (6.3.6)		x					
Attitude Ground Support (6.3.7)		x					
Mass Data Storage Playback (6.3.8)		x					
Sensor Operations and Payload Support (6.3.10)		x					
Key Management (6.3.11)		x					
Flight Software Upgrade (6.3.12)		x					
Flight Vehicle Simulation (6.3.13)	x	x					
Decommissioning (6.3.14)		x					
Data Acquisition and Routing (6.4.1)			x	x			
Stored Mission Data Handling (6.5.1)					x		
Data Accounting and Recovery (6.5.2)					x		
Data Quality Assurance (6.5.3)					x		
Mission Support Data Handling (6.5.4)	x				x		
Algorithm Development and Maintenance (6.5.5)					x	x	
Cal/Val of Data Products (6.6.1)						x	
Field Terminal User Support (6.7.1)							x
Direct Broadcast Quality Monitoring (6.7.2)							x

Table: 6.1-2 Summary of JPSS Ground System Operational Threads

Threads	Brief Description
Fleet Ground Management	JPSS mission system management that oversees the operations of a fleet of heterogeneous spacecraft and their remote sensing payloads, and the JPSS Ground System to achieve overall program objectives across all missions: • Interfaces with external stakeholders • Conducts fleet level long-term planning • Makes management decisions that guide space and ground operations. • Maintains a situation awareness of the JPSS system as a whole. Analyze and reports system operation statistics. • Coordinates contingency operations.
Mission Planning and Scheduling	JPSS Ground System operations to manage mission tasks, plan mission activities, schedule system resources, and resolve any resource conflicts based on the mission guidelines: • Task definition and request process • Task scheduling and schedule deconfliction • System and mission schedule and implementation products generation • Flight products generation and verification
System Status/ Situational Awareness	Describe State of Health (SOH) and State of Service (SOS) monitoring of the JPSS Ground System at the global and nodal level to support situational awareness. Provide the capability at both the global and nodal levels for operators to configure the information by viewing data hierarchically so that only a summary status is presented and by configuring filters based on thresholds so that only relevant detailed information is presented. The primary functions in the flow are: • Nodal monitoring for the JPSS Ground System Nodes • Monitoring the interfaces of external systems such as ESPC JPSS Interfaces, SDS, CLASS, and Ancillary data providers • Global Level and JPSS Mission Level Monitoring Providing status and reporting to internal operations and external customers
Ground Operations	Describe the execution of JPSS mission operations based on the mission schedules and plans. This includes creating, validating, and executing ground system commands derived from the mission schedules. The ground commands are for space/ground communications, SMD, telemetry, and command data routing; and data processing. The primary functions of GO are the following: • Operate the JPSS Ground System • Work with the System Fault Detection & Recovery and System Maintenance & Upgrade functions to restore ground operations when problems occur • Support mission upgrades as required
Integrated Support	JPSS operations support for both satellites and ground systems. Describes a centralized approach for data format and content management. Defines common Configuration Management (CM) and Discrepancy Report (DR) systems used by JPSS Flight Project and JPSS Ground project. The Integrated Support thread describes the lifecycle of DRs and feeds System Maintenance and Upgrade, Flight Software Upgrade, and Algorithm Development and

Threads	Brief Description
	Maintenance for system upgrades throughout the JPSS Flight Project and JPSS Ground Project.
System Maintenance and Upgrade	Concepts of performing system maintenance as well as system upgrade. As a multi-mission support infrastructure, the ground system will go through multiple upgrades over its life-span. The upgrades, minor or major, will fix existing problems, enhance system functionalities and operations, and expand system capabilities to support new missions. The ConOps describes various scenarios to upgrade the system without interfering on-going mission operations and data productions
Continuity of Operations	JPSS Ground System operations to support an Alternate Common Ground System (ACGS) so that the critical mission control and data processing functions can continue in an emergency in which the CGS at NOAA NSOF becomes inoperable or incommunicable. The thread consists of three parts: the synchronization between the CGS and ACGS during nominal operations; the transition of operations from the CGS to ACGS in contingency; and the transition of operations back to the CGS once the working conditions are restored at the NOAA NSOF. The thread also discusses using the FCDAS and Troll as a backup to support mission operations.
System Fault Analysis	Describes the process for identifying and implementing solutions for issues or anomalies when they cannot be resolved by the ground operations (for ground problems) or telemetry and commanding (for flight problems) using routine operations procedures.
Security	Describes the activities required to monitor the JPSS Ground System for security incidents; and the process for responding to those incidents when they occur. The JPSS Ground System has two Security Boundaries. Security boundary NOAA-5042 encompasses the Common Ground System (CGS) and the Flight Vehicle Test Suite (FVTS). Security boundary NOAA-5048 encompasses the GRAVITE and FTS.
Launch Readiness Support	JPSS Ground System operations at the launch site in preparation for launch. It starts at the arrival of the satellite at the launch site and ends at the beginning of final countdown. The operations include final integration and testing, launch and flight readiness reviews, launch countdown rehearsals, and launch decision making.
Launch and Early Orbit	JPSS Ground System operations during the satellite launch phase and early orbit phase. The launch phase begins with the final countdown; goes through the liftoff, ascent, separation from the Launch Vehicle (LV); and finishes with the satellite being placed in the designated orbit and in the sun-pointing survival mode. The operations then transition into the early orbit phase as the spacecraft stabilizes in its designated orbit and establishes reliable communication with the MMC. The early orbit phase completes when the spacecraft and instruments have been successfully activated, deployed and checked out as functional. The operations during the launch phase include tracking, telemetry monitoring, predicted acquisition vector updates, and mission planning updates if necessary. During the early orbit phase, the operations center around the activation, initialization and checkout of the spacecraft bus system and subsystems. They will also cover activation and initialization of instruments in preparation for their Intensive Calibration (Cal)/Validation (Val) operations.

Threads	Brief Description
Telemetry and Command	Concept of Telemetry and Command (T&C) operations during each T&C contact. The thread starts with a given set of contact schedules, pass plan and flight products; and describes T&C operations during the pass. Anomaly conditions and responses during the pass will be considered. The thread discusses T&C operations both through the primary ground station and through the Space Network (SN).
Space Operations	Describe the comprehensive awareness capability for every satellite in the fleet. This includes vehicle state of health and planning and scheduling of satellite events. Satellite awareness is provided visually through the use of a dashboard display per satellite, which are available to all MOT members. The dashboard provides immediate, pertinent status from all of the software that is processing satellite specific data as well as some post-processing analysis of back orbit commanding completion. Also important to satellite awareness is telemetry analysis, which includes limit checking with alarm notification and telemetry reports, as well as options such as plotting, expression analysis, trending and curve fitting.
Space Network Support	JPSS Ground System operations to request and use the NASA Space Network (SN) in support of satellite T&C communication during launch and early orbit operations, orbit maneuver as well as during contingency operations. The SN support is also used as an alternate to support JPSS-1/2/3/4 SMD downlink. Even during nominal operations, routine SN supports will be scheduled and exercised to maintain MOT proficiency and JPSS-1/2/3/4 Ka-band antenna working condition.
Orbit Maintenance	JPSS Ground System operations to maintain proper orbits for the JPSS-managed satellites and to produce orbit products. The scope includes estimating the satellite position, propagating the orbits to some future epoch, predicting orbit events, generating orbit products, checking constraint violations, designing delta-v maneuvers to adjust the orbit, commanding satellites to perform required maneuvers and verifying the results of completed maneuvers. As an alternate flow, the conjunction assessment process and necessary avoidance maneuver planning and execution are also discussed.
Attitude Ground Support	JPSS Ground System operations for monitoring and maintaining the performance of JPSS satellite's onboard attitude determination and control systems, including: • Routine ground assessment of on-board systems • Attitude maneuver planning & verification • Calibration coefficient generation & evaluation • Performance trending • Anomaly resolution
Mass Data Storage Playback	Concept of operations to manage the S-NPP and JPSS Mass Data Storage (MDS), also called the Solid State Recorder (SSR) in Block 2.0, for SMD playback. The concept of operations takes into account planned SMD receiving sites and TDRSS support, MDS capabilities and constraints, and flexibility in the spacecraft SMD transmission. Multiple SMD playbacks during each SMD contact, duplicate copies, and retransmissions on command are planned to meet the system data latency and availability requirements.

Threads	Brief Description
Sensor Operations and Payload Support	Concepts of sensor operations and associated JPSS Ground System support activities that provide sensor operations teams needed satellite telemetry, raw science data and other information. The focus is on the operational interactions amongst the instrument support node and the ground system. Special considerations are given to the CERES and RBI operations since its science ops team is outside of JPSS Mission Operations Team (MOT). The thread describes sensor operations, including monitoring of instrument state of health, activities planning, trending, table updates, etc.
Key Management	JPSS Ground System operations to manage the encryption keys used for the JPSS satellite command uplink.
Flight Software Upgrade	Operations to change flight software (FSW) onboard. The flow begins with the approval of change requests and covers from change development, testing and verification, to the version control at the MMC. The flow ends with the upload of the changed FSW and successful confirmation of the uploaded FSW.
Flight Vehicle Simulation	Concept of simulation operations to be performed by a suite of Flight Vehicle Simulators and test tools in support of mission operations. The simulations include spacecraft buses, instruments, as well as ground station links at varying levels of fidelity.
Decommissioning	JPSS Ground System operation for the planning and execution of de-orbiting and disposal of JPSS-managed satellites as the satellite reaches the end of its mission life.
Data Acquisition and Routing	Concept of services for acquiring and/or routing the mission data from the receiving sites to the mission's data centers. The JPSS Ground System is currently employed to support the Coriolis/WindSat, DMSP and Metop missions, as well as NASA SCaN-supported missions.
Stored Mission Data Handling	Describe acquisition, routing and processing of Stored Mission Data (SMD), and distribution of JPSS environmental data products. The thread begins with the downlinked SMD being acquired at the ground stations and receptor sites. It further describes the SMD being routed to the Data Processing Node as well as designated data consumers such as FNMOC, NAVOCEANO, and the NASA SDS. The SMD is processed together with appropriate Mission Support Data (MSD) to produce data products and metadata. The thread finishes when selected JPSS data products and associated metadata are provided to configured recipients such as the ESPC, CLASS, and GRAVITE. When JPSS-1 is launched, the system supports multiple sets of near-identical sensors in a constellation. This thread includes the scenarios of transitioning the products generated from new sensors to operational status while maintaining the operations of existing ones; of operating both operational and non-primary sensors; and of failover options.
Data Accounting and Recovery	JPSS Ground System operations to monitor Stored Mission Data flow; measure the data availability and data latency; and when a data gap is detected, retransmit the missing data from one of the upstream data stores, including from the spacecraft.
Data Quality Assurance	Describe online and offline operations to monitor the quality of environmental data products and the roles of different teams in product quality management. Describe the generation and dissemination of data quality notifications based on quality monitoring results.

Threads	Brief Description
Mission Support Data Handling	Describe operations to acquire, manage, and distribute Mission Support Data (MSD) in support of environmental data product generation and of mission operations. The MSD, consisting of ancillary data from external sources and auxiliary data from internal sources, plays a critical role in achieving the quality of data products. Both nominal flow and contingency flow are covered.
Algorithm Development and Maintenance	JPSS Ground System operations to support continued algorithm development, maintenance and deployment, including: • Developing new algorithms and/or modify baseline algorithms in an offline environment • Performing offline testing and/or execution of new/modified algorithms • Evaluation of new/modified algorithms before moving to the production system • Delivery, Management and CM of product algorithms • Independent Science Facility data delivery and algorithm support interactions Analyzing and compare the test results of the new/modified algorithms by performing parallel processing in the I&T and Ops domains.
Calibration and Validation of Data Products	Concepts of performing initial and ongoing Cal/Val of data products by establishing and maintaining stable and consistent environmental data products that meet the product quality specifications. The main activities involve continuous monitoring of product quality and early problem detection, periodic in-depth analysis of certain parameters and products, defining solutions for quality deficiencies, and archiving of the Cal/Val data products. Such solutions may include updates to processing coefficients, updates to the processing lookup tables, algorithm calibrations, and algorithm modifications. The thread starts after instrument activation/initialization and lasts through the entire operational life-span of the JPSS satellites
Field Terminal User Support	Description of software and operational support provided by the JPSS Ground System that enables the JPSS Field Terminal Support customers to acquire and process S-NPP and JPSS direct broadcast data.
Direct Broadcast Quality Monitoring	Description of JPSS Ground System operations at Svalbard to monitor the signal quality and content of direct broadcast High Rate Data (HRD) from JPSS-managed satellites.

6.2 Enterprise Management and Ground Operations

6.2.1 Fleet and Ground Management

6.2.1.1 Description

Fleet and Ground Management (FGM) thread (GS-NML-010) describes the JPSS mission system management overseeing the operation of a fleet of satellites and the JPSS ground system to achieve overall program objectives across all missions. As part of the Mission Management (MM) function, FGM accesses a wide variety of data, analyzes the data from a system perspective and publishes results in the form of reports, directives, mission notices and other products.

GS-NML-010 describes the operational activities of Fleet and Ground Management (FGM). It provides a description of the active monitoring, management, and reporting on the status of the JPSS System. In addition, alternate flows are included to address Mission Task & Event Review, Maintenance of Mission Priorities, Master Schedule Deconfliction, Planning and Coordination of Contingency & Special Operations. The operational flows apply to all JPSS-managed satellites, including S-NPP, JPSS-1/2/3/4. For JPSS-supported satellites such as GCOM-W1, DMSP and MetOp, the thread covers verification of sufficiency of resources provided to those missions. The scope of this thread includes routine and periodic operations, as well as the more common contingency and special operations. This thread does not address launch and early orbit operations (see the Launch and Early Orbit thread, GS-SAD-130), nor does it address operations required for disposal (see the Decommissioning thread, GS-SAD-150).

The Fleet and Ground Management for JPSS Missions is allocated to the JPSS Common Ground System (CGS). As depicted in Figure 6.2.1-1, CGS capabilities supporting Global and Nodal Situational Awareness are utilized to provide useable global displays and reports. FGM monitors system status via interfaces with Space Operations (GS-NML-320) and Ground Operations (GS-NML-310), and provides directives which reconfigure the system or modify procedures, as necessary, to meet JPSS requirements. System capabilities and their operational use are well described in the System Status/Situational Awareness (SyS) thread, GS-NML-300. The CGS capabilities supporting Mission Planning and Scheduling (see thread GS-NML-020)) are utilized by Fleet and Ground Management to effectively manage system resources in the short and long-term.

A critical activity of the Fleet and Ground Management is to maintain a situational awareness of the JPSS system as a whole, analyzing logged data in the central repository and real-time nodal status. It presents the following: a global level state of health, state of service, planned master timeline, Schedule Event readiness assessment, Schedule Event support performance status, and reporting. Additionally, system operation statistics are analyzed (trended) and reported, including key performance parameters. This process is discussed in the Fleet and Ground Management Basic Flow.

The Fleet and Ground Management evaluates system capacity, allocation, utilization and performance. FGM will interface with internal & external stakeholders and make management decisions that guide space and ground operations. Examples of such management activities include assessment of instrument/spacecraft operational status, prioritization of mission objectives, coordination of space operations and ground operations, etc. The management directives guide the daily operations planned out by the Lead JPSS Mission Planner (MPL) and carried out by the Space Operations (SO) and Ground Operations (GO). Reports generated by FGM provide summaries and long-term trends for system utilization and performance. This process is also discussed in the Fleet and Ground Management Basic Flow.

OSPO Mission Operations Division (MOD) management is the primary group involved in global system management. MOD is alerted to issues requiring their attention, receives reports summarizing system status and trends useful in providing insight at the system level. As leads of space and ground activities, the Spacecraft Analyst (SCA), the Enterprise Manager (EM) and the OSPO Lead Engineer are daily operations interfaces and use FGM capabilities for overall system situational awareness. When a critical system anomaly occurs that affects multiple missions,

MOD takes a lead role in activating contingency plans, allocating resources, directing emergency responses, organizing anomaly investigation, and overseeing efforts to restore system operational capabilities. The Coordination of Contingency & Special Events Alternate Flow discusses this process.

OSPO Mission Operations Division management and the OSPO Lead Engineer may issue Mission Notices as a result of FGM activities. A Mission Notice is a management message providing status and/or direction. It is typically used to broadcast significant internal and external system events that have impacts on system operations and data users. Examples include spacecraft anomalies, communication outages, planned orbit maneuvers, post-maneuver confirmations, system start-ups and shutdowns, system configuration changes, etc.

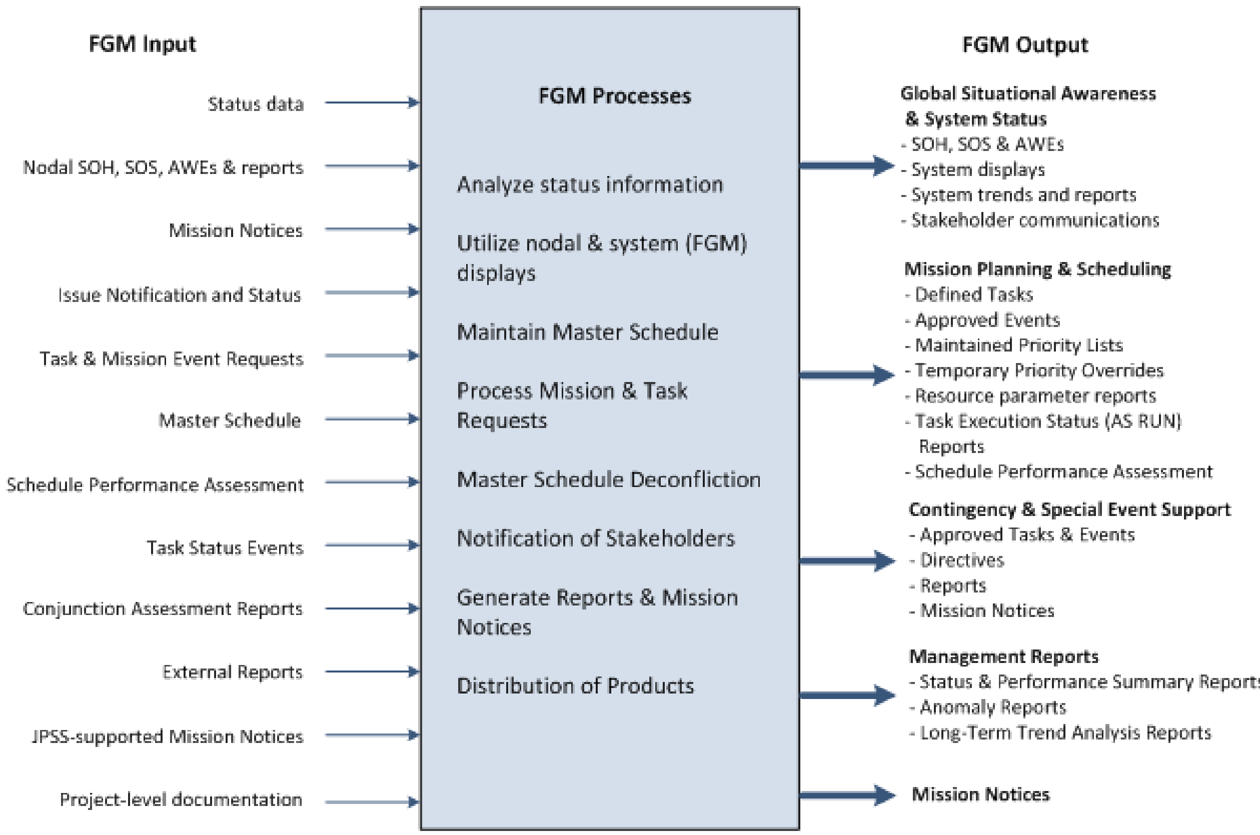


Figure: 6.2.1-1 CGS Processes and Context for Fleet and Ground Management

6.2.1.1.1 Manage Fleet / Ground Operations Activity

This activity supports execution of the core FGM functions, including:

- Establish Global Situational Awareness
- Report Global System Status
- Support Management of Ground System Services
- Monitor Fleet State of Health

- Coordinate Issues with External Parties

6.2.1.1.1.1 Global Situational Awareness

In addition to reporting Global System Status, FGM capabilities can be utilized by the OSPO Lead Engineer (and the MOD) to evaluate Alarm, Warning, Event messages (AWE) and reports generated by Space Operations and Ground Operations. This information guides the OSPO Lead Engineer's use of nodal displays, as well as global displays designed to support FGM operations. In addition, FGM accesses and evaluates logged data. During the process, global parameter values are generated and reported. It is through this reporting of global parameters upon which the FGM bases its system-wide status knowledge. The FGM also establishes automated report configurations for FGM reports distributed both internally and externally.

FGM has the capability to collect reports generated by other system threads (GO and SO).

6.2.1.1.1.2 Global System Status Assessment

FGM provides the capability to generate reports based on analysis of status information collected from across the JPSS System to determine optimum system configuration, overall system availability and detailed data accounting such as:

- Availability and utilization of resources
- Overall data availability (amount of data collected by the satellite, recovered by the ground, amount of data delivered, etc.)
- Overall data quality
- Overall data latency

These reports are generated and made available to operations personnel and external users.

6.2.1.1.1.3 Manage Ground System Services Activity

FGM accesses logs, Mission Notices, State of Health, State of Service, and reported issues from the Manage Global Situational Awareness activity. This provides the basis for MOD and OSPO Engineering awareness of ground system situations. Once alerted, OSPO Engineering utilizes GO capabilities to evaluate the issue and monitor its resolution. In the event the issue may affect multiple missions, the MOD may support its resolution via the System Fault Analysis activity.

On a routine basis, reports and analysis of logged information provided by GO is evaluated for status history, global level trends, and ground system performance.

6.2.1.1.1.4 Monitor Satellite State of Health Activity

FGM accesses logs, Mission Notices, and reported issues from the Monitor Satellite State of Health activity. This provides the basis for MOD and OSPO Engineering awareness of satellite situations. Once alerted, OSPO Engineering utilizes SO (TT&C) capabilities to evaluate the issue and monitor its resolution. In the event the issue may affect multiple missions, MOD supports its resolution via the System Fault Analysis activity.

On a routine basis, reports and analysis of logged information provided by SO is evaluated for satellite history and performance.

6.2.1.1.1.5 Coordinate Issues with External Parties

There are two primary operations positions that are participants of the FGM thread - the OSPO Lead Engineer and the Enterprise Manager (EM)

In the context of the FGM thread, the OSPO Lead Engineer represents the function of all Operations Personnel. As part of the FGM function, the OSPO Lead Engineer receives status reports, accepts and responds to system warnings and alerts, and accepts / approves configuration changes from the system.

The Enterprise Manager (EM) conducts real-time monitoring all of the JPSS ground and space resources that are required to receive and process JPSS mission and satellite data. The EM is responsible for continuous monitoring of JPSS status and for ensuring system compliance with policy and requirements. The EM is responsible for "tuning" the functional behavior of MON status analysis function, and providing status-based situational awareness to the OSPO Lead Engineer and MOD.

Responsibility for nominal and non-nominal operations of space and ground assets are defined in the Space Operations (SO) and Ground Operations (GO) ConOps threads. FGM's responsibility is at the system level. SO and GO will independently detect, respond to, and report a segment- or component- level fault; FGM will detect and respond to faults and failures with system-wide availability implications, such as an antenna failure or degradation, and the failure or degradation of a mission critical function at any given site. In each of these circumstances, FGM will independently analyze log & status information, access SO and GO status, and respond to issued reports. When needed, the OSPO Lead Engineer will ascertain root cause of the failure or degradation, determine the appropriate action to mitigate the detected problem, obtain approval to proceed, and then interact with MPL to schedule system-wide configuration changes.

6.2.1.1.2 Collect Mission Support Data Activity

On a routine basis, FGM creates a set of reports providing the status and performance of the fleet and ground system from a global perspective. These, along with products generated on an 'as needed' basis, are gathered by the Collect Mission Support Data activity for subsequent delivery and storage.

6.2.1.1.3 Define Mission Tasks & Event Activity

As part of the product control board approval process, the OSPO Lead Engineer supports the review of new/modified tasks. In addition, MOD may support the scheduling of Special Mission Tasks and Schedule Events which may have an impact on fleet or ground operations or require non-routine resources. The MOD and OSPO Lead Engineer may support users developing specifications for Special Mission Task submissions and Mission Task requests by coordinating with affected parties and reviewing resource, priority and scheduling specifications.

6.2.1.1.4 Process Mission Activity & Task Requests Activity

FGM supports planning and scheduling activities affecting the ground, space/ground, or multiple satellites in several respects:

- Approval and/or scheduling of Special Mission Tasks & Events

- Deconfliction of tasks which could not be resolved by the Mission Planners
- Evaluates system resource capacity, allocation, utilization and performance
- New or adjustment of task priorities
- Coordination of Master Schedule changes in support of Contingency or Special events

Prior to utilization by the Mission Planner, new or modified tasks must be processed through an approval process. The OSPO Lead Engineer assists in the assignment of the task priority, supports the scheduling of tasks which may affect the schedules of other missions and verifies that implementation of the task does not violate system resource utilization constraints or impede the attainment of mission/fleet objectives. Reference the section above for additional details.

The planning and scheduling system minimizes conflicts through the use of established priorities. However, when conflicts are identified, the Mission Planners have the authority to resolve conflicts as defined in OSPO documentation. In the event that a conflict cannot be resolved by these means, occurs frequently, or affects multiple missions, it can be brought to the MOD for resolution as discussed in the section below.

System resources (and their capacities) that require scheduling and/or utilization monitoring are defined in the OSPO documentation and the MPS system. Likewise, the allocation of those resources are defined in documentation received from the Flight Project (priority procedure, generic scheduling requests, etc.) and incorporated into the MPS system. In the process of planning and scheduling mission tasks, the MPS system reserves resources, identifies / resolves resource conflicts, verifies constraints are met and reports a resource utilization profile. This profile, in conjunction with the resource utilization information provided by the Manage Global Situational Awareness activity is used by Fleet and Ground Management to assess global and mission resource utilization. GO and SO reports received by FGM are utilized to assess system and resource performance. The above information, along with resource conflict information from the MPS, allows FGM to continuously evaluate system resource capacity, allocation, utilization and performance. Results of this evaluation are periodically reported by FGM and support the Master Schedule deconfliction process, setting of new priorities and modification of existing priorities.

6.2.1.1.5 Deconflict Master Schedule Activity

Routine mission planning and scheduling activities are conducted by Mission Planners for JPSS-managed and supported missions as per the Mission Planning and Scheduling thread, GS-NML-140. During this process, resource allocation conflicts are identified and resolved by the planners following documented guidelines. In the event that a conflict is un-resolvable (competing tasks of equal priority) or resolution by application of priorities results in a threat to satellite state of health, the issue is addressed by OSPO Lead Engineer and/or MOD. The MOD reviews global status, consults with stakeholders, evaluates options and provides direction in the form of task re-scheduling, application of temporary priority overrides or the permanent modification of priorities. Refer to the Master Schedule Deconfliction Alternate Flow for additional details.

6.2.1.2 Primary Interfaces

Figure 6.2.1-2 illustrates external parties as the primary external interfaces involved in the execution of Fleet and Ground Management. Note that direction provided by Mission Management affects JPSS planning & Scheduling, Space Operations, and Ground Operations and Mission Support Data Handling.

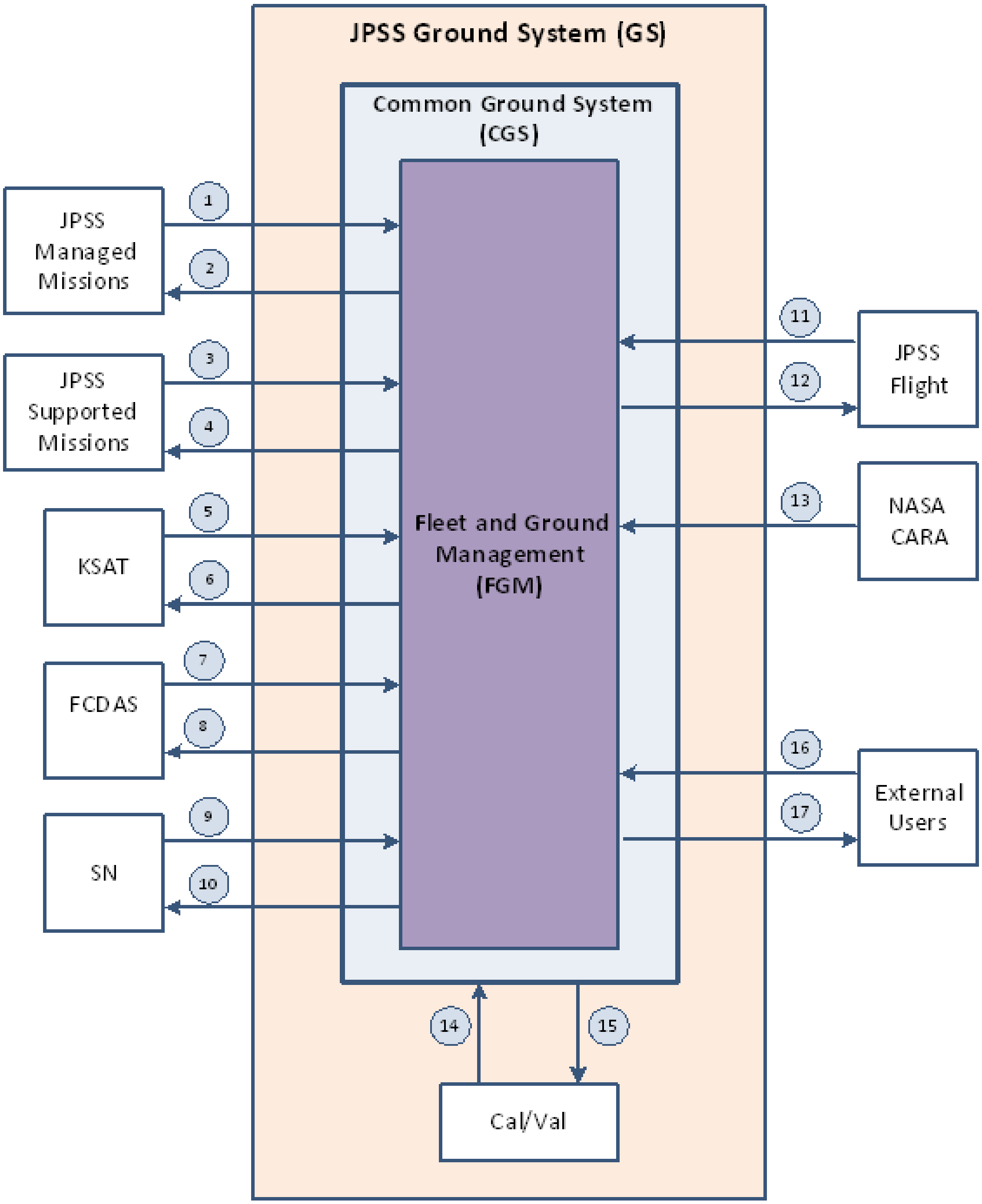


Figure: 6.2.1-2 Primary Interfaces for Fleet and Ground Management

Table: 6.2.1-1 Fleet and Ground Management Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	CGS < S-NPP, JPSS-1, JPSS-2/3/4	Management agreements and reports, Spacecraft or Sensor Status Information, Event & Task Requests, Mission Notices
2	Internal	CGS > S-NPP, JPSS-1, JPSS-2/3/4	Management Reports, Management Directives, Mission Notices
3	External	CGS < DMSP, MetOp, Coriolis	Management agreements and reports, , Mission Notices
4	External	CGS >DMSP, MetOp, Coriolis	Management Reports, Management Directives, Mission Notices
5	External	CGS < KSAT	Management agreements and reports, Station Status Information, Mission Notices
6	External	CGS > KSAT	Management Reports, Management Directives, Mission Notices
7	External	CGS < FCDAS	Management agreements and reports, Station Status Information
8	External	CGS > FCDAS	Management Reports, Management Directives, Mission Notices
9	External	CGS < SN	Management agreements and reports, Station Status Information
10	External	CGS > SN	Management Reports, Management Directives, Mission Notices
11	Internal	CGS < JPSS Flight Project	Management agreements and reports, Spacecraft or Sensor Status Information, Event & Task Requests, Mission Notices
12	Internal	CGS > JPSS Flight Project	Management Reports, Management Directives, Mission Notices
13	External	CGS < CARA	CA Summary Reports, High Interest Event Reports
14	External	CGS < Cal/Val	Task Requests, Issues, Mission Notices
15	External	CGS > Cal/Val	Mission Notices
16	External	CGS < External Users	Mission Notices, reports
17	External	CGS> External Users	Mission Notices, trends & reports

Table: 6.2.1-2 Fleet and Ground Management Interface Documentation

No.	IRD/ICD
1, 2	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
3, 4	JPSS GS-DMSP SLA JPSS GS-MetOp SLA JPSS GS-WindSat SLA
5, 6	JPSS CGS-SvalSat ICD JPSS Ground Project-KSAT GCOM-W1 (JAXA) JPSS CGS-KSAT ICD for GCOM (JAXA) JPSS CGS-KSAT ICD for GCOM (KSAT) JPSS CGS Services IDD (KSAT)

No.	IRD/ICD
	JPSS Space/Ground Data Format XMT Database
7, 8	JPSS GS-FCDAS IRD JPSS CGS- FCDAS ICD JPSS Space/Ground Data Format XMT Database
9, 10	SN-NIMO NRD SN-JPSS CGS ICD JPSS Space/Ground Data Format XMT Database
11, 12	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
13	JPSS GS Conjunction Assessment IRD
14, 15	JPSS CGS Services ICD JPSS GS Services Specifications JPSS Space/Ground Data Format XMT Database
16, 17	JPSS GS Services Specifications JPSS CGS Services IDD

6.2.1.3 Assumptions & Constraints

The following assumptions are made for the successful performance of the Fleet and Ground Management functions:

- JPSS Ground System provides the following input to Fleet and Ground Management:
  - Raw log and status information from all nodes is deposited in the central repository
  - Current nodal State of Health (SOH), State of Service (SOS) and AWE views
  - Issue reports and status updates
  - Nodal TPP, trends and reports
  - Mission Notices
  - Mission Planning & Scheduling products, including the Master Schedule
  - Mission Planning and Scheduling Schedule Performance Assessment
  - MPS irreconcilable conflict messages
- The OSPO Lead Engineer, and Enterprise Manager (EM) are the primary points of contact to which the MOD provides direction.

6.2.1.4 Pre-Conditions

The following pre-conditions apply to this thread:

- One or more satellites are in the normal operational phase.

6.2.1.5 Operational Flow

Figure 6.2.1-3 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.

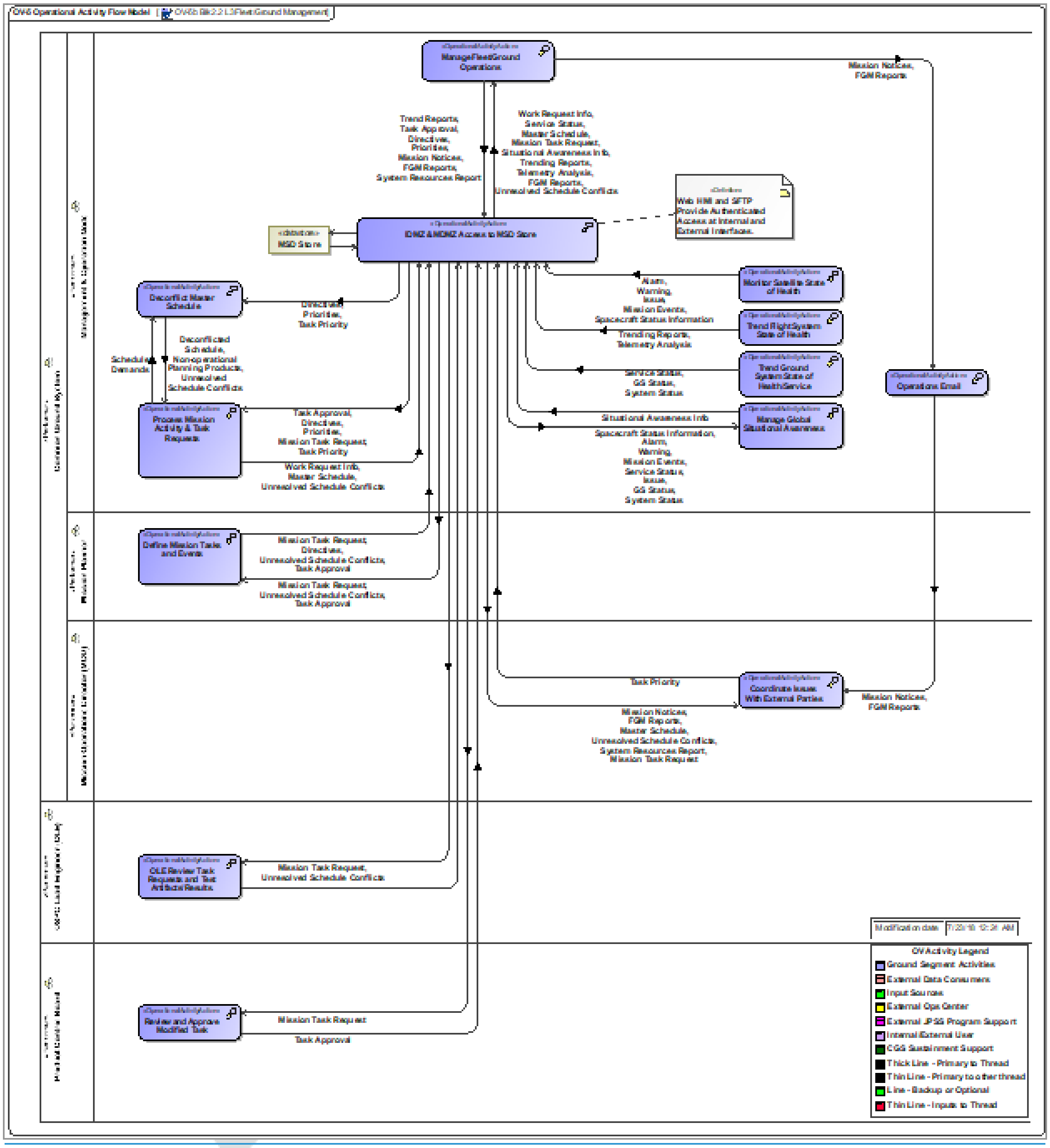


Figure: 6.2.1-3 Fleet and Ground Management Operational Flow Diagram

6.2.1.6 Basic Flow

Table 6.2.1-3 defines the operational flow of Fleet and Ground Management.

Table: 6.2.1-3 Fleet and Ground Management Basic Flow

No.	Actors	Actions	Notes
		Monitor Functions	
		Situational Awareness	
1	MON	The MON Manage Fleet / Ground Operations activity interfaces with the MON IDMZ & MDMZ Access to MSD Store activity to receive status information and reports aggregated from throughout the JPSS System (flight and ground assets) by the MON Manage Global Situational Awareness activity that provides a human machine interface for the data from the MON Monitor Satellite State of Health, MON Trend Flight System State of Health, and MON Trend Ground System State of Health/Service activities.	All status information from the JPSS System received by FGM is System Status data that is presented by Situational Awareness.
1a	MON	The MON Manage Global Situational Awareness activity displays GO related Mission Notices in near-real-time for receipt and subsequent processing by FGM.	GO Mission Notices.
1b	MON	The MON Manage Global Situational Awareness activity collects logs with all the status details and AWE messages from each of the JPSS nodes. This log includes information from the MON node and is available to the MON Manage Fleet / Ground Operations activity.	GO logs
1c	MON	The MON Trend Flight System State of Health activity generates a variety of trend reports used by the MON Manage Fleet / Ground Operations activity. These reports are distributed to FGM by the MON IDMZ & MDMZ Access to MSD Store activity.	SO reports: Trend Reports
1d	MON	The MON Monitor Satellite State of Health activity issues satellite related Mission Notices in near-real-time for receipt and subsequent processing by FGM.	SO Mission Notices
1e	MON	The MON Monitor Satellite State of Health activity collects logs with all the status details and AWE messages from each of the JPSS missions. This log is available to the MON Manage Fleet / Ground Operations activity.	SO logs
		FGM Global Situational Awareness	
2	MON	The MON Manage Fleet / Ground Operations activity receives reports from the MON IDMZ & MDMZ Access to MSD Store activity.	Periodic routine summary reports are generated from a global perspective.
3	MON	The MON Manage Fleet / Ground Operations activity receives selected mission Key Performance Parameter (KPP) reports, trends & reports.	See Section 7 for details on KPP

No.	Actors	Actions	Notes
4	MON	The MON Manage Fleet / Ground Operations activity receives selected Space Operations trends & reports from the MON IDMZ & MDMZ Access to MSD Store activity.	
5	MON	The MON Manage Fleet / Ground Operations activity receives selected reports from internal and external entities, such as Attitude Ground Support, etc. from the IDMZ & MDMZ Access to MSD Store activity.	
6	MON	The MON IDMZ & MDMZ Access to MSD Store activity logs report arrivals, maintains a directory of available reports, and provides authorized user access to that data from the MSD Store.	
7.1	MON	The MON Manage Fleet / Ground Operations activity notifies the FGM user upon receipt of reports meeting selection criteria.	
7.2	MON	The MON Manage Fleet / Ground Operations activity edits reports and sends them via the MON IDMZ & MDMZ Access to MSD Store activity to authorized users and/or via the MON Operations Email activity.	
		Resource Management	
8	MON, Mission Planner, MOD, OLE	The MON Process Mission Activity & Task Requests activity maintains the Master Schedule. The Mission Planner notifies OSPO Lead Engineer (OLE) of any un-resolvable conflicts. MOD has access to the Master Schedule via this activity. Associated reports from MPS are received by FGM.	Reference the Master Schedule Deconfliction alternate flow below.
9	MON	The MON Manage Fleet / Ground Operations activity extracts system utilization and performance information from logs and reports upon receipt.	Provides global resource utilization (actual) and system performance information.
10	MON	The MON Manage Fleet / Ground Operations activity extracts system capacity and allocation information from the Master Schedule and reports.	Provides global resource capacity and utilization (planned) information.
11	MON	The MON Manage Fleet / Ground Operations activity compiles system statistics and assessments for resource capacity, allocation, utilization, and performance data. Derived parameters are generated using this data.	Reference the Maintain Mission Priorities alternate flow below.
12	MON	The MON Manage Fleet / Ground Operations activity displays and reports system resource statistics and assessment parameters.	

No.	Actors	Actions	Notes
13	MON, OLE, MOD	The MON Manage Fleet / Ground Operations activity trends system resource statistics and assessment parameters. These trends are available for display and provided in routine reports. These reports are reviewed by MOD and distributed by the MON IDMZ & MDMZ Access to MSD Store activity. MOD may initiate modification of mission priorities to provide more uniform resource margins.	Trend analysis- Reference the Maintain Mission Priorities alternate flow below.

6.2.1.7 Alternate Flow

The following alternate flows are executed as called out by the basic flow or on an 'as needed' basis in support of FGM.

6.2.1.7.1 Mission Task & Event Review

When a new (or modification to an existing) Mission Task is requested, it is considered a Special Mission Task and requires product control board approval. Likewise, when planning an event (subsequently supported by a mission task) requiring additional resource support or of high priority, it is referred to as a Schedule Event. Both items require review and action by FGM. Authorized users can submit requests to create/modify mission tasks or events. The user inputs all required data into the request. Once approved, new/modified tasks or inclusion of Schedule Events can be scheduled. Scheduling of tasks is accomplished by submitting a Mission Task Request, which adheres to a defined process and timeline. The details of the Task and Schedule Event approval process applicable to FGM are defined in this alternate flow.

Table 6.2.1-4 defines the alternate flow of Fleet/Ground Management - Mission Task & Event Review.

Table: 6.2.1-4 Mission Task & Event Review Alternate Flow

No.	Actors	Actions	Notes
		Special Mission Task	Steps 1-6 only
1	Mission Planner	The Mission Planner's Define Mission Tasks & Events activity generates the request for a new task or modification of an existing task.	
2	OLE	The OSPO Lead Engineer reviews the request for completeness, with particular attention paid to task resource utilization and recommended priority.	
3	OLE	The OSPO Lead Engineer reviews evaluation and test artifacts from test scenarios utilizing the task executed on the FVTS and/or in long-term planning & scheduling studies.	Verifies the task does not violate resource allocations, cause undue resource conflicts and assists in the assignment of task priority.
4	MOD	The MOD recommends a priority for the task through coordination with affected missions.	Reference Maintenance of Mission Priorities Alternate Flow

No.	Actors	Actions	Notes
		The value is reviewed as part of the product control board process.	
5	MOD, OLE, Product Control Board	The Product Control Board approves the new / modified task.	
6	MON, Mission Planner	The Mission Planner releases the approved task definition for use by the CGS Process Activity & Task Requests activity and inclusion in the Master Schedule.	
		Special Schedule Event	Steps 7- 12 only
7	Mission Planner	The Mission Planner's Define Mission Tasks & Events activity generates the request for placing a Special Schedule Event on the Master Schedule.	
8	MOD	The MOD reviews the request for completeness, with particular attention paid to resource utilization, allocation of cross-mission resources and constraints / options for positioning the event.	
9	MOD, OLE, Mission Planner	The MOD and/or OSPO Lead Engineer coordinates with affected missions, approves addition of the event and provides direction for the positioning of the event.	
10	Mission Planner, Authorized Users	The Mission Planner issues a Mission Notice to Authorized Users directing inclusion of the event in the Master Schedule and providing applicable details.	
11	MOD	If inclusion of the event may result in un-resolvable conflicts, the MOD may direct a temporary adjustment in task priority (see Maintenance of Mission Priorities alternate thread) or direct a temporary override to resolve the conflict.	
12	MON, Mission Planner	The Mission Planner uses the MON Process Activity & Task Requests activity to place the event on the Master Schedule.	

6.2.1.7.2 Master Schedule Deconfliction

Any violations and conflicts identified during the scheduling process are reported to the Mission Planner. Some may be resolved by the Mission Planner with slight adjustments to the schedule. The Mission Priority and Detailed Mission Priority Specifications are used by the mission planning and scheduling system to resolve others. Conflicts which cannot be resolved by the Mission Planner are reported to the Lead JPSS Mission Planner for resolution. With direction from Fleet Mission Management, the Mission Planner incorporates the changes and re-processes the mission activity and task requests. This alternate thread discussed the details of that process.

Table 6.2.1-5 defines the alternate flow of Fleet and Ground Management - Master Schedule Deconfliction.

Table: 6.2.1-5 Master Schedule Deconfliction Alternate Flow

No.	Actors	Actions	Notes
		Deconfliction by Mission Planners	
1	MON	The MON Process Mission Activity & Task Requests activity identifies conflicts in the Master Schedule and attempts to resolve those conflicts as per the Detailed Mission Priority assigned to the task.	Identification and CGS resolution of conflicts.
2	MON, MPL, OLE, Mission Planner	The Lead JPSS Mission Planner (MPL) reviews the results of MON Process Mission Activity & Task Requests activity for unresolved conflicts and/or conflict resolutions which may adversely affect the performance of the fleet. The MPL reports the root cause of the conflict to OSPO Lead Engineer and coordinates possible mitigation actions with the affected Mission Planners.	See Maintenance of Mission Priorities alternate flow.
3	MON, Mission Planners	The affected Mission Planners modify their mission schedules or apply temporary priority overrides as directed by MPL. The MON Process Mission Activity & Task Requests activity is performed. The results of that activity are evaluated.	
		Deconfliction by MOD	
4	MOD, MPL, Mission Planners	The MOD verifies the reported root cause. Resource capacity, allocation, utilization and performance reports for the fleet and ground system are reviewed to derive recommendations for permanent mitigation. These recommendations may include: • Increase in ground system capacities • Reallocation of ground resources based on agreed upon mission objectives (modified priorities) Reallocation of ground resources based on assessment of allocated resource utilization (modified priorities, task definitions or scheduling rules).	Supports the disposition of unresolved conflicts or re-occurring conflicts.

6.2.1.7.3 Maintenance of Mission Priorities

The initial set of priorities are developed by NOAA in coordination with JPSS Flight Project, managed and supported missions. These priorities are applied to defined mission tasks supporting Mission Planning and Scheduling activities and used to resolve resource utilization conflicts in the Master Schedule. FGM has the responsibility to monitor the effectiveness of

these priorities (Steps 8-13 in the Primary Flow) and to develop specific recommendations for their maintenance. This alternate thread addresses the temporary and permanent modification of priorities.

Table 6.2.1-6 defines the alternate flow of Fleet and Ground Management - Maintenance of Mission Priorities.

Table: 6.2.1-6 Maintenance of Mission Priorities Alternate Flow

No.	Actors	Actions	Notes
		Setting Initial Values	
1	NOAA, JPSS Flight, JPSS-Managed Missions, JPSS-Supported Missions, MOD, Mission Planners	NOAA defines Mission Priority procedures for missions utilizing JPSS resources in conjunction with the JPSS Managed and Supported Missions. The procedures provide a priority ranking for high-level resources for each mission using the resource. This ranking may be determined by support type. Verification that the priority scheme allows each mission to successfully meet agreed upon support levels is performed through analysis. Refinement of these priorities is addressed later in this thread. The Priority Procedures are reviewed whenever mission operational status changes. These procedures provide high-level guidance to MOD and the Mission Planners.	
2	JPSS Flight, JPSS-Managed Missions, JPSS-Supported Missions	JPSS missions determine Detailed Mission Priorities internal to each mission which are subsequently applied to mission tasks. The overall priority scheme is reviewed by JPSS Flight. This process is repeated in response to revision of Priority Procedures or detailed mission priorities. These priorities are utilized by the planning and scheduling system.	
3	MON	The MON Process Mission Tasks & Events activity is utilized to define tasks within the mission planning and scheduling system. Each task is assigned a priority consistent with the Detailed Mission Priorities. The planning and scheduling system utilizes these priorities to deconflict the master schedule.	
4	CGS, OLE, MOD	The MON IDMZ & MDMZ Access to MSD Store activity or MON Manage Global Situational Awareness activities provides the information necessary for OSPO Lead Engineer to adjust mission priorities as follows: • Temporary Overrides as a result of:	

No.	Actors	Actions	Notes
		- Contingency or Special Event support - Temporary loss of resource - Resource assessment parameters violate threshold The MON Manage Fleet / Ground Operations activity provides the information necessary for MOD to adjust mission priorities as follows: Permanent Modification • Change in mission status • Change is resource status • Trends indicate low or no margin for resource allocation	
		Temporary Override of Detailed Mission Priorities	
5	MON OLE, Mission Planners	OSPO Lead Engineer issues a directive and/or Mission Notice directing the Mission Planners to temporarily modify task priorities for explicit tasks and time period.	
6	MON, OLE	If the temporary override of detailed mission priorities provides a short term resolution to a long term problem, the OSPO Lead Engineer initiates processes to support permanent adjustment of priorities (continue to step 7).	
		Permanent Adjustment to Priorities	
7	MOD	MOD analyses resource utilization and performance reports and trends to identify any priority issues and develop recommendations for the permanent adjustment of mission and/or detailed mission priorities.	
8	MON, MOD	The MON Process Mission Activity and Task Requests activity is used to perform off-line analysis to evaluate the recommended priority modifications. The MOD reviews the results of that analysis.	
9	MOD	The MOD submits the recommended priority modifications for review and approval (steps 1-3 above).	

6.2.1.7.4 Coordination of Contingency & Special Events

The MOD provides coordination of resources and supports the planning of tasks for Contingency and Special operations for events utilizing shared resources in excess of normal operations or whose use impacts other missions. Additionally, MOD may apply resources requiring ‘call- up’. In addition, MOD provides a line of communication with external entities not essential to the immediate operations.

This alternate flow is executed under the following conditions:

- MOD has been notified of a Contingency Event by the OSPO Lead Engineer or messages exceeding thresholds (Step No 1 in the Primary Flow).
- JPSS Mission Planner has requested scheduling of a Special Event requiring extensive resources (Alternate flow - Mission Task & Event Review)

Table 6.2.1-7 defines the alternate flow of Fleet and Ground Management - Coordination of Contingency & Special Events

Table: 6.2.1-7 Coordination of Contingency & Special Events Alternate Flow

No.	Actors	Actions	Notes
		Contingency Event	Steps 1-4, 7-14
1	MON	The MON Manage Fleet / Ground Operations activity alerts the FGM user upon receipt of messages meeting Contingency Event criteria.	Step 1 of Primary Flow.
2	MOD, OLE, EM	The MOD contacts the OSPO Lead Engineer and/or EM to verify the validity of the alert and address the immediate course of action.	
3	MOD, OLE, EM	If needed, the MOD assists the OSPO Lead Engineer/EM in developing a plan for isolating the root cause of the alert and subsequent recovery.	
4	MOD	The MOD assists in the notification of stakeholders in the event. Go to Step 7	
		Special Event	Steps 5 - 14
5	MON	The MON Manage Fleet / Ground Operations activity alerts the FGM user upon receipt of messages meeting Special Event criteria.	Step 1 of Primary Flow.
6	MON, MOD	The MON Manage Fleet / Ground Operations activity alerts the FGM user upon receipt of messages meeting selection criteria.	
		Continuation of Support	
7	FGM, MPL	The MPL reviews the Master Schedule to assess the extent to which operated and supported mission are affected by the event and its resolution.	
8	MPL	The MPL notifies affected missions and applicable mission support personnel via voice communications.	
9	MPL	The MPL issues Mission Notices to update the status of the issue.	
10	MOD, AGS, SMS	The MOD coordinates support from cross-mission resources such as SN/CDA/McMurdo contingency contacts, AGS analytical support, spacecraft /mission support, etc.	
11	MOD, Mission Planners	The MOD provides direction for any necessary modification of the Master Schedule and monitors the re-plan process.	

No.	Actors	Actions	Notes
12	MOD, OLE, EM	The MOD oversees implementation of the recovery plan.	
13	MON	The MON Manage Fleet / Ground Operations activity compiles system statistics and assessments related to the issue.	Edit pre-formatted and/or Ad-hoc reports
14	MON	The MON Manage Fleet / Ground Operations activity edit reports and sends them to the MON Manage Global Situational Awareness to authorized users and/or Operations Related Email activities.	

6.2.1.8 Post Condition

The fleet of JPSS-managed missions is fully meeting mission objectives. Agreed upon resource allocations for JPSS supported missions are satisfied. Short and long term schedules are in place and conflict free.

6.2.1.9 Related Threads

Provide a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-020	Mission Planning and Scheduling
GS-NML-220	Security
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-NML-320	Space Operations
GS-NML-140	Mission Support Data Handling
GS-NNL-110	Data Link Management
GS-NNL-120	Continuity of Operations
GS-NNL-130	System Fault Analysis
GS-NNL-140	System Maintenance and Upgrade
GS-NML-400	Flight Software Upgrade
Various	Multiple threads providing log & report input to FGM

6.2.1.10 Child Threads

The following is a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-010-010	Ground Operations
CGS-010-020	Space Operations
CGS-020-010	Mission Planning and Scheduling
CGS-030-010	Status and Situational Awareness

6.2.2 Mission Planning and Scheduling

6.2.2.1 Description

Mission Planning and Scheduling (MPS) thread (GS-NML-020) describes the planning and scheduling of JPSS mission tasks, operations and resources (space and ground) as part of the Mission Management (MM) function and the distribution of the Mission Planning and Scheduling products within the JPSS program.

GS-NML-020 only addresses planning and scheduling directly related to the day-to-day routine on-orbit operations of the JPSS missions and does not provide details on any extended set of tasks such as support for contingency or special operations, although those and other sets of tasks are planned by the Mission Planning and Scheduling thread. The focus of this thread is on the scheduling process itself, not the particular tasks that may be scheduled. Refer to the appropriate threads listed in the Related Threads subsection for thread particular details regarding task inputs to Mission Planning & Scheduling. This thread does not specify operational details, such as nominal command load start times, which may be mission specific and are best addressed in OSPO Operations documentation.

Inputs to the process come from a wide variety of sources. Many are received on a routine basis, their receipt is monitored by the Mission Planner for completeness prior to initiating the batch processing of Schedule Events and Tasks. Those events and tasks are discussed throughout this thread. Other events and task requests are received on an as-needed basis and are coordinated with the Mission Planner, as well as Fleet Mission Management. Details concerning the generation and delivery of those inputs are addressed in the appropriate threads. The results of the planning and scheduling effort are captured in the Master Schedule. The Master Schedule is a formatted time-ordered set of Events and Tasks for all JPSS missions. Various operational products are derived from the Master Schedule and distributed.

Derivatives of the Master Schedule include Mission Schedules and various implementation plans. The Mission Schedule is a report of Events and Tasks for a single mission. The Mission Planner works in a Master Schedule covering the planning period (months) and generates Mission Schedules for each mission over a shorter scheduling period (days) defined by the OSPO Operations documentation. There are several categories of implementation plans, including Activity Schedule, Command Load Files and Operational Implementation Plans. These implementation plans are utilized by the Mission Operations Team. The Activity Schedule is consumed by the ground system.

This thread applies to the JPSS-managed satellites such as S-NPP, JPSS-1/2/3/4; as well as JPSS-supported satellites such as GCOM-W1, DMSP, the current Ground System (CGS, FVTS, FTS and GRAVITE) and its schedulable assets (KSAT, McMurdo, FCDAS). However, MPS only applies to the scheduling of JPSS resources for which MPS has the direct responsibility of scheduling. Thus, the scenario varies at the schedule coordination stages as identified in this thread. The thread will be updated to accommodate other satellites in the future such as the EUMETSAT Metop-SG.

Mission Planning and Scheduling for JPSS Missions is allocated to the JPSS Common Ground System (CGS). As depicted in Figure 6.2.2-1, CGS activities used to accomplish this function include Task & Mission Event Definition, Determination of View Periods, Event & Task

Request Ingest, Process Mission Activity & Task Requests, Master Schedule Deconfliction, Generation of Implementation Plans, Generation & Validation of Command Load Files, and the Distribution of the Mission Schedule & derivatives of the associated Operational Implementation Plans (i.e. Common Contact Schedule (CCS), Pass Plan, etc.).

The inputs to these processes include Task Requests, Orbit & Schedule Events, Ephemeris products, Mission and Instrument Priorities, Station Contact Schedules, external contact schedule information, Notices from Mission Operations Centers, Two-Line Elements, Flight Products, Maneuver Planning Data, and TDRSS schedule information.

As Outputs from these processes, the CGS produces a maintained Master Schedule, Mission Schedules, Spacecraft and Instrument loads, schedule performance assessments, the KSAT, Fairbanks and McMurdo Contact Schedules & Common Contact Schedule (CCS), Pass Plans, and JPSS Mission Notices. Schedule information for future ground resources will be added as those resources come online.

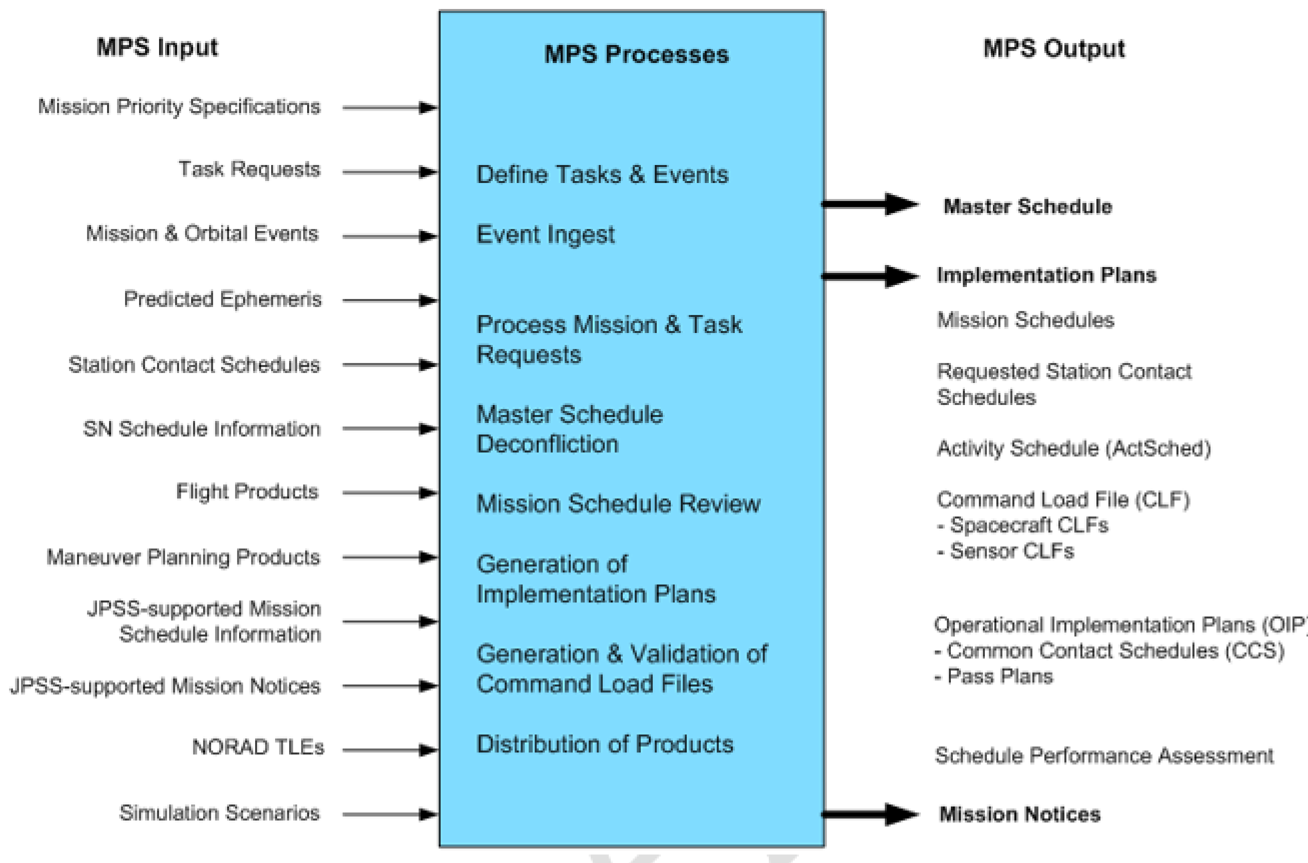


Figure: 6.2.2-1 CGS Processes and Context for Mission Planning and Scheduling

6.2.2.1.1 Planning and Scheduling Personnel and Roles and Responsibilities

The operations personnel most involved in the day-to-day use of the Mission Planning and Scheduling functionality are the Mission Planners, Lead JPSS Mission Planner and, to a lesser degree, OSPO MOD. The following sections describe their roles and responsibilities.

JPSS Mission Planner (MP)

The mission planners perform the planning and scheduling of ground and space tasks for a specific mission. The Mission Planners are assigned to one or more missions. This support includes execution of the operations discussed in this thread.

The JPSS Mission Planner performs the following operations over the planning period:

- Maintains Mission Task and Event Definitions
- Places approved Mission Tasks and Events on the Master Schedule
- Coordinates with Mission Planners for other JPSS-managed and JPSS-supported missions
- Mitigates potential schedule conflicts with other Mission Planners
- Receives Event and Ephemeris Products from Orbit Operations
- Supports scheduling of Ground Stations and Space Network (SN) contacts
- Monitors receipt of external contact schedule information, Ground Station & SN Schedules, TLEs, etc.
- Coordinates with spacecraft and instrument engineers
- Maintains the Master Schedule

The JPSS Mission Planner performs the following operations over the scheduling period for their assigned missions:

- Processes Mission Activity & Task Requests
- Coordinates with Mission Planners for other JPSS-managed and JPSS-supported missions to resolve residual conflicts
- Resolves outstanding schedule conflicts with the Lead JPSS Mission Planner and Fleet/Ground Management
- Generates the Activity Schedules (ActSched), Command Load Files (CLF), and implementation plans: Pass Plan (PP), Common Contact Schedule (CCS))
- Reviews, with support from the MOT, the generated CLFs and implementation plans
- Distributes and exports generated products
- Assesses the Mission Schedule performance with a weekly scheduling evaluation
- Generates Mission Notices for system activities
- Coordinates with Mission Managers to ensure all customer operations needs are met

Lead JPSS Mission Fleet Planner (MPL)

The Lead JPSS Mission Planner ensures that the overall schedule (Master Schedule) meets fleet objectives. The Lead JPSS Mission Planner provides a technical interface between OSPO MOD

Management and the Mission Planners. This support includes execution of the duties listed below:

- Reviews the allocation of schedulable resources across the fleet
- Monitors resource availability and utilization from a fleet perspective
- Coordinates evaluation and scheduling of Special Mission Tasks with the Mission Planners
- Assess responses to predicted RFI Autotrack conjunction events
- Assists in the resolution of outstanding schedule conflicts
- Reviews the implementation and performance of directives originating from OSPO MOD Management
- Supports the scheduling process during the Pre-Launch, Launch & Early Orbit and Decommissioning phases.

OSPO Mission Operations Division Management (MOD)

The MOD provides JPSS mission system management overseeing the operation of a fleet of satellites and the JPSS ground system to achieve overall program objectives across all missions. In this capacity, the MOD interfaces with the Mission Planners, Flight Project and external users as follows:

- Interfaces with the JPSS Flight Project, mission project offices and external organizations.
- Oversees the general availability, allocation & performance of system resources
- Establishes / modifies priority lists utilized in mission planning at the fleet level
- Approves Special Mission Tasks and authorizes scheduling of special Schedule Events
- Provides final disposition of any outstanding schedule conflicts
- Authors / distributes directives which effect mission planning and scheduling

The MOD includes the OSPO Lead Engineer.

6.2.2.1.2 Mission Planning and the Collection of Inputs

Mission planning activities include pass planning, new/modified Mission Event & Task generation, event ingest, and Ground Station Scheduling (KSAT (including Svalbard and Troll), Fairbanks, McMurdo and the Tracking and Data Relay Satellite System).

Events represent real world occurrences that occur at specific times independent of the schedule. There are two general types of Events, *Orbit Events* which are defined by the satellite orbit and *Schedule Events* which are defined and approved by Mission Management. Examples of Orbit Events on the schedule are lunar eclipses of the sun, crossing the day-night terminator, crossing the South Atlantic Anomaly (SAA) boundaries, RFI conjunctions and ground station view periods. Examples of Schedule Events might include Orbit Maneuvers, large-scale Calibration Events, etc. *Tasks* are pre-planned sequences of actions that can be molded into the schedule as

system operations and activities. Task definitions may include ground system and spacecraft commands. Examples of routine Tasks, some of which may be schedule-driven or event-driven or constrained, are Stored Mission Data (SMD) playbacks, routine sensor calibrations, and Electrical Power Subsystem State of Health (EPS SOH) checks. Tasks may be scheduled relative to events incorporated into the schedule. Some Tasks are event and ground station independent and may occur anytime. Some are dependent upon contact schedules, such as a Stored Mission Data (SMD) playback.

6.2.2.1.3 Scheduling Operations and Products

For mission scheduling, Mission Schedules, Station Contact Schedules, Activity Schedules, Command Load Files (Spacecraft and Instrument), and Operational Implementation Plans are created. These products generally overlap those delivered in the previous scheduling cycle. Figure 6.2.2-2 illustrates this concept for a notional timeline where creation of a Mission Schedule occurs on Day n for on-board execution times beginning on Day n+1, covering eight days. The uplinked Command Load Files overwrite the currently loaded CLFs onboard the Satellite. Out-of-cycle updates are permitted and illustrated during Operational Week 2 of the figure.

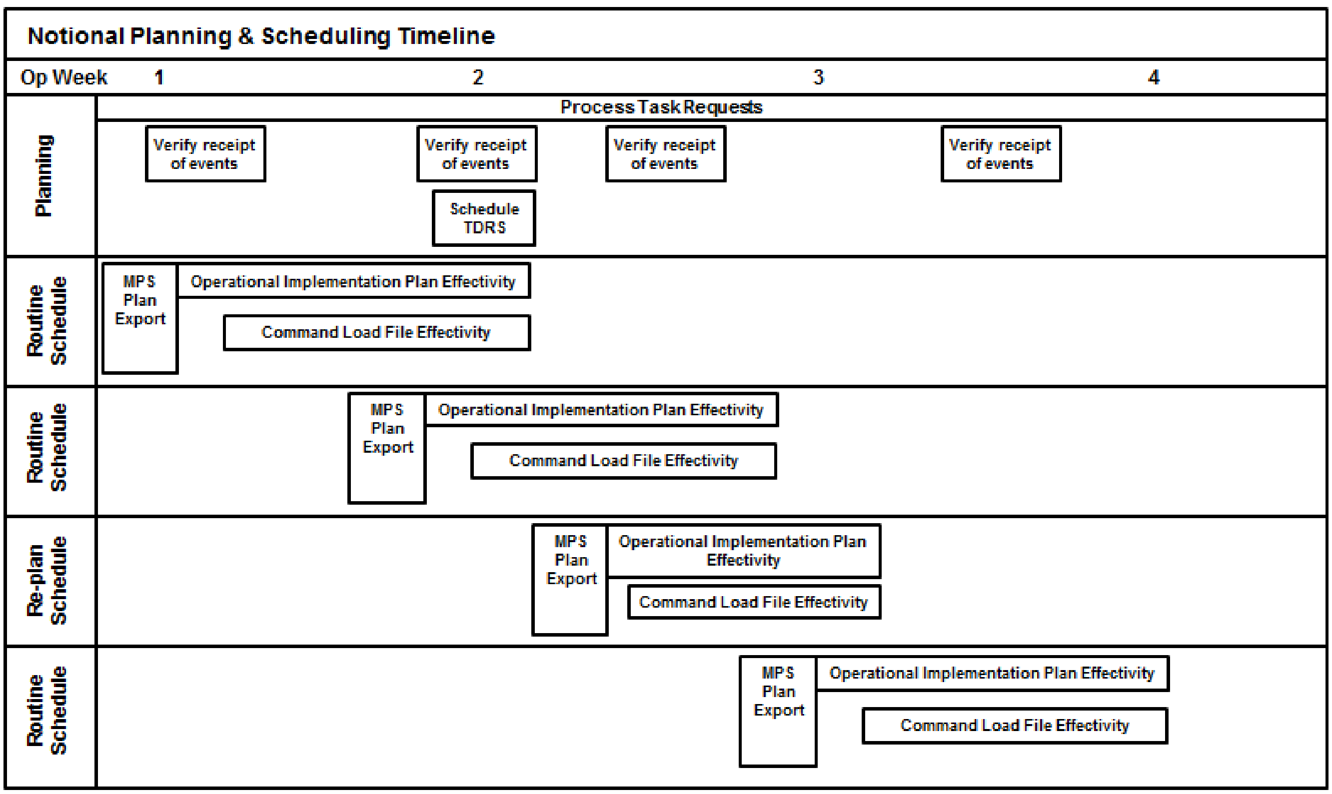


Figure: 6.2.2-2 Scheduling Notional Timeline

A *Mission Schedule* is a formatted time-ordered report of Events (e.g., nodal crossings, RFI conjunctions, etc.), and Tasks for each mission, posted to an external Web server.

The *Station Contact Schedule* (SCS) is a time-ordered list of events on the schedule which support space to ground station communications. The events include station/antenna ID,

spacecraft ID, event times for AOS & LOS, and communications configuration codes. The SCS are mission independent but site or antenna specific schedules. For JPSS-managed missions, station contact planning begins three or more weeks in advance. A Requested Station Contact Schedule is generated and delivered to the ground station scheduler. The request is evaluated and a response issued in the form of the Station Contact Schedule. The JPSS Planning & Scheduling system ingests the response and updates the Master Schedule. This exchange of products occurs at the frequency and product duration specified by OSPO Operations documentation and applies to KSAT and NOAA CDA resources.

Note that for cases where JPSS GS is responsible for managing the schedule (i.e. acting as the scheduling office) of JPSS resources, such as the McMurdo receptors, the process is reversed. In this case, user's issue Requested Station Contact Schedules or Proposed Mission Schedules which are ingested into the Planning & Scheduling system. The JPSS Mission Planner deconflicts all requests for the resource and delivers a response (Station Contact Schedule or Mission Schedule).

An *Activity Schedule* (ActSched) is a timeline schedule of tasks that form a set of commands supporting the time-ordered execution of tasks as laid out in the Mission Schedule. It is the source of the Command Load Generator-produced load (i.e. Command Load Files) and Operations Implementation Plans.

Command Load Files (CLF) are implementation plans which contain sequences of tasks that form a set of commands for time-phased execution autonomously by a spacecraft or instrument. The contents are uplinked to the satellite and loaded to memory locations allocated for stored commands. The files are uplinked regularly by the MMC and contain direct commands to the spacecraft subsystems and instruments.

Operational Implementation Plans (OIP) are per-contact time-phasing of both space and ground activities that execute spacecraft, instrument and ground commands and procedures in real-time.

Common Contact Schedule (CCS) is a planned contact schedule containing receptor. Ground Station and/or Tracking and Data Relay Satellite (TDRS) contact times for a given satellite or constellation; and the required commands to configure the ground system to facilitate the contacts.

A *Pass Plan* (PP) is a per-contact schedule of Events, Tasks and activities for executing ground system, spacecraft and instrument command procedures, such as JPSS GS Front-End configuration at the ground station, SOH checks and transmitter on/off commands executed by CGS. It includes all commanding to the Spacecraft from the Ground System. A Back Orbit State Table is provided with the Pass Plan to enable the MMC operators to compare expected telemetry values with actual values at AOS.

JPSS-issued *Mission Notices* are issued System-wide to appropriate entities and are used to notify stakeholders of key Schedule Events on the Master Schedule such as satellite maneuvers, data product anomalies, or system outages. They include Mission Notices received from external sources.

Formal definition of the above, and other, italicized terms used in this thread are found in the Joint Polar Satellite System (JPSS) Program Lexicon, 470-00041.

6.2.2.1.4 Mission Planning Process

The Mission Planning Process is a continuous activity executed by the Mission Planner and supports several functions maintaining the Master Schedule.

6.2.2.1.4.1 Define Mission Task & Events

When a new (or modification to an existing) Mission Task is requested, it is considered a *Special Mission Task* and requires product control board approval. Authorized users can submit requests to create/modify mission tasks. The user inputs all required data into the request for the task. The process for accomplishing this allows for implementation with sufficient time for the Mission Planner to identify and resolve schedule conflicts. Exceptions (short notice tasking) are handled on a case-by-case basis. New/modified tasks are updated for evaluation and testing. These tasks may be evaluated utilizing the backup MPS system and the FVTS. Results of the test are reported to the product control board. These results are reviewed by the board during the approval process. Once approved, new/modified tasks can be scheduled after their status has been updated to reflect their approval. Scheduling of tasks is accomplished by submitting a Mission Task Request, which adheres to a process and timeline defined by OSPO Operations documentation. Processing and approving new/modified Mission Tasks will not impact real-time Telemetry and Command operations. Additional details concerning the Task and Mission Event approval process can be found in the GS-NML-010, Fleet and Ground Management (FGM) ConOps thread.

Anomaly resolution tasks take priority over all other mission task requests. They can be submitted as required following a prescribed OSPO Operations documented process. This expedited process allows the operations team to react quickly when necessary to restore the safety of the mission (see Alternate Flow: Expedited Re-Planning).

6.2.2.1.4.2 Orbit Maintenance (OrM) Interfaces

The MPS uses Orbit Determination, calibration requirements, and Work Request information from the Orbit Maintenance thread as inputs to develop the JPSS Mission Schedules. This interface is the source for Orbit Events, and requests for scheduling of Schedule Events & Special Mission Tasks supporting activities, such as Delta-v Maneuvers. Details on orbit determination and operations are described in the GS-NML-040 Orbit Maintenance (OrM) ConOps thread.

OrM provides the MPS with ground station visibility orbit events for all JPSS-managed, JPSS-supported and other spacecraft of interest. The orbit events for JPSS-managed missions are derived based on the propagated orbit determined by OrM. For JPSS-supported missions, the events are based on propagated Two-Line Elements (TLEs), which are provided by the mission or obtained from Spacecom. Station visibility events for other spacecraft are likewise generated based on TLEs available from Spacecom. This group of spacecraft includes those which pose a potential RFI risk to the JPSS-managed and supported missions or are in contention for FCDAS 13 meter Antenna resources.

6.2.2.1.4.3 Determine View Periods

This activity supports the acquisition and utilization of ground station assets for KSAT and Fairbanks. The Mission Planner routinely schedules KSAT for JPSS-managed missions as per the generic schedule request of one contact per JPSS-managed mission per orbit. *Generic Schedule Requests* (GSR) are resource scheduling templates which define resource allocations and their characteristics, such as frequency, duration and minimum / maximum cumulative allocation over a time period. These templates are applied by the Mission Planner during the planning phase. Applicable GSRs are usually defined in project-level documentation such as Service Level Agreements (SLA), Memorandum of Understanding (MOU), etc. Meeting of these defined resource allocations is verified during the scheduling process. The Fairbanks Command & Data Acquisition Station (FCDAS) is scheduled as per contingency, short-term and long-term guidelines to supplement support provided by KSAT (the Svalbard Ground Station and Troll). Scheduling of TDRSS is addressed by the Schedule TDRSS Access activity.

The MPS interacts with the KSAT Network Operations System (for SGS and Troll), FCDAS Scheduling and OSPO (for FCDAS) scheduling offices to produce contact schedules for each station asset. This process is iterative and occurs continuously over the station support period. The Mission Planner provides refinements to the set of requested contacts and responses to the scheduling offices. The resultant station contact schedules from each scheduling office result in refinement of contact events or tasks on the timeline (Master Schedule). A *Station Contact Schedule* (SCS) is a time-ordered schedule of space to ground contact events issued by the station scheduling office. The SCS reflect the resolution of ground station conflicts identified by the station scheduling office, such as resource outages, resource allocation to a higher priority user, and RFI conjunctions. The details of this process are specific to each scheduling office interface.

During this activity, the MPS identifies and dispositions potential RFI conjunctions and utilizes predicted visibility events to minimize the potential conflicts with other missions utilizing FCDAS.

Scheduling of FCDAS 13 meter Antenna contact schedules in support of JPSS-managed missions is complicated by the very short planning (seven days or less) and scheduling (less than one day) horizons for several high-priority JPSS-supported missions, including DMSP. In order to minimize resource conflicts, the MPS and/or Mission Planner optimally schedule JPSS-managed mission utilizing visibility conjunction assessments (See GS-NML-040 Orbit Maintenance ConOps thread). Visibility conjunction assessment information is made available via report and/or event data. Contact schedule requests are generated for visibilities with the fewest predicted conjunctions. Note that with three 13 meter antennas, FCDAS may concurrently support up to 3 spacecraft contacts.

Determination of view periods supports the scheduling of ground contacts with SGS and FCDAS for the JPSS-managed missions (S-NPP, JPSS-1); and McMurdo for the JPSS-supported DMSP mission. For the JPSS managed missions, this activity directly supports the station scheduling cycle. For the JPSS-supported missions, contact scheduling is coordinated with schedulers for the specific mission (i.e. DMSP SOCC for DMSP, JAXA via KSAT for GCOM).

6.2.2.1.4.3.1 Schedule FCDAS Contacts

The NESDIS FCDAS provides Contingency Contact support for the JPSS-managed missions and Backup SMD Recovery support. For S-NPP, X-Band downlink of SMD utilizes the FCDAS 13m antennas. For JPSS-1, the Ka downlink of SMD data is received by the JPSS Receptors at FCDAS. S-Band uplink and downlink for both S-NPP and JPSS-1 may be supported by the FCDAS 13m antennas. To schedule contacts, the JPSS GS interfaces with FCDAS scheduling at the Fairbanks Satellite Operations Facility (FSOF). The planning and scheduling horizon of FCDAS scheduling is less than three weeks. Nominally, and for all planning three weeks or more in advance, JPSS requests for FCDAS supports are submitted to the NSOF mission planner of OSPO Operations. This approach is routinely used to schedule Proficiency Contacts of 3-4 per month for each JPSS-managed satellite. Likewise for S-NPP Backup SMD Recovery contacts outside the currently executing FCDAS Operational Day. The Scheduling of FCDAS Contacts alternate flow describes the process. In scheduling contingency contacts with FCDAS, a separate process applies in this case or whenever a change to the Station Contact Schedule currently in use by the station is executing for the current operational day. This process is described in the Alternate Thread entitled Contingency Contact Scheduling.

6.2.2.1.4.3.2 Schedule TDRSS Access

The MPS uses contact schedule information from the SN support thread to place the Tracking Data and Relay Satellite (TDRS) contact events and/or tasks on the schedule. The SN Support ConOps thread (GS-NNL-150) provides the steps for scheduling TDRS contacts with the JPSS-managed spacecraft. The ConOps has three variants. The first is for Bulk Schedule Request to support routine TDRS contact operations; the second for Specific Schedule Request to modify existing schedule, and the third for Ad hoc Schedule Request to support contingency operations. TDRS contacts are scheduled to support contingency operations, maintain operational proficiency, contingency recovery and some special operations, such as orbit maneuver execution.

6.2.2.1.4.3.3 Schedule JPSS-Supported Missions

In the cases where the MPS is acting as the scheduling office for scheduling of JPSS resources in support of JPSS-supported missions (DMSP), their two-line elements are propagated to determine view period events. This information is subsequently used in the planning and scheduling process.

6.2.2.1.4.4 MPS Contact Planning

The Mission Planner utilizes approved Mission Tasks to schedule activities satisfying the objectives of each contact. The planner schedules contacts to perform routine and periodic operations. Routine and periodic operations assess/maintain satellite state of health, uplink command load file, and downlink SMD. The S-NPP and JPSS-1/2/3/4 on-board Mass Data Storage (MDS) have the capacity to store at least 3.5 orbits worth of mission data. Additional support for special or contingency operations is scheduled on an as-needed basis. The Mission Planner schedules TDRS contacts as described in the Space Network Support ConOps thread.

Table 6.2.2-1 shows the contact planning element table depicting S-NPP and JPSS-1/2/3/4 spacecraft activities that must be done on every contact (routine) and on daily, weekly, monthly

(periodic) and other (special) bases. These activities are defined by corresponding Mission Tasks within the MPS system.

Table: 6.2.2-1 Contact Planning Element Table

Every Pass	Daily	Weekly	Monthly	Other
SOH CHECK	Dump Error Logs (and upon exception)	CLF upload (multiple times per week)	Telemetry Mass Data Storage (aka. DSU) Dump & Compare	Maneuvers
MDS Dump (begins at 5° elevation)	Dump Command Data Processor (CDP) Table 1 - Command Storage Memory (CSM)	VIIRS Day/Night Transition Table update (twice weekly)	2 TDRS Contacts for Proficiency Exercises	Sensor Calibrations
MDS Retransmit Procedure (PROC) (as required)	Dump CDP Table 79 - Command History	OMPS CLF upload (twice weekly)	Exercise Ground System Backup (B/U) Components	Lunar Calibrations
			Exercise manual PROC sending	S/C and Instrument Loads

6.2.2.1.4.5 Collect External Contact Plans

JPSS-supported missions share JPSS resources. In some cases, those resources are directly scheduled by the JPSS Mission Planner; otherwise, the information is utilized to monitor resource loading and schedule of tasks to avoid under-allocation and over-subscription of the resource. Under this activity, the MPS collects contact schedule information and two-line elements. For example, in support of DMSP scheduling at McMurdo, the MPS collects and ingests DMSP Proposed Mission Schedules and Two-line element sets. The Proposed Mission Schedule contains specific requests and configuration information for each visibility. This information is subsequently used in the planning and scheduling process.

6.2.2.1.5 Mission Scheduling Process

The Mission Scheduling Process is a periodic activity executed by the Mission Planner which supports several functions in generating and distributing the Mission Schedule and Implementation Plans. Prior to the initiation of the scheduling process, the Mission Planner verifies that all the necessary planning activities for the schedule period have been completed.

6.2.2.1.5.1 Process Mission Activity & Task Requests

During this process, the MPS populates the schedule, applying event-driven Tasks, evaluates the schedule for constraint violations, task execution or resource utilization conflicts. All violations and conflicts are resolved prior to the creation of the Mission Schedules. This is a batch process initiated by the Mission Planner.

6.2.2.1.5.2 Deconflict Mission Schedules

Any violations and conflicts identified during batch processing are reported to the Mission Planner. The MPS attempts to deconflict the Master Schedule during execution of this activity. Residual conflicts may be resolved by the Mission Planner with slight adjustments to the schedule. The Mission Priority Specifications are used to resolve others. Conflicts which cannot be resolved by the Mission Planner are reported to the OSPO Lead Engineer, reference Fleet/Ground Management (GS-NML-010), for resolution. With direction from Fleet/Ground Management, the Mission Planner incorporates the changes and re-processes the mission activity and task requests. Upon attaining an issue free Master Schedule, the Mission Planner proceeds to generate the Mission Schedule and implementation plans.

6.2.2.1.5.3 Generate Implementation Plans

The implementation plans are a set of operational products used to support satellite and ground operations. They include the Activity Schedules (ActSched), Command Load Files (CLF), Pass Plans (PP), and Common Contact Schedules (CCS). Implementation plan start-times, duration and frequency of release are defined by the mission's OSPO Operations documentation. The concept of operations details are driven by satellite capabilities, instrument needs and operational considerations. The implementation plan generation and validation process should complete early enough in the scheduling period to allow for two or more uplink opportunities of the CLFs. Note that the implementation plan generation schedule may be specific to a plan type or mission.

6.2.2.1.5.3.1 Station Contact Schedule Generation

During the generation of implementation plans, the Station Contact Schedules and Requested Station Contact Schedules are generated and collected for distribution as Mission Support Data. These files include the CDAS Schedule Request making the request for FCDAS support for JPSS-managed missions.

6.2.2.1.5.3.2 Activity Schedule (ActSched) Generation and Validation

The routine Activity Schedules (ActSched) for a planning period are exported with a nominal default or user specified start time. This start time may be mission specific and specified in OSPO Operations documentation. The Mission Planner validates the schedule prior to exporting it. This validation includes a check for dropped commands, border condition violations, AOS/LOS commanding, continuous consumables exceeding capacity, and temporal constraint violations. The Mission Planner must resolve any violations before continuing. After the schedule has been validated, the ground system exports ActScheds to the Command Load Generator (CLG).

6.2.2.1.5.3.3 Generate & Validate Satellite CMD

The Generate & Validate Satellite CMD activity extracts the stored command information from the ActSched and performs constraint checking on the extracted commands. If conflict free, CLG output files - Command Load Files (CLF) - are generated and handed off to T&C for encryption and real-time uplink. Same-day changes made to an uploaded CLF are addressed by a Critical Change (Late or out-of cycle) Re-Plan.

6.2.2.1.5.3.4 Pass Plan (PP) Generation

Pass Plans are generated by the Generate Implementation Plans functionality using the Master Schedule following the generation of the Mission Schedules. Upon successful PP generation, they are released for distribution and utilized by the Execute Ground Commands and Execute Satellite Commands & Loads activities. Reference the Ground Operations (GS-NML-310) and Telemetry and Command (GS-NML-030) threads for additional details.

6.2.2.1.5.3.5 Common Contact Schedule (CCS) Generation

Common Contact Schedules are generated during the Generate Implementation Plans activity. Following validation of the implementation plans, the CCSs are released for distribution and utilized by the Execute Ground Commands activity. Reference the Ground Operations (GS-NML-310) thread for additional details.

6.2.2.1.5.4 Operations Implementation Plan Distribution

The Mission Planner exports the Operational Implementation Plans to the Distribute Mission Schedule activity, where the ActSched, PP & CCS are routed to the Mission Operators, and the Mission Schedule & CCS to the internal and external web servers.

6.2.2.1.6 Mission Notice Generation and Distribution

Mission Notices are generated within CGS and are distributed to appropriate stakeholders system-wide to notify stakeholders of key events on the system such as satellite maneuvers, data product anomalies, or system outages. They include Mission Notices received from external sources

6.2.2.2 Primary Interfaces

Figure 6.2.2-3 illustrates the actors and primary external interfaces involved in the execution of JPSS Mission Planning and Scheduling. Each interface illustrated in the figure, labeled with a number, is described in Table 6.2.2-2, along with the information about types of data, exchange method and frequency. Table 6.2.2-3 lists the Primary Interface documentation (ICDs, IRDs).

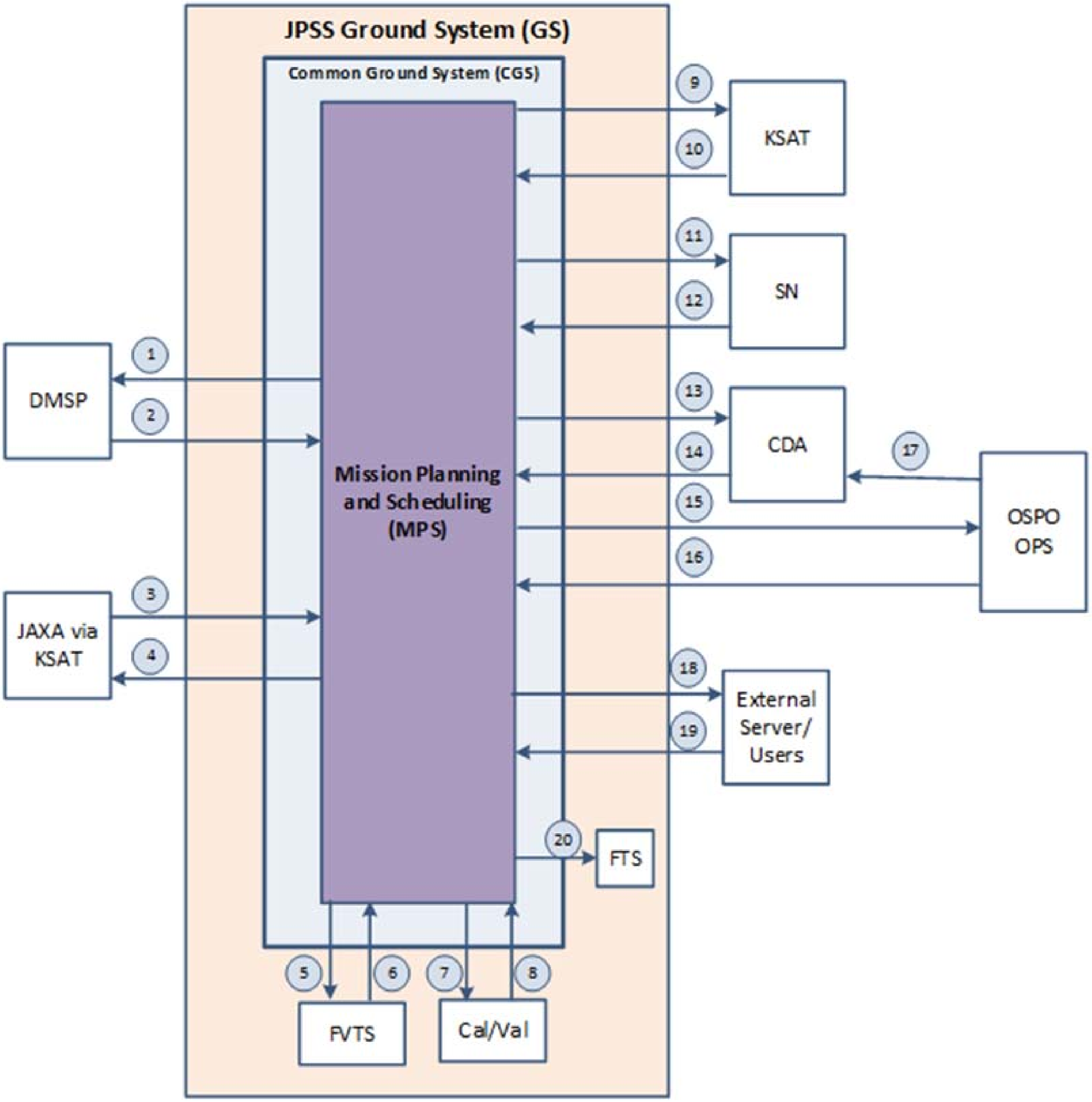


Figure: 6.2.2-3 Mission Planning and Scheduling Primary Interfaces

Table: 6.2.2-2 Mission Planning and Scheduling Primary Interfaces

No.	Type	Actors	Purpose
1	External	CGS ⇒ DMSP	Mission Schedule, Mission Notices
2	External	DMSP ⇒ CGS	Proposed Mission Schedule, TLEs, Mission Notices
3	External	JAXA via KSAT ⇒ CGS	Mission Notices, Satellite Status Information

No.	Type	Actors	Purpose
4	External	CGS ⇒ JAXA via KSAT	Mission Notices
5	Internal	CGS ⇒ FVTS	Control Directives, Command Load Files (spacecraft and instrument), Ancillary Information
6	Internal	FVTS ⇒ CGS	Telemetry and Status
7	Internal	CGS ⇒ Cal/Val	Mission Task Information
8	Internal	Cal/Val ⇒ CGS	Mission Task Requests
9	External	CGS ⇒ KSAT	Requested Station Contact Schedule, TLEs, Mission Notices
10	External	KSAT ⇒ CGS	Station Contact Schedule, Mission Notices
11	External	CGS ⇒ SN	Schedule Request Information
12	External	SN ⇒ CGS	Interim and Confirmed Schedule Information
13	External	CGS ⇒ FCDAS	TLEs, Mission Notices
14	External	FCDAS ⇒ CGS	Station Contact Schedule, optional reports
15	External	CGS ⇒ OSPO Operations (Mission Planner)	JPSS schedule request to NSOF scheduling for FCDAS support
16	External	OSPO Operations (Mission Planner) ⇒ CGS	NSOF scheduling response to JPSS schedule request for FCDAS
17	External	OSPO Operations (Mission Planner) ⇒ FCDAS	Requested Station Contact Schedule
18	External	CGS ⇒ External Server/Users	Contact Schedules, Mission Notices
19	External	External Server/Users ⇒ CGS	Mission Task Requests
20	Internal	CGS ⇒ FTS	Mission Task Information

Table: 6.2.2-3 Primary Interface Documentation

No.	IRD/ICD
1,2	Joint Polar Satellite System (JPSS) Ground System (GS) to Defense Meteorological Satellite Program (DMSP) Interface Requirements Document (IRD)
3, 4, 9, 10	JPSS Ground System to Kongsberg Satellite Services (KSAT) Interface Requirements Document
5, 6	JPSS CGS to FVS IRD JPSS CGS to FVTS IRD
7, 8	JPSS CGS to GRAVITE IRD
11, 12	SN to JPSS C3S ICD Network Requirements Document for JPSS-2 RFICD S-NPP S/C and SN (451-RFICD-S-NPP/SN, 472-REF-00082) JPSS Interface Requirements Document (IRD) for Radio Frequency (RF) Interfaces To and From JPSS Satellites 2 through 4 (JPSS-2/3/4 RF IRD) SNAS MOC Client Software Users' Guide, 452-UGSNAS JPSS Space/Ground Data Format XML Database S-NPP Network Operations Support Plan

No.	IRD/ICD
13, 14, 15, 16, 17	Joint Polar Satellite System (JPSS) Ground System (GS) to National Environmental Satellite, Data, and Information Service (NESDIS) Fairbanks Command and Data Acquisition Station (FCDAS) Interface Requirements Document (IRD) FCDAS 13M Antennas Resource Conflict Priorities Procedure
18, 19	JPSS CGS Services IDD
20	JPSS CGS to FTS IRD

6.2.2.3 Assumptions & Constraints

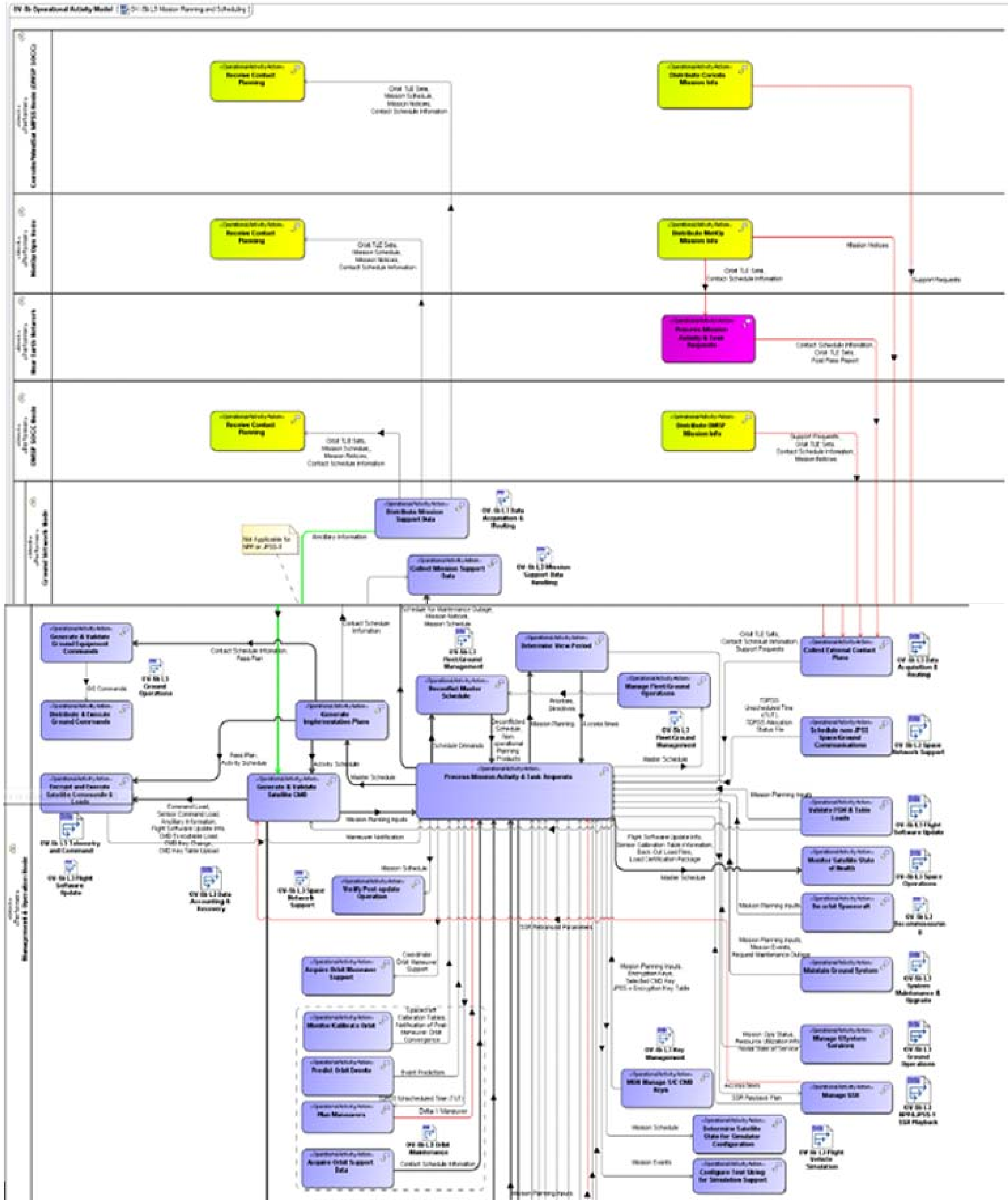
- All necessary mission tasks exist and are under configuration control
- The CLF supports 7 days of autonomous Suomi NPP operations <Loads for other missions will be described when the information is available>.
- The content of the Mission Schedules describing the overall activities for the schedule period has been defined.
- All Master Schedule component products are S/C or ground segment element specific
- The Master Schedule can be generated and updated as often as needed
  - Mission Schedules modified through *Expedited Re-Planning* apply only for the currently executing scheduling period.
- All Flight Products have been validated during generation and approved and placed under configuration control
- Planning and Scheduling are performed for the JPSS; task definitions may be mission-specific
- Mission data users are notified of Mission Schedule updates through Mission Notices
- A Back Orbit state table is distributed at the same time the Pass Plan Schedule is distributed.
- Mission Support Data is addressed in a separate ConOps thread
- The KSAT KNOS acts as the scheduling office for antenna resources at Svalbard and Troll
  - Applies to S-NPP, GCOM-W1, and Coriolis/Windsat
- The NASA WOTIS acts as the scheduling office for NASA antennas at McMurdo
  - Applies to Metop and SCaN missions

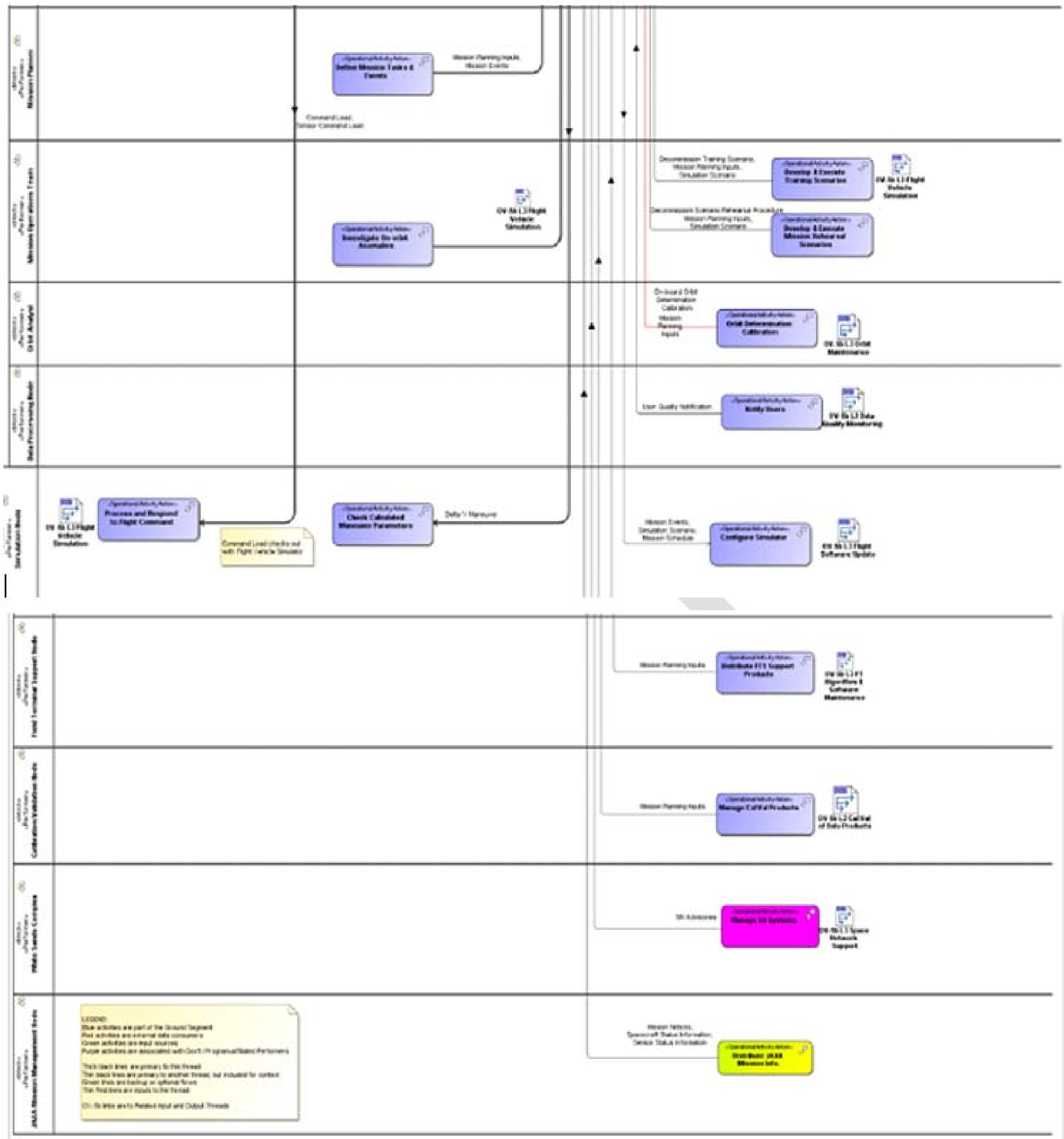
6.2.2.4 Pre-Conditions

- Satellite access times (KSAT and other view periods) have already been calculated by CGS

- All Tasks have been submitted using Task Requests and have already been received by the Mission Planner
- The GCOM-W1, DMSP, Coriolis/WindSat, and Metop contact schedules have already been coordinated with their respective agencies and ingested by CGS
- The Suomi NPP Spacecraft is operational on orbit
- The GCOM-W1 Spacecraft is operational on orbit
- The satellite-ground access times and TDRS access times have been determined

6.2.2.5 Operational Flow





Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.2-4 Mission Planning and Scheduling Operational Flow

6.2.2.6 Basic Flow

Table 6.2.2-4 shows the Mission Planning and Scheduling data flow.

Table: 6.2.2-4 Mission Planning and Scheduling Flow

No.	Actors	Activities	Notes
1	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity ingests schedule inputs (planned outages, routine and special task requests, Schedule/TLE, Notices from external Operations centers, Orbital data from OrM thread)	1-6 define the planning process. 1 & 2 are ongoing steps, occurring as early as 2 months or more prior to any scheduled operations day.
2	CGS	The CGS Process Mission Activity & Task Requests activity performs initial planning of satellite and ground tasks. This activity identifies and attempts to resolve conflicts utilizing a priority scheme. Unresolved task request conflicts are brought to the attention of the Fleet Planner. Fleet Planner then tries to deconflict manually. If the conflict still cannot be resolved, the Mission planner notifies the Fleet Mission Manager to provide direction. The MOD, by way of the CGS Manage Fleet/Ground Operations activity performs schedule and resource deconfliction.	
3	CGS	The CGS Process Mission Activity & Task Requests activity processes Task Requests to ensure instrument and spacecraft tasking has been defined, validated and controlled. Candidate and approved tasks are placed on the timeline. Upon completion of the scheduling process, the Master Schedule is released and long-term Mission Schedules and Station Contact Schedules (including the CDAS Scheduling Request) are produced.	3-6 typically occur 2 months to 1 week prior to scheduled operations day.
4	CGS, Schedule Stakeholders	The CGS Collect Mission Support Data activity releases the Mission and Station Contact Schedules to stakeholders for review and	Stakeholders include OSPO Lead Engineer, SATCON, Instrument Engineer

No.	Actors	Activities	Notes
		comment. Stakeholders review the content of the Mission and Station Contact Schedules for accuracy, validity and feasibility, and provide feedback to the Mission Planner.	
5	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity revises the proposed Master Schedule based on review.	
6	Mission Planner	The Mission Planner iterates the review and revision cycle as required.	
7	CGS, Mission Planner	Upon receiving concurrence from the stakeholders, the Mission Planner uses the CGS Process Mission Activity & Task Requests activity to initiate the scheduling process for the operational period. Upon successful completion, the Master Schedule is published and Mission Schedules are produced.	Start of the scheduling process.
8	CGS	The CGS Collect Mission Support Data activity provides the Mission Schedules to internal and external stakeholders. This step includes distribution of Schedules to JPSS-supported missions, such as DMSP.	7-16 occur within 1 week of scheduled operations day. Updates to the Master Schedule are performed as required Revised Mission Schedules are released as necessary.
9	CGS	The CGS Generate Implementation Plans activity creates the operational Activity Schedule, Station Contact Schedules, Common Contact Schedules, and Pass Plans for the scheduling period.	The Common Contact Schedules are station / antenna specific but contain entries for all scheduled spacecraft. Pass Plans are satellite specific.
10	CGS	The CGS Collect Mission Support Data activity collects the Ground Contact Schedules for subsequent distribution.	SVAL, Troll, FCDAS
11	CGS	The CGS Generate & Validate Ground Equipment Commands activity receives the Common Contact Schedule (CCS) and Pass Plan, as applicable, for each JPSS-controlled mission and produces a time ordered sequence of ground system commands for execution by the CGS Distribute & Execute Ground Commands activity.	CCS: SVAL, FCDAS, WSC, McMurdo, Troll

No.	Actors	Activities	Notes
12	CGS	The CGS Generate & Validate Satellite CMD activity receives the Activity Schedule and generates a proposed command loads for the spacecraft or one of its associated instrument sensors. The command loads may be sent to the FVTS Process and Respond to Flight Command activity to verify operation. After successful verification the command loads are sent to the CGS Encrypt & Execute Satellite Commands & Loads activity for subsequent uplink to the satellite (Command Load Files) or real-time execution (CMD Executable Load). Satellite retransmit requests from the Data Accounting and Recovery thread may be included in the command load or implemented in real-time commanding.	See Flight Vehicle Simulation thread for more details on the simulation applicability and other aspects for the command load.
13	CGS	The CGS Distribute Mission Support Data activity distributes Ancillary data for FT usage for future satellites for potential uplink for broadcast to FT users.	
14	CGS	The CGS Process Mission Activity & Task Requests activity issues Mission Notices to the CGS Collect Mission Support Data activity, which makes them available to all authorized recipients (standard list).	
15	CGS	The CGS Process Mission Activity & Task Requests activity performs schedule performance assessment and forwards a report to the CGS Collect Mission Support Data activity, which makes them available to all authorized recipients, including Fleet/Ground Management.	

6.2.2.7 Alternate Flows

The alternate flows below discuss processes executed by the Mission Planner on an 'as needed' basis and are not part of the routine flow of operations.

6.2.2.7.1 Expedited Re-Planning

Occasionally, there is a need to re-plan short-term elements of the Master Schedule occurring within the time span of the currently executing scheduling period. The process is similar to that described in the Mission Planning and Scheduling Flow. However, this flow varies in the incorporation of added/modified/deleted events and tasks (see Section 6.2.2.1.2 - Task & Mission Event Definition), timeline for schedule generation and the distribution of implementation plans. Note that Command Load Files and/or Operational Implementation Plans may be affected.

Table 6.2.2-5 shows the Mission Planning and Scheduling Re-planning flow.

Table: 6.2.2-5 Expedited Re-planning Flow

No.	Actors	Activities	Notes
1	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity collects added / modified / deleted schedule inputs such as events and tasks.	This is performed over the currently active schedule period or less.
2	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity performs re-scheduling of satellite and ground activities. Any conflicts are identified and the Mission Planners resolve those within their authority. The CGS Collect Mission Support Data activity releases the Mission Schedule to stakeholders for review and comment.	
3	Schedule Stakeholders	Stakeholders review the content of the Mission Schedule for accuracy, validity and feasibility, and provide feedback to the Mission Planner.	Stakeholders include OSPO Lead Engineer, SATCON, Instrument Engineer
4	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity revises the proposed Mission Schedule based on review.	Repeat steps 1-4 as necessary.
5	CGS	The CGS Collect Mission Support Data activity provides the revised Mission Schedules to internal and external stakeholders.	
6	Mission Planner, OSPO Lead Engineer, SATCON, Instrument Engineer	The Mission Planner, with the assistance of the MOT, determines which implementation plans require update.	
7	CGS	The CGS Collect Mission Support Data activity collects the Station Contact Schedules for subsequent distribution.	If required

No.	Actors	Activities	Notes
8	CGS	The CGS Generate & Validate Ground Equipment Commands activity receives the Common Contact Schedule (CCS) and Pass Plan for each JPSS-controlled mission and produces a time ordered sequence of ground system commands for execution by the CGS Distribute & Execute Ground Commands activity.	If required
9	CGS	The CGS Generate & Validate Satellite CMD activity receives the Activity Schedule and generates a proposed command loads for the spacecraft or one of its associated instrument sensors. The command loads are reviewed by the stakeholders. After successful verification the command loads are sent to the CGS Encrypt & Execute Satellite Commands & Loads activity for subsequent uplink to the satellite (Command Load Files) or real-time execution (CMD Executable Load).	If required

6.2.2.7.2 Contingency Contact Scheduling

If the need arises, contacts may be scheduled with KSAT or FCDAS on short notice (contact to execute within the current Operational Day). Contingency contact can also be scheduled with Space Network (SN), which is described in Section 6.3.5, Space Network Support thread.

Table: 6.2.2-6 Contingency Contact Scheduling with FCDAS Flow

No.	Actors	Activities	Notes
1	SATCON	The MOT determines that an unscheduled contact needs to be supported.	
2	SATCON	The SATCON reviews the appropriate Station Contact Schedule and the Predicted Orbit Events Report for station visibility periods and selects candidate AOS/LOS times.	Utilizes Predicted Orbital Events Report.
3	SATCON, Station Shift Lead	The SATCON contacts the station Shift Lead via voice circuit and requests the candidate AOS/LOS times and obtains mutually acceptable contact times.	Utilizes Predicted Orbital Events Report.
4	Station Shift Lead	The station Shift Lead modifies the station schedule in execution to provide the agreed upon support.	

No.	Actors	Activities	Notes
5	CGS, Mission Planner (if available)	If the Mission Planner is available: The CGS Process Mission Activity & Task Requests activity performs re-planning of satellite and ground activities. Any conflicts are identified and the Mission Planners resolve those within their authority. The CGS Collect Mission Support Data activity releases the Mission Schedule. If time allows, the ActSched is released for subsequent generation of the Common Contact Schedule and Pass Plan.	See the *Expedited Re-Planning* alternate flow.
6	SATCON	The SATCON utilizes the revised Common Contact Schedule and additional Pass Plan to execute the added contact, if available. Otherwise, the SATCON configures the ground system manually following contingency operating procedures.	
7	SATCON	Following the scheduled AOS time, the SATCON commands a blind acquisition of the satellite.	
8	CGS	The CGS Collect Mission Support Data activity provides Final Mission Schedule to the CGS Distribute Mission Support Data activity for dissemination to stakeholders.	

6.2.2.7.3 Scheduling of FCDAS Contacts

On a routine basis (3-4 contacts per month per satellite), JPSS-managed missions utilize FCDAS to conduct Proficiency Contacts in order to maintain operational expertise and verify ground system functionality in the event of needed Contingency Support (see alternate thread above) or, in the case of S-NPP, Backup SMD Recovery Contacts. The flow for scheduling of these contacts is applied to the long-term scheduling of all supports with FCDAS. This process directly interfaces with the OSPO scheduler and utilizes NSOF scheduling capabilities. It provides the advantage of request deconfliction with a large group of missions scheduled by NSOF which are supported by FCDAS. The requests are forwarded to FCDAS for deconfliction and scheduling at the station level. Note that all planning three weeks or more in advance follows this process. For shorter term scheduling, the JPSS Mission Planner may directly interface with the FCDAS operations staff, if needed. Note that this flow runs ‘as needed’ and executes concurrent with the basic flow, Mission Planning and Scheduling. This flow lists the steps that are unique to the scheduling of FCDAS contacts.

Table 6.2.2-7 shows the Scheduling of FCDAS Contacts flow for JPSS-managed missions.

Table: 6.2.2-7 Scheduling of FCDAS Contacts Alternate Flow

No.	Actors	Activities	Notes
1	CGS, Mission Planner	Exercising the CGS Define Mission Tasks & Events activity, the Mission Planner manually places tasks & events supporting FCDAS contacts on the timeline, other than Proficiency Contacts.	1-6 define the planning process. 1 & 2 are ongoing steps, occurring as early as 2 months or more prior to any scheduled operations day.
2	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity collects schedule inputs (FCDAS planned outages, Orbital Event data for conflict free FCDAS visibilities from OrM thread)	
3	CGS	The CGS Process Mission Activity & Task Requests activity performs initial scheduling of satellite and ground activities, including routine scheduling of FCDAS proficiency contacts. The CGS Collect Mission Support Data activity releases the Mission Schedule to stakeholders for review and comment.	CGS utilizes scheduling rules and conjunctive visibility events to minimize potential conflict with other FCDAS 13m users.
4	Schedule Stakeholders	Stakeholders review the content of the Mission Schedule for accuracy, validity and feasibility, and provide feedback to the Mission Planner.	
5	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity revises the proposed Master Schedule based on review.	
6	Mission Planner	The Mission Planner iterates the review and revision cycle as required.	
7	CGS, Mission Planner	Upon receiving concurrence from the stakeholders, the Mission Planner uses the CGS Process Mission Activity & Task Requests activity to initiate the scheduling process. The CDAS Schedule Request is generated and made available to OSPO Operations via CGS Web Services.	7-15 occur within 1 week of scheduled operations day. Updates to the Master Schedule are performed as required Revised Mission Schedules are released as necessary.
8	OSPO Operations (Mission Planner)	The OSPO Mission Planner pulls the CDAS Scheduling Request and JPSS TLE Sets from the CGS Web Server. These contact requests are ingested into the NSOF scheduling system. The JPSS TLE Sets are forwarded to FCDAS.	

No.	Actors	Activities	Notes
9	OSPO Operations (Mission Planner)	The OSPO Mission Planner identifies JPSS request conflicts and resolves them to the fullest extent possible utilizing the FCDAS 13M Antennas Resource Conflict Priorities procedure.	Step includes OSPO Scheduler review of the CDAS Scheduling Request from JPSS for S-NPP, JPSS-1 & JPSS-2.
10	OSPO Operations (Mission Planner)	The OSPO Mission Planner generates the CDAS Scheduling Response and delivers to the CGS for JPSS Mission Planner review and ingest by the CGS Process Mission Activity And Task Request activity.	
11	OSPO Operations (Mission Planner)	The OSPO Mission Planner generates the NSOF requested contact schedule and delivers to FCDAS scheduling.	Daily process - also includes incorporation of DMSP, etc. schedule requests.
12	FSOF Scheduling	The FCDAS scheduler ingests the NSOF requested contact schedule, identifies any conflicts and resolves them to the fullest extent possible utilizing the FCDAS 13M Antennas Resource Conflict Priorities procedure.	
13	FSOF Scheduling	The FCDAS scheduler generates the conflict-free Station Contact Schedule and distributes.	
14	CGS	The CGS Process Mission Activity & Task Requests activity collects the Station Contact Schedule.	
15	CGS	The CGS Process Mission Activity & Task Requests activity performs scheduling of satellite and ground activities, including FCDAS contacts.	

6.2.2.7.4 Scheduling of JPSS-Supported Missions

On a routine basis, JPSS resources are utilized by JPSS-supported missions. When these resources must be scheduled through JPSS to avoid conflict, this thread applies. While resource utilization is continuously monitored, not all shared resources are scheduled and, in some cases, their loading is estimated. These estimations are made available to the MPS.

This thread addresses the planning and scheduling of JPSS resources by JPSS-supported missions through the application of the basic flow (see section 6.2.2.6). While it is directly applied to the planning and scheduling of the McMurdo Receptors for DMSP, the approach is followed for all cases.

Table 6.2.2-8 shows the Scheduling of JPSS-Supported Missions flow applicable to the shared resources which are actively scheduled by JPSS.

Table: 6.2.2-8 Scheduling of JPSS-Supported Missions Alternate Flow

No.	Actors	Activities	Notes
1	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity collects schedule inputs (planned outages, routine and special task requests, Schedule/TLE, Notices from external Operations centers, Orbital data from OrM thread)	1-6 define the planning process. 1 & 2 are ongoing steps, occurring as early as 2 months or more prior to any scheduled operations day.
1a	CGS, Mission Planner, JPSS-supported missions	The CGS Collect External Contact Plans activity collects schedule inputs from the JPSS-supported mission. This includes schedule information and TLEs.	For DMSP, this is the Proposed Mission Schedule, TLEs are acquired through Spacecom.
2	CGS	The CGS Process Mission Activity & Task Requests activity performs initial planning of satellite and ground tasks. This activity identifies and attempts to resolve conflicts utilizing a priority scheme. Unresolved task request conflicts are brought to the attention of the Fleet Planner. Fleet Planner then tries to deconflict manually. If the conflict still cannot be resolved, the Mission planner notifies the Fleet Mission Manager to provide direction. The MOD, by way of the CGS Manage Fleet/Ground Operations activity performs schedule and resource deconfliction.	
2a	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity plans utilization of the JPSS receptors based on resource availability, and all schedule requests. Competing requests are resolved utilizing a priority list and manual intervention by the Mission Planner.	
3	CGS	The CGS Process Mission Activity & Task Requests activity processes Task Requests to ensure instrument and spacecraft tasking has been defined, validated and controlled. Upon completion of the scheduling process, the Master Schedule is released and long-term Mission Schedules and Station Contact Schedules (including the CDAS Scheduling Request) are produced.	3-6 typically occur 2 months to 1 week prior to scheduled operations day.
3a	CGS, JPSS-supported missions	The CGS Process Mission Activity & Task Requests activity produces the	Mission Schedules are produced for DMSP.

No.	Actors	Activities	Notes
		long-term Mission Schedules for JPSS-supported missions.	
4	CGS, Schedule Stakeholders	The CGS Collect Mission Support Data activity releases the Mission and Station Contact Schedules to stakeholders for review and comment. Stakeholders review the content of the Mission and Station Contact Schedules for accuracy, validity and feasibility, and provide feedback to the Mission Planner.	Stakeholders include OSPO Lead Engineer, SATCON, Instrument Engineer
5	CGS, Mission Planner	The CGS Process Mission Activity & Task Requests activity revises the proposed Master Schedule based on review.	
6	Mission Planner	The Mission Planner iterates the review and revision cycle as required.	
7	CGS, Mission Planner	Upon receiving concurrence from the stakeholders, the Mission Planner uses the CGS Process Mission Activity & Task Requests activity to initiate the scheduling process for the operational period. Upon successful completion, the Master Schedule is published and Mission Schedules are produced.	Start of the scheduling process. The frequency of scheduling and duration of schedule periods is defined by OSPO Operations documentation.
8	CGS	The CGS Collect Mission Support Data activity provides the operational Mission Schedules to internal and external stakeholders. This step includes distribution of operational Mission Schedules to JPSS-supported missions.	7-16 occur within 1 week of scheduled operations day. Updates to the Master Schedule are performed as required Revised Mission Schedules are released as necessary.
8a	CGS	The CGS Collect Mission Support Data activity provides the operational Mission Schedules to JPSS-supported missions.	Mission Schedules are delivered for DMSP.
9	CGS	The CGS Generate Implementation Plans activity creates the operational Activity Schedule, Station Contact Schedules, Common Contact Schedules and Pass Plans for the scheduling period.	The Station Contact Schedules are station / antenna specific but contain entries for all scheduled spacecraft. Pass Plans are satellite specific.
10	CGS	The CGS Collect Mission Support Data activity collects the Station Contact Schedules for subsequent distribution.	Station Contact Schedules are produced for the McMurdo Receptors.
11	CGS	The CGS Generate & Validate Ground Equipment Commands activity receives the Common Contact Schedule (CCS) and Pass Plan for each JPSS-controlled	

No.	Actors	Activities	Notes
		mission and produces a time ordered sequence of ground system commands for execution by the CGS Distribute & Execute Ground Commands activity.	
11a	CGS	If the JPSS GS is controlling ground assets via ground command, Common Contact Schedules and Pass Plans are produced.	
12		Reserved	
13		Reserved	
14	CGS	The CGS Process Mission Activity & Task Requests activity issues Mission Notices to the CGS Collect Mission Support Data activity, which makes them available to all authorized recipients (standard list).	
15	CGS	The CGS Process Mission Activity & Task Requests activity performs schedule performance assessment and forwards a report to the CGS Collect Mission Support Data activity, which makes them available to all authorized recipients, including Fleet/Ground Management.	

6.2.2.8 Post-Conditions

- This thread completes after the Master Schedule (including all elements or subsets) is generated and distributed but the cycle repeats as subsequent planning and scheduling activities are in various stages of planning and their pertinent operations days approach.
- Execution of the scheduled activities is initiated by operator action or autonomously, depending on the nature of the tasks and events
- There are also post-schedule execution analysis activities that extend into subsequent schedule cycles.

6.2.2.9 Related Threads

Thread ID	Thread Title
GS-NML-010	Fleet / Ground Management
GS-NML-030	Telemetry and Command
GS-NNL-150	Space Network Support
GS-NML-050	Orbit Maintenance
GS-NML-220	Security
GS-NML-300	System Status/Situational Awareness
GS-NML-130	Data Accounting and Recovery
GS-NML-310	Ground Operations

Thread ID	Thread Title
	Threads Providing Input to Mission Planning & Scheduling
GS-NML-180	Data Acquisition and Routing
GS-NML-070	Flight Software Update
GS-NNL-140	System Maintenance & Upgrade
GS-NML-310	Ground Operations
GS-NML-102	Mass Data Storage Playback
GS-NML-080	Flight Vehicle Simulation
GS-NML-150	Cal/Val of Data Products
GS-NML-200	Key Management
GS-MAD-150	Decommissioning
GS-NML-110	Data Quality Assurance

6.2.2.10 Child Threads

Thread ID	Thread Title
CGS-020-010	CGS Mission Planning and Scheduling

6.2.3 System Status/Situational Awareness

6.2.3.1 Description

The System Status/Situational Awareness (SyS) concept of operations (ConOps) thread (GS-NML-300) collects and distributes the State of Health (SOH); State of Service (SOS); and Alarms, Warnings, & Events (AWE) within the JPSS ground. Also, SyS provides mission notices for service affecting failures and system configuration events to external data users. SyS provides status for the JPSS Ground System and for JPSS controlled satellites. SyS collects this information at both the local node and JPSS mission level. When this status information is consolidated at the node and JPSS mission level, it provides Situational Awareness (SA) to JPSS operators, the Ground Operations (GO), Space Operations, Mission Planning & Scheduling (MPS), System Fault Analysis (SFA), the Continuity of Operations (COOP), and the Fleet Ground Management (FGM) ConOps threads at the nodal and global level. The term “log” is used throughout the thread to reference any type of data store including AWE and does not specifically imply an implementation of a physical log file. The structure of SyS is shown in Figure 6.2.3-1.

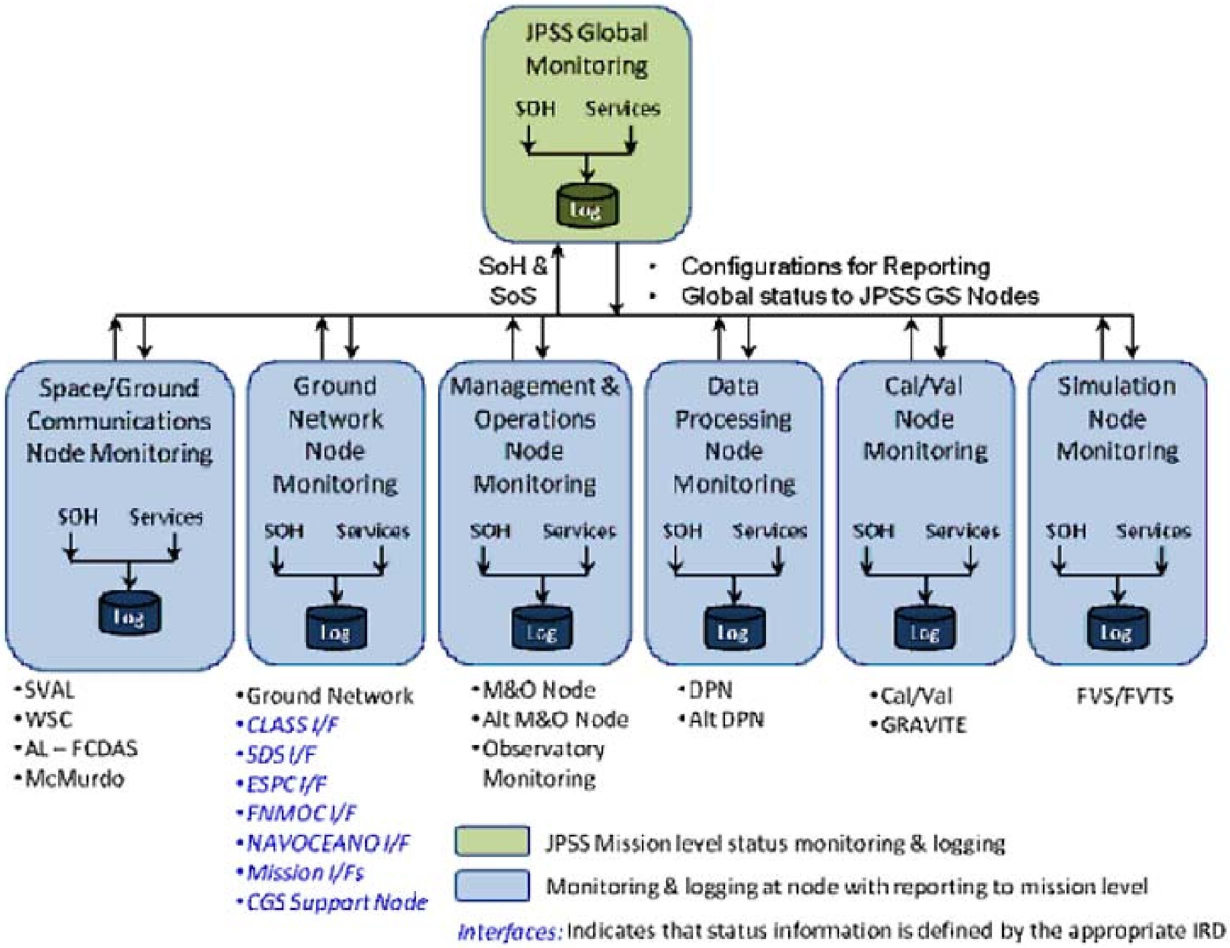


Figure: 6.2.3-1 System Status/Situational Awareness Reporting Structure

As Figure 6.2.3-1 shows, SyS uses a reporting structure where each node in the JPSS Ground System monitors its own SOH and performance information. Each node provides that information in near real-time to that node's operator displays and logs that information at the local node. Each node also reports that information to the Management & Operations Node (MON) to allow MON to have SA of the entire JPSS Ground System SOH and SOS. The global mission level monitoring at the MON node collects the log files from each node provides a central repository for all historical status information on the JPSS Ground System for the life of the system. JPSS Ground System operators at nodal locations will also have read only access to the MON's global situational awareness data. The following paragraphs describe in more detail the types of information collected by SyS, and its capabilities for providing that data to JPSS operators.

6.2.3.1.1 General Capabilities

SyS Data

SyS provides SOH, SOS, and AWE data. SOH information is intended to reflect hardware, software, and network status including failures in these areas. SOH reported software failures

are significant, such as processes terminating unexpectedly. SOH may or may not affect the ability of the JPSS Ground System to provide mission services. For example, if a redundant server fails and the back-up server is successfully processing all the mission data, then the SOH status would be that the primary server is down, but SOS would not be affected because the JPSS Ground System would be able to provide mission services.

SOS information is related to the ability of the JPSS Ground System to provide mission services, and it may or may not be related to a fault in the system. For example, if software queues back up and delay delivery of data beyond data latency requirements; a change in SOS message would be sent.

SOH and SOS information reflects both nominal status and non-nominal conditions. For non-nominal conditions, SyS will provide Alarm, Warning, or Event (AWE) notification. AWE notifications consist of both a visual indication on the operator's workstation (e.g. text and/or status color change). The definitions of AWE notices and the conditions in which they are provided are given below:

- **Alarm Notification** - an alarm notification is generated due to a failure which could have a binary operational/non-operational value or a SOH value that exceeds an alarm threshold. An alarm notification requires operator attention, and the operator to acknowledge the message.
- **Warning Notification** - a warning is generated due to an error about which the operator should know or a SOH value exceeding a warning threshold. Warning notifications require no operator acknowledgement
- **Event Notification** - an event notification is provided when either change in the operational state of the JPSS system has occurred or a action has been completed. Event notifications are informational only and do not require operator acknowledgement or action.

AWE messages are fixed format messages that are automatically generated. AWE is provided to the JPSS Ground System node and mission level operators.

Examples of SOH and SOS information are provided in Table 6.2.3-1. These status items are not intended to be requirements, but have been provided as the types of information that the JPSS Ground System operations team would need to know to quickly resolve potential problems before they affect the JPSS mission performance objectives.

Table: 6.2.3-1 SOH and SOS Examples

Type	Description	Filter Examples
SOH	Satellite Ground Station Terminal Hardware	• Antenna & pedestal motor and bearing status. • RF Equipment faults • Modem and Bit Sync faults • Frame sync faults
	Processing Hardware	• Power supply faults • Hard drive file system errors • Power supply input and output voltage levels and voltages that exceed tolerances.
	Software	• Real-time notification of stopped or suspended software processes. • Inter-process communications errors
	Networks	• Network equipment faults or link faults.
SOS	System Mode	• Indicate which set of resource is configured as the Primary string to support mission operations; and which one as non-Primary to support other activities.
	Performance metrics	• Product creation & delivery latency. This includes the nodal contributions to latency. • Data availability metrics
	The JPSS service performance is provided to system status from the SMD Handling, Data Quality Assurance, and Data Accounting & Recovery threads	• Data is produced in the Data Processing Node but is not delivered to data user in a timely manner due to a data quality threshold criteria not being met or queue backlogs. These metrics are calculated to cover a 30-day period and provided in the Data Availability Report and Data Latency Report. • Missing Application Packets (APs). • Subscriptions that have stopped between the data processing node and the data users. This can be caused by delivery processes stopping or by communications issues. • Higher order products not produced as determined by comparison of the higher order products and the EVCDUs and supporting Ancillary data that were provided to the Data Processing Node. • Products produced but not delivered comparing products in the Data Processing Node DMS with the products that were delivered in the DDRs and CDDRs.
	Satellite Ground Station Terminal Hardware	• Pointing and tracking accuracy. LNA excessive noise. • RF Equipment signal to noise ratio • Modem and Bit Sync BER both for correctable and uncorrectable errors. • Frame sync errors, acquisition times, and frame losses during contact period.
	Processing Hardware	• Network and other connections operational including packet loss and errored packets on these connections.

Type	Description	Filter Examples
		• Hard drives file system errors, and corrupt files.
	Software	• Inter-process communications errors • Input and output queues exceeding thresholds
	Networks	• Latency of command, Ancillary, and SMD data, and science products across the network. • BER performance and percent of bad packets received
	Resource Utilization	• Hard drive utilization/free disk space. • Memory utilization and free memory. • Processor utilization percentage and the percentage of processor bandwidth that each active process is using. • Percentage of available bandwidth on each network link.

The last type of SyS status is Mission Notices. Mission Notices will be sent out when significant events occur. Mission Notices are free-format and are generated by JPSS Ground System personnel. Mission Notices are sent out to JPSS and NOAA management as well as to downstream users of data and external missions. Mission Notices can also result from security incidents. Security notifications are only sent through security channels.

Mission Notices can be provided at either the local node or at the JPSS Mission Level. Distribution of these notices by type of notice is shown in Table 6.2.3-2.

Table: 6.2.3-2 Distribution of Mission Notices by Content

Notification Type	Node Level	Global Level	NASA JPSS Mgmt.	External Data Users & Missions	Notional Response Time	Comment
Service Affecting Failures	Yes	Yes	Yes	Dependent on content	Minutes to hours	External data users and missions would be notified only if their data or assets were affected
Event Notification	Yes	Yes	Yes	Yes	Up to an hour	

SyS Data Presentation & Logging

In order to present the most meaningful information to the JPSS node and MON operators, SyS will provide the following two mechanisms to present relevant data to the operator:

1. **Displays:** SyS will provide the ability for operators to view a top-level graphical representation of each node, the entire JPSS Ground System, each JPSS controlled satellite, and a combined fleet/ground view. Nodal operators will have the ability to access the nodal view and to view their nodal status independently. This representation will provide color-coding to represent the SOH of the items in the view. For example, green could mean full operational capability, yellow could indicate degraded performance, and red would mean unable to perform its operational function. A similar view will be provided for all services (SoS) that are being provided by the JPSS GS.

   In some cases, SyS could provide the capability to allow the operator to select one of the items on the top-level view of a part of the JPSS Ground System and open that item up to see additional details regarding the SOH of that item.

2. **Data Filtering:** SyS provides the capability to configure the status information that is provided to global and operator workstations. The filtering of SOH and SOS data is set by system level policies with each operator being able to make limited adjustments to their screens. These adjustments may include determining which items to display on their screen at one time. The purpose of these filters is to prevent operators from receiving more data than they can effectively interpret or act on. For example, if a failure occurs in one sub-segment of the system, messages from other affected parts of the JPSS

Ground System could mask the status of the failed sub-segment. This SyS configuration provides the following two different types of filtering:

a. **Threshold Filtering**: SyS enables the operator to filter status information based on thresholds. Thresholds levels and values are not operator settable, but will be configurable without modifications to software code. SyS will generate at least 2 levels of warnings or alarms depending on which threshold was exceeded. For example, the first out-of-tolerance level could be a warning and a greater out-of-tolerance level could be set to be an alarm. SyS allows the ability to configure which warnings and/or alarms are displayed on that operator's display.

b. **Data Type Filtering:** The SyS will allow the operator to select specific types of data to be displayed such as specific types of equipment or software processes. This allows the operator to keep the displayed messages or information to a manageable level. SyS will provide the operator the ability to filter on SOH and SOS information. The filtering for this data supports both nominal and AWE SOH and SOS information. Filtering may be done based on equipment type, equipment location, and equipment operational status. Filtering for software status can be done based on types processes & queues, status of processes & queues running on specific servers. Filtering can also be performed on different threshold levels of AWE as well as for AWE for specific pieces of equipment or software.

   SyS will provide separate filtering parameters for the operators monitoring node status and another set of independent filtering parameters for the operators monitoring Global JPSS mission status to manage the volume of information and messages provided to the operator.

As previously stated, AWE will be provided to the local node operator's workstation, and will be recorded for the life of the mission. Security data will not be kept in the SOH log file, but in separate restricted access logs that can only be accessed by authorized security personnel. Also, the JPPS Ground System will allow specific warnings and alarms thresholds in for each node to be configured without software changes for rapid notification. If the parameter threshold is configured for rapid notification, then the detection for a threshold violation for that alarm or warning should occur within 30 seconds, and the information be provided to the node operator's workstation in near real-time (i.e. within 5 seconds) after detection.

All of the above capabilities are provided to JPSS Ground System operators based on user account based access. Operators are only allowed to view or control areas of the JPSS Ground System in accordance with the privileges assigned to their account. Those privileges are available to an operator on any JPSS Ground System workstation that an operator logs into.

Logs of system status information are collected at both the nodal and global level. The log files at each node include all AWE notification and all monitored parameters. This information will be collected by the global JPSS Ground System monitoring function at the MON, but it will also be retained at each node's monitoring server for a minimum of 7 days.

6.2.3.1.2 Nodal Situational Awareness Capabilities

Each node in the JPSS Ground System provides SOH information and SOS information to the authorized operators and to global SA function in the MON as it applies to that node. The combination of these two types of data provides operational status of that node to global SA. SOH data for each node would provide any equipment faults at that node. SOS for each node includes data processing statistics that are relevant for that node. For example, the Space/Ground Communications Node would report on the number frames received with errors, the number of VCDUs delivered for each contact, and the latency of that delivery to the MMC. Other nodes should have similar metrics for the data that is processed in that node where appropriate.

As Figure 6.2.3-1 shows, the JPSS Ground System also collects status information from systems that are not part of JPSS Ground System. The contents of this status information are defined by the Interface Requirements Document (IRD) between the JPSS Ground System and the external system. The Ground Network Node collects this data, and it should include as a minimum the status of the connectivity between the external system and the JPSS Ground System.

Multiple operators will perform monitoring of the JPSS Ground System status. Some but not all nodes will have their own dedicated operator (e.g. DPN) to monitor their status.

In other cases, the operator for a specific node could be supporting multiple nodes. For example an operator that supports the MON could also support the Ground Network Node. The functions of the workstations on the JPSS Ground System are determined by the user's log in privileges. Therefore, additional operators and/or managers can log in to a workstation and monitor individual nodes on the system if they have the correct privileges.

6.2.3.1.3 Global Situational Awareness Capabilities

Global JPSS Mission status is collected and analyzed at the Mission Operations Node (MON) by collecting data from all of the nodes both in real-time and from log files. This provides an overall SOH of the JPSS Ground System. This overall view allows the MON to make informed decisions on how best to address equipment and software SOH issues in real-time as well as monitor the SOS performance of JPSS data processing and data distribution. This global SOH information is passed to the Ground Operations ConOps thread to perform global JPSS Ground System level SOS analysis and to provide global SA. The global JPSS Mission Status monitoring function at the MON will generate mission notices when either a service level failure occurs or when a system level configuration changes.

As with the nodal alarm and warning monitoring, a global alarm or warning threshold can be configured without software modification for rapid notification. If a threshold is configured for rapid notification, then the detection for a threshold violation for that alarm or warning must occur within 30 seconds, and the information be provided to the global operator's workstation in near real-time (i.e. within 5 seconds) after detection.

In addition to providing global near real-time SOH, the global SOH function collects logs with all the status details and AWE messages from each of the JPSS nodes and archives them for the life of the JPSS mission. These logs will be kept in on-line storage for a minimum of 30 days. As with other logs, this global log is searchable by type of data or a time window the global SOH operator. This log contains both the SOH and SOS information from each node.

6.2.3.2 Primary Interfaces

Primary interfaces driven by this ConOps thread are depicted in Figure 6.2.3-2. This includes both external interfaces and inter-system interfaces within the Ground System.

Interfaces with Ground System Elements and Ground System Nodes outside of the Common Ground System are required for overall JPSS mission status.

In order to provide this SOH, configuration information, and mission performance status to other JPSS ConOps threads, the System Status/Situational Awareness thread must obtain information from many other JPSS ConOps threads.

Once system status has collected and processed the information from the rest of the JPSS missions, it distributes this information to other ConOps threads such as Ground Operations.

Status of some systems that are external to the JPSS Ground System (e.g. authorized data consumers) is limited to their interface status to the JPSS Ground System. The JPSS Ground System obtains this status by attempting to connect to or send data to the external. In some cases the JPSS Ground System may monitor retransmission requests to determine successful delivery of products at the external system. The status of these system interfaces enables a complete awareness of the operational state of the ground system.

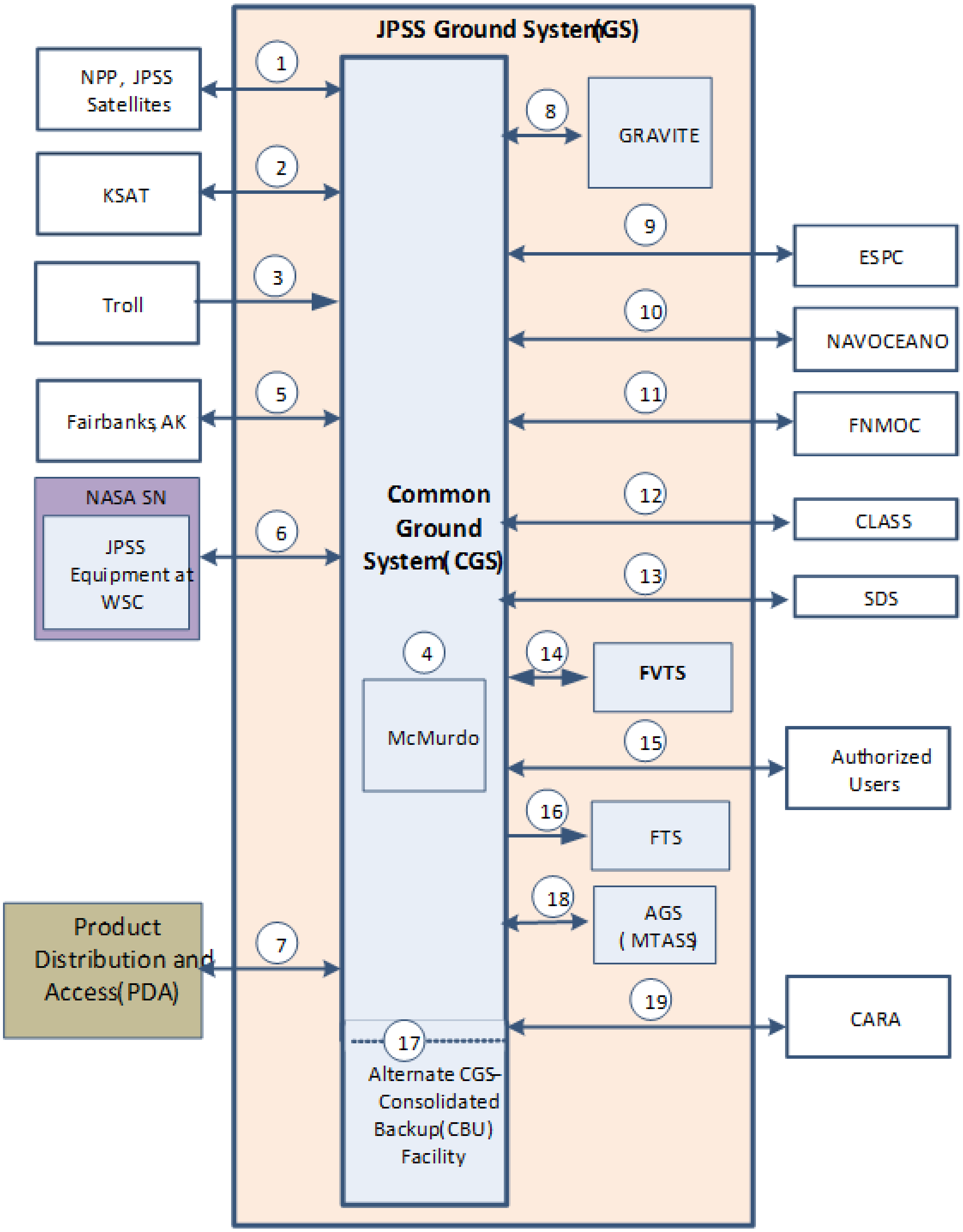


Figure: 6.2.3-2 Primary Interfaces for System Status/Situational Awareness

Each interface in Figure 6.2.3-2 is labeled with a number and defined in Table 6.2.3-3 with types of interface, actors, purpose, types of data, exchange method and frequency. Table 6.2.3-4 provides the relevant IRDs and/or ICDs for those interfaces.

Table: 6.2.3-3 System Status/Situational Awareness Primary Interfaces

No.	Type	Actors	Purpose
1	External	Satellite(s), CGS	Status: SOH and SOS for SMD downlink; HRD, downlink; telemetry downlinks (real-time and stored); receive S-NPP & JPSS sensor data, & command uplink
2	External	Kongsberg Satellite Services (KSAT), CGS	Status: Receive SOH and SOS status of JPSS equipment at SVAL, and KSAT ground station SOS status via KSAT SOH and SOS monitoring tools (e.g. MEOS).
3	External	Troll, CGS	Status; Receive Troll ground station SOS status via Post Pass Reports.
4	Internal	McMurdo, CGS	Status; Receive SOH and SOS of JPSS equipment at McMurdo and McMurdo ground station SOS status via COTS SOS monitoring tools (e.g. MEOS).
5	External	FCDAS, CGS	Status; Receive FCDASs ground station SOS status FCDAS SOH and SOS monitoring tools and via COTS monitoring tools (e.g. MEOS).
6	External	Space Network (SN) Tracking Data Relay Satellite System (TDRSS), CGS	Status: SOH and SOS status of JPSS Equipment at WSC and that equipment's ability to communicate with the SN (WSC & TDRS) by attempting to communicate to the SN with JPSS equipment at WSC.
7	External	ESPC Product Distribution and Access (PDA) system.	Status: SOS interface Status for Receive Dynamic Ancillary Data by the CGS attempting to connect to and or receive data from the PDA
8	Internal	CGS, Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE)	Status: Status of deliveries of S-NPP & JPSS RDRs, Dynamic Ancillary Data to GRAVITE, and the GRAVITE interface SOH by the CGS attempting to connect to and or deliver products GRAVITE. The CGS will monitor retransmission requests to determine the successful ingest of products at GRAVITE.
9	External	CGS, Environmental Satellite Processing Center (ESPC)	Status: Status of deliveries of JPSS products and the interface to ESPC by the CGS attempting to connect to and/or deliver products to ESPC. The CGS will monitor retransmission requests to determine the successful ingest of products at ESPC.
10	External	CGS, Naval Oceanographic Office (NAVOCEANO)	Status: Status of deliveries of JPSS products and the interface to NAVOCEANO by the JPSS SMD Hub attempting to connect to and/or deliver Application Packets to NAVOCEANO.
11	External	CGS, Fleet Numerical Meteorology and	Status: Status of deliveries of JPSS products and the interface to FNMOC by the JPSS SMD Hub attempting to connect to and/or deliver Application Packets to FNMOC.

No.	Type	Actors	Purpose
		Oceanography Center (FNMOC)	
12	External	CGS, Comprehensive Large Array-Data Stewardship System (CLASS)	Status: status of product deliveries and the CGS to CLASS interface SOH by the CGS attempting to connect to and/or deliver products to CLASS. The CGS will monitor retransmission requests to determine the successful ingest of products at CLASS.
13	External	CGS, Science Data Segment (SDS)	Status: Status of TLM Reports and deliveries to SDS interface SOH by the CGS attempting to connect to and/or deliver products to SDS.
14	Internal	CGS, Flight Vehicle Test Suite (FVTS)	Status: FVTS SOH status to CGS. The FVTS will also report to the CGS which string (A or B) it is currently connected to.
15	External	CGS. All Externals	Status: Mission Notices of JPSS status to external users including external missions (e.g. DMSP)
16	Internal	Field Terminal Support (FTS), CGS	Status: FTS retrieves Mission Notices from CGS.
17	Internal	CGS to Consolidated Backup Facility (CBU)	Status: CBU SOH and SOS to CGS
18	Internal	CGS to AGS	Status: AGS SOH interface to CGS by the CGS attempting to connect to and or retrieve products from AGS.
19	External	Conjunction Assessment Risk Analysis (CARA)	Status: Communications SOH statuses via attempting at communications to either deliver or retrieve product to/from CARA.

Table: 6.2.3-4 System Status/Situational Awareness Interface Documentation

No.	IRD/ICD
1	JPSS GP to JPSS FP IRD JPSS CGS to S-NPP & JPSS-1 S/C Vendor ICD (474-000425) JPSS CGS to S-NPP & JPSS-2 S/C Vendor ICD (474-001438) S-NPP SMD ICD to Norway GS S-NPP HRD RF ICD S-NPP X-Band Data Format ICD JPSS-1 TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS-2/3/4 TT&C to GS RF ICD JPSS-2/3/4 TT&C Data Format ICD JPSS-1 Spacecraft SMD to Ground Segment RF ICD (472-00162) JPSS-1 Mission Data Format ICD (472-00163) JPSS-1 HRD to Direct Broadcast Stations RF ICD (472-00165) JPSS-2/3/4 Spacecraft SMD to Ground Segment RF ICD JPSS-2/3/4 Mission Data Format ICD JPSS-2/3/4 HRD to Direct Broadcast Stations RF ICD
2	JPSS Ground System to KSAT IRD

No.	IRD/ICD
	JPSS CGS to KSAT ICD JPSS Ground System to Coriolis/Windsat IRD JPSS CGS to Coriolis/WindSat ICD
3	JPSS Ground System to KSAT IRD JPSS CGS to KSAT ICD
4	JPSS Ground System to National Science Foundation (NSF) IRD JPSS CGS to NSF ICD JPSS-National Science Foundation (NSF) Service Level Agreement (SLA) for McMurdo/MOA
5	JPSS Ground System to National Environmental Satellite, Data, and Information Service (NESDIS) Fairbanks Command and Data Acquisition Station (FCDAS) IRD JPSS CGS to NESDIS FCDAS ICD
6	JPSS Ground System to NASA SCaN IRD JPSS CGS to NASA SCaN ICD SN/WSC to JPSS CGS ICD
7	JPSS Ground System to NESDIS ESPC IRD JPSS CGS to NESDIS ESPC ICD
8	JPSS CGS to GRAVITE IRD JPSS CGS to GRAVITE ICD
9	JPSS Ground System to NESDIS Environmental Satellite Processing Center (ESPC) IRD
10	JPSS Ground System to NAVOCEANO IRD JPSS CGS to NAVOCEANO ICD
11	JPSS Ground System to FNMOC IRD JPSS Ground System to FNMOC ICD
12	JPSS Ground System to Comprehensive Large Array-Data Stewardship System (CLASS) IRD JPSS CGS to CLASS ICD
13	JPSS Ground System to NASA Science Data Segment (SDS) IRD JPSS CGS to NASA SDS ICD
14	JPSS CGS to Flight Vehicle Test Suite (FVTS) IRD JPSS CGS to FVTS ICD
15	JPSS CGS Services IDD
16	JPSS CGS Services IDD
17	JPSS Ground System to NESDIS Consolidated Backup (CBU) Facilities IRD JPSS Ground System to NESDIS CBU Facilities ICD
18	JPSS CGS to AGS IRD
19	JPSS CGS to CARA ICD

6.2.3.3 Assumptions & Constraints

The key assumptions and constraints for the JPSS System Status/Situational Awareness ConOps thread to perform successfully are provided below:

- All ConOps threads that provide information to the System Status/Situational Awareness are able to provide meaningful status for their JPSS element in time.
- All of the operations personnel have received sufficient training on the system status monitoring tools to properly set threshold filters and interpret the received element and JPSS system level status information.

- All hardware, software, and communications equipment in the JPSS Ground System is capable of detecting and reporting its configuration and status changes.

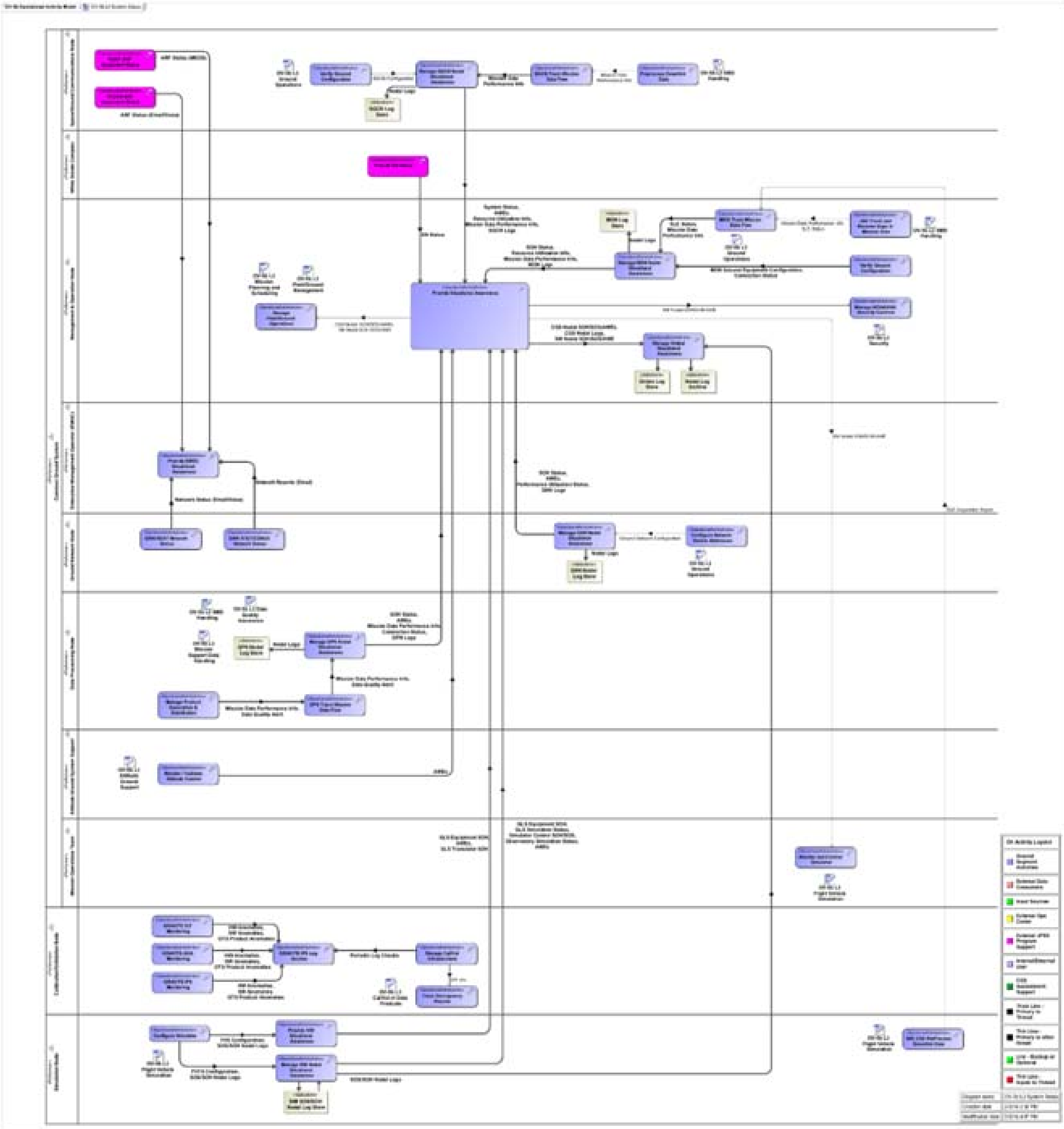
6.2.3.4 Pre-Conditions

The key pre-conditions for the JPSS System Status/Situational Awareness ConOps thread to perform successfully are provided below:

- A status reporting infrastructure must exist, which can consolidate status information from multiple system nodes. This system must be able to gather status from different types of systems including RF equipment, communications equipment, and data processing equipment. The status collection system must also be able to monitor software process performance. All of this information must be communicated back to a central location in sufficient time to allow for corrective action to be implemented before mission objectives are compromised.
- To support the status reporting infrastructure, a high level of connectivity between all JPSS mission element must be in place. This includes both within the JPSS Ground System and to external segments.
- If anomalous conditions exist there is sufficient reliability (redundancy and continuity of ops) in the architecture design to continue receiving critical near real-time operational status information.

6.2.3.5 Operational Flow

Figure 6.2.3-3 OV-5b System Status/Situational Awareness Operational Flow Diagram (L3) provides an illustration of system activities taking place in the basic flow of the SyS ConOps.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.3-3 System Status/Situational Awareness Operational Flow Diagram

6.2.3.6 Basic Flow

The activities from the OV-5b view that have been separated out and summarized into specific SyS basic flows. These basic flows activities are the following:

- General SOH and SOS node level monitoring
  - Common Ground System (GGS) Space/Ground Communications Node Monitoring
  - CGS Ground Network Node Monitoring
  - CGS Management & Operations Node monitoring
  - CGS Data Processing Node monitoring
  - CGS Support Node Communications Monitoring
  - JPSS Simulation Node Monitoring
  - JPSS Cal/Val Node Monitoring
  - HRD Monitoring
  - Monitor Satellite SOH
- JPSS Mission Level Monitoring

All SyS basic flows operate simultaneously and continuously to provide near real-time monitoring of the JPSS Ground System and the missions it supports for 24 hours a day over every day of the year.

Table 6.2.3-5 provides a summary of the actions that SyS performs to support all node level SOH and SOS monitoring activities. The Tables 6.2.3-6 to 6.2.3-15 provide summaries of the SyS activities that are performed at the nodal level, and Table 6.3.10-16 provides a summary of the activities that are performed at the JPSS mission level.

Table: 6.2.3-5 SyS General SOH and SOS Node Monitoring SyS Activities

No	Actors	Actions	Notes
1	Space Ground Communications Node, MON, Ground Network Node, DPN, MOT, Simulation Node, Cal/Val Node	The general flow to gather SOH and SOS information is for each node to gather their SOH and SOS information in their local SOH activity. These include the following: • Manage SGCN Nodal Situational Awareness • Manage MON Nodal Situational Awareness • Manage GNN Nodal Situational Awareness • Manage DPN Nodal Situational Awareness • Manage SIM Nodal Situational Awareness • Manage Cal/Val Infrastructure • SGCN Track Mission Data Flow • HRD monitoring	

No	Actors	Actions	Notes
		These data are flowed up to the JPSS Ground System level by these activities to the Provide Situational Awareness and Manage Global Situational Awareness activities for the global SOH and SOS monitoring. For all SyS SOH and SOS monitoring activities, operators with the ability to view either real-time or historical status. In this manner, the JPSS Ground System operators can view a graphical status of the entire system.	
2	Space Ground Communications Node, Ground Network Node, DPN	As data is processed in each of the JPSS ground system nodes, each node will track the data availability through that node. This is defined as the percentage of data that is not produced or delivered compared to the amount of data that could have been produced or delivered based on the data that was stored onboard the Mass Data Storage, on the satellite. In addition, each node will track the latency of the data processing and communications through that node. Data latency information will include the contributions to overall latency made by each node. Both the data availability and data latency statistics will be logged and made available for collection at the JPSS mission level by the CGS Provide Situational Awareness activity.	For GCOM-W1 mission, the data availability is based on the amount of data received at the Svalbard Ground Station.
3	Space Ground Communications Node, MON, Ground Network Node, DPN, MOT, Simulation Node, Cal/Val Node	All SOH and SOS data is logged in local node log files. Security data is not kept in SOH and SOS service log files, but in separate restricted access logs that can only be accessed by authorized security personnel. SOH and SOS data is kept locally for 7 days. This information is also available to be collected at the JPSS mission level by the CGS Provide Situational Awareness activity.	See the Security thread for details on security data logging.
4	Space Ground Communications Node, MON, Ground Network Node, DPN, MOT, Simulation Node, Cal/Val Node	The SyS activities at each JPSS Ground System node review SOH and SOS data to determine if a threshold has been exceeded. Thresholds for alarms and warning will be configurable without software code modifications. If so, or if an event has occurred, then an AWE message is generated and reported at that Ground System Node and to the CGS Provide Situational Awareness activity.	
5	Space Ground Communication	SyS provides these JPSS Ground System Node operators the ability to filter the SyS data on	

No	Actors	Actions	Notes
	s Node, MON, Ground Network Node, DPN, MOT, Simulation Node, Cal/Val Node	their workstations either by type of data or by location within the JPSS Ground System. Also all authorized JPSS Ground System operators can filter SyS data in log files based on time windows, type of data, type of report, equipment, and node. The JPSS Ground operators can set filters to specify which AWE to display when values are outside normal levels of operation. Specific alarms can be selected without software modification to be detected within 30 seconds and presented to the JPSS Ground System workstation in near real-time (i.e. within 5 seconds) after detection.	

The first node-specific SyS basic flow is CGS Space/Ground Communications Node Monitoring. This flow monitors the SOH JPSS ground station equipment at SVAL, Fairbanks Alaska, and McMurdo. It also monitors the performance of the space ground links at these locations. Finally, this flow monitors the performance of the JPSS equipment at WSC and receives status of the TDRS Space Network (SN) from the SN. Table 6.2.3-6 provides more detailed information for each of the activities performed by the CGS Space/Ground Communications Node Monitoring flow.

Table: 6.2.3-6 CGS Space/Ground Communications Node Monitoring SyS Activities

No	Actors	Actions	Notes
1	Space Ground Communications Node, MON, EMOC	The CGS SGCN Track Mission Data Flow activity receives SOH and SOS for the quality of the SMD for JPSS-1/2/3/4 and DMSP at the McMurdo Ground Station (SOH for JPSS-1/2/3/4). It receives SOS information about the quality of the S-NPP, JPSS-1/2/3/4, GCOM-W1 SMD data received from Svalbard Ground Station. It also receives SOS for the quality of the SMD for S-NPP and JPSS-1/2/3/4 at the FCDAS Ground Station. Finally, the SGCN Track Mission Data Flow Receive SOS information about the quality of the JPSS-1/2/3/4 SMD data received at the WSC Ground Station. This information includes the number of bad packets, or missing APIDs. The Nodal Situational Awareness ensures that the ground station transmitting equipment is operating properly during transmissions to the satellite (S-NPP and JPSS-1) and the space operations and analyze telemetry activities provide feedback that the commanding was successful.	See the Data Accounting & Recovery thread to determine how Ground System SMD status information is collected.

No	Actors	Actions	Notes
		For all of the steps in the following flow, SOH and SOS are monitored by the EMOC. To monitor the SOH of the ground station equipment, the KSAT ARF Equipment Status and FCDAS ARF Equipment Status activities monitors the SOH and performance of the ground station equipment at Svalbard, Norway and Fairbanks, Alaska, respectively. The CGS Manage SGCN Nodal Situational Awareness activity Monitors the SOH and performance of the JPSS ground station equipment at McMurdo, Svalbard, FCDAS, and WSC. SOH issues could consist of Antenna Problems, RF equipment problems, PPS problems (including disk and power supply failures), and network equipment failures. This flow also monitors the SOS performance of the space ground communications links at these locations including signal to noise levels, bit sync errors, frame sync errors, correctible bit errors and uncorrectable bit errors. The KSAT ARF Equipment Status activity monitors SOH and performance of KSAT Svalbard antenna equipment. It provides ARF Status to the EMOC. The FCDAS ARF Equipment Status activity monitors and provides FCDAS Station Equipment Status. FCDAS generates and provides Equipment Status Reports (ESR) and Station Summary Reports.	
3	MON, MOT, Space/Ground Communications Node	To monitor the SOH from the Space/Ground Communications node, the CGS Manage SGCN Nodal Situational Awareness activity obtains the network equipment SOH, throughput performance, bad packet information, dropped packet performance, and latency performance, and AWE information from JPSS equipment and the commercial network supplies.	
4	WSC, Space Ground Communications Node, MON	To monitor the operational state of the SN network, the WSC Provide SN Status activity provides AWE messages concerning the SOH of the WSC SN RF front end, modem equipment, processing equipment, scheduling systems, and other equipment to the CGS Provide Situational Awareness activity. This activity also provides status of the availability of TDRS spacecraft to support JPSS missions.	See the SN Support thread to determine how JPSS equipment at WSC status information is collected.

No	Actors	Actions	Notes
		The JPSS equipment at WSC consists of the PPS and networking equipment. The RF equipment and modem equipment is provided by and maintained by the SN. The CGS Manage SGCN Nodal Situational Awareness activity monitors the equipment status and performance from the JPSS equipment located at the WSC. This includes PPS resource utilization such as disk storage, processor loading, and throughput. This activity also monitors the SOH of the networking equipment at WSC. If out of tolerance conditions exist, this activity will create an AWE message for that condition. This activity provides the SOH, performance, and AWE data of the JPSS equipment at WSC to the CGS Provide Situational Awareness activity.	
5	Space Ground Communications Node, MON	The CGS Provide Situational Awareness activity receives that data from activities 1 to 4 of this basic flow and provides overall JPSS Mission SOH and SOS status. This activity is discussed further in the JPSS Mission Level Monitoring basic flow for this ConOps.	

The Ground Network Node provides communications between the JPSS Ground System, other nodes, and to external systems that either supply data to the JPSS Ground System or received data from the JPSS Ground System. The Ground Network Node must change configuration to support different missions because the JPSS performs difference services for different missions and because the communications paths are different for different missions. Table 6.2.3-7 provides the services that the JPSS Ground System provides for different JPSS supported missions, and Table 6.2.3-8 provides how the Ground Network Node monitors its different configurations to support these missions.

Table: 6.2.3-7 JPSS Ground System Support by Mission

Mission	Support Level	Enterprise Management & GO	Space/ Ground Comms.	Data Routing	Data Processing	Satellite Operations
S-NPP	Full Support	Yes	Yes	Yes	xDR Level	Yes
JPSS-1/2/3/4	Full Support	Yes	Yes	Yes	xDR Level*	Yes
DMSP	Data Acquisition & Routing (DA&R)	Yes	Yes	Yes	No	No
Coriolis/WindSat	Data Acquisition	Yes	Yes	Yes	No	No

Mission	Support Level	Enterprise Management & GO	Space/ Ground Comms.	Data Routing	Data Processing	Satellite Operations
	& Routing (DA&R)					
GCOM-W1	Data Acquisition, Routing & Processing	Yes	Yes	Yes	RDR only	No
SCaN Supported Missions	Data Routing (DR)	Yes	No	Yes	No	No
Metop	Data Routing (DR)	Yes	No	Yes	No	No

*B2.2 only supports RDRs for JPSS-2.

As Table 6.2.3-7 shows, JPSS will provide satellite operations support only to the S-NPP and JPSS missions. Therefore SyS will only provide SOH information on the S-NPP and JPSS satellites. However, JPSS will provide space ground data acquisition to the S-NPP, JPSS-1/2/3/4, GCOM-W1, DMSP, and Coriolis/WindSat missions. So SyS will provide data acquisition status for down linked data for these missions. SyS will provide network monitoring for the GCOM-W1, SCaN-supported missions, and Metop missions. Finally, SyS will provide data processing and product distribution monitoring for S-NPP, JPSS and GCOM-W1.

Table 6.2.3-8 provides a description of each of the activities in the Ground Network Node Monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow monitors the SOH of the JPSS ground network and of all the communications to elements that are outside the JPSS Ground System. The SOH monitoring of the JPSS Ground network includes monitoring of the communications links between the NSOF and the JPSS ground stations at McMurdo, Svalbard, Troll, FCDAS, and to the WSC. Part of this monitoring consists of getting network and link status information from commercial providers such as AT&T.

The external element communications monitored by the Ground Network Node Monitoring flows include the ESPC, CLASS, SDS, and to the service delivery points (SDPs) for external missions (e.g., DMSP, Coriolis/WindSat, and Metop). In addition, the Ground Network Node monitors the network connections to the ancillary data providers.

The Ground Network Node Monitoring basic flow collects SOH and SOS data from all of these sources and then processes this data to determine if an alarm, warning, or event message should be sent out.

Table: 6.2.3-8 Ground Network Node Monitoring SyS Steps

No	Actors	Actions	Notes
1	Ground Network Node, MON	To Monitor the overall SOH of the JPSS networks, the CGS Manage GNN Nodal Situational Awareness activity monitors the SOH, performance, and security status (if available) information	

No	Actors	Actions	Notes
		provided from the JPSS networking equipment throughout the JPSS Ground system. The CGS Manage GNN Nodal Situational Awareness activity monitors these activities for equipment at McMurdo, Svalbard, Belrose, FCDAS, Nittedal (to support Troll), WSC, NSOF, CBU, CSN Riverdale, CSN Indy, CSN Aurora, and GSFC. The CGS Manage GNN Nodal Situational Awareness activity provides this SOH status and any out of tolerance conditions to the Ground Network Operator (GNO) display, the Ground Network Node local log, and to the CGS Provide Situational Awareness activity. This information includes failed equipment or interfaces, packet delay, packet loss, reduced throughput, intrusion alerts, and network utilization. This activity will produce post-pass reports as required by specific missions at the conclusion of each contact and provide that report to the Manage Fleet/Ground Operations and Manage Global Situational Awareness activities. For any out of tolerance conditions, the CGS Manage GNN Nodal Situational Awareness activity will generate the appropriate AWE and provide that to the CGS Provide Situational Awareness activity. Both SOH and AWE are logged locally at the Ground Network Node. The Provide Situational Awareness uses the information from Manage GNN Nodal Situational Awareness to assess the health of the JPSS networks and identify any current or potential issues.	
2a	Ground Network Node, MON, MOT	For the DMSP mission, the CGS Manage MON Nodal Situational Awareness activity gathers network routing statistics information for the ground, microwave, and satellite network links from McMurdo through the JPSS Ground Network to the DMSP SDP.	
2b	Ground Network Node, MON, MOT	The Metop missions uses external ground terminals, so the CGS Manage MON Nodal Situational Awareness activity gathers some of the network routing statistics information from the McMurdo Multi-Mission LAN, satellite links, and the JPSS WAN as required.	

No	Actors	Actions	Notes
2c	Ground Network Node, MON, MOT	For the Coriolis/WindSat mission, the CGS Manage GNN Nodal Situational Awareness activity provides the CGS Provide Situational Awareness activity network routing statistics and packet loss information for the ground network links from the NEP at SVAL through the JPSS Ground Network to the SDP for the Coriolis/WindSat mission.	
2d	Ground Network Node, MON, MOT	The GCOM missions uses external (non-JPSS) ground terminals, so the MON Track Mission Data Flow thread gathers some of the network routing statistics and packet tracking information from this from the SG-25 and SG-3 ground terminals at Svalbard via the KSAT interface to the JPSS Ground System. In addition, status information for GCOM data is collected from the JPSS Ground Network as required.	
2e	Ground Network Node, MON, MOT, White Sands Complex	For the TDRS Contacts, the CGS MON Track Mission Data Flow activity gathers network routing statistics, Real-Time or Playback telemetry packet, and command packet tracking information for the ground network links form the WSC through the JPSS Ground Network to the NSOF.	
3a	Ground Network Node, EMOC	The CGS GNN AT&T/CONUS Network Status activity generates network reports that are sent to the CGS Provide EMOC Situational Awareness activity to support Network Performance Metrics.	
3b	Ground Network Node, EMOC	The CGS GNN KSAT Network Status activity generates network reports that are sent to the CGS Provide EMOC Situational Awareness activity to support Network Performance Metrics.	
4	Ground Network Node, MON	The CGS Provide Situational Awareness activity receives that data from activities 1 to 3b of this basic flow and provides overall JPSS Mission SOH and services status. This activity is discussed further in the JPSS Mission Level Monitoring basic flow for this ConOps.	

Table 6.2.3-9 provides a description of each of the activities in the CGS Management & Operations Node (MON) monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow obtains MON resource utilization and MON status and provides it to the CGS Provide Situational Awareness activity. This basic flow also processes this data to determine if an alarm, warning, or event message should be sent out locally to the MON and potentially to the CGS Provide Situational Awareness activity for mission level monitoring.

Table: 6.2.3-9 CGS Management & Operations (M&O) Node monitoring SyS Steps

No	Actors	Actions	Notes
1	Ground Network Node, MON, MOT, Space/Ground Communications Node	To monitor the network performance in receiving SMD data either via space ground communications for S-NPP, JPSS-1/2/3/4, GCOM, Coriolis/WindSat, and DMSP or via network communications for Metop, SCaN-Supported Missions, or TDRS data; the CGS JSH Track and Recover Gaps in Mission Data activity provides down-linked SMD data routing, data latency, packet data loss, and bad packet statistics, telemetry, and other data delivered from the Network Entry Point (NEP) to the Service Delivery Point (SDP) for each mission. This information enables the CGS MON Track Mission Flow activity to monitor network performance for delivery of data from the satellite. Specific CGS MON Track Mission Data Flow activity functions for each mission configuration are provided in rows 2a through 2f of this table.	
2	Ground Network Node, MON, MOT, Space/Ground Communications Node	For the S-NPP, JPSS-1/2/3/4, and GCOM missions, the CGS MON Track Mission Data Flow activity gathers network routing statistics and VCDU tracking information for the ground network links from the NEP at ground stations through the JPSS Ground Network to the JPSS Relay using the CCSDS Space Link Extension (SLE) data transfer services protocol to provide reliable VCDU delivery.	
3	Ground Network Node, MON, MOT	To monitor network performance in receipt of ancillary data. The CGS MON Track Mission Data Flow activity collects the status of the communications by trying to communicate with ESPC PDA. This activity provides the status of these links to the CGS Provide Situational Awareness activity. This enables the Provide Situational Awareness activity to monitor the availability of Ancillary data for science processing. The CGS Provide Situational Awareness activity will monitor and log any change from Official Dynamic Ancillary Data (ODAD) and provide status information on the ODAD availability.	
4	MON	To monitor the SOH of the MON, the CGS Manage MON Nodal Situational Awareness	

No	Actors	Actions	Notes
		activity collects status information about the MON equipment, communications services, and software processes and provides this status to the CGS Provide Situational Awareness activity in near real-time on operator displays and in report files. MON SOH is logged locally at the M&O Node. The CGS Provide Situational Awareness activity also provides the same monitoring of the SOH and operational capability for the Back-Up and/or Alternate Mission Management & Control facility. SOH information can include equipment status, ground communications links status, and software process status. SOS would include resource utilization such as processor loading and network loading. The GNO provides SOH and SOS status information to local M&O monitoring and to the CGS Provide Situational Awareness activity to provide JPSS Ground System level monitoring.	

Table 6.2.3-10 provides a description of each of the activities in the CGS Data Processing Node monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow monitors the flow of SMD to the DP node and then monitors the production and distribution of science data products. This basic flow then processes this data to determine if an alarm, warning, or event message should be sent out.

Table: 6.2.3-10 CGS Data Processing Node Monitoring SyS Steps

No	Actors	Actions	Notes
1	DPN, MON	The CGS Manage DPN Nodal Situational Awareness activity monitors the health and performance of the Data Processing Node in the JPSS GS. The SOH monitoring includes processing and communications equipment status. SOS includes processor loading, disk space usage, process execution station, and data queue status. This includes SOS monitoring of the mission data processing for data latency and availability to ensure that all science products are delivered timely and data quality monitoring to ensure that the science products that are delivered contain quality data and are complete. The CGS Manage DPN Nodal Situational Awareness activity provides SOH and SOS information and mission processing status to the IDP operator workstation display, DP Node log files, and forwards appropriate SOH and SOS	

No	Actors	Actions	Notes
		information to the CGS Provide Situational Awareness activity. When either the SOH or status values are out of thresholds, then the CGS Manage DPN Nodal Situational Awareness activity will issue AWE messages to the DPN operators and to the CGS Provide Situational Awareness activity.	
2	DPN, MON	To report on the production of science products, the CGS Manage Product Generation and Distribution activity provides data production reports, data quality information, and AWE. To monitor the delivery of data products to downstream users, the CGS Manage Product Generation and Distribution activity supports the CGS Manage DPN Nodal Situational Activity by providing the status of the data product distribution. This includes monitoring of subscription status to downstream users, monitoring of data delivery queues, and overall throughput status. If queues are backed up, subscriptions are down, or overall throughput is below thresholds, then the CGS Manage DPN Nodal Situational Awareness activity will provide AWE to the CGS Provide Situational Awareness activity.	See the SMD Handling ConOps thread for additional information. See the Data Accounting & Recovery ConOps thread for additional information on the data reports See the Data Quality Management (DQM) ConOps thread for data quality monitoring information.
3	DPN, MON	The CGS DPN Track Mission Data Flow activity provides status of the processing of retransmitted data by generating reports and passing the reports to the CGS Manage DPN Nodal Situational Awareness activities. These reports include Data Accountability Reports, Latency reports, and the number of pending retransmission requests.	
4	DPN, MON	The CGS Provide Situational Awareness Activity receives that data from activities 1 to 3 of this basic flow and provides overall JPSS Mission SOH and services status. This activity is discussed further in the JPSS Mission Level Monitoring basic flow for this ConOps.	

Table 6.2.3-11 provides a description of each of the activities in the CGS Support Node monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow obtains status of CGS Support Node and forwards this status to the overall Ground System monitoring activities. This basic flow then processes this data to determine if an alarm, warning, or event message should be sent out.

Table: 6.2.3-11 CGS Support Node Monitoring SyS Steps

No	Actors	Actions	Notes
1	Ground Network Node, MON	This JPSS CGS Support Node provides a test bed for new software and hardware configurations of the CGS. As a result the configuration of the CGS Support Node is constantly changing. So the Provide Situational Awareness only monitors the communications to the CGS Support Node. This is done by attempting to send data to or retrieve data from the CGS Support Node.	
2	GNN, MON	The CGS Provide Situational Awareness Activity receives that data from step 1 of this basic flow and provides overall JPSS Mission SOH and services status. This activity is discussed further in the JPSS Mission Level Monitoring basic flow for this ConOps.	

Table 6.2.3-12 provides a description of each of the activities in the JPSS Simulations Node monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow obtains status of Flight Vehicle Test Suite (FVTS) simulators and forwards this status to the overall Ground System monitoring activities. This basic flow then processes this data to determine if an alarm, warning, or event message should be sent out.

Table: 6.2.3-12 JPSS Simulation Node Monitoring SyS Steps

No	Actors	Actions	Notes
1	Simulation Node, MOT	To monitor the status of the Simulations Node the SIM Configure Simulators activity obtains system SOH operational capability, SOS resource utilization, and may include security data from the Flight Vehicle Simulation (FVS) ConOps thread and provides that information to the SIM Provide SIM Situational Awareness activity (for FVS) and the SIM Manage SIM Nodal Situational Awareness activity (for FVTS). This FVS configuration information is sent to the CGS Provide Situational Awareness activity to determine the operational capability of the FVS and its ability to verify satellite commanding and other simulation functions.	See the Flight Vehicle Simulation ConOps thread for additional information.
2	Simulation Node, MOT	The FVTS configuration information is sent to the SIM Manage SIM Nodal Situational Awareness activity to be logged locally and then provides the SOS and SOH information to the CGS Manage Global Situational Awareness activity.	

No	Actors	Actions	Notes
		This SOH also includes which processing string "A" or "B" the FVTS is connected to.	

Table 6.2.3-13 provides a description of each of the activities in the JPSS Cal/Val Node monitoring basic flow along with the actors and the actions in that activity. The Cal/Val Node consists of GRAVITE and supporting local computing facilities (LCFs) that support the Cal/Val functions. This basic flow obtains status of GRAVITE and forwards this status to the overall Ground System monitoring activities. This basic flow then processes this data to determine if an alarm, warning, or event message should be sent out. Status for the LCFs is not monitored by SyS.

Table: 6.2.3-13 JPSS Cal/Val Node Monitoring SyS Steps

No	Actors	Actions	Notes
1	Cal/Val Node, MOT	The CAL Manage Cal/Val Infrastructure activity provides equipment SOH of GRAVITE. All of this Cal/Val SOH information is logged locally at the Cal/Val Node. The communications status between CGS and GRAVITE is obtained by the CGS when trying to communicate and/or send data products to the GRAVITE. The CGS will also monitor data retransmit requests to monitor the successful ingest of data at GRAVITE. Issues (errors, faults, and failures) related to the infrastructure, software processes, and Off-the-Shelf (OTS) vendor products are logged locally at the Cal/Val Node. The GRVITE system administrators and operators are responsible for detection and remediation of anomalies by periodic log checks via the GRAVITE IPS System. When an issue is found, a Discrepancy Report (DR) is created and tracked by the Operators and Management. GRAVITE management can close a DR once the issue has been resolved.	See the Cal/Val of Data Products ConOps thread for additional information.

Table 6.2.3-14 provides a description of each of the activities in the JPSS Ground HRD monitoring basic flow along with the actors and the actions in that activity.

Table: 6.2.3-14 HRD Monitoring SyS Steps

No	Actors	Actions	Notes
1	FTS, CGS	The Direct Broadcast Quality Monitoring ConOps thread receives the direct broadcast data and analyzes the packets received during the ground station contact to report the mapping of	See the Direct Broadcast Quality Monitoring ConOps

No	Actors	Actions	Notes
		APID and VCID as received. In addition, the Direct Broadcast Quality Monitoring thread monitors the quality of the RF signal from the S-NPP or JPSS-1/2/3/4 satellite. The Direct Broadcast Quality ConOps thread provides this information to the CGS Monitor Direct Broadcast Performance activity.	thread for additional information
2	FTS, CGS	The CGS Trend Ground System SOH/SOS activity creates a HRD monitoring report.	

Table 6.2.3-15 provides a description of each of the activities in the Monitor Observatory SOH basic flow along with the actors and the actions in that activity. In summary, this basic flow obtains the satellite SOH and the satellite orbit data from other ConOps threads. This basic flow then processes this data to determine if an alarm, warning, or event message should be sent out.

Table: 6.2.3-15 Monitor Satellite SOH SyS Steps

No	Actors	Actions	Notes
1	Space/Ground Communications Node, MOT, MON	To monitor the satellite SOH, the CGS Analyze Telemetry activity collects RT and stored telemetry, spacecraft status, and sensor status information from the Telemetry and Command ConOps thread and analyzes this data to determine SOH of the satellite. The results of this analysis will indicate if there are current problems with either the spacecraft or any of the instruments on the spacecraft. This includes internal spacecraft communications, power supply levels, and temperature issues. This analysis is sent to the Trend Flight System State of Health to monitor long-term changes in the telemetry and to determine if any corrective actions are necessary.	See the Telemetry & Command (T&C) thread to determine how spacecraft status information is collected. Also, see the Orbit Maintenance (GS-NML—050) thread to get additional information regarding satellite orbit monitoring.

Table 6.2.3-16 provides a description of each of the activities in the JPSS Mission Level Monitoring basic flow along with the actors and the actions in that activity. In summary, this basic flow obtains status information including SOH, configuration, and data flow status from other activities in this ConOps thread and determines whether or not to send out a JPSS Mission Level Mission Notice for either a service affecting failure or a system status change.

Table: 6.2.3-16 JPSS Global Level Monitoring SyS Steps

No	Actors	Actions	Notes
1	Space Ground Communications Node, MON, Ground Network Node, DPN, MOT, Simulation	In order to monitor the overall JPSS Ground System SOH, the CGS Provide Situational Awareness activity receives SOH and SOS status as defined in table 6.2.3.3 from all of the manage JPSS node SOH activities. These include the following: • Space/Ground Communications Node	Global, including nodal SOH is passed to the Ground Operations, Space Operations, Mission Planning & Scheduling (MPS), System Fault

No	Actors	Actions	Notes
	Node, Cal/Val Node	• Ground Network Node • M&O Node • Data Processing Node • Simulation Node • Cal/Val Node • CGS Support Node Communications The CGS Provide Situational Awareness activity also receives SOH status from HRD monitoring and satellite monitoring flows within this ConOps. Finally, the CGS Provide Situational Awareness activity receives success or failure status of command execution to ground systems from the CGS Execute Ground Command activity. The CGS Provide Situational Awareness activity takes this information and creates a consolidated view of the overall status of the JPSS Ground System in near real-time for the M&O node personnel workstation displays. This information will also be stored in logs at the M&O node for the life of the mission. This log information will be stored in on-line storage for a minimum of 30 days. Finally this activity forwards the overall JPSS Ground System SOH to the CGS Manage Global Situational Awareness activity and delivers positive response notifications to the affected system operators.	Analysis (SFA), the Continuity of Operations (COOP), and the Fleet Ground Management (FGM) ConOps threads to determine Global SOS and Global SA as well as to determine appropriate actions from the Global SOS and Global SA.
2	MON	Finally, the MON provides the global situational awareness read only data to each of the JPSS Ground System Nodes. The CGS Manage Global Situational Awareness activity displays nodal latency statistics. MON collects local logged Nodal SOH and SOS Information from each node and stores in online storage for a minimum of 30 days. MON collects local logged Nodal SOH and SOS Information from each node and archives the logs for the life of the Program. MON collects local detail Nodal Logs from each node and stores in online storage for a minimum of 30 days. MON collects local detail Nodal Logs from each node and archives logs for the life of the Program. Make available the retrieval of log	

No	Actors	Actions	Notes
		data based on user-defined search parameter. Automated execution of sequences when violations of thresholds occur. Authorized ground system users access to global SA status.	
3	MON	The CGS Provide Situational Awareness activity will provide the CGS Manage Fleet/Ground Operations activity with CGS Nodal SOH/SOS/AWEs.	
4	MON, MOT	The CGS Provide Situational Awareness activity will provide the CGS Monitor and Control Simulator activity with CGS Nodal SOH/SOS/AWEs.	

6.2.3.7 Alternate Flow

Alternate flows are only required when multiple critical failures are preventing status data and info from properly being monitored, collected, evaluated, analyzed, and reported. Primary, Alternate, and Backup elements, nodes, and architecture redundancies provide this for both our status and recovery flows. In this situation, then either the System Fault Detection and Recovery thread or the Continuity of Operations Thread would address this situation.

6.2.3.8 Post Condition

The System Status/Situational Awareness ConOps thread runs continuously a 100% of the time. So there is no end state of this thread as long as the JPSS mission continues.

Its end products are SOH, Configuration, and notices on the state of all of the JPSS Mission elements. The MSD Handling, Mission Planning System, and Ground Operations are the other ConOps threads that receive the System Status/Situational Awareness thread's products. Other recipients of the System Status/Situational Awareness thread's products will depend the level and severity of the alarm, warning or event. This is provided in Table 6.2.3-3 of this thread.

6.2.3.9 Related Threads

The ConOps threads listed below provides the primary related JPSS Ground System ConOps that contain helpful info for understanding how specific actions or operational activities in this SyS ConOps thread act or relate to other threads. The ConOps threads listed below also provides the threads that either provide inputs to the SyS thread or receive outputs from the SyS thread.

Thread ID	Threads Title
JPSS ConOps Threads Related to SyS	
GS-NML-010	Fleet Ground Management (FGM)
GS-NML-320	Space Operations (SO)
GS-NML-120	Continuity of Operations (COOP)
GS-NML-130	System Fault Analysis (SFA)
GS-NML-220	Security
JPSS ConOps Threads that Provide Inputs to SyS	
GS-NML-030	Telemetry and Command (T&C)

Thread ID	Threads Title
GS-NML-050	Orbit Maintenance (OrM)
GS-NML-090	Flight Vehicle Simulation (FVS)
GS-NML-100	Stored Mission Data Handling (SMD)
GS-NML-110	Data Quality Assurance (DQA)
GS-NML-130	Data Accounting and Recovery (DAccR)
GS-FTS-140	Direct Broadcast Quality Monitoring (DBQM)
GS-NML-150	Cal/Val of Data Products
JPSS ConOps Threads that Receive Outputs from SyS	
GS-NML-310	Ground Operations (GO)
GS-NML-020	Mission Planning and Scheduling (MPS)
GS-NML-100	Mission Support Data Handling (MSD)

6.2.3.10 Child Threads

The ConOps threads listed below provide the child threads for the System Status/Situational Awareness thread.

Thread ID	Thread Title
CGS-030-010	Status and Situational Awareness

6.2.4 Ground Operations

6.2.4.1 Description

ConOps thread GS-NML-310, Ground Operations (GO) consists of the activities necessary to manage the JPSS Ground System in both normal operations and works with the System Fault Analysis thread and the System Maintenance & Upgrade thread to restore operations when problems arise. Ground Operations can also refer to an organization, this ConOps thread is not intended to cover all of the activities performed by the Ground Operations organization. For example, the Ground Operations organization supports the Integration Test & Check-Out (ITCO) for new releases as part of the System Maintenance and Upgrade ConOps thread, but that activity is not addressed in the GO ConOps thread. The basic and alternative threads for GO are provided below:

Basic GO Flows

- Operate the Ground System (GS)
- Manage the GS Health and Performance
- GS Health and Performance Metrics Calculations

Alternative GO Flows

- Restore Ground Operations
  - Using Routine Standard Operating Procedures (SOPs)
  - Coordinating with the System Maintenance & Upgrade (SMU) thread to resolve routine maintenance issues

- Support System Updates

The alternate GO ConOps flows are to support anomaly resolutions that are routine corrective actions or to support SMU in implementing system repairs or updates. Figure 6.2.4-1 shows the process for resolving system issues or anomalies and which ConOps threads activities are involved in this process.

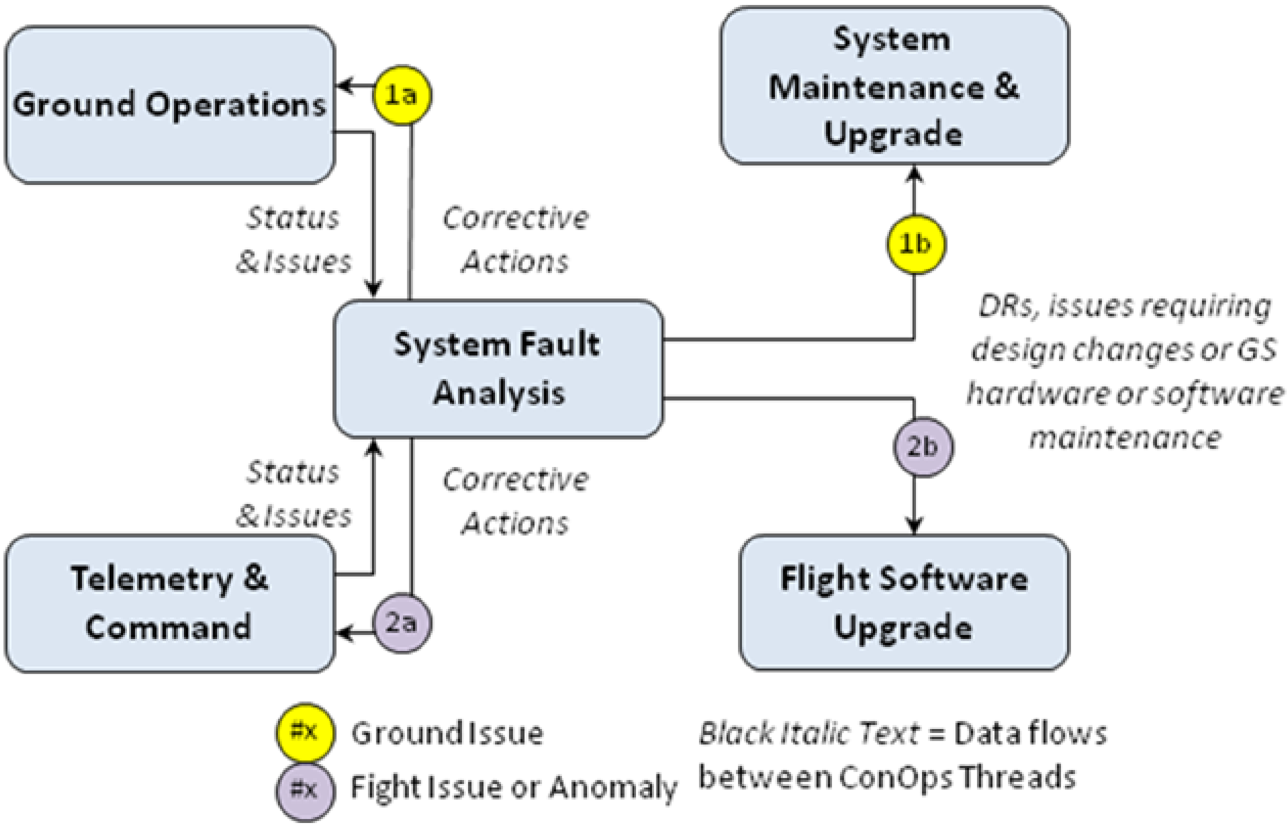


Figure: 6.2.4-1 JPSS GS Issue Resolution Process Flow

As Figure 6.2.4-1 shows, status and issues are provided to the System Fault Analysis (SFA) ConOps thread. Activities in SFA will determine the corrective action for issues or anomalies. The types of corrective actions from the flows in Figure 6.2.4-1 and the ConOps thread that describes the corrective actions are provided in Table 6.2.4-1:

Table: 6.2.4-1 Corrective Actions & Performing ConOps Threads

No.	Corrective Action	Performing ConOps Thread
1a	Routine commanding or configuration changes on the JPSS GS	Ground Operations
1b	Design changes or maintenance actions to the JPSS GS	SMU
2a	Routine satellite commanding	Telemetry & Command
2b	Satellite or instrument software changes and/or tables	Flight Software Upgrade

GO provides the activities listed above for the ground system resources at several facilities including the NOAA Satellite Operations Facility (NSOF), the Alternate Common Ground

System (ACGS) Consolidated Back-Up (CBU) facility, the Svalbard ground station, the McMurdo ground station, the FCDAS (Alaska) ground station, and the JPSS CGS equipment at WSC. GO also manages the networks between these facilities and downstream users of the JPSS mission data, the CGS support node, instrument support nodes, and ancillary data providers.

Summary of GO Flows

The GO ConOps thread defines the operations personnel and activities, their functions, roles and responsibilities, and their interactions in the operational flow. GO configures ground assets (antennas, receiving/transmitting systems, data processing systems, and other elements) to support planned mission activities based on plans, schedules and products generated by Mission Planning and Scheduling (MPS) and priorities that are determined and distributed by the Fleet Ground Management (FGM).

In addition to configuration of ground assets to support planned mission activities, GO manages the status of JPSS Ground System ground station equipment (including equipment at MON) and performance. The collection of this status is described in the System Status/Situational Awareness (SyS) ConOps thread. GO provides the functionality that evaluates JPSS Ground System ground station status received from SyS, and determines if a routine action can address a potential ground system issues. If routine actions can resolve ground system issues, then GO will implement those routine actions.

GO also provides a level of situational awareness of the ground system; analyzing status information and presenting ground system level health, mission readiness and performance status to operations personnel in near real-time. GO provides summary status information to Fleet Ground Management (FGM) and SYS for System-wide monitoring and control.

A description of the basic and alternate flows for the GO ConOps thread is provided below.

Basic Flows

1. **Operate the Ground System:** The Operate the Ground System basic flow receives schedules from the Mission Planning and Schedules ConOps thread activities. From these schedules it generates ground commands for the Space Ground Communication Node(s) (SGCN), and for the command, telemetry and mission data hardware at MON. Each mission can be operated from separate operational environments. For example, S-NPP could be operated from String A and JPSS-1 could be operated from String B. These ground commands are verified using a combination of simulators, internal software checks, and manual review. Once these commands are verified, they are sent to the SGCN and MON in advance of a contact with a satellite observatory or receipt of data depending on the mission being supported.

   During JPSS-1 launch and early orbit operations when the JPSS-1 satellite flies in its transition orbit 10 km below the S-NPP orbit with changing angular separation from S-NPP, there may be back-to-back T&C and SMD contacts of S-NPP and JPSS-1 at Svalbard. GO must be able to support these close contacts.

   The Ground Network Node (GNN) configurations are typically created once for each mission or until the network configuration changes either due to an upgrade or after a fault. The Data Processing Node's (DPN's) processing activities are data driven, GO does not send

configuration commands to DPN. The DPN's processing is configured by mission specific configuration tables that are included in the DPN's software builds.

GO receives confirmation of successfully executed configuration ground commands as well as unsuccessfully executed ground commands, and with State of Health (SOH) and State of Service (SOS) data provided by the SyS thread, the Data Quality Assurance thread, and the Data Accounting and Recovery thread. This SOH and SOS status will enable GO to determine if there were any unintended configuration changes that have resulted from either unsuccessful ground commands or due to other causes. When the JPSS Ground System is processing data, GO thread activities monitor the data processing and delivery performance of the JPSS Ground System CGS.

2. **Manage the GS Health and Performance:** The Manage the GS Health and Performance flow receives both global and nodal SOH information from SyS. It also receives nodal SOS from SyS. This information also includes trend reports for different aspects of the JPSS Ground System SOH and services. SyS provides GO with hierarchical status displays, configurable thresholds, and filtering capability for warnings and alarms at the Global and Nodal level. These display capabilities enables SyS and GO to provide manageable and relevant information to the JPSS GS operators.

   The GO thread uses the above information that SyS provides to determine if there is a performance issue in the JPSS GS equipment, data processing service, or data delivery service.

   If an issue does occur in the JPSS GS or a JPSS managed satellite that required support from personnel not at the operational facility (off-site), then a two-way escalating page can be configured to be sent out. This page requires a response from the recipient within a given time period or another page will be sent to an alternate person or a more senior manager.

   The JPSS GS requires that operators must login to gain access to their workstations and JPSS GS applications. The capabilities that the operator has to read SOH/SOS status and command the JPSS GS are determined by the privileges assigned to that authorized user login.

   GO activities provide the capability for authorized personnel to access SOH/SOS status as well as general information (e.g. teleconference numbers) through a secured web server that is located on a government-provided server outside of the NOAA5042 security boundary. The authorized users would typically be operations personnel that are not currently at the NSOF but could also be other mission stakeholders as well. Status data is pushed to the server via one-way connection. Such non-local SOH/SOS status access is critical for timely anomaly response and recovery. This secure web server will also provide a collaboration capability based on a COTS toolset. The collaboration capability will allow both GS operators and authorized external users to post information on to a message board. The collaboration capability will improve the ability of authorized operators and authenticated users to resolve technical and operational issues.

   If there is a corrective action that the operator can take using a Standard Operations Procedure (SOP), then the operator controlling that node will take the corrective action. If

no corrective action is possible, then this thread passes the issue to the System Fault Analysis ConOps thread.

Two examples of the global monitoring of JPSS GS performance are provided below:

- **SMD Situational Awareness:** The global SA function in the SYS thread will monitor the end-to-end JPSS processing of SMD. This will include monitoring of latency, data accounting, data delivery status through SGCN, the GNN, MON, and DPN. This information will be provided by each node, and the global SA function will provide summary statistics of the overall JPSS ground system performance.
- **MSD routing:** The global SA function will monitor the collection of ancillary (ANC) data through the GNN and DPN, the creation of internally produced auxiliary (AUX) data, and the delivery of MSD data such mission schedules to both internal operations and external users of this data. The global SA will collect information from the all of these steps in MSD creation and distribution in order to determine the latency of the MSD delivered any MSD delivery issues.

GO will issue a Mission Notice if there is a SOH or SOS issue that cannot be corrected by operator intervention.

GO also provides situational awareness of the ground system, by analyzing status information and presenting ground system level health, mission readiness and performance status to operations personnel in near real-time. GO provides summary status information to Fleet Ground Management (FGM) for System-wide monitoring and control.

3. **JPSS Ground System Performance Metrics:** Additional JPSS SOS monitoring at the Global level includes generation of data availability and latency reports over 30 day sliding window periods to provide periodic assessment of how the JPSS GS is performing. These data availability and latency reports will be available at least once per day. Other custom reports can be generated with different window durations through querying of the raw data availability and latency data. The data availability report will provide the percentage of data that was delivered compared with the data that could have been produced and delivered from the received satellite data. The latency report will provide statistics on the end-to-end latency of processed data through the JPSS GS. These statistics will include the latency through each of the ground system processing nodes (i.e. SGCN, GNN, MON, and DPN).

Alternate Flows

1. **Restore Ground Operations:** GO can restore JPSS Ground Operations with one of the following two scenarios.
   a. **SOP Based Restoration:** When GO determines that a problem cannot be addressed through routine operations, the issue is passed the System Fault Analysis ConOps thread. If the System Fault Analysis ConOps thread determines the solution to the problem can be addressed by GO using standard SOPs, then GO thread implements this corrective action on the JPSS GS and restores operations. Once operations are restored, the GO thread sends out a Mission Notice to JPSS data users and missions supported by the JPSS Ground System that operations have been restored.

b. **Routine Maintenance:** As before, when GO determines that a problem cannot be addressed through routine operations; the issue is passed the System Fault Analysis ConOps thread. After System Fault Analysis ConOps thread determines the cause of the problem and develops a solution for the problem that requires the SMU thread to perform a maintenance action, then GO implements supports SMU in implementing this hardware or software maintenance action on the JPSS GS and restores operations. Once operations are restored, the GO thread sends out an Event notice to JPSS data users and missions supported by the JPSS Ground System that operations have been restored.

2. **Support System Updates:** When a system upgrade is planned or a new table such as Processing Coefficient Table (PCT) is to be uploaded by the System Maintenance and Upgrade ConOps thread, GO supports System Maintenance and Upgrade in implementing this upgrade or table on the back-up JPSS Ground Processing string for Integration Test & Check-Out (ITCO). After the upgrade or table is checked out, then GO supports the System Maintenance & Upgrade ConOps thread in transitioning from the upgraded alternate JPSS GS string to becoming the operational string. GO also supports bringing the remaining JPSS Ground Processing string to the same configuration as the new operational string. The timing for this upgrade is determined by the MPS ConOps thread.

6.2.4.2 Primary Interfaces

Primary interfaces driven by this ConOps thread are depicted in Figure 6.2.4-3. This includes both external interfaces and inter-system interfaces within the Ground System. Interfaces for the Consolidated Back-Up (CBU) Alternate Common Ground Station (ACGS) are designated with an “a” after the interface number in Figure 6.2.4-2.

Interfaces with Ground System Elements and Ground System Nodes outside of CGS may be required for Status and Control. GO does not configure or receive status directly from GRAVITE.

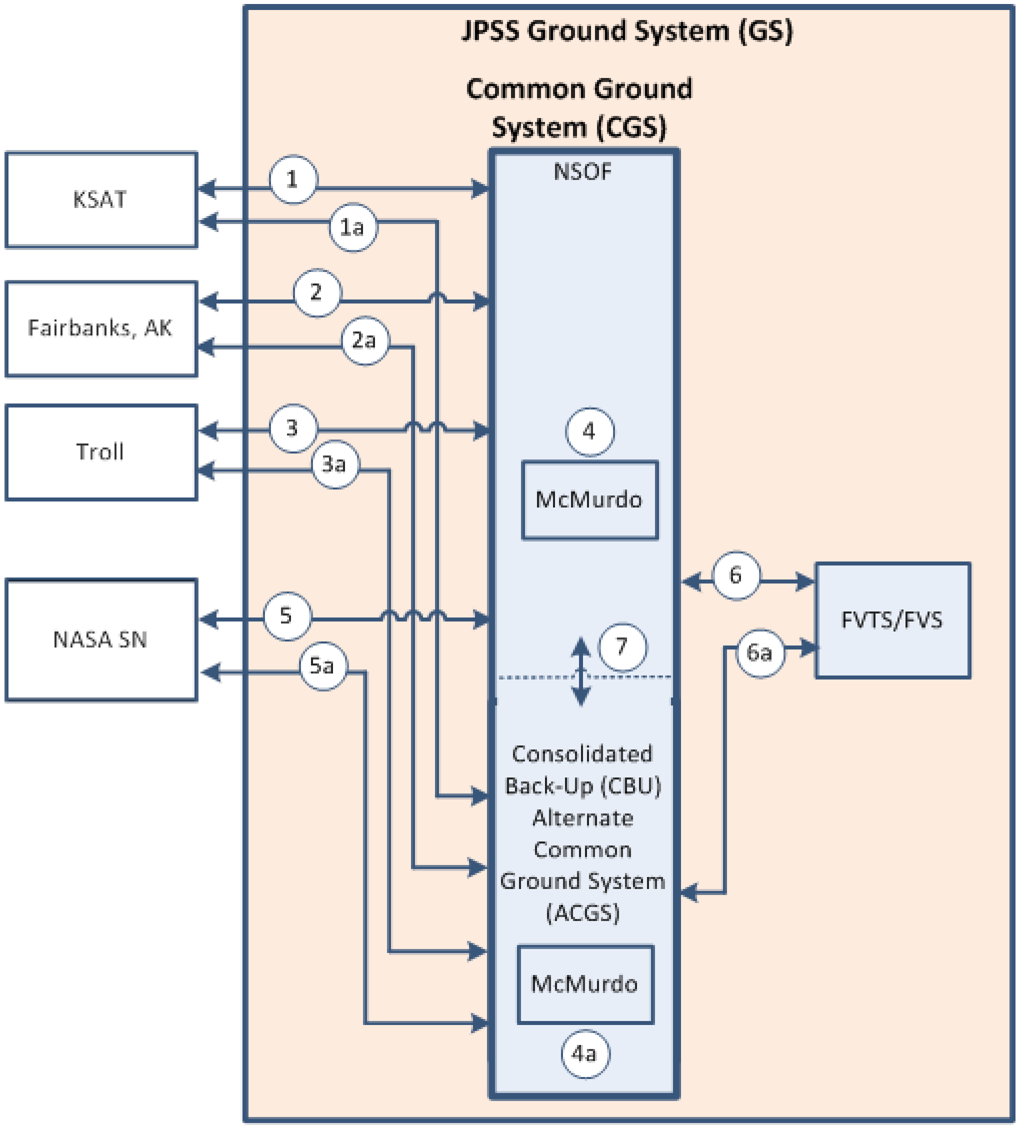


Figure: 6.2.4-2 Primary Interfaces for Ground Operations

Each interface in Figure 6.2.4-2 is labeled with a number and defined in Table 6.2.4-2 with types of interface, actors, purpose, types of data, exchange method and frequency. Table 6.2.4-3 provides the relevant IRDs and/or ICDs for those interfaces.

Table: 6.2.4-2 Ground Operations Primary Interfaces

No.	Type	Actors	Purpose
1, 1a	External	Kongsberg Satellite Service (KSAT), CGS	Status: Receive KSAT ground station SOH and SOS status (SG3 & SG4 Antenna Only)
2, 2a	External	Fairbanks, AK, CGS	Status: Receive Fairbanks ground station SOS status (13m X/S Band Antenna Only)
3, 3a	External	Troll, CGS	Status: No Status is received from Troll. JPSS CGS Ground Equipment is configured to interface with Troll Ground Station

No.	Type	Actors	Purpose
4, 4a	Internal	CGS	Status: Receive Svalbard ground station SOH and SOS status for JPSS CGS ground equipment at SVAL Commands for JPSS ground equipment at SVAL Status: Receive FCDAS ground station SOH and SOS status for JPSS CGS ground equipment at FCDAS (Includes KA Band Antenna) Commands for JPSS ground equipment at FCDAS Status: SOH and SOS Status of JPSS CGS Equipment at McMurdo Commands for JPSS CGS ground equipment at McMurdo
5, 5a	External	Space Network (SN) Tracking Data Relay Satellite (TDRS), CGS	Status: SOH and SOS Status of JPSS CGS Equipment at WSC, SOS status of SN (WSC & TDRS) Commands for JPSS CGS equipment at WSC
6, 6a	Internal	CGS, Flight Vehicle Test Suite (FVTS)	Status: FVTS (FVS, J1Sim, FSE (B2.2)) status to CGS
7	Internal	CGS (NSOF), ACGS (CBU)	SOH status, SOS status, and non-local management of ACGS at CBU from CGS at NSOF

Table: 6.2.4-3 Ground Operations Interface Documentation

No.	IRD/ICD
1, 1a	JPSS GS to KSAT IRD JPSS CGS to KSAT ICD GCOM-W1 Mission Ops Interface Specification JPSS GS Services Specification JPSS CGS Services ICD
2, 2a	JPSS GS to National Environmental Satellite, Data, and Information Service (NESDIS) Fairbanks Command and Data Acquisition Station (FCDAS) IRD JPSS CGS - FCDAS ICD
3, 3a	JPSS GS to KSAT IRD JPSS CGS to KSAT ICD
4, 4a	JPSS CGS Internal Services ICD JPSS CGS Intersegment ICD
5, 5a	SN-JPSS CGS ICD SN-Networks Integration Management Office (NIMO) Network Requirements Document (NRD) (for S-NPP) SN-NIMO Project Service Level Agreement (PSLA) (for S-NPP) SN-NIMO Project Service Level Agreement (PSLA) (for JPSS-1) SN-NIMO Project Service Level Agreement (PSLA) (for JPSS-2) JPSS GS Services Specification JPSS CGS Internal Services ICD

No.	IRD/ICD
	JPSS CGS Intersegment ICD
6, 6a	JPSS CGS-FVTS IRD JPSS CGS-FVTS ICD
7	N/A (CGS Internal Document)

6.2.4.3 Assumptions & Constraints

The following assumptions are made for the successful performance of ground operations functions:

- All personnel involved in ground operations functions have the appropriate training and certifications.
- External organizations such as KSAT ensure a high availability of their ground station assets, have available resources to meet JPSS needs, and respond appropriately to JPSS requests and mission plans.
- All hardware and software upgrades to the system are adequately tested before being installed on the operational ground system.
- FGM is able to reconcile resource constraints between JPSS and other missions to meet customer expectations.

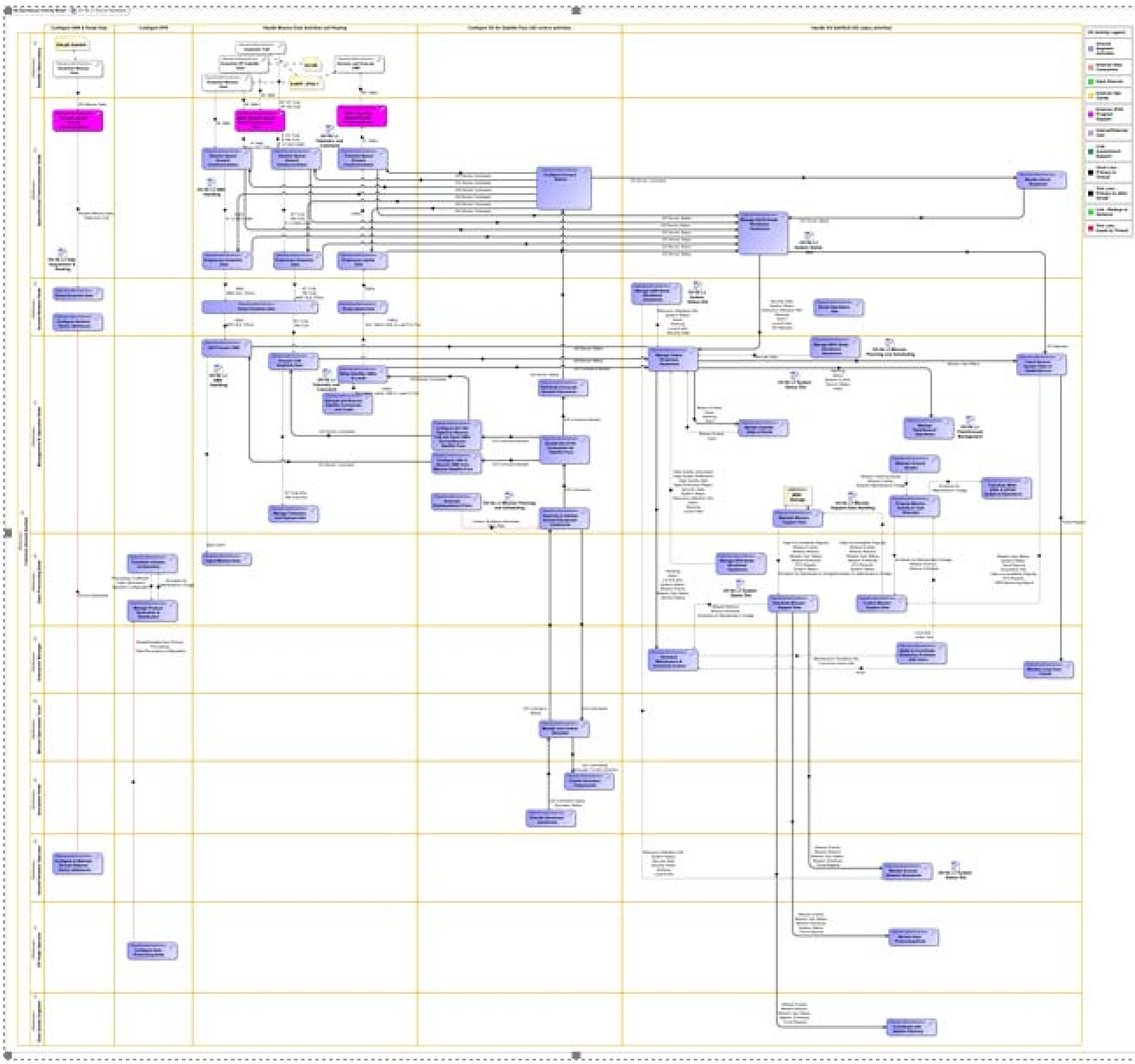
6.2.4.4 Pre-Conditions

Preconditions for GO processes include the following:

- The JPSS WAN is configured, running and ready to transport data.
- System status/Situational Awareness is able to obtain all of the necessary JPSS GS and network status information in a time to allow for necessary corrective actions to be taken such as request a retransmission or restart of a data delivery process.
- All satellite observatories meet operational expectations for their missions.

6.2.4.5 Operational Flow

The operational flow is illustrated in Figure 6.2.4-3. This diagram is an OV-5b view that ties this thread into the rest of the system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.4-3 The DoDAF OV-5b view of the GO Processes

6.2.4.6 Basic Flows

The basic data flows from the GO OV-5b view have been separated out and summarized into specific GO flows. These basic GO flows are the following:

- Operate the Ground System
- Manage the GS Health and Performance
- GS Health and Performance Metrics Calculations

For the Operate the Ground System flow, the JPSS Ground System and the GO thread must support several missions with differing levels of services. These missions include S-NPP, JPSS-1, JPSS-2, GCOM-W1, DMSP, Coriolis/WindSat, SCaN, and Metop. Table 6.2.4-4 shows the levels of support that the JPSS Ground System provides to each of these missions.

Table: 6.2.4-4 JPSS Ground System Support by Mission

Mission	Support Level	Enterprise Mgmt & GO	Space/Ground Comms	Data Routing	Data Processing	Satellite Operations
S-NPP	Full Support	Yes	Yes	Yes	xDR Level	Yes
JPSS-1/2/3/4	Full Support	Yes	Yes	Yes	xDR Level*	Yes
DMSP	Data Acquisition & Routing	Yes	Yes	Yes	No	No
Coriolis/WindSat	Data Acquisition & Routing	Yes	Yes	Yes	No	No
GCOM-W1	Data Acquisition & Routing, Data Processing	Yes	Yes	Yes	RDR only	No
SCaN Supported Missions	Data Routing	Yes	No	Yes	No	No
Metop	Data Routing	Yes	No	Yes	No	No

*B2.2 only supports RDRs for JPSS-2.

GO must configure the JPSS Ground system differently to provide these levels of service. Examples of these configuration changes per mission are provided below:

- For the S-NPP, GCOM-W1, JPSS-1/2/3/4 missions, GO configures ground system resources for full support (only VCDU delivery, AP delivery and RDR generation for GCOM-W1)
- For Coriolis/WindSat, GO configures ground system resources for data routing from the SVAL Ground station
- For DMSP GO configures ground system resources for data acquisition from the satellite/ground link and for data routing from JPSS receptors at McMurdo
- For Metop and SCaN supported missions, GO configures ground system resources for data routing only
- For a TDRS command and telemetry contact, GO must configure the JPSS equipment at WSC to receive the data and the ground network to route that data to Management and Operations Node (MON) at NSOF. GO also configures JPSS equipment at WSC to receive commands from MON and send those via TDRS to the S-NPP, JPSS-1/2/3/4 observatories.

- For a TDRS SMD contact, GO must configure the JPSS equipment at WSC to receive the JPSS-1/2/3/4 SMD and route the SMD to the JPSS SMD Hub (JSH).

Table 6.2.4-5 provides a description of each of the steps in the Operation the Ground System GO activities for each of these configurations along with the actors and the actions in that process.

Table: 6.2.4-5 Operate the Ground System GO Flow Actions

No	Actors	Actions	Notes
1	MON, MOT, FVTS	The CGS Generate and Validate Ground Equipment Commands activity receives pass plan and activity schedule information from the CGS Generate Implementation Plan activity, which gets this information from the Mission Planning and Scheduling ConOps thread. The CGS Generate and Validate Ground Equipment Commands activity takes that information and generates the ground commands for that satellite contact and/or data receipt. This activity also verifies these commands by internal checks and/or by running them against the Flight Vehicle Test Suite (FVTS) to ensure the commands are consistent with the configurations of the ground system and the satellite before sending them to the CGS Distribute and Execute Ground Commands activity. Additional ground command verification can be complete via the CGS Verify Ground CMDs activity. This activity is a MOT manual review of the ground commands. Each mission (e.g. S-NPP or JPSS-1/2/3/4) may be operated from separate operational environments such as string A or string B.	See the Mission Planning and Scheduling ConOps thread (GS-NML-020) for additional information on pass plans.
2	MON, SGCN	The CGS Distribute and Execute Ground Commands activity provides detailed scheduling information to the CGS Configure Ground Station activity at each SGCN ground station and MON. The detailed schedule information includes all required ground commands to support the Common Contact Schedule (CCS). CCS contains specific activities to configure each contact at each ground station for each mission. The CGS Distribute and Execute Ground Commands activity must support instances where back to back passes of two different satellites will occur at the same ground station antenna with as little as 20 minutes between the AOS of each satellite. This 20 minute window between AOSs of the two satellites, means the ground station including the antenna must be re-configured for the	SGCN ground stations include Svalbard, FCDAS, McMurdo & WSC

No	Actors	Actions	Notes
		second satellite AOS in as little as 5 minutes after the first satellite's termination of contact. This reconfiguration activity includes re-positioning the ground antenna and completing pre-pass configuration commanding.	
3	MON, SGCN, MOT	The CGS Configure Ground Station activity receives detailed scheduling information from the CGS Distribute and Execute Ground Commands Activity. This activity then determines the correct processing configuration for each pass and locally configures the JPSS ground system assets based on this information. Note: Antenna tracking is performed using S-NPP/JPSS-1 Two Line Element (TLE) information. GO receives confirmation of successfully executed configuration commands as well as unsuccessfully executed commands, and with State of Health (SOH) and State of Service (SOS) data provided by the SyS thread, the Data Quality Assurance thread, and the Data Accounting and Recovery thread. This SOH and SOS status will enable GO to determine if there were any unintended configuration changes that have resulted from either unsuccessful commands or due to other causes. Once this configuration is complete, the ground station will execute the satellite contact without additional operator intervention under normal operations. The CGS Verify Ground Configuration activity provides a ground configuration to CCS comparison back to the MPS, which allows the MPS to have insight to if the ground system was configured per the CCS.	See FGM GS-NML-010, and MPS GS-NML-020 ConOps threads for more information on the guidance given to the GO thread for the JPSS GS configuration.
3a	MON, SGCN, MOT, KSAT	For the S-NPP/JPSS-1/2/3/4 the CGS Configure Ground Station data activity configures the JPPS CGS ground station equipment at SVAL, FCDAS or McMurdo (JPSS SMD only) for receiving SMD and telemetry data and routing it onto the JPSS WAN Ground Network. This activity also configures the SVAL and FCDAS ground station equipment for an uplink to command the S-NPP/JPSS-1/2/3/4 satellite. Note: The JPSS CGS ground station equipment includes the SG60 Antenna at SVAL, the 4m Ka	McMurdo supports JPSS SMD only There is no JPSS CGS Ground station equipment at Troll

No	Actors	Actions	Notes
		Band Antenna at FCDAS and McMurdo MC1/MC2 Antennas. In addition, the CGS Configure Ground Station activity configures the SMD, telemetry and commanding supporting equipment at MON (JSH, DCP, DTG & CEP). The KSAT Configure Ground Station activity captures the KSAT responsibility for configuring the S-NPP (SG3 & SG4) and JPSS (SG22) SVAL Antennas and JPSS Troll ground station equipment (including TR2 antenna) that is under their control.	
3b	SGCN, KSAT	For the Coriolis/WindSat mission, the CGS Configure Ground Station data activity does not configure ground station equipment because this function is performed by the KSAT Configure Ground Station activity for these missions. KSAT also routes the SMD onto the JPSS WAN Ground Network.	
3c	SGCN, MOT	For the DMSP missions, the CGS Configure Ground Station data activity configures the JPSS ground station equipment at McMurdo for receiving data from their satellites and routing it onto the McMurdo Multi-mission LAN.	
3d	External	The Metop, and SCaN supported missions use ground receptors that are external to JPSS, so the GO thread does not configure equipment at those ground stations.	
3e	MON, SGCN, MOT	The GCOM-W1 mission uses the KSAT SG-25 and SG-3 antenna at Svalbard that are external to JPSS, so the GO thread does not configure RF equipment. However, the CGS Configure Ground Station activity does configure JPSS CGS equipment at Svalbard for receiving the GCOM-W1 SMD from KSAT as the IF signal, processing it, and routing it onto the JPSS WAN Ground Network. In addition, the activity configures the SMD supporting equipment at MON (JSH).	
3f	MON, SGCN, MOT	For the TDRS contacts, the CGS Configure Ground Station activity configures the JPSS ground station equipment at the WSC for receiving data from S-NPP and JPSS satellites and routing it the CGS.	TDRS supports JPSS SMD only

No	Actors	Actions	Notes
		For the telemetry and commanding portion of the S-NPP and JPSS missions, the CGS Configure Ground Station data activity configures JPSS ground station equipment at WSC to receive commands from the CGS MON and transmit them to the S-NPP/JPSS-1/2/3/4 satellite via a TDRS satellite. The activity also configures MON equipment for receipt for telemetry and clear and/or encrypted commanding. For the receipt of SMD portion of the CGS Configure Ground Station activity configures the JPSS ground station equipment at WSC to receive data from the JPSS satellites via a TDRS satellite. The activity also configures the SMD equipment at MON (JSH) to process and forward that data to the CGS DPN.	
4	GNN	The CGS Configure Network Routing activity configures the GNN equipment to support operations per the specifications. The GO thread does not configure GNN on a per-contact nor per-mission schedule. The GNN configuration is created once for each mission or until the network configuration changes either due to an upgrade or after a fault. In the case of an upgrade or fault the CGS Manage Ground Networks activity will update configurations on the GNN equipment. In addition this activity can be used to support anomaly resolution and GNN system monitoring.	
4a	GNN	For the S-NPP/JPSS-1/2/3/4 missions the CGS Configure Network Routing activity configures the JPSS ground network and equipment at SVAL, FCDAS, Nittedal (JPSS Only) and McMurdo (JPSS Only) for receiving SMD and telemetry data onto the JPSS WAN and routing the data to the MON. The CGS Configure Network Routing activity also configures the JPSS ground network equipment and the JPSS WAN to send commands from the MON to SVAL, FCDAS and Troll (JPSS Only) ground stations. Finally, the CGS Configure Network Routing activity routes the SMD data from the JPSS SMD Hub (JSH) at MON to the DPN at NESDIS.	Nittedal is the CGS Network Interface point to the Troll ground station that operated and managed by KSAT

No	Actors	Actions	Notes
		Note: Telemetry data is processed at MON.	
4b	GNN	For the Coriolis/WindSat mission and SCaN supported missions, the CGS Configure Network Routing activity configures the ground network and equipment at SVAL or FCDAS for receiving data onto the JPSS WAN and routing it to their service delivery points (SDPs). The SCaN SDPs is at GSFC, and the Coriolis/WindSat SDP is at the NSOF in Suitland Maryland.	The routing of the data from the SDPs to the processing centers for those missions is outside the scope of JPSS.
4c	GNN	For the DMSP and Metop missions, the CGS Configure Network Routing activity configures the McMurdo Multi-mission LAN, and the JPSS WAN to route each mission's data to their SDP. The NSF configures the NSF Microwave Relay that is also in the link. The SDP for each mission is provided below: DMSP: 557th WW Metop: Central Application Facility (CAF) at EUMETSAT in Darmstadt, Germany. The CGS Configure Network Routing activity does not route data beyond the SDPs for these missions.	
4d	GNN	For S-NPP and JPSS Mission TDRS command & telemetry contacts, the CGS Configure Network Routing activity configures the JPSS ground network and equipment at WSC for receiving telemetry data from the source satellite and routing it the MON. This activity also configures the JPSS ground network equipment and the JPSS WAN to send commands from MON to the WSC ground station. For JPSS Mission TDRS SMD contacts, the CGS Configure Network Routing activity configures the JPSS ground network and equipment at WSC for receiving SMD data onto the JPSS WAN and routing the data to MON Finally, the Configure Network Routing activity routes the JPSS Mission SMD data from the JPSS SMD Hub (JSH) at MON to DPN at NESDIS. Note: Telemetry data is processed at MON	TDRS supports JPSS SMD in a contingency operations mode.
4e	GNN	For the GCOM-W1 mission the CGS Configure Network Routing activity configures the JPSS ground network and equipment at SVAL for receiving SMD data onto the JPSS WAN and routing the data to the JSH at MON.	

No	Actors	Actions	Notes
		The CGS Configure Network Routing activity also routes the GCOM-W1 SMD data from the JSH at MON to DPN at NESDIS.	
5	MON, DPN	The DPN processing is data driven based on the configuration files that included in the DPN software created by the System Maintenance and Upgrade ConOps thread. Therefore, the DPN automatically determines the correct data processing for each mission based on that mission's requirements as defined in the configuration files.	
5a	DPN	For S-NPP/JPSS-1, DPN performs xDR level processing and data distribution based on the configuration files for S-NPP/JPSS-1 data. For JPSS-2 in B2.2, DPN performs RDR level processing and data distribution to GRAVITE to support JPSS-2 compatibility tests up to JCT-2. (in B2.2) Nominal configuration updates includes loading of LUTs and PCTs.	
5b	DPN	For GCOM-W1, DPN performs RDR level processing and data distribution based on the configuration files for GCOM-W1.	Typically, this distribution provides for GCOM-W1 RDRs to the ESPC and CLASS.
5c	DPN	JPSS does not perform data processing for DMSP, Coriolis/WindSat, SCaN supported missions, or Metop.	

Table 6.2.4-6 provides a description of each of the steps in the Monitor Health and Performance GO flow along with the actors and the actions in that process. The primary process for GO is to monitor the health and performance status of the GS. This Monitor Health and Performance Status activates continues 100% of the time of the JPSS missions. All of the steps in this process are performed continuously and not in a specific order. If a fault is determined, and GO can resolve or mitigate the issues through routine operations based on SOPs, then GO will resolve the issue. Examples of mitigation activities performed by GO are also provided in Table 6.2.4-6.

Table: 6.2.4-6 Manage the GS Health and Performance GO Flow Actions

No	Fault/Actors	Actions & Routine Mitigations	Notes
1	MON, MOT	GO utilizes the System Status/Situational Awareness thread's CGS Manage Global Situational Awareness activity that receives the overall Ground System SOH and SOS. This activity analyzes current system SOH and SOS information and provides hierarchical SOH and SOS situational awareness to the EMOC, GNO, OSPO Management, and IDP Operator	For additional information on SOH and SOS information, see the System Status/Situational Awareness ConOps thread, GS-NML-300

No	Fault/Actors	Actions & Routine Mitigations	Notes
		workstations. Trending analysis of SOH and SOS information, to identify potential future issues, is completed by the CGS Trend Ground System State of Health/Service Activity. The information provided includes SOH, configuration, and AWE information of each of the JPSS nodes. AWE information can result in a two-way escalating page to be sent to someone that is not at the operational facility (off-site). If an AWE message is configured to generate a page, then the recipient must respond to the page within a given time period or the page will be sent to an alternate person or a more senior manager. As part of the CGS Manage Global Situational Awareness activity, operators must log into a GS workstation to gain access to GS applications and SOH information. The capabilities that the operator has to read SOH/SOS status and command the JPSS GS are determined by the privileges assigned to that operator's login. The CGS Manage Global Situational Awareness activity provides off-site authorized personnel access to SA data through a secured web server that is located outside of the NOAA5042 security boundary, to which the SA data is pushed to through a one-way connection. The CGS Manage Global Situational Awareness activity provides the capability for these operators to look at individual unit's or software process' status, and to set filters for the data presented. Filters can be used to limit the types of data presented either by equipment type, node, or function such as hardware or software. Filters can also be used to set thresholds for when out of tolerance conditions create alarms on their workstations and what types of alarms are created. In addition, the CGS Manage Global Situational Awareness provides each operator with the ability to access log files and apply these filters to select relevant data for each JPSS node to view the history of this information. If a GO identifies a routine SOH problem to the JPSS Ground System operator that can be addressed by a routine ground system action, then GO will perform the routine	

No	Fault/Actors	Actions & Routine Mitigations	Notes
		operation such as switching to a back-up workstation. Routine corrective actions can also be performed by automated sequences or scripts. These scripts can be executed automatically based on system threshold or via operator initiation. Examples of routine ground operations restoral or mitigation of service are provided in steps 1a and 1b of this flow. If the SOH issue cannot be addressed by a routine operation, GO sends this information to the System Fault Analysis ConOps thread.	
1a	Temporary Loss of Sensor Data MON, MOT, SGCN, GNN	If SMD is not being received by the JPSS Ground System DPN, the CGS Manage Global Situational Awareness activity will provide relative SOH/SOH information to GO to perform corrective actions via the CGS Schedule Maintenance & Corrective Actions activity. Data Restoration Actions: • If the loss of data is due to downlink problems, then see step number 1b in this flow. • If the problem is from the ground station to NSOF, then resend data from ground station. If extended outage, recover stored data at Ground Station once network link restored. • If the problem is from the satellite to the ground station, have the satellite re-transmit data to the same or an alternate ground station (for JPSS-managed satellites only) Processing node actions as a result of loss of data • Continue to generate products based on available science data • If data is recovered, then DPN will process recovered data to create missing science products.	
1b	Ground (Downlink Receptor or Uplink) Fails MON, MOT, SGCN, MPS	If the Downlink has failed, the CGS Manage Global Situational Awareness activity will provide relative SOH/SOH information to GO to perform corrective actions via the CGS Schedule Maintenance & Corrective Actions activity: • Re-plan for alternate site • Request retransmit of data from the satellite at back-up site • CGS creates science products from retransmitted data	See the Mission Planning and Scheduling ConOps thread (GS-NML-020) for additional information re-planning

No	Fault/Actors	Actions & Routine Mitigations	Notes
		• Send out mission notices as appropriate If the uplink has failed, GO will initiate the following: • Re-plan for alternate site or TDRS if no back-up exists • Re-plan for primary ground station after uplink has been restored • Send out mission notices as appropriate	
2	MON, MOT	GO utilizes the System Status/Situational Awareness thread's CGS Manage Global Situational Awareness activity that receives the overall Ground System SOH/SOS and satellite SOH (when applicable). From this information, this GO makes determinations about the ability of the JPSS ground system to support operations for planned missions. This information is provided back to FGM for potential impacts on mission scheduling. An example of a mitigation activity for a satellite issue is provided in step 2a of this flow.	For additional information on satellite SOH information, see the Command & Telemetry ConOps and Space Operations threads
2a	Spacecraft goes into Safe Hold or Spacecraft goes into Earth or Sun Pointing mode MON, MOT	If the spacecraft goes into safe-hold, the CGS Manage Global Situational Awareness activity will provide relative SOH/SOH information to GO to perform corrective actions via the CGS Schedule Maintenance & Corrective Actions activity: • Collect RT and Play back telemetry • Stop science data processing • Generate mission notices as appropriate Downlink any available SMD that has not been transmitted as soon as the spacecraft is determined to be in a thermally and power safe state.	
3	MON, GNN, MOT	The CGS Manage Global Situational Awareness activity provides the MOT with SOH information of the JPSS networks including data completeness, bad packets, packet loss, latency, and network hardware status. This information is provided by the System Status/Situational Awareness ConOps thread. The CGS Manage Global Situational Awareness activity provides the capability for GNO & EMOC to look at individual unit's or software process' status, and to set filters for the data presented. Filters can be used to limit the types of data	

No	Fault/Actors	Actions & Routine Mitigations	Notes
		presented either by equipment type, node, or function such as hardware or software. Filters can also be used to set thresholds for when out of tolerance conditions create alarms on their workstations and what types of alarms are created. In addition, the CGS Manage Global Situational Awareness activity provides the GNO and EMOC with the ability to access Ground Network node local log files and apply these filters to select relevant data for each JPSS node to view the history of this information. Based on this information, the GNO may take action to correct network problems and/or forward issues to Manage Ground System Services depending on the type and severity of the problem. An example, of a mitigation action by the GNN is provided in step 3a of this flow.	
3a	Transatlantic Network cut MON, GNN, MOT	If the GNN reports status that the transatlantic link has been cut, then, the CGS Manage Ground Network activity will request the following corrective actions via the CGS Schedule Maintenance & Corrective Actions activity. Data Restoration Actions: • Select the back-up communications link between SVAL and the Service Delivery Point (SDP) • If the back-up communications link is unavailable, provide that status to the CGS Manage Global Situational Awareness activity, and that activity will schedule the use of an alternate ground station through the CGS Schedule Maintenance & Corrective Actions activity.	
4	DPN, MOT	The CGS DPN Nodal Situational Awareness activity provides the IDP Operator workstation with SOH information of the data processing node including failed hardware, software process status, product creation status, and product delivery status. This information is provided to Manage Data Processing by the System Status/Situational Awareness ConOps thread.	

No	Fault/Actors	Actions & Routine Mitigations	Notes
		The CGS DPN Nodal Situational Awareness activity provides the capability for IDP Operator to look at individual unit's or software process' status, and to set filters for the data presented. Filters can be used to limit the types of data presented either by equipment type, node, or function such as hardware or software. Filters can also be used to set thresholds for when out of tolerance conditions create alarms on their workstations and what types of alarms are created. In addition, the CGS Manage Global Situational Awareness activity provides the IDP Operator with the ability to access Data Processing node local log files and apply these filters to select relevant data for each JPSS node to view the history of this information. Based on this information, the IDP Operator may take action to correct IDP processing problems and/or forward issues to Manage Ground System Services depending on the type and severity of the problem.	
4a	MON, MOT, DPN Significant Processing Node Fault	After a significant data processing fault, the CGS Manage Global Situational Awareness activity will provide relative SOH/SOH information to GO to perform CGS Corrective Actions activity will perform the following: • Restart the affected DP node (Warm or Cold Start) • Resend data from MON for the science products lost during the restart • Produce missing science products • Resume normal processing Send out mission notices as appropriate	
4b	MON, MOT, DPN Back End Interface Fault to CLASS, ESPC, and GRAVITE	If the DP equipment has a fault as reported by SyS, then the CGS Manage DPN Nodal Situational Awareness activity will request the following corrective actions via the Schedule Maintenance & Corrective Actions: • Restore DP service • Resend missing data • Send out notifications as appropriate If the fault is in the ESPC, GRAVITE, or CLASS equipment, the following actions are performed:	

No	Fault/Actors	Actions & Routine Mitigations	Notes
		• User isolates the fault at their end • User corrects their equipment • User re-requests missing data from DP or CLASS • User resolves any duplicate data	
5	MON, MOT	The CGS Trend Ground System State of Health/Service activity collects Mission Ops Status, System Status, service status and Resource Utilization Info from the CGS Manage Global Situational Awareness activity. The CGS Trend Ground System State of Health/Service activity creates trend reports based on current and recent SOH and SOS information from JPSS Ground System nodes hardware and software processes. The activity looks at SOH and SOS data history and looks for trends in the data that have not yet resulted in an operational problem, but will likely result in a problem if no action is taken. These issues are passed to the CGS Schedule, Maintenance, & Corrective Actions activity in the alternate Restore GS operations activities for potential corrective action. The mitigation activities for a long-term trend issue would be similar to the other mitigations activities is sections 1 through 4 of this flow.	

Table 6.2.4-7 provides a description of performance metrics that are calculated by GO for data availability, data latency, and operational availability.

Table: 6.2.4-7 GS Health and Performance Metrics Calculations

No.	Fault/Actors	Actions & Routine Mitigations	Notes
1	SGCN, MON, GNN, DPN, MOT, SIM, Cal/Val Node	MON will collect the data availability and data latency from each JPSS nodes, and MON will compute the overall data availability and data latency of the JPSS ground system for sliding window periods of 30 days. SyS will provide these reports at least on a daily basis.	Track Mission Dataflow activity

6.2.4.7 Alternate Flows

As previously stated, the Monitor Health and Performance Status process continues 100% of the time of the JPSS missions. If an event occurs such as a system problem, an update to the ground system, or a security incident; then GO supports alternate flows concurrently with the Monitor Health and Performance Status activity to address these events. The following are the alternative flows supported by GO:

- Restore Ground Operations
  - Using Routine Standard Operating Procedures (SOPs)

- Coordinating with SMU to resolve routine maintenance issues

- Support System Updates

If a problem occurs in the Monitor Health and Performance Status process, then the alternate Restore Ground Operations flow starts concurrently with the Health and Performance Status process. Table 6.2.4-8 provides a description of each of the steps in the Restore Ground Operations flow along with the actors and the actions in that process. Note that the GO ConOps thread does not trouble shoot problems in the JPSS Ground System nor does it determine the corrective action. These functions are performed by the See the System Fault Analysis ConOps Thread (GS-NNL-130) and the System Maintenance & Upgrade ConOps Thread (GS-NNL-140) respectively.

Table: 6.2.4-8 Restore Ground Operations Flow Actions

No	Actors	Actions	Notes
1	MON, MOT	GO utilizes the System Status/Situational Awareness thread's CGS Manage Global Situational Awareness activity that receives the overall Ground System SOH and SOS. This activity reviews the JPSS Ground System SOH and determines if an issue exists with equipment SOH that requires corrective action. If so, then this activity forwards the JPSS Ground System SOH status and any related AWE to the CGS Schedule Maintenance & Corrective action activity in the System Fault Analysis ConOps thread to determine what if any corrective action is needed.	See System status/Situational Awareness GS-NML-300 to determine how status information is collected.
2	MON, MOT	GO utilizes the System Status/Situational Awareness thread's CGS Manage Global Situational Awareness activity that receives the overall Ground System SOH and SOS. This activity reviews the JPSS Ground System SOS and determines if an issue exists that affects the ability of the JPSS Ground System to perform its required mission services. If so, then this activity forwards the JPSS Ground System service issue and any related AWE to the CGS Schedule Maintenance & Corrective action activity in the System Fault Analysis ConOps thread to determine what if any corrective action is needed.	
3	MON, MOT	Once it receives fault information, the System Fault Analysis ConOps thread performs fault analysis to determine the appropriate corrective action. This corrective action can be one of the three following types: 1. The Ground System can be restored through normal GO actions using SOPs. This is described in row 3a of this flow.	See the System Fault Analysis ConOps Thread (GS-NNL-130) to determine how corrective actions are determined

No	Actors	Actions	Notes
		2. The Ground System can be restored through hardware or software maintenance activities. This is described in row 3b of this flow. 3. The Ground System can only be restored through hardware or software design updates. This is described in next alternate GO thread flow called Support System Update.	
3a	MON, MOT	If the System Fault Analysis ConOps thread determines that the JPSS Ground System can be restored by GO using SOPs, then GO will restore the JPSS Ground System to an operational state using the SOP and send out the appropriate mission notices. Examples of this type of corrective action are provided in table 6.2.4-5.	See the System Fault Analysis ConOps Thread (GS-NNL-130) to determine how corrective actions are determined
3b	MON, MOT	If the System Fault Analysis ConOps thread determines that the JPSS Ground System can be restored through a software or hardware maintenance action such as replacing a server, the System Maintenance & Upgrade (SMU) ConOps thread determines what the detailed maintenance action should be. If the maintenance action can be performed without impacting the JPSS GS operations, (e.g. replacing a monitor) then the SMU thread works with GO to implement the maintenance action. If the maintenance action will impact the performance of the JPSS GS while it is being implemented, then the action will be scheduled through the Mission Planning & Scheduling ConOps thread. When the corrective action is scheduled, then GO supports the implementation of the corrective action on either the operational string or the back-up I&T string for check out while running in parallel with the operational string. If the implementation is on the back-up I&T string, then GO will support the transition of the back-up I&T string to the operational string once the check-out is complete. GO will also send out a mission event notice once the ground system is fully restored.	See the System Fault Analysis ConOps Thread (GS-NNL-130) to determine how corrective actions are determined and the System Maintenance & Upgrade thread (GS-NNL-140 to determine maintenance actions are implemented.

When a maintenance or upgrade activity is requested by the System Maintenance & Upgrade ConOps thread requires loading of Processing Coefficient Tables (PCTs) or Look Up Tables (LUTs) on the ground system, then GO must coordinate with Mission Planning and Scheduling to determine when to load these tables. In addition, GO must notify external users when this

action will take place. Table 6.2.4-9 provides a description of each of the steps in the Support System Update GO flow along with the actors and the actions in that process.

Table: 6.2.4-9 Support System Update GO Flow Actions

No	Actors	Actions	Notes
1	MON, MOT, DPN	For loading tables such as, Processing Coefficient Table (PCT) or Look-Up Table (LUT) updates, the System Maintenance & Upgrade ConOps Thread requests the time from the CGS Manage Product Generation & Distribution activity to load the tables. GO implements PCT and/or LUT upload at the time provided by Mission Planning and Scheduling. PCT and/or LUT uploads can be performed on the operational string or the back-up ground processing string.	See the System Maintenance & Upgrade ConOps Thread (GS-NNL-140) for more information on how upgrades are performed.

6.2.4.8 Post-Condition

This thread describes ongoing operations; the only Post Condition is that the Ground System is sufficiently monitored and configured to support all Ground Operations.

6.2.4.9 Related Threads

The ConOps threads listed below provide background information for the GO thread. Review of these will help in the understanding of the GO thread activities.

Thread ID	Thread Title
JPSS ConOps Threads that are related to GO	
GS-NML-100	Stored Mission Data Handling
GS-NML-180	Data Acquisition and Routing
GS-NNL-130	System Fault Analysis
GS-NML-220	Security
JPSS ConOps Threads that directly interface to GO	
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning & Scheduling
GS-NML-030	Space Operations
GS-NML-130	Data Accounting and Recovery
GS-NML-140	Mission Support Data Handling
GS-NML-150	Cal/Val of Data Products
GS-NML-300	System Status/Situational Awareness
GS-NNL-120	Continuity of Operations
GS-NNL-140	System Maintenance & Upgrade
GS-FTS-140	Direct Broadcast Quality Monitoring

6.2.4.10 Child Threads

The OpsCon threads listed below are the Level 4 threads that directly flow down from this Level 2/3 GO thread.

Thread ID	Thread Title
CGS-010-010	Ground Operations
CGS-030-040	Fault Detection & Recovery

6.2.5 Integrated Support

6.2.5.1 Description

This Integrated Support thread (GS-NML-400) describes the mission support efforts that the Joint Polar Satellite System (JPSS) Ground System (GS) provides. The support efforts include those activities that are necessary for the operation of the JPSS GS but are not performed by the CGS nor are they critical to real-time delivery of JPSS products or services. These efforts include the following:

1. **Documentation Maintenance:** Maintenance of support documentation. Support documentation includes design documentation and operations documentation (e.g. Standard Operating Procedures (SOPs)).
2. **Operator Training & Certifications:** Training of operations personnel is required when significant changes become effective, when new staff is added, and when critical documentation (e.g. SOPs) has significant updates.
3. **Support Systems**: Implementation and support for tracking and reporting systems such as, the Work Request System (WRS), the Discrepancy Reporting (DR) System, the Common Configuration Management (CM) System, the Data Product Engineering and Support (DPES) CM system supporting both Cal/Val and Field Terminal Support Nodes, and the Simulation Node CM system. Any changes to the JPSS GS configuration resulting from Work Requests (WRs) or DRs will be reviewed at an Operations Configuration Control Board (OCCB). Representatives from all affected parts of the JPSS GS are invited to attend the OCCB. As a result, the OCCB provides a notification of any changes to the JPSS GS among all of the affected organizations. Additional coordination for the implementation of these changes is provided by the System Maintenance & Upgrade (SMU) thread.
4. **Centralized Data Format Management:** For JPSS-managed satellites, the JPSS Ground System utilizes a common structure for databases to be used throughout the ground system. This encompasses the mission-specific Command and Telemetry (C&T), memory architecture and table description, and data product generation databases. The managed content includes the structures and definitions of the data formats. Compared to the documentation-based approach, the centralized data format management significantly shortens the cycle of data format and configuration changes and reduces human introduced error.
5. **Enterprise Asset Management:**

These efforts are the basic flows for integrated support. These flows are further described below:

1. **Documentation Maintenance:** There are hundreds of SOPs and Recommended Operating Procedures (ROPs) that are used by ground and space operations personnel to operate the JPSS Ground System and the JPSS controlled satellites. In addition, there are

hundreds of ground systems and satellite design documents that the ground and space operations personnel rely on in order to maintain the ground system and the satellite. The third type of document that is used by operations personnel are configuration documents. Configuration documents provide specific versions hardware and software on the JPSS Ground System and settings for those items. Settings include router configurations and access control lists (ACLs).

SOPs and ROPs are managed by the Mission Operations Team (MOT)/Mission Operations Support Team (MOST) based on input from the CGS Support Node, the Instrument Vendor or the Spacecraft Support Node (SSN). Design documentation is directly provided by the CGS Support Node, the Instrument Vendor, and the SSN. The operations staff sets up the JPSS Ground System configurations and provides this information to the MOT.

These documents must be both readily available and current to the latest revision for the ground and satellite operations team to be effective in diagnosing and correcting problems as quickly as possible. For the documentation to be readily available it must be well organized and locally available to the ground and satellite operations teams. The Integrated Support ConOps thread is responsible for ensuring that the all of these objectives are met for the life of the JPSS Ground System.

2. **Operator Training & Certifications:** As the JPSS Ground System changes and new operators are added to the ground and satellite operations staff, the existing operator's training and certifications will need to be kept current and the new operators will need to be trained and certified for their positions. The Integrated Support ConOps thread is responsible for tracking the status of operations staff training levels, coordinating with the ground system and satellite vendors to develop training material, and providing training to ground system and satellite operators. Training material can include written material, on-line computer based training, and training with simulators.

3. **Support Systems:** The Integrated Support ConOps thread is responsible for ensuring that the support systems that the JPSS Ground System needs to continue operations are in place and operating effectively. These support systems include the, the Work Request System (WRS), the Discrepancy Reporting (DR) system, and the Common Configuration Management (CM) System.

   - **WRS:** The WRS is used to request many different types of actions. These include everything from setting up system accounts to implementing a software change on the ground system. A Work Request (WR) is used to request an action on the WRS. Approval for WRs is through one of three Work Request Review Panels (WRRPs). The three WRRPs are the following:

   1) **The C3S WRRP:** This WRRP reviews, adjudicates, and approves WRs that are related to the C3S hardware & software part of the CGS.

   2) **The IDPS WRRP:** This WRRP reviews, adjudicates, and approves WRs that are related to the IDPS hardware & software part of the CGS. It also reviews, adjudicates, and approves IDPS operational products such as SOPs and Work Instructions (WIs).

3) **The Product WRRP:** This WRRP reviews, adjudicates, and approves operational products (PROCs) that are submitted to the MOT CM for operational use.

   – Integrated Support ConOps thread is responsible for ensuring that the WRS system is operational, the correct users have accounts, and the WRRP system is reviewing, prioritizing, tracking, and closing WRs.

- **DR System:** The DR system is used to captures unresolved issues and anomalies in the JPSS Ground System and JPSS controlled satellite. DRs can be submitted by anyone using a form, but the final entry into the DR system requires an account on the DR system. The DR Review Board (DRB) reviews, prioritizes, tracks, and closes DRs. Integrated Support ConOps thread is responsible for ensuring that the DR system is operational, the correct users have accounts, and the DRB is reviewing, prioritizing, tracking, and closing DRs.

  The DR System is provided by the Ground Project, and is not part of CGS.

- **Common CM System:** The Common CM System is used to maintain and control the latest versions of the ground software and the Processing Coefficient Tables (PCTs) and Look-Up Tables (LUTs) that are used in ground data processing by the DPN. In addition, proposed changes to the algorithms are submitted to the Common CM system through Proposed Change Requests (PCRs). The CM System provides user accounts that enable users to request the currently baselined software, to request changes to that software, and for the users to track the status of those changes. Final approval of these changes comes from the OSPO Configuration Change Control Board (OSPO CCB). The Integrated Support ConOps thread provides the following CM System functions:

  - Maintains the Common CM System
  - Ensures that it keeps a repository of the JPSS software that is accessible by authorized users.
  - Uses the Common CM to ensure that the JPSS GS maintains a configuration baseline for all hardware and software in the JPSS GS.

4. **Centralized Data Format Management:** For the centralized management of data formats, the Ground System provides a repository, tools and processes. The repository is stand-alone, outside of CGS and the operational 5042 security boundary. It can be accessed by the operations CM, CGS Support Node, and externals such as the Space Support Node and Instrument Support Node(s). The tools enable import, export, editing, displaying reporting, and publishing the contents of the repository and provide version control. Updates to the repository are governed by approval boards, guided by CM processes, and once approved and deployed, propagated through the systems.

5. **Manage Enterprise Assets:** The Ground System provides a tool for deployment, tracking, and management of CGS hardware and software assets.

6.2.5.2 Primary Interfaces

Figure 6.2.5 -1 illustrates the internal and external interfaces JPSS Ground System interfaces that are used by the Integrated Support ConOps thread. These include interfaces to CLASS,

GRAVITE, FVS/FVTS (B2.0), FVS/J1Sim/FSE (B2.2), and authorized users of WRS, DRS, centralized data format repository, and the Common CM system.

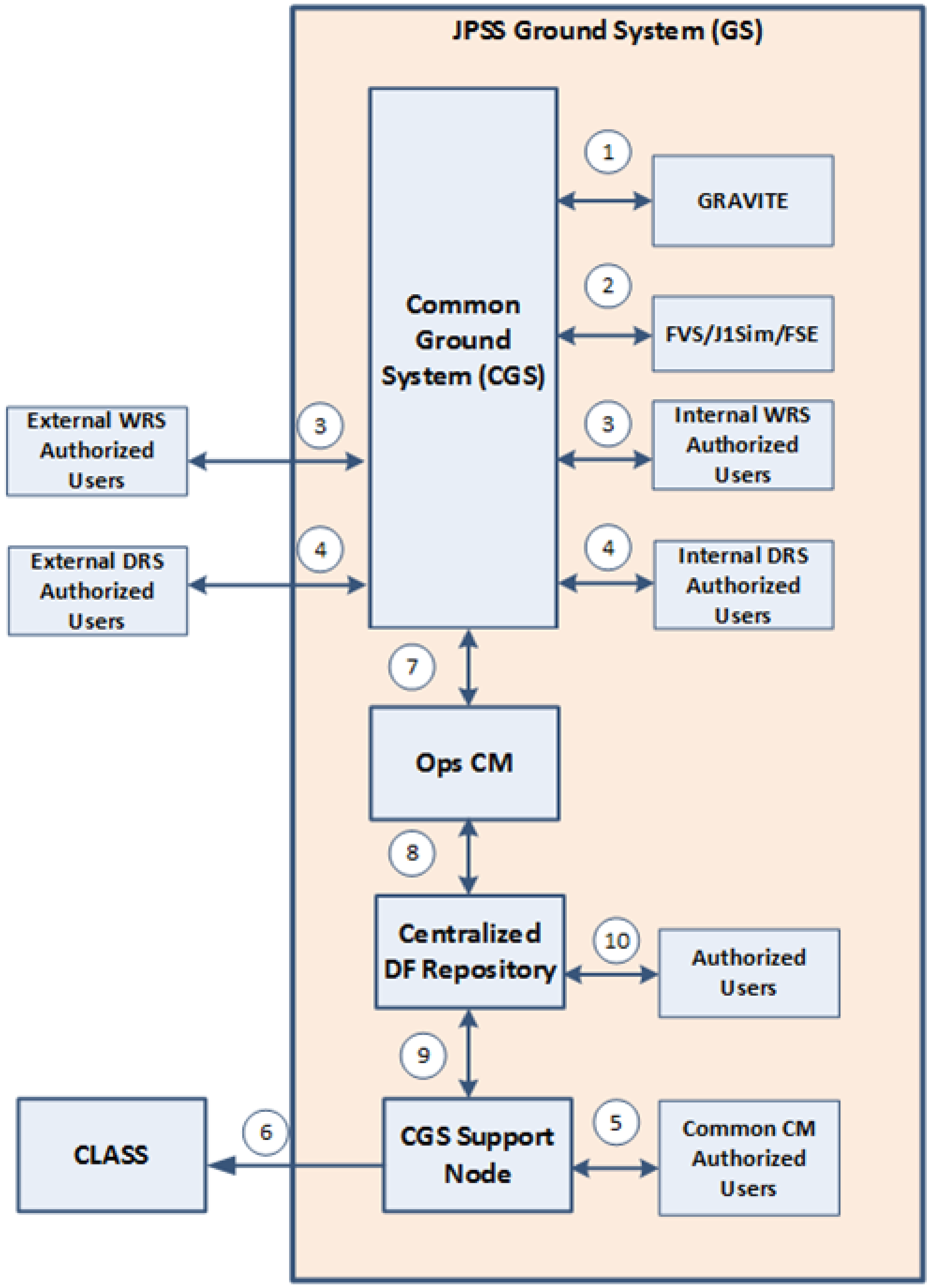


Figure: 6.2.5-1 Integrated Support Primary Interfaces

Each interface in Figure 6.2.5-1 is labeled with a number and defined in Table 6.2.5-1 with types of interface, actors, and purpose of the interface. Table 6.2.5-2 provides the relevant IRDs and/or ICDs for those interfaces.

Table: 6.2.5-1 Integrated Support Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	GRAVITE, CGS	Notification of GRAVITE upgrade or maintenance that will prevent GRAVITE from ingesting science data products. This communication is done through a series of non-system communications such as e-mails, phone calls, and meetings.
2	Internal	FVS/J1Sim/FSE (B2.2), CGS	Notification of FVS/J1Sim/FSE (in B2.2) upgrade or maintenance that will prevent FVS/J1Sim/FSE (in B2.2) from being able validate satellite commanding. This communication is done through a series of non-system communications such as e-mails, phone calls, and meetings.
3	External	CGS, WRS users	WRs and status of those WRs
4	External	GS, DRS users	DRs and status of those DRs
5	External	CGS Support Node and Common CM users	Requests for baseline software, proposed software changes, and status of those changes
6	External	CSN, CLASS	Data Processing Node (DPN) software update/release packages (including documentation and table updates)
7	Internal	CGS, Ops CM	CM'ed C&T DB, memory architecture and data formats in XML (manual file transfer within Ops CM))
8	Internal	Ops CM, Data Format Repository	CM'ed C&T DB, memory architecture and data formats in XML
9	Internal	CSN, Data Format Repository	CM'ed C&T DB, memory architecture and data formats in XML
10	External	Authorized Users, Data Format Repository	ECR/CCR, C&T DB, memory architecture and data formats

Table: 6.2.5-2 Support Primary Interface Documentation

No.	IRD/ICD
1	N/A
2	N/A
3	Work Request System (WRS) User's Manual JPSS CGS Service IDD
4	DRS User's Manual
5	Common CM User's Manual JPSS CGS to CGS Support Node IRD JPSS CGS to CGS Support Node ICD
6	JPSS GS to CLASS IRD JPSS CGS to CLASS ICD

No.	IRD/ICD
7	Operations procedures
8	Operations procedures
9	CGS Internal Services ICD
10	Command and Telemetry Update Process (CTUP), FSW and Table Update Delivery Process (FUDP), Spacecraft and instrument table description documents, MDFCB and CDFCB, JPSS CGS Services IDD

6.2.5.3 Assumptions & Constraints

The following assumptions are made for the successful performance of integrated support functions:

- Integrated Support will have access to all operations and design documentation necessary to support JPSS missions. Intellectual property rights or security issues that may prevent access to documentation can be resolved.

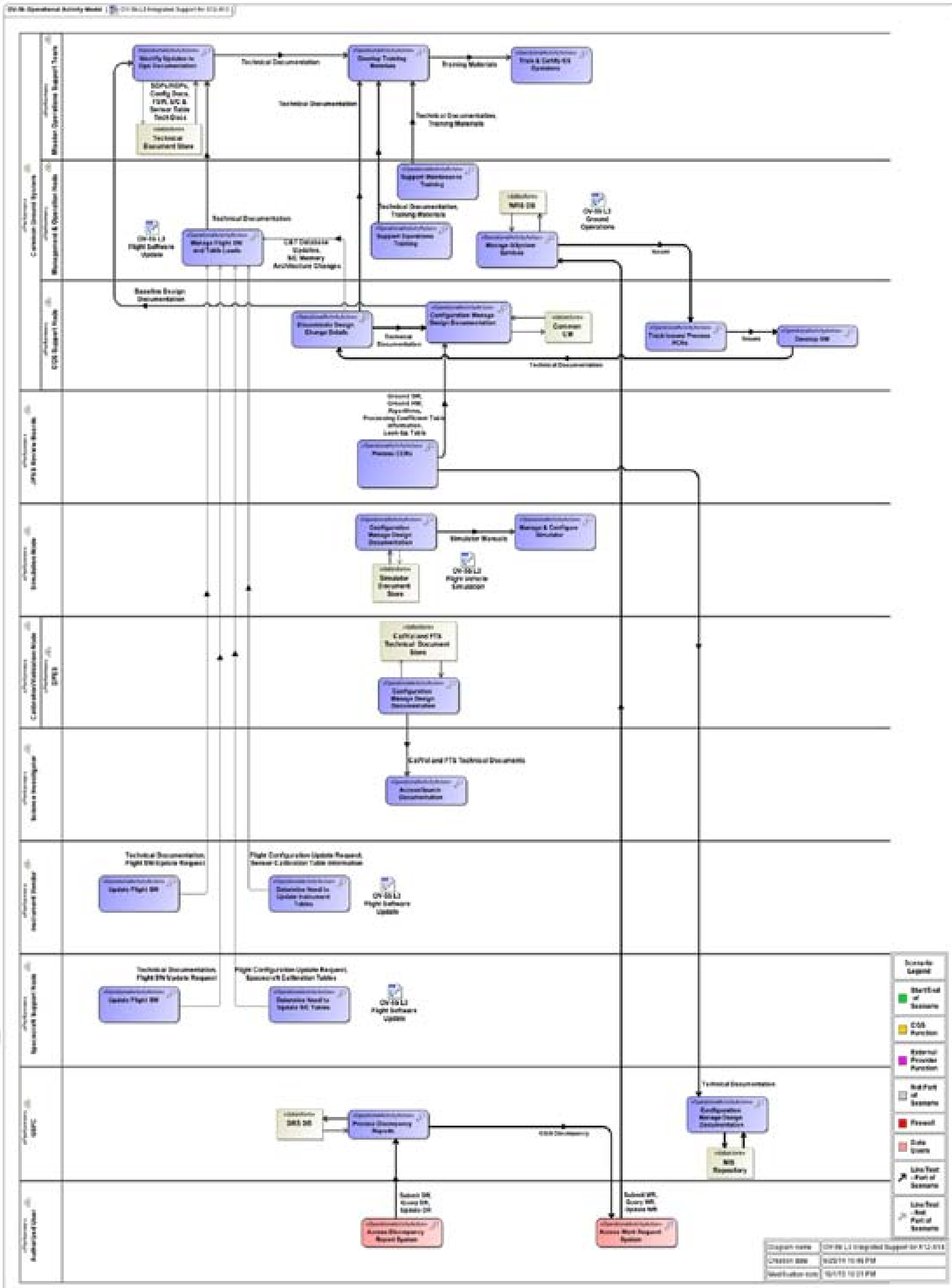
6.2.5.4 Pre-Conditions

Preconditions for Integrated Support processes include the following:

- The NSOF has sufficient physical and electronic storage space and security systems in place to allow for local storage of operational and design documentation.
- All of the existing JPSS satellite and ground system design documentation has been collected and stored locally at the operations facilities.
- JPSS CM agrees to notify the OSPO when updated design documents are under JPSS CM control.
- The spacecraft and instrument vendors are contracted to provide support for development of operator training and certification material.
- The processes for WRRPs, DRBs, and CCBs are agreed to by NASA and NOAA as part of the transition from JPSS operations to NOAA operations.
- The agreed to WRRPs, DRBs, and CCBs along with their supporting systems are in place at the time the ConOps becomes effective.

6.2.5.5 Operational Flow

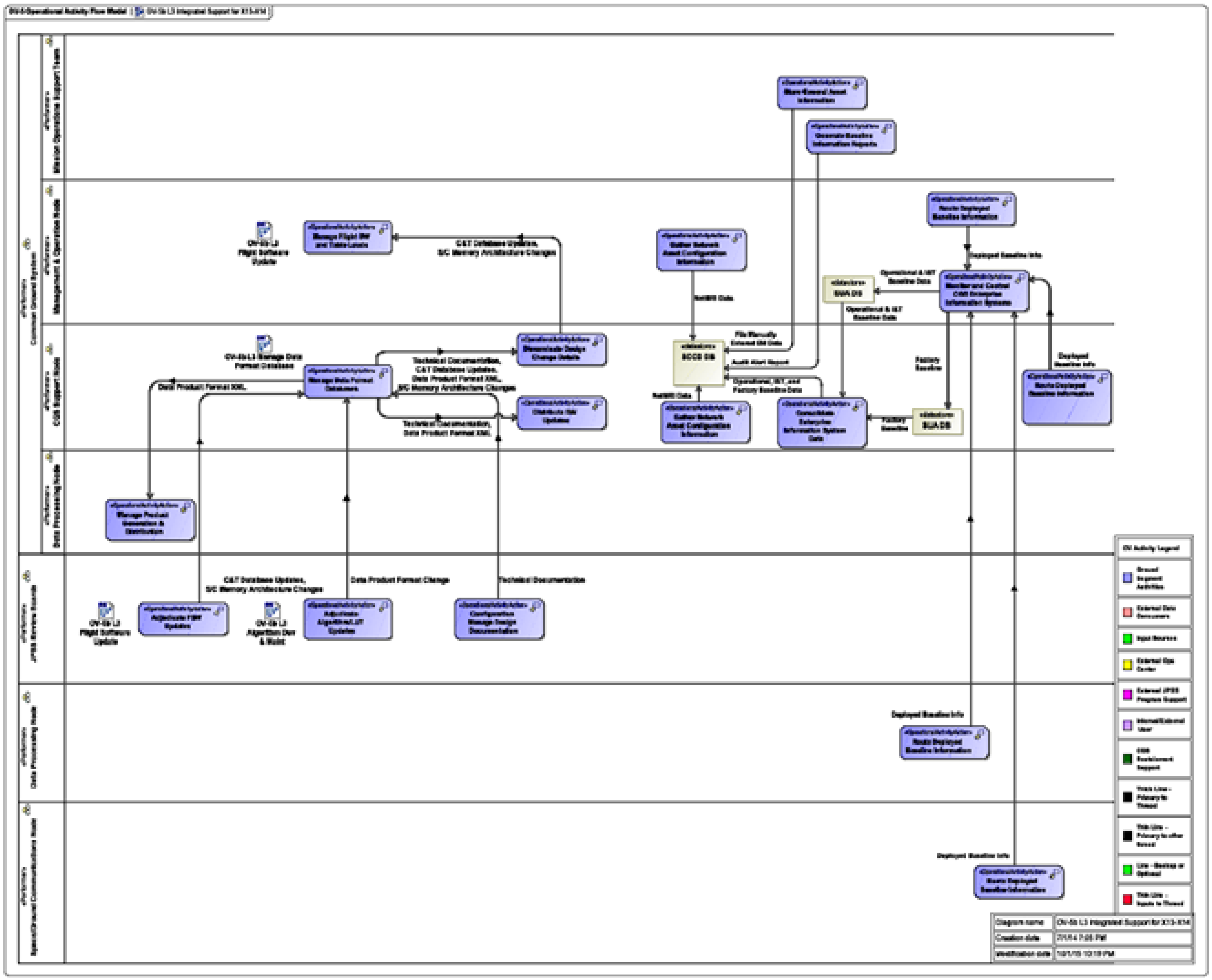
Figure 6.2.5-2 provides an illustration of system activities taking place in the Integrated Support basic flow for: 1) Document Maintenance; 2) Operator Training and Certification; 3) Support Systems.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.5-2 Integrated Support Operational Flow Diagram For Document Maintenance, Training, and Support Systems

Figure 6.2.5-3 provides an illustration of system activities taking place in the Integrated Support basic flow for: 1) Centralized Data Format Management; and 2) Enterprise Asset Management.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.5-3 Integrated Support Operational Flow Diagram For Data Format Management and Enterprise Assets Management

6.2.5.6 Basic Flow

The basic flows for the Integrated Support ConOps thread are the following:

- Documentation Maintenance
- Operator Training & Certifications
- Support Systems
- Centralized Data Format Management

- Enterprise Asset Management

These flows are described in Tables 6.2.5-3 to 6.2.5-7.

Table 6.2.5-3 describes the Integrated Support flow for maintaining documentation for the JPSS Ground System operations team to use for fault isolation and trouble-shooting. This flow assumes that the OSPO has a complete set of existing design documentation. So the effort to collect and archive the initial copy of the design document is not included in this flow.

Table: 6.2.5-3 Documentation Maintenance

No.	Actors	Actions	Notes
1a	CGS Support Node (CSN), Operations staff	For JPSS Ground System design changes and configuration changes; the CGS Configuration Manage Design Documentation activity provides baseline technical documentation to the Identify Updates to Ops Documentation activity that is performed by the operations staff.	
1b	CSN, MOT/MOST	For JPSS Ground System SOP/ROP changes, the Configuration Manage Design Documentation activity provides baseline technical documentation to the Identify Updates to Ops Documentation activity that is performed by the MOT/MOST.	
2	Spacecraft Support Node (SSN), Instrument Vendor, MON	For flight software changes or new satellite design information (e.g. for JPSS-1), the SSN, and the Instrument Vendor provide the latest spacecraft and instrument software design documentation to the CGS Manage Flight SW and Table Loads activity in the MON.	
3	MON, Operations staff, MOT/MOST	The MON receives these updates and forwards them to the Identify Updates to Ops Documentation activity that is performed by the operations staff and/or MOT/MOST.	
4	Operations staff, MOT/MOST	The operations staff and/or MOT/MOST stores a copy of the updated JPSS Ground System design and flight software documentation locally at the operations facility as part of the Identify Updates to Ops Documentation activity.	

Table 6.2.5-4 provides a summary of the activities required to provide training for operators and certify them for ground operations.

Table: 6.2.5-4 Training and Certification Conduct

No.	Actors	Actions	Notes
1	Mission Operations Support Team (MOST), SSN, CGS Support Node, and	The operations staff develops JPSS Ground training materials for operational system from interactions with the CGS Support Node, the SSN, the Instrument Vendor, and the repository of on-line documentation stored locally at the operational facility.	

No.	Actors	Actions	Notes
	Instrument Vendor		
2	Operations staff, SSN, CGS Support Node, Instrument Vendor, and the OSPO.	The operations staff submits the training material for review and approval to the SSN, the Instrument Vendor, the OSPO, and the CGS Support Node. These organizations review and approve JPSS Ground training materials.	
3	Ground System Factory, Operations staff	CGS and the operations staff develop Initial Plan of Instruction (IPOI).	
4	MON, DPN, Operations staff	The operations staff conducts classroom training, as required.	
5	Operations staff	The operations staff submits course completion data to Training Database.	
6	Operations staff	Training Database course completion data is updated.	Training Database is maintained by Integrated Logistics Support (ILS) Helpdesk.
7	MON, Operations staff	Mission planner schedules a B-side outage for the duration of B-side training activities.	
8	MON, DPN, Simulation Node, Operations staff	The operations staff configures B-side for training operations. Training operations can include any subset of capabilities of the operational string, except satellite commanding, operational ground commanding and status, and operational data product distribution.	Configuration includes inclusion of the FVS (C3S) or CSIE and RIS (IDPS) for OTJ training.
9	MON, DPN, Operations staff	The operations staff selects data types for replication to B-side, if necessary. The operations staff initiates data replication from A-side to B-side.	
10	MON, DPN, Operations staff	The operations staff conducts On-the-Job Training (OJT) on B-side.	OJT includes Hands-on console training, side by side operations, and Mission Rehearsals, Exercises, and Satellite Tests, and DITL and WITL tests.
11	Operations staff	The operations staff submits course completion data to Training Database.	
12	Operations staff	Training Database course completion data is updated.	Training Database is maintained by ILS Helpdesk.

No.	Actors	Actions	Notes
13	Operations staff, MON, DPN	B-side is released for other activities.	
14	Operations staff	Certification Training is executed as required.	

Table 6.2.5-5 provides a summary of the actors and actions required to maintain the JPSS support systems. These include the WRS, the DRS, and Common CM systems.

Table: 6.2.5-5 Support Systems

No.	Actors	Actions	Notes
1	Operations staff, MON	WRs are written by anyone with access to the WRS. These WRs are reviewed by one of the three WRRPs depending on what type of product or JPSS GS segment if affects. The WRRP assigns priorities, assigns responsible party(s), tracks status, and closes WRs as required to accomplish the requested effort.	
2	Operations staff, MON	Integrated Support ensures that the WRS is operational, the appropriate personnel attend the WRRPs, and that the WRS data bases are updated as required.	
3	Operations staff, Ground System	DRs are written by anyone with access to the DR System or via a DR form. These DRs are reviewed by the DRB. The DRB assigns priorities, assigns responsible party(s), tracks status, and closes DRs as once the discrepancy is resolved. DRs deemed as CGS Discrepancy will be submitted as WRs for further investigation and resolution.	
4	Operations staff, Ground System	Integrated Support ensures that the DR System is operational, the appropriate personnel attend the DRBs, and that the DR System data bases are updated as required.	
5	Operations staff, MON	Configuration Change Requests (CCRs) written by anyone with access to the Common CM system or via a CCR form. These CCRs are reviewed by the JPSS Review Board. The Board determines if the proposed change will be accepted or not. If accepted, the change will become part of the JPSS GS configuration baseline. If the change is not accepted, then no change to the baseline will be made.	
6	Operations staff, MON	Integrated Support ensures that the Common CM System, the Cal/Val Node CM System, and the Simulation Node CM System are operational, the appropriate personnel attend the CCBs, and that these CM data bases are updated as required.	
7	Operations staff, CSN	The Common CM system performs the following as part of the CGS Configuration Manage Design Documentation activity:	

No.	Actors	Actions	Notes
		• Ensures that it keeps a repository of the JPSS ground software and ground processing PCTs/LUTs that is accessible by authorized users. • Maintains a configuration baseline for all hardware and software in the JPSS GS.	
8	Operations staff, Cal/Val Node, FTS Node	The DPES CM system performs the following as part of the Cal/Val Configuration Manage Design Documentation activity: • Ensures that it keeps a repository of the baseline Cal/Val and FTS software and tools are accessible by authorized users. • Maintains a configuration baseline for all hardware and software in the Cal/Val Node and FTS Node.	
9	Operations staff, Simulation Node	The Simulation Node CM system performs the following as part of the SIM Configuration Manage Design Documentation activity: • Ensures that it keeps a repository of the baseline Simulation Node software and tools are accessible by authorized users. • Maintains a configuration baseline for all hardware and software in the Simulation Node.	
10	JPSS Review Boards	All changes to the JPSS GS must be approved the JPSS Review Boards. All affected organizations are required to have representation at the JPSS Review Boards. So the JPSS Review Boards ensures that all changes to the JPSS GS have been reviewed and approved by the affected JPSS GS organizations. JPSS Ground Project Configuration Manage Design Documentation activity maintains the JPSS Review Board approved technical documentation in its Mission Information System (MIS) repository and provide access to authorized users.	The CCB provides the first level of change coordination. Additional coordination regarding the details and timing for implementing these changes is provided by the SMU ConOps thread. (GS-NNL-140)

Table 6.2.5-6 provides a summary of the actors and actions required to modify the data format repository and to disseminate the updates.

Assumptions and Constraints

- The centrally managed data format databases are developed during the system development.
- The centrally managed data format databases are the sole source in the system for the command and telemetry database, memory architecture and table description, mission data format and data product format information during test, installation, and operations.

Preconditions

- The format change has been requested, or
- There is a software release pending; or
- A new operations configuration is needed.

Table: 6.2.5-6 Centralized Data Format Management

No.	Actors	Actions	Notes
1	JPSS Review Boards, CGS Support Node (CSN)	For JPSS database and memory/data format changes, the Adjudicate FSW Updates and Adjudicate Algorithm/LUT Updates activities provide the requested database and memory/data format changes to the CGS Manage Data Format Databases activity.	AERB adjudicates the data product format changes. [OCCB?] Adjudicates database and memory architecture changes. The database includes C&T database and Data Product Generation database
2	CSN	Based on the requested format changes, the CGS Manage Data Format Databases activity prepares the proposed Database and/or Data Format in XML and technical documentation to the Disseminate Design Change Details activity.	Translation may be needed from the native format to the XML
3	CSN, JPSS Review Boards	The CGS Disseminate Design Change Details activity forwards the proposed changes to the Configuration Manage Design Documentation activity.	
4	JPSS Review Boards, CSN	The Configuration Manage Design Documentation activity approves the proposed changes and sends the approved changes to the CGS Manage Data Format Databases activity.	The Ground project ERB adjudicates the data format changes. Ops ERB adjudicates the C&T DB and Memory Architecture changes.
5	CSN	The CGS Manage Data Format Databases activity updates the Data Format Database based on the approved changes.	Some changes affecting file format may be accompanied by software releases.
6a	CSN, MON	The CGS Manage Data Format Database activity outputs the C&T DB and Memory Architecture Format in XML and the CGS Disseminate Design Change Details activity forwards it to the CGS Manage Flight SW and Table Loads activity for configuration of command load generation, and telemetry decommutation, monitoring and analysis.	System configuration files may be generated from the XML files for configuring system operations

No.	Actors	Actions	Notes
6b	CSN, DPN	The CGS Manage Data Format Databases activity outputs the Data Product Format in XML to the CGS Manage Product Generation and Distribution activity for configuration of data product generation and distribution.	System configuration files may be generated from the XML files for configuring system operations
7	CSN	The CGS Manage Data Format Databases activity exports the Data Product Format in XML and technical documentation to the CGS Distribute SW Updates activity for packaging the format updates for archival.	
8	CSN, CLASS	The CGS Distribute SW Updates activity formats the data format updates into the DPN software update package and send it to the Receive & Archive Software activity at the Long Term Archive (CLASS).	
9	CSN	The CGS Manage Data Format Databases activity exports the contents of the Data Format Database in XML, HTML and readable formats to the CGS Distribute SW Updates activity for access by the authorized users.	
10	CSN, CLASS	The CGS Distribute SW Updates activity makes the contents of the Data Format Database in XML, HTML and readable formats available to the authorized users.	

Table 6.2.5-7 provides a summary of the actors and actions required to maintain, monitor and track assets and baseline configuration management of hardware, custom software and COTS software throughout their lifecycles.

Assumptions and Constraints

- Endpoint Managers are used to verify and implement controlled baselines, automatically status only available where Endpoint managers execute on.
- Data Migration Plan for moving CM data into CAMDb from other CM tools has been executed.
- Network monitoring does not automatically status on network equipment that does not have the standard Management Information Base (MIB). Factory CM tools, ClearCase and ClearQuest only interface with the factory CAMDb (not the OPS CAMDb).
- Manually entered data is available through purchase orders, vendor hardware information and non-Cisco network equipment information.

Preconditions

- Endpoint Manager Agents have been installed on all applicable end points and are up and running.

- New or updated hardware or software has been deployed and is reporting status.

Table: 6.2.5-7 Common Asset Management Database

No.	Actors	Actions	Notes
1	Factory Staff, MST	The Factory Staff and MST manually stores Enterprise Management data into the Common Asset Management Database using the Store General Asset Information activity	
2	SGCN, MON, DPN, and CSN	The SGCN, MON, DPN, and CSN agents' forward asset end point status using the Route Deployed Baseline Information activity to the Monitor and Control CGS Enterprise Information Systems activity.	
3	MON, CSN	The MON and CSN network monitoring forwards status data to the Common Asset Management Database in the factory and operational environments during the Gather Network Asset Configuration Information activity	
4	CSN	The end point status and network data are stored in the Common Asset Management Database during the Consolidate Enterprise Information System Data activity.	
5	Factory Staff, MST	The Generate Baseline Information Reports activity allows the user to query and view reports on baseline discrepancies and other information as desired.	
6	CSN	Based on a configurable rule set being triggered, CAMDb will send an email to the pre-defined user list (e.g.; a HW part X warranty will expire in three months). The trigger is a chronological job that occur in the Consolidate Enterprise Information System Data activity.	

6.2.5.7 Alternate Flow

The Integrated Support ConOps thread provides support services for non-real-time activities. These activities are done in the background of normal operations; therefore there are no alternate flows for this ConOps thread.

6.2.5.8 Post Condition

This thread describes ongoing operations; the only Post Condition is that the Ground System is sufficiently supported to enable on-going operations.

6.2.5.9 Related Threads

The ConOps threads listed below provide background information for the Integrated Support thread. Review of these will help in the understanding of the Integrated Support thread activities.

Thread ID	Thread Title
GS-NNL-140	System Maintenance and Upgrade
GS-NML-070	Flight Software Upgrade
GS-NML-150	Cal/Val of Data Products
GS-NML-310	Ground Operations
GS-NML-300	System Status/Situational Awareness
GS-NML-100	Stored Mission Data Handling
GS-NML-030	Telemetry and Commanding
GS-NML-320	Space Operations

6.2.5.10 Child Threads

The OpsCon threads listed below are the Level 4 threads that directly flow down from this Integrated Support thread.

Thread ID	Thread Title
CGS-030-030	Integrated Support
CGS-030-050	Internal Data Management

6.2.6 System Maintenance and Upgrade

6.2.6.1 Description

The System Maintenance and Upgrade (SMU) ConOps thread (GS-NNL-140) describes Ground System (GS) activities associated with Maintenance and Upgrade Operations. This includes maintenance actions and upgrades for the CGS. It also includes coordination of maintenance and upgrades activities among CGS, the Simulation Node, and the Cal/Val Node. Specifically, this ConOps thread covers the following:

1. **Maintenance and upgrade activities for CGS segments:** This includes maintenance and upgrade activities at the MMC, data processing facility located at the NOAA NSOF and the Consolidated Back Up facility. The types of maintenance and upgrades are provided below:
    a. **Patch Upgrades:** Small software upgrades that can be incorporated between maintenance releases.
    b. **Maintenance Releases:** A set of coordinated Problem Change Request (PCR) and Work Request (WR) fixes that do not require the addition of major new functionality:
    c. **Block Upgrades:** Provides significant functionality increase to the JPSS GS.
    d. **Hardware Upgrades:** May be part of a software Block Upgrade and provides significant functionality increase to the JPSS GS.

   As part of performing CGS maintenance and upgrades, the SMU ConOps thread coordinates with other JPSS GS ConOps threads and segments.

2. **Coordination Support for Simulation Node Maintenance & Upgrades:** The SMU thread does not perform the maintenance and upgrade of the Simulation Node, but the SMU does provide coordination between the Simulation node and the other JPSS GS nodes to ensure the Simulation node maintenance or upgrade does not affect JPSS GS operations.
3. **Coordination Support for the Cal/Val Node Maintenance & Upgrades:** The SMU thread does not perform the maintenance and upgrade of the Cal/Val Node, but the SMU does provide coordination between the Cal/Val node and the other JPSS GS nodes to ensure the Cal/Val node maintenance or upgrade does not affect JPSS GS operations.

Figure 6.2.6-1 shows the process for resolving system issues or anomalies and which ConOps threads are involved in this process.

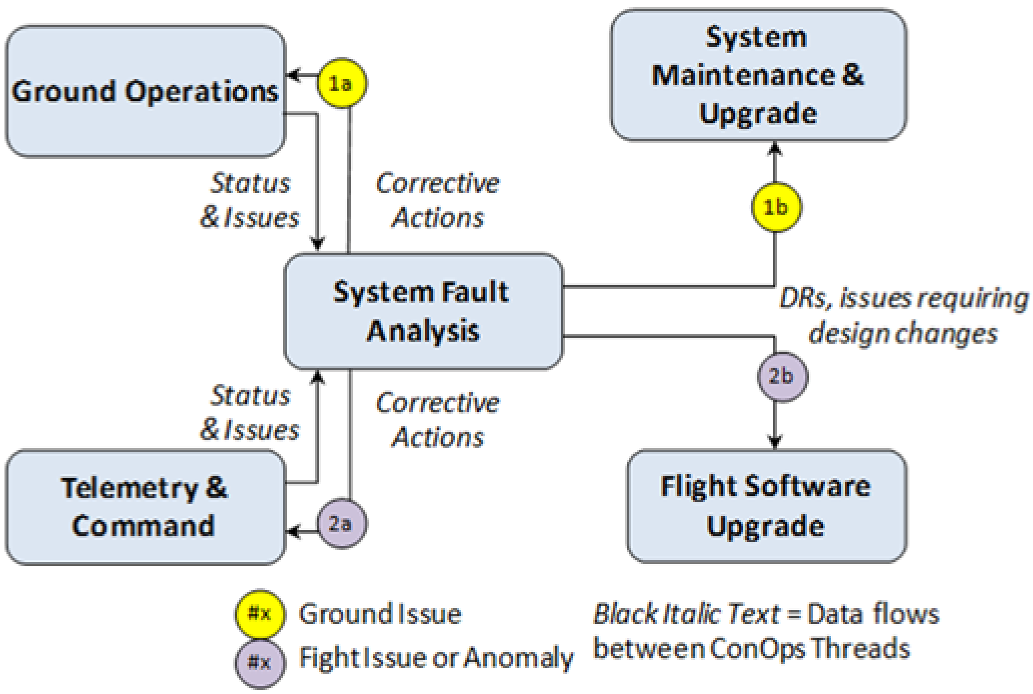


Figure: 6.2.6-1 JPSS GS Issue Resolution Process Flow

As figure 6.2.6-1 shows, status and issues are provided to the System Fault Analysis (SFA) ConOps thread. SFA will determine the corrective action for issues or anomalies. The types of corrective actions from the flows in Figure 6.2.6-1 and the ConOps thread that performs this action are provided in Table 6.2.6-1:

Table: 6.2.6-1 Corrective Actions & Performing ConOps Threads

No.	Corrective Action	Performing ConOps Thread
1a	Routine commanding or configuration changes on the JPSS GS	Ground Operations
1b	Design changes or maintenance actions to the JPSS GS	System Maintenance and Upgrade
2a	Routine satellite commanding	Telemetry & Command
2b	Satellite or instrument software changes and/or tables	Flight Software Upgrade

The SMU ConOps thread is responsible for performing the maintenance and upgrade actions for the JPSS GS for either planned upgrades or in response to issues as shown in Table 6.2.6-1. This process is described in more detail below.

6.2.6.1.1 Maintenance and upgrade activities for CGS segments

CGS provides a capability for system upgrade with minimum system downtime (within 5 minutes). This upgrade performance is enabled through installation and operation of a secondary processing string at NSOF as part of the Management & Operations Node (MON), and Data Processing Node (DPN), denoted here as “B-string”, in conjunction with nominally providing 3 separate deployment directories on each string - OPS1, OPS2, and SUP1. OPS1 and OPS2 deployment directories contain either the current operational build, the previous operational build for the purposes of fallback, or a candidate operational build. The SUP1 directory contains the current operational build, as well as approved Category 3 test tools. The Space Ground Communications Node (SGCN) and the Ground Network Node (GNN) do not have a complete secondary processing string, but they each have pooled resources that allow for upgrades to be installed on one set of equipment while operations continue on the baseline set of equipment.

The 3rd processing string is installed at NOAA Consolidated Backup (CBU) facility in Fairmont, WV. Denoted as “C-String” or “String C”, it has the same configuration as the A/B strings.

Each processing string may operate as the primary string running the current version of CGS in support of the primary operations. Each processing string can also operate in support of the parallel operations or test operations that can be used for support functions such as integration, test and validation of system upgrades; “on the job” training; anomaly resolution; or for developing new spacecraft activities before moving them into operations.

The strings are connected to redundant network infrastructure appliances (routers, switches, and firewalls). Each string contains internal redundancy such that a single unit may fail and operations continue on the string to meet operational availability requirements. Sufficient spares are stocked on site to replace failed units. Failed units are either repaired or replaced per unit’s vendor’s maintenance agreement.

In addition, there is an I&T string that contains a subset of operational capabilities. This third string at NSOF, not operations-capable, is used for integration, checkout, and test of patch upgrades while both A-string and B-string are in use.

Certain functions in CGS are implemented through Common Components outside of processing strings. This includes communication infrastructure, common services, and security enclave. These functions are shared by processing strings. Their upgrades can be carried out in one of three options based on the type of upgrade:

1. Inline concurrent upgrade
    - Used for routine patches like security patches
2. Upgrade the common components at CBU then transition the primary operations to CBU. Upgrade the common components at NSOF then transition the primary operations back to NSOF.
    - Used for multi-component non-routine upgrades (e.g., OS and COTS updates)

3. Create temporary virtual B instances in support of upgrade
   - Used for single component non-routine upgrades (e.g., COTS updates)

Nominal Operations

Nominal operations for the strings are shown in Figure 6.2.6-2.

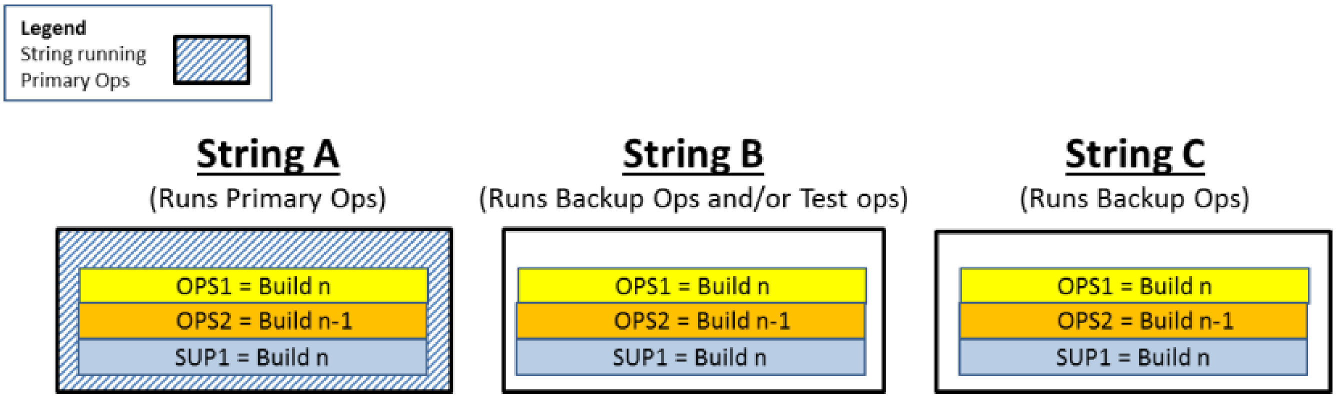


Figure: 6.2.6-2 String Utilization during Nominal Operations

As the above figure shows, the String A nominally runs the primary operations and the String B the backup operations and/or testing for the S-NPP, JPSS-1/2/3/4 missions (up to three). The String C runs the backup operations to provide the Continuity of Operations (COOP). All three strings have built-in internal redundancy. As a result, a single failure should not cause a string to fail. However, if the String A fails as results of a double-failure, the operation can fail over to the String B. If the NSOF facility becomes inoperable due to a COOP event (e.g., a catastrophic power outage or natural disaster), the operations will fail over to the CBU string that is nominally synchronized with the String A closely.

The Common Components will not be transitioned with the strings. These functions will be internally fully redundant and will support operations regardless of whether or not the A or B string is being used for operations. The CBU will have independent instances of these functions. So the corrective action if the Common Components fail at the NSOF is to failover to the CBU for these functions.

System Upgrade

All new builds are initially checked out on the I&T string before being loaded onto one of the operations-capable strings. Once installed on the operations-capable string, the new build runs through the rigorous Integration Test & Check-Out (ITCO) process to validate and certify for operations. Before being promoted to the operational baseline, it also runs the Parallel Operations with the current baseline to verify its functions and performance.

It should be noted that upgrades to the system nodes such as MON and DPN are typically asynchronous and are carried out separately.

Figure 6.2.6-3 illustrates steps in a notional system upgrade for a major build. It shows how the three strings of servers can be used to transition from the current version of the CGS to a new version of CGS without interruption to normal production operations.

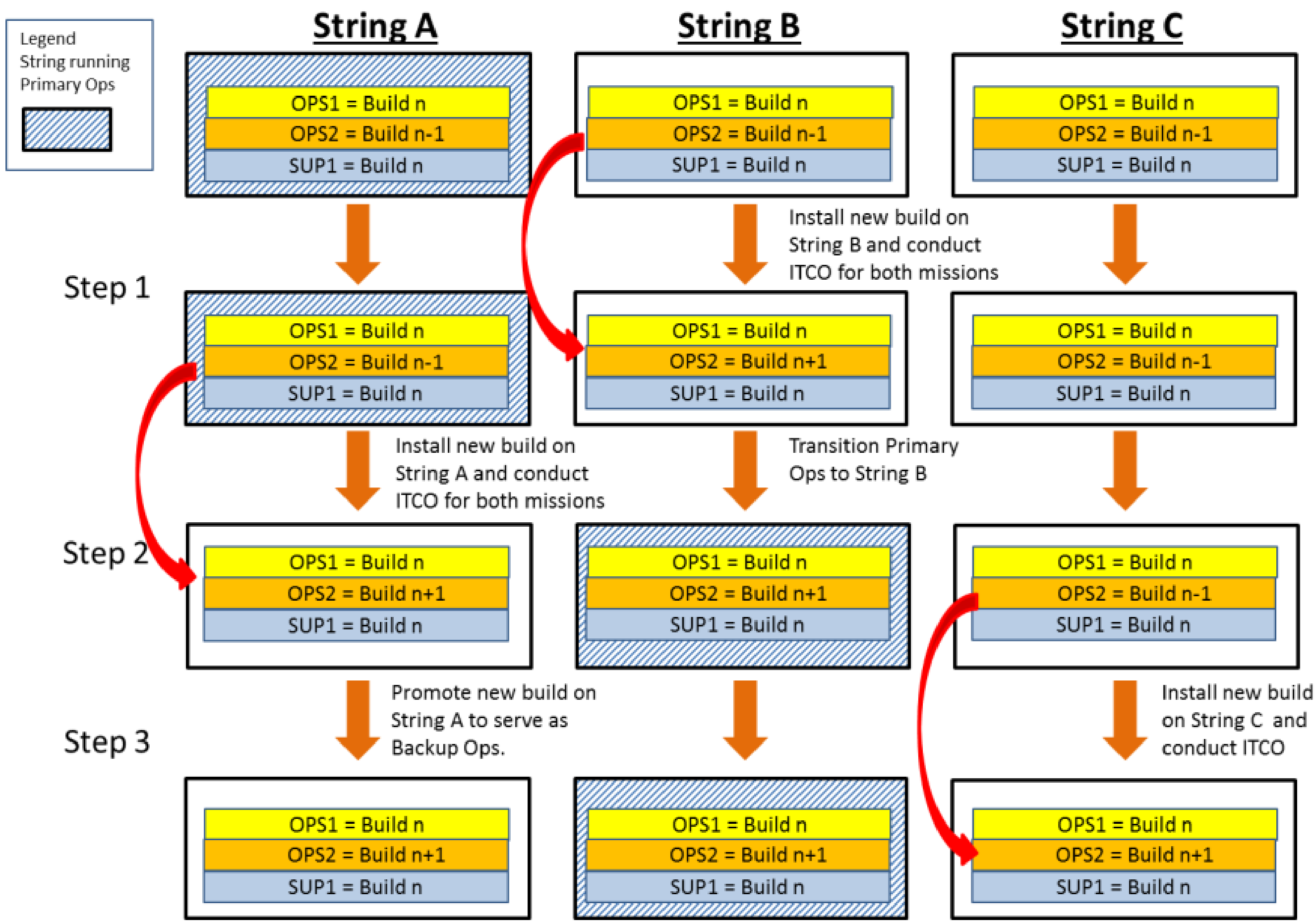


Figure: 6.2.6-3 Notional System Upgrade for a Major Release

Assume the current release, (Build n) of CGS is installed and running production operations on the A-string in the OPS1 environment. The B-string also has the current version installed in the OPS1 directories and both strings have the current operational build deployed to SUP1 directories.

With OPS1 running on the A-string, users are able to initialize the current operational build from the SUP1 directories by logging into the B-string and invoking installation utilities that copy and/or link files to SUP1 specific directories. Both strings also have the previous version of CGS installed in the OPS2 directories, but the previous build is not used after the installation, checkout, approval to operate, and switch-over to OPS1 directories using the current version.

OPS1 is running on the A-string, and a new version of CGS (Build n+1) has been released and approved for installation. Installation personnel will log in to the B string and begin installation of the new CGS version in the OPS2 directories as part of Step 1 in Figure 6.2.6-3.

Once configured, a checkout is performed on the new version. Checkout includes delivery of parallel products to and from both the current software build on the A-string (i.e. production) and the new software build on the B-string (checkout). Destination addresses for B-string will be configured to point to “test” directories on all receiving servers for the checkout period.

The checkout activities will be coordinated with all Mission Operations Team (MOT) management, instrument teams, and other external interfaces. Utilization of the SUP1 environment on the I&T string may be needed during installation, checkout, validation and transition. In addition, the OPS1 environment on the B-string still contains the current ops version of CGS in case there is a ground anomaly on the A-string. In a worst case scenario, the CBU string can also be used for failover.

At the direction of the OSPO Management, and after approval by a review board, the B-string can be configured to execute normal operations with the new software baseline running from the OPS2 directories as shown in Step 2 Figure 6.2.6-3. Before the transition switchover to the B-string, OPS2 destinations need to be reconfigured to match production operations destinations. In addition, an announcement of the transition is made to all users coordinating the transition time. C3S components transition with the IDPS. C3S transition of operations is planned and scheduled when Space Segment and Ground Segment are not in contact; similarly, IDPS transitions are planned and scheduled based on review board consideration of data request load.

When the decision to transition is made, the B-string is initialized in the operational configuration. Interface touch points are reconfigured to flow data into and out of the B-string, as required. When the configuration of the interfaces is complete, operational data flows through the B-string and normal operations continue. Data requestors may continue to make requests for data products throughout the maintenance and transition periods, as the transition of operations activity is transparent to the data requestor. In case of data processing algorithm upgrades that affects data products, real-time consumer such as ESPC will receive data products from the B-string after transition; while time-delayed consumer such as CLASS will continue receiving delayed-delivery of data products from A-string until the product observation time matches up with the transition time. This is done to ensure the archived products are of the same version as the ones received by the real-time consumers.

During transition of primary operations from one environment to the other, the transition team may decide to abort the transition and revert the primary operations back to the pre-transition environment. If this happens, the pre-transition environment must be ready for the time critical mission operations within 5 minutes from the initiation of the transition reversal.

Once normal operations are established and running smoothly on the B string, the installation team will install the new version of CGS into the OPS2 directories on the A string over-writing the version that was there, which is now 2 versions old. The MOT Senior Systems Engineer coordinates the A-string installation with external interfaces and MOT team members because it may impact activities that could occur on the A-string after ops is running on the B-string. After the new version of CGS has been installed to OPS2 directories on the A-string, a short checkout will occur there using test destinations. Once the checkout of the new build on the A-string is complete, I&T string is updated to the new build from the SUP1 directories (not shown).

As shown in the final step (Step 3) in Figure 6.2.6-3, the installation of Build n+1 on the C string at the CBU facility will commence once agreed to by the OSPO Management. At last (not shown), the SUP1 directories on each string will be upgraded from Build n to Build n+1.

6.2.6.1.2 Types of Maintenance and Upgrades

CGS Maintenance and Upgrade is divided into four related flows: Patch Upgrades, Maintenance Releases, Block Upgrades, and Hardware Upgrades. CGS Patch Upgrades, Maintenance Releases, Block Upgrades, and Hardware Upgrades can be for multiple missions or for a single mission. In the steps of the basic flow, the steps that deviate based on the type of maintenance activity are annotated in the step number as well as in the Action column.

a. **Patch Upgrades:** Patch upgrades contain updates to COTS items deployed as part of the CGS operational system. The upgrades in general are small enough in size and high enough priority to be installed onto the operational system outside the regular Maintenance Upgrade schedule (nominally three upgrades per year). CGS Patch upgrades are installed between telemetry and commanding contacts or at a time where the load of data requests is light to minimize impacts to operations. Patch upgrades are checked out on the I&T string before they are applied to operations. Large COTS patches, or patch upgrades that require invasive installation procedures are treated as Maintenance Releases.

b. **Maintenance Releases:** Maintenance releases contain a set of coordinated Problem Change Request (PCR) and Work Request (WR) fixes that do not require the addition of major new functionality, additional data products, or functions associated with data processing for a new mission. Maintenance Releases are installed and validated on the string that is not currently running mission operations. Validation activities may be executed with simulation assets, or with a subset of available system interfaces.

c. **Block Upgrades**: Block upgrades contain major changes to functionality in the current operations system, additions of new data products or processing threads, additions of new missions to CGS. Block Upgrades take advantage of CGS the non-operational string for extensive Installation, Checkout, and Test (IC&T) activities, and SMO (Shadow Mode Operations) to validate upgrades compliance with requirements and operational needs. Upon completion of validation activities, normal operations are transitioned from operational string to the non-operational string. After transition is complete, the upgrades are installed and validated on the other string at the primary site.

d. **Hardware Upgrades:** Hardware upgrades contain upgrades to Commercial Off-The Shelf (COTS) hardware items used in executing CGS mission operations. An example of a hardware upgrade is a technology refresh of MMC servers. New hardware is delivered to operational sites in a phased manner where feasible. Current hardware from the non-operational string is removed prior to the installation of new hardware. New hardware is installed, checked out, and validated on the string that is not running production operations of the primary site first. When the hardware validation activities are complete, a transition from the operational string to the string with the validated hardware is scheduled and coordinated amongst stakeholders and CGS operational assets. SMO and Parallel Operations are executed as a part of the Transition of Operations activity. Once Transition of Operations is complete, hardware upgrades are installed and validated on the non-operational string of the primary site.

In general, software upgrades, including patch upgrades, maintenance releases, and block upgrades, are developed in the CGS Support Node (CSN). Requested changes to the operational

software baseline are primarily identified at the operational sites, the ISF/SN, or flowed down from the IPT CCBs. Requested software changes are documented and tracked in a PCR within the JPSS CGS Work Flow Management (WFM) tool. The operational sites and external users will track the status of requested changes using the Work Requests. GSN will track the status of requested changes using software PCRs.

Steps in the scenario may identify a specific facility and/or string for an activity (for example "Primary Site, A-string"). This is done for clarity reasons. For the purposes of this scenario, it is assumed operations are running on Primary Site, A-String at the beginning of all flows.

This scenario applies to S-NPP and all JPSS missions.

6.2.6.1.3 Coordination Support for Simulation Node Maintenance & Upgrades

The FVTS maintenance includes FVS, J1Sim, and FSE (starting in B2.2) hardware (HW) and software (SW) maintenance and support. The FVTS is used to verify commanding to the JPSS controlled satellites such as S-NPP, JPSS-1, and JPSS-2/3/4. These platforms are based on satellite hardware which cannot be changed. Therefore almost all of the updates to the FVS/FVTS(B2.0)/J1Sim/FSE(B2.2) are FSW/Table updates.

Because the FVTS is used to validate commands to the satellite, the FVTS is needed to support satellite operation. Therefore, updates to the FVTS must be done in close coordination with the Telemetry & Commanding ConOps thread.

6.2.6.1.4 Coordination Support for the Cal/Val Node Maintenance & Upgrades

The Cal/Val node consists of the Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE) and supporting Local Computing Facilities (LCFs). GRAVITE is a data-intensive system that provides an area, with ready access to S-NPP data, for algorithm experts to develop and manually test improvements to S-NPP data product algorithms, resources and methods for the regular processing of repetitive tasks needed for S-NPP algorithm calibration and validation, and an Algorithm Development Area (ADA) on which alternate data, LUTs, and/or algorithms can be run in an environment similar to the IDPS for the purpose of S-NPP algorithm calibration and validation.

GRAVITE receives science data products directly from the Data Processing Node (DPN), and the LCFs interface with GRAVITE. The only potential real-time impact to the CGS of the Cal/Val node is through its interface with GRAVITE. The CGS must be aware when GRAVITE maintenance activities will affect GRAVITE's ability to receive data from DPN. Coordination between GRAVITE and DPN for GRAVITE updates will allow data subscriptions to be put on hold while GRAVITE is being repaired or upgraded. This action is needed so that the queues of data to GRAVITE don't back up and affect DPN operations.

6.2.6.2 Primary Interfaces

Figure 6.2.6-4 illustrates the actors and primary external interfaces involved in the execution of system maintenance and upgrade. Each interface illustrated in the figure, labeled with a number, is described in Table 6.2.6-2, along with the information about types of data, exchange method and frequency. Table 6.2.6-3 provides relevant IRDs/ICDs information.

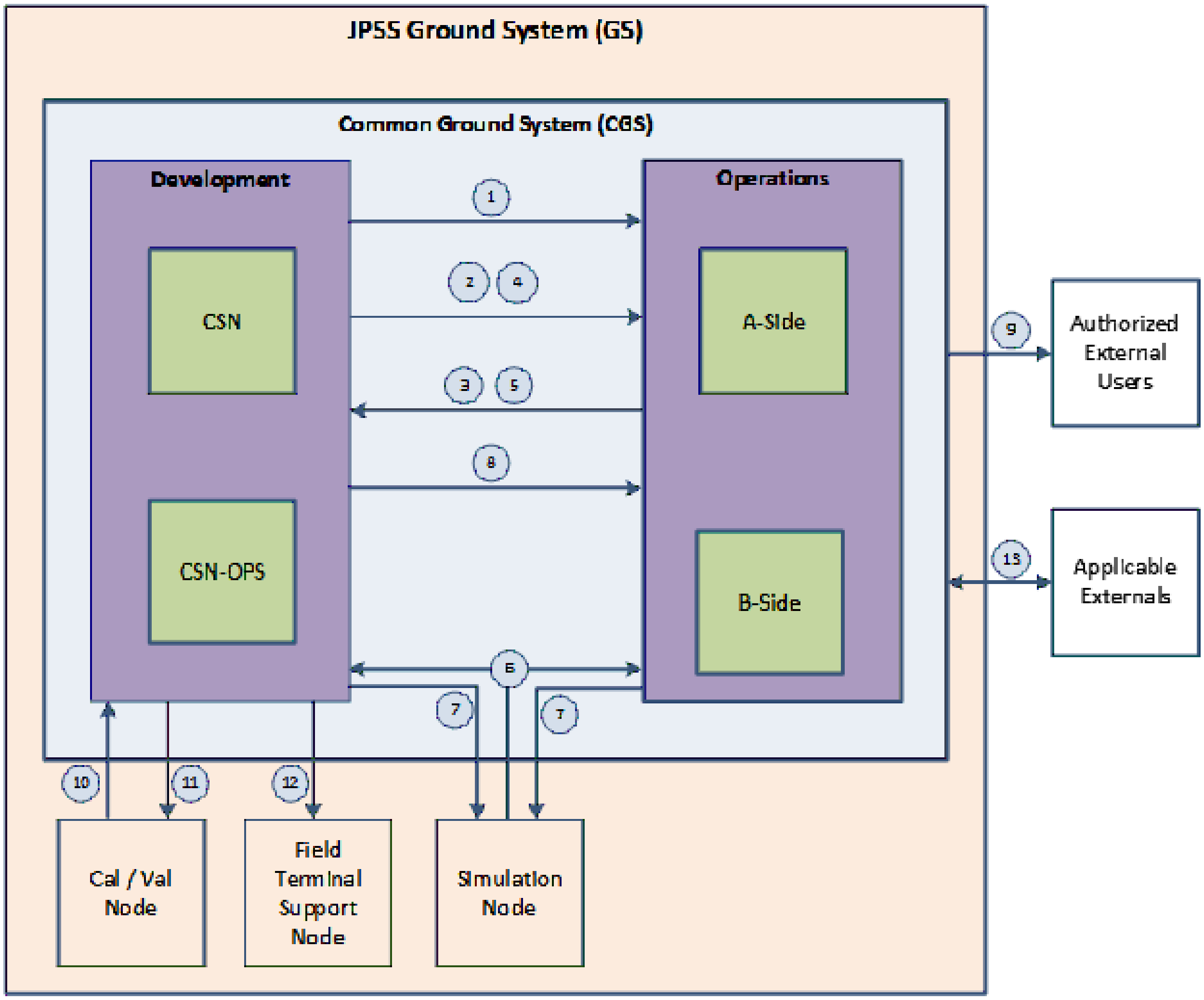


Figure: 6.2.6-4 System Maintenance and Upgrade Primary Interfaces

Table: 6.2.6-2 System Maintenance and Upgrade Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	CSN, Space/Ground Communications Node (SGCN), Ground Network Node (GNN), Management & Operation Node (MON), Data Processing Node (DPN)	SGCN, GNN, MON, DPN Software Upgrades
2	Internal	CSN, DPN	Operational Data Request
3	Internal	DPN, CSN	Requested Operational Data
4	Internal	CSN, MON	Operational Data Request
5	Internal	MON, CSN	Requested Operational Data
6	Internal	Simulation Node, CSN, MON	FVS/FVTS(B2.0)/J1Sim/FSE(B2.2) Telemetry
7	Internal	MON, CSN, Simulation Node	FVTS Commands

No.	Type	Actors	Purpose
8	Internal	CSN, MON	Work Request
9	External	MON, Authorized External Users	Mission Notices
10	External	Cal/Val Node CSN	Algorithm code updates
11	External	CSN, Cal/Val Node	Program Change Request (PCR) status
12	External	CSN, Field Terminal Support Node (FTSN)	Algorithm code updates
13	External	MON, DPN, Science Data Segment (SDS), CLASS, NESDIS ESPC	External Test Interfaces (as applicable)

Table: 6.2.6-3 Primary Interface Documentation

No.	IRD/ICD
1 - 5	JPSS CGS to CSN ICD
6, 7	JPSS CGS to Flight Vehicle Test Suite (FVTS) IRD JPSS CGS to FVTS ICD
8, 9, 12	JPSS CGS Services IDD
10, 11	JPSS CGS to GRAVITE IRD JPSS CGS to GRAVITE ICD JPSS Data Product Format XML Database
13	JPSS GS to CLASS IRD JPSS GS to NESDIS ESPC IRD JPSS GS to NASA SDS IRD

6.2.6.3 Assumptions & Constraints

The following assumptions are made for the successful performance of System Maintenance & Upgrade thread functions:

- Stakeholders have agreed on the content contained in a new Block.

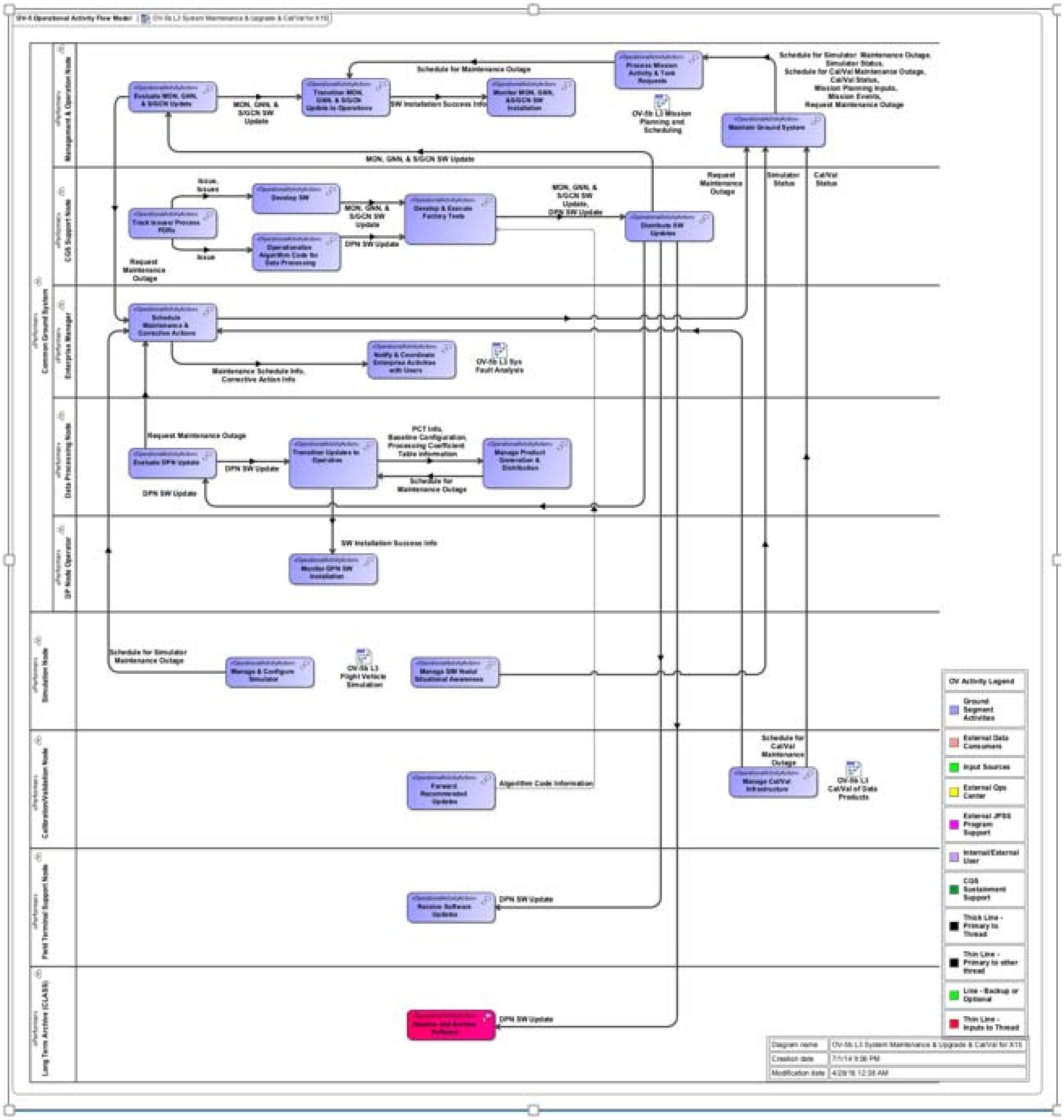
6.2.6.4 Pre-Conditions

The pre-conditions for the System Maintenance & Upgrade ConOps thread include the following

- Operations staff (including development and test staff at the site) has submitted a Work Request (WR) to investigate a potential software problem.
- A Discrepancy Report has been submitted that results in a design change to the Ground System
- The System Fault Analysis ConOps thread has determined that a design change is required to the JPSS GS.

6.2.6.5 Operational Flow

Figure 6.2.6-5 provides an illustration of system activities taking place in the basic flow for the System Maintenance & Upgrade thread.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.6-5 Upgrade System Flow

6.2.6.6 Basic Flow

The basic flows for the System Maintenance & Upgrade ConOps thread are the following:

- Maintenance and upgrade activities for CGS segments

- Simulation Node (FVTS) upgrade coordination
- Cal/Val Node (GRAVITE) upgrade coordination

These flows are described in Tables 6.2.6-4 to 6.2.6-6.

Table 6.2.6-4 provides a summary of the actors and actions for the implementation and coordination of JPSS GS software upgrades for CGS nodes. These upgrades include patches, maintenance releases, and block upgrades.

Table: 6.2.6-4 Maintenance and Upgrade

No.	Actors	Actions	Notes
1a	CSN, JPSS Review Boards	Stakeholders determine functions and/or new missions to be included in the Block Upgrade. Block upgrades can affect multiple missions or a single mission.	See Integrated Support (GS-NML-400) scenario Support Systems thread for details on the CCR process.
1b	CSN, MOT	For Patch Upgrades or Maintenance Releases, the CGS Track Issues/Process PCRs activity investigates WRs and provides support to MOT to determine solutions to the WR. The impact, mitigation, and upgrade/patch timing of upgrades/patches that address security issues is governed by NASA and NOAA security policies. Patch upgrades or maintenance releases can affect multiple missions or a single mission.	See Integrated Support (GS-NML-400) scenario Support Systems thread for details on the WRRP and GS-NML-220 (Security) for security operations concepts.
2a	CSN, JPSS Review Boards	New functions are documented and approved for development in a Block Upgrade.	See Integrated Support (GS-NML-400) scenario Support Systems thread for details on the CCR process.
2b	JPSS Review Boards	For Patch Upgrades or Maintenance Releases, Work Request Review Board (WRRB) assigns the WR to CSN to develop a change to the software to address the WR.	
3	CSN	For Patch Upgrades, Maintenance Releases, the CGS Track Issues/Process PCRs activity generates one or more PCRs to document the software change(s) that needs to be made.	1 PCR is written per software baseline that is affected.
4	CSN	For Maintenance Releases, Patch Upgrades, and Block Upgrades, Ground System Factory determines a set of PCRs for inclusion in a software release.	

No.	Actors	Actions	Notes
5	CSN	The Develop SW activity develops software changes.	Development occurs in CSN development environment.
6	Cal/Val Node, CSN	For Block Upgrades or Maintenance Releases, the Cal/Val Forward Recommended Updates Activity provides algorithm code updates and ground tables associated with a FSW upgrade to the CGS Develop & Execute Factory Tests activity for operationalization, integration and verification.	Details on algorithm code change development can be found in Algorithm Development and Maintenance (GS-NML-170). Details on Flight Software Upgrades can be found in Flight Software Upgrade (GS-NML-070).
7	MON, DPN, CSN	The CGS Develop &Execute Factory Tests activity requests operational data from MMC A-string and/or IDP A-string necessary to conduct verification activities on the Patch Upgrade, Maintenance Release, or Block Upgrade.	The A-string is assumed to be the Primary Operational String. These requests are made via WRS (C3S) or direct from operational CGS (IDPS).
8	MON, DPN, CSN	CGS MMC A-string and/or IDPS A-string provide requested data.	Data can be in electronic format or can be placed on media to transfer to CSN.
9a	CSN	For Block Upgrades, the CGS Develop &Execute Factory Tests activity verifies Block requirements for new requirements, interfaces, functionality, or missions.	Block Verification happens at Qualification Test and FAT tests.
9b	CSN	For Patch Upgrades or Maintenance Releases, the CGS Develop &Execute Factory Tests activity verifies PCR fixes for the software release's PCRs.	PCR verification occurs in the CSN test environment, and may use the FVTS for verification activities, if necessary.
10	JPSS Review Boards	The JPSS Review Board approves build for delivery to B-string.	Approval can include specific ground assets reserved (e.g. a pooled resource) for validation activities, as well as a schedule of B-string validation activities for all reserved assets.
11	CSN, Cal/Val Node, MON, DPN, JPSS CM	For Maintenance Releases or Patch Upgrades, the CGS Track Issues/Process PCRs activity updates the status of PCRs included in the Maintenance Build or Block	

No.	Actors	Actions	Notes
		Release, where they can be viewed by the Track Discrepancy Reports activity	
12	CSN	The Distribute SW Update activity delivers software release to operational site.	New software build may be delivered electronically via FTP or may be delivered on media
13	Field Terminal Support (FTS) Node	The FTS Receive & Archive Software activity receives the software.	
14	MON, DPN, GNN, Space/Ground Communications Node (SGCN)	The CGS Evaluate DPN Update and CGS Evaluate MON, GNN, & S/GCN Update activities install software release on the Secondary B-string at the operational site or on the pooled resource hot spare.	
15	MON, DPN	The CGS Evaluate DPN Update and CGS Evaluate MON, GNN, & S/GCN Update activities trigger data synchronization between Primary A-string and Secondary B-string.	
16	MON, DPN	The Evaluate DPN Update and Evaluate MON, GNN, & S/GCN Update activities replicate Primary A-string data to CGS Secondary B-string.	
17	MON, DPN, GNN, SGCN, SDS, CLASS, NESDIS ESPC	The CGS Evaluate DPN Update and CGS Evaluate MON, GNN, & S/GCN Update activities conduct installation, test, and checkout (ITCO) activities on the new build on the Secondary B-string.	This activity includes ITCO and SAT activities. SAT activities include interface testing with externals on test interfaces with the MON/DPN build undergoing test.
18	MOT, MON, DPN	The CGS Evaluate DPN Update and CGS Evaluate MON, GNN, & S/GCN Update activities conduct validation activities on the software release on the Secondary B-string or pooled resource hot spare.	Validation activities may include SMO.
19	JPSS Review Board	The JPSS Review Board determines software release is ready to be transitioned to primary ops.	
20	MOT, MON, DPN, GNN, Space/Ground Communications Node	The CGS Transition MON, GNN, S/GCN Update to Operations and CGS Transition Update to Operations activities transition primary ops to the Primary B-string. The Secondary A-string or remaining pooled	Length of SMO period is determined by stakeholders.

No.	Actors	Actions	Notes
		resources continue Shadow Mode Operations in case fallback is required.	
21a	MOT	The MOT Notify & Coordinate Enterprise Activities with Users activity distributes Mission Notice to authorized external users of the new baseline for S/GCN, MON or DPN.	
21b	MOT	The MOT Notify & Coordinate Enterprise Activities with Users activity distributes Mission Notice to authorized external users that a revert/fallback to the previous baseline for S/GCN, MON or DPN is required.	Revert to the prior operational configuration within five minutes in case of HW/SW anomalies with the new capabilities.
22	MON	The CGS Process Mission Activity & Task Request activity release Secondary A-string for other Maintenance and Upgrade activities.	
23	MOT, MON, DPN, GNN, SGCN	Repeat Steps 13-17 where B-string is acting as Primary and A-string is acting as Secondary. Review Board reviews validation results from Secondary A-string, and releases Secondary A-string for other activities.	

Table 6.2.6-5 provides a summary of the actors and actions for the coordination of JPSS GS upgrades for the Simulation Node (FVTS). The simulation node upgrade implementation is addressed in the Simulation Node ConOps thread. SMU is responsible for the coordination of Simulation Node upgrades with other parts of the JPSS GS.

Table: 6.2.6-5 Simulation Node (FVTS) Upgrade Coordination

No.	Actors	Actions	Notes
1	Simulation Node (SIM), MON	The SIM Manage and Configure Simulator activity provides schedule for maintenance outage to the Schedule Maintenance & Corrective Actions activity.	
2	MON	The Schedule Maintenance & Corrective Actions activity provides the Simulator schedule for maintenance outage to the CGS Process Mission Activity & Task Request activity via the Maintain Ground System activity.	For more information on mission planning, see the Mission Planning & Scheduling (MPS) ConOps thread.
3	MON	The CGS Process Mission Activity & Task Request activity performs mission planning based on the reduced FVTS availability and capability.	
4	Simulation Node	The SIM Manage & Configure Simulator activity conducts upgrade activities on the FVTS.	Upgrade activities are conducted in accordance

No.	Actors	Actions	Notes
			with relevant FVTS plan documents.
5	Simulator Node, MON	The SIM Manage SIM Nodal Situational Awareness activity determines that the FVTS upgrade has been successfully completed and provides Simulator status information to the CGS Maintain Ground System activity. The CGS Maintain Ground System activity notifies the CGS Process Mission Activity & Task Request activity the updated Simulator status. From this point forward, the CGS Process Mission Activity & Task Request activity returns to planning based on having the full capability of the FVTS to support flight and ground operations.	

Table 6.2.6-6 provides a summary of the actors and actions for the coordination of JPSS GS upgrades with the Cal/Val node. The only interface of the Cal/Val Node to CGS is GRAVITE.

Table: 6.2.6-6 Cal/Val Node (GRAVITE) Upgrade Coordination

No.	Actors	Actions	Notes
1	Cal/Val Node, MON	The Cal/Val Manage Cal/Val Infrastructure activity provides schedule for maintenance outage to the Schedule Maintenance & Corrective Actions activity.	
2	MON	The Schedule Maintenance & Corrective Actions activity provides the Cal/Val schedule for maintenance outage to the CGS Process Mission Activity & Task Request activity via the CGS Maintain Ground System activity.	
3	MON	The CGS Process Mission Activity & Task Request activity performs mission planning based on the reduced Cal/Val availability and capability.	
4	Cal/Val Node	The Cal/Val Manage Cal/Val Infrastructure activity conducts upgrade activities.	Maintenance activities are conducted in accordance with relevant GRAVITE plan documents.
5	Cal/Val Node, MON	The Cal/Val Manage Cal/Val Infrastructure activity determines that the Cal/Val Node Maintenance/Upgrade has been successfully completed, and notifies the CGS Maintain Ground System activity. The CGS Maintain Ground System activity notifies the CGS Process Mission Activity & Task Request activity, which in turn will	

No.	Actors	Actions	Notes
		perform mission planning based on the full Cal/Val availability and capability.	

6.2.6.7 Alternate Flow

Hardware upgrades, facilities planning, and facility requirements are coordinated with stakeholders prior to the Hardware Upgrade procurement cycle. Hardware is procured in according with the procuring agency's hardware procurement processes. Updates are made to the Product Baseline Indentured Drawing Lists, and those updates are CCB controlled. A Physical Configuration Audit is held prior to hardware shipment to ensure the "as-built" hardware is as documented in the design documentation (specifications, drawings, etc.). Hardware upgrades are installed on B-string at the primary site. A-string at the primary site continues to run normal operations, while B-string executes installation, check out, test, and validation activities. A review board reviews and approves the validation activity results, and normal operations are transitioned to the B-string. Once transition of operations is complete, the hardware upgrade is installed, checked out, and validated on A-string and at the CBU.

Issues that occur during verification, installation, check out, validation, and SMO activities are documented in PCRs. If PCRs occur before completion of SAT, PCRs are worked off before or during the next applicable Verification Event. If the PCR occurs during the SMO phase of maintenance activities, the OSPO Management may revert the B-string to the current software baseline installed in the OPS1 directories, freeing the B-string assets for other activities. If the PCR occurs during post-transition SMO, the OSPO Management and review board may choose to fall back to the current software baseline on the A-string. Fallback operations may require graceful termination of B-string software in the OPS2 directories, and initialization of software from OPS1 directories.

6.2.6.8 Post Condition

Upgrades are installed and verified. The upgraded system performs normal operations.

6.2.6.9 Related Scenarios

The ConOps threads shown below provide background information for the SMU thread. Review of these will help in the understanding of the SMU thread activities.

Thread ID	Thread Title
GS-NML-080	Flight Vehicle Simulation
GS-NML-310	Ground Operations
GS-NNL-120	Continuity of Operations
GS-NML-070	Flight Software Upgrade
GS-NML-400	Integrated Support
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-170	Algorithm Development and Maintenance
GS-NML-220	Security

6.2.6.10 Child Threads

The OpsCon threads shown below are the Level 4 threads that directly flow down from this Level 2/3 SMU thread.

Thread ID	Thread Title
CGS-030-020	Maintenance & Upgrade

6.2.7 Continuity of Operations

6.2.7.1 Description

The Continuity of Operations (COOP) thread (GS-NNL-120) describes JPSS Ground System (GS) activities associated with ensuring that the missions the JPSS program is entrusted with are always supported. This means that the GS will maintain spacecraft health and safety and continue to produce mission data products even in the event of a catastrophic failure. This concept is progressively implemented in the CGS via a Stop Gap Management & Operations Node (MON), an Alternate Ground Station (AGS) and the associated alternate network, brought online in Block 1.2.2 and 1.2.3 respectively, to ensure the health and safety of the S-NPP satellite. In Block 2.0, the Stop Gap MON is replaced by the Alternate Common Ground System (ACGS) consisting of the Alternate MON (including an Alternate JPSS SMD Hub (AltJSH)) and an Alternate Data Processing Node (DPN). ACGS ensures that there is a full backup at a remote location for all mission-critical items within the GS and supports the S-NPP, JPSS-1/2/3/4 (B2.2) and GCOM-W1 missions. For the purpose of COOP discussion, AltJSH is treated as a separate entity even though it is a part of Alt MON; and so are JSH and MON.

This thread describes the synchronization and transition between the primary MON and the Alternate MON (AltMON). It also describes the transition between the DPN and the Alternate DPN (AltDPN) and the transition of the JPSS SMD Hub (JSH) to the AltJSH. This includes primary-backup synchronization during nominal operations, the transition of operations from the primary to the backup in contingency, and the transition of operations back to the primary. The Mission Operations Team (MOT) Configuration Management (CM) group keeps the sites in synchronization with respect to their CM libraries. This activity is separate from the synchronization activities described in the flows.

The Stop Gap MON, located at CGS Support Node - Operations (CSN-OPS) in Aurora, Colorado, is an interim limited capability starting in Block 1.2.2. It is comprised of Telemetry and Command (T&C) and mission-critical offline functions required to maintain the S-NPP satellite in the event that the primary MON becomes unavailable. It does not support data accounting and recovery, situational awareness, or Mission Support Data (MSD) functions. In Block 2.0, the Stop Gap MON is replaced by the AltMON, which supports all the same capabilities and interfaces as the primary MON.

The Alternate Data Processing Node provides backup SMD processing capabilities. It is capable of generating all products that the primary DPN at NSOF creates. Prior to the AltDPN in Block 2.0, up to 24 hours of manually commanded restoration capability is available once the DPN returns to functionality. The AltDPN supports all internal CGS interfaces as well, but only provides for the CLASS and NOAA ESPC interfaces external to the CGS. The CLASS ingest

node and ESPC allow data product processing, archive and storage, and distribution to users to continue through an outage event. The GRAVITE interface is not supported at the AltDPN.

The Alternate Common Ground System (ACGS) is a single string, internally redundant version of the MON, DPN, JSH, hosts an OPS-class JPSS-1 simulator (J1Sim) and a FSE JPSS-2/3/4 (in B2.2) simulator, and the payload support capability that enables local and remote instrument analysts to access the database containing a complete view of relevant application packets as well as the support tools to analyze those packets. It provides continuous backup/failover operations functionality for the S-NPP, JPSS-1/2/3/4, and GCOM-W1 missions. The ACGS can be functional within 12 hours of the decision to transfer operations and can be accessed remotely from the NSOF (MON and DPN). It is physically located within NOAA's Consolidated Backup (CBU) facility in Fairmont, WV, in order to avoid a localized disaster (e.g., hurricanes or floods) that could affect both primary and backup CGS installations. The 12 hours transition time includes an allocation of up to 8 hours for operations personnel to travel to CBU (including prep time, nominal drive time plus contingency for weather/traffic).

The CBU is planned to be used for up to 30 days continuously, it is not considered a permanent solution for primary operations. Because it is a short-term use facility, the CBU does not support preparation for software upgrades, spacecraft compatibility testing, or have a direct link to vendor sustaining engineering facilities. Vendor support will be obtained on an as-needed basis if issues arise while the CBU is primary. In addition, the AltDPN doesn't support Data Quality Assurance (DQA) capability. During the transition period, the ACGS is not held to data latency or data availability requirements. However, once the transition to the ACGS is completed, data latency and data availability requirements apply.

The Alternate Ground Station (AGS), also known as the Alternate Space/Ground Communication Node (Alternate SGCN) in Block 2.0, has the full capability of the Primary Ground Station in Svalbard, Norway, and is located at NOAA's Fairbanks Command and Data Acquisition Station (FCDAS) in Fairbanks, Alaska. Due to its location, the Alternate SGCN does not have all the S-NPP, JPSS-1/2/3/4 satellite visibilities that Svalbard does. Thus, when using FCDAS, data arrival may be less timely, but no mission data is lost. To meet tighter latency requirements, a second Primary Ground Station is added for JPSS-1 at McMurdo in Antarctica, along with a second Alternate Ground Station (TrollSat) located in Jutulsessen, Antarctica. The Space Network is also used as a backup for SMD retrieval for JPSS-1/2/3/4.

Transition from primary (aka the A-String) to secondary (aka the B-String) is not considered part of COOP, since for planning purposes, the primary and secondary strings are to support upgrades, training, and other non-operational activities. Such transition may also occur as a failover for an anomaly condition. For a description of the transition from the primary to the secondary string, see System Maintenance and Upgrade (GS-NNL-140).

While this thread focuses on the mission management, flight operations and data processing of S-NPP, JPSS-1/2/3/4 and GCOM-W1 missions in support of COOP, the JPSS Ground System will also continue to provide full support to the JPSS-supported missions such as Metop, NSF, DMSP, and SCaN missions during a COOP event. The only exception is the Coriolis/WindSat mission that normally has its mission data routed from Svalbard to NSOF. Because it has no connectivity at CBU, therefore no data routing service will be provided to the Coriolis/WindSat mission during a COOP event.

The OSPO Management is responsible for determining that a transition between sites should occur following the documented procedures.

Two government documents govern the use of the backup facilities. The NOAA5042 JPSS Contingency Plan and the Business Impact Analysis Plan describe each site's activation, when and how, chain of command and provide SOPs and other required operational descriptions.

6.2.7.2 Primary Interfaces

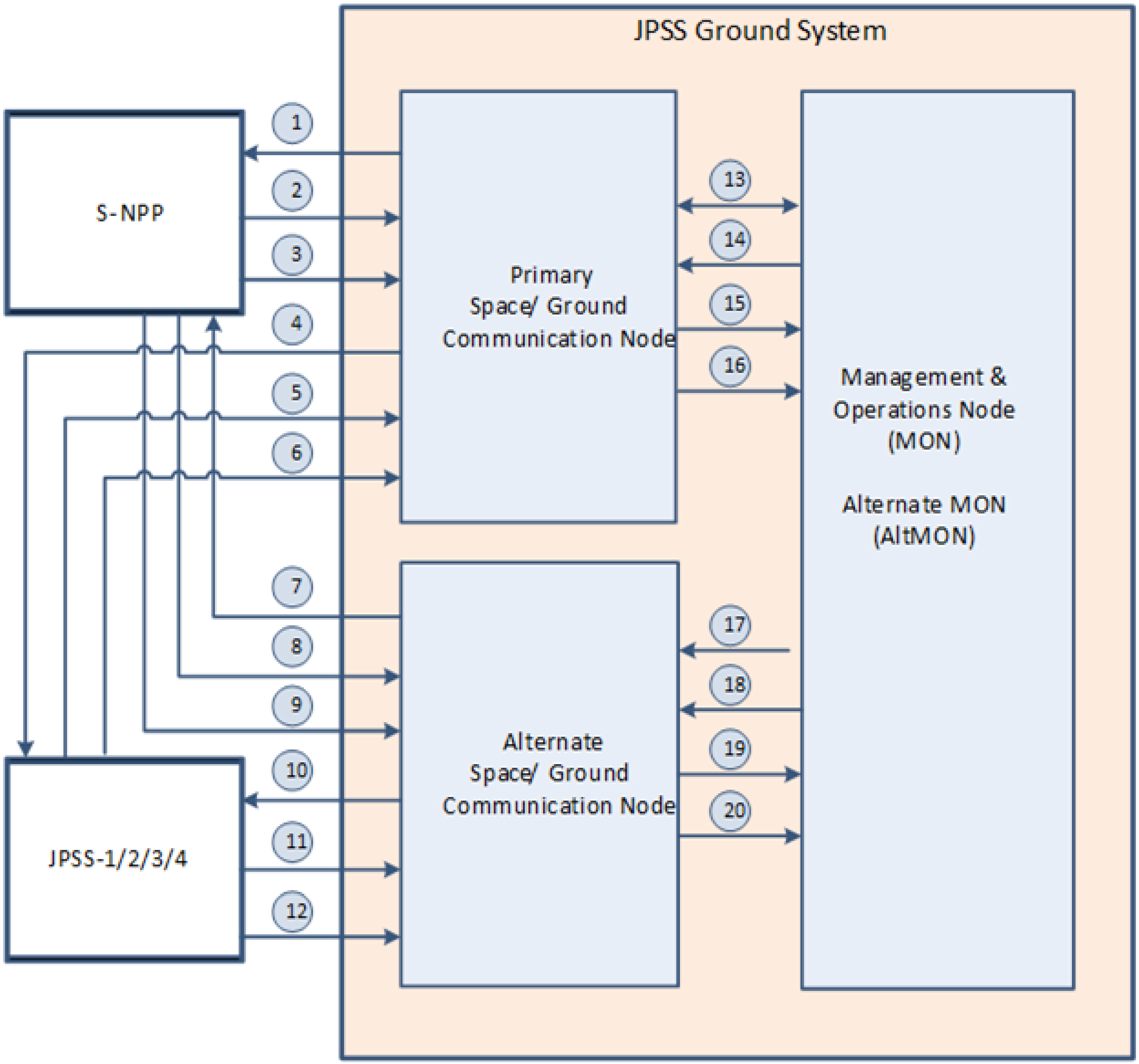


Figure: 6.2.7-1 Alternate Space/Ground Communications Node Primary Interfaces

Table: 6.2.7-1 Alternate Space/Ground Communications Node Primary Interfaces

No.	Type	Actors	Purpose
1	External	S-NPP, Primary Space/Ground Communications Node	CMDs
2	External	S-NPP, Primary Space/Ground Communications Node	SMD
3	External	S-NPP, Primary Space/Ground Communications Node	RT-TLM and PB-TLM
4	External	JPSS-1/2/3/4, Primary Space/Ground Communications Node	CMDs
5	External	JPSS-1/2/3/4, Primary Space/Ground Communications Node	RT-TLM and PB-TLM
6	External	JPSS-1/2/3/4, Primary Space/Ground Communications Node	SMD
7	External	S-NPP, Alternate Space/Ground Communications Node	CMDs
8	External	S-NPP, Alternate Space/Ground Communications Node	RT-TLM and PB-TLM
9	External	S-NPP, Alternate Space/Ground Communications Node	SMD
10	External	JPSS-1/2/3/4, Alternate Space/Ground Communications Node	CMDs
11	External	JPSS-1/2/3/4, Alternate Space/Ground Communications Node	RT-TLM and PB-TLM
12	External	JPSS-1/2/3/4, Alternate Space/Ground Communications Node	SMD
13	Internal	MON/Alt_MON, Primary Space/Ground Communications Node	HW Status & Control
14	Internal	MON/Alt_MON, Primary Space/Ground Communications Node	CMDs
15	Internal	MON/Alt_MON, Primary Space/Ground Communications Node	RT-TLM and PB-TLM
16	Internal	MON/Alt_MON, Primary Space/Ground Communications Node	S-TLM

No.	Type	Actors	Purpose
17	Internal	MON/Alt_MON, Alternate Space/Ground Communications Node	HW Status & Control
18	Internal	MON/Alt_MON, Alternate Space/Ground Communications Node	CMDs
19	Internal	MON/Alt_MON, Alternate Space/Ground Communications Node	RT-TLM and PB-TLM
20	Internal	MON/Alt_MON, Alternate Space/Ground Communications Node	S-TLM

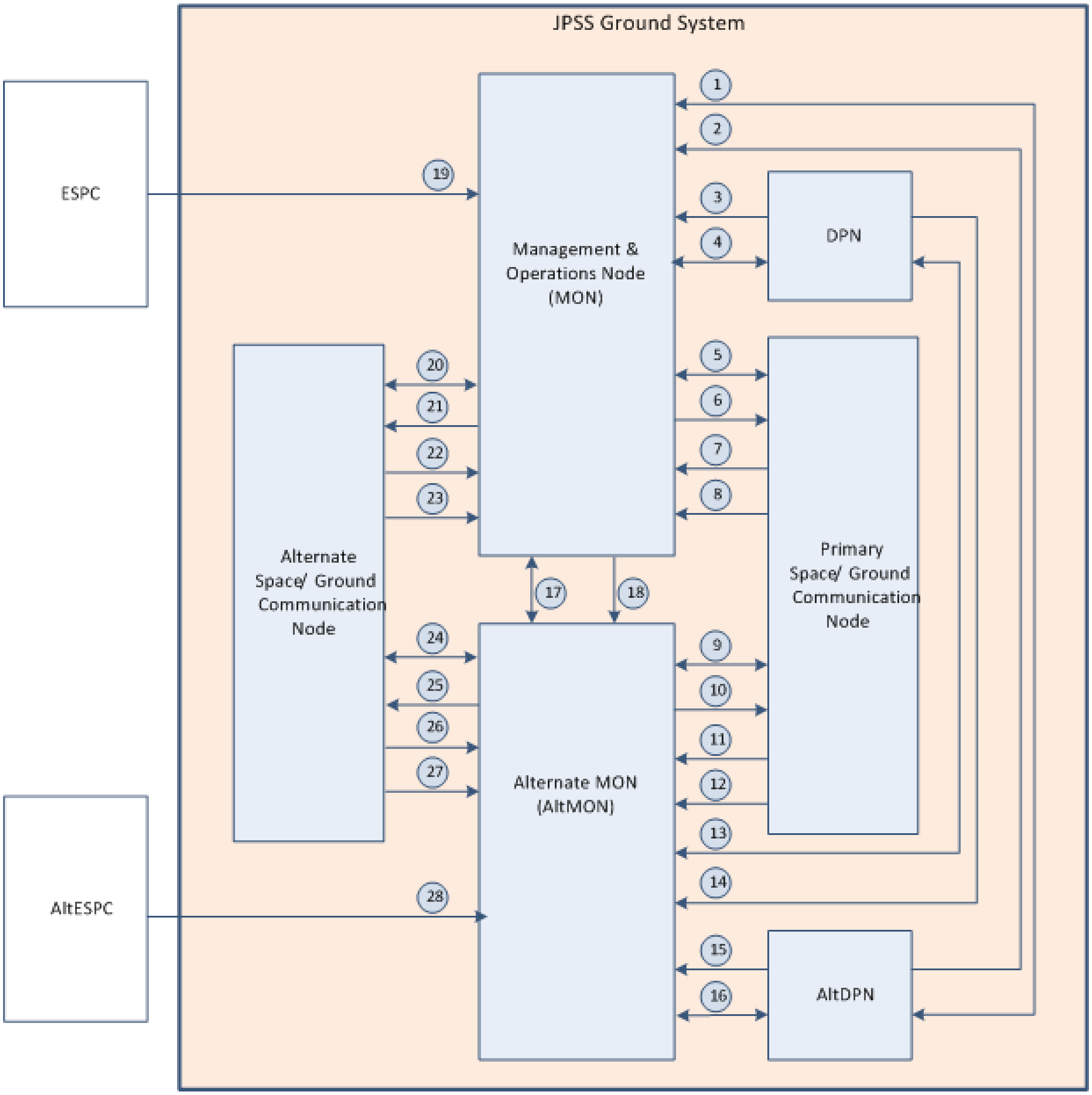


Figure: 6.2.7-2 Alternate MON Primary Interfaces

Table: 6.2.7-2 Alternate MON Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	MON, Alternate (Alt) DPN	Mission Support Data (MSD)
2	Internal	Alt DPN, MON	Status
3	Internal	DPN, MON	Status
4	Internal	MON, DPN	MSD
5	Internal	MON, Primary Space/Ground Communications Node (SGCN)	HW Status & Control

No.	Type	Actors	Purpose
6	Internal	MON, Primary SGCN	CMDs
7	Internal	Primary SGCN, MON	RT-TLM and PB-TLM
8	Internal	Primary SGCN, MON	S-TLM
9	Internal	Alt MON, Primary SGCN	HW Status & Control
10	Internal	Alt MON, Primary SGCN	CMDs
11	Internal	Primary SGCN, Alt MON	RT-TLM and PB-TLM
12	Internal	Primary SGCN, Alt MON	S-TLM
13	Internal	Alt MON, DPN	MSD
14	Internal	DPN, Alt MON	Status
15	Internal	Alt DPN, Alt MON	Status
16	Internal	Alt MON, Alt DPN	MSD
17	Internal	MON, Alt MON	Data Synchronization
18	Internal	MON, Alt MON	Remote access
19	External	ESPC, MON	Ancillary data
20	Internal	MON, Alt SGCN	HW Status & Control
21	Internal	MON, Alt SGCN	CMDs
22	Internal	Alt SGCN, MON	RT-TLM and PB-TLM
23	Internal	Alt SGCN, MON	S-TLM
24	Internal	Alt MON, Alt SGCN	HW Status & Control
25	Internal	Alt MON, Alt SGCN	CMDs
26	Internal	Alt SGCN, Alt MON	RT-TLM and PB-TLM
27	Internal	Alt SGCN, Alt MON	S-TLM
28	External	Alt ESPC, Alt MON	Ancillary data

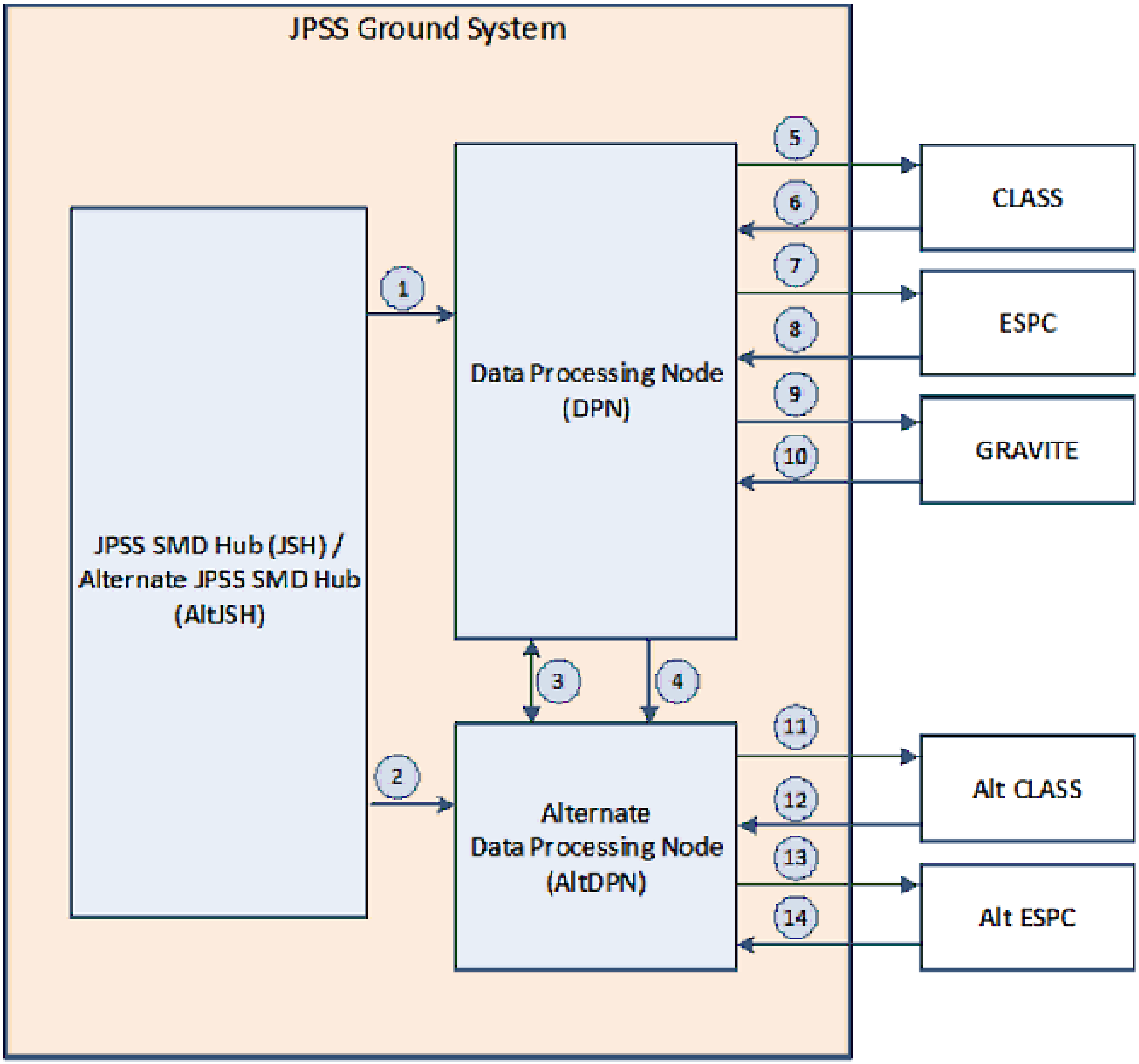


Figure: 6.2.7-3 Alternate DPN Primary Interfaces

Table: 6.2.7-3 Alternate DPN Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	JSH, DPN	SMD VCDUs or APs
2	Internal	AltJSH, AltDPN	SMD VCDUs or APs
3		Reserved	
4	Internal	DPN to AltDPN	Remote access, Data Analysis Report (DAR)
5	External	DPN to CLASS	JPSS xDRs, GCOM-W1 RDRs, IPs, metadata, MSD
6	External	CLASS to DPN	Data product request

No.	Type	Actors	Purpose
7	External	DPN to ESPC	JPSS xDRs, GCOM-W1 RDRs, IPs, metadata, MSD
8	External	ESPC to DPN	Data product request, Ancillary data
9	External	DPN to GRAVITE	Alerts and supporting data related to product quality events. JPSS xDRs, IPs, metadata, MSD
10	External	GRAVITE to DPN	Data product request
11	External	AltDPN to Alt CLASS	JPSS xDRs, GCOM-W1 RDRs, IPs, metadata, MSD
12	External	Alt CLASS to Alt DPN	Data product request
13	External	Alt DPN to Alt ESPC	JPSS xDRs, GCOM-W1 RDRs, IPs, metadata, MSD
14	External	Alt ESPC to Alt DPN	Data product request, Ancillary data

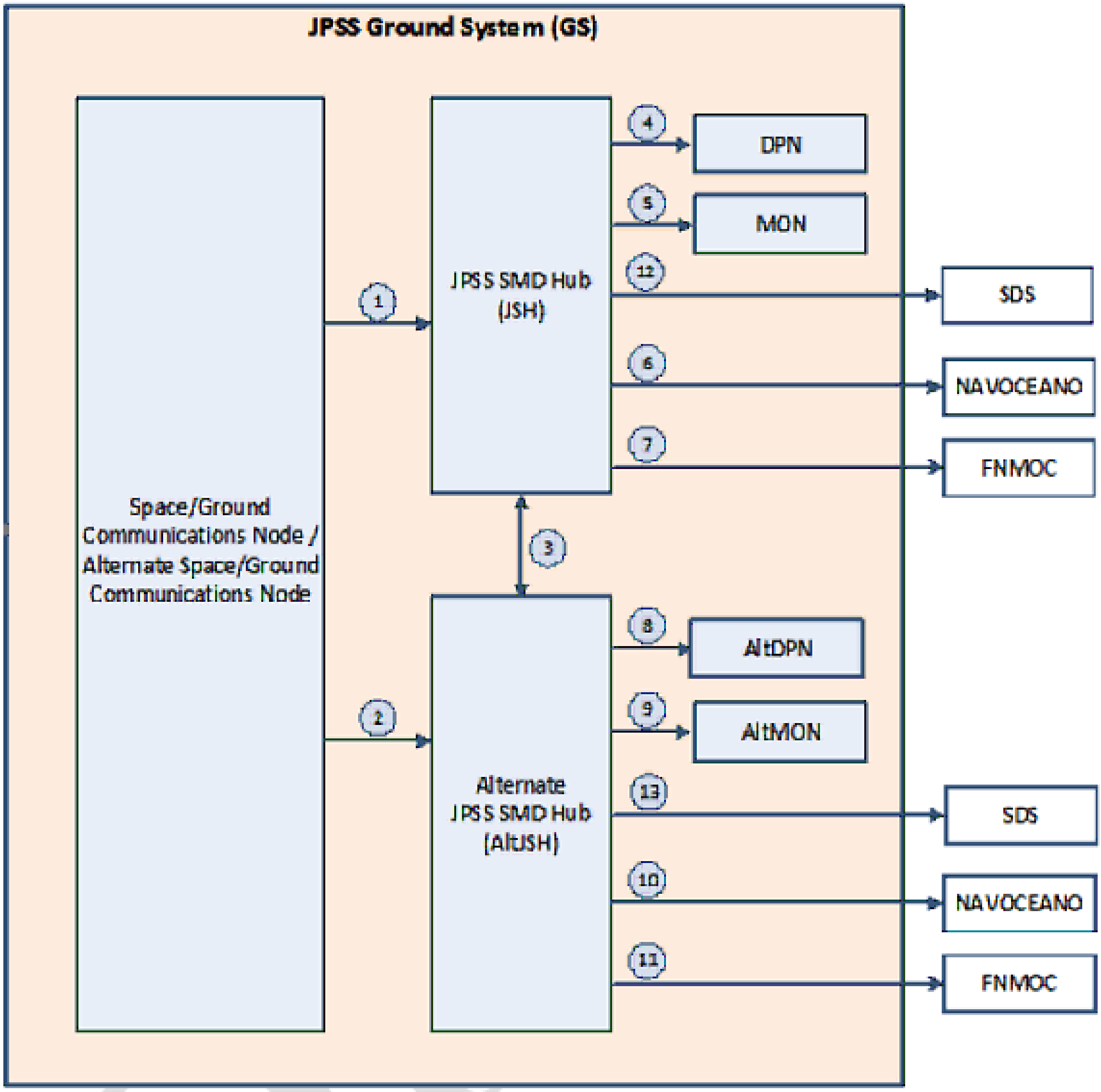


Figure: 6.2.7-4 Alternate JSH Primary Interfaces

Table: 6.2.7-4 Alternate JSH Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	Space/Ground Communications Node, JPSS SMD Hub	SMD VCDUs
2	Internal	Space/Ground Communications Node, Alternate JPSS SMD Hub	SMD VCDUs
3	Internal	JPSS SMD Hub, Alternate JPSS SMD Hub	SMD VCDUs
4	Internal	JPSS SMD Hub, DPN	SMD APs
5	Internal	JPSS SMD Hub, MON	S-TLM APs, Status
6	External	JPSS SMD Hub, NAVOCEANO	SMD APs
7	External	JPSS SMD Hub, FNMOC	SMD APs
8	Internal	Alternate JPSS SMD Hub, AltDPN	SMD APs

No.	Type	Actors	Purpose
9	Internal	Alternate JPSS SMD Hub, AltMON	S-TLM APs, Status
10	External	Alternate JPSS SMD Hub, NAVOCEANO	SMD APs
11	External	Alternate JPSS SMD Hub, FNMOC	SMD APs
12	External	JPSS SMD Hub, SDS	SMD VCDUs
13	External	Alternate JPSS SMD Hub, SDS	SMD VCDUs

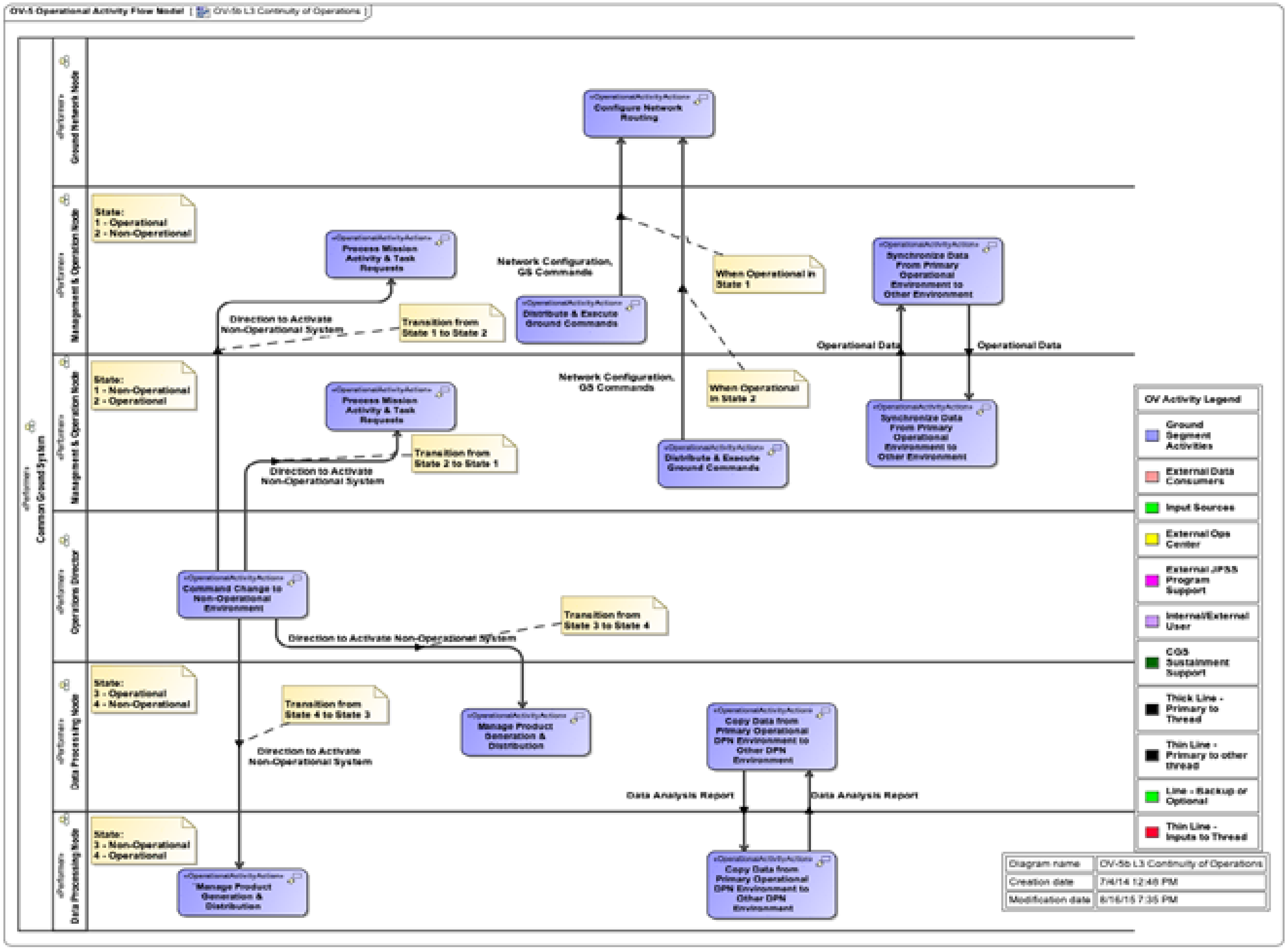
6.2.7.3 Assumptions & Constraints

- The ESPC Product Distribution and Access (PDA) System has a presence at CBU and makes ancillary data available to ACGS at all times.
- It is possible for S-NPP or JPSS-1, JPSS-2/3/4 contacts to be taken at both Svalbard and FCDAS during the same orbit for both telemetry and SMD. However, only one ground station can send commands to the spacecraft during the concurrent contacts.
- Either MON or AltMON is in control, but it is possible to do parallel operations with commanding disabled.
- MON (without JSH), JSH, and DPN can transfer their operations to the alternate site independently. It is recommended to transfer JSH together with DPN to reduce data latency.
- Data accounting resumes after the transition is complete.
- S-NPP Mission Data has a potential to be lost when using FCDAS since there are daily 4 orbit gaps where the current onboard storage is about 6 orbits worth of SMD. Depending on the Svalbard failure type, timing of the failure, and decision time to use FCDAS data may not be recoverable. Therefore recovering the oldest data from onboard Mass Data Storage, Solid State Recorders (SSR) in B2.0 that has not been received should be given a priority in recovery.

6.2.7.4 Pre-Conditions

6.2.7.5 Operational Flow

Figure 6.2.7-5 provides an illustration of system activities covering data synchronization and transition between CGS and ACGS.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.7-5 CGS to ACGS Flow Diagram

6.2.7.6 MON to AltMON Flow

Trigger: Data synchronization between the MON and the AltMON occurs continuously. In the event of a failure, the steps pertaining to transfer of operations from the MON to the AltMON and the return to the primary MON are triggered by the decision being made by the OSPO management (the Command Change to Alternate Facility activity).

Table: 6.2.7-5 MON to AltMON Flow

No.	Actors	Actions	Notes
Data Synchronization			
1	CGS	The Synchronize Data from Primary Operational Environment to Other Environment activity synchronizes offline data from the MON to the AltMON to ensure that the AltMON has	Offline data products include items like schedules and OPS products.

No.	Actors	Actions	Notes
		the offline data products necessary to take over MON operations. Synchronization occurs when new products are created at the primary MON.	
2a	CGS, S-NPP	The CGS AltMON receives S-NPP telemetry and processes it concurrent with the primary MON.	
2b	CGS, JPSS-1/2/3/4	JPSS-1/2/3/4 telemetry is also received and processed at the MON and the AltMON concurrently.	
Transition to AltMON			
3	CGS	Once the decision has been made to transition to the AltMON, the MON staff brings the AltMON into full operational commanding order within 12 hours. This includes transferring the situational awareness and data accounting and recovery primary capabilities to the AltMON.	Transition to the AltMON may occur due to failure or for training purposes. The 12 hours transition time includes an allocation of up to 8 hours for operations personnel to travel to CBU
4a	CGS, S-NPP	The AltMON continues to receive and process S-NPP TLM and begins to command S-NPP per the schedule.	See NML-030 Satellite Telemetry and Command for details.
4b	CGS, JPSS-1/2/3/4	The AltMON continues to receive and process JPSS-1/2/3/4 TLM and begins to command JPSS-1/2/3/4 per the schedule.	
5	CGS	New orbital products are generated, per nominal process. Orbital product generation may also occur out of cycle as one of the activities related to transitioning back to the MON.	
6	CGS	Nominal scheduling process occurs. Additional scheduling may take place as one of the activities related to transitioning back to the MON.	The JPSS mission scheduler will establish contact with the DMSP backup SOCC at Schriever AFB, CO to coordinate DMSP contact schedule and provide continued support to the DMSP operations.
7	CGS	During COOP, the JPSS Ground System continues to provide data routing services to the JPSS-supported missions with the exception of the Coriolis mission. The AltMON monitors network operations in support of the data routing service.	The Coriolis SDP is at NSOF. The Coriolis mission does not have a presence at CBU.

No.	Actors	Actions	Notes
8	Simulation Node	The Simulation Node will have an OPS-class FVTS at CBU to support the JPSS-1/2/3/4 flight operations during COOP.	The lack of FVS at CBU to support S-NPP flight operations is a known risk to the project.
Transition back to MON			
9	CGS	Prior to command and control returning to the MON, operational staff brings all functionality back up and ensures that it is ready to take back operations. This includes transferring the data accounting and recovery primary capability back to the MON, as well as readying the Mission Support Data to be current for externals.	
10	CGS	The Synchronize Data from Primary Operational Environment to Other Environment activity synchronizes data between the AltMON and the MON to bring the MON up-to-date. This includes processed telemetry that the MON missed and any updated schedules and products, orbital and otherwise, that were created at the AltMON.	
11	CGS	The MON staff uses the situational awareness capability to determine when the MON is ready to return to primary operations.	
12	OSPO	Once the MON is deemed ready to return to operations, the OSPO Lead Engineer sets a time to transition back to the MON.	
13	CGS	The CGS command and control software resumes control and all MON functions return to normal.	
14	CGS	After operations have transitioned to the MON and been confirmed, the AltMON returns to the nominal processing of TLM and data synchronization.	

6.2.7.7 DPN to AltDPN Flow

Trigger: In the event of a failure, the steps pertaining to transfer of operations from the DPN to the AltDPN and the return to the primary DPN are triggered by the decision being made by the OSPO Management (the Command Change to Alternate Facility activity).

Table: 6.2.7-6 DPN to AltDPN Flow

No.	Actors	Actions	Notes
Data Synchronization			

No.	Actors	Actions	Notes
1	CGS	Initially and with each upgrade, the DPNs are seeded to ensure parallel processing starts in the same place.	
2	CGS	The AltDPN acquires ancillary data from ESPC PDA PoP at CBU.	
3	CGS	The DPN and AltDPN process SMD in parallel as it is received from the JSH. The MOT monitors the processing at the AltDPN in a similar manner to the DPN processing (via remote access). The Copy Data from Primary Operational DPN Environment and Other DPN Environment activity copies the Data Analysis Report (DAR) from the primary operational IDP to other IDPs daily.	SMD processing is described in Stored Mission Data Handling (GS-NML-100)
Transition to AltDPN			
4	CGS	Once the decision has been made to transition to the AltDPN, the primary concern at the AltDPN is assuring the connections to the CLASS and ESPC PoPs are checked to make sure they are up and running. The NESDIS ESPC PDA PoP is also checked to make sure it is up and running. The pre-defined user requests are enabled; and the data distribution resumes from a selected time in the past before the transition to ensure no data gaps. Provide the Mission Support Data to the externals. The AltDPN is now considered the operational string and if time allows, recovery processing has begun to produce the data products that were missed during transition.	Transition to the AltDPN may occur due to failure or for training purposes. Duplicate data may be delivered. Data distribution resume time can be set per user.
5	CGS	If the transition from the DPN to the AltDPN was planned, the DPN continues to run in order to ensure complete continuity of repaired products and retransmissions. The DPN is no longer operational or available for outside connection once the retransmit period has expired.	
Transition back to DPN			

No.	Actors	Actions	Notes
6	CGS	Prior to operational science data processing returning to the DPN, operational staff brings all functionality back up. If the DPN requires a new seed, it is applied	
7	CGS	Once science data processing has been running for a predetermined period of time, a drift comparison is performed. If the DPN is confirmed to be in sync with the AltDPN, operations are ready to transfer back. The Copy Data from Primary Operational DPN Environment and Other DPN Environment activity copies the Data Analysis Report (DAR) from the primary operational IDP to other IDPs daily.	
8	CGS	Once the DPN is deemed ready to return to operations, the OSPO management sets a time to transition back to the DPN.	
9	CGS	At the DPN, existing user requests are deconflicted to ensure duplicate data is not delivered.	
10	CGS	After operations have transitioned to the DPN and been confirmed, the AltDPN returns to shadow processing and data synchronization.	

6.2.7.8 JSH to AltJSH Flow

Trigger: The JSH and AltJSH are components of the Ground Network Node. Data synchronization between the JSH and the AltJSH occurs during science data flow. In the event of a failure, the steps pertaining to transfer of operations from the JSH to the AltJSH and the return to the primary JSH are triggered by the decision being made by the OSPO management (the Command Change to Alternate Facility activity). Note that while JSH typically transitions together with DPN to minimize the data latency, it can be transitioned independently of MON and DPN if needed.

Table: 6.2.7-7 JSH to AltJSH Flow

No.	Actors	Actions	Notes
Data Synchronization			
1	CGS	The JSH provides SMD APs to the DPN at NESDIS ESPC, MON, FNMOC, NAVOCEANO and the CSN. The JSH also provides SMD VCDUs to SDS. In addition, the JSH	

No.	Actors	Actions	Notes
		provides SMD VCDUs to the AltJSH for CBU shadow processing.	
2	CGS	The AltJSH receives SMD VCDUs from the JSH. It provides SMD APs to the AltMON and AltDPN at CBU.	
Transition to AltJSH			
3	CGS	Transition to the AltJSH requires prepass changes to ensure that the AltJSH connects to the receiving Space/Ground Communications Node for all SMD.	Transition back to JSH follows the same paradigm.
4	CGS	The AltJSH provides SMD APs to the AltDPN at CBU, FNMOC, NAVOCEANO and the CSN. The AltJSH also provides SMD VCDUs to SDS. The SMD APs are delivered to the MON/AltMON (whichever is primary). If the JSH is available, it receives SMD VCDUs for parallel processing.	

6.2.7.9 Alternate Ground Station Flow

Trigger: The Alternate Ground Station is scheduled in the event of an outage at a Primary Ground Station or to cover an RF conjunction event at a Primary Ground Station.

In order to use the Alternate Ground Station, the Mission Planner must coordinate with FCDAS and TrollSat to ensure availability. Otherwise, it is planned for use and scheduled in exactly the same way that a Primary Ground Station is. That is, see GS-NML-020 Mission Planning and Scheduling for a description of the process to determine satellite visibilities and schedule ground resources for contacts, after coordination. The process by which the CGS commands the satellite and receives telemetry and SMD is exactly the same as though it were a primary ground station (see GS-NML-030 Telemetry and Command and GS-NML-100 Stored Mission Data Handling).

6.2.7.10 Post Conditions

6.2.7.11 Related Scenarios

Thread ID	Thread Title
GS-NML-300	System Status/Situational Awareness
GS-NML-220	Security
GS-NML-310	Ground Operations
GS-NML-010	Fleet Ground Management
GS-NML-140	Mission Support Data Handling
GS-NML-100	Stored Mission Data Handling
GS-NNL-140	System Maintenance and Upgrade

6.2.7.12 Child Threads

Thread ID	Thread Title
CGS-010-030	Continuity of Operations

6.2.8 System Fault Analysis

6.2.8.1 Description

The System Fault Analysis ConOps thread (GS-NNL-130) describes the process for identifying and implementing solutions for issues or anomalies when they cannot be resolved by the ground operations (for ground problems) or telemetry and commanding (for flight problems) using routine operations procedures. The System Fault Analysis ConOps thread receives unresolved issues from either the Ground Operations ConOps thread for ground system issues or the Telemetry & Commanding ConOps thread for issues having to do with JPSS managed satellites. This thread supports all JPSS supported missions; however, the fault analysis provided by JPSS will be limited to the extent of support provided by JPSS. For example, for missions where JPSS does not provide satellite operations support; the System Fault Analysis thread will be limited to investigating issues with the JPSS Ground System and to isolating the fault to mission systems outside of JPSS.

Following the convention used by S-NPP, an issue is defined as any problem that occurs in the JPSS Ground System or JPSS managed observatories. If an issue delays data by more than one orbit or causes data to be lost then that issue is reclassified as an anomaly. Anomalies are more serious than issues and require additional efforts to resolve them. The issues and anomalies are captured and tracked in the Discrepancy Report (DR) system.

This ConOps thread does not provide specific trouble-shooting steps or resolutions for specific issues or anomalies. These specific trouble-shooting steps and corrective actions are beyond the scope of the JPSS ConOps document.

Once the issue or anomaly has been identified, the System Fault Analysis ConOps thread reviews the issue to determine whether or not the problem is related to either the JPSS Ground System; a JPSS managed satellite, or an intersegment (i.e., JPSS Ground System and JPSS managed satellite) issue. The basic flows in this ConOps thread are organized around those three types of issues and are provided below:

1. **The JPSS Ground System**
    a. **Routine Corrective Action**: Corrective action requires routine execution of a Standard Operating Procedure (SOP) or similar procedure by the Ground Operations ConOps thread.
    b. **Routine Maintenance:** Corrective actions are performed by the System Maintenance & Update (SMU) ConOps thread. These involve hardware repair software patches of COTS products or other updates that don't require design changes.

c. **Design Change Required:** Corrective actions require hardware, software, or network architecture design changes. This upgrade is performed by the SMU ConOps thread.

2. **A JPSS managed satellite**

   a. **Commanding of Satellite:** Corrective actions only require commanding of the space craft or one of its instruments. A flight software update of either the spacecraft of its instruments is not required. This corrective action is performed by the Telemetry and Commanding ConOps thread.

   b. **Fight Software Update:** Corrective action requires a design change or table configuration change of either the space craft or its instruments flight software. This corrective action is performed by the Flight Software Update (FSU) ConOps thread.

3. **An intersegment issue that may involve both the JPSS Ground System and a JPSS Managed Satellite.**

The interactions with other ConOps threads for the above classifications of issues/anomalies to resolve them is shown in Figure 6.2.8-1 As previously stated, these outcomes are the basic flows for the SFA ConOps thread and are shown in circles with numbers in them in this figure. Yellow shaded circles indicate solutions for JPSS Ground System issues and light purple shaded circles indicate solutions for JPSS managed satellite issues.

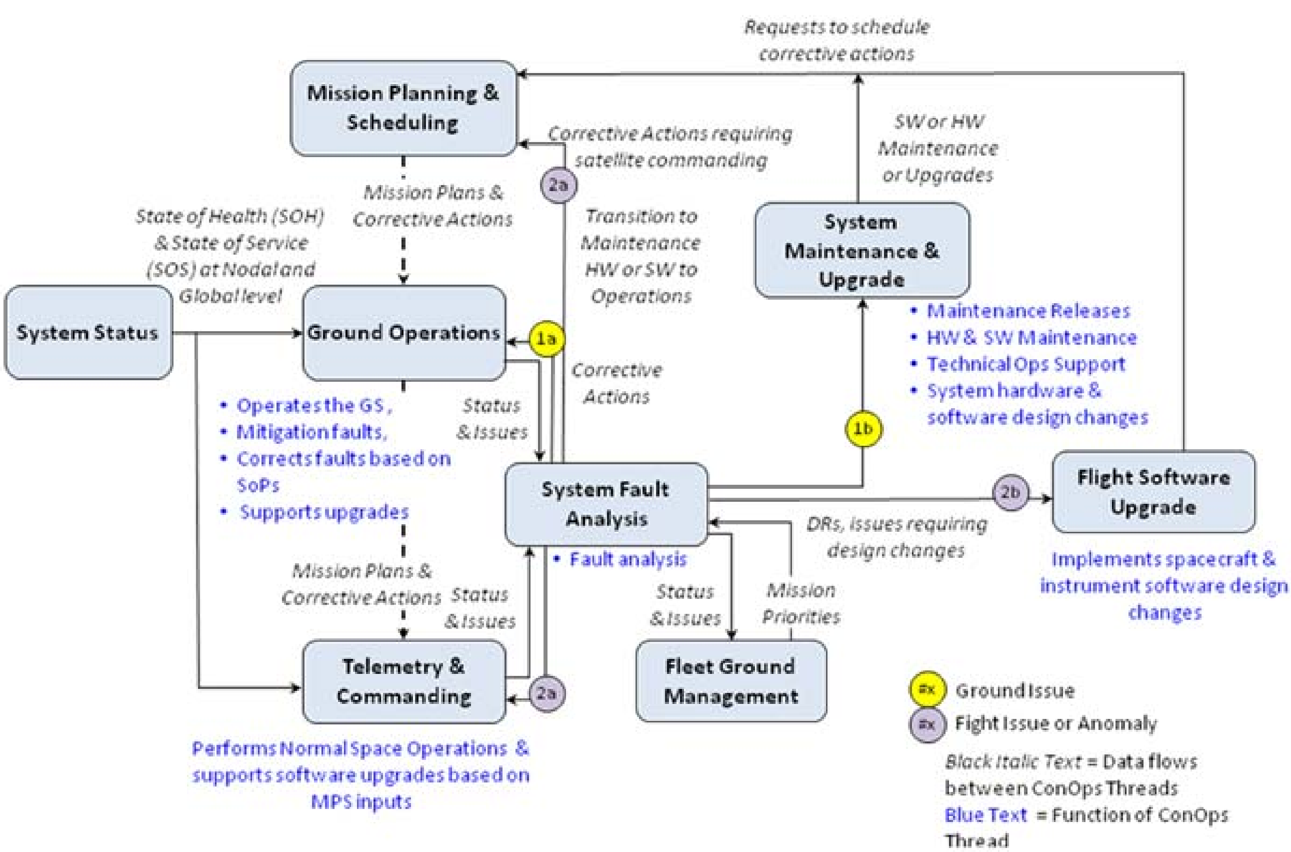


Figure: 6.2.8-1 System Fault Analysis Issue or Anomaly Resolution Approach

The resolution of each issue or anomaly includes the following phases.

1. **Issue/Anomaly Discovery:** In this phase the issue is discovered and classified. The issue is isolated to the ground system, the satellite, or both. If the issue cannot be resolved without data being lost or delayed for more than one orbit, then the issue is classified as an anomaly.
2. **Recovery Actions/Plans:** A recovery plan that includes a set of recovery actions is developed either by the operations team or an Anomaly Review Board (ARB) in the case of an anomaly. The JPSS Ground System or Satellite will have been restored to full operations after the recovery actions have been completed.
3. **Closure:** After JPSS has been restored to full operations, the long-term impact of the issue or anomaly is assessed, users are notified, and any open Work Requests (WRs) or Deficiency Reports (DRs) are closed.

Each of the basic flows for the SFA ConOps thread addresses all three of the above phases for that flow.

6.2.8.2 Primary Interfaces

The System Fault Analysis ConOps thread does not directly interface with internal JPSS Ground System Segments or Externals. This thread receives is status from other ConOps threads such as System Status/Situational Awareness, Ground Operations, and Commanding & Telemetry. Also the System Fault Analysis thread provides mission notice based reporting via the Mission Support Data Handling thread.

The System Fault Analysis ConOps thread does require that fault analysis investigators interact with external systems to determine status of non JPSS equipment used on missions supported by JPSS. However these interfaces are as a user or client on an external mission system or via voice communications rather than as a system interface. Therefore these interfaces are not shown in this thread.

6.2.8.3 Assumptions & Constraints

The following assumptions are made for the successful performance of ground operations functions:

- Sufficient system documentation exists to allow for fault analysis to be performed by JPSS personnel.
- Support from the spacecraft vendor, the instrument vendors, and the ground system vendor is sufficient and timely enough to support fault analysis.
- System Status/Situational Awareness provides sufficient information to allow for an accurate and rapid diagnosis of the issue to at least the satellite or ground system level.
- The existing operations personnel have sufficient training to perform fault analysis.
- Support from external missions is sufficient to determine if the issues are within the JPSS Ground System or within the external mission equipment.

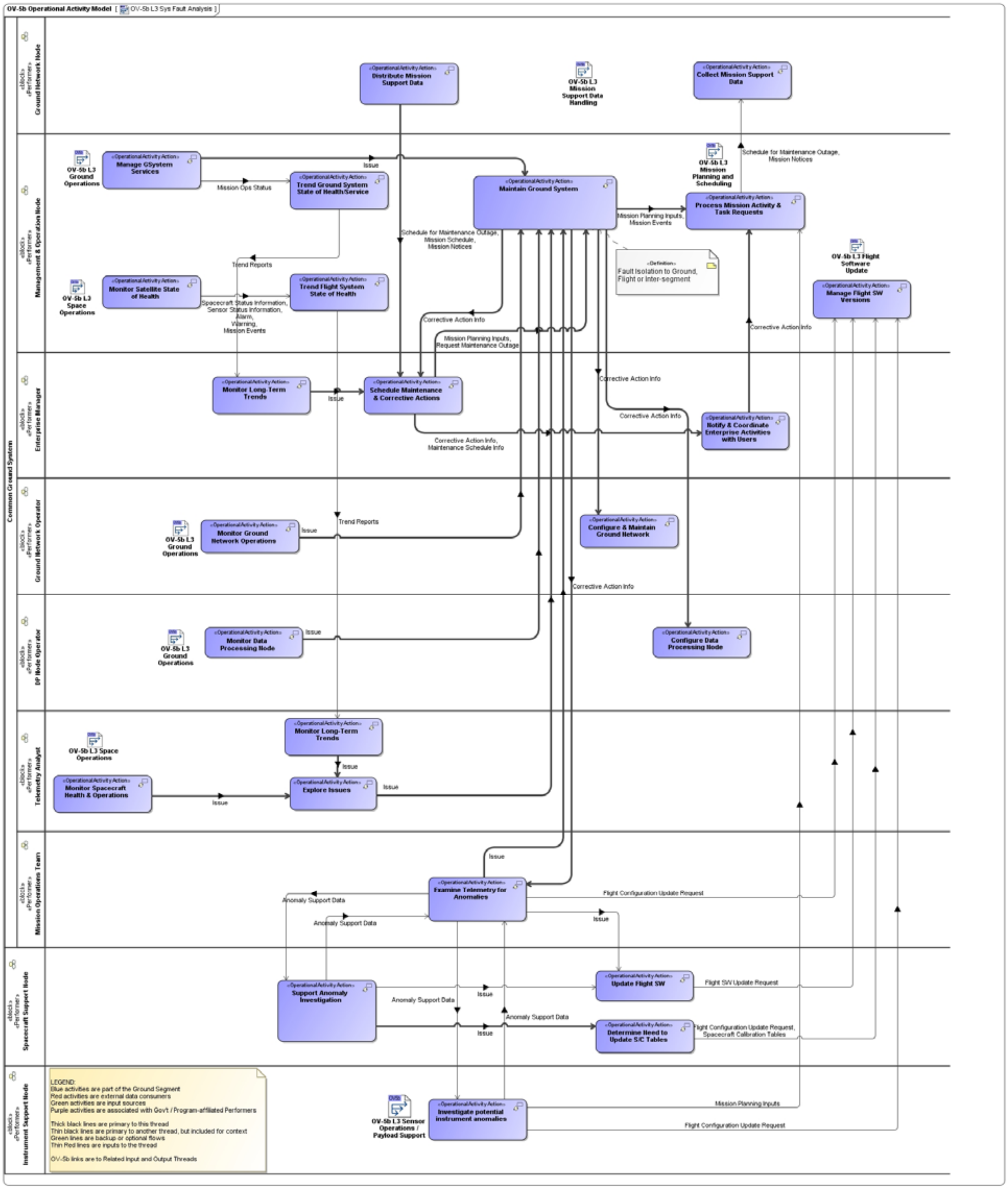
6.2.8.4 Pre-Conditions

Preconditions for System Fault Analysis processes include the following:

- The state of the JPSS Ground System is known prior to the occurrence of any issues.
- Agreements exist that allow JPSS personnel to query remote systems to determine the status of external equipment that supports JPSS mission.

6.2.8.5 Operational Flow

The operational flow for the System Fault Analysis ConOps thread is illustrated in Figure 6.2.8-2. This diagram is an OV-5b view that ties this thread into the rest of the system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.8-2 The DoDAF OV-5b view of the System Fault Analysis Processes

6.2.8.6 Basic Flows

The basic data flows from the System Fault Analysis OV-5b view have been separated out and summarized into specific System Fault Analysis flows. These basic System Fault Analysis flows are the following:

Table 6.2.8-1 provides a summary of the basic flows for System Fault Analysis and their mapping to the tables for each of the flows:

Table: 6.2.8-1 Summary of System Fault Analysis Basic Flows

Type	Flow	Table
Ground	Routine Corrective Action by Ground Operations	6.2.8-2
	Routine Maintenance	6.2.8-3
	Design Change Required	6.2.8-4
Satellite	Commanding of Satellite	6.2.8-5
	Fight Software Update	6.2.8-6
Intersegment Issue	Intersegment: JPSS Ground System and JPSS Managed Satellite	6.2.8-7

Table 6.2.8-2 provides a summary of the actions and actors for resolving routine corrective action on the JPSS Ground System that can be handled by the Ground Operations ConOps thread.

Table: 6.2.8-2 Ground System Issue: Routine Corrective Action by Ground Operations

No.	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads, the Fault Isolate the Problem activity isolates the problem to JPSS Ground System Problem.	See the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads for further information on the status provided.
2	MOT, MON	Review impact of the issue in the Monitor Ground SOH and Monitor Satellite SOH activities to determine if it will cause a loss of data or delay of data for more than one orbit (101 minutes).	
3a	MOT	If the delay will be greater than one orbit or if data will be lost, then form an anomaly review board (ARB) to address the issue. If the impact does not merit an ARB, then convene the appropriate operations personnel to determine the best solution for the issue in the Fault Isolate Problem activity. If an anomaly, then the ARB will assemble the appropriate key technical folks as soon as possible to discuss the options to resolve the issue in the Fault Isolate Problem activity. In addition, send out a mission notice to inform downstream data users	

No.	Actors	Actions	Notes
		that data products will be affected in the Notify and Coordinate Enterprise Activities with Users.	
3b	MOT	In the case where this issue is not an anomaly, the core operations team will convene to determine the best corrective action in the Schedule Maintenance & Corrective Actions activity. No mission notice will be sent out in this case.	
4	MOT	For this basic flow, the corrective action for either an issue or an anomaly is to perform a routine action by the Ground Operations ConOps thread in the Manage GSystem SOH activity. In this case, the corrective actions are documented in an SOP or addressed by the training of the operations personnel.	See the Ground Operations ConOps thread for further information on the types of activities performed.
5a	MOT	In the case of an anomaly, an updated mission notice would be sent out to all downstream users to inform them that science data processing has been restored in the Notify and Coordinate Enterprise Activities with Users.	
5b	N/A	In the case of an issue, no additional mission notice needs to be sent because data was not lost or delayed.	

Table 6.2.8-3 provides a summary of the actions and actors for resolving routine maintenance corrective action that can be addressed by the System Maintenance & Update (SMU) ConOps thread.

Table: 6.2.8-3 Ground System Issue: Routine Maintenance Corrective Action by SMU

No	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads, the Fault Isolate the Problem activity isolates the problem to JPSS Ground System Problem.	See the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads for further information on the status provided.
2	MON, MOT	Review impact of the issue in the Monitor Ground SOH and Monitor Satellite SOH activities to determine if it will cause a loss of data or delay of data for more than one orbit (101 minutes). If the delay will be greater than one orbit or if data will be lost, then form an anomaly review board (ARB) to address the issue. If the impact does not merit an ARB, then convene the appropriate operations personnel to determine the best solution for the issue in the Fault Isolate Problem activity.	

No	Actors	Actions	Notes
3a	MOT, MON	If an anomaly, then the ARB will assemble the appropriate key technical folks as soon as possible to discuss the options to resolve the issue in the Fault Isolate Problem activity. In addition, a mission notice will be sent out to inform downstream data users that data products will be affected in the Notify and Coordinate Enterprise Activities with Users. For this type of anomaly that requires a maintenance action, a work request (WR) and/or a discrepancy report (DR) will be written in the Maintain Ground System activity.	
3b	MOT	In the case where this issue is not an anomaly, the core operations team will convene to determine the best corrective action in the Fault Isolate Problem activity. For this type of issue a work request (WR) will be written in the Maintain Ground System activity because a maintenance action will need to be performed.	
4	MON, MOT	For this basic flow, the corrective action for either an issue or an anomaly is to perform a routine maintenance action in the Maintain Ground System by the SMU ConOps thread. This could include a commercial software patch or a hardware replacement such as a disk drive. This activity could be documented in an SOP or it could be addressed by the training that is provided in the SMU ConOps thread.	See the System Maintenance & Update ConOps thread for further information on the types of activities performed.
5a	MOT	In the case of an anomaly, an updated mission notice would be sent out to all downstream users to inform them that science data processing has been restored in the Notify and Coordinate Enterprise Activities with Users. After the problem has been resolved WR will be closed, and the DR (if written) will be closed at the next Discrepancy Review Board (DRB).	
5b	MOT	In the case of an issue that is not an anomaly, the WR will be closed after the issue has been resolved and no mission notice will be sent out.	

Table 6.2.8-4 provides a summary of the actions and actors for resolving issues that require a design change to the JPSS Ground System. This type of corrective action is handled by the System Maintenance & Update ConOps thread.

Table: 6.2.8-4 Ground System Issue: Design Change Required by System Maintenance and Upgrade

No	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations,	See the System Status/Situational

No	Actors	Actions	Notes
		and Telemetry & Commanding threads, the Fault Isolate the Problem activity isolates the problem to JPSS Ground System Problem.	Awareness, Ground Operations, and Telemetry & Commanding threads for further information on the status provided.
2	MOT, MON	Review impact of the issue in the Monitor Ground SOH and Monitor Satellite SOH activities to and determine that a design change will be required in the Fault Isolate Problem activity to fully resolve the issue. However, additional analysis will be performed to determine if a work around can be performed to continue data processing and deliveries. An example of a work around would be a warm start (i.e. stopping and restarting processes on servers) in order to resume data processing. If a work around does not exist that will prevent a delay of data for more than one orbit (101 minutes) or a loss of data, then an ARB will be formed to address the issue in the Fault Isolate Problem activity. If the work around can be identified to continue data processing, then the impact does not merit an ARB. In the case of a valid work around, the appropriate operations personnel will be convened to work out the implementation for the work around. The work around will be performed by Ground Operations in the Manage GSystem SOH activity until the design update is implemented and operational.	See the Ground Ops ConOps thread for further information on the types of activities performed.
3a	MON, MOT	If an anomaly, then the ARB will assemble the appropriate key technical folks as soon as possible to discuss the options to resolve and/or implement a work around for the issue in the Fault Isolate Problem activity. In addition, a mission notice will be sent out in the Notify and Coordinate Enterprise Activities with Users to inform downstream data users those data products will be affected. For this type of anomaly a work request (WR) and/or a discrepancy report (DR) will be written.	
3b	MON	If a work around has been identified that can prevent data from being lost or delayed, then the Ground Operations ConOps thread will implement this work around in the Maintain Ground System activity. For this type of issue, a work request (WR) and a discrepancy report (DR) will be written because a design change is required in the Maintain Ground	

No	Actors	Actions	Notes
		System activity. A mission notice will not be sent out if data is not lost or delayed.	
4	MON, MOT	For this basic flow, the determination of the Fault Isolate Problem activity is that the corrective action for either an issue or an anomaly is to perform a design change to the JPSS Ground System. This could be to software, hardware, or to the network architecture. This change will be implemented by the System Maintenance & Upgrade ConOps thread. This will likely require factory support and take weeks or months to implement and check-out the update. Until the update is implemented on the operational string, the Ground Operations ConOps thread will continue to use the work around to maintain data processing and delivery in the Maintain Ground System activity. Once the work around has been implemented and data processing restored, then a Mission Notice will be sent out to the downstream users to inform them that data processing has been restored in the Notify and Coordinate Enterprise Activities with Users activity	See the System Maintenance & Upgrade ConOps thread for further information on the types of activities performed.
5a	MOT	After the system upgrade is completed, then in the case of an anomaly, an updated mission notice would be sent out to all downstream users to inform them the design change (e.g. new software build) has been implemented on the operational system in the Notify and Coordinate Enterprise Activities with Users activity. After the problem has been resolved WR will be closed, and the DR will be closed at the next Discrepancy Review Board (DRB).	
5b	MOT	In the case of an issue that is not an anomaly because a work around mitigated the issue before data was lost or delayed, the WR or DR will be closed after the issue has been resolved, but no mission notice will be sent out	

Table 6.2.8-5 provides a summary of the actions and actors for resolving JPSS managed satellite issues that only require spacecraft or instrument commanding to be resolved. This type of corrective action is handled by the Telemetry and Commanding ConOps thread.

Table: 6.2.8-5 JPSS Managed Satellite Issue: Spacecraft Commanding Corrective Action

No	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads, the Fault	See the System Status/Situational Awareness, Ground Operations, and

No	Actors	Actions	Notes
		Isolate the Problem activity isolates the problem to a JPSS managed satellite issue.	Telemetry & Commanding threads for further information on the status provided.
2	MON, MOT	Review impact of the issue in the Monitor Ground SOH and Monitor Satellite SOH activities to determine if it will cause a loss of data or delay of data for more than one orbit (101.5 minutes). If the delay will be greater than one orbit or if data will be lost, then form an anomaly review board (ARB) to address the issue. If the impact does not merit an ARB, then convene the appropriate operations personnel to determine the best solution for the issue in the Fault Isolate Problem activity.	
3a	MON, MOT	If an anomaly, then the ARB will assemble the appropriate key technical folks as soon as possible to discuss the options to resolve the issue in the Fault Isolate Problem activity. In addition, a mission notice will be sent out to inform downstream data users that data products will be affected in the Notify and Coordinate Enterprise Activities with Users.	
3b	MON, MOT	In the case where this issue is not an anomaly, the core operations team will convene to determine the best corrective action in the Fault Isolate Problem activity.	
4	MON, MOT, Spacecraft Support Node (SSN), and Instrument Support Node (ISN).	For this basic flow, the corrective action for either an issue or an anomaly is to send commands to the spacecraft or one of its instruments. After the MOT in the telemetry and commanding ConOps thread determines what commands needed to be sent to the satellite, the MOT will determine if the necessary commanding would put the spacecraft or its instruments at risk. If there is some doubt about the commanding risk, the MOT will solicit guidance from the SSN and the ISN to make a final risk determination. If the commands are routine and do not put the spacecraft or its instruments at risk, then the MOT may issue the commands to the satellite at the next contact, If the commanding is not routine or may put the satellite at risk, this activity would need to be scheduled by mission planning and scheduling ConOps thread in the Process Mission Activity & Task Requests activity. In this case, the commanding information would be send to mission	See the Telemetry and Commanding as well as the Mission Planning threads for further information on the types of activities performed.

No	Actors	Actions	Notes
		planning and scheduling to determine when these commends would be sent to the satellite and what approvals will be required.	
5a	MON, MOT, Telemetry Analyst.	In the case of an anomaly, an updated mission notice would be sent out to all downstream users in the Notify and Coordinate Enterprise Activities with Users to inform them that science data processing has been restored after the commanding had been successfully sent to the satellite.	
5b		In the case of an issue, no additional mission notices needs to be sent because data was not lost or delayed.	

Table 6.2.8-6 provides a summary of the actions and actors for resolving JPSS managed satellite issues that require and update to the spacecraft and/or instrument software to be resolved. This type of corrective action is handled by the FSU ConOps thread.

Table: 6.2.8-6 JPSS Managed Satellite Issue: Flight Software Change Required

No	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads, the Fault Isolate the Problem activity isolates the problem to JPSS managed satellite.	See the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads for further information on the status provided.
2	MOT, MON	Review impact of the issue in the Monitor Ground SOH and Monitor Satellite SOH activities to and determine that a software update to either the space craft or one of its instruments will be required to fully resolve the issue in the Fault Isolate Problem activity. However, additional analysis will be performed to determine if a work around can be performed to continue data processing and deliveries. An example of this would be manually resetting a command or data counter on the satellite so it doesn't overflow. If a work around does not exist that will prevent a delay of data for more than one orbit (101 minutes) or a loss of data, then an ARB will be formed to address the issue in the Fault Isolate Problem activity. If the work around can be identified to continue data processing, then the impact does not merit an ARB.	See the Telemetry and Commanding ConOps thread for further information on the types of activities performed.
3a	MON, MOT	If an anomaly, then the ARB will assemble the appropriate key technical folks as soon as possible	

No	Actors	Actions	Notes
		to discuss the options to resolve or implement a work around for the issue in the Fault Isolate Problem activity. In addition, a mission notice will be sent out to inform downstream data users that data products will be affected in the Notify and Coordinate Enterprise Activities with Users. For this type of anomaly a work request (WR) and/or a discrepancy report (DR) will be written.	
3b	MON, MOT, Telemetry Analyst	If a satellite work around does exist that can prevent the loss or delay of data, then an ARB will not be formed. The appropriate operations personnel will be convened to work out the implementation for the work around in the Monitor Spacecraft Health and Operations activity The Telemetry and Commanding ConOps thread will determine the specific commands that need to be sent to the satellite and schedule those command uploads through the Mission Planning and Scheduling ConOps thread in the Process Mission Activity & Task Requests activity. The work around will continue to be performed by the Telemetry and Commanding ConOps thread until the flight software design update is implemented and operational. For this type of anomaly a work request (WR) and/or a discrepancy report (DR) will be written by the Monitor Spacecraft Health & Operations activity. However, a mission notice will not be sent out if data is not lost or delayed.	
4	Instrument Support Node (ISN), Spacecraft Support Node (SSN)	For this basic flow, the corrective action for either an issue or an anomaly is to perform a software design change to the spacecraft or one of its instruments. This change will be implemented by the FSU ConOps thread. This will require spacecraft vendor and/or instrument vendor support and take weeks or months to implement and check-out the update. If the update involves Processing Coefficient Tables (PCTs) or Look Up Tables (LUTs), the FSU will update both the satellite and ground processing table simultaneously. Until the update is implemented on the operational string, the Telemetry and Commanding ConOps thread will continue to use the work around in the Monitor Spacecraft Health and Operations activity to maintain data processing and delivery. Once the work around has been implemented and data processing restored, then a Mission Notice will be	See the Flight Software Update ConOps thread for further information on the types of activities performed.

No	Actors	Actions	Notes
		sent out to the downstream users to inform them that data processing has been restored in the Notify and Coordinate Enterprise Activities with Users.	
5	MOT	After the system upgrade is completed, then in the case of an anomaly, an updated mission notice would be sent out to all downstream users to inform them the a new software build has been implemented on the JPSS Managed Satellite in the Notify and Coordinate Enterprise Activities with Users activity. After the problem has been resolved WR will be closed, and the DR will be closed at the next Discrepancy Review Board (DRB).	

Table 6.2.8-7 provides a summary of the actions and actors for resolving issues that involve both a JPSS managed satellite and the JPSS Ground System. Several ConOps threads may be required to resolve this type of issue.

Table: 6.2.8-7 Intersegment Issue: JPSS Ground System & JPSS Managed Satellite

No	Actors	Actions	Notes
1	MOT	Based on information from the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads, the Fault Isolate the Problem activity determines issue requires corrective actions to both the JPSS Ground System and the JPSS managed satellite issue.	See the System Status/Situational Awareness, Ground Operations, and Telemetry & Commanding threads for further information on the status provided.
2	MOT, ISN, SST, Telemetry Analyst	Additional resources will be convened to determine what the issues on the JPSS Ground System are and what are the issues on the JPSS managed satellite. After the problem has been decomposed in this manner the appropriate ground system issue basic flow from tables 6.2.8- 2 to 6.2.8-4 will be invoked, and the appropriate JPSS managed satellite issue basic flow from tables 6.2.8-5 and 6.2.8-6 will be invoked The Schedule Maintenance and Corrective Activity in SFA will coordinate between the JPSS Ground System corrective actions and the flight system corrective actions to ensure that those actions are implemented in a manner that restores the JPSS system to full operational capability.	

6.2.8.7 Alternate Flows

No Alternate Flows identified at this time.

6.2.8.8 Post Condition

The post condition of the System Fault Analysis thread is that all JPSS support for all of its missions has been fully restored.

6.2.8.9 Related Threads

The ConOps threads in listed below provide background information for the System Fault Analysis thread. Review of these will help in the understanding of the System Fault Analysis thread activities.

Thread ID	Thread Title
JPSS ConOps Threads that are related to System Fault Analysis	
GS-NML-100	Stored Mission Data Handling
GS-NML-180	Data Acquisition and Routing
GS-NML-320	Space Operations
JPSS ConOps Threads that directly interface to System Fault Analysis	
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning & Scheduling
GS-NML-030	Telemetry & Commanding
GS-NML-130	Data Accounting and Recovery
GS-NML-140	Mission Support Data Handling
GS-NML-300	System Status/Situational Awareness
GS-NNL-120	Continuity of Operations
GS-NNL-140	System Maintenance & Upgrade

6.2.8.10 Child Threads

The ConOps threads listed below are Level 4 threads that flow down from this Level 3 System Fault Analysis ConOps thread.

Thread ID	Thread Title
CGS-030-040	Fault Detection & Recovery
CGS-010-020	Space Operations

6.2.9 Security

6.2.9.1 Description

The Security ConOps thread (GS-NML-220) describes JPSS Ground System (GS) activities required for security protection (i.e., management and enforcement), detection (i.e., monitoring), response (i.e., incident handling), and recovery (i.e. revaluation of current security posture). The JPSS GS has two System Boundaries NOAA5042 and NOAA5048. NOAA5042 consists of the Common Ground System (CGS) and the Simulation Node (i.e. Flight Vehicle Test Suite (FVTS)). Further CGS consists of the following: the Space/Ground Communication Node, Management & Operations Node, Data Processing Node, Ground Network Node, and CGS Support Node. Security requirements for NOAA5042 are defined in the JPSS Ground System Security Requirements Document (GSSRD) up to including Block 2.1. In Block 2.2 and later, functional security requirements for NOAA5042 are defined in Appendix C of the CGS

Requirements Document (CGSRD). NOAA5048 only includes the GRAVITE portion of the Cal/Val Node and the Field Terminal Support Node (FTSN). The Security ConOps thread provides sub-flows to address the differences between these two security boundaries.

Security activities (Protection, Detection, Response, and Recovery) are planned and executed in accordance with National Institute for Standards and Technology (NIST) Special Publication (SP) 800-53, **Security and Privacy Controls for Federal Information Systems and Organizations**. This document sets forth security best practices and methodologies called "Security Controls", organized into "Control Families" and augmented with "Control Enhancements." NIST SP 800-53 Control Families are two-letter identifiers. Individual Controls are the Control Family two-letter identifier followed by a number, separated by a dash. A Control Enhancement is a Control identifier followed by a number within parentheses.

The JPSS Ground System Security Requirements Document (GSSRD) applies through Block 2.1 and derives its requirements from the NIST SP 800-53 Revision (Rev) 3, and enhances the requirements based on Department of Commerce IT SPP, NOAA IT Security Policies, National Environmental Satellite, Data, and Information Service (NESDIS) policies and Office of Satellite and Product Operations (OSPO) Policies and Procedures. In Block 2.2 and later, Appendix C of the CGSRD derives requirements from NIST SP 800-53 Rev 4 as well as the updated versions of the IT SPP, NOAA, NESDIS and OSPO policies and procedures described above.

The activities in the Security ConOps thread detect security events which may or may not be severe enough to be classified as security incidents. A security event indicates that a security policy may have been violated, a safeguard may have failed, or the security of an information system, service, or network may have been breached or compromised. After reviewing the security event or events, a Security Administrator (Admin) determines whether or not a security incident has occurred. A security incident is defined by NIST SP 800-53 as any adverse event whereby some aspect of computer security could be threatened: loss of data confidentiality, disruption of data or system integrity, or disruption or denial of availability. A security incident can involve a real or suspected breach or the act of willfully causing a vulnerability or breach. Typical incidents include the introduction of viruses or worms into a network, DoS (denial of service) attacks, unauthorized alteration of software or hardware, and identity theft of individuals or institutions. Hacking in general is considered a security incident unless the perpetrators have been deliberately hired for the specific purpose of penetration testing a computer or network to identify vulnerabilities.

All security incidents will be reviewed by the JPSS Computer Anomaly Analysis Team (J-CAAT), made up of the Information System Security Officer (ISSO), Mission Operations Manager (MOM), Ground Security Manager (GSM), and supporting staff to determine if the incident should be reported to the NOAA Computer Incident Response Team (N-CIRT). In addition, the JPSS Computer Anomaly Analysis Team will determine what should be the appropriate incident response. A response may be only to continue to monitor for additional events.

Response time constitutes a critical consideration in assembling, maintaining and deploying an effective CIRT. A rapid, accurately targeted, and effective response can minimize the overall damage to mission, hardware, and software caused by a specific incident. Another important consideration involves the ability of the CIRT to track down the perpetrators of an incident so

that the guilty parties can be shut down and effectively prosecuted. High impact incidents are a greater priority and thus require more rigorous reporting and response actions. However, the overall impact of an incident is directly related to the criticality of the system affected by the incident.

Federal Agency Incident Categories

Category	Name	Description	Reporting Timeframe
CAT 0	Exercise/Network Defense Testing	This category is used during state, federal, national, international exercises and approved activity testing of internal/external network defenses or responses.	Not Applicable; this category is for each agency's internal use during exercises.
CAT 1	Unauthorized Access	In this category an individual gains logical or physical access without permission to a federal agency network, system, application, data, or other resource.	Within one (1) hour of discovery/detection.
CAT 2	Denial of Service (DoS)	An attack that successfully prevents or impairs the normal authorized functionality of networks, systems or applications by exhausting resources. This activity includes being the victim or participating in the DoS.	Within two (2) hours of discovery/detection if the successful attack is still ongoing and the agency is unable to successfully mitigate activity.
CAT 3	Malicious Code	Successful installation of malicious software (e.g., virus, worm, Trojan horse, or other code-based malicious entity) that infects an operating system or application. Agencies are NOT required to report malicious logic that has been successfully quarantined by antivirus (AV) software.	Daily Note: Within one (1) hour of discovery/detection if widespread across agency.
CAT 4	Improper Usage	A person violates acceptable computing use policies.	Weekly
CAT 5	Scans/Probes/Attempted Access	This category includes any activity that seeks to access or identify a federal agency computer, open ports, protocols, service, or any combination for later exploit. This activity does not directly result in a compromise or denial of service.	Monthly Note: If system is classified, report within one (1) hour of discovery.
CAT 6	Investigation	Unconfirmed incidents that are potentially malicious or anomalous activity deemed by the reporting entity to warrant further review.	Not Applicable; this category is for each agency's use to categorize a potential incident that is

Category	Name	Description	Reporting Timeframe
			currently being investigated.

[1] Impact definitions adopted from Federal Incident Reporting Guidelines, http://www.us-cert.gov/federal/reportingRequirements.html, July 25, 2006.

The Management & Operations Node (MON) is responsible for collecting overall system status and security management information for the CGS and Simulation Node in NOAA5042, and the security functions for NOAA5048 may be performed by a separate entity in the Cal/Val Node and FTS Node. NOAA5042 has been assessed as a high impact system, and NOAA5048 has been assessed as a moderate impact system. So the controls for the two security boundaries will vary based on their security impact level using security control methods from NIST Special Publication 800-53. The primary difference between moderate and high impact systems is requirements for automated solutions in high impact systems. Nevertheless security processes for both systems are very similar so they will be described together in the rest of this thread with their differences pointed out where appropriate.

The basic Security ConOps thread follows the Protection, Detection, Response, and Recovery, or PDRR, model as depicted in Figure 6.2.9-1.

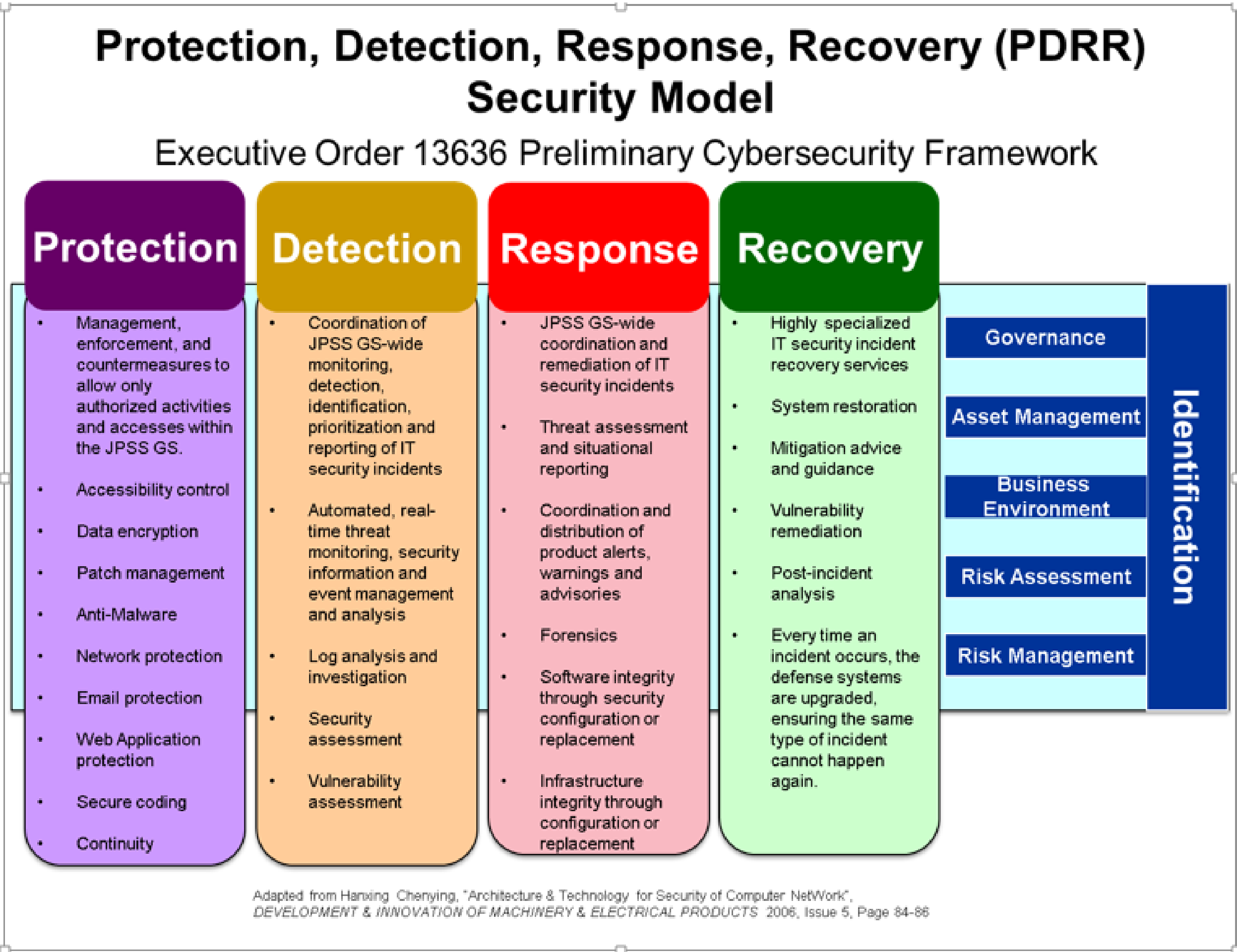


Figure: 6.2.9-1 PDRR Security Model

The four major components of the PDRR model are:

1. **Protection:** Protection includes management, enforcement, and countermeasures to allow only authorized activities and accesses within the JPSS GS. As the security threats and known vulnerabilities change, the activities depicted here deploy updated security policies (e.g., malware prevention and detection, user access removal, and configuration setting changes).
2. **Detection**: Some of security data monitoring is addressed by the State of Health (SOH) data collected by MON and Cal/Val Node activities in the System Status/Situational Awareness ConOps thread. This is because system faults or process errors can result from security issues. The security event monitoring system collects data from the logs created by System Status activities. The types of data collected include network activity and intrusion detection events, to assess the security status of the JPSS GS. Security data is maintained in several restricted access logs. These logs can only be accessed by authorized security personnel. Incident detection includes the use of automated tools to monitor JPSS GS activity thresholds based on historical data and the Security Admin to determine if the reported event is a security incident. The security thresholds are

described within the Ground System Security Requirements Document (GSSRD) (Block 2.1 or earlier).

3. **Response:** When security incidents occur within a JPSS GS boundary, there are two levels of reporting and response that must take place. The first level is to the Security Admin within that system boundary. The second level is to ensure that the appropriate security officials throughout the JPSS GS and responsible government agency are aware of the incident so they can take appropriate corrective and/or protective actions. This is done when the J-CAAT is convened, who then notifies N-CIRT of the incident.
4. **Recovery:** Recovery is a longer term adjustment to protection, detection, and response to one or more security incidents. This could include a change in policy, security controls, and/or security architecture within the JPSS GS.

All NOAA5042 security functions are performed by the Space/Ground Communications Node, the Ground Network Node, the Management & Operations Node, the Data Processing Node, the CGS Support Node, and the NOAA5042 Security Admin. Each node will have the security functions appropriate for that node. Not every node will have every security control.

Additional details for these four basic Security ConOps flows are provided in the following sections.

6.2.9.1.1 Protection

Security protection functions are used to manage and enforce security policies, in alignment with applicable NIST SP 800-53 controls. The implementation of several of these security functions employ centralized and automated Policy Decision Points (PDPs) with distributed Policy Enforcement Points (PEPs). A security policy is a set of system behaviors typically containing a list of configuration settings. PDPs provide an entry point to the system for security policy implementation. PDPs then flow security policy updates to PEPs for implementation. These PDPs and PEPs manage and enforce security policies supporting protection activities. Table 6.2.9-1 provides several examples security functions with related controls, PDPs, and PEPs and their associated protection functions.

Table: 6.2.9-1 Protection Security Control Management and Enforcement

Security Function with Control or Control Family	Centralized Policy Decision Point (PDPs)	Distributed Policy Enforcement Points (PEPs)
Access Control (AC) Family	Manage identities, credentials, and privileges	Present login screens; enforce authorized access to system resources and information
Anti-Malware Scanners: System and Information Integrity (SI) Family	Provide updated malware prevention whitelist signatures and threat detection heuristics updates to hosts	Block malware
Network Protection: AC Family; Secure Configuration (SC) Family	Manage Access Control Lists (ACLs)	Control flows of data in transit

Security Function with Control or Control Family	Centralized Policy Decision Point (PDPs)	Distributed Policy Enforcement Points (PEPs)
Secure Configurations: Configuration Management (CM) Family	Manage and monitor secure configuration settings for COTS products	Install baseline with secure configuration settings for COTS products
Audit and Accountability (AU) Family	Provides real-time system wide log consolidation and analysis of security events	Customizable reporting and alerting functions
Inventory Management: CM Family	Automated and centralized inventory management system	Tracks additions, changes and removal of hardware and software
Security Sustainment & Risk Assessment: AU Family	Timely identification and testing of flaw remediation	Analyze Vulnerability scan results and recommend remediation
Cryptography: SC Family	Implements and enables FIPS 140-2 validated cryptography	Uses secure protocols for passwords and configuration files at rest and in transit
Contingency Planning (CP) Family	Continuity of Operations (COOP)	
Application Security: SI Family	Hardening entry points into system software to protect against unexpected input from internal and external sources	Web Application Firewall and input validation for external interfaces and inter-segment interfaces
Secure Development: SI Family	Establishes development processes, training, and tools necessary to implement the Application Security function for efficient vulnerability remediation	Static code analysis tools, and compliance documentation about the verification of security requirements and the configuration control of those environments
Media Protection (MP) Family	Manage removable media to reduce the frequency and consequence of related incidents	Performs scanning via COTS before any data is brought into the operational environment

Under Executive Order 13636, Preliminary Cybersecurity Framework, Protection also includes the capabilities that ensure:

- **Access Control:** Access to information resources and associated facilities are limited to authorized users, processes or devices (including other information systems), and to authorized activities and transactions.
- **Awareness and Training:** The organization's personnel and partners are adequately trained to perform their duties (including security-related duties) and responsibilities consistent with related policies, procedures, and agreements.
- **Data Security:** Information and records (data) are managed consistent with the organization's risk strategy to protect the confidentiality, integrity, and availability of information.
- **Information Protection Processes and Procedures:** Security policy (that addresses purpose, scope, roles, responsibilities, management commitment, and coordination

among organizational entities), processes, and procedures are maintained and used to manage protection of information systems and assets.

- **Maintenance:** Maintenance and repairs of operational and information system components is performed consistent with policies and procedures.
- **Protective Technology:** Technical security functions are managed to ensure the security and resilience of systems and assets, consistent with related policies, procedures, and agreements.

The process of implementing protection in NOAA5042 and NOAA5048 is very similar. The major difference between the two System Boundaries is that NOAA5048 is categorized as a moderate system with moderate controls and enhancements and NOAA5042 is categorized as a high system with high controls and enhancements.

6.2.9.1.2 Detection

Detection can occur through alerts in various network security tools (Intrusion Detection Devices, Anti-Malware, Web Application Firewalls, Vulnerability Scans), logs (OS, application, network devices), people within the organization, and publicly available information about new vulnerabilities and exploits (US-CERT Bulletins, National Vulnerability database, Common Vulnerabilities and Exposures (CVE)).

Security event detection consists of several types of monitoring. The first types are the collection of State of Health (SOH) and State of Service (SOS) data from the System Status/Situational Awareness (SyS) and Ground Operations (GO) ConOps threads. Security events can originate from System or Network Administrators as they perform System Fault Analysis (SFA) on detected anomalies. Examples of these types of data that would affect the JPSS GS security status are provided in Tables 6.2.9-2 for SOH data and 6.2.9-3 for SOS data:

Table: 6.2.9-2 SOH Security Impact Data Examples

Description	Examples of Security Impact from SOH Data
Satellite Ground Station Terminal Hardware	• Ground station hardware problems could be due to normal hardware failures due to wear and tear or due to malicious activities.
Processing Hardware	• Hard drive file system errors could affect system logging including logging of security related data such as a) logins attempted; and b) message traffic records.
Software	• Stopped or suspended software processes or inter-process communications errors could be the result of malicious code or a system intrusion.
Networks	• Network equipment faults or link faults could be the result of a denial of service attack or the network equipment being compromised.

Table: 6.2.9-3 SOS Security Impact Data Examples

Description	Examples of Security Impact from SOS Data
Performance metrics	• Issues with product creation, delivery latency, or data availability could be due to viruses or network attacks.

Description	Examples of Security Impact from SOS Data
SMD Processing SOS	• An excessive number of missing Application Packets (APs) could be caused by denial of service attacks or intentional corruption of packet data. • Subscriptions that have stopped between the data processing node and the data users could be caused by spoofing the DPN with messages to cancel subscriptions. • Higher order products not produced could be caused by viruses in the DPN or intentional corruption of ancillary data by malware.
Satellite Ground Station Terminal Hardware	• Ground station hardware issues such as poor signal strength could be the result of attempted jamming or attempts to re-route satellite commanding data.
Processing Hardware	• Network and other connections operational including packet loss and packets errors on these connections could be the result of attacks on network equipment.
Networks	• Problems with data latency in command, ancillary, SMD data, or a high percentage of bad packets on the network could be the result of Data Denial of Service (DDoS) attacks, redirecting traffic through spoofing, or hacking into the network control systems.
Resource Utilization	• Over filled hard drives and limited free disk space could result in the inability to maintain security data. • Excessive memory utilization could be due to viruses. • Excessive processor utilization percentage could be caused by viruses or spy software collecting system information. • Increased network loading issues could be caused by spy software sending out network information.

In addition to SOH and SOS data from activities in SyS ConOps thread, the MON and the Cal/Val Node produce additional event data via their own Security Event Management (SEM) systems within their security boundaries. The SEM provides near real-time monitoring of logs from networks, security devices, systems and applications and automatically detects security events in the logs through recognition of log entries or correlation of multiple log entries. The SEM collects logs from each of the nodes within their system boundary including all boundary protection devices (routers, intrusion detection systems (IDS), and firewalls). The SEM also provides long-term security event and log data storage and analytics. For events that could indicate a security issue on the system dealing with satellite command and control data, or an event related to audit log collection, the SEM will send security alerts to the Enterprise Management system, which, in turn, will alert system operators. Since the Security Admin position is not manned 24x7, all security alerts are sent to the EMOC. The EMOC will forward the alerts to the Security Admin during business hours or will call in the Security Admin after hours to perform the investigation.

The SEM also supports non-real-time data analysis. Through the centralized collection and standardization of disparate system and application information (such as system logs, audit trails, event logs and transaction records), the Security Admin can consult the SEM archive and retrieve information through standardized queries. Forensic analysis is greatly facilitated through

the SEM's log management features, while the centralized logging capabilities help ease the task of managing retention times to comply to applicable laws and NOAA policy.

Table 6.2.9-4 presents Security Functions and their associated detection functions:

Table: 6.2.9-4 Detection Security Function Control Management and Enforcement

Security Function with Control or Control Family	Centralized Policy Decision Point (PDPs)	Distributed Policy Enforcement Points (PEPs)
Access Control (AC) Family; AU Family	Monitor for access control violations	Report access control violations
Anti-Malware Scanners: SI Family	Provide updated malware signatures, whitelists, and threat detection heuristics updates to hosts	Scan hosts for malware, malware behavior (by heuristic rules), and whitelist violations, and report findings to centralized capability
AU Family	Aggregate/correlate system logs and present information to Security Admin	Log security-relevant events and publish to centralized auditing capability
Server Host Security: CM Family	Manage list of suspicious and unauthorized file modifications	Detect and notify centralized logging capability of suspicious and unauthorized file modifications
Inventory Management: CM Family	Manage list of hosts and deployed products	Report discrepancies found on hosts and deployed products to personnel
Network Protection: AC Family; SC Family	Aggregate violation attempts of ACLs	Notify JPSS Authorized security personnel and the central logging capability of ACL violations
Secure Configurations: CM Family	Monitor secure configuration settings for COTS products	Notify JPSS Authorized security personnel and the central logging capability of configuration changes
Security Sustainment: Risk Assessment (RA) Family, AU Family	Invoke vulnerability scans based on updated vulnerability signatures	Scan hosts for vulnerabilities and report findings to key personnel and to Auditing and Accountability

The Security incident detection consists of using both automated Continuous Diagnostics and Mitigation (CDM) tools to monitor anomalous conditions that would affect the security status of the JPSS GS and occasionally using the Security Admin to determine if the security events that have occurred are security incidents. Examples of anomalous conditions that would be monitored by automated tools include:

- Significant unplanned changes to network traffic volumes that are inconsistent with historical values
- Unplanned JPSS GS configuration changes either in the network or in application software/hardware. These changes could be in either connectivity or in the network security profile data such as router ACLs
- An unusually high number of login failures

- Execution of unidentified software processes
- Automatic detection of viruses or worms on a network or server, or detection of files in critical portions of storage which fail to match whitelists
- Automatic detection of DoS (denial of service), TCP SYN Flooding, UDP Flooding, IP Spoofing, DNS Amplification and other network attacks
- Automatic detection of SQL Injection, Cross-site scripting (XSS), HTTP response splitting, Injection flaws, Session hijacking and other attacks on Web Servers
- Access violations (i.e., attempts to access files without necessary privileges, attempts to access servers without necessary privileges)

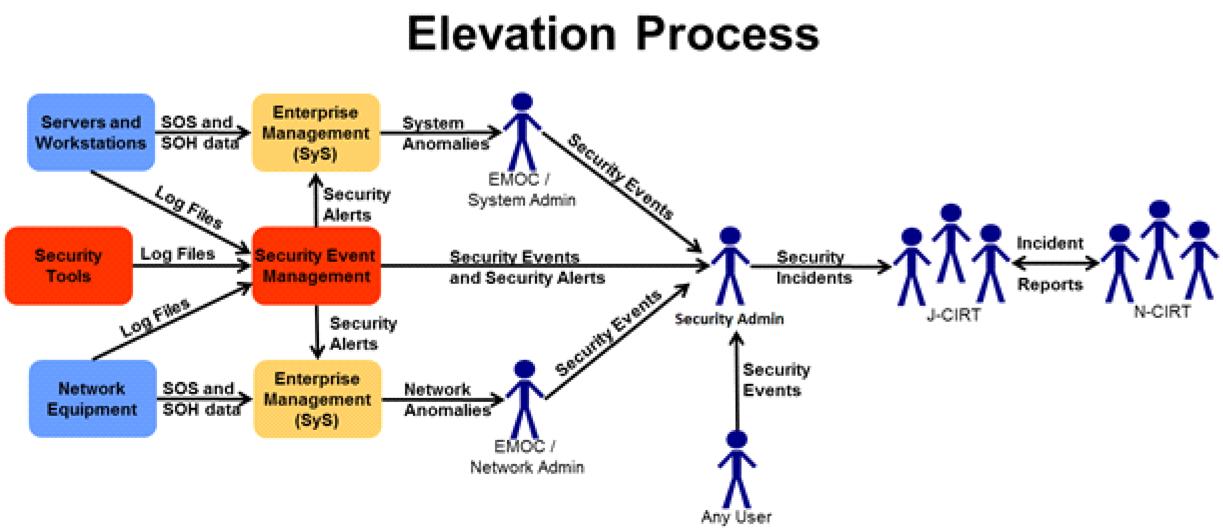


Figure: 6.2.9-2 Elevation Process (Anomaly, Security Event, Security Incident)

Anomalies detected under the SyS ConOps thread can be elevated to security events by those performing System Fault Analysis (SFA). System and Network Administrators may also notify the Security Admin of potential security events when analyzing trends of anomalies. Similarly, the Satellite Controller may elevate satellite anomalies (e.g. jamming) to the Security Admin.

The SEM is configured to recognize specific log entries or correlations among log entries as security events, which it sends to the System Admin. The SEM categorizes the security events and creates Security Alerts from high priority security events. Security Alerts are sent immediately to the Security Admin and to the Enterprise Management Operator (EMOC) via the Enterprise Management system.

The Security Admin will investigate the cause of the security event, what the impacts are, and if the system is vulnerable. The Security Admin must first determine whether the suspicious event may have been caused by a misconfiguration, planned outage, or other benign action. If these are ruled out, the Security Admin must investigate further. To do this, the Admin will review the security event logs, related system logs, SOH/SOS data, and SEM data, as well as information provided by system operators. Based on the results of investigation, the Security Admin will determine if a security incident has occurred. Both security events and incidents will be logged

and reported to the JPSS GS security personnel who will then, once verified, report them to N-CIRT and agency management.

If a security event is determined to be a security incident, it will be reviewed by the JPSS Computer Anomaly Analysis Team (J-CAAT) to determine if the incident should be reported to the NOAA Computer Incident Response Team (N-CIRT). In addition, the JPSS Computer Anomaly Analysis Team will determine the appropriate incident response. The Incident Response Team will work quickly to analyze and validate each incident, while documenting all steps taken. The initial analysis will include determining the scope, which systems/ applications are affected, how the incident occurred, and the attack vectors. After the initial analysis, a severity is given to each incident in order to prioritize incidents and their possible impact to the mission.

Under Executive Order 13636, Preliminary Cybersecurity Framework, Detection also includes the capabilities that ensure:

- **Anomalies and Events:** Anomalous activity is detected in a timely manner and the potential impact of events is understood.
- **Security Continuous Monitoring:** The information system and assets are monitored to identify cybersecurity events and verify the effectiveness of protective measures.
- **Detection Processes:** Detection processes and procedures are maintained and tested to ensure timely and adequate awareness of anomalous events.

The process of security incident detection is very similar in both the CGS/FVTS (NOAA5042) and in the GRAVITE /FTS (NOAA5048). The only differences would be the following:

a. The NOAA5042 and the NOAA5048 security boundaries may have different security monitoring systems and personnel.
b. NOAA5048 has been categorized as a moderate system requiring moderate controls and enhancement, so some of the controls and enhancements may not apply to NOAA5048.

6.2.9.1.3 Response

When the MON or the Cal/Val node reports a security incident, the J-CAAT reviews the incident to determine its severity and potential actions needed, if any. The J-CAAT performs security incident triage to include determining scope, urgency, and potential impact; identifying the specific vulnerability and making recommendations that enable expeditious remediation. Once the severity has been determined, it is reported through the proper security organization channels; and the N-CIRT is informed. JPSS mission partners who may be impacted will be notified of the security incidents as appropriate. The J-CAAT performs real-time Security Incident Handling (e.g., forensic collections, intrusion correlation/tracking, log correlation, threat analysis, etc.) tasks to support N-CIRT remediation efforts. The N-CIRT determines corrective set of actions, and then the Security Admin work with the N-CIRT, the ISSO, and the operations staff to implement the corrective set of actions. Containment is necessary before an incident spreads throughout the network. Predetermined strategies and procedures on containment based on the type of incident will be established to make decisions easier. Gathering and preserving evidence is also important if legal proceedings occur from the incident. Eradication is necessary

to eliminate components of the incident, including, for example, removing malware from systems and disabling user accounts. If a system update is required to address the security incident, then the Security Admin work with the CGS Support Node or the Cal/Val Node to implement the update as part of the System Maintenance and Upgrade ConOps thread. The goal is to restore all functions and data to a known good state. Operators may be asked to test systems and applications to ensure that they are working properly and that the data is current and complete, as well as performing other actions to validate that system restoration was successful.

Under Executive Order 13636, Preliminary Cybersecurity Framework, Response also includes the capabilities that ensure:

- **Response Planning:** Response processes and procedures are maintained and tested to ensure timely response of detected cybersecurity events.
- **Communications:** Response activities are coordinated with internal and external stakeholders, as appropriate, to include external support from federal, state, and local law enforcement agencies.
- **Analysis:** Analysis is conducted to ensure adequate response and support recovery activities.
- **Mitigation:** Activities are performed to prevent expansion of an event, mitigate its effects, and eradicate the incident.
- **Improvements:** Organizational response activities are improved by incorporating lessons learned from current and previous detection/response activities.

The process of determining the security incident response is very similar in both the CGS/FVTS (NOAA5042) and in the GRAVITE/FTS (NOAA5048). The only differences are the following:

a. In the NOAA5048 (GRAVITE/FTS), the capabilities for detection, reporting, and eradication may be less automated than NOAA5042, however the response for a similar incident will be reported, but may be detected manually.
b. Portions or the entire GRAVITE/FTS may be taken off-line to resolve a security incident without affecting the ability of the JPSS GS to meet its real-time mission objectives.
c. Only redundant portions of the CGS can be taken off-line to resolve security issues without affecting the ability of the JPSS GS to meet its real-time mission objectives.

GRAVITE, FTS, CGS, and FVTS security personnel will work together to assess the impact of a security incident in either system boundary. This means that all incidents in either boundary will be reported to security personnel in both boundaries.

6.2.9.1.4 Recovery

Security incident response is a short term (See the Incident Response Plan) response to an incident. Recovery is a longer term re-evaluation of protection, detection, and response mechanisms used in the existing JPSS GS security posture. In effect, recovery is both the lessons learned and the long-term corrective measures. In recovery, security management directs system administrators to remediate vulnerabilities to prevent similar attacks from occurring again. This may include re-architecting subsystems, installing patches or version updates, and

implementing tighter network perimeter security controls. These measures could require changes in policies, security systems, architecture, or design changes to the JPSS GS.

The automated criteria configured in SEM may be updated to detect if the incident occurs again. The prioritization configured in SEM may also be updated to create a Security Alert if the incident occurs again.

Under Executive Order 13636, Preliminary Cybersecurity Framework, Recovery also includes the capabilities that ensure:

- **Recovery Planning:** Recovery processes and procedures are maintained and tested to ensure timely restoration of systems or assets affected by cybersecurity events.
- **Improvements:** Recovery planning and processes are improved by incorporating lessons learned into future activities.
- **Communications**: Restoration activities are coordinated with internal and external parties, such as coordinating centers, Internet Service Providers, owners of attacking systems, victims, other Incident Response Teams, and vendors.

The recovery process is the same in both CGS/FVTS (NOAA5042) and GRAVITE/FTS (NOAA5048).

6.2.9.1.5 Access Control

For internal access, user's manager will make a request for an account to be generated for a user. This is a three phase process: access verification, security verification, and access procurement. Access verification will include, but not limited to, an acceptable background investigation (if not completed by hiring organization), a verification of access location, and a check for completeness and accuracy by the sponsor (typically the supervisor or local manager). A Common Access Card (CAC) or Personal Identity Verification (PIV) card is required. If user has not been issued a certificate a request from the organizational Regional Authority (RA) (e.g. OSPO or NESDIS) for a certificate from the Certificate Authority (CA) will be submitted. The security verification will include, but not limited to an assurance that background investigation is completed; IT Security Training is up to date; and a verification of the access requested is warranted. The access procurement phase includes the submission of the work request to the account manager to add, modify, or delete the user access within the CGS or Ground subsystem. In the cases of adding the CAC (or PIV), certificate will be obtained via a secure transfer of the public key to be inserted into the access control system. To close the work request the account administrator will notify the sponsor and the user of the account access action.

External access requests will be handled in a similar process with the exception of access location. Registered Mission Partners will have supplied fixed IP addresses from which their users will be accessing the CGS from. However, others may need to provide fixed IP addresses and a firewall modification. Request will be required and approved by the Information System Security Officer (ISSO) and the system owner.

The authentication process in general works as the following. The user will be required to insert their CAC card into the workstation reader. The authentication service Human-Machine Interface (HMI) will prompt the user for a PIN. If the PIN matches the PIN on the card, the

reader will extract the certificate from the CAC. The authentication service will determine if the certificate has been revoked by the CA. If not, it will then compare the public key stored to the certificate from the card. If they match the user is authenticated.

6.2.9.2 Primary Interfaces

Primary interfaces driven by this ConOps thread are depicted in Figure 6.2.9-3. This includes both external interfaces and inter-system interfaces (internal) within the Ground System. The Security ConOps thread obtains SOH and SOS information for JPSS GS nodes from the SyS ConOps thread; however, the Security ConOps thread also must interface JPSS Ground System Nodes to monitor overall JPSS GS security event status.

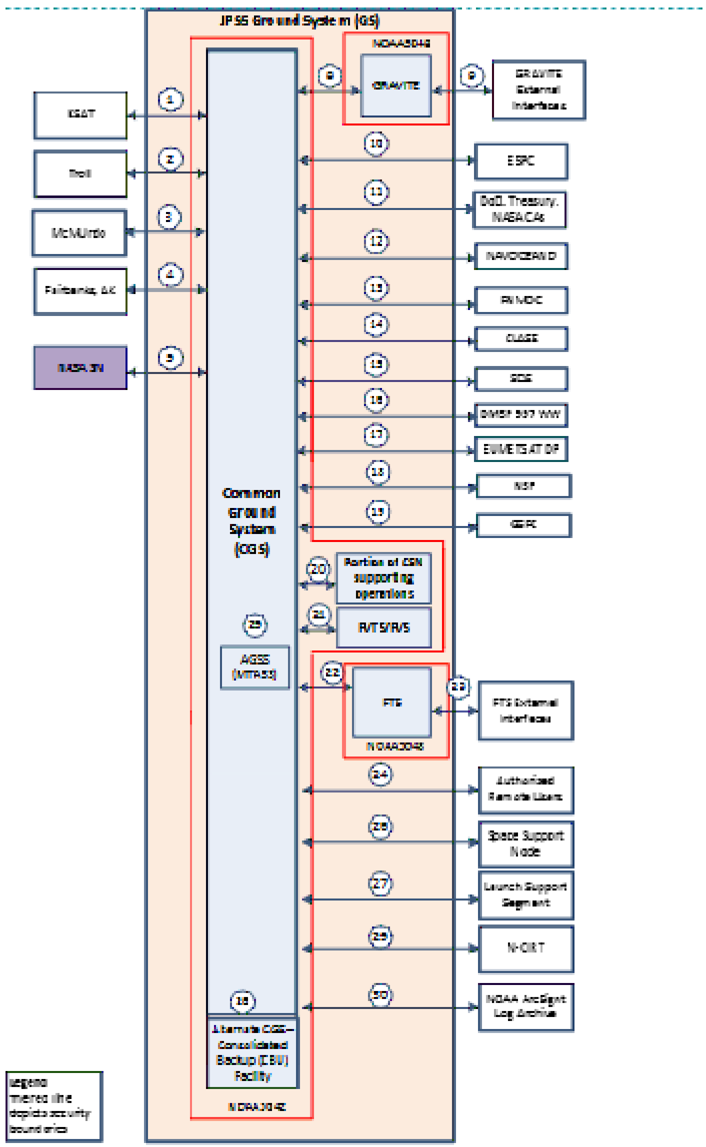


Figure: 6.2.9-3 Primary Interfaces for Security

* Within NOAA5042 is only the Ops portion of CGS Support Node (CSN) that supports operations by receiving and processing SMD and telemetry, and providing updated software builds to the CGS. The development portion of CSN is outside of NOAA5042.

The entities listed inside the NOAA5042 and the NOAA5048 are the entities that are inside this system boundary and are part of the JPSS Ground System. Entities that are not part of the JPSS Ground System are not shown inside the JPSS Ground System portion of this system boundary.

Each interface in Figure 6.2.9-1 is labeled with a number and defined in Table 6.2.9-5 with types of interface, actors, and purpose. Table 6.2.9-6 provides the relevant security requirements documents that define the security provisions for those interfaces.

Table: 6.2.9-5 Security ConOps Primary Interfaces

No.	Type	Actors	Purpose
1	External	Kongsberg Satellite Services (KSAT), CGS	Security Status; Security incidents reported via procedural communications methods such as e-mails or phone calls.
2	External	Troll, CGS	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
3	Internal	McMurdo, CGS	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
4	External	Fairbanks Command and Data Acquisition Station (FCDAS) Fairbanks, AK, CGS	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
5	External	Space Network (SN) Tracking Data Relay Satellite System (TDRSS), CGS	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
6	Reserved		
7	Reserved		
8	Internal	CGS, Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
9	External	GRAVITE, Cal/Val	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
10	External	CGS, Environmental Satellite Processing Center (ESPC)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
11	External	DoD, Treasury, NASA Certificate Authorities	Certificate Management: Provide current security certificates and Certificate Revocation Lists (CRLs).

No.	Type	Actors	Purpose
12	External	CGS, Naval Oceanographic Office (NAVOCEANO)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
13	External	CGS, Fleet Numerical Meteorology and Oceanography Center (FNMOC)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
14	External	CGS, Comprehensive Large Array-Data Stewardship System (CLASS)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
15	External	CGS, Science Data Segment (SDS)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
16	External	DMSP 557th Weather Wing Delivery Point	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
17	External	European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) Delivery Point	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
18	External	National Science Foundation Delivery Point	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
19	External	Goddard Space Flight Center Delivery Point	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
20	Internal	CGS, CGS Support Nodes (CSN)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls. Only applied to the Ops portion of CSN
21	Internal	CGS, Flight Vehicle Test Suite (FVTS), and Mini-C3S systems	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls. FVTS and Mini-C3S systems at NSOF and CBU send security data to CGS. At NSOF and SEIT OPS-like, the Enterprise Security enclave provides services to FVTS GLS through the Security Relay in Sim Control and to Mini-C3S through its own Security Relay. At CBU, the Enterprise Security enclave provides services to FVTS GLS through the Security Relay in Sim Control. At GSFC, the FVTS Factory Rack Enterprise-like Security enclave provides a subset of services to FVTS GLS through the Security Relay in Sim Control and to Mini-C3S through its own Security Relay.

No.	Type	Actors	Purpose
22	Internal	Field Terminal Support (FTS), CGS	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
23	External	FTS, FT Customers	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
24	External	CGS. All Authorized Remote Users	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
25	Internal	Attitude Ground System (AGS) (MTASS)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
26	External	Space Support Node (SSN)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
27	External	Launch Support Segment (LSS)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
28	Internal	CGS, Consolidated Backup (CBU)	Security Status: Security incidents reported via procedural communications methods such as e-mails or phone calls.
29	External	N-CIRT	Information about new vulnerabilities and exploits (US-CERT Bulletins, National Vulnerability database, Common Vulnerabilities and Exposures (CVE)) reported via procedural communications methods such as e-mails or phone calls.
30	External	NOAA ArcSight Log Archive	Security Event Logs from SEM to ArcSight.(Block 2.1)

Table: 6.2.9-6 Security Interface Documentation

No.	ISA/SLA
1	Service Level Agreement (SLA) between NOAA, NASA and Norwegian Space Centre.
2	Interconnection Security Agreement (ISA) between JPSS and Troll
3	Interconnection Security Agreement (ISA) between JPSS and National Science Foundation (NSF) for McMurdo Interconnection Security Agreement (ISA) between JPSS and NASA for McMurdo
4	Interconnection Security Agreement (ISA) between JPSS and POES.
5	Interconnection Security Agreement (ISA) between JPSS and White Sands Complex (WSC) for Test
6	Reserved
7	Reserved
8	Interconnection Security Agreement (ISA) between JPSS (NOAA5042) and GRAVITE (NOAA5048)
9	Interconnection Security Agreement (ISA) between GRAVITE (NOAA5048) and Local Computing Facilities
10	SSP

No.	ISA/SLA
11	NESDIS Security Services Operations Concept
12	Interconnection Security Agreement (ISA) between JPSS and Naval Oceanographic Office (NAVOCEANO)
13	Interconnection Security Agreement (ISA) between JPSS and Fleet Numerical Meteorology and Oceanography Center (FNMOC)
14	Interconnection Security Agreement (ISA) between JPSS and CLASS
15	Interconnection Security Agreement (ISA) between JPSS and NASA Science Data Segment (SDS)
16	Interconnection Security Agreement (ISA) between JPSS and DMSP
17	Interconnection Security Agreement (ISA) between JPSS and European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)
18	JPSS Ground System Security Requirements Document (GSSRD) (Block 2.1 or earlier); Security requirements will be a part of the requirements documents associated with their respective elements (e.g. CGS) (Block 2.2 and later). Only applied to the Ops portion of CSN
19	SLA between GSFC corporate LAN, NOAA admin LAN (NOAA5006), JPSS (NOAA5042), and GRAVITE (NOAA5048)
20	n/a (within 5042)
21	n/a (within 5042)
22	Interconnection Security Agreement (ISA) between JPSS and the Field Terminal Support (FTS)
23	n/a
24	n/a
25	n/a (within 5042)
26	
27	Interconnection Security Agreement (ISA) between JPSS and Vandenberg AFB
28	n/a (within 5042)
29	
30	

6.2.9.3 Assumptions and Constraints

The following assumptions are made for the successful performance of Security ConOps thread functions:

- The JPSS GS is implemented with a Security Event Management (SEM) systems that can access data collected from the event log files collected by the nodes as part of the System Status/Situational Awareness ConOps activities.
- Security incidents are communicated between staff of various systems by procedural communications methods such as phone calls and e-mails.

6.2.9.4 Pre-Conditions

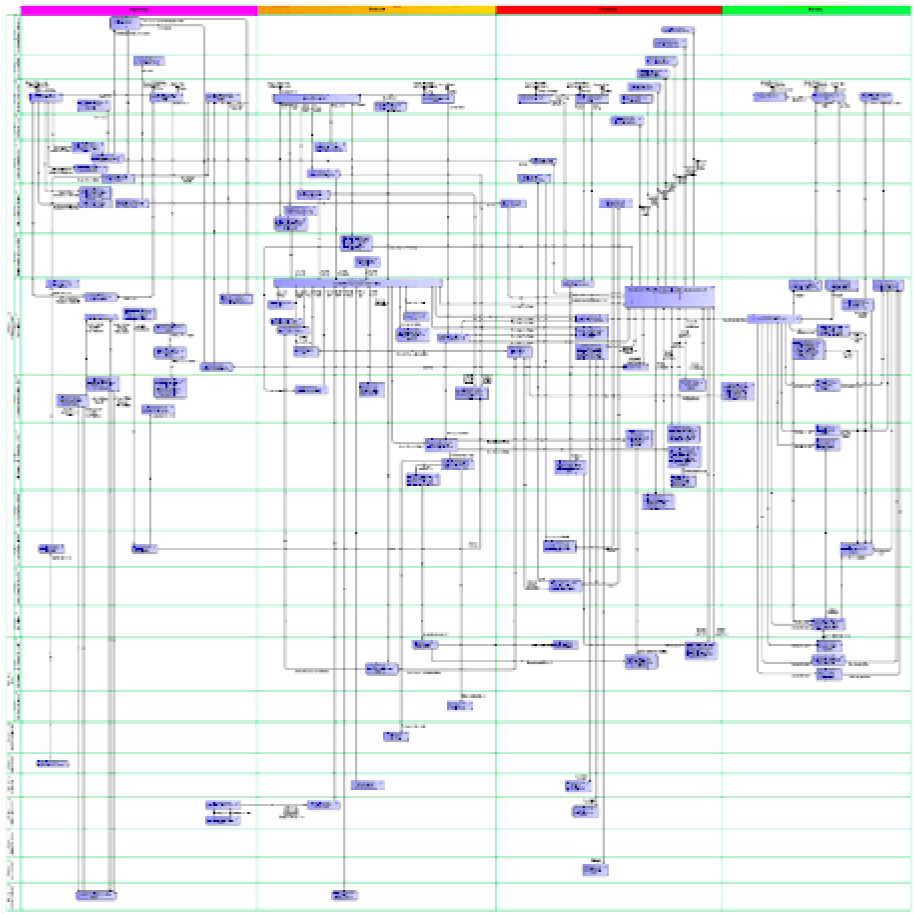
The pre-conditions for the Security ConOps thread include the following

- Security event thresholds have been established from GSSRD (Block 2.1 or earlier) or LSSRD (Block 2.2 and later) and operational normal conditions and documented in the NOAA5042 System Security Plan

- All elements of the JPSS GS provides security event data
- The implemented JPSS GS has been given the Authority To Operate (ATO)

6.2.9.5 Operational Flow

Figure 6.2.9-4 provides an illustration of system activities taking place in the basic flow for the Security ConOps thread.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.2.9-4 Security ConOps Thread OV-5b

6.2.9.6 Basic Flow

The basic flows for the Security ConOps thread, described in Tables 6.2.9-7 through 6.2.9-10, are the following:

- Protection
- Detection
- Response

- Recovery

Table 6.2.9-7 provides a summary of the actors and actions for the JPSS GS protection activities.

Table: 6.2.9-7 JPSS GS Security Protection

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Account Maintenance				
1a	External or internal Users	Submit Account Change or Creation Request	Access Control	AC-2	
1b	Information Systems Security Officer (ISSO)	Reviews and Approval Authority for all Account Access Requests (IDMZ/MDMZ user enrollment process)	Access Control	AC-2	
1c	Information Systems Security Officer (ISSO)	Reviews and Approval Authority for all Replacement of Non-Person Entity (NPE) Certificate requests	Access Control	AC-2	
1d	System Administrator (SysAdmin)	Manages user access (add, delete, disable, enable, modify, update)	Access Control	AC-2 (2), (3)	
	Security Tool Maintenance				
2a	Software Vendors	Notifies Software Updates	All	RA-5 (1), SI-3	
2b	System Administrator (SysAdmin)	Performs Security Tool updates (Anti-Malware signatures, Patches, Plugin updates, etc.)	All	SI-3 (1), (2)	Centralized PDP protection functions (see table 6.2.9-1) are performed at the MON in the Manage NOAA5042 security

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
					controls and distributed PEP protection functions are performed in node equipment as part of the node configuration activities in each node.
2c	Security Admin	Applies security policies to meet security objectives of the system	All	CM-5, CM-6	
2d	System Administrator (SysAdmin)	Test and Deploy Security Tool Updates	All	MA-3	
2e	Management & Operation Node	Manage NOAA5042 Security Controls	All		
2f	Security Admin	Apply security policies to meet security objectives of the system	All	CM-5, CM-6	
2g	Space/Ground Communications Node	Configure Ground Station	Network Protection	CM-5, CM-6	
2h	Ground Network Node	Configure Network Routing	Network Protection	CM-5, CM-6	
	Day-to-Day Monitoring				
3a	Security Admin	Ensures all systems security operations and maintenance activities are properly documented and		AU-2	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
		updated as necessary			
3b	Security Admin	Conducts regular log reviews and audits		AU-2 (3), AU-6	
3c	Security Admin	Monitor and evaluate the security posture of all systems		CA-2	
3d	Information Systems Security Officer (ISSO)	Assess implementation and functionality of security requirements and appropriate IT policies and procedures that are consistent with NOAA's mission and goals		CA-7	
3e	Information Systems Security Officer (ISSO)	Ensure certification and accreditation of all systems		CA-6	
3f	Configuration Management (CM)	Maintain CM Documentation		CM-2	
3g	System Administrator (SysAdmin)	Verify the System Status to ensure the system running normally		SI-4	
3h	Security Admin	Conduct regular System log reviews and audits		AU-2 (3), AU-6	
3i	Network Administrator (NetAdmin)	Verify the Network System Status to ensure the system running normally		SI-4	
3j	Security Admin	Conduct Network regular		AU-2 (3), AU-6	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
		log reviews and audits			
3k	Management & Operation Node	Monitor and Control CGS Enterprise Information Systems		SI-4	Centralized PDP protection functions (see table 6.2.9-1) are performed at the MON in the Manage NOAA5042 security controls and distributed PEP protection functions are performed in node equipment as part of the node configuration activities in each node.
3l	Management & Operation Node	Enterprise Management			
3m	Management & Operation Node	Security Event Management (SEM)		SI-4	
3n	Calibration/Validation Node	Manage Cal/Val Infrastructure			
3o	Calibration/Validation Node	Manage NOAA5048 Security Controls			
	Backups				
4a	System Administrator (SysAdmin)	Perform Backups of System and Security Tool Configurations	All	CP-9	
4b	Reserved				-

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
4c	Network Administrator (NetAdmin)	Perform Backups of Network Configurations	Network Protection	CP-9	
4d	Security Admin	Validate Backups	All	CP-9 (2)	Periodically, the backups are tested to validate that the backup procedure is working as expected

Table 6.2.9-8 provides a summary of the actors and actions for the JPSS GS detection activities.

Table: 6.2.9-8 JPSS GS Security Detection

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Determine Vulnerabilities				
1a	NOAA Computer Incident Response Team (N-CIRT)	Share common vulnerabilities to the NOAA community		RA-5 (1)	
1b	Security Admin	Perform Vulnerability Scans		RA-5	
1c	Management & Operation Node	Integrate Vulnerability Scan findings into Audit Logs		AU-3	
	Sources of Security Events				
2a	Management & Operation Node	Enterprise Management		AU-2, AU-3	
2b	Management & Operation Node	Security Event Management (SEM)		AU-2, AU-3	
2c	External or internal Users	User Reported Security Violations		AU-2, AU-3	
2d	Management & Operation Node	Monitor and Control CGS		AU-2, AU-3	Centralized PDP protection

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
		Enterprise Information Systems			functions (see table 6.2.9-1) are performed at the MON in the Manage NOAA5042 security controls and distributed PEP protection functions are performed in node equipment as part of the node configuration activities in each node.
2e	Simulation Node	Monitor Simulators and Output Status		AU-2, AU-3	
2f	Calibration/Validation Node	Monitor NASA5048 for Security Issues		AU-2, AU-3	Centralized PDP protection functions (see table 6.2.9-1) are performed at the MON in the Manage NOAA5042 security controls and distributed PEP protection functions are performed in node equipment as part of the node configuration activities in each node.
2g	Security Admin	Review account activity		AU-2, AU-3	
2h	Security Admin	Review Quarantined items		AU-2, AU-3	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
2i	Security Admin	Investigate the cause of events, what the impacts are, and if the system is vulnerable		AU-2, AU-3	
2j	Security Admin	Investigate and responds to Security Alerts from SEM		AU-2, AU-3	
2k	Information Systems Security Officer (ISSO)	Manage and control changes to the system and assesses the security impact of those changes		CM-3, CM-4	
2l	Information Systems Security Officer (ISSO)	Recognize possible security violations and takes appropriate action to report the incidents		SI-7	
2m	System Administrator (SysAdmin)	Investigate and responds to any Security Alerts from EM		IR-4	See SyS (GS-NML-300) for details on the collection of SOH information.
2n	System Administrator (SysAdmin)	Investigate and Respond to Anomalies		IR-4	See System Fault Analysis Thread for details.
2o	Network Administrator (NetAdmin)	Investigate and responds to any Security Alerts from EM		IR-4	See SyS (GS-NML-300) for details on the collection of SOH information.
2p	Network Administrator (NetAdmin)	Investigate and Respond to Anomalies		IR-4	See System Fault Analysis Thread for details.

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
2q	Network Administrator (NetAdmin)	Receive and analyze network alerts from EM and determines possible causes of such alerts		IR-4	
2r	Enterprise Management Operator (EMOC)	Receive automated Security Alerts from EM; elevate them to Security Admin and coordinate response with Security Admin		IR-4	
2s	Enterprise Management Operator (EMOC)	Monitor Long Term SOS and SOH Trending		CA-7	
	Elevate Security Event(s) to Security Incident				
3a	Security Admin	Determines if the reported event is a security incident		IR-4	
3b	Security Admin	Determines Security Status		IR-4	
3c	JPSS Computer Anomaly Analysis Team (J-CAAT)	Review Security Incidents to determine severity and potential actions needed, if any		IR-4	
3d	JPSS Computer Anomaly Analysis Team (J-CAAT)	Report the Security Incidents to the appropriate NOAA and NASA security authorities		IR-4	
3e	JPSS Computer Anomaly Analysis Team (J-CAAT)	Determine if security incident should be reported to the		IR-4	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
		NOAA Computer Incident Response Team (N-CIRT)			
3f	NOAA Computer Incident Response Team (N-CIRT)	Analyze Security Incident Report		IR-4	
3g	NOAA Security Management	Receive Security Incident Report		IR-6	
3h	NASA Security Management	Receive Security Incident Report		IR-6	
3i	Information Systems Security Officer (ISSO)	Participate in an information security risk assessment		RA-3	
3j	NOAA Computer Incident Response Team (N-CIRT)	Refer security events to the DOC Office of Inspector General as appropriate		IR-6	

Table 6.2.9-9 provides a summary of the actors and actions for Responding to Security Incidents that have previously been detected in the JPPS GS.

Table: 6.2.9-9 JPSS GS Response to Security Incidents

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Respond to Vulnerabilities				
1a	Patch and Vulnerability Group (PVG)	Create Engineering Change Requests (ECRs) to remediate findings from vulnerability scans		SI-2 (1), (2)	
1b	System Administrator (SysAdmin)	Remediate system vulnerabilities per ECRs		SI-2	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
1c	Network Administrator (NetAdmin)	Remediate network vulnerabilities per ECRs		SI-2	
1d	Configuration Management (CM)	Update CM documentation to reflect any changes to the baseline		CM-2	-
	Respond to Security Incident				
2a	Security Admin	Work with the N-CIRT, the ISSO, the DOC Office of Inspector General (if needed) and the operations staff to implement corrective set of actions for each Security Incident		SI-2	
2b	Security Admin	Work with the CGS Support Node or the Cal/Val Node to implement an update as part of the System Maintenance and Upgrade ConOps thread		SI-2	
2c	Security Admin	Maintain historical logs of events and security incidents		AU-2, AU-4 (1)	
2d	Security Admin	Track and document security incidents from initial detection through final resolution		IR-5	
2e	Information Systems Security Officer (ISSO)	Report and responds to IT security incidents		IR-4	
2f	Mission Operations Manager (MOM)	Begin Security Incident response in accordance with baseline SOPs		IR-4	
2g	JPSS Computer Anomaly	Perform Security Incident triage to		IR-4	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Analysis Team (J-CAAT)	include determining scope, urgency, and potential impact; identifying the specific vulnerability and making recommendations that enable expeditious remediation			
2h	JPSS Computer Anomaly Analysis Team (J-CAAT)	Perform real-time Security Incident Handling (e.g., forensic collections, intrusion correlation/tracking, log correlation, threat analysis, etc.) tasks to support N-CIRT remediation efforts		IR-4 (4)	
2i	JPSS Computer Anomaly Analysis Team (J-CAAT)	Determine any changes to the security posture of the JPSS GS for both NOAA5042 and NOAA5048		IR-4	
2j	NOAA Computer Incident Response Team (N-CIRT)	Determine any changes to the security posture of the JPSS GS for both NOAA5042 and NOAA5048		IR-4	
2k	NOAA Computer Incident Response Team (N-CIRT)	Coordinate Security Incident response and act as a source of expertise and information regarding vulnerabilities and responses as pertains to the NOAA environment		IR-6	
2l	NOAA Computer	Trend Long Term Security Incidents		IR-5	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Incident Response Team (N-CIRT)				
2m	NOAA Computer Incident Response Team (N-CIRT)	Coordinate investigations with the Office of the Inspector General when needed.		IR-5	
	Implement Corrective Actions				
3a	Management & Operation Node	Manage MON Nodal Situational Awareness		SI-4	See SyS (GS-NML-300) for details on the collection of SOH information.
3b	Management & Operation Node	Manage Global Situational Awareness		SI-4	See SyS (GS-NML-300) for details on the collection of SOH information.
3c	Data processing Node	Manage DPN Nodal Situational Awareness		SI-4	See SyS (GS-NML-300) for details on the collection of SOH information.
3d	Space/Ground Communications Node	Manage SGCN Nodal Situational Awareness		SI-4	See SyS (GS-NML-300) for details on the collection of SOH information.
3e	Ground Network Node	Configure Network Routing		AC-4	See SyS (GS-NML-300) for details on the collection of SOH information.
3f	Ground Network Node	Manage GNN Nodal Situational Awareness		SI-4	See SyS (GS-NML-300) for details on the collection

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
					of SOH information.
3g	Simulation Node	Manage & Coordinate Baseline Changes		CM-3	See SyS (GS-NML-300) for details on the collection of SOH information.
3h	Calibration/Validation Node	Manage & Coordinate Baseline Changes		CM-3	See SyS (GS-NML-300) for details on the collection of SOH information.
3i	CGS Support Node	Manage & Coordinate Baseline Changes		CM-3	See SyS (GS-NML-300) for details on the collection of SOH information.
3j	Configuration Management (CM)	Update CM documentation to reflect any changes to the baseline		CM-3	
3k	Security Admin	Restore from Backup		CP-10	If Required
3l	System Administrator (SysAdmin)	Restore from Backup		CP-10	If Required
3m	Network Administrator (NetAdmin)	Restore from Backup		CP-10	If Required
	Collect Forensics				
4a	NOAA Computer Incident Response Team (N-CIRT)	Perform Forensics analysis		IR-4	
4b	Management & Operation Node	Enterprise Management		AU-2, AU-3	
4c	Management & Operation Node	Security Event Management (SEM)		SI-4	

Table 6.2.9-10 provides a summary of the actors and actions for the JPSS GS Security Recovery.

Table: 6.2.9-10 JPSS Ground System Recovery from Security Incidents

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Post Incident Activities				
1a	Security Admin	Perform Post Incident Analysis		IR-4	
1b	Security Admin	Correct security deficiencies identified during security/certification testing		IR-5, SI-2	
	Evaluate Security Policy				
2a	JPSS Computer Anomaly Analysis Team (J-CAAT)	Determine if New Security Policy Required		IR-8, PL-2	
2b	NOAA Computer Incident Response Team (N-CIRT)	Determine if New Security Policy Required		IR-8, PL-2	
2c	Security Admin	Implement new security functions based on new security policy			
2d	Information Systems Security Officer (ISSO)	Determine if New Security Policy Required		IR-8, PL-2	
2e	Management & Operation Node	Manage NOAA5042 Security Controls			
2f	Information Systems Security Officer (ISSO)	Update security policy based on lessons learned from security incidents.		IR-8, PL-2	
	Evaluate Architecture				
3a	JPSS Computer Anomaly Analysis	Determine if System Architecture Change Required		IR-8, PL-8	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
	Team (J-CAAT)				
3b	NOAA Computer Incident Response Team (N-CIRT)	Determine if System Architecture Change Required		IR-8, PL-8	
3c	System Engineer	Incorporate improvements to processes and/or systems based on lessons learned from security incident		SA-17, SC-22	
	Update Monitoring				
4a	Management & Operation Node	Enterprise Management		AU-2, AU-3	
4b	Management & Operation Node	Security Event Management (SEM)		AU-2, AU-3	
4c	Security Admin	Update automated criteria configured in SEM to detect security incidents		AU-3	
4d	Security Admin	Update prioritization configured in SEM for security incidents		AU-3	
4e	Configuration Management (CM)	Update CM documentation to reflect any changes to the baseline		CM-2, CM-3	
	Update Documentation				
5a	Security Admin	Ensure Recovery and Continuity plans are executable in the system operational environment		CP-4	
5b	Security Admin	Perform security reviews and identifies security gaps in security architecture resulting in recommendations for		CA-2, CM-4	

No.	Actors	Actions	Security Function	Control Family, Control, or Enhancement	Notes
		the inclusion into the risk mitigation strategy			
5c	Information Systems Security Officer (ISSO)	Ensure plans of actions and milestones or remediation plans are in place for vulnerabilities identified during risk assessments, audits, inspections, etc.		CA-5	
5d	Configuration Management (CM)	Update CM documentation to reflect any changes to the baseline		CM-2, CM-3	

6.2.9.7 Alternate Flow

There is no alternate flow for the Security ConOps thread.

6.2.9.8 Post-Conditions

If a security incident occurs, then the response to that incident can result in changes to normal CGS/FVTS and GRAVITE/FTS operations and configurations. After the incident is resolved, the post condition for the Security ConOps thread is normal operations with continuous security monitoring. If the configuration changes as a result of the security response, then configuration management of the new configuration continues.

6.2.9.9 Related Threads

The ConOps threads shown below provide background information for the Security thread. Review of these will help in the understanding of the Security thread activities.

Thread ID	Thread Title
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-050	Orbit Maintenance
GS-NML-060	Attitude Ground Support
GS-NML-070	Flight Software Upgrade
GS-NML-080	Flight Vehicle Simulation
GS-NML-100	Stored Mission Data Handling
GS-NML-140	Mission Support Data Handling
GS-NML-180	Data Acquisition and Routing
GS-NML-500	Sensor Operations and Payload Support
GS-NNL-150	Space Network Support

Thread ID	Thread Title
GS-NNL-120	Continuity of Operations
GS-NNL-140	System Maintenance and Upgrade
GS-NML-150	Cal/Val of Data Products
GS-NML-170	Algorithm Development and Maintenance
GS-NML-200	Key Management
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-MAD-110	Launch Readiness Support
GS-MAD-120	Launch and Early Orbit
GS-FTS-110	Field Terminal User Support

6.2.9.10 Child Threads

The ConOps threads below are the Level 4 threads that directly flow down from this Level 2/3 Security thread.

Thread ID	Thread Title
CGS-030-060	Ground System Security

6.3 Flight Operations

6.3.1 Launch Readiness Support

6.3.1.1 Description

The Launch Readiness Support ConOps thread (GS-MAD-110) encompasses the activities necessary to ready the mission operations and prepare the JPSS satellite and supporting ground facilities for launch. It is applicable to JPSS-1/2/3/4. A launch support plan will be developed for the satellite launch with more details about the launch preparation. In cases where this ConOps thread conflicts with the satellite launch support plan, the launch support plan will take precedence.

The main activities for the Launch Readiness Support ConOps thread are illustrated in Figure 6.3.1-1.

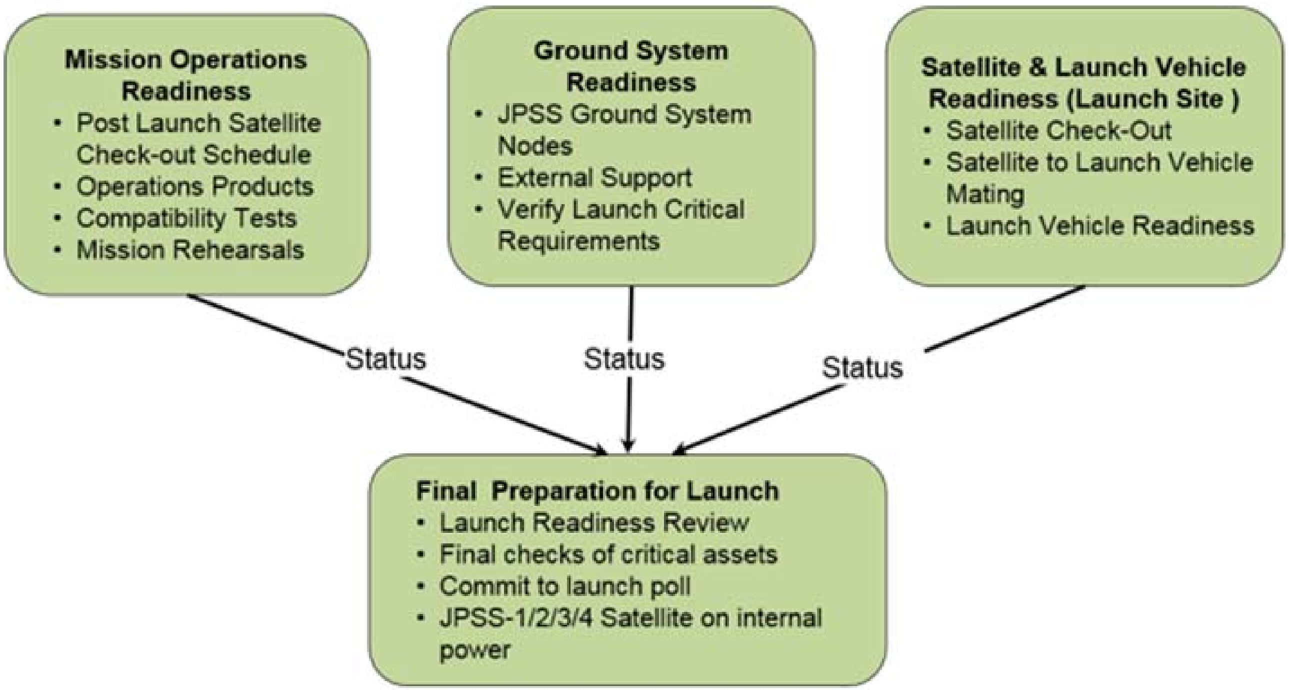


Figure: 6.3.1-1 Main Activities for Launch Readiness Support

The basic flows of the Launch Readiness Support thread are summarized below:

Mission Operations Readiness

- **Launch and Early Assent Mission Timeline Preparation:** An Integrated Mission Timeline (IMT) will be developed prior to launch and will be used throughout the pre-launch testing phase and post launch checkout of the observatory. This timeline provides the detailed order of operations during the activation and check-out of the spacecraft and its instruments. The IMT will also contain key stored commands, which include on S-NPP and JPSS-1 the Command Sequence Memory (CSM) and Command Block Memory (CBM), and on JPSS-2/3/4 the Absolute Time Sequence (ATS) and Relative Time Sequence (RTS). CSM/ATS is used for commanding the satellite during the back-orbit based on absolute time references, and CBM/RTS is used to command the satellite during back-orbit with relative time references.

  The on-orbit check-out period typically takes 90 days after launch. The IMT will be used for post launch checkout operations. All commanding will be validated both against the FVTS simulators and with the test as you fly approach. Specifically, FVTS testing ensures that the operational procedures (PROCs) are validated for commanding both the spacecraft and its instruments.

- **Ops Products (e.g. PROCs, SOPs) check-out:** Prior to pre-launch testing, the operational procedures (PROCs) that will be used to command the spacecraft are verified and validated. These PROCs are used during mission readiness testing to verify the execution time of the PROCs can be executed within a contact and to ensure that these PROCs perform the proper functions correctly. Written Standard Operating Procedures

(SOPs) that the mission operators follow are also verified during mission readiness testing. See Section 5.8 for an overview of the development of these operations products.

- **JPSS Compatibility Tests:** JPSS Compatibility Tests (JCTs) exercise the flight and ground interfaces against the JPSS-1/2/3/4 satellites. JCTs are comprised of a subset of the functional threads as well as interface tests to provide a higher degree of confidence leading up to the Mission Rehearsals.

  The elements involved in the JCT testing are the functionally configured spacecraft, and the elements of the delivered Ground System to provide at a minimum: telemetry and command capability from Riverdale, NSOF and the CBU, and special ground communications links between the Ground System and spacecraft factories (BATC for JPSS-1 and Orbital ATK for JPSS-2/3/4).

  Specifically for J2 JCT2, due to the introduction of a new spacecraft, new APIDs and modified AP format, checking the correct production and formatting of the science algorithms provides an early opportunity to discover any issues so they can be corrected before the JCT-3B RFR. Therefore, the DPN will distribute test data (J2 RDRs) to the Cal/Val Node, which makes the test data available to the science community.

  The Flight and Ground System RF interface will be exercised through a separate RF system test.

  Data collected during JCT testing will be used in the data processing component of the ground system / segment to validate end-to-end data flow.

  A test tool to support the integration of JPSS-1/2/3/4 spacecrafts and the Ground System, the JPSS Compatibility Test (JCT) Rack emulates the ground station functions. It interacts with the JPSS-1/2/3/4 spacecrafts and MON. The JCT Rack will be used to support spacecraft integration at the JPSS-1 spacecraft vendor site and JPSS-2/3/4 spacecraft vendor site; and to support pre-launch activities at the Vandenberg Air Force Base. Through the JCT Rack, encrypted and unencrypted test commands are sent from MON to the spacecraft under test while telemetry and stored mission data are received at MON from the spacecraft.

- **Mission Rehearsals:** Rehearsal activities are performed by the Mission Operations Support Team (MOST) with support from the instrument vendors, and the spacecraft manufacturer in as much of a test-as-you-fly manner as possible. The Mission Rehearsals will use actual planned contacts with SVAL, FCDAS, McMurdo, Troll, and TDRSS to ensure that the operational products, the mission timelines, and the mission operations personnel are all able to perform their functions in the time available and that the initialization sequences are correct. The Mission Rehearsals will use the FVTS to simulate satellite command and telemetry operations. In addition, some of the Mission Rehearsals will introduce anomalies to validate the MOST's readiness to respond to anomalies.

  The Mission Rehearsals are performed to exercise the on-orbit check-out of satellite after launch and normal operations. In both cases, the Mission Rehearsals address both nominal and anomalous operational conditions on the spacecraft bus, any of the instruments, or any ground system component. Anomalous conditions usually include

having the satellite go into safe-hold mode due to a component failure or some type of instrument problem. Loss of ground station support could also occur, preventing communications with the spacecraft for one or more orbits. A Risk Mitigation Maneuver situation could also occur, requiring a quick FDF planning scenario to be executed to ensure the safety of the spacecraft. Mission Rehearsals are developed by the Mission Operations Support Team (MOST) and in some cases independently from the operations personnel to ensure as much realism as possible. The mission operations personnel with support of instrument and satellite vendors perform the Mission Rehearsals without any advance knowledge of any anomalous conditions injected in the Mission Rehearsals. The final Mission Rehearsal will be a launch rehearsal with the NSOF connected to the satellite at the LSS through the launch vehicle umbilical connection to the JPSS-1/2/3/4 Electrical Ground Support Equipment (EGSE).

The mission readiness tests include at least one dress rehearsal where the JPSS Launch Management Team at VAFB and the Mission Operations Team at the JPSS Ground System work together in a simulated launch countdown.

Satellite and Launch Vehicle Readiness at Launch Site

- **Satellite Check-out & Launch Preparation**: After the satellite arrives at the launch site, the spacecraft and all of the instruments are checked out by the JPSS launch team personnel prior to mating of the satellite to the launch vehicle. This includes physical inspection, battery charging & testing, functional tests, propulsion testing, instrument testing, internal communications testing, command link testing in both clear and encrypted mode, and launch simulation testing.

  After the satellite is fully tested, final launch preparations are completed including final cleaning, installation of the fairing, propellant loading, and final satellite close-outs.

- **Satellite to Launch Vehicle mating**: After the satellite is fully tested and prepared for launch, it is integrated with the launch vehicle by launch vehicle personnel. At this point all communications and power to the satellite are provided via the launch vehicle umbilical connection to the JPSS-1/2/3/4 EGSE. These communications include satellite commanding, telemetry, and sensor data when available.

- **Launch Vehicle Readiness**: After integration of the satellite with the launch vehicle, final launch preparations on the launch vehicle are completed by the launch vehicle personnel. A Flight Readiness Review is conducted by the NASA Launch Director approximately a week before launch to determine readiness status of both the satellite and the launch vehicle to support the launch operations.

Ground System Readiness Verification

- **JPSS Ground System Nodes and External Support Readiness Verification**: The final testing of the ground system and its networks to external supporting systems occurs during pre-launch preparations. This includes final check-out of the JPSS launch critical ground system nodes including the Space Ground Communications Node, the Management and Operations Node (MON), the Data Processing Node (DPN), the Ground Network Node (GNN), and the Flight Vehicle Test Suite (FVTS).

- **External Support:** Supporting facilities such as the KSAT support for SVAL, Fairbanks, the Launch Site Support (LSS) communications to the MON, and the SN are verified to ensure that they are ready to support the JPSS-1/2/3/4 launch.
- **Launch Critical Requirements Verification:** Also during final preparation for a launch, a review of all launch critical requirements is done to ensure that the ground system either fully meets these requirements or has an acceptable work around for that requirement that does not jeopardize the success of the launch.

Final Preparation for Launch

- **Launch Readiness Review (LRR):** On or about two days before launch, a LRR will be held that determines the readiness of all of the critical flight and ground systems and personnel functions required to support the JPSS launch operations. The LRR is chaired by the U.S. Air Force Space Wing at the launch site with the JPSS Launch Management Team serving in a supporting role. Critical systems include health of the JPSS satellite, the launch vehicle, and associated support systems such as the NSOF, SVAL, and SN. The LRR also covers readiness of range safety functions such as flight termination system, flight trajectory analysis, flight safety rules, and destruct criteria.
- **Final Verification of all launch critical assets:** All JPSS launch-critical assets are verified prior to launch. These are fully defined in the Launch Commit Criteria document and include: Voice communications between VAFB and the NSOF, Pre-launch command and telemetry data flow between VAFB and NSOF, SMD playback capability at SVAL, and command & telemetry data flow from the spacecraft via TDRSS
- **Final JPSS Commit to Launch Poll:** Prior to the final NASA KSC launch management poll, a final JPSS Launch Management Team Commit-to-Launch poll will be taken to ensure that all systems are ready for launch. This poll includes go/no go of all key mission personnel including the JPSS Systems Team, the Flight & Network Support Team, the JPSS Spacecraft vendor, JPSS Safety & Mission Assurance, JPSS-1/2/3/4 Observatory Manager, JPSS Mission Manager, space program director, and JPSS Mission director. The JPSS Flight Project Manager shall report final readiness of the JPSS Launch Team to the NASA Launch Director.
- **JPSS-1/2/3/4 Satellite Switched to Internal Power:** Assuming all satellite, launch vehicle and range systems are ready for launch, the JPSS-1/2/3/4 satellite is switched to its own internal power at approximately 10 minutes before launch.

6.3.1.2 Primary Interfaces

Primary interfaces driven by this ConOps thread are depicted in Figure 6.3.1-2. This includes both external interfaces and inter-system interfaces within the Ground System.

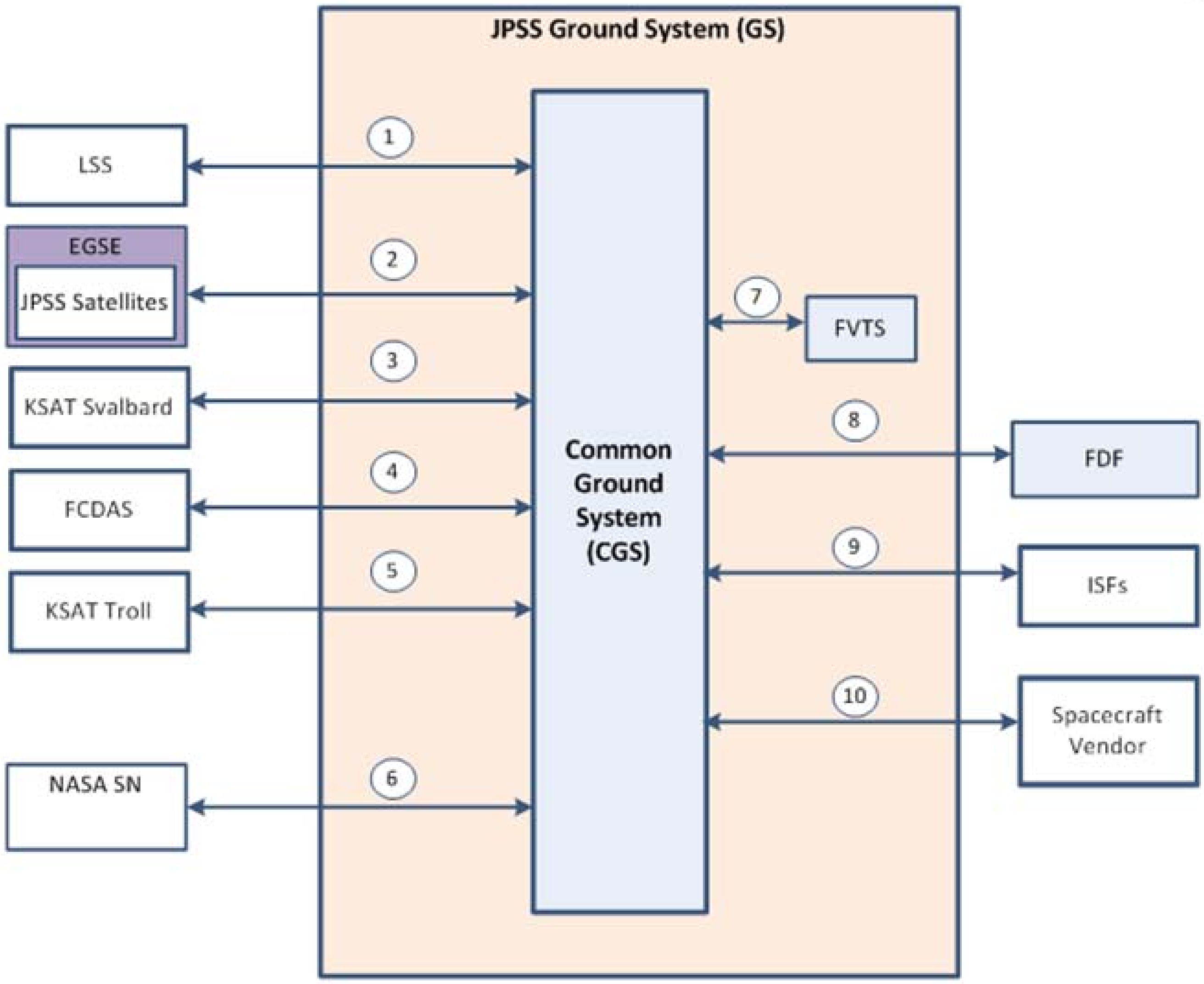


Figure: 6.3.1-2 Primary Interfaces for Launch Readiness Support

In addition to the interfaces used to complete this ConOps thread, multiple voice circuits will be active during the launch of JPSS satellites. Each interface in Figure 6.3.1-2 is labeled with a number. The interfaces in Figure 6.3.1-2 are defined in Table 6.3.1-1 with types of interface, actors, and purpose. Table 6.3.1-2 provides the relevant IRDs and/or ICDs for those interfaces.

Table: 6.3.1-1 Launch Readiness Support Primary Interfaces

No.	Type	Actors	Purpose
1	External	Launch Site Support (LSS), JPSS GS	Voice and data communications to the MON is required to support launch. SOS of the LSS
2	External	Satellite(s) (through EGSE), JPSS GS	Status: SOH and SOS status of the SMD downlink; HRD downlinks; telemetry downlinks (real-time and stored); receive JPSS sensor data, & command uplink

No.	Type	Actors	Purpose
3	External	Kongsberg Satellite Services (KSAT), JPSS GS	Status: Receive SOH and SOS status of JPSS equipment at SVAL, and KSAT ground station SOS status. Voice communications.
4	External	FCDAS, JPSS GS	Status; Receive Fairbanks ground station SOS status. Voice communications.
5	External	KSAT Troll, JPSS GS	Status; Receive Troll ground station SOS status. Voice communications.
6	External	Space Network (SN), JPSS GS	Status: SOH and SOS status of JPSS equipment at WSC, SOS Status of SN White Sands Complex (WSC & TDRS), Voice communications.
7	Internal	CGS, Flight Vehicle Test Suite (FVTS)	Status: FVTS SOH and SOS status to CGS FVTS Control, Simulated T&C and SMD flow
8	External	JPSS GS, Flight Dynamics Facility (FDF)	Satellite tracking and orbit data
9	External	JPSS GS, Instrument Support Facility (ISF)	Support for instrument check-out at launch site
10	External	JPSS GS, Spacecraft Vendor	Support for satellite check-out at launch site

Table: 6.3.1-2 Launch Readiness Support Interface Documentation

No.	IRD/ICD
1	JPSS-1/2/3/4 Launch Site Support Plan
2	JPSS Space Segment to Ground Segment TT&C Interface Requirements Document (IRD) JPSS GS to KSAT ICD JPSS GS Services Specification JPSS CGS Services IDD JPSS Space/Ground Data Format XML Database
3	JPSS GS to KSAT IRD JPSS CGS to KSAT ICD GCOM-W1 Mission Ops Interface Specification JPSS GS Services Specification JPSS CGS Services IDD
4	JPSS GS to National Environmental Satellite, Data, and Information Service (NESDIS) Fairbanks Command and Data Acquisition Station (FCDAS) IRD JPSS CGS to FCDAS ICD
5	JPSS GS to KSAT IRD
6	JPSS SS-GS TT&C IRD JPSS Space/Ground Data Format XML Database SN-JPSS CGS ICD JPSS GS Services Specification JPSS CGS Services IDD
7	JPSS CGS to FVTS IRD JPSS CGS to FVTS ICD
8	JPSS CGS to NASA Flight Dynamics Facility (FDF) ICD
9	JPSS GS to ISF IRDs

No.	IRD/ICD
10	JPSS GS to S/C SF ICD

6.3.1.3 Assumptions & Constraints

The following criteria must be met to ensure successful checkout of the spacecraft while it is at the launch facility.

- Personnel involved in ground operations functions have the appropriate training and certifications.
- External organizations such as KSAT ensure a high availability of their ground station assets, have available resources to meet JPSS needs, and respond appropriately to JPSS requests.
- Hardware and software upgrades to the system are adequately tested before being installed on the operational ground system.
- FGM is able to reconcile resource constraints between JPSS and other missions to meet system priorities and customer expectations.

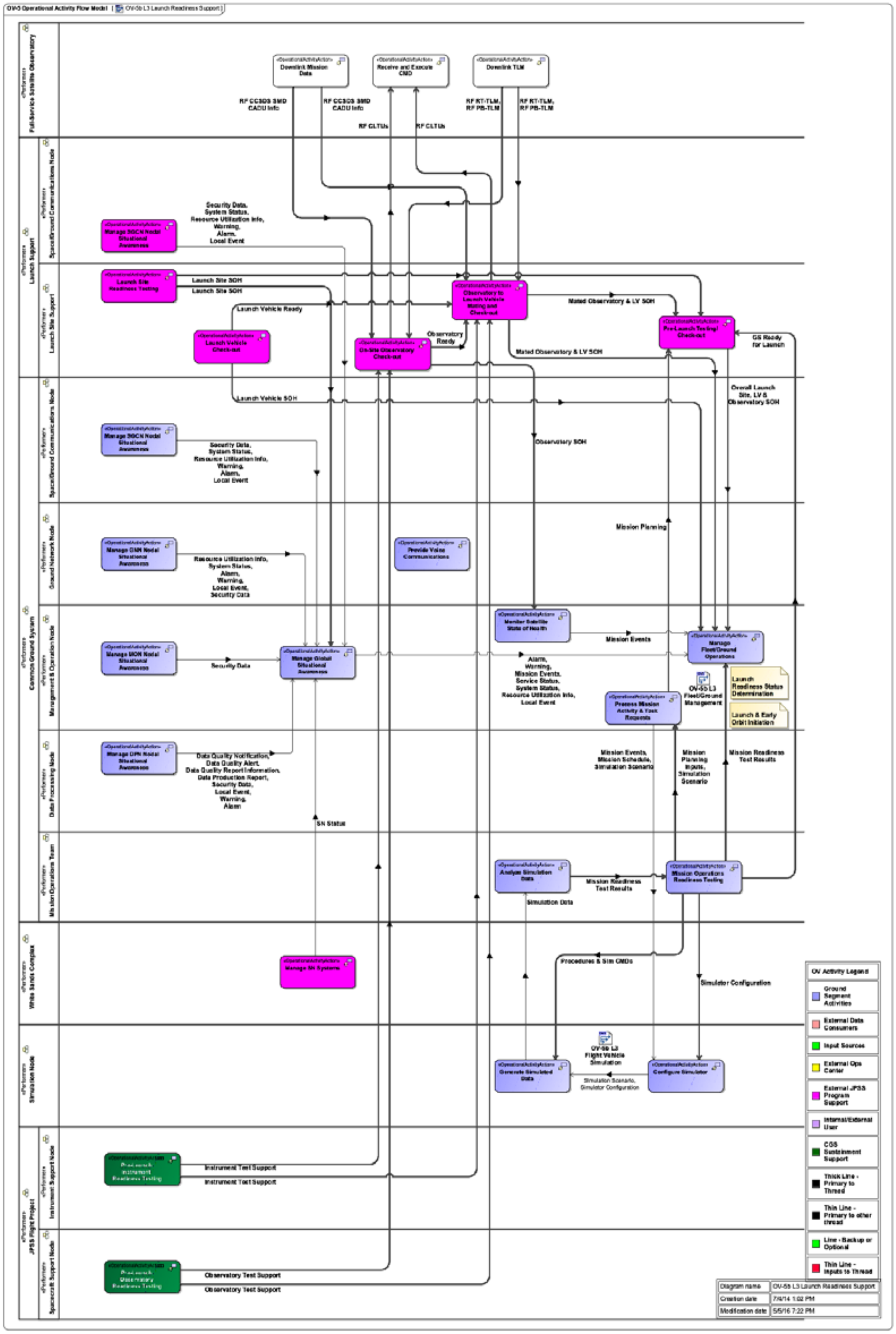
6.3.1.4 Pre-Conditions

Preconditions for Launch Readiness Support when Satellite is at the Launch Site include the following:

- Spacecraft and instruments adequately tested prior to arrival
- Launch vehicle ready to support integrated operations with the satellite
- Communications networks provisioned and tested between the Launch Site, MON, and Ground Stations.

6.3.1.5 Operational Flow

The operational flow is illustrated in Figure 6.3.1-3. This diagram is an OV-5b view that ties this thread into the rest of the system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.1-3 The DoDAF OV-5b view of the Launch Readiness Support

6.3.1.6 Basic Flows

The basic data flows from the Launch Readiness Support OV-5b view have been parsed out and summarized into specific Launch Readiness Support flows. The basic Launch Readiness Support flows are as follows:

- Launch Site Readiness of Satellite and Launch Vehicle
- Ground System Readiness Verification
- Mission Operations Readiness
- Final Preparation for Launch

The descriptions and activities for each of these flows are provided in Tables 6.3.1-3 to 6.3.1-6.

Table 6.3.1-3 provides a description of each of the steps in the Launch Readiness Support activities required to prepare the Mission Operations team for launch with the actors and the actions for each step.

Table: 6.3.1-3 Mission Operations Readiness Actions

No	Actors	Actions	Notes
1	MON , MOST	The launch readiness of the Mission Operations Support Team (MOST) and its supporting products must be verified prior to launch. The first step in performing this verification is to develop the Integrated Mission Timeline (IMT) that details all of the activities to be performed and completed from launch through the 90-day checkout period. This will be done in the Process Mission Activity & Task Request activity. The IMT will be used to drive mission rehearsal testing prior to launch.	
2	MOST, Simulation Node, SSN, and ISN	Operational products including the ground operations scripts, PROCs and SOPs must also be verified. This is done in the Mission Readiness Testing activity. The FVTS will be used to verify the performance of the PROCs and validate the SOPs in the Simulate Flight Vehicle Activity.	
3	MOST, SGCN, GNN, MON, FVTS, DPN, Cal/Val, SSN, ISN	JPSS Compatibility Tests (JCTs) exercise the flight and ground interfaces against the satellite. JCTs are comprised of a subset of the functional threads as well as interface tests to provide a higher degree of confidence leading up to the Mission Rehearsals.	
4	MOST, Simulation Node, SSN, and ISN	MRs are performed for both check-out of the satellite after launch scenarios and normal operations scenarios. In both cases, MRs address both nominal operational sceneries and anomalous conditions on either the spacecraft or one of the instruments MRs contain anomalous conditions that simulate spacecraft and instrument faults as well as	

No	Actors	Actions	Notes
		emergency maneuvers such as would be required for collision avoidance with orbital debris. These MRs validate the training of the mission operations team, the correctness of the PROCs, and the ability of the activities for that test to be performed during a contact with the satellite. MRs exclusively use the FVTS to validate commanding, command responses, and telemetry processing. To ensure the Mission Rehearsals (MRs) are as realistic as possible, they are developed by a select subset of MOST and in some cases independently from the operations personnel. Then the MOST, with the support of spacecraft and instrument vendors support the MR without any advance knowledge of any planned anomalous conditions. At least one MR will provide an end to end test where the Launch Management Team at VAFB and MOST at NSOF work together in a simulated launch countdown. One of the last MRs will simulate the launch with the satellite at the LSS through the EGSE.	

Table 6.3.1-4 provides a description of each step in the Launch Readiness Support process at the launch site to integrate the satellite and launch vehicle in preparation for flight. It also lists the actors and the actions required for each step.

Table: 6.3.1-4 Launch Site Readiness of Satellite and Launch Vehicle Actions

	Actors	Actions	Notes
1	Launch Site Support (LSS), Spacecraft Support Node (SSN), Instrument Support Node (ISN)	After the satellite arrives at the launch site, the JPSS launch team personnel re-test the spacecraft and its instruments in the On-Site Observatory Check-out activity. This consists of re-verifying the flight readiness of all aspects of both the spacecraft and its instruments. Checks include physical inspection, battery, solar array, and power distribution system testing, and internal and external communications system testing. This testing is supported by the Spacecraft Support Node and the Instrument Support Node.	Voice Comm. verbiage (large # active for launch)
2	LSS, SSN, and ISN	After the satellite has been determined to be flight ready, the satellite is prepared for integration with the launch vehicle in the Observatory to Launch Vehicle Mating and Check-Out activity. This includes a final cleaning, loading of propellant, installation of the fairing, and final satellite close-out activities.	

	Actors	Actions	Notes
3	LSS, SSN, and ISN	After the satellite standalone preparations are complete, the Observatory to Launch Vehicle Mating and Check-Out activity mates the satellite to the launch vehicle.	
4	LSS, SSN, and ISN	After the satellite is mated to the launch vehicle, the Observatory to Launch Vehicle Mating and Check-Out activity makes final preparation to ensure the vehicle is ready for launch.	

Table 6.3.1-5 provides a description of each of the steps in the Launch Readiness Support activities required to prepare the JPSS Ground System for launch with the actors and the actions in that process.

Table: 6.3.1-5 Ground System Readiness Actions

No	Actors	Actions	Notes
1	Space/Gnd Communications Node, Ground Network Node, MON, DPN	In preparation for launch, the several activities check the readiness of the nodes in the JPSS Ground Station (GS). The activities that monitor the JPSS GS nodes that are provided below: • The CGS Manage SGCN Nodal Situational Awareness Activity monitors the SOH of the JPSS equipment and SVAL, Fairbanks, and the White Sands Complex (WSC). • The CGS Manage GNN Nodal Situational Awareness activity monitors the connectivity between the ground stations. It monitors the connectivity between the MON and the Launch Site. It also monitors the connectivity between the MON/DPN and downstream users of data • The CGS Manage MON Nodal Situational Awareness activity monitors the ability of the NSOF equipment to provide commanding to and process telemetry form the satellite. All of these activities feed their SOH status to the CGS Manage Global Situational Awareness activity. This activity provides a go/no go status of the JPSS GS for the final launch decision.	See the System Status/Situational Awareness ConOps thread for additional information about SOH information
2	Simulation Node	The FVTS is monitored by the Monitor and Configure Simulators activity. This information is also provided as part of the launch decision.	
3	MON, Ground Network Node	The MON monitors the readiness for launch of the external facilities and systems such as KSAT systems at SVAL that are used by JPSS, non-JPSS equipment at Fairbanks, and the SN. This is done in the CGS Manage Global Situational Awareness activity. This information is also provided as part of the launch decision.	

No	Actors	Actions	Notes
4	MON	Part of the determination that the JPSS GS is ready for launch is to verify that all of the launch critical requirements have been met by the JPSS GS.	

Table 6.3.1-6 provides a description of each of the steps in the Launch Readiness Support activities required to make the final launch decision with the actors and the actions for each step.

Table: 6.3.1-6 Final Launch Decision & Preparation

No	Actors	Actions	Notes
1	LSS, SSN, ISN, MON, and, MOST	On or about two days before launch, a Launch Readiness Review will be held that determines the readiness of all of the critical flight and ground systems and personnel functions required to support the JPSS launch operations. The LRR is chaired by the U.S. Air Force Space Wing at the launch site with the JPSS Launch Management Team serving in a supporting role. Critical systems include health of the JPSS Satellite, the launch vehicle, and associated support systems such as the NSOF, SVAL, and the SN. The LRR also covers readiness of range safety functions such as flight termination system, flight trajectory analysis, flight safety rules, and destruct criteria. The LRR will be supported as part of the Manage Fleet Ground Operations activity.	
2	LSS, SSN, ISN, MON, and MOST	Just prior to launch the LST works with the CGS Manage Global Situational Awareness activity, Manage & Configure Simulators activity, and Prelaunch Testing & Check out activity to verify that all of the launch critical systems are operational for launch functions. These include voice communications between VAFB and the NSOF, Pre-launch command and telemetry at VAFB, command & telemetry at the NSOF, command, telemetry, and SMD playback capability at SVAL, command & telemetry via TDRSS, and spacecraft hardware.	
3	LSS, SSN, and ISN, MON, and, MOST	Prior to the final NASA KSC launch management poll, a final JPSS Launch Management Team Commit-to-Launch poll will be taken to ensure that all systems are ready for launch of the JPSS Satellite. This poll includes go/no go of all key mission personnel including the JPSS Systems Team, the Flight & Network Support Team, the JPSS Spacecraft vendor, JPSS Safety & Mission Assurance, JPSS-1/2/3/4 Observatory Manager, JPSS Mission Manager, space program director, and JPSS Mission director. The JPSS Flight Project Manager shall report final readiness of the JPSS Launch Team to the NASA Launch Director.	
4	LSS, SSN, and ISN, MON, and MOST	Assuming a successful “JPSS Commit to Launch Poll”, at approximately 10 minutes before launch the JPSS-1/2/3/4 satellite will be switched to its own internal power. Once	For additional information on that activities

No	Actors	Actions	Notes
		this happens, the activities for this ConOps thread have been completed.	that occur after launch see the Launch and Early Orbit thread.

6.3.1.7 Alternate Flows

No Alternate Flows identified at this time.

6.3.1.8 Post-Condition

The satellite, the launch vehicle, the JPSS Ground System, and the Mission Operations Team are all ready for launch.

6.3.1.9 Related Threads

The ConOps threads listed below provide background information for the Launch Readiness Support thread. Review of these will help in the understanding of the Launch Readiness Support thread activities.

Thread ID	Thread Title
GS-MAD-120	Launch & Early Orbit
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning & Scheduling
GS-NML-030	Telemetry & Commanding
GS-NML-080	Flight Vehicle Simulation
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-NNL-120	Continuity of Operations

6.3.1.10 Child Threads

The OpsCon threads listed below are the Level 4 threads that directly flow down from this Level 3 Pre-Launch & Launch Readiness thread.

Thread ID	Thread Title
CGS-040-030	Pre-launch, Launch & Early Orbit Support

6.3.2 Launch and Early Orbit

The Launch and Early Orbit (LEO) (GS-MAD-120) thread (aka. Launch, Early Orbit & Activation, or LEO&A) provides a high level description of Ground System operations during the satellite launch and early orbit phase for the JPSS-managed satellites yet to be launched. The thread addresses ground activities supported by the JPSS Ground System from the launch to the final checkout of the satellite, including the instruments. The launch phase begins with the liftoff, ascent, separation from the Launch Vehicle (LV); and finishes with the satellite being placed in the designated injection orbit and in the sun-pointing survival mode via autonomous action of on-board systems and sequences. The operations then transition into the early orbit

phase as the spacecraft attitude stabilizes and establishes reliable communication with the Management and Operations Node (MON). The early orbit phase completes when the spacecraft and instruments have been successfully activated, deployed and checked out as functional.

The operations during the launch phase include tracking, telemetry monitoring from the Space Network (SN)/Tracking and Data Relay Satellite System (TDRSS), predicted acquisition vector updates, and mission planning updates, if necessary. During the early orbit phase, the operations center around the activation, initialization and checkout of the spacecraft bus system and subsystems, as well as the activation and initialization of instruments.

The operational flows apply to the JPSS-managed satellites, including JPSS-1/2/3/4. The scope of this thread includes ground system activities conducted during LEO&A. This thread focuses on the preparation and the initial activation and checkout of the spacecraft bus and through which, describes unique ground system capabilities that are essential to support all activities in the early orbit phase. For other activation and checkout activities in the early orbit phase, please see the mission-specific LEO&A Plan.

The flow of this thread is segmented into two stages as listed below:

- Launch / Ascent
- Activation & Checkout

Operational control of the JPSS-managed satellites, orbits and ground system is allocated to the JPSS Common Ground System (CGS). The CGS capabilities include orbit prediction and control, mission planning and scheduling, command and control, mission support data collection, data distribution, data processing and archival storage, and ground system management (including IT Networks). While these same capabilities are exercised during normal operations, additional functionality and/or execution of specific tasks is required to support the LEO&A phase.

This thread discusses the overall plan for commissioning of the space and ground components for JPSS-managed missions as it applies to the utilization and maintenance of the JPSS Ground System. The information it contains is based on the requirements and guidelines presented in applicable and reference NASA/GSFC standards (STD), NASA Procedural Requirements (NPR) and GSFC Procedural Requirements (GPR) which apply while the mission is NASA-managed. Documentation produced as a result includes, at a minimum, a mission-specific LEO&A Management Plan.

This thread addresses the operational and ground system activities resulting from the items listed below related to the commissioning and transition to operational mode of the satellite:

- Update and execution of the 90-day Integrated Mission Timeline (IMT)

The following documents provide additional information to this thread:

- Flight Activation Operations Plan
- CERES/RBI FM6 Activation Plan
- CERES/RBI Launch and Commissioning Support Plan

Operations during the LEO&A phase are managed by the Mission Operations Support Team (MOST) with varying levels of support by spacecraft and instrument vendors. Spacecraft vendor support is heaviest up through spacecraft activation and Mission Point Mode, with instrument vendor support peaking at instrument activation. The team's composition, roles and responsibilities are determined by the Mission Operations Manager and clearly defined in the LEO&A Management Plan. The MOST is composed of:

- **Mission Operations Manager (MOM):** Final Operations approval authority for all JPSS missions and overall LEO&A operations responsibility.
- **Mission Readiness Manager (MRM):** JPSS-1/2/3/4 mission-specific lead for mission readiness and LEO&A operations responsibility.
- **Flight Readiness Lead (FRL)**: coordinates execution of the IMT with engineering and operations. Provides technical direction of MOST personnel, directing spacecraft and instrument subsystem operations leads in the development of pre-launch test plans, procedures, methodologies, and post-launch engineering check-out of the JPSS satellites. The FRL takes direction from the MOM and MRM.
- **Ground Readiness Manager (GRM)**: Provides management oversight of the JPSS-1/2/3/4 ground segment readiness activities to include the C3S and Interface Data Processing System (IDPS) upgrades required for JPSS multi-mission operations. The GRM oversees the ground system contractors that provide mission support analysts, operations security, IT support, ground systems engineering, ground operations product development, database administration, training, and configuration management.
- **Operations (Ops) Product Validation Lead**: Systems engineer responsible for all operations products supporting satellite operations activities are developed, tested, and verified.
- **Spacecraft Systems Engineer and Instrument Systems Engineer**: Flight System Engineers responsible for leading the creation, development, testing and verification of all products supporting flight operations activities for JPSS-1/2/3/4 spacecraft. Leads for MOST Flight Engineers.
- **Flight Directors**: Leads real-time execution of all satellite operations. Directs Satellite Controllers and on-line engineering personnel during IMT execution, special events and 24/7 health and safety shifts. Leads development of special LEO&A processes (documented in LEO&A Management Plan). Satellite Manufacturer Engineer - coordinates spacecraft / satellite activities with satellite manufacturer.
- **Rehearsal Manager**: Develops and coordinates mission rehearsals, OREs and simulations to exercise the MOST and NOAA during routine and contingency scenarios.
- **MOST Flight Engineers**: Subsystem spacecraft engineers support the Lead Engineers in development of LEO&A procedures and are members of the LEO&A team to execute the activation of the JPSS-1/2/3/4 mission and monitor the health and safety of the spacecraft until the transition to NOAA OSPO.

- **Vendor Support Engineer**: Subsystem spacecraft and instrument engineers support the MOST in development of LEO&A procedures and are members of the LEO&A team to support the activation of the JPSS-1/2/3/4 satellites.
- **Simulation Engineers**: Develop simulation scenarios for the FVTS to support operations procedure validation and mission rehearsals. Coordinates and schedules simulator resources between MOST and ground system development activities. Operate the FVTS during mission rehearsals and product validation.
- **Training Coordinator**: Leads coordinator for all MOST training requirements, ensures the vendors deliver training materials, and coordinates vendor training (both high level group and detailed shoulder-to-shoulder type training) to the MOST and NOAA OSPO personnel.
- **Integrated Mission Timeline Developers (IMTD) -** Coordinates all mission timeline events for spacecraft bus and instrument activation sequences. Develops and maintains the IMT, constraints are verified, and coordinated/reviewed by spacecraft bus and instruments vendors and the JPSS Flight Project.

Operations during the LEO&A phase are executed by the MOST with support from spacecraft and instrument vendors. The team's composition, roles and responsibilities are determined by the Mission Operations Manager as clearly defined in the JPSS LEO&A Management Plan (472-00463).

The JPSS Ground System supports these operations through the Maintain Integrated Mission Timeline and Fleet/Ground Management central activities. The MOST interfaces with internal and external stakeholders, conducts planning of short to long-term tasks such as satellite real-time commanding on a pass-by-pass basis to task sequencing for the entire IMT period, provides data supporting mission management activities, collects, processes, distributes and archives MSD. Examples of such operational activities include presenting LEO&A artifacts to a very wide audience, notifying stakeholders of proposed/planned LEO&A activities, coordinating space and ground operations, etc.

Inputs to the process come from the LEO&A Management Plan, the Integrated Mission Timeline (IMT), and other mission-specific documentation providing implementation details supporting the activation and commissioning activities. The IMT is developed and validated pre-launch and updated during the post-launch timeframe as required.

Outputs support planning, scheduling, mission-level simulation, command and telemetry operations. During this phase, a large number of products are produced servicing a large group of stakeholders requiring various levels of detail.

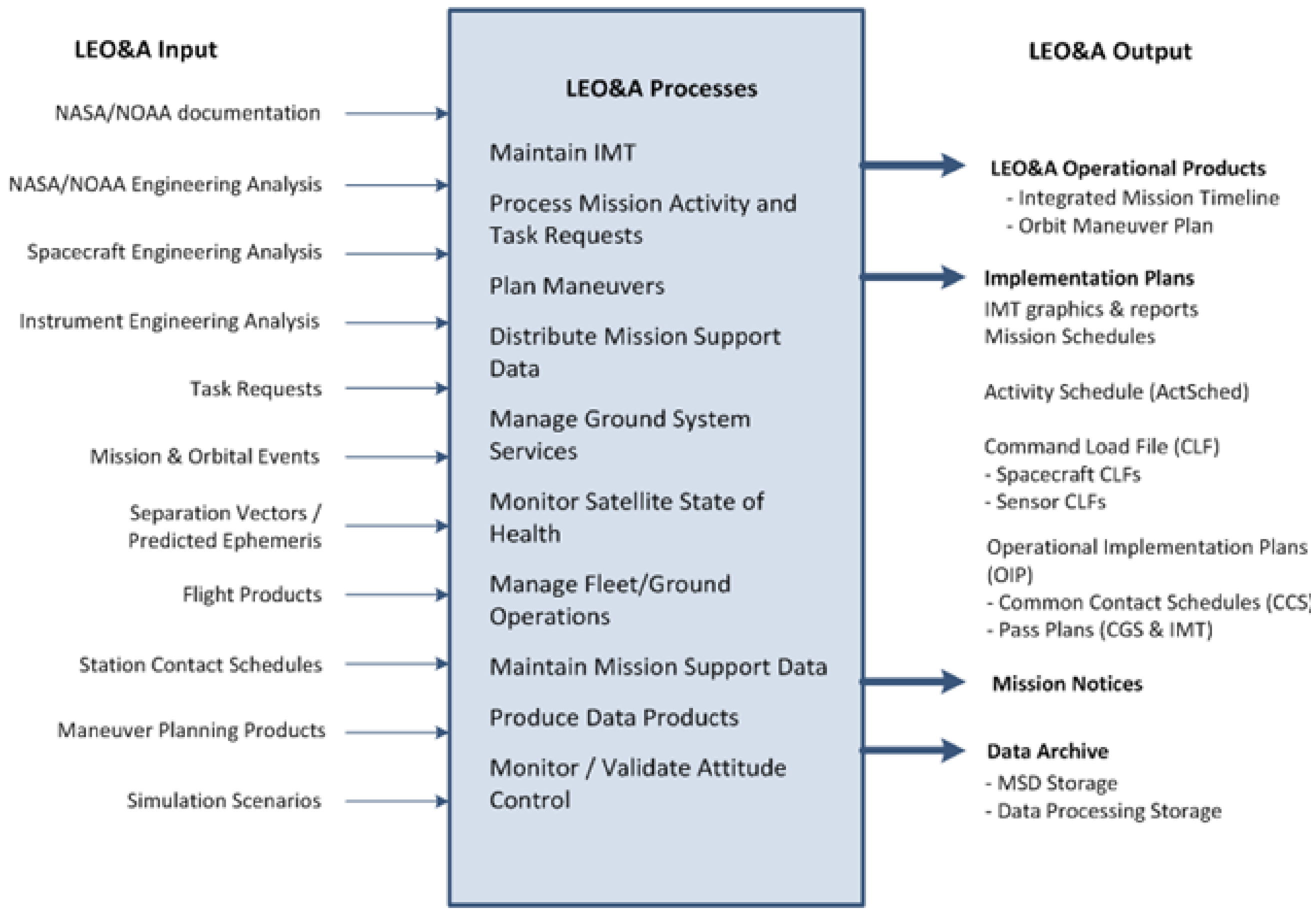


Figure: 6.3.2-1 CGS Processes and Context for Satellite Launch & Early Orbit

6.3.2.1 LEO&A Processes

LEO&A processes support execution of the core LEO&A functions, including:

- Maintain and validate the Integrated Mission Timeline, both pre-launch and post-launch
- Process Mission Activity and Task Requests supporting LEO&A activities
- Design and Plan Orbit Maneuvers
- Distribute Mission Support Data
- Manage Ground System Services
- Monitor Satellite State of Health
- Manage Fleet / Ground Operations
- Maintain Mission Support Data
- Produce Data Products

- Monitor / Validate Attitude Control

6.3.2.1.1 Maintain the Integrated Mission Timeline (IMT) Activity

Planning activities support Satellite Commissioning throughout the entire process. Prior to Launch, an Integrated Mission Timeline (IMT) is developed, tested and approved by the mission for the entire LEO&A phase. Reference the Launch Readiness Support (GS-MAD-110) for additional information concerning the development and test of the IMT pre-launch. The IMT is built by the Integrated Mission Timeline Developer (IMTD). This configuration managed product is maintained throughout the LEO&A phase via several vehicles:

- Regular IMT Focus Group (IMTFG) meetings
- Updated Orbital Events (see Orbit Maintenance thread)
- Updated Mission Schedules (see Planning and Scheduling thread)

Following launch, re-planning of the IMT can be expected. To facilitate this, planning meetings are held during shift handover and as needed. Management, engineering and operations are represented at the meetings where the IMT is revised. A revised IMT is made available to the planning and scheduling system for subsequent use in scheduling satellite and ground activities. Conversely, products of the planning and scheduling system are made available to the IMT activity for ingest into the IMT. Fleet Mission Management is active in the planning process, represents the interests of all missions, coordinates overall resource utilization and communicates with the other missions and external users.

Functionality utilized in this activity is unique to the LEO&A phase. The following capabilities are not normally exercised during normal operations:

- Addition, deletion and modification of Mission Events and Special Tasks on the IMT by controlled manual means
- Ingest of Orbital Events for maintenance of IMT events
- Ingest of planning & scheduling Mission Schedules for the maintenance of IMT activities
- High density of special tasks and events
- Rapid re-plan of a large number of tasks
- Development and review of graphical timelines at various levels of detail (long to short term)
- Schedule development and review at the activity level
- Larger volume of input from external sources (Flight Project, satellite representatives, instrument representatives, etc.)
- Generation of IMT Command Queues supporting the execution of real-time spacecraft commands

Important note: Planning of mission tasks (and limited generation of implementation plans) is performed by this activity throughout the LEO&A period. MPS, a planning & scheduling

system is operated concurrently. The planning roles and responsibilities evolve over the LEO&A period. During LEO&A, while the IMT is supporting commanding activities, MPS is still used to generate Common Contact Schedules for ground hardware configuration and Activity Schedules for the generation of Command Load Files, but not Pass Plans which automatically execute in SOTC. Contact configuration is initially handled in the IMT tool and then transitions to being handled in MPS as LEO&A proceeds nominally. If contact configuration is handled in the IMT tool, procs are manually executed by operations to configure the ground and spacecraft for a contact. If contact configuration is handled in MPS, a CCS and a DAS (stored commands) are generated and are visible in the IMT.

6.3.2.1.2 Process Mission Activity and Task Requests

Planning and Scheduling activities support Satellite Commissioning throughout the entire process, from the generation of the 1st Command Load File shortly after launch to the routine scheduling of normal operations activities.

All the functionality utilized during normal operations is exercised in this phase. The following capabilities may exceed those normally exercised:

- High density of special tasks and events
- Rapid re-plan of a large number of tasks
- Development and review of graphical timelines at various levels of detail
- Schedule development and review at the activity level

6.3.2.1.3 Plan Maneuvers Activity

Orbit Maintenance and Attitude Maneuver activities support Satellite Commissioning process from design of maneuvers supporting under-fly/over-fly activities to the trim burns used to refine the final orbit. Attitude maneuvers support calibration / validation activities.

All the functionality utilized during normal operations may be exercised in this phase. The following capabilities may exceed those normally exercised:

- Design of large-scale delta-V maneuvers
- Generation of a sequence of maneuvers
- Maneuver design & evaluation for events months in the future

6.3.2.1.4 Distribute Mission Support Data Activity

This activity distributes Mission Support Data related to LEO&A.

All the functionality utilized during normal operations may be exercised in this phase. The following distributions may exceed those normally exercised:

- Extended stakeholder list
- Project-level documentation
- Additional IMT, MPS and Orbit Maintenance products

- External distribution of ITAR products
- External distribution of TLM files

6.3.2.1.5 Manage Ground System Services Activity

This activity provides ground system services related to LEO&A. During this period, the configuration of hardware, software and IT networks is tightly controlled. Required modifications are subject to an extensive approval process as defined in the Early Orbit and Activation (LEO&A) Management Plan and supporting documentation. All approved changes are coordinated by the Mission Operations Manager. The assessment of overall ground system state of service, its allocation and utilization by the fleet is the responsibility of the Fleet Mission Manager. Mission priority for resources during the LEO&A phase is elevated above those defined for normal mission operations.

6.3.2.1.6 Monitor Satellite State of Health Activity

CGS capabilities are utilized to continuously assess satellite status. This is a broad and detailed evaluation of telemetry values and trends against predefined operational thresholds.

All the functionality utilized during normal operations is exercised in this phase. There is nothing unique in functionality or implementation unique to commissioning. However, during this phase, the following should be expected:

- Increased frequency in component state changes
- Configuration to non-nominal states
- More rapid variation in operational limits
- Implementation of LEO&A specific reports, their generation and distribution
- Utilization by a larger audience less familiar with the ground system

6.3.2.1.7 Manage Fleet/Ground Operations Activity

CGS capabilities are utilized to continuously assess satellite status which is summarized and reported to the Flight Project. In addition, this activity assists in coordinating resource allocations with the other missions.

All the functionality utilized during normal operations is exercised in this phase. There is nothing unique in functionality or implementation unique to commissioning. However, during this phase, the following should be expected:

- Increased frequency Master Schedule modifications
- Increased utilization of JPSS resources
- Increased utilization of non-nominal resources such as SN, FCDAS, FDF, AGS, etc.

6.3.2.1.8 Maintain Mission Support Data Activity

CGS capabilities are used to archive the following on a routine basis.

- MSD - including products generated during normal operations as well as additional products generated during the LEO&A phase (i.e. IMT timeline products, AGS reports, etc.).

6.3.2.1.9 Produce Data Products Activity

CGS capabilities are used to produce SMD data products and by-products for instrument activation and calibration. Activity provides for the generation, distribution and archival of the following products:

- SMD data and products

6.3.2.1.10 Monitor / Validate Attitude Control Activity

In addition to the routine Ground-Based Attitude Determination (GBAD) assessments, this activity performs the following analytical functions during LEO&A:

- Monitor of satellite attitude while in non-nominal attitude control modes
- Support for attitude maneuvers supporting orbit and calibration maneuvers
- Determination of alignment and calibration parameter values for ACS components

6.3.2.2 LEO&A Ground System Supported Facilities

The Launch & Early Orbit phase places the maximum requirements on the number and distribution by location of ground system components. Data and voice communications are maintained over the period needed.

The MON is designed to provide support for all phases of the JPSS multi-mission environment, providing sufficient hardware and network resources to support multiple operable ‘strings’ or configurations. Additional resources, such as a Launch Control Room, are established, and maintained. Note that the ground system maintains support for routine and special operations for up to two additional JPSS-managed missions.

Ground system deployments during the LEO&A phase which exceed those of the remaining mission phases include:

- Launch Control Room
  - Generally 30 - 40 additional telemetry workstations to host MOST Flight Engineers, Ground System Engineers and Flight Vendors
  - Staffed support for MTASS execution
  - Support for IMT maintenance
  - Display of data from various sources via large overhead monitors

6.3.2.3 Primary Interfaces

Figure 6.3.2-2 illustrates external parties as the primary external interfaces involved in the execution of Launch and Early Orbit Activities.

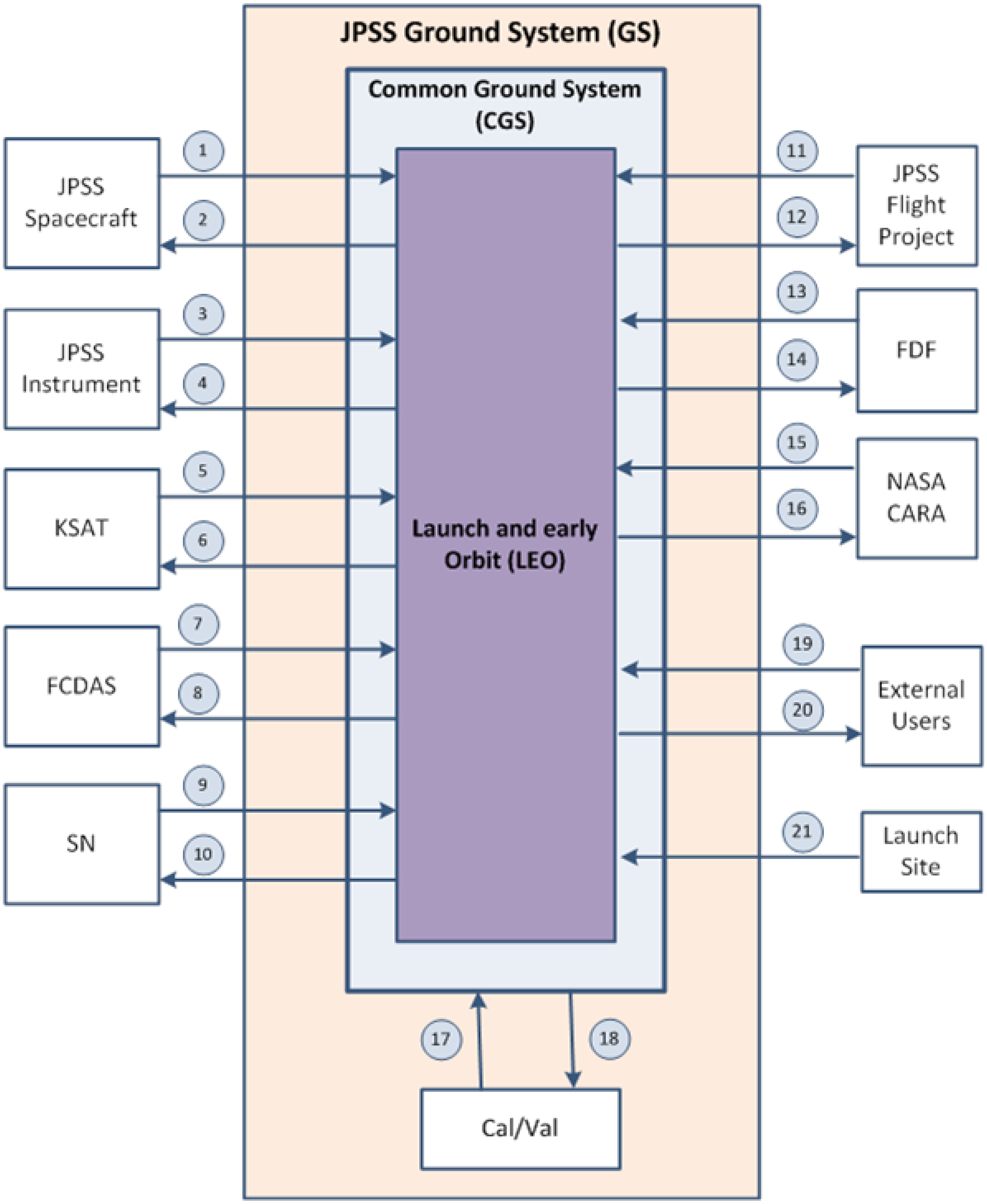


Figure: 6.3.2-2 Primary Interfaces for Launch & Early Orbit Activities

Table: 6.3.2-1 Launch & Early Orbit Primary Interfaces

No.	Type	Actors	Purpose
1	External	CGS < JPSS Spacecraft Vendor	Spacecraft Status Information, Engineering Analysis, Event & Task Requests, Mission Notices
2	External	CGS > JPSS Spacecraft Vendor	Satellite Telemetry, Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
3	External	CGS < JPSS Instrument Vendors	Instrument Status Information, Engineering Analysis, Event & Task Requests, Mission Notices
4	External	CGS > JPSS Instrument Vendors	Satellite Telemetry, Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
5	External	CGS < KSAT	Station Status Information, Station Contact Schedule T&C support
6	External	CGS > KSAT	Schedule Requests, Mission Notices T&C support
7	External	CGS < FCDAS	Station Status Information, Station Contact Schedule T&C support
8	External	CGS > FCDAS	Schedule Requests, Mission Notices T&C support
9	External	CGS < SN	Station Status Information, Station Contact Schedule T&C support
10	External	CGS > SN	Schedule Requests T&C support
11	External	CGS < JPSS Flight Project	Management directives, Event & Task Requests, Mission Notices, IMT Input
12	External	CGS > JPSS Flight Project	Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices, IMT
13	External	CGS < FDF	Satellite Tracking Analysis, ephemeris, Reports
14	External	CGS > FDF	Orbit Maneuver Plans, ephemeris
15	External	CGS < NASA CARA	CA Summary Reports, High Interest Event Reports
16	External	CGS > NASA CARA	Ephemeris, Covariance & Maneuver information
17	External	CGS < Cal/Val	Mission Planning Inputs (Task Requests), Issues
18	External	CGS > Cal/Val	Mission Schedule, Issues, Mission Notices
19	External	CGS < External Users	Requests, reports
20	External	CGS > External Users	Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
21	External	CGS <Launch Site	Actual Lift-Off time, Launch vehicle flight status, Separation Vector

Table: 6.3.2-2 Launch & Early Orbit Interface Documentation

No.	IRD/ICD
1,2,3,4	JPSS Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
5,6	Joint Polar Satellite System (JPSS) Ground System (GS) to Kongsberg Satellite Services KSAT) Interface Requirements Document (IRD), 474-00109

No.	IRD/ICD
7,8	Joint Polar Satellite System (JPSS) Ground System (GS) to National Environmental Satellite, Data, and Information Service (NESDIS) Fairbanks Command and Data Acquisition Station (FCDAS) Interface Requirements Document (IRD), 474-00305
9,10	SN to JPSS CGS ICD WSC- S-NPP C3S ICD RFICD S-NPP S/C and SN (451-RFICD-S-NPP/SN, 472-REF-00082) SNAS MOC Client Software Users' Guide, 452-UGSNAS JPSS Space/Ground Data Format XML Database S-NPP Network Operations Support Plan
11,12	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
13, 14	NIMO NRD for JPSS-1 NIMO NRD for JPSS-2/3/4 JPSS PSLA
15, 16	Joint Polar Satellite System (JPSS) Ground System (GS) Conjunction Assessment Interface Requirements Document (IRD), 474-00300
17, 18, 19, 20	JPSS CGS Services IDD
21	JPSS Launch Site Support Plan JPSS-1 Launch Vehicle ICD JPSS-2 Launch Vehicle ICD JPSS-3 Launch Vehicle ICD JPSS-4 Launch Vehicle ICD

6.3.2.4 Assumptions & Constraints

The following assumptions are made for the successful performance of the Satellite Commissioning functions:

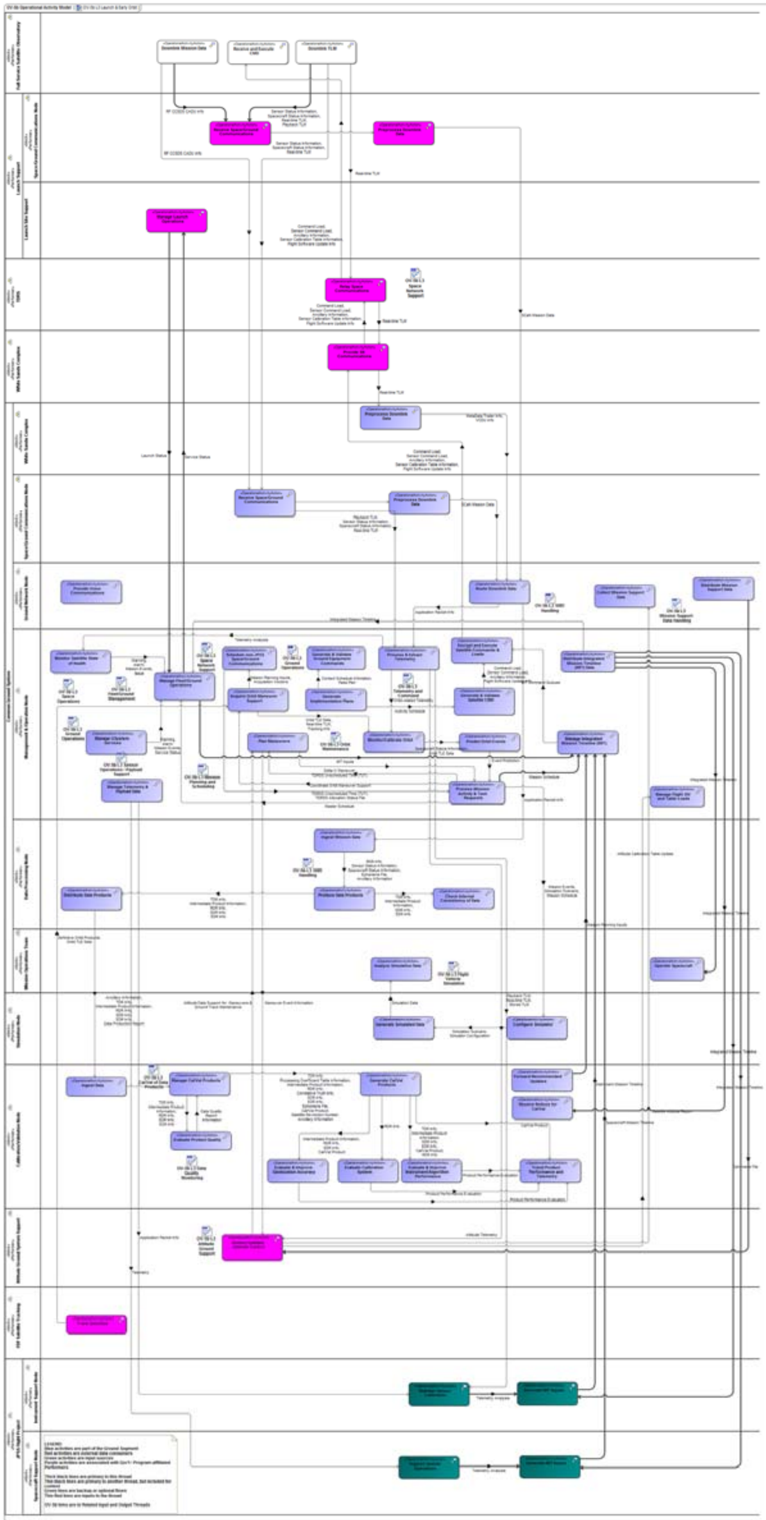
6.3.2.5 Pre-Conditions

The following pre-conditions apply to this thread:

- The satellite Launch Countdown has reached T-0.
- The IMT has been approved prior to launch.

6.3.2.6 Operational Flow

Figure 6.3.2-3 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.2-3 Launch and Early Orbit Operational Flow Diagram

6.3.2.7 Basic Flow

Table 6.3.2-3 defines the operational flow of Satellite Commissioning. This flow covers the first two stages of the commissioning process:

- Launch / Ascent (thru the completion of separation sequences except comm sequence)
- Initial spacecraft bus Activation & Checkout

This flow continues the basic flow defined in the Launch Readiness Support thread (GS-MAD-110).

Table: 6.3.2-3 Launch and Early Orbit Basic Flow

No.	Actors	Actions	Notes
		Launch / Ascent	
1	GS, MOST	The VAFB voice circuits are monitored by the MOST for Launch Countdown status, etc.	
2	MOST, LSS	The GS Voice Communications activity is utilized to inform stakeholders of the actual lift-off time and the delta from the planned time.	Pre-launch operational products are biased by the determined delta T.
3	CGS, IMTD	The CGS Maintain IMT activity applies a time bias to the IMT based on the actual lift-off time announced by LSS.	Revises event UTC time, time relative to T0 remains unchanged.
4	CGS	The CGS Distribute IMT Data activity provides the updated Mission IMT and derived products to internal and external stakeholders.	
		RF Comm via Separation Sequence	Steps 5-8- repeat as per comm schedule of the separation sequence.
5	CGS, SN	The CGS Manage Space/GND Comm Node State of Health activity provides satellite telemetry to the MON upon acquisition of telemetry via TDRSS.	Spacecraft communications configuration managed my separation sequence, ground configuration by Command Queues (IMT).
6	MOST	The CGS Monitor Satellite State of Health activity provides data used by the MOST to monitor separation sequence progress and results.	Command is restricted to contingency only following confirmation of spacecraft separation from LV.
7	CGS, KSAT, FCDAS	The CGS Manage Space/GND Comm Node State of Health activity provides satellite telemetry to the MON upon acquisition of telemetry via ground network stations.	Spacecraft communications configuration managed my separation sequence, ground configuration by Command Queues (IMT)
8	MOST	The CGS Monitor Satellite State of Health activity provides data used by the MOST to monitor separation sequence progress and results.	Command is restricted to contingency only following confirmation of spacecraft separation from LV.

No.	Actors	Actions	Notes
9	Spacecraft	Separation sequences configuring the spacecraft bus complete. Flight software establishes and maintains sun pointing mode. Comm schedule continues.	Command restriction is released.
		Activation & Checkout	
10	AGS, CGS	The AGS Monitor/Validate Attitude Control activity monitors the performance of the on-board attitude control system.	Reference the Attitude Ground Support thread (GS-NML-060)
11	LSS, CGS	The CGS Acquire Orbit Support activity obtains the satellite separation vector from LSS	
12	CGS	The CGS Monitor/Calibrate Orbit activity propagates the separation vector.	
13	CGS	The CGS Predict Orbit Events activity generates a set of orbital events based on the separation vector.	
14	CGS	The CGS Process Mission Activity & Task Requests activity generates a revised Mission Schedule based on the Separation Vector orbital events.	
15	CGS	The CGS Generate Implementation Plans activity produces a CLFs and Mission Schedules based on the Separation Vector orbital events.	Note: the tasks supported in these schedules and implementation plans are consistent with parameter values in the IMT.
16	CGS, MOST	The CGS Distribute Mission Support Data activity provides the updated Mission Schedule and Implementation Plans to the CGS and internal / external stakeholders.	Pre-launch operational products are revised using the Separation Vector ephemeris.
17	CGS	The CGS Maintain IMT activity ingests orbital events based on the separation vector.	
18	IMTD, CGS	The CGS Maintain IMT activity updates the IMT based on the revised orbital events for the separation vector.	Revised timeline products are available to the MOST.
19	IMTD, CGS	The CGS Maintain IMT activity generates implementation plans (i.e. Command Queues) based on the revised orbital events. Modified implementation plans may be verified utilizing the FVTS prior to release for execution.	Note: the tasks supported in these implementation plans are as per the implementation parameter values in the MIMT.
20	CGS	The CGS Distribute IMT Data activity provides the updated Mission IMT and derived products to internal and external stakeholders.	Pre-launch operational products are revised using the Separation Vector ephemeris.

No.	Actors	Actions	Notes
21	MOST	The MOST makes the decision to uplink a Spacecraft CLF based on the Separation Vector.	
22	IMTD, MOST	The MOST conducts periodic planning meetings to revise the IMT. During the first days of LEO&A, meetings are held: • Post-pass - re-plan upcoming contacts • Shift handover - re-plan upcoming day • Daily - perform long-term re-planning	
23	CGS, IMTD	The CGS Maintain IMT activity incorporates modifications as a result of the re-plan meetings. Modified implementation plans and operational products may be verified utilizing the FVTS prior to release for execution.	
24	OSPO Management	The OSPO Management coordinates resource utilization issues with affected JPSS missions and external users.	
		Post-Pass Re-Plan	Time sensitive activity which completes within 15 minutes.
25	IMTD, CGS	The CGS Maintain IMT activity updates the IMT based on direction received in the Post-Pass Re-Plan Meeting.	Steps 25 - 29 repeat as necessary throughout the LEO&A phase.
26	IMTD, CGS	The CGS Maintain IMT activity generates implementation plans (i.e. Command Queues) based on the revised IMT. Modified implementation plans and operational products may be verified utilizing the FVTS prior to release for execution.	
27	CGS	The CGS Distribute IMT Data activity provides the updated Mission IMT and Pass Plans to internal and external stakeholders.	
28	MOST	MOST reviews the IMT and Command Queues. Designated approvers respond to the IMT with approval or comments.	Electronic Command Queues available for review, final approval version is paper.
29	IMTD	The IMTD delivers the approved Command Queues to the MOT for execution via manual input.	CGS transfers Command Queues from IMT tool to SOTC
		Uplink of the first spacecraft CLF	CLF-Command Load File
30	MOST	The MOST reviews the planned events and tasks defined in the Master Schedule for the duration of the upcoming CLF. Proposed modifications are reviewed and approved at the Re-Plan Meetings. Input for inclusion /	Pre-launch Master Schedule planned routine tasks, such as RF communications management.

No.	Actors	Actions	Notes
		deletion of events & tasks is provided to the Mission Planner and IMTD.	
31	CGS, Mission Planner	The CGS Define Mission Tasks & Events activity is used by the Mission Planner to define and plan tasks in the Master Schedule.	Performed, as needed, via manual synchronization with the IMT by the Mission Planner.
32	CGS, Mission Planner	The CGS Process Mission Activity & Task activity requests and produces the CGS Master Schedule for review and approval.	
33	CGS	The Generate Implementation Plans activity produces the Activity Schedule and Common Contact Schedule.	Modified implementation plans and operational products may be verified utilizing the FVTS prior to release for execution.
34	CGS	The CGS Generate & Validate Satellite CMD activity utilizes the Activity Schedule to generate the 1st Spacecraft CLF for uplink.	
35	CGS, IMT	The Maintain IMT activity optionally ingests the Remote Schedule to update the IMT.	
36	CGS	The Common Contact Schedule and Spacecraft CLF are utilized by the CGS to execute activities scheduled in the CGS Activity Schedule.	
37	IMT, MOST	The IMT Command Queues are utilized by the MOST to execute activities planned in the IMT but not scheduled in the CGS Mission Schedule.	Operator manual input?
		Continuation of Satellite Activation & Checkout	
38	CGS, MOST	The TLM Analysis activity provides satellite status, parameter trends and log information to the MOST. This information is used to assess the execution status of planned satellite activities and monitor system performance.	Steps 38-40 occur continuously during the LEO&A period.
39	IMTD, MOST	The MOST conducts Shift Handover & Daily Planning meetings in addition to “as needed” Post-pass - Re-plan Meetings.	Reference Steps 25-29
40	IMTD, Mission Planner	The IMT database and Master Schedule are updated, products generated and distributed for use.	Reference Steps 30-37
		GPS & OD Initialization & Checkout	Verification by FDF
41	SN, NEN, C-Band stations, FDF	FDF Systems acquires tracking and antenna angle data to produce GPS/ JPSS GS-independent orbit determination information.	
42	FDF, SN, NEN	FDF Systems provide acquisition data to the SN, NEN & C-Band stations.	For a period of up to 4 weeks following launch - as per PSLA

No.	Actors	Actions	Notes
43	FDF, CGS	FDF Systems provide predicted / definitive ephemeris to the CGS for subsequent utilization.	For a period of up to 4 weeks following launch - as per PSLA.
43.1	CGS, CARA	The CGS Distribute MSD activity delivers the ephemeris to CARA for Conjunction Avoidance (CA) screening. The CARA Assess Collision Risks activity performs close approach screening and delivers the CA Summary Report and CA analysis results to the JPSS MOT.	For more details, see the Orbit Maintenance ConOps thread.
44	CGS, MOST	The CGS Process & Extract Telemetry activity provides GPS unit status and filter performance data for evaluation by the MOST. The following activities may be performed to enhance on-board filter performance: • GPS Catalog load to the GPS unit • Uplink of filter parameters to the GPS unit	
45	CGS	The CGS Process & Extract Telemetry activity provides GPS telemetry to the CGS Monitor Calibrate Orbit activity. This data includes the raw NAV messages and on-board orbit determination information.	
46	CGS	The CGS Monitor Calibrate Orbit activity performs ground based orbit determination.	
47	CGS, FDF	The CGS Distribute Mission Support Data activity provides on-board orbit determination information and ground based orbit determination results to FDF.	
48	FDF	FDF compares pairs of ephemeris sets (FDF, CGS, on-board) to assess the performance of the CGS and on-board orbit determination systems.	
49	MOST	The MOST reviews the performance comparison reports to determine when the GPS on-board system and CGS functionality are operational.	
		Attitude Analysis	
50	AGS, AGST	The AGS Monitor / Validate Attitude Control activity monitors on-board attitude determination and control performance through the routine off-line batch processing of satellite telemetry.	Reference the Attitude Ground Support thread (GS-NML-060)
50.1	AGS, AGST	The AGS Monitor / Validate Attitude Control activity monitors on-board attitude during real-time contacts on an “AS NEEDED” basis	

No.	Actors	Actions	Notes
		in support of attitude mode transitions, attitude slew execution, and contingency support.	
51	AGS, AGST	The AGS Monitor / Validate Attitude Control activity generates refined attitude sensor calibrations and reports the results.	
52	AGS, AGST	The AGS Monitor / Validate Attitude Control activity reprocesses satellite telemetry using the candidate calibration values. The AGS evaluates the processing results, comparing them to previously processed data. The AGS makes the recommendation to deploy the candidate value	
53	MOST	The MOST makes the decision to uplink new ACS calibration values to the spacecraft and update applicable ground system applications.	Attitude sensor calibration parameters are reported to Cal/Val.
54	AGS, AGST	The AGS Monitor / Validate Attitude Control activity monitors attitude maneuver performance including slew rates, settler times, etc.	Attitude maneuver performance parameters are reported to Cal/Val.

6.3.2.8 Alternate Flow

The following alternate flows are executed as called out by the basic flow or on an 'as needed' basis in support of LEO&A.

6.3.2.8.1 Development & Maintenance of the IMT

This flow continues the basic flow defined in the Launch Readiness Support thread.

Table: 6.3.2-4 Develop & Maintain IMT Alternate Flow

No.	Actors	Actions	Notes
		Pre-Launch Preparations	
1	SMS, JPSS Flight	MOST generates a Spacecraft IMT in conjunction with the JPSS Flight Project and spacecraft vendor. The timeline is developed relative to lift-off and duration of 90-days	Spacecraft vendor contribution to the IMT
2	IMS, JPSS Flight	MOST generates a Spacecraft IMT in conjunction with the JPSS Flight Project and instrument vendors. The timeline is developed relative to lift-off and duration of 90-days.	Instrument vendor contribution to the IMT
3	CGS, IMTD	The CGS Maintain IMT activity ingests the Spacecraft & Instrument IMTs into the Mission IMT database.	The IMT manages timeline events and tasks.
4	IMT, IMTD	The CGS Maintain IMT activity sequences tasks and events (and activities) by either absolute or time relative to an event. The	

No.	Actors	Actions	Notes
		time reference can be set or modified by the IMTD.	
5	IMT, IMTE	The CGS Maintain IMT activity manages the specific actor for each entry (event, task, activity) in the IMT database. The specific actor value can be set or modified by the IMTD. This field is available for output of IMT reports.	The specific actor is the entity (person or application) responsible for the execution of the entry. For example, a spacecraft command actor may be stored, CGS Pass Plan, IMT Command Queues etc.
6	CGS, IMT	The CGS Maintain IMT activity supports configuration management of the IMT database. Additions / modifications / deletions / re-sequencing are tracked.	Note that at least two instances of the IMT database are deployed with the backup instance maintained in real-time with the primary instance.
7	CGS	The CGS Maintain IMT activity generates timeline reports and graphics using the IMT.	Steps 5 - 14 are repeated as necessary.
8	CGS	The CGS Distribute Mission Support Data activity distributes the Mission IMT and derived products to internal and external stakeholders for review.	
9	CGS	The CGS Maintain IMT activity makes current and previous releases of the Mission IMT and derived products (reports & graphics, etc.) available for on-line viewing to internal and external stakeholders for review.	
10	CGS	The CGS Maintain IMT activity accepts and manages proposed task definitions. Proposed task definitions are marked as that in the IMT.	Allows for development of task definitions.
11	CGS	The CGS Maintain IMT activity accesses approved tasks as defined in the Mission Planning and Scheduling function.	Allows for use of task definitions in the operational database.
12	CGS	The CGS Maintain IMT activity maintains a task definition source parameter for each task placed on the IMT.	
13	CGS	The CGS Maintain IMT activity optionally displays / reports task definition details for tasks resident on the IMT. The source for the task definition is determined by the source parameter value.	
14	CGS	The CGS Maintain IMT activity maintains a task implementation parameter for each task placed on the IMT.	The task implementation parameter value determines if the task activities are to be scheduled and implementation plans generated by the CGS or

No.	Actors	Actions	Notes
			output as IMT Command Queues.
15	IMT, MOST, SMS, Instrument Support, JPSS Flight, JPSS Instruments	The IMT Lead conducts working group sessions to fully develop the Mission IMT. Proposed changes are evaluated and approved for incorporation into the IMT.	
16	CGS	The CGS Maintain IMT activity incorporates modifications to the IMT. Changes are tracked and reported.	
17		Reserved	
18	IMT, CGS, Mission Planner	The CGS Generate Implementation Plans activity generates Remote Schedules for optional ingest by the Maintain IMT activity.	Reference the Launch Readiness Support (GS-MAD-110) for additional information concerning the development and test of the IMT pre-launch.
		Utilization during the Launch/Ascent Phase	
19	IMT, CGS	The CGS Maintain IMT activity updates the IMT with the actual lift-off time and regenerates reports and graphical products.	Note: IMT is event driven system with the capability to specify absolute time events & tasks. Specification is user selectable.
19a	CGS, IMT	The CGS Maintain IMT activity optionally ingests Remote Schedules produced by the MPS.	
19b	CGS, IMT	The CGS Maintain IMT activity generates IMT Mission Schedules.	
19c	CGS, IMT	The CGS Maintain IMT activity generates IMT Command Queues.	Modified implementation plans and operational products may be verified utilizing the FVTS prior to release for execution.
19d	CGS	The CGS Distribute IMT Data activity provides the updated Mission IMT and derived products to internal and external stakeholders.	
		Utilization during Activation and Checkout	
20	IMT, CGS	The CGS Maintain IMT activity updates the IMT based on the revised orbital events using the separation vector. Plans, reports & graphical products are regenerated as per Steps 19a - 19d.	Steps 20 - 25 repeat as orbital events and MPS schedules are revised. Revised timeline products are available to the LMT.

No.	Actors	Actions	Notes
21	CGS, IMT	The CGS Maintain IMT activity incorporates modifications as a result of the Post-Pass re-plan meetings. Plans, reports & graphical products are regenerated as per Steps 19a - 19d.	This activity is time sensitive - completed within 15 minutes
22	CGS, IMT	The CGS Maintain IMT activity generates IMT Command Queues.	
23	CGS, IMT	The CGS Maintain IMT activity generates IMT Mission Schedules for optional ingest by the MPS.	
24	CGS, IMT	The CGS Maintain IMT activity optionally ingests Mission Schedules produced by the MPS.	
25	CGS	The CGS Distribute IMT Data activity provides the updated Mission IMT and derived products to internal and external stakeholders.	

6.3.2.9 Post Condition

Commissioning is determined satisfactorily. The satellite has been Activated and met On-orbit verification requirements. The ground system meets operational requirements.

6.3.2.10 Related Threads

The following is a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-MAD-110	Launch Readiness Support
GS-NML-020	Mission Planning and Scheduling
GS-NML-310	Ground Operations
GS-NML-320	Space Operations
GS-NML-030	Telemetry and Command
GS-NML-140	Mission Support Data Handling
GS-NML-010	Fleet Ground Management
GS-NML-150	Calibration and Validation of Data Products

6.3.2.11 Child Threads

The following is a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-040-030	Pre-launch, Launch & Early Orbit Support

6.3.3 Telemetry and Command

6.3.3.1 Description

The Telemetry and Command thread (GS-NML-030) describes how the JPSS Ground System generates/sends commands to and receives telemetry from JPSS-managed satellites, either through the JPSS polar ground stations or through the NASA Space Network. This thread describes how these activities are accomplished and the roles played by the Common Ground System (CGS), S-NPP, JPSS-1/2/3/4 satellites, and external authorized users.

The Telemetry & Command (T&C) thread is responsible for the conduct of activities supporting the utilization of the communications links (uplink/downlink, command/telemetry) with the satellites. The primary ground station for T&C operations is KSAT Svalbard, with NOAA FCDAS and KSAT Troll (JPSS-1/2/3/4 only) as alternates. JPSS uses the Space Network for launch and early orbit, orbit maneuver, contingency, and other non-nominal operations that require continued T&C communications.

The S-NPP and JPSS-1/2/3/4 satellites use S-band for uplink. Table 6.3.3-1 shows various uplink rates used by these satellites. Uplink contents include commands, table loads, and flight software. They are normally always encrypted for security. Clear commanding is allowed only in predefined contingency for S-NPP and JPSS-1 but not JPSS-2/3/4. All telemetry and satellite commands are archived for the life of the program within the JPSS CGS.

Table: 6.3.3-1 JPSS Satellite S-band Uplink Rates

	Direct Uplink (bps)	Uplink via TDRSS (bps)
S-NPP, JPSS-1	2,000; 128,000	125; 1,000
JPSS-2/3/4	16,000; 128,000	250; 1,000

It should be noted that while S-NPP and JPSS-1 use the CCSDS Day Segmented (CDS) time code format for all its command and telemetry processing, JPSS-2/3/4 use the CCSDS Unsegmented Time Code (CUC) format for their core hardware processing. As results, the time stamps of S-NPP and JPSS-1 uplink commands are in the CDS format and that of JPSS-2/3/4 are in the CUC format.

The S-NPP and JPSS-1/2/3/4 satellites also use S-band for telemetry downlink. Table 6.3.3-2 shows various downlink rates used by these satellites. Note that the downlink rates listed in Table 6.3.3-2 are CADU rates that include 14.5% of CCSDS protocol overhead and Reed Solomon encoding overhead. The actual information rate is ~85.5% of the CADU rates.

During a T&C contact, real-time telemetry (RT-TLM) is downlinked for satellite health and safety monitoring and commanding. Telemetry on S-NPP and JPSS-1/2/3/4 is always recorded in onboard telemetry Mass Data Storage (MDS) for downlink as playback telemetry (PB-TLM) during T&C contact so that the health and safety of satellites during back-orbit can be assessed. On S-NPP and JPSS-1, the content of the RT-TLM and recorded telemetry is independently configurable by specifying the telemetry map(s) for each rate.

Table: 6.3.3-2 JPSS Satellite S-band Downlink Rates (CADU rate)

	Direct Downlink (bps)	Downlink via TDRSS (bps)
S-NPP, JPSS-1	Real-time: 1,024; 4,096; 16,384; 32,768 Playback: 524,800	Real-time only: 1,024; 4,096; 16,384
JPSS-2/3/4	Real-time only: 16,000 Real-time & Playback: 1,600,000	Real-time only: 8,000; 16,000

JPSS-2/3/4 generates real-time telemetry at a rate up to 216,000 bps. It has two S-band space-to-ground downlink rates: a low rate (16,000 bps) and a high rate (1,600,000 bps). At the low rate, only a pre-defined set of critical telemetry is downlinked in real-time. At the high rate, all real-time generated telemetry is downlinked, along with PB-TLM and diagnostic data if so commanded. Fill Packets and Fill Frames will be used to fill in the bandwidth when there is no valid data to transmit.

While S-NPP and JPSS-1 have only a single TLM storage, JPSS-2/3/4 have five Stored State Of Health (SSOH) telemetry storages for different applications as summarized in Table 6.3.3-3. The first one is used to store SSOH for downlink each orbit to support back-orbit satellite health and safety monitoring. The SSOH is sampled at rates configurable by APID and specific storage. For example, if the sample rate is 6, every 6th telemetry packet will be stored at a rate of approximately 36,000 bps; and three orbits of PB-TLM can be downlinked in 10 minutes along with the RT-TLM. The second telemetry storage saves Extended SSOH (ESSOH) for at least 48 hours at a rate so that ESSOH can be downlinked via S-band in 10 minutes after an event of an extended communication outage to support anomaly diagnostics and recovery. In addition, there are two other smaller storages for special situations: one for storing essential telemetry during launch and ascent (LTLM); and the other for critical telemetry (CTLM), which can be preserved in an event of a FSW reboot so that the anomaly can be diagnosed. Once the critical telemetry is retrieved, recording should be resumed by command. The 5th, and last SOH telemetry storage can store Full-resolution SSOH (FSSOH) telemetry for 31 hours. Normally the Ground System receives full-resolution telemetry through stored-telemetry (S-TLM) in VCID 0 and VCID 54 via Ka-band SMD. If that fails because of an anomaly, any size subset of this full-resolution telemetry can be recovered from this storage through S-band (constrained only by bandwidth limitations).

Alternatively, JPSS-2/3/4 spacecraft provides capability to downlink FSSOH in its entirety in VCID 55 via Ka-band SMD. This can be used only in a contingency during which no S-TLM/SMD had been received by the Ground System for more than 3 orbits. At 300 Mbps CADU rate, the entire 31 hours of FSSOH can be downlinked in under 2 minutes. Categorized as non-SMD, FSSOH downlinked via Ka-band will only be distributed to the same TLM users as those that receive FSSOH when downlinked via S-band. As a non-nominal activity, the playback of FSSOH and its downlink via Ka-band is managed by manual commands during a Ka-band contact either at a ground station or through the NASA Space Network. Since FSSOH is used for offline diagnostics, the playback priority should be given to the planned nominal SMD playback activities.

Table: 6.3.3-3 JPSS-2 Spacecraft Telemetry Storages

Telemetry Buffer	VCID	Description	Downlink
SSOH	52	Stored State Of Health (SSOH) data filtered so that 3 orbits of data can be played back in a 10 minute S-band contact	S-band
ESSOH	56	Extended SSOH (ESSOH) of last 48 hours sized to play back all of it in a 10 minutes S-band contact	S-band
Launch Telemetry	53	Hardware-generated telemetry during launch and ascent until flight software (FSW) boots up and takes over telemetry generation	S-band
Critical Telemetry	53	Includes command log, event message log, console messages, ACS state boot data and other critical telemetry. The content can be preserved in an event of a FSW reboot so that the anomaly can be diagnosed	S-band
S/C & Instrument HK	0	Normally the GS receives FSSOH as S-TLM over Ka-band SMD via both VCID 0 and 54	Ka-band
S/C Diagnostics & Command Echo Tel	54		
FSSOH	55	Full-resolution SSOH that is normally provided as S-TLM over Ka-band SMD or that can be played back over S-band (selected subset due to bandwidth), or the entire 31 hours can be downlinked via Ka-band to support contingency operations in VCID 55	S-band or Ka-band

The PB-TLM is critical for the satellite health and safety and should be downlinked at every T&C contact (except SN) via S-band, which is available even when the spacecraft is not in the mission point mode.

Part of JPSS-2/3/4 telemetry contains diagnostic information that should be made available to operators soon after receipt to ensure the latest information about spacecraft performance and state of health are known. Diagnostic data includes command echo, flight software (FSW) event messages, and console log.

In addition, JPSS-2/3/4 spacecraft can store the most recent 1024 FSW event messages in an Event Log buffer, which are also available in RT-TLM and PB-TLM. At the beginning of each T&C contact, new event messages since the last contact are played back from this buffer and displayed in near real-time to enable MOT to perform quick assessment of spacecraft and instrument states of health. The event messages will be displayed in time order.

All S-NPP and JPSS-1 telemetry use the CCSDS Day Segmented (CDS) time code format. All software-generated JPSS-2/3/4 telemetry also use the CDS time code format. However the hardware-generated JPSS-2/3/4 telemetry, in rare occasions when spacecraft CPU is going through reset, use the CCSDS Unsegmented Time Code (CUC) format. The hardware-generated telemetry is segregated from software-generated telemetry by using different Application Process (AP) IDs so that appropriate time code processing can be applied on the ground.

To improve cross-support compatibility with externally operated ground stations (e.g., KSAT Troll) and to improve overall communications reliability, the CCSDS standard Space Link Extension (SLE) protocol is used to transfer commands and telemetry between MON and ground stations. Timely Online and Complete Online SLE delivery modes are nominally used for RT-TLM and PB-TLM transfer respectively during a contact.

In addition to the RT-TLM and PB-TLM, a copy of full-resolution telemetry is also stored on the spacecraft Mass Data Storage (MDS) along with the mission data for transmission from the satellite to the ground via the Stored Mission Data (SMD) link. The SMD link is X-band for S-NPP and Ka-band for JPSS-1/2/3/4. SMD data and handling are covered in the Stored Mission Data Handling thread (GS-NML-100). S-TLM is processed in an offline mode as described in the Space Operations thread (GS-NML-320).

The T&C thread is split into three flows: the Telemetry and Commanding (Table 6.3.3-6), Telemetry Recovery (Table 6.3.3-7), and Prepare Command Load (Table 6.3.3-8). The Telemetry and Commanding describes the activities required to execute a telemetry and commanding contact with the satellite as well as a telemetry only or commanding only contact. Command passes are expected to be nominally made each orbit when the spacecraft is in view of the chosen ground station. The commanding software allows the SATCON to transmit real-time commands from the MON during a T&C contact. However, during nominal operations, commanding will nominally be performed via ground system execution of the Pass Plan and contact schedules. The SATCON may execute real-time commands as prescribed by Pass Plan Change Requests or authorized execution of SOPs. All critical commands require notification, authorization and operator confirmation (as per defined OSPO process) before being included in a command upload. Critical commands are associated with hazardous or critical functions on the satellite and also require confirmation before sending if they are real-time commands. Commands queues are available to the SATCON to monitor the pending commands and procs awaiting execution, the capability to manipulate the command queue to reorder or delete commands and procs, and to monitor the status of uplinked commands.

The telemetry aspect of the T&C flow covers the receipt of satellite telemetry and its real-time processing. RT-TLM is processed for every telemetry and command contact. Nominally, commanding and telemetry are concurrent activities. Telemetry received from the satellite is processed into engineering unit values and limit checked against the Command and Telemetry Database (C&T DB). Displays are provided to the operations staff (SATCON) for the customizable viewing of various telemetry pages and alarms, warning and events (AWE). In addition to the spacecraft and sensor telemetry values contained in the downlink, Command Link Control Words (CLCWs) are also downlinked that provide validation of satellite commands sent to the spacecraft within the framework of the CCSDS Command Operations Protocol-1 (COP-1).

The T&C flow also accommodates the off-nominal configurations of receiving telemetry without a concurrent commanding session and the sending of commands without a concurrent telemetry session. In the case of commanding without telemetry, a customized software configuration is required that allows the system to suspend COP-1 validation so that commands can be processed without validation. These configurations (telemetry only or commanding only) generally occur during off-nominal or special mission phases (e.g., LEO&A and maneuvers).

Telemetry and Command is primarily monitored and managed 24x7 by the SATCON. The SATCON has the capability to respond to out of limit warnings and other non-nominal conditions for some telemetry Last Recorded Values (LRV) and certain commanding mismatches, such as command/telemetry data rate differences, a mismatched COP-1 code or an invalid encryption key. Standard Operating Procedures (SOP) are in place for all the SATCON's response capabilities.

For non-nominal conditions that are beyond the SATCON's ability to respond, the OSPO Management is called in to help determine a plan of action. Since the OSPO Management is not a 24x7 position, the Enterprise Management Operations Controller (EMOC), a 24x7 position, is the backup. There is also an Anomaly Resolution Board (ARB) available to work anomalies that are not easily resolved.

The second flow, Telemetry Recovery, covers the activities associated with recovery of telemetry (RT-TLM and/or PB-TLM) from a ground station (including SN WSC for RT-TLM) or recovery from the spacecraft via PB-TLM. Telemetry gaps are identified and a telemetry recovery source located by a spacecraft telemetry analyst monitoring received telemetry datasets. Telemetry recoveries are initiated manually either by the EMOC for ground recoveries or the SATCON for flight recoveries. Ground station recoveries extract the recovery data from the ground station storage and utilize the SLE Offline mode to forward the data to the MON. Downlinked PB-TLM for spacecraft recoveries is automatically forwarded to the MON when it is received at the ground station.

The third flow, Prepare Command Upload, covers the activities associated with the preparation of uplink Command Load files. These consist of stored command sequences (known as Command Storage Memory (CSM) on S-NPP and JPSS-1; and ATS on JPSS-2/3/4) for the spacecraft (including commands for ATMS, CrIS, and CERES), VIIRS and OMPS, Flight Software (FSW) updates for the spacecraft and the sensors, or other memory/table loads. The stored commands can be time-tagged for execution using either relative or absolute time. While MOT generates memory/table loads for all other instruments based on input from their support teams, the CERES/RBI instrument support team provides formatted and validated CERES/RBI memory/table loads ready for uplink. Mission Planning and Scheduling (GS-NML-020) provides the scheduling data needed to create and validate a load prior to acceptance for uplink. Command load verification using a satellite simulation via the FVS/J1Sim/FSE is executed at operations discretion. For stored command sequence loads (e.g., DAS), Load Generation Reports are forwarded to the applicable external entities for validation; and authorization of the upload prior to uplink to the satellite as necessary. The Telemetry & Command flow accepts the command load files (P-Load) for uplink at a subsequent contact. The Prepare Command Upload is an operator intensive process with a Mission Operations Team (MOT) engineer directing the process as a load evolves from candidate status to ready for uplink. In addition to externally provided loads from the flight support team, the operators have the tools to select and edit pre-existing flight images/loads as the basis for a new candidate load.

The JPSS-2/3/4 spacecraft has capability to accept and process compressed loads. The JPSS-2/3/4 spacecraft vendor provides spacecraft loads always in uncompressed form. The JPSS Ground System supports generation and management of compressed or uncompressed loads at MOT's discretion, while the compressed load is nominally used for uplink to the JPSS-2/3/4

spacecraft. The compressed loads may shorten required uplink time significantly, which can be advantageous in situations like large loads or low uplink rates. Note that the instrument loads remain uncompressed.

The T&C thread relies upon several other threads to set up critical parts of the system to make telemetry and commanding successful. The contact schedules used to accomplish satellite contacts are created in Mission Planning and Scheduling (GS-NML-020). Commanding relies on encryption keys being in place and synchronized between the satellites and the ground system. This is covered in Key Management (GS-NML-200). Interaction with the Space Network is discussed in Space Network Support (GS-NNL-150). Spacecraft and Ground System anomalies are addressed in the System Fault Analysis (GS-NNL-130). Offline processing of flight telemetry (all forms) and memory dumps included in the downlinked telemetry occurs in Space Operations (GS-NML-320). Ground Operations (GS-NML-310) describes the status of the ground equipment and Fleet/Ground Management (GS-NML-010) is the umbrella thread that explains the high level situational awareness available for the entire system, space and ground.

6.3.3.2 Primary Interfaces

Figure 6.3.3-1 illustrates the actors and primary Ground System external interfaces involved in telemetry and command operations. Each interface illustrated in the figure, labeled with a number, is described in Table 6.3.3-4, along with the information about relevant ICDs and types of data in Table 6.3.3-5.

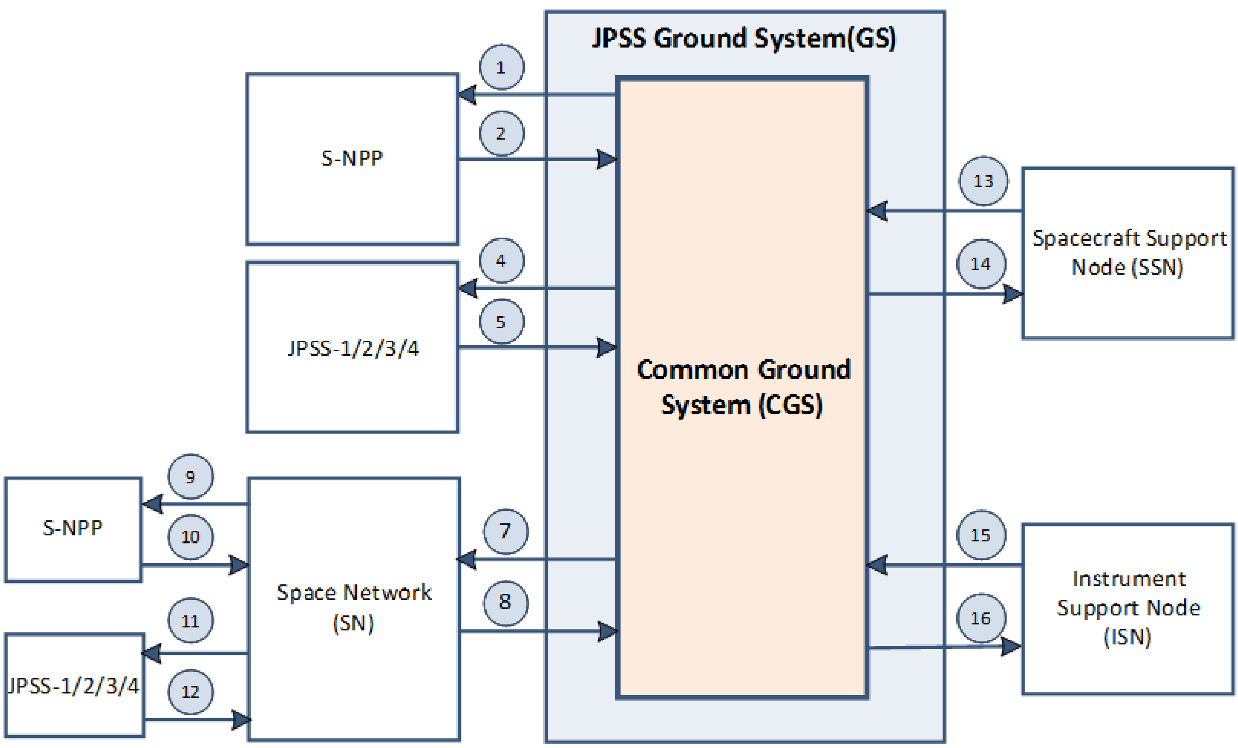


Figure: 6.3.3-1 Primary External Interfaces for Telemetry and Command

Table: 6.3.3-4 Primary External Interfaces for Telemetry and Command

No.	Type	Actors	Purpose
1	External	CGS, S-NPP	CMDs
2	External	S-NPP, CGS	RT-TLM and PB-TLM
3	Reserved		
4	External	CGS, JPSS-1/2/3/4	CMDs
5	External	JPSS-1/2/3/4, CGS	RT-TLM and PB-TLM
6	Reserved		
7	External	Space Network (SN), CGS	CMDs
8	External	SN, CGS	RT-TLM
9	Outside[1]	SN, S-NPP	CMDs
10	Outside[1]	S-NPP, SN	RT-TLM
11	Outside[1]	SN, JPSS-1/2/3/4	CMDs
12	Outside[1]	JPSS-1/2/3/4, SN	RT-TLM
13, 15	External	SSN/ISN, CGS	FSW/Table Updates
14, 16	External	CGS, SSN/ISN	Load Generation Reports

1. An outside interface is one between external entities, not directly connected to the JPSS ground system. It is included for reference only.

Table: 6.3.3-5 Primary External Interface Documentation

No.	IRD/ICD
1	NPP SODOM (BATC 549349) NPP Command & Telemetry Handbook (BATC 568423) JPSS NPP Command Hold-off times for JPSS CGS Ingest (474-00099) NPP Spacecraft S-Band Radio Frequency ICD to the Norway Ground Station (429-03-02-25) NPP S-Band Data Format ICD (429-04-02-27)
2	NPP Command & Telemetry Handbook (BATC 568423) NPP Spacecraft S-Band Radio Frequency ICD to the Norway Ground Station (429-03-02-25) NPP S-Band Data Format ICD (429-04-02-27)
3	Reserved
4, 5	JPSS-1 Command and Telemetry Handbook (BATC 2373580) JPSS-1 TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS IRD for RF Interfaces to and from the JPSS-1 (472-00173) JPSS-2/3/4 Command and Telemetry (C&T) Handbook (6470-ML31100) JPSS-2/3/4 TT&C to GS RF ICD (472-00336) JPSS-2/3/4 TT&C Data Format ICD (472-00290) JPSS IRD for RF Interfaces to and from the JPSS-2/3/4 (470-00205)
6	Reserved
7	SN to NPOESS C3S ICD (474-REF-00190)
8	SN to NPOESS C3S ICD (474-REF-00190)
9, 10	RF ICD NPP Spacecraft and the Space Network (474-REF-241)
11, 12	RF ICD JPSS-1 Spacecraft and the Space Network and the Near Earth Network (450-RFICD-JPSS-1/SN/NEN) JPSS IRD for RF Interfaces to and from the JPSS-1 (472-00173)

No.	IRD/ICD
	RF ICD JPSS-2/3/4 Spacecraft and the Space Network and the Near Earth Network (472-00330) JPSS IRD for RF Interfaces to and from the JPSS-2/3/4 (470-00205)
13, 15	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD) (474-00223) NPP SODOM (BATC 549349) NPP Command & Telemetry Handbook (BATC 568423) JPSS NPP Command Hold-off times for JPSS CGS Ingest (474-00099) NPP S-Band Data Format ICD (429-04-02-27) NPP MDFCB (429-05-02-42) JPSS-1 Spacecraft Flight Software TDD (472-00311) JPSS-1 VIIRS TDD (472-00254) JPSS-1 CrIS TDD (472-00255) JPSS-1 OMPS TDD (472-00256) JPSS-1 ATMS TDD (472-00257) JPSS Common Data Format Control Book – External Volume 6 – Ancillary Data, Auxiliary Data, Messages, and Reports (474-0001-06)
14, 16	JPSS Common Data Format Control Book – External Volume 6 – Ancillary Data, Auxiliary Data, Messages, and Reports (474-0001-06)

Note 1 Outside interface is the one between external entities and not directly connected to the JPSS Ground System. It is included for reference purpose.

6.3.3.3 Assumptions & Constraints

- Kongsberg Satellite Services (KSAT) antennas and supporting equipment are considered part of the GS (Note: The MON does not have visibility into TrollSaT equipment).
- The satellite S-band receivers are always powered on.
- The CGS can command and process telemetry at the same time.

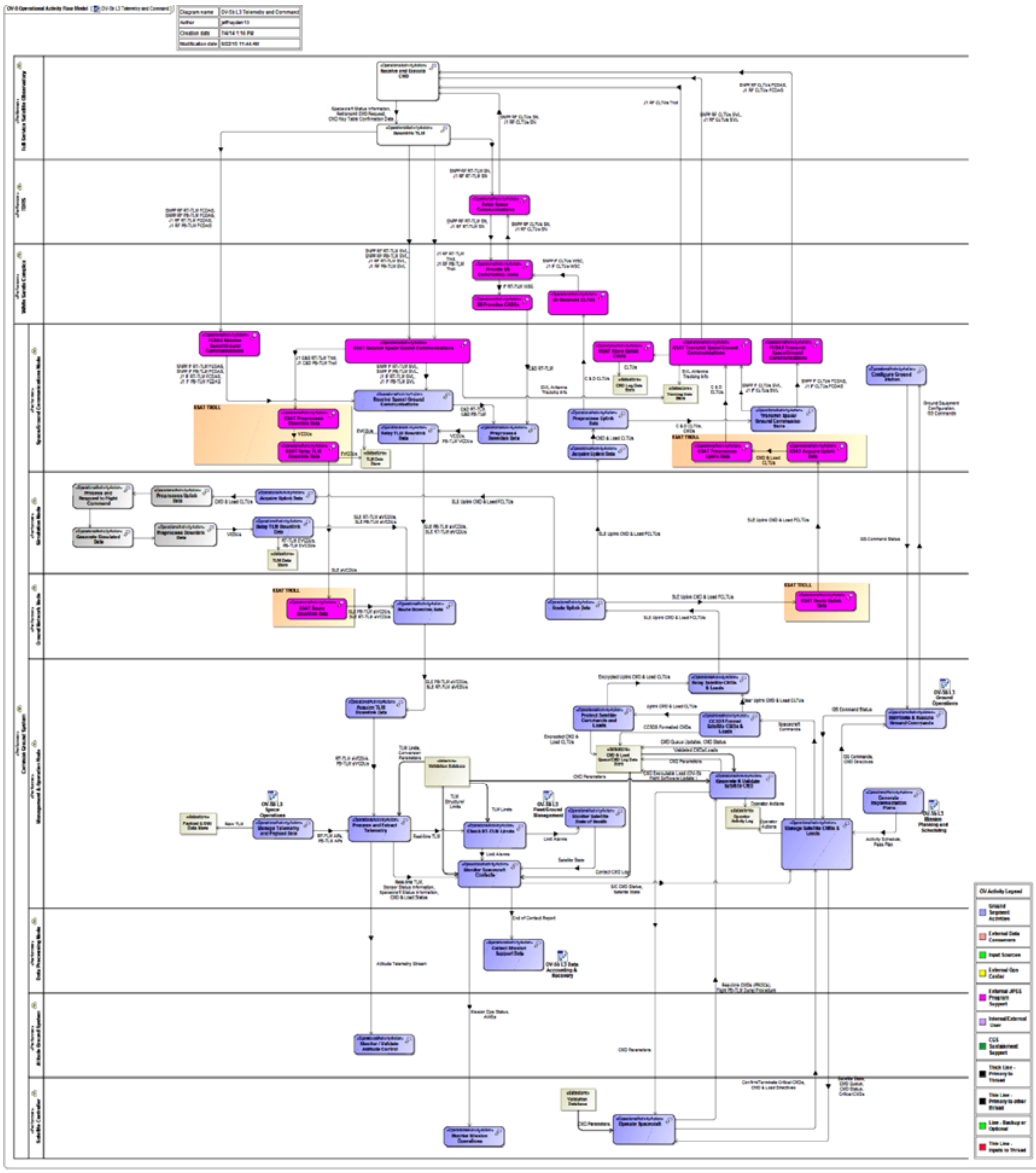
6.3.3.4 Pre-Conditions

- Nominally the stored commands to turn on the satellite transmitter have previously been uploaded. The perform commanding without telemetry flow provides a workaround in case the telemetry transmitter is not turned on prior to a contact.
- Proc(s) used by the SATCON for real-time commanding have been validated, approved by the Operations CM review board, and can be executed in real-time by the SATCON when necessary.
- Activity schedules have been generated (see Mission Planning and Scheduling) in support of Command Upload Generation and Validation
- Activity schedules, Pass Plans and Common Contact Schedules have been generated in support of Telemetry and Commanding

- Ground Operations (GS-NML-310) configures/releases JPSS ground assets for a telemetry and command contact. This includes providing KSAT with current Two Line Elements (TLEs) for satellite acquisition and tracking.

6.3.3.5 Operational Flow

Figure 6.3.3-2 provides an illustration of system activities taking place in the basic flow for command and telemetry.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.3-2 Telemetry and Command Flow Diagram

6.3.3.6 Telemetry & Commanding

Trigger: This flow is schedule driven. It starts when the schedule directs the CGS to prepare for a contact. Schedules are created in the Mission Planning and Scheduling thread (GS-NML-020). The activities required for the special cases of telemetry without commanding and commanding without telemetry are noted.

Table: 6.3.3-6 Telemetry and Commanding

No.	Actors	Activities	Notes
1	CGS MON CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The space and ground configuration occurs according to the type of contact, ground station capabilities and configuration. Types of contact at a ground station include full T&C, blind commanding, and telemetry only. RT-TLM is nominally configured for each type of contact. PB-TLM is not available through SN and but is configured for every Svalbard contact. All aspects of processing at the CGS MON support at least 3 simultaneous contacts, each of which can be a full T&C, telemetry only or blind commanding contact. Only one command session is allowed per mission. Two simultaneous telemetry sessions are permitted. Ground station support of simultaneous contacts is dependent upon the equipment configuration at each ground station supporting the JPSS managed missions as well as the mission phase. For telemetry only processing proceed to Step 13.	See Ground Operations (GS-NML-310) for configuration of the ground equipment. This step is included in the blind commanding configuration.
2	CGS MON	The CGS Generate & Validate Satellite CMD activity generates and validates satellite commands. Procs and individual commands are displayed and selected for execution via this activity using configurable operator (SATCON) displays for the generation of real-time commands, executable procs, and previously generated command uploads. Commands are generated and validated according to the C&T DB for the target satellite and are tagged to execute at an absolute or relative time. The output of this activity is the command set capable of being processed by the intended spacecraft/sensor subsystem. Any actions taken by the operator are logged and archived.	Command Load File generation and validation is covered in Flight Software Upgrade (GS-NML-070) and Mission Planning and Scheduling (GS-NML-020). Activity Schedules are covered in Mission Planning and Scheduling (GS-NML-020). This step is included in the blind commanding configuration.

No.	Actors	Activities	Notes
3	CGS MON	The CGS Manage Satellite CMDs & Loads activity manages the command queues during a command enabled contact. Commands placed into the command queue originate from the CGS Mission Planning and Scheduling activity schedules and pass plans. Real-time commands and procs are managed according to operator discretion. Critical commands requiring confirmation from a second operator are identified and held until the confirmation is received. Commands include ground commands as well as satellite commands. This activity provides interactive displays for the operators (SATCON) to view, approve, reorder and delete individual commands, command loads and procs. Only one command session per mission is permitted. No-op command(s) are sent automatically at the beginning of a contact, if enabled, to verify satellite state prior to initiating full commanding. Command queue entries suitability for transfer to the satellite takes into consideration satellite state as well as the status of previously transferred commands as indicated via the COP-1 protocol. COP-1 processing can be suspended as required during non-nominal situations, such as during blind commanding. Commands are stored and archived by this activity for real-time and offline processing. Commands sent to the satellite are archived for the life of mission (LOM). The output of the activity is satellite commands and commands loads for final formatting and transfer to the satellite and related ground commands transferred to ground operations for execution. Any actions taken by the operator are logged and archived.	This step is included in the blind commanding configuration. Commanding may be discontinued on the ground if it does not fit the proper format. If this is the case, the SATCON must fix the problem and re-enable commanding before commanding can resume. Pass Plans and Activity Schedules are covered in Mission Planning and Scheduling (GS-NML-020).
4	CGS MON	The CGS CCSDS Format Satellite Commands & Loads activity formats commands and loads according to the mission specific satellite RF ICDs. This includes the CCSDS packetization and framing standards for Space Packets and Telecommand (including Command Operation Procedures-1 (COP-1) and Frame Operation Procedures-1 (FOP-1)). The output of this activity is Command Link Transmission Units (CLTUs) appropriate for encrypted or clear	This step is included in the blind commanding configuration. Clear commanding is only supported on S-NPP and JPSS-1 but not on JPSS-2/3/4.

No.	Actors	Activities	Notes
		commanding. For clear commanding go to step 6.	
5	CGS MON	The CGS Protect Satellite Commands & Loads performs the command encryption per mission capabilities. S-NPP command encryption uses Caribou and JPSS-1 command encryption uses Advanced Encryption Standard (AES). The output of this activity is encrypted CLTUs. Go to step 6.	This step may be included in the blind commanding configuration. While the command stream is nominally encrypted, certain satellite modes will only accept clear commands. The CGS accommodates this by simply by-passing the encryption step.
6	CGS MON	The CGS Relay Satellite Commands & Loads activity forwards encrypted and clear commands and command loads (CLTUs) to the ground station using the SLE Forward CLTU service. The service provides mechanisms for authenticating the endpoints of the session and verifying the integrity of the transfer using underlying protocols.	This step is included in the blind commanding configuration. Clear commanding is only supported on S-NPP and JPSS-1 but not on JPSS-2/3/4.
7	CGS GNN (Svalbard, FCDAS, SN WSC, TrollSat (Nittedal)) KSAT GNN (Nittedal, TrollSat)	The CGS Route Uplink Data activity provides network communications services between the MON and the SGCN TGE nodes supporting the routing and transport of the SLE communications session. The GNN provides worldwide WAN services between the NSOF/CBU and the CONUS (Fairbanks, AK and SN WSC) and OCONUS (Svalbard, NO and TrollSat Antarctica (via Nittedal)) ground stations. To provide confidentiality of the satellite commands, the communication sessions between NSOF/CBU and the ground stations are transferred in FIPS 140-2 compliant encrypted tunnels between the MON GNN and the GNN at the ground station. For communications with the TrollSat, Antarctica ground station, KSAT provides a SATCOM link between Nittedal, Norway and TrollSat to complete the communications path from the NSOF/CBU. The CGS GNN encrypted tunnel ends in Nittedal prior at the communications demarcation with the KSAT SATCOM link.	This step is included in the blind commanding configuration.

No.	Actors	Activities	Notes
8	CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The Acquire Uplink Data activity at the ground station receives the command data from the MON via the SLE Forward CLTU service. It participates in the authentication with the MON during session establishment and verifies the integrity of the transferred data using the underlying protocols. The KSAT SGCN ground station in TrollSat provides the same functionality as the CGS SGCN. The output of this activity is CLTUs.	This step is included in the blind commanding configuration.
9	CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The Preprocess Uplink Data activity processes CLTUs into a modulated IF (Intermediate Frequency) signal that complies with the mission specific S-Band RF ICD. At the SN WSC ground station, the CLTUs are processed into a serialized bit stream (clock and data) to the WSC interface for SN uplink and relay to the JPSS satellite via S-Band.	This step is included in the blind commanding configuration.
10	CGS SGCN FCDAS SGCN KSAT SGCN	The Transmit Space/Ground Communications activity forwards the IF signal to the S-Band uplink system at the ground station for conversion to S-Band and transmission to the spacecraft. The KSAT SGCN Stored Uplinked Commands activity at Svalbard stores the uplinked commands for two years per the Svalbard treaty.	This step is included in the blind commanding configuration.
11	Satellite	The satellite Receive and Execute Command activity receives the commands via S-Band from the ground station or SN. The commands are decrypted if necessary and the frames and sequence numbers are validated per the COP-1 protocol. Frame verification responses are put into the CLCWs for transfer to the MON via addendum to the RT-TLM. The space packets are reconstructed and forwarded to the applicable spacecraft or sensor subsystem for processing.	This is the concluding step of command uplink processing. This step is included in the blind commanding configuration.
12	CGS MON CGS SGCN (Svalbard, FCDAS, SN WSC), KSAT SGCN (TrollSat)	For commanding in the blind contact, the ground configuration supporting the contact is reset. For telemetry without commanding contacts, the ground configuration is configured to support the reception of telemetry. For full T&C contacts, the ground configuration is already configured to support both commanding and telemetry.	See Ground Operations (GS-NML-310) for configuring of the ground equipment. This step is included in the telemetry without commanding configuration.

No.	Actors	Activities	Notes
13	Satellite, TDRS (SN WSC)	The Downlink Telemetry sends RT and optionally PB-TLM to the ground via S-Band. For SN contacts, RT-TLM is relayed to the TDRS satellite via S-Band which downlinks the telemetry to the WSC ground station via Ku-Band.	This step is included in the telemetry without commanding configuration.
14	KSAT SGCN (Svalbard, TrollSat) FCDAS SGCN (FCDAS) WSC (SN WSC)	The Receive Space/Ground Communications activity acquires the RF downlink signal per the mission RF ICDs and down-converts to IF for output. At Svalbard, this activity also stores antenna tracking data for the contact per the treaty. The WSC Provide SN Communications extracts the JPSS mission data from the multi-user downlink, converts to IF and demodulates the IF to provide clock & data bit stream output.	This step is included in the telemetry without commanding configuration.
15	CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The Preprocess Downlink Data activity receives the telemetry IF signal, recovers the RT-TLM and PB-TLM signals, performs demodulation, frame synchronization, de-randomization and performs Reed-Solomon error correction to recover the VCDUs for output. The Preprocess Downlink Data at WSC receives RT-TLM only as a demodulated bit stream CADUs and performs the other processing to extract the VCDUs for output.	This step is included in the telemetry without commanding configuration.
16	CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The Relay TLM Downlink Data receives RT-TLM VCDUs and PB-TLM VCDUs, if present in the downlink, annotates them with timestamp and ground stations information to create aVCDUs. The aVCDUs are forwarded to the MON using the SLE RAF or RCF services. RT-TLM is forwarded in Timely Online mode which ensures the RT-TLM is transferred in near real-time. PB-TLM is forwarded in Complete Online mode to ensure the full downlinked PB-TLM data set is transferred to the MON. The service provides mechanisms for authenticating the endpoints of the session and verifying the integrity of the transfer using underlying protocols. The Relay TLM Downlink Data activity also stores the aVCDUs for a minimum of 7 days to support offline recovery of the data by the MON if needed.	This step is included in the telemetry without commanding configuration.

No.	Actors	Activities	Notes
17	CGS GNN (Svalbard, FCDAS, SN WSC, TrollSat (Nittedal)) KSAT GNN (Nittedal, TrollSat)	The Route Downlink Data activity provides network communications services between the MON and the SGCN TGE nodes supporting the routing and transport of the SLE communications session similar to the Route Uplink Data activity described above. There is no need to provide confidentiality of the satellite telemetry per FIPS 140-2 as is the requirement for satellite commands.	This step is included in the telemetry without commanding configuration.
18	CGS MON	The CGS Acquire TLM Downlink Data activity receives the telemetry data from the SGCN via the SLE RAF or RCF services via Timely (RT-TLM) and Complete Online (PB-TLM) modes. It participates in the authentication with the ground station SGCN during session establishment and verifies the integrity of the transferred data using the underlying protocols. The CGS Acquire TLM Downlink Data activity can process two RT-TLM streams from the same mission simultaneously. The output of this activity is RT-TLM and optionally PB-TLM aVCDUs.	This step is included in the telemetry without commanding configuration.
19	CGS MON	The CGS Process and Extract Telemetry activity receives aVCDUs, converts the aVCDUs to Extended VCDUs (EVCDUs) by modifying the annotation to include additional information used for subsequent processing. The on-board CCSDS application packets (APs) are recovered from the EVCDUs and annotated to create Extended APs (EAPs). The RT-TLM and PB-TLM EAPs are forwarded to the Manage Telemetry and Payload Data activity for offline sorting, analysis, reporting, storing and archival of telemetry from all sources. The CGS Process and Extract Telemetry also processes the RT-TLM EAPs into individual telemetry Last Recorded Values (LRVs) and Derived LRVs per a validation database that includes the flight Command & Telemetry DB (C&T DB). The C&T DB is enhanced with additional information, including specification for ground defined Derived LRVs consisting of two or more Flight LRVs. The engineering unit telemetry (processed telemetry) LRVs are forwarded to the CGS Check RT-TLM Limits and CGS Monitor	See Space Operations (GS-NML-320) for the offline processing of RT-TLM, PB-TLM and S-TLM. See Space Operations (GS-NML-320) for the post update verification of FSW updates and memory/table loads. This step is included in the telemetry without commanding configuration.

No.	Actors	Activities	Notes
		Spacecraft Contact activities for processing and display with SOH and situational awareness. Command Link Control Words (CLCWs) appended to the RT-TLM VCDUs by the satellite are removed from the RT-TLM aVCDUs, prepended with additional information to create ECLCWs and forwarded to the Monitor Spacecraft Contacts for command verification processing (COP-1).	
20	CGS MON	The CGS Check RT-TLM Limits activity receives and checks the processed telemetry (LRVs) derived from the RT-TLM against pre-defined limits as contained in the validation database. Limit warnings and alerts are generated as appropriate and forwarded to the CGS Monitor Spacecraft Contacts and CGS Monitor Satellite State of Health activities for SOH display and processing. The CGS Monitor Spacecraft Contacts activity provides configurable satellite (spacecraft and sensor) displays to the operators (SATCON and others). The activity uses the received processed telemetry LRVs and limit warnings and alerts to populate the displays. This activity also processes the ECLCWs received from the spacecraft, using them to update the status of uplinked commands for the Manage Satellite CMDs and Loads activity. Command verification responses not received within a timeout are alarmed and forwarded to the Manage Satellite CMDs and Loads activity for potential automated retransmit. The command verification processing can be disabled at the discretion of the operator for situations such as blind commanding contacts.	This step is included in the telemetry without commanding configuration.
21	CGS MON CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	At Loss of Signal (LOS), the CGS Execute Ground Commands activity releases the ground equipment from the T&C contact.	See Ground Operations (GS-NML-310) for the de-configuration of the ground equipment. This step is included in the telemetry without commanding configuration.

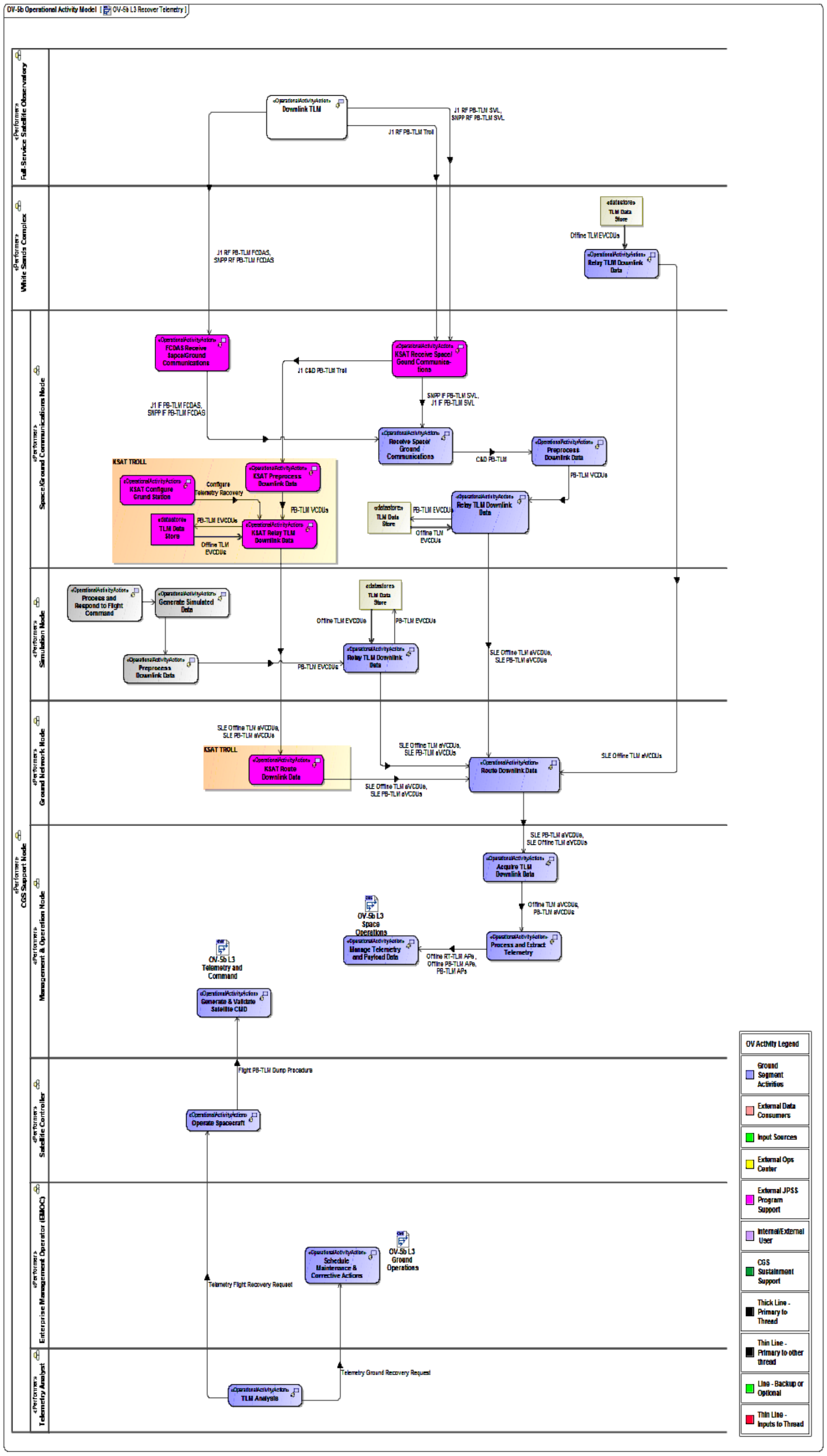
6.3.3.7 Telemetry Recovery

6.3.3.7.1 Assumptions & Constraints

- For offline recoveries from a ground station, the desired telemetry data has not expired due to 7-day archival limitations.
- For spacecraft recoveries, the storing of RT-TLM into the onboard Mass Data Storage (MDS) for PB-TLM downlink has been configured to support operational needs.

6.3.3.7.2 Pre-Conditions

- Telemetry analysis has been performed to identify telemetry gaps and the ground station or on-board telemetry MDS has been identified as the source for Telemetry Recovery.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.3-3 Telemetry Recovery Flow Diagram

Trigger: This flow is event driven. It starts when operations identifies the need to recover RT-TLM and/or PB-TLM from a ground station via SLE Offline services or to recover PB-TLM from the telemetry MDS on-board the spacecraft.

Table: 6.3.3-7 Telemetry Recovery

No.	Actors	Activities	Notes
1	TLM Analyst	The TLM Analysis activity identifies the need to recover telemetry from the spacecraft or from an existing data telemetry data store at a ground station. Missing telemetry may result from a missed contact or the unavailability of S-TLM for a period of time due to other anomalies. The TLM Analysis activity initiates a Telemetry Ground Recovery Request. Go to Step 2. The TLM Analysis activity initiates a Telemetry Flight Recovery Request. Go to Step 8.	See Space Operations (GS-NML-320) for the offline processing of RT-TLM, PB-TLM and S-TLM that identifies the need for a telemetry recovery operation.
2	EMOC	The Schedule Maintenance and Corrective Actions activity receives the Telemetry Ground Recovery Request and identifies the ground location containing the required telemetry by viewing acquisition reports from the ground station(s) with contacts in the timeframe of the request.	
3	EMOC	The Schedule Maintenance and Corrective Actions activity schedules an offline recovery of the requested telemetry from the appropriate ground station.	See Ground Operations (GS-NML-310) for the scheduling of an offline recovery from a ground station.
4	CGS SGCN (Svalbard, FCDAS, SN WSC) KSAT SGCN (TrollSat)	The Relay TLM Downlink Data receives offline telemetry recovery request, retrieves the requested aVCDUs from its 7 day storage and begins forwarding the aVCDUs to the MON using the SLE RAF Service in Offline mode. It participates in the authentication with the ground station SGCN during session establishment and verifies the integrity of the transferred data using the underlying protocols.	
5	CGS GNN (Svalbard, FCDAS, SN WSC, TrollSat (Nittedal)) KSAT GNN (Nittedal, TrollSat)	The Route Downlink Data activity provides network communications services between the MON and the SGCN TGE nodes supporting the routing and transport of the SLE Offline communications session as described in Table: 6.3.3-3 Telemetry and Commanding. The SLE Offline data may be given a lower	

No.	Actors	Activities	Notes
		priority in the network than the SLE Online transfers since it is not time critical.	
6	CGS MON	The CGS Acquire TLM Downlink Data activity receives the recovered telemetry data from the SGCN via the SLE RAF or RCF services via the Offline mode. It participates in the authentication with the ground station SGCN during session establishment and verifies the integrity of the transferred data using the underlying protocols. The output of this activity is RT-TLM and/or PB-TLM aVCDUs.	
7	CGS MON	The CGS Process and Extract Telemetry activity receives recovered aVCDUs, converts the aVCDUs to EVCDUs by modifying the annotation to include additional information used for subsequent processing. The on-board CCSDS Application Packets (APs) are recovered from the EVCDUs and annotated to create Extended APs (EAPs). The RT-TLM and/or PB-TLM EAPs are forwarded to the CGS Manage Telemetry and Payload Data activity for offline sorting, analysis, reporting, storing and archival of telemetry from all sources. This is the last step in the Telemetry Ground Recovery Request processing for this thread.	See Space Operations (GS-NML-320) for the offline processing of RT-TLM, PB-TLM.
8	SATCON CGS MON	The Operate Spacecraft activity generates the appropriate spacecraft and ground commands (nominally via pre-existing Proc) to perform the playback of the PB-TLM from the on-board telemetry MDS at the next contact opportunity. The commands/Proc are initiated via the Generate and Validate Satellite CMD.	The Full-resolution SSOH (FSSOH) may be downlinked through either S-band or Ka-band. However FSSOH downlink via S-band is very limited as only about 6 minutes of FSSOH can be downlinked for each minute of high-rate S-band (1.6 Mbps) contact.
9	CGS MON	The commands/proc are processed per the steps in Table: 6.3.3-3 Telemetry and Commanding. The processing of the downlinked PB-TLM is also processed and forwarded to the Manage Telemetry and Payload Data described in the table. This is the last step in the Telemetry Flight Recovery Request processing for this thread.	See Space Operations (GS-NML-320) for the offline processing of PB-TLM.

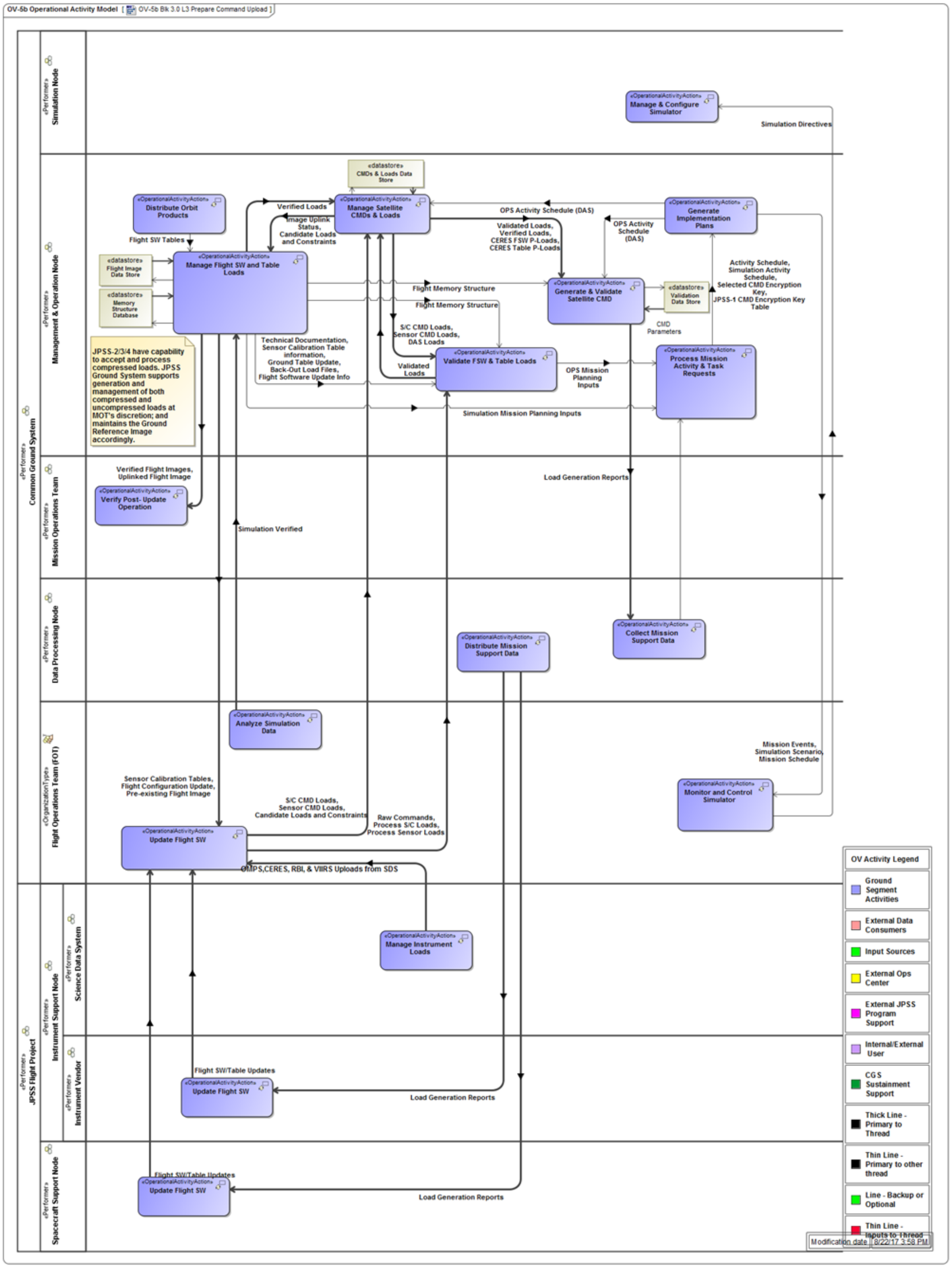
6.3.3.8 Prepare Command Upload

6.3.3.8.1 Assumptions & Constraints

- The prepare command upload process is managed by the operations staff.
- The validation database, which includes the C&T DB, is identical to the validation database used for T&C processing.
- The CERES/RBI FSW/Table P-Load (Packet Load) received from the CERES/RBI team is properly formatted and valid for the spacecraft and CERES/RBI instrument.

6.3.3.8.2 Pre-Conditions

- The desired spacecraft and/or instrument uploads (including the stored command sequence from Mission Planning) are available to the operations staff at the MON and have been approved for command upload preparation.
- The required parameters for upload generation have been prepared, including the Sim and/or operations activity schedule(s).
- The constraints against which the upload is validated are reasonable for the parameters of the desired upload.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.3-4 Prepare Command Upload

Trigger: This flow is triggered by a CGS MON flight engineer (spacecraft or instrument engineer) action to process a command upload. The command upload is generated from a spacecraft or instrument Flight Software (FSW) update or memory/table load generated internally by the CGS MON operations staff or received from an external entity such as a spacecraft or instrument vendor or support node (SSN or ISN). The stored command sequences for the spacecraft, VIIRS and OMPS are prepared for upload using this process.

Table: 6.3.3-8 Prepare Command Upload

No.	Actors	Activities	Notes
1	Flight Engineer, CGS MON	The CGS Manage FSW and Table Load activity supports the generation of the memory structure/table format database by an authorized user. The database is used to generate and validate command uploads for S-NPP and JPSS-1/2/3/4. The database is ingested by the command load and validation software without requiring a software update.	Memory structure/table format database updates are vetted via the configuration management processes described in FSW Upgrade (GS-NML-070).
2	Flight Engineer, CGS MON	The CGS Manage FSW and Table Load activity uses the memory structure/table format database to generate the command load for the S-NPP or JPSS-1/2/3/4 spacecraft or instrument (except CERES/RBI). For locally generated images, the Flight Engineer can edit an existing ground managed image to be used as the basis for a command upload. FSW or memory images from the spacecraft or instrument support teams (vendor or SSN/ISN) are also used to generate the command upload. CERES/RBI instrument FSW and memory/table update products are provided as pre-built Packet Load files suitable for upload. Go to Step 5 for CERES/RBI.	Images selected for upload are vetted via the configuration management processes described in FSW Upgrade (GS-NML-070). The JPSS-2/3/4 spacecraft has capability to accept and process compressed loads. The JPSS Ground System supports generation and management of compressed or uncompressed loads at MOT's discretion, while the compressed load is nominally used for uplink to the JPSS-2/3/4 spacecraft. Note that the instrument loads remain uncompressed.
3	Flight Engineer, CGS MON	The CGS Validate FSW and Table Loads activity validates the spacecraft and instrument command images received for command load generation based on flight specifications.	Flight specifications include Table Description Documents (TDD), Satellite and Operations Description Manuals (SODM) for S-NPP and JPSS-1, Spacecraft Operator's

No.	Actors	Activities	Notes
			Manual (SOM) for JPSS-2/3/4, Mission Data Format Control Books (MDFCB) and other applicable configuration managed documentation generated by the flight team(s).
4	Flight Engineer, CGS MON	The CGS Generate and Validate Satellite CMD activity generates the command loads from the validated image. The system will support load generation simultaneously for at least three satellites. Load commands are formatted and validated according to flight specification and the command and telemetry database. Constraint checking is performed based on the parameters provided by the operations staff at the time of load generation. Uploads include an integrity verification field (checksum or Cyclic Redundancy Check (CRC)) as required by the spacecraft and/or instrument. Loads are segmented into one or more CCSDS packet load (P-Load) partitions based on CCSDS Protocol Data Unit (CP PDU) spacecraft and/or instrument length constraints. A P-Load (partition) must be capable of being uplinked during a single T&C contact. In addition to the load data, the P-Load files contain metadata identifying the number of packets in the file, the on-board destination (unit) of the load (i.e., spacecraft or instrument), and optional hold-off timer constraints for inter-packet spacing. Load control files are generated to manage the uplink of the loads and include any spacecraft or instrument commands required to execute the load. The load control files contain a time window for which the load is valid. Command loads are time-tagged according to absolute or relative time as specified by the Sim or Operational Mission Planning activity schedule. Multiple versions of a command load may be generated according to different activity schedules based on the need for operational flexibility. Operations staff can select from	Exercising the generated stored command sequence load (e.g., DAS) through the FVTS is an optional step performed by the operations staff. At successful completion of the simulated validation, an operational load may be created using an operational activity schedule with updated time-tags. See FSW Upgrade (GS-NML-070) and Flight Vehicle Simulation (GS-NML-080) for additional details.

No.	Actors	Activities	Notes
		the candidate versions prior to or during the contact. Generated command loads are optionally uploaded to a satellite simulator FVTS for validation.	
5	Flight Engineer, CGS MON	The CGS Generate & Validate Satellite CMD activity creates Load Generation report(s) for distribution to the vendor or SSN/ISN for validation and authorization to upload. If the load is approved for satellite deployment, the load is uploaded to the satellite per the operational activity schedule as described in Table 6.3.3-4, Telemetry & Commanding. The Manage Flight SW & Table Uploads activity stores uploaded images as updated memory reference images.	See Space Operations (GS-NML-320) for additional details regarding post updated validation of FSW and memory/table uploads. See FSW Upgrade (GS-NML-070) for additional information about on-orbit reference.

6.3.3.9 Post Conditions

All real-time and recovered telemetry processing is complete, reports have been posted internally and externally, and satellite memory models are updated for successfully uploaded images (except CERES/RBI which does not require a ground reference image).

6.3.3.10 Related Threads

Thread ID	Thread Title
GS-NML-010	Fleet/Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-070	Flight Software Upgrade
GS-NML-080	Flight Vehicle Simulation
GS-NML-100	Stored Mission Data Handling
GS-NML-200	Key Management
GS-NML-310	Ground Operations
GS-NML-320	Space Operations
GS-NNL-130	System Fault Analysis
GS-NNL-150	Space Network Support

6.3.3.11 Child Threads

Thread ID	Thread Title
CGS-020-030	Telemetry and Command

6.3.4 Space Operations

6.3.4.1 Description

Space Operations (GS-NML-320) describes the comprehensive situational awareness capability for every satellite in the fleet managed by JPSS. This includes vehicle state of health and on-

orbit memory reporting. Satellite awareness is supported by the generation of telemetry trending and analysis reports and memory dump reports. These reports are made available both internally to the JPSS Ground System and externally to authorized users. Telemetry analysis includes limit checking, plotting, expression analysis, trending and curve fitting. Memory analysis includes the capability to compare two memory images such as an upload image and the subsequent downlink memory dump image. These tools support ad hoc reporting in addition to the standing reports for anomaly resolution and other engineering investigations into satellite (spacecraft and sensor) health, status and performance.

In addition to the trending reports, the JPSS Ground System also provides State of Health (SOH) telemetry Analysis Tool for Orchestrated Measurement/Measuring (ATOM) Repository Files (ARF) to the Spacecraft Support Node (SSN), which consists of the spacecraft vendors such as Ball Aerospace & Technologies Corp (BATC) for S-NPP and JPSS-1 as well as Orbital ATK (OA) for JPSS-2/3/4. This telemetry can be used by SSN to support LEO&A operations and anomaly resolution throughout the life of the mission.

Space Operations reporting supports Fleet Ground Management (GS-NML-010). Fleet Ground Management (FGM) provides the highest level of system monitoring, providing awareness of the entire system.

Space Operations also relies on or supports major activities described in Telemetry and Command (GS-NML-030), Mission Planning and Scheduling (GS-NML-020), Orbit Maintenance (GS-NML-050), Attitude Ground Support (GS-NML-060), and Stored Mission Data Handling (GS-NML-100).

The recovery of missing Stored Telemetry (S-TLM) may be done for data product generation purposes or in support of the telemetry archive at the MON. This is covered in Data Accounting and Recovery (GS-NML-130). If the Satellite Controller (SATCON) detects missing real-time telemetry (RT-TLM), a satellite dump of playback telemetry (PB-TLM, aka Stored State Of Health (SSOH)) or ground recovery of RT/PB-TLM can be executed to retrieve telemetry for the missing timeframe. In case of extended Ka-band outage (e.g., over 3 orbits) that renders S-TLM unavailable, Full-resolution SSOH (FSSOH) may be downlinked from JPSS-2/3/4 to support diagnostics and telemetry archive. Telemetry recovery is described in Telemetry and Command (GS-NML-030).

The Spacecraft Engineers (Spacecraft Analysts) and the Instrument Engineers (Sensor Analysts) are the primary positions involved in Space Operations. Secondary positions include the Flight Software Analyst, Mission Planner and the Orbit Analyst. As the leads on the operations floor, the Enterprise Management Operations Controller (EMOC) and the OSPO management are daily operations interfaces. The Space Operations dashboard would be used by the Spacecraft Engineer, the Instrument Engineer, the EMOC and the OSPO management primarily.

6.3.4.2 Primary Interfaces

Figure 6.3.4-1 illustrates the actors and primary external interfaces involved in a telemetry and command contact between the space system (SS) and ground system (GS). Each interface illustrated in the figure, labeled with a number, is described in Table 6.3.4-1, along with the information about relevant IRDs and ICDs in Table 6.3.4-2.

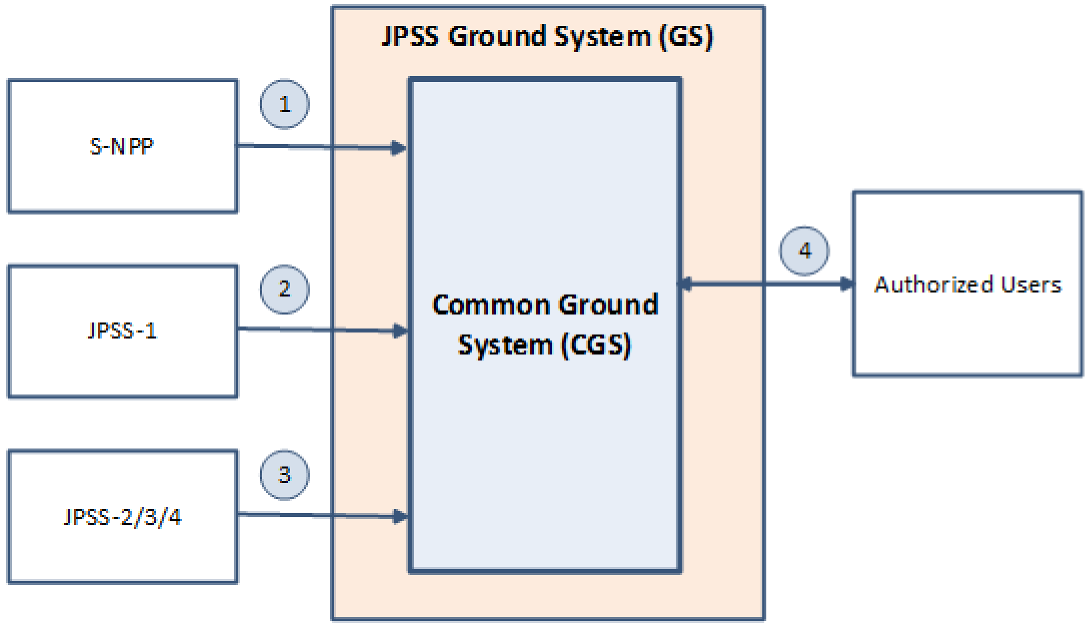


Figure: 6.3.4-1 Primary External Interfaces for Space Operations

Table: 6.3.4-1 Primary External Interfaces for Space Operations

No.	Type	Actors	Purpose
1	External	S-NPP, CGS	RT-TLM/PB-TLM/S-TLM
2	External	JPSS-1, CGS	RT-TLM/PB-TLM/S-TLM
3	External	JPSS-2/3/4, CGS	RT-TLM PB-TLM/S-TLM/FSSOH
4	External	CGS, Authorized Users	Telemetry Analysis/Trending and Memory Reports/TLM from the LOM (ARFs)

Table: 6.3.4-2 Primary External Interface Documentation

No.	IRD/ICD
1	S-NPP Spacecraft S-Band RF ICD to the Norway GS (429-03-02-25) S-NPP S-Band Data Format ICD (429-04-02-27)
2	JPSS IRD for RF Interfaces to and from JPSS-1 (472-00173) JPSS-1 TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161)
3	JPSS IRD for RF Interfaces to and from the JPSS-2/3/4 (470-00205) JPSS-2/3/4 TT&C to GS RF ICD JPSS-2/3/4 TT&C Data Format ICD
4	JPSS CGS Services Interface Definition Document (474-00562) JPSS GS to NASA SDS IRD (474-00304) JPSS Ground Project to Flight Project IRD (474-00223) JPSS CGS to AGS IRD (474-00316) Joint Polar Satellite System Common Ground System to Suomi National Polar-orbiting Partnership (S-NPP) and Joint Polar Satellite System-1 (JPSS-1) Spacecraft Vendor Interface Control Document (474-00425)

No.	IRD/ICD
	JPSS CGS to JPSS-2 Spacecraft Vendor ICD (474-01438)

6.3.4.3 Assumptions & Constraints

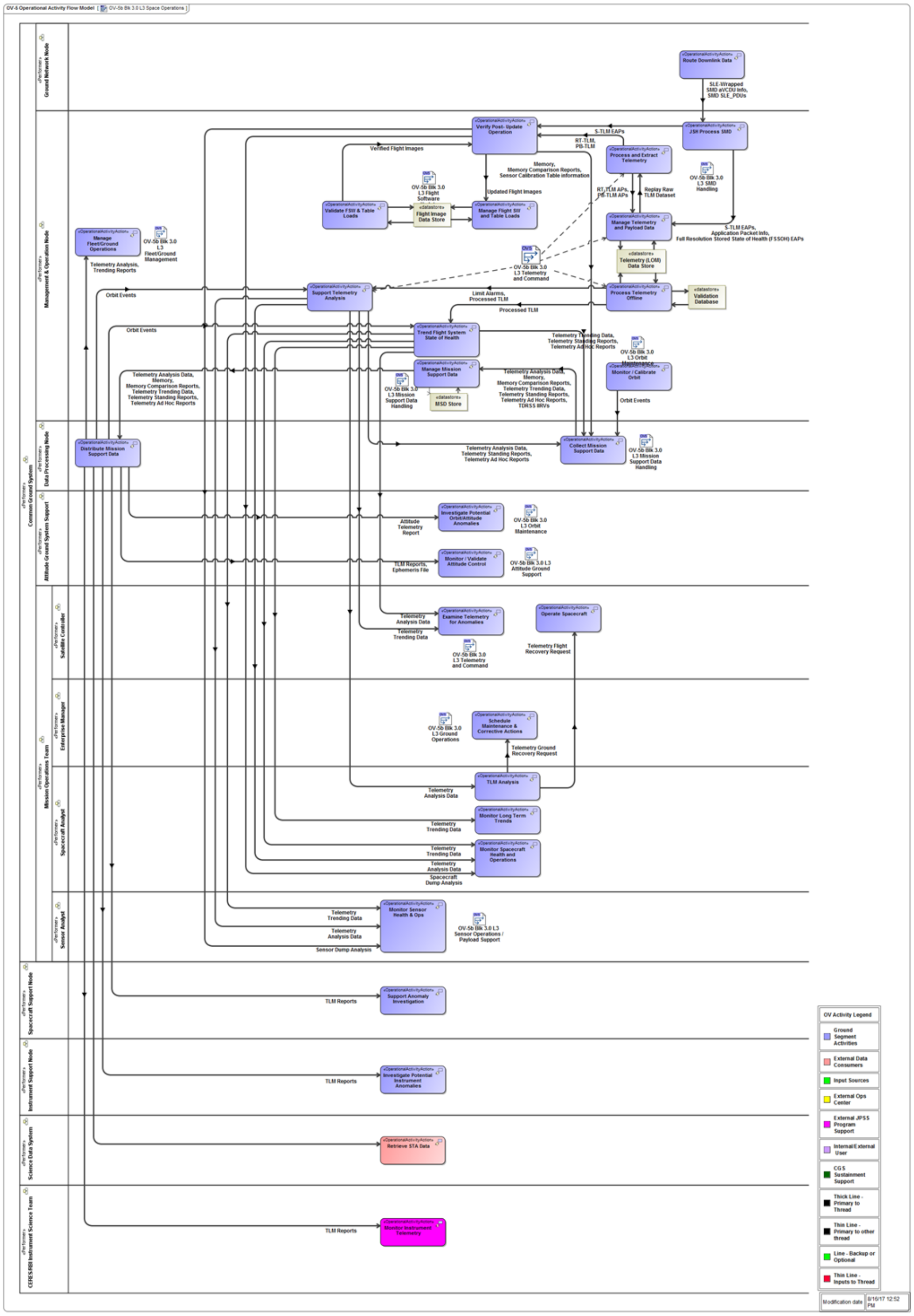
None.

6.3.4.4 Pre-Conditions

The system is up and running.

6.3.4.5 Operational Flow

Figure 6.3.4-2 provides an illustration of system activities taking place in the basic flow for space operations and telemetry analysis.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.4-2 Space Operations and Telemetry Analysis Flow Diagram

6.3.4.6 Offline Telemetry Processing and Reporting

Trigger: This flow is data driven and occurs when there is available RT-TLM, PB-TLM, S-TLM, or FSSOH input data or when there is a telemetry analysis or trending report generation request. Report generation can be scheduled via timeline or event (e.g., orbital events) or submitted as ad hoc real-time operator or external user request.

Table: 6.3.4-3 Offline Telemetry Processing and Reporting Flow

No.	Actors	Activities	Notes
1a	CGS MON	The CGS Manage Telemetry and Payload Data activity receives RT-TLM and PB-TLM Extended Application Packets (EAPs) from the CGS Process & Extract Telemetry activity.	See Telemetry and Command (GS-NML-030) for more details
1b	CGS MON CGS GNN	The CGS Manage Telemetry and Payload Data activity receives S-TLM EAPs or FSSOH EAPs from the CGS JSH Process SMD activity.	See Stored Mission Data Handling (GS-NML-100) for more details.
2	CGS MON	The CGS Manage Telemetry and Payload Data activity identifies, stores and archives new packets by APID, sequence number and time. Packets received with identical APID, sequence number and timestamp as previously processed packets are not inserted into the archive but set aside for possible future analysis. The CGS Manage Telemetry and Payload Data activity supports concurrent processing of telemetry for all JPSS managed missions.	
3	CGS MON	The CGS Trend Flight System SOH and the CGS Support Telemetry Analysis activities provide trending and analysis tools that support operator or external user requests or standing requests for report generation. The tools are capable of generating plots, performing expression analysis, limit checking/state checking, performing trending, or viewing the contents of the telemetry. The reports are used for SOH and performance assessments based on a selected telemetry dataset with an interval of up to one year. A Spacecraft Analyst also uses the tools to identify any gaps in the received telemetry (RT/PB/S-TLM/FSSOH) and request a telemetry recovery to fill the gaps.	
4	CGS MON	The CGS Process Telemetry Offline activity converts the Telemetry from the LOM (ARFs) packets of a selected dataset into engineering unit telemetry Last Recorded Value (LRV) parameters using the T&C Validation Database. For some reports the LRVs are checked against the TLM Validation Database for out of limit	The TLM Validation Database includes the satellite C&T DB. Nominal standing reports include the following as

No.	Actors	Activities	Notes
		conditions. Out of limit conditions are archived for the life of the program. The CGS Trend Flight System SOH and the CGS Support Telemetry Analysis activities automatically generate standing reports. Additional standing reports are requested by the operations or operations support staff or external entities. Ad Hoc reports are requested as needed to support troubleshooting or anomaly resolution. The operations and operations support teams' spacecraft and instrument engineers and the spacecraft and instrument support teams and vendors are users of these reports. Reports are generated in industry standard formats. The CGS Process Telemetry Offline, Trend Flight System SOH and Support Telemetry Analysis activities support concurrent processing and reporting of telemetry for all JPSS managed missions.	specified in Appendix A of the CGSRD: • Stored Telemetry Analysis Science • Data Segment Telemetry Report • Stored Telemetry Analysis Limit Checking Report • Stored Telemetry Analysis Trend Report • Stored Telemetry Analysis State Checking Report • Stored Telemetry Analysis Plots
5	CGS MON	Reports are made available to internal users and systems via local storage and external users via the MSD environment and the Internet via the CGS Collect Mission Support Data and Distribute Mission Support Data activities. External users include the Space and Instrument Support teams. The CGS Manage Fleet/Ground Operations provides online storage for reports for 30 days and archives the reports for the life of the program.	See Fleet Ground/Management (GS-NML-010), Attitude Ground Support (GS-NML-060), Fleet Ground Management (GS-NML-010), Mission Planning and Scheduling (GS-NML-020), Mission Support Data Handling (GS-NML-140), Orbit Maintenance (GS-NML-050), Sensor Ops and Payload Support (GS-NML-500) for more details regarding distribution and utilization of these reports.

6.3.4.7 On-orbit Memory Processing and Reporting

Trigger: Memory analysis and report generation can be scheduled via timeline or event (e.g., orbital events) or submitted as an ad hoc real-time operator or external user request.

Table: 6.3.4-4 On-orbit Memory Processing and Reporting

No.	Actors	Activities	Notes
1a	CGS MON	The CGS Verify Post-update Operation activity receives RT-TLM and PB-TLM memory dump Extended Application Packets (EAPs) from the CGS Process & Extract Telemetry activity.	See Telemetry and Command (GS-NML-030) for more details
1b	CGS MON	The CGS Verify Post-update Operation activity receives S-TLM memory dump EAPs from the CGS JSH Process SMD activity.	See Stored Mission Data Handling (GS-NML-100) for more details.
2	CGS MON	The CGS Verify Post-update Operation activity uses the memory structure and table formats provided by the spacecraft and sensor vendors to construct on-orbit images of flight memory. The on-orbit images are considered ground references of flight memory used to verify uploads and record current satellite state.	
3	CGS MON	The CGS Verify Post-update Operation activity provides the capability of comparing two memory images to confirm a FSW update or memory/table upload was correctly installed on the satellite. The CGS Verify Post-update Operation activity generates standing and ad hoc reports as required by internal and external users and systems. The CGS Verify Post-update Operation activity supports concurrent memory analysis and reporting of memory dumps for all JPSS managed missions.	See Flight Software Upgrade (GS-NML-070) for the FSW and memory/table update process. Nominal standing reports include the following as specified in Appendix A of the CGSRD: • Memory Dump Report • Memory Comparison Report • Satellite Log Report
4	CGS MON	The CGS Manage Fleet/Ground Operations stored reports online for 30 days and archives them for the life of the JPSS programs. On-board memory reports are made available to internal users and systems via local storage and external users via the MSD environment and the Internet.	See Fleet Ground Management (GS-NML-010) and Mission Support Data Handling (GS-NML-140) for additional details regarding management and distribution of memory reports.

6.3.4.8 Offline Telemetry Transfer

Trigger: The telemetry files (ARF) from the LOM are automatically made available to the SSN. Operations personnel can obtain TLM files from the LOM to support ad hoc requests.

Table: 6.3.4-5 Offline Telemetry Transfer

No.	Actors	Activities	Notes
1	CGS MON	The CGS Manage Telemetry and Payload Data activity extracts from the LOM data store State Of Health (SOH) telemetry packets (ARFs) within specified times and makes them available to the SSN Support LEO and Anomaly Investigation activity on a secured file server for up to 7 days.	Telemetry to be transferred can be specified by starting and ending time. Telemetry data are separated by missions. Each telemetry data file will be kept on the file server for up to 7 days.
2	SNN	The SSN Support LEO and Anomaly Investigation activity pulls SOH telemetry packets from the secured file server.	

6.3.4.9 Post Conditions

The telemetry trending reports and memory analysis reports are available to the authorized users. The telemetry data files are available to the spacecraft vendors (a subset of authorized users).

6.3.4.10 Related Scenarios

Thread ID	Thread Title
GS-NML-010	Fleet Ground Operations
GS-NML-030	Telemetry and Command
GS-NML-020	Mission Planning and Scheduling
GS-NML-050	Orbit Maintenance
GS-NML-060	Attitude Ground Support
GS-NML-100	Stored Mission Data Handling
GS-NML-500	Sensor Operations and Payload Support
GS-NML-070	Flight Software Upgrade
GS-NML-140	Mission Support Data Handling

6.3.4.11 Child Threads

Thread ID	Thread Title
CGS-010-020	Space Operations

6.3.5 Space Network Support

6.3.5.1 Description

The Space Network Support (GS-NNL-150) thread describes the capabilities of JPSS Ground System to use NASA Space Network (SN) to support JPSS missions.

The SN provides communication relay services to satellite systems and currently consists of the Tracking Data and Relay Satellite System (TDRSS) and its supporting elements. TDRSS is comprised of a constellation of Tracking Data and Relay Satellites (TDRSs) in geosynchronous

orbit, and a ground segment consisting of the TDRSS Ground Terminals (TGTs) located at the White Sands Complex (WSC). SN support is requested, and status of Space Network ground assets is provided, via the Space Network Access System (SNAS). Details on the use of SNAS may be found in Space Network Access System (SNAS) MOC Client Software Users' Guide, 452-UGSNAS.

During an SN Telemetry and Command (T&C) contact, command data generated by the Common Ground System (CGS) is relayed to the spacecraft via the Tracking Data and Relay Satellite (TDRS) using the S-band Single Access (SSA) forward link service when possible. Telemetry data from the spacecraft is received by TDRS via the SSA return link services and routed to CGS. CGS uses SN support as a backup to its primary T&C Space/Ground Communication Node (SGCN) assets in situations where the ground station assets are not visible, accessible, or available. CGS uses SN support during Launch and Early Orbit operations, orbit maneuvers, and anomaly operations when only TDRSS can provide continued T&C access and tracking. The SN T&C support is scheduled during spacecraft Launch and Early Orbit operations from launch through separation of the satellite from the launch vehicle (LV), placement of the satellite in the correct orbit, until the establishment of a T&C link from the orbiting satellite to CGS via Svalbard ground station. SN resources are also scheduled for orbit maneuvers to maintain T&C contacts throughout any maneuver operations. In addition, SN contacts are required to receive and evaluate RT-TLM when the JPSS spacecraft is not in view of Svalbard or other ground stations, and to receive commands during contingency operations.

The SN also provides Ka-band support to the CGS utilizing the Ka-capable TDRS SA for SMD playback from the JPSS-1/2/3/4. This capability is utilized to support anomaly recovery. At WSC, CGS can support TDRS contacts with two satellites simultaneously, each running T&C and/or SMD operations. CGS sends ground commands to and receives ground status from CGS ground assets installed at WSC.

This thread details setting up SN contacts for SMD Playback and/or T&C operations. See GS-NML-030 Telemetry and Command Operations for specific details on telemetry received and commands transmitted through the SN.

The SN is used to provide SMD downlink for contingency operations for JPSS-1/2/3/4. At present time, only TDRS East (AOR F9) and TDRS West (POR F10/11) are available for this support. TDRS support for the Indian Ocean Region (IOR) is not available in the JPSS-2 timeframe. During scheduled SN SMD contacts, the SMD is played back from onboard Mass Data Storage (MDS) and relayed to the ground via the assigned TDRS using the Ka-band SA return link service. The SMD received at WSC is routed to the CGS for data processing. Due to the lack of IOR support, there is a gap over the Indian Ocean in the contact global coverage, leaving about 10% of TDRS contact AOS-to-AOS separations greater than 50 minutes.

JPSS-1/2/3/4 use TDRSS in combination with the Svalbard and McMurdo polar ground stations as contingency operations to downlink SMD. More details of using TDRSS to support the JPSS SMD operations can be found in the S-NPP and JPSS MDS Playback thread (GS-NML-102).

For JPSS-1 and JPSS-2 SMD operations, TDRS contact schedules are constrained by data latency consideration. Separation times between SMD contacts should be managed within a range that will ensure the data latency compliance. To reduce resource conflicts, the TDRSS schedule request for each contact includes a start time tolerance bounded by the latency

constraint range. This will enable SN scheduling system to schedule a contact event around conflicting time slot thus reducing manual de-confliction work significantly.

JPSS is an operational mission and as such, per the NOAA/NASA agreement, is given a high priority over other robotic missions that require SN support. This means that during the forecast scheduling phase, JPSS requests will be prioritized in TDRSS resource scheduling. On the other hand, requests for adding/modifying events to the active schedule should be based on the resource availability identified in the current TDRSS Unused Time (TUT) file. However in case of an extended anomaly that jeopardizes the mission objectives (e.g. data latency) but TUT indicates no resource available at desired time slots, the JPSS mission management may consider declaring "mission contingency" and submitting contingency support request that will be handled at higher priority.

SN Support automation is applied to routine operations and scheduling of contacts supporting several defined scenarios:

- Deliver JPSS-managed mission Acquisition Data (IIRV) to SNAS
- Receive TDRS Acquisition Data (IIRV) from the FDF Customer Interface Layer (CIL)
- Receive TDRSS Forecast Schedule and Confirmed Contact Schedule (aka. TDRSS Allocation Status file)

SN performs the following automated routine functions:

- Transfer JPSS-managed mission Acquisition Data (IIRV) from SNAS to SN
- Send to NSOF via SNAS the TDRSS Forecast Schedule and Confirmed Contact Schedule (aka, TDRSS Allocation Status file)

Manual functions of SN Support are performed by the Mission Planner staff position within the Mission Operations Team (MOT). Their responsibilities include:

- Prepare and generate schedule requests for TDRSS service
- Submit Bulk, Specific, or ad-hoc schedule requests of TDRSS services to SNAS
- Deconflict SN Forecast Schedule with SN Forecast Analyst (FA)
- Coordinate with the SN Scheduling Office (SNSO)
- Receive and ingest the TDRSS Allocation Status file
- Generate Master Schedule

This scenario applies to all JPSS-managed missions, including the S-NPP, JPSS-1/2/3/4 missions.

Other ConOps threads closely related to this one include the Mission Planning and Scheduling (GS-NML-020), Telemetry and Command (GS-NML-030), Mass Data Storage Playback (GS-NML-102), and Mission Support Data Handling (GS-NML-140). For details in SN resource scheduling, see NASA Space Network User's Guide (450-SNUG).

6.3.5.2 Primary Interfaces

Figure 6.3.5-1 illustrates the SN support primary interfaces. Each interface illustrated in the figure, labeled with a number, is described in Table 6.3.5-1, along with the information about types of data exchanged. Table 6.3.5-2 provides relevant IRDs/ICDs information.

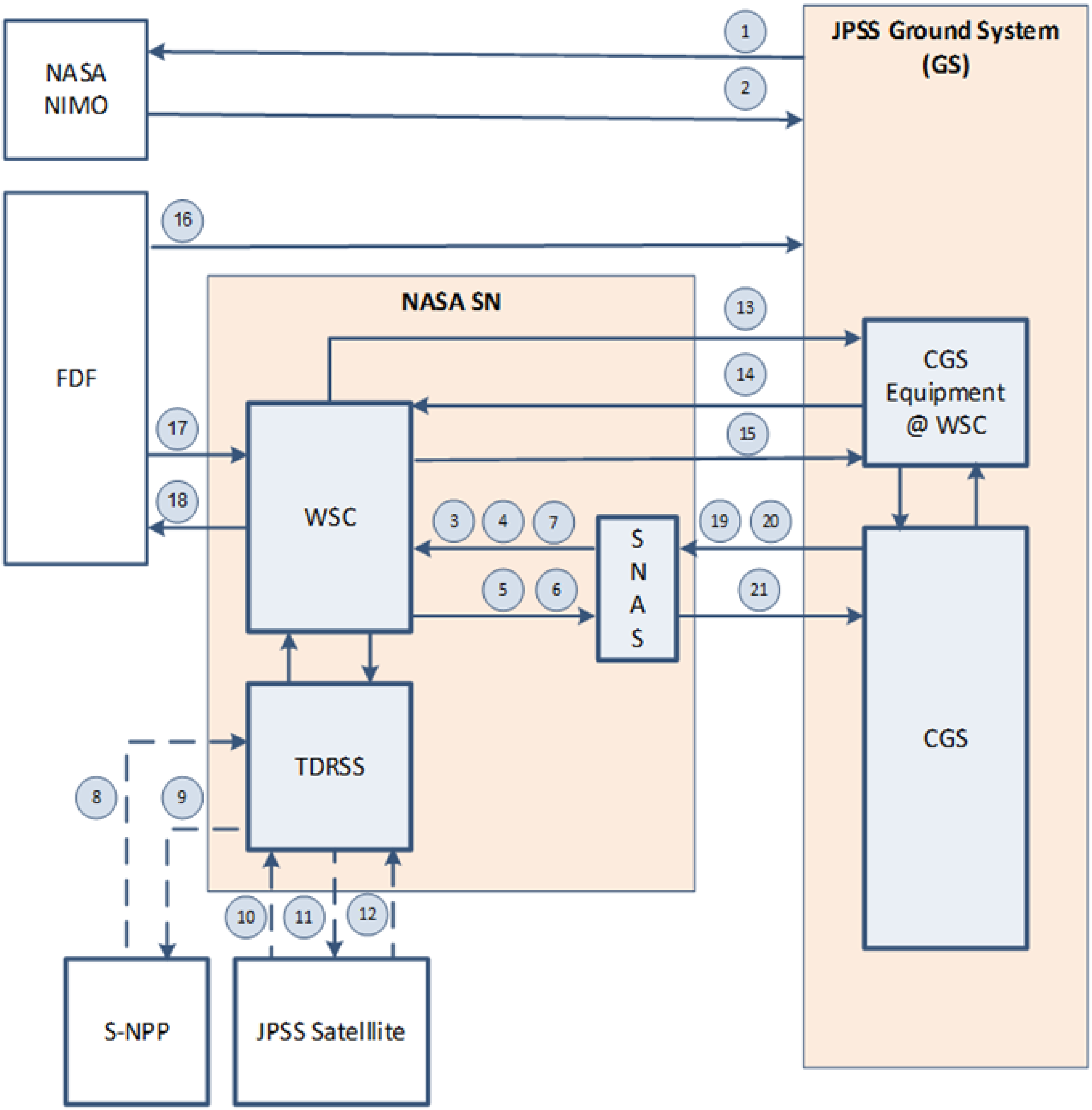


Figure: 6.3.5-1 Space Network Support Primary Interfaces

Table: 6.3.5-1 Space Network Support Primary Interfaces

No.	Type	Actors	Purpose
1	External	GS, NASA NIMO	Space Network Services customer requirements
2	External	GS, NASA NIMO	Space Network provided services
3	External	SNAS, SN	S-NPP and JPSS-1/2/3/4 Orbit State Vectors (IIRV)
4	External	SNAS, SN	JPSS Specific Schedule Requests - Schedule Add Requests (SAR), schedule modifications or deletions JPSS Bulk Schedule Requests
5	External	SN, SNAS	TDRSS Allocation Status File (Contact Schedules), TDRSS Unscheduled Time (TUT)
6	External	SN, SNAS	SN service status - User Schedule Message (USM), Ground Control Message (GCM), User Performance Data (UPD)
7	External	SNAS, SN	WSGT, STGT configuration commands - Ground Control Message Request (GCMR)
8	Outside	S-NPP, SN	S-NPP Real-time Telemetry
9	Outside	SN, S-NPP	S-NPP Command
10	Outside	JPSS-1/2/3/4, SN	JPSS-1/2/3/4 Real-time Telemetry
11	Outside	SN, JPSS-1/2/3/4	JPSS-1/2/3/4 Commands
12	Outside	JPSS-1/2/3/4, SN	JPSS-1/2/3/4 SMD
13	External	SN, CGS	S-NPP and JPSS-1 Real-Time Telemetry
14	External	CGS, SN	S-NPP and JPSS-1/2/3/4 Commands
15	External	SN, CGS	JPSS-1/2/3/4 SMD
16	External	FDF, CGS	TDRS Orbit Vectors (IIRV)
17	External	FDF, SN	Acquisition Data
18	External	SN, FDF	Tracking Data
19	External	CGS, SNAS	JPSS-1/2/3/4 Orbit State Vectors (IIRV)
20	External	CGS, SNAS	JPSS Bulk Schedule Requests or Specific Schedule Requests
21	External	SNAS, CGS	TDRSS Allocation Status file

Table: 6.3.5-2 Space Network Support Primary Interface Documentation

No.	IRD/ICD
1, 2	SN-NIMO PSLA SN-NIMO NRD
3,4, 5, 6, 7, 19, 20 & 21	SN to NPOESS C3S ICD 450-ICD-SN/NPOESS SN to JPSS CGS ICD Space Network User's Guide (SNUG), 450-SNUG SN-Customer for Service Management ICD, 452-ICD-SN/CSM SNAS MOC Client Software Users' Guide, 452-UGSNAS JPSS Space/Ground Data Format XML Database

No.	IRD/ICD
	S-NPP Network Operations Support Plan
8, 9, 10, 11 & 12	RFICD S-NPP S/C and SN (451-RFICD-S-NPP/SN, 472-REF-00082) RFICD JPSS-1 S/C and SN and NEN (472-00164, 450-RFICD-JPSS-1/SN/NEN) JPSS-2/3/4 S/C and SN and NEN RF ICD (472-00330) S-NPP S-Band Data Format ICD JPSS-1 TT&C Data Format ICD (472-00161) JPSS-1 Mission Data Format ICD (472-00163) JPSS-2/3/4 TT&C Data Format ICD (472-00290) JPSS-2/3/4 Mission Data Format ICD (472-00289) JPSS Space/Ground Data Format XML Database
13, 14, 15	RFICD S-NPP S/C and SN (451-RFICD-S-NPP/SN, 472-REF-00082) RFICD JPSS-1 S/C and SN and NEN (472-00164, 450-RFICD-JPSS-1/SN/NEN) JPSS-2/3/4 S/C and SN and NEN RF ICD (472-00330) JPSS-1 TT&C Data Format ICD (472-00161) JPSS-2/3/4 TT&C Data Format ICD (472-00290)
16, 17, 18	NSOF - NASA FDF OA JPSS CGS to FDF ICD

6.3.5.3 Assumptions & Constraints

- A Specific Schedule Request supports a single change request to add, modify, or delete a TDRS access event.
- A Bulk Schedule Request support multiple change requests to add, modify, or delete TDRS access events.
- TDRS contact requests must be planned and transmitted at least 10 minutes in advance (See SNUG Section 10.2.3.7).
- TDRS command receivers do not auto-detect incoming bit rates.
- WSC Ground Hardware (STGT and WSGT) is configured through SNAS, not CGS.
- SN service status is shown through the SNAS interface.
- TDRS S-band Single Access (SSA) and Ka-band Single Access (KaSA) service links will be scheduled.
- TDRS contacts are used for Commanding, Real-Time Telemetry, Stored Mission Data (SMD) for JPSS-1/2/3/4, and providing orbital tracking data to FDF during contingency scenarios.
- Using the orbital tracking data, FDF produces JPSS acquisition data during LEO and contingencies; and provides it to WSC.
- CGS can accept replayed RT-TLM from WSC Ground Hardware. This replay is scheduled via SNAS.
- CGS can accept replayed RT-TLM and SMD (including S-TLM) from CGS equipment at WSC. This replay is performed using the SLE Offline Service and is not scheduled via SNAS.

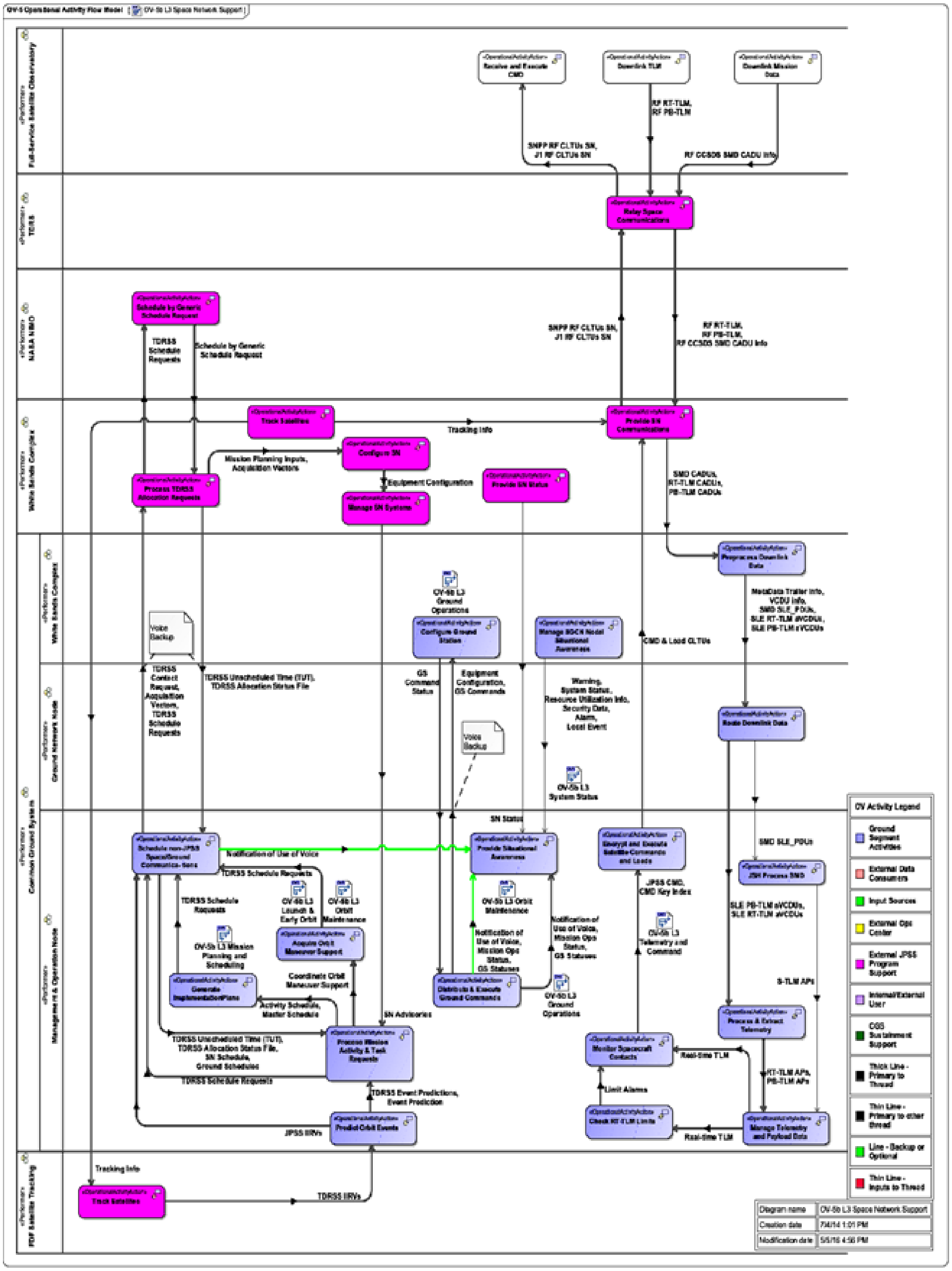
- JPSS-1 spacecraft requires ground-calculated TDRS pointing vector for each SMD contact.
- JPSS-2/3/4 spacecraft requires TDRS ephemerides to calculate TDRS pointing vector for SMD contacts, used during contingencies.
- JPSS SN service request for SMD operations is given #3 priority in the SN scheduling system, after manned-flights and the MMS mission.
- SN service scheduling follows the SN Event Schedule Process as defined in SNUG and occurs on weekly basis.

6.3.5.4 Pre-Conditions

- The JPSS Mission Planner has determined the need for TDRS contacts (or telemetry retransmission from WSC).
- FDF has generated TDRS Orbit Vectors (IIRV).

6.3.5.5 Operational Flow

Figure 6.3.5-2 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.5-2 Space Network Support Operational Flow Diagram

6.3.5.6 Basic Flow

Table 6.3.5-3 defines the operational flow of Space Network (SN) support thread.

Table: 6.3.5-3 Space Network Support Basic Flow

No.	Actors	Actions	Notes
		Routine Operations for SN Support	
1	MON, WSC	The CGS Distribute Orbit Products activity provides S-NPP and JPSS-1/2/3/4 Orbit Vectors (IIRV) to SN.	Transferred via EM to SNAS- Monday - Friday. SN pulls from SNAS.
2	MON, FDF	The CGS Collect Mission Support Data activity acquires TDRS Orbit Vectors (IIRV) from FDF.	Pulled from FDF TDRS directory. FDF updates three times per week.
3	WSC, MON	The Schedule non-JPSS Space/Ground Communications activity acquires TDRSS Unscheduled Time (TUT) from SN.	TUT contains unscheduled TDRSS times between 7 to 14 days to assist user ad-hoc TDRS contact request.
4	MON	The CGS Predict Orbit Events activity predicts the orbit states of JPSS-managed and TDRS satellites for at least 21 days.	
5	MON	The CGS Predict Orbit Events activity identifies TDRS Visibility events and Zone Of Exclusion (ZOE) events using the predicted orbit states.	Under nominal conditions, this activity is performed on a weekly basis.
6	MON	The GGS Process Mission Activities & Tasks activity ingests the TDRS Visibility events and ZOE events.	
		Scheduling TDRSS - Bulk Schedule Request Note 1: Bulk scheduling is also known as Batch scheduling Note 2: Specific Schedule Request is similar to the Bulk Schedule Request but has only a single request entry.	Typically used for adding multiple TDRSS events between 14-21 days in the future. Requests for contacts less than 14 days in the future may also be submitted.
7	MON, Mission Planner (MPL)	The MPL selects predefined TDRS Access Request tasks for each JPSS-managed mission that requires TDRS contacts.	Under nominal conditions, this activity is performed on a weekly basis.
8	MON	Based on the selected TDRS Access Request tasks, the CGS Process Mission Activity & Task Requests activity generates bulk scheduling requests for SN resources on Monday of each week for the forecast week beginning 14 days from the current Monday.	Each TDRS Event request entry should consist of the following: - Spacecraft ID - Type of service - Event start and stop time - Event start time tolerance

No.	Actors	Actions	Notes
			While the event start time is determined by the optimal data latency performance; the start time tolerance is bounded by the data latency thresholds. Specifying the start time tolerance provides flexibility in SN resource scheduling and reduces manual intervention in scheduling process.
8.1	MPL	The MPL reviews the CGS-generated bulk scheduling requests and makes manual adjustment if necessary.	Check for contact separation threshold violations to ensure data latency compliance.
9	MPL, MON, WSC	Using the CGS Schedule non-JPSS Space/Ground Communications activity, MPL submits the bulk scheduling requests for SN resources on Monday of each week.	Request is submitted through SNAS. The request should be submitted before 1200Z on Monday for priority processing.
10	SN Forecast Analyst, JPSS Mission Planner	During one-week forecast scheduling period, the SN Forecast Analyst (FA) processes the JPSS bulk scheduling requests. The SN FA coordinates with the JPSS Mission Planner to de-conflict any conflict in the submitted request.	Manual de-confliction occurs when SN FA cannot schedule the requested event with start time within specified tolerance.
11	WSC, MON	The WSC Process TDRSS Allocation Requests activity sends confirmed TDRSS Forecast Schedule to CGS via SNAS on Monday, 7 days prior to the beginning of the week covered by that forecast schedule.	The release of the 7-day Forecast Schedule automatically extends the current Active Schedule from 7 to 14 days.
12	MON	The CGS Schedule non-JPSS Space/Ground Communications activity ingests the confirmed Forecast Schedule.	
		Schedule Implementation and Execution	
13	MON	The CGS Process Mission Activity & Task Requests activity generates the master schedule and mission schedules based on confirmed TDRSS schedule and other scheduling input.	For JPSS-1 Ka-band SMD transmission, the CGS OO also generates the initial pointing vector for S/C antenna to point to the

No.	Actors	Actions	Notes
			assigned TDRS at the mid-point of contact. The vector is a part of JPSS-1 antenna position command. For JPSS-2/3/4, the spacecraft generates the TDRS pointing vector based on the contact time and TDRS orbit vectors (IIRV) uploaded from ground. See S-NPP and JPSS-1/2/3/4 MDS Playback thread for more information.
14	MON	The CGS Generate Implementation Plans activity produces the Activity Schedule for generating satellite commands and Ground Contact Schedule and the Pass Plans for generating ground control commands.	See GS-NML-020, Mission Planning and Scheduling, for implementation plan generation and distribution.
15	WSC	The WSC Configure SN activity configures for acquisition of signal.	SN configuration includes ground and space assets.
16	MON	The CGS Distribute & Execute Ground Commands activity issues a series of commands to CGS equipment manager located at the WSC at the scheduled time.	See GS-NML-310 for Ground Operations
17	MON, SGCN	The CGS Configure Ground Station activity at WSC receives the ground commands and issues the ground commands to the local ground equipment to configure it for a contact.	CGS configures WSC JPSS ground assets for a WSC contact
18	SGCN	The CGS Configure Ground Station activity executes commands to change the configuration of User Local Equipment (ULE) at WSC.	
19	SGCN	The CGS Manage SGCN Nodal Situational Awareness activity generates status on WSC CGS ULE.	
20	SGCN, MON	The CGS Manage SGCN Nodal State of Health activity sends the status of WSC CGS ULE to the CGS Manage GSystem State of Health activity.	
21	WSC, SS	The WSC Provide SN Communications activity acquires signal from JPSS Spacecraft via TDRS satellite. The WSC Track Satellites activity provides tracking info to FDF.	

No.	Actors	Actions	Notes
22	TDRS, WSC, SGCN, MON	The TDRS Relay Space Communications activity transmits RT-TLM and/or SMD from JPSS Spacecraft through TDRS to WSC and commands from WSC through TDRS to JPSS Spacecraft. The WSC Provide SN Communications activity sends RT-TLM and/or SMD from WSC to CGS and receives commands from CGS to WSC.	See GS-NML-030 for Telemetry and Command operations. See GS-NML-102 for Suomi NPP and JPSS-1/2/3/4 MDS Playback operations.
23	WSC, MON	The WSC Manage SN Systems activity provides status on SN services to the CGS Manage GSystem State of Health activity.	Status on Forward and Return services is provided via SNAS.
24	MON	The CGS Distribute & Execute Ground Commands activity issues a command to de-configure the Ground Equipment to return to its original state when the contact is completed.	

6.3.5.7 Alternate Flow

CGS may manually configure JPSS assets if automatic configuration of JPSS assets at WSC is unsuccessful or fails for some reason. SN personnel and JPSS personnel coordinate via voice communications, and SN console operators assume partial or complete control of their respective systems, as required. The Satellite Controller (SATCON) will notify the OSPO Management and the Mission Planner (MP) the contact was configured manually and why it was necessary after successful contact completion.

For emergency or other unplanned situations, SN contacts may also be accomplished through ad-hoc scheduling whereby the SN contact (or event) request and subsequent CGS configuration is executed in an ad-hoc fashion. Contacts are scheduled through the SNAS system, or by telephone call to WSC; though scheduling through SNAS is the preferred method. Such request must be submitted at least 10 minutes prior to the start of contact. SN personnel and JPSS personnel coordinate via voice communications, and SN console operators assume partial or complete control of their respective systems, as required. The SATCON will notify the OSPO Engineering Lead and MP the contact was set up and configured manually and why it was necessary after successful contact completion.

6.3.5.8 Post Condition

SN contact is complete, and SN and CGS assets have been de-configured from their contact configuration.

6.3.5.9 Related Threads

Provide a list of threads that area related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-030	Telemetry and Command
GS-NML-020	Mission Planning and Scheduling
GS-NML-050	Orbit Maintenance
GS-NML-140	Mission Support Data Handling
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-MAD-120	Launch & Early Orbit

6.3.5.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-040-020	Space Network Operations
CGS-020-050	Stored Mission Data Handling
CGS-020-010	Mission Planning and Scheduling
CGS-020-020	Orbit Operations

6.3.6 Orbit Maintenance

6.3.6.1 Description

The Orbit Maintenance (GS-NML-050) provides a ground system-level end-to-end operational thread that describes satellite orbit operations. In addition, an alternate flow is included to describe the thread for collision avoidance maneuver planning and execution. The operational flows apply to all JPSS-managed satellites, including S-NPP, JPSS-1/2/3/4. The scope of this thread is limited to routine JPSS-managed satellite orbit maintenance and collision avoidance. This thread does not address launch and early orbit operations (see the Launch and Early Orbit thread, GS-MAD-130), nor does it address orbit operations required for decommissioning (see the Decommissioning thread, GS-MAD-150).

The nominal orbits of the JPSS-managed satellites have been carefully defined in order to meet a variety of xDR performance requirements. Examples of key drivers in the orbit definition include sensor revisit rates, minimization of altitude variation, and minimization of conflicts with ground receptor contact times. In addition, S-NPP and JPSS-1/2/3/4 satellites will operate in the same sun-synchronous orbit as a constellation, each maintaining its position within a given control box in the constellation. Fundamentally, maintenance of JPSS-managed satellites' orbits requires the ability to control the following orbit features:

- Orbit Altitude
- Inclination
- Frozen Orbit Conditions
- Relative Phasing among satellites
- Local Time of Ascending Node (LTAN)

- Repeat Ground Track (RGT)

Operational control of the JPSS-managed satellites and orbits is allocated to the JPSS Common Ground System (CGS). The CGS capabilities include accurately estimating the location of each satellite, propagating the orbits to some future epoch, predicting orbit constraint violations, designing delta-v maneuvers to correct the orbit parameters, commanding the satellites to perform the required maneuvers and verifying the results of the maneuvers.

Orbit maintenance requires the processing of data from a variety of sources across the JPSS ground system, as well as from sources external to the system, including:

- Spacecraft telemetry
- Geophysical data from the International Earth Rotation and Reference Systems Service (IERS)
- Space weather forecasts from the Space Environment Center (SEC)
- Ephemeris data to/from the GSFC Flight Dynamics Facility (FDF)

The CGS must also produce orbit maintenance related products to support ground system operations, internal entities as well as external entities. Internal entities include the Attitude Ground System (AGS). External entities include NASA/NOAA collision risk assessment teams and Field Terminal (FT) customers. The CGS also performs Radio Frequency Interference (RFI) analysis to support mission planning and scheduling, supplementing the analysis provided by the ground station service providers (e.g. KSAT) and providing RFI situational awareness.

It is expected that GSFC FDF will provide the Sun Lunar Planetary (SLP) Ephemeris file (updated every 5 years or as needed) to support JPSS orbit operations during normal operation. FDF can also provide ephemeris data in the form of Improved Inter-Range Vector (IIRV) and/or orbit ephemeris messages during applicable contingency situations. The CGS provides FDF with IIRVs and/or orbit ephemeris messages on as needed basis, primarily during Launch and Early Orbit or contingency operations. Reference the Launch and Early Orbit Thread for additional operations with the FDF.

The Orbit Maintenance thread works in conjunction with several other threads in the system. For example, it provides the orbit products to the Mission Planning and Scheduling thread for planning mission operations and scheduling ground contacts. When preparing and executing orbit maneuvers, it relies on the Mission Planning and Scheduling thread to build spacecraft commands; the Telemetry and Command thread to upload the command during a contact; and the Space Network Support thread to provide critical communication link during the maneuver. Orbit Maintenance provides JPSS-managed mission IIRVs to the NASA SN, propagates TDRS IIRVs, generates TDRSS access events, and calculates the TDRS Earth-Centered Earth-Fixed (ECEF) x,y,z position vectors for SN Support. The distribution of orbit products to the DR users is accomplished via the DR User Support thread.

6.3.6.2 Primary Interfaces

Figure 6.3.6-1 illustrates the actors and primary external interfaces involved in the execution of orbit maintenance. Each interface illustrated in the figure, labeled with a number, is described in

Table 6.3.6-1, along with the information about types of data, exchange method and frequency. Table 6.3.6-2 provides relevant IRDs/ICDs information.

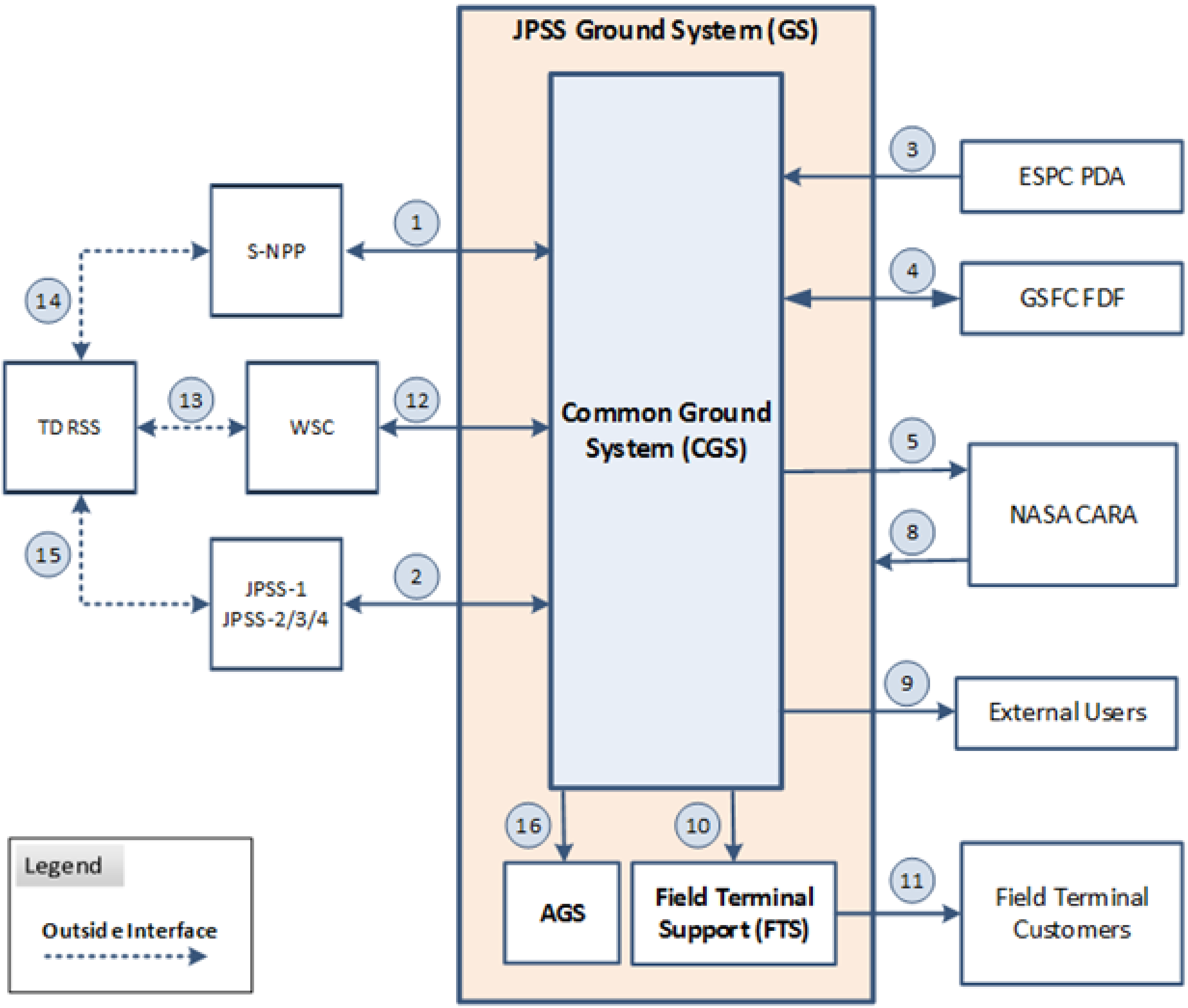


Figure: 6.3.6-1 Primary External Interfaces for Orbit Maintenance

Table: 6.3.6-1 Orbit Maintenance Primary Interfaces

No.	Type	Actors	Purpose
1	External	S-NPP, CGS	Upload CMD for orbit maneuvers Receive real-time and stored TLM for orbit determination
2	External	JPSS-1/2/3/4, CGS	Upload CMD for orbit maneuvers Receive real-time and stored TLM for orbit determination
3	External	ESPC PDA, CGS	Receive orbit support data such as geophysical data for use in the models and simulations to determine orbits, includes space weather forecast, earth orientation data, GPS Almanac, and leap second data

No.	Type	Actors	Purpose
4	External	FDF, CGS	JPSS Ephemeris data (IIRV and/or orbit ephemeris messages) and Planned Maneuver Data for contingency support, TDRS IIRVs, Sun Lunar Planetary (SLP) Ephemeris file, every few years.
5	External	NASA CARA, CGS	Ephemeris and Covariance files for each JPSS satellite supported by CARA
6	Reserved		
7	Reserved		
8	External	CGS (via NASA email system), NASA CARA	Daily CA Summary Report and (optional) High Interest Event Report
9	External	CGS, External Users	Distribute orbit data to external users
10	Internal	CGS, FTS	Distribute orbit data to FT customers through the FTS
11	External	FTS, FT Customers	Distribute orbit data to FT customers through FTS Web Portal
12	External	CGS, WSC	Relayed command and telemetry, contact schedules, JPSS IIRVs
13	Outside*	TDRSS, WSC	Relayed command and telemetry
14	Outside*	S-NPP, TDRSS	Relayed command and telemetry
15	Outside*	JPSS-1/2/3/4, TDRSS	Relayed command and telemetry
16	Internal	CGS, AGS	Definitive & predicted ephemeris, maneuver data

* Outside interface is the one between external entities and not directly connected to the JPSS Ground System. It is included for reference purpose.

TDRSS - Tracking and Data Relay Satellite System

WSC - White Sand Complex

L&EO - Launch and Early Orbit

CARA - Conjunction Assessment Risk Analysis

Table: 6.3.6-2 Orbit Maintenance Primary Interface IRDs and ICDs

No.	IRD/ICD
1	S-NPP SS-GS TT&C IRD S-NPP S-Band RF ICD to Norway GS S-NPP S-Band Data Format ICD S-NPP X-Band Data Format ICD S-NPP X-Band Data Format ICD (GSFC 429-04-02-28) S-NPP Spacecraft X-Band RF ICD to the Norway Ground Station
2	JPSS Ground Project to Flight Project IRD (474-00223) JPSS-1 TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS-1 SMD to GS RF ICD (472-00162) JPSS-1 Mission Data Format ICD (472-00163)

No.	IRD/ICD
	JPSS IRD for RF Interfaces to and from JPSS-1 (472-00173) JPSS-1 TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS IRD for RF Interfaces to and from the JPSS-2/3/4 (470-00205) JPSS-2/3/4 TT&C to GS RF ICD JPSS-2/3/4 TT&C Data Format ICD
3	JPSS CGS-NOAA ESPC ICD
4	NPP PSLA JPSS1 PSLA S-NPP NSOF-FDF OA JPSS-1 NSOF-FDF OA JPSS-2/3/4 NSOF-FDF OA JPSS CGS to NASA FDF ICD
5, 8	JPSS CGS to NASA CARA ICD
6, 7	Reserved
9	JPSS GS Services Specifications JPSS CGS Services IDD
10	JPSS CGS Services IDD
11	JPSS FTS Services IDD
12	WSC- JPSS CGS ICD SN to JPSS CGS ICD SN-NIMO NRD
13, 14,15	Out of scope for this ConOps
16	JPSS CGS to AGS ICD

6.3.6.3 Assumptions & Constraints

- The JPSS satellites and the ground system are operational.
- External orbit support data is available to the CGS via the Internet.
- Satellite stored ephemeris and attitude auxiliary data from the SMD data stream is acquired by the CGS and is available for orbit maintenance activities.
- All orbit maneuvers are performed by the stored command load as loaded on-board by command and executed by the satellites.
- Orbital constraint limits are sufficiently protected by “guard band” limits to absorb unanticipated conditions.
- Concurrent TT&C support via SN is required during orbit maneuvers.
- GSFC FDF supports launch and early operations, and anomaly resolution. FDF is the source of the TDRS IIRVs for the life of the mission.

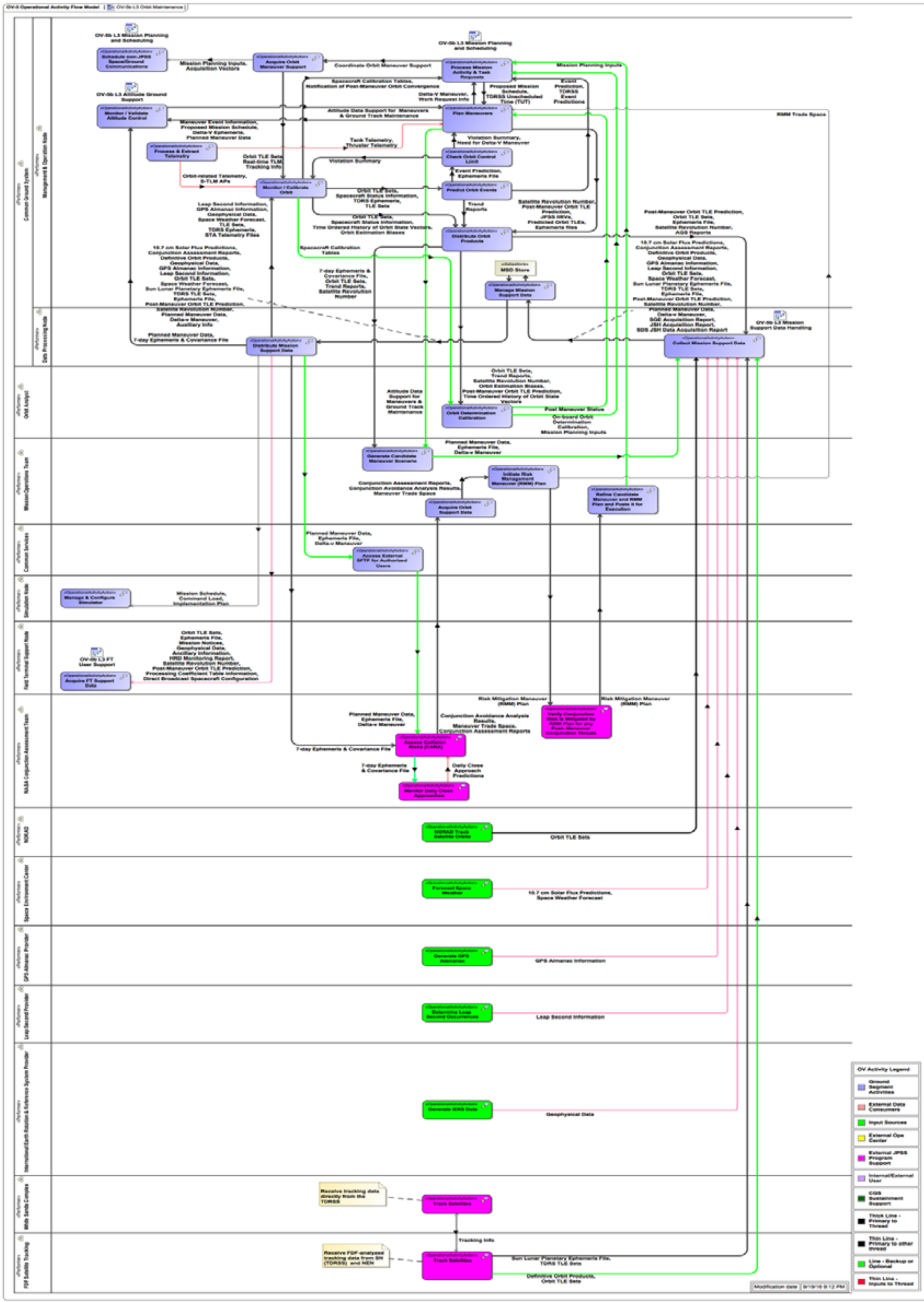
6.3.6.4 Pre-Conditions

- Initial thruster calibration burn(s) have been successfully completed during early orbit operations to calibrate the spacecraft thrusters for maneuvers.

- Initial calibration of attitude sensor(s) has been completed during early orbit operations.
- The Flight Vehicle Test Suite (FVTS) is available to facilitate the verification of the Command Load File (CLF) and required uplinks to the satellite.
- The orbit-related telemetry is received from the CGS Analyze Telemetry activity.
- The orbit support data is received from the orbit support data providers
- The CA report is available from the NASA Conjunction Assessment Risk Analysis (CARA)

6.3.6.5 Operational Flow

Figure 6.3.6-2 provides an illustration of system operations taking place in the basic flow of the thread. Orbit maintenance of the JPSS-managed satellites requires looping through four basic activities: the Monitor/Calibrate Orbit activity; the Predict Orbit Events activity; the Check Orbit Control Limits activity; and the Plan Maneuvers activity. This basic flow is applied to each satellite in the constellation.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.6-2 Orbit Maintenance Operational Flow Diagram

6.3.6.6 Basic Flow

The basic flow is described in Table 6.3.6-3 as follows.

Table: 6.3.6-3 Orbit Maintenance Basic Flow

No.	Actors	Actions	Notes
1	Management & Operations Node (MON), ESPC PDA, FDF	The CGS Distribute Mission Support Data activity routinely or when needed provides orbit support data (orbital, geophysical and space environment data) from internal and external sources as listed in the notes. Note the data from external sources is received through ESPC PDA.	IERS Data: • Earth orientation • International Celestial Reference Frame (ICRF) • International Terrestrial Reference Frame (ITRF) • General geophysical data and conventions NOAA SEC Data: • 10.7 cm solar flux predictions (short term and long term) GPS almanac data Leap second data TDRS IIRV FDF orbit products
1.1	MON, Satellites	The CGS Monitor/Calibrate Orbit activity routinely ingests satellite telemetry from the CGS Trend Flight System State of Health activity for all JPSS-managed satellites to obtain: • Satellite Ephemeris • Satellite Attitude • GPSR Navigation Solution • GPSR Navigation data, when available	See the CGS Telemetry and Command thread for more details on the Trend Flight System State of Health activity
1.2	MON	The CGS Monitor/Calibrate Orbit activity routinely ingests from ESPC PDA and EM (for DMSP) orbit TLEs of satellites that are potential sources of RFI or station visibilities constraining JPSS satellite communications.	TLEs are collected for RFI and FCDAS scheduling analysis
2	MON	The CGS Monitor/Calibrate Orbit activity determines the present orbit states and produces the definitive orbit state vectors (e.g. orbit ephemeris message, TLE sets) for each of the satellites it is operating on a daily basis (Monday - Friday, except holidays). The CGS Monitor/Calibrate Orbit activity generates orbit reports.	The daily orbit reports generally include the following: • daily definitive ephemeris and covariance • Orbit estimation divergence The definitive ephemeris is needed for ground based attitude determination and optionally, science data processing and/or FDF evaluation.

No.	Actors	Actions	Notes
3	MON	The CGS Monitor/Calibrate Orbit activity routes the definitive orbit state vectors (e.g. TLE, IIRV sets) to the CGS Predict Orbit Events activity for processing and to the CGS Distribute Orbit Products activity for distribution to the internal and external users.	Internal OO interface; external users include FCDAS
4		Reserved	
5	MON, Orbit Analyst (OA)	The CGS Orbit Determination / Calibration activity monitors the trend of Orbit Estimation divergences, which are differences between the on-board orbit determination and ground-based orbit determination. If the divergence is within a configured threshold, proceeds to Step 8. If the divergence and other checks indicate a possible faulty sensor or equipment, alert the Orbit Analyst for further investigation and anomaly resolution. Otherwise continue to Step 6 for calibration.	The JPSS spacecraft nominally relies on GPS receivers for onboard orbit determinations. No routine sensor calibration is required. However in the event of a GPS receiver failure, the GS uses other navigation sensors on board as a backup to the remaining GPS receiver. These sensors require routine calibrations. See the T&C thread for SOH and limit checking
6	MON, OA	The CGS Orbit Determination / Calibration activity generates a new set of calibration parameters/tables for on-board instruments and FSW table update. *Examples of calibration parameters/tables for S-NPP:* • *Initial Conditions Vector (ICV)* • *Orbital State Table* • *Drag Coefficients table* • *Gravity Table* • *Gravity CNM table and SNM table* • *Filter Gain Value (propagator and GPS mixer)*	The specifics of calibration depend on the on-board orbit determination implementation of each spacecraft and should be detailed in the lower level OpsCon.
7	MON, OA	The OA initiates a Mission Task Request (schedule request) for an on-board orbit determination calibration along with the new set of calibration parameters/tables for uploading.	See the CGS Mission Planning and Scheduling ConOps thread for more details.
8	MON	The CGS Predict Orbit Events activity predicts on a daily basis (Monday - Friday, except holidays), the orbit states of JPSS-managed satellites for 14 days and saves the results in ephemeris & associated covariance files. IIRVs and TLEs are produced based on the predicted ephemeris.	A 15-day ephemeris file (one day definitive and 14 days of high quality predicted ephemeris) & associated covariance file is produced for Conjunction Assessment and delivered to CARA by 12 Noon ET.

No.	Actors	Actions	Notes
		The CGS Predict Orbit Events activity passes the predicted ephemeris, Satellite Rev Number, IIRVs, and TLEs to the Distribute Orbit Products activity for distribution.	IIRVs and TLEs for JPSS-managed missions are generated from the predicted ephemeris and distributed. Note: TLEs for several days may be generated but distributed as scheduled.
8.1	MON	The CGS Predict Orbit Events activity propagates the orbit state of JPSS-managed satellite for 90 days and saves the results in an ephemeris file. Under nominal conditions, this propagation is performed on a weekly basis.	90-day propagation is based on S-NPP OTR and is mainly used for station-keeping analysis. NOTE: Prediction of per-orbit opportunities for communication and orbit events for up to 120 days may be required to support planning of special events, including LEO and DEC.
8.2	MON	The CGS Predict Orbit Events activity propagates the orbit state of JPSS-supported satellites, TDRS spacecraft, and other satellites of potential RFI sources or station scheduling conflicts for 40 days and saves the results in an ephemeris file. Under nominal conditions, this propagation is performed on a weekly basis.	40-day propagation is mainly to support the determination of per-orbit opportunities for communication with JPSS-managed satellites.
9	MON	The CGS Predict Orbit Events activity identifies future events based on the propagation. Examples of events to be determined includes the following: • Delta-v maneuver (non)opportunity times • solar eclipse times (including lunar induced eclipses) • day/night terminator crossings • apogee, perigee, and nodal events • South Atlantic Anomaly (SAA) entry and exit times • TDRS contact opportunity times and Zone Of Exclusion (ZOE) events • TDRS ECEF-value events • Primary T&C contact opportunities • Primary SMD contact opportunities Under nominal conditions, this activity is performed on a weekly basis.	Predicting important celestial and terrestrial events related to the predicted orbit and orientation of the JPSS-managed satellites. Important events to consider are communication and delta-v opportunities. The ZOE events are used in SN bulk schedule request generation. They should be based on a user-defined minimum threshold.
9.1	MON	The CGS Predict Orbit Events activity calculates the potential RFI conjunctions and generates the orbital events for predicted RFI conjunctions.	The RFI conjunction is determined based on the predicted TLEs and RF

No.	Actors	Actions	Notes
			characteristics of these satellites.
9.2	MON	The CGS Predict Orbit Events activity calculates Station Visibilities for FCDAS 13 meter supported missions. This is used to generate the orbital events for JPSS-managed mission visibilities which are minimally in conflict as determined using a user provided threshold value of maximum conjunctions during a visibility.	These events facilitate scheduling of station contacts at FCDAS which do not conflict with missions of higher priority.
10	MON	The CGS Predict Orbit Events activity analyzes the propagation data and produces trending data. The CGS Predict Orbit Events activity passes the long-term propagation ephemeris file, event prediction and trending reports to the Distribute Orbit Products activity for distribution. The CGS Predict Orbit Events activity passes the long-term propagation ephemeris file and event prediction report to the CGS Check Orbit Control Limit activity for processing.	The trending reports cover the past as well as the future The Mission Planning and Scheduling will use the predicted events in the pass planning and contact scheduling. Orbital trending analysis should include: - Trend On-orbit Orbit Determination error - Trend orbit state vectors - Trend Repeat Ground Track (RGT) - Event Prediction
11	MON	The CGS Check Orbit Control Limit activity compares the data in the ephemeris file the ideal orbit to determine if any action is necessary to correct the orbits of JPSS-managed satellites to avoid impending orbit requirement violations.	The following orbit control limits and constraints are considered key drivers: • RGT • LTAN • Altitude • Inclination • Frozen Orbit Condition • Satellite Phasing • Seasonal maneuver • opportunity constraints
12	MON	The CGS Check Orbit Control Limit activity generates the orbit control limits/constraint list with predicted times to next limit/constraint violation (90-day look ahead). If a delta-v maneuver is not needed in the next 30 days to avoid violating any orbit requirements, then the orbit control limit checks **pass**	The key purpose of the Check Orbit Control Limits flow is to determine the need for intervention in the form of a delta-v orbit correction. If review of the results reveals no need for intervention at this time, then the system can

No.	Actors	Actions	Notes
		evaluation - Return to Step 2, Monitor/Calibrate Orbit activity. Else a delta-v maneuver is required in the next 30 days to avoid violating any orbit requirements, then the checks **fail** - continue to the next step to invoke the CGS Plan Maneuvers activity.	wait for some period of time before returning to Step 2, Monitor/Calibrate Orbit. Under nominal conditions, if no delta-v orbit corrections are required within 30 days, then the orbit control limit check cycle only need be repeated at the basic monitoring interval of once per week. If a delta-v orbit correction is required in less than one week, then the basic flow needs to be repeated with increasing frequency.
13	MON, MOT	At T-30 days, the CGS Plan Maneuvers activity, under supervision of Orbit Analyst, calculates delta-v maneuver parameters for the planned maneuver. The parameters include, as a minimum: • delta-v burn vector • delta-v burn attitude quaternion • start time of rotation to burn attitude • delta-v burn start time • estimated thrust levels for each thruster • satellite mass • maximum burn duration • Predicted post maneuver TLE sets The delta-v maneuver parameters are used to model the maneuver and predict spacecraft ephemeris. The maneuver planning should ensure adequate TDRS coverage, avoid solar exclusion zone, and include contingency planning (e.g. abort criteria and procedures).	This and following steps are needed for station keeping, attitude control, instrument Cal/Val, and collision avoidance. Multiple maneuvers need to be planned for each orbital adjustment required. The additional maneuvers will serve as backup if the primary maneuver is not able to be executed due to Space Weather conditions, unfavorable Collision probabilities, or spacecraft conditions.
14	MON, MOT	At T-30 days, MOT submits a task request for orbit maneuver along with the maneuver parameters to the CGS Process Mission Activities and Task Requests activity to schedule necessary resources. The Mission Planner generates the Special Mission Task (SMT) based on the maneuver plan. The SMT should include any activities necessary to reconfigure the payload or spacecraft subsystems as required prior to the maneuver;	The CGS Process Mission Activities and Task Requests activity will notify stakeholders about the planned maneuver.

No.	Actors	Actions	Notes
		and the activities to restore payloads and spacecraft subsystems to pre-maneuver states following the maneuver. The SMT should include activities necessary to change on-board Attitude Control System (ACS) pointing mode to the coarse point mode prior to the maneuver and to the fine point mode after the maneuver. The SMT should include commands to set up S-band communication with TDRSS prior to the maneuver and to restore the ground contact setup following the maneuver.	
14.1	MON SN	The CGS Acquires Orbit Maneuver Support activity schedules SN support for TT&C operations during the maneuver at T-21 days	Specific schedule request(s) are submitted to NASA SN as early as 21-days out.
15	MOT	At T-14 days, the MOT should hold a meeting to coordinate the maneuver through a maneuver plan.	
16	MON, MOT, FVTS, AGS	At T-13 days, MOT validates and updates the maneuver plan by running it against the FVTS under the CGS Manage & Configure Simulators activity. The AGS Monitor/Validate Attitude Control activity models the attitude maneuvers, assess attitude performance, and evaluates possible sensor interferences during the maneuver period. This step may be repeated till T-1 day to ensure the accuracy of maneuver plan.	See the MPS thread for more details on command load generation and validation. Time is a critical element of the delta-v maneuver planning cycle because the precision of knowledge about the satellite location decays rather quickly after an orbit determination.
16.1	MON, MOT, CARA	At T-7 days, the Orbit Analyst verifies the planned maneuver with the NASA CARA for conjunction assessment. If the assessment indicates the maneuver plan is unsafe, recalculate the maneuver parameters under CARA's guidance under the CGS Assess Collision Risks (CARA) activity This step may be repeated till T-0 day to ensure the safety of the maneuver plan.	See Alternate Flow for additional details.
17	MOT	At T-1 day, the Command Authorization Meeting (CAM) is held by MOT to: • Review the maneuver at a full system level • Identify key contingency activities • Ensure proper product set generated/verified • Ensure adequate staffing to support the maneuver	

No.	Actors	Actions	Notes
		• Brief Management on team's readiness to perform the maneuver and receive management approval	
17a	MON, AGS, CARA, FDF	The CGS Distribute Orbit Products activity distributes the predicted ephemeris (burn modeled and NO-BURN) and /or planned maneuver data to internal and external users.	
18	MON, Satellite, TDRSS	During the scheduled T&C contact, the CGS Execute Spacecraft Commands and Loads activity will upload the delta-v maneuver CLF to the spacecraft. Prior to the scheduled maneuver time, the CGS establishes the communication link with the satellite through TDRSS, receiving real-time telemetry and tracking information.	See the Telemetry and Command thread for more details on command uplink and verification
19	Satellite, TDRSS, MON, MOT, AGS	At the scheduled time, the satellite executes the delta-v CLF to perform the planned maneuver. The MOT monitors the progress of maneuver through real-time telemetry; and takes corrective actions if the abort criteria are met. Attitude system performance is monitored using RTADS supporting the AGS Monitor / Validate Attitude Control activity.	RTADS utilized to monitor spacecraft attitude in near real-time.
20	MON, CGS	After each maneuver, the CGS Monitor/Calibrate Orbit activity checks if the orbit correction was achieved as planned and determines if an emergency follow-up maneuver is required.	Uses OO Maneuver Reconstitution Job
21	MON	After each maneuver, the CGS Plan Maneuver activity collects the Spacecraft Propulsion System Telemetry, including: • Tank Temperature • Tank Pressure • Thruster Firing History • Thruster Temperature Profile Based on these data, the CGS Plan Maneuver activity calibrates the delta-v maneuvers by characterizing the thruster performance and updating delta-v calculation model as well as the satellite model for future burn planning.	Some performance data from a delta-v characterization are: • Estimated thrust levels • Estimated thrust repeatability • Estimated center of mass coordinates Some satellite model data are: • Fuel remaining • Total satellite mass • Estimated center of mass coordinates • Thrust levels, directions, and repeatability
21a	MON	The CGS Monitor/Calibrate Orbit activity calculates definitive post-maneuver orbit TLEs based on GPS readings in the telemetry; and passes it to the CGS Distribute Orbit Products activity.	

No.	Actors	Actions	Notes
		The CGS Distribute Orbit Products activity distributes the definitive post-maneuver orbit TLE to internal and external users	
22	MOT	MOT compares the definitive post-maneuver TLE with the predicted post-maneuver TLE and determines if the required orbit correction has been achieved. If yes, continue onto Step 24. If not, go back to Step 13 to plan for another maneuver.	Uses OO Maneuver Reconstitution Job
23	Cal/Val Node	After a successful maneuver, the Cal/Val of Data Products activities may perform a delta Cal/Val based on the new satellite position.	See the Cal/Val of Data Products thread for details on delta Cal/Val.

6.3.6.7 Alternate Flow - Collision Avoidance Maneuvers

This alternate thread depicts the steps required to perform Collision Avoidance (CA) operations for the JPSS missions. In the JPSS program, mission operations of JPSS-managed satellites such as S-NPP and JPSS-1/2/3/4 will evolve in two stages. During launch, commissioning and check-out, the mission operations are under NASA/JPSS control. After the satellite is determined to be fully operational, the control of mission operations will be transferred to NOAA's Office of Satellite and Product Operations (OSPO). At the direction of NOAA JPSS Office, the collision avoidance operations will use GSFC Space Systems Protection Mission Support Office Conjunction Assessment Risk Analysis (CARA).

Operational collision risk assessment is performed for the JPSS satellite by CARA during their lifetime. With support from JSpOC, the CARA team generates the daily close approach predictions and performs probabilistic risk assessment analysis. CARA qualifies the collision risk and ensures that the tracking data collection levels are sufficient. During high-risk events, the JPSS MOT works with CARA to develop a Risk Mitigation Maneuver (RMM) plan. Once the maneuver plan is complete, the CARA Team evaluates this maneuver plan to ensure no other post-maneuver conjunction events pose a collision threat.

While this section describes nominal collision risk assessment operations, it should be noted that due to the nature of the Launch and Early Orbit mission phase, off-nominal CARA support is often needed. This is because the anticipated maneuver frequency often requires a quicker turnaround on the ephemeris screening and analysis than the nominal process provides. Additionally, these screenings may require support outside of nominal staffing hours. CARA will request a tentative schedule at least two (2) weeks prior to launch with updates as launch approaches or slips. Possible responses to high risk events that occur prior to the propulsion system activation need thought and coordination.

6.3.6.7.1 Assumptions & Constraints

The CARA Team, with support from JSpOC, is responsible for generating daily close approach predictions for the JPSS satellite.

6.3.6.7.2 Operational Flow

The CA operational flow, which is repeated for each mission, is detailed in Table 6.3.6-4.

Trigger: No specific trigger. On-going operations.

Table: 6.3.6-4 Collision Avoidance Operational Flow

No.	Actors	Activities	Notes
1	MON, CARA	The CGS Distribute MSD activity delivers the CA products (predicted ephemerides, covariance, and planned maneuver data) autonomously to CARA daily.	Routine delivery of ephemeris products.
2	CARA	The CARA Assess Collision Risks activity identifies close conjunctions between the JPSS satellite and other orbiting objects in the USSTRATCOM Space Objects Catalog, based on comparisons of the ephemerides of objects contained in the catalog with the JPSS satellite ephemeris. The close approach screening results include predicted time of closest approach and miss distance, along with other quantitative characteristics for the close encounter for further, in-depth analysis to quantify the risks.	CARA staff located at JSpOC will use the CA products and JSpOC data for screening analysis
3	CARA	The CARA Assess Collision Risks activity processes close approach screening results and archive the data and analysis reports. For each predicted event, the CARA team determines the nature of the threat (i.e., the risk of collision) posed to the JPSS satellite, including the probability of collision and other relevant geometrical factors intrinsic to the close conjunction.	
4		Reserved	
5		Reserved	
6	CARA, MOT, NASA Institution al email Service	CARA delivers the CA Summary Report and CA analysis results to the JPSS MOT via NASA institutional email service.	CARA notifies MOT by phone, if necessary, when a High Interest Event Report is issued to ensure a timely response.
7	MOT, CARA	When the risk of collision exceeds a pre-defined threshold as evaluated by the MOT Initiate Risk Management Maneuver Plan activity, MOT works with the CARA Team to determine and plan Risk Mitigation Maneuvers (RMM), if required.	CARA will assess the conjunction risk, and advise MOT in the RMM planning process.
8	CARA,M OT	The CARA Assess Collision Risks activity provides MOT a trade space of maneuver magnitudes and times that will reduce the risk of collision.	Data contained in High Interest Event Report
9	MOT, CARA	MOT performs detailed RMM planning based on the trade space, mission schedule, and mission orbit constraints under the Generate Candidate Maneuver Scenario activity.	The maneuvers should keep the satellite within its normal operational range, and ideally take the place

No.	Actors	Activities	Notes
			of a normal station-keeping maneuver.
9.1	MON, OA, Mission Planner (MP)	Under the CGS Plan Maneuvers activity, the OA initiates a Mission task request for the maneuver. The OA and MP utilize mission schedules and trade space information to identify opportunities for execution of orbit maneuvers. The Mission Planner provides proposed mission schedule information.	
9.2	OA, MON	The CGS Plan Maneuvers activity, under the direction of the OA, performs detailed orbit maneuver planning based on mission orbit constraints, candidate orbit maneuver times, and the CARA-provided trade space.	MOT-developed Optimized RMM Planning Tool may be used to assist RMM planning.
9.3	MOT, CARA	MOT provides the candidate RMMs to only CARA via manual SFTP under the CGS Push Data by SFTP to External Users activity for validation in the form of orbit ephemeris messages and supporting planned maneuver reports. Distribution of this data is restricted to CARA.	The maneuvers should keep the satellite within its normal operational range, and ideally take the place of a normal station-keeping maneuver.
10	CARA, MOT	The CARA Assess Collision Risks activity verifies that the conjunction risk has been mitigated by the planned RMMs. If the planned RMMs are not verified by CARA, perform Steps 1 - 9 until a proposed Delta-v maneuver is successful. MOT selects the optimal RMM from the verified list for execution.	
10.1	CARA, MOT, NASA Institutional eMail Service	The CARA Assess Collision Risks activity delivers the CA Summary Report and Maneuver Conjunction Avoidance Analysis Results to the JPSS MOT	CARA notifies MOT by phone, if necessary, when a High Interest Event Report is issued to ensure a timely response.
10.2	CGS, OA	The Refine RMM Plan & Post for Execution activity under the direction of the OA, releases the RMM Plan products and generates Mission Notices. The CGS Distribute MSD activity delivers the Delta-v ephemeris, Planned Maneuver Data, and NO-BURN ephemeris to internal and external users. The OA generates Mission Notices supporting the RMM Plan.	CARA notifies MOT by phone, if necessary, when a High Interest Event Report is issued to ensure a timely response.

No.	Actors	Activities	Notes
11	MOT, MON	MOT executes the selected maneuver to mitigate the collision risk as described in Steps 13-23 of the Basic Flow at an accelerated pace (within 3-7 days vs. 30 days).	

6.3.6.8 Post Condition

The orbits of JPSS-managed satellites are within the desired ranges and free of collision threats. All orbit parameters, thruster calibration data, and satellite models are updated. The TLE sets are periodically updated and distributed.

6.3.6.9 Related Threads

The following list provides the related JPSS Ground System threads that contain helpful information for understanding how specific steps in this thread function or related to other threads.

Thread ID	Thread Title
GS-NML-150	Cal/Val of Data Products
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-060	Attitude Ground Support
GS-NML-140	Mission Support Data Handling
GS-NNL-150	Space Network Support
GS-MAD-130	Launch and Early Orbit
GS-MAD-150	Decommissioning
GS-FTS-110	Field Terminal User Support

6.3.6.10 Child Threads

The following list provides the child threads that are traced to this system thread.

Thread ID	Thread Title
CGS-020-020	Orbit Operations

6.3.7 Attitude Ground Support

6.3.7.1 Description

The Attitude Ground Support (GS-NML-060) thread provides a high level description of Ground System operations for monitoring and maintaining the performance of JPSS satellite's onboard attitude determination and control systems during the mission's operational phase. This operational flow applies to the JPSS-managed satellites such as Suomi NPP (S-NPP) and JPSS-1/2/3/4.

A highly accurate and consistent control of satellite's attitude is essential for mission success. S-NPP, JPSS-1/2/3/4 satellites employ an Attitude Determination and Control Subsystem (ADCS) in conjunction with the flight software subsystem for determining and controlling the satellite attitude and providing attitude and ephemeris information for inclusion in the mission data

stream for science data processing. The ADCS is a three-axis stabilized system using Reaction Wheels as the primary control actuators and star trackers, Inertial Reference Units (IRUs) and GPS Receivers as primary sensors. The system also uses Coarse Sun Sensors (CSS) and Three-Axis Magnetometers (TAM) to complement the primary sensors and provide data in fault/safe mode, and magnetic torque rods for momentum management.

To monitor and maintain the performance of ADCS, the Ground System performs Ground-Based Attitude Determination (GBAD) and calibration of attitude sensors. For each JPSS-managed satellite, GBAD is performed routinely. The onboard attitude sensor calibration is performed during the early orbit operations as well as when needed during the nominal satellite operations.

The GBAD results in a high precision satellite attitude that can be used as a reference with which to calibrate and assess the health and performance of the satellite's ADCS. It is achieved by processing longer durations of attitude sensor data than the satellite's onboard attitude determination system by taking advantage of a more diverse set of processing algorithms and estimators.

Prior to launch, Spacecraft Manufacturer Support (SMS) performs ground-based calibration of the attitude sensors. These calibration values are documented, loaded to the spacecraft flight software, tested and utilized in-flight. These same values are available from the CGS archive and installed in the Ground System for telemetry & GBAD processing. Reference the Launch Readiness thread (GS-MAD-110) for additional details related to Pre-Launch activities applicable to Attitude Ground Support.

During the early orbit operations, calibration and initialization of onboard attitude determination sensors is performed (see the Launch & Early Orbit thread, GS-MAD-120) using CSS, TAM, start trackers, and gyro measurements to determine the spacecraft attitude. The computed attitude is distributed for use in operations.

Once the initial in-flight calibrations of the attitude sensors are complete, the Ground System and spacecraft flight software values are updated, if necessary (See Flight S/W Update thread, GS-NML-070). Monitor of the performance of the onboard attitude determination system continues by performing GBAD on a routine basis and trending the errors between the onboard and ground attitude solutions over time. Key attitude parameter statistics trended include:

- Attitude comparison statistics
- Roll, pitch, yaw ground attitude solution statistics
- Ground-determined gyro biases
- Sensor residual statistics

Initially, GBAD will be performed on at least a weekly basis. As the MOT gains confidence in the satellite's performance, they have the discretion to decrease the monitoring frequency. In the event that attitude error growth threatens to degrade the performance of the onboard attitude determination and control beyond the specified limits, recalibration of the attitude sensors will be performed.

Additionally, attitude control maneuvers will be performed over the life of all JPSS-managed missions. It is the responsibility of AGS to provide support for the execution of these

maneuvers, including planning and monitor of their execution. The Planning Maneuvers alternate flow of this thread describes the process.

The Attitude Ground Support is functionally allocated to the Ground System (GS). This functionality is provided by the *Attitude Ground System Team (AGST)* through NASA Code 591. The AGST provides software and analytical support. Prior to launch of a supported mission, the AGST configures instances of the *Multi-mission Three-Axis Stabilized Spacecraft (MTASS) system/software*, supports its integration & test, and provides analytical support during the Launch and Early Orbit phase. The Attitude Ground System (AGS) uses the MTASS software to provide both the real time and offline ground-based verification of the on-board ADCS and other analysis applications. AGS consists of the Real-Time Attitude Determination System (RTADS) and the offline Attitude Determination System (ADS). During normal operations, AGST provides analytical expertise as well as MTASS software maintenance. This includes the periodic update of AGS (MTASS) Software, Attitude Configuration Data, and Attitude Support Files. Analytical support is also provided during the Decommissioning Phase. The Mission Operations Team's (MOT) Attitude Analyst has the primary responsibility for routine Attitude Ground Support operations. AGST will provide support for attitude calibration, validation and anomaly support during normal operations. Analytical and anomaly support can also be provided by the SMS. This interface also provides alignment & calibration information used in the pre-launch configuration of the AGS. Post-launch update of the calibration values is supported by both the AGST and SMS. Routine Attitude Ground Support operations are off-line functions. Real-time AGS operations are performed on an 'as needed' basis, primarily supporting contingency and maneuver operations.

There are other operational threads that take place in parallel with the Attitude Ground Support. The Orbit Maintenance thread provides information on orbit determination and maintenance. The Telemetry and Command thread describes receiving telemetry from and uplink spacecraft commands to the satellite. The Flight Software Upgrade thread explains how the calibration tables are updated. Mission Support Data Handling thread provides information on attitude data distribution.

6.3.7.2 Primary Interfaces

Figure 6.3.7-1 illustrates AGST as a primary external interface involved in the execution of Attitude Ground Support. Note that while onboard attitude data is returned through telemetry and attitude sensor calibration tables are uploaded through commands, those interfaces are covered in the Telemetry and Command thread.

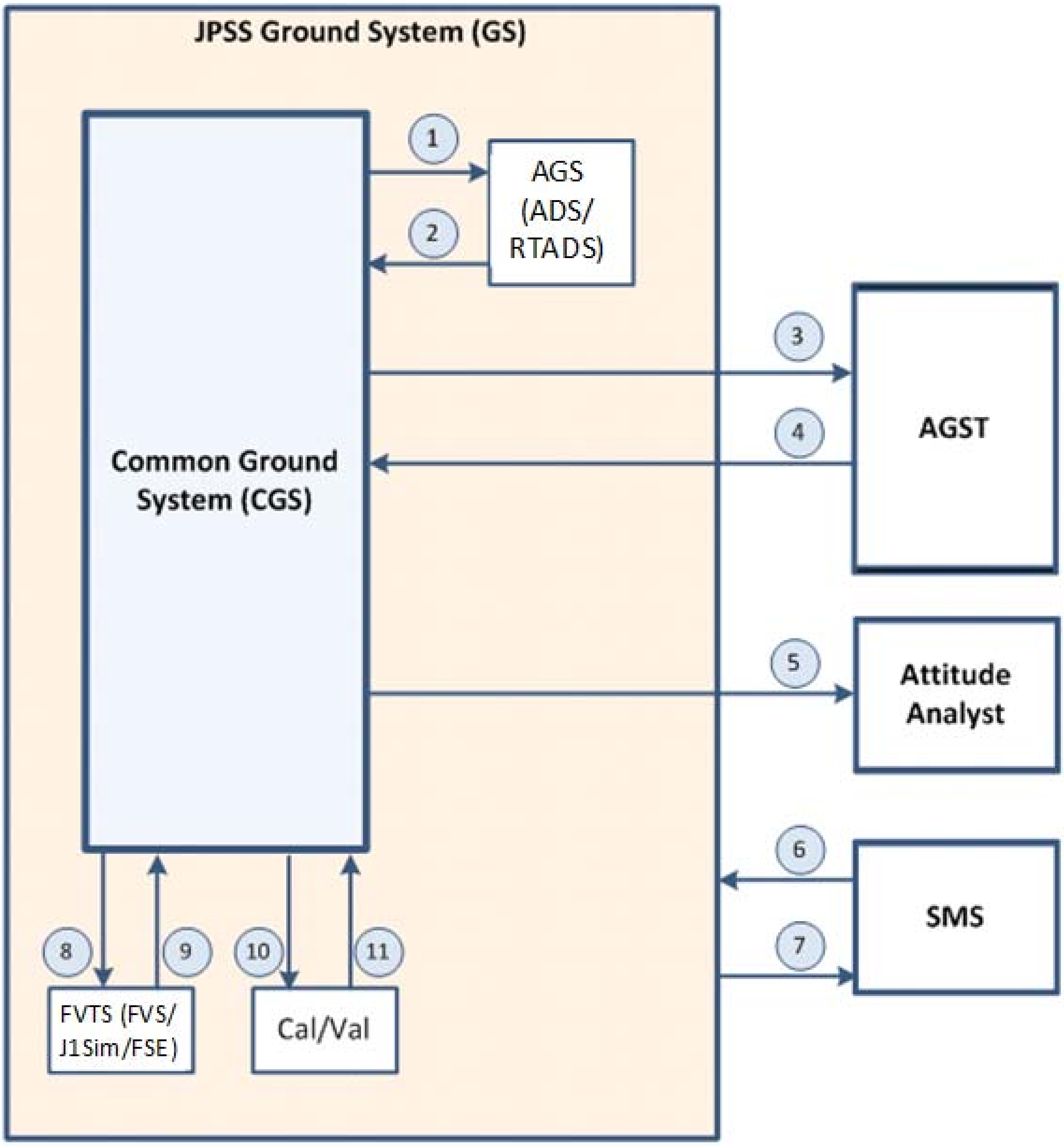


Figure: 6.3.7-1 Primary Interfaces for Attitude Ground Support

Table: 6.3.7-1 Attitude Ground Support Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	CGS > AGS	Predicted & Definitive Ephemeris data, Attitude TLM streams & datasets, Maneuver Plans, AGS Software, Attitude Configuration Data, Attitude Support Files
2	Internal	CGS < AGS	Alarms, Warnings, Events, State of Health, Attitude Reports
3	External	CGS > AGST	Attitude Configuration Data

No.	Type	Actors	Purpose
4	External	AGST > CGS	AGS Software, Attitude Configuration Data, Attitude Support Files
5	External	CGS > Attitude Analyst	Maneuver Planning Data, Mission Notices
6	External	SMS > GS	Reports, Spacecraft Tables, Anomaly Support Data
7	External	GS < SMS	VCDUs for TLM, Flight Software Change Request, Satellite Reports, Calibration Information
8	Internal	CGS > FVTS	Simulation files
9	Internal	CGS < FVTS	Results of simulation execution
10	Internal	CGS > Cal/Val	Mission Schedules, Mission Notices, selected Attitude Reports
11	Internal	CGS < Cal/Val	Coordination of maneuver settle time and attitude calibration activities

Table: 6.3.7-2 Attitude Ground Support Interface Documentation

No.	IRD/ICD
1, 2, 3, 4, 5	JPSS CGS to AGS IRD
6, 7	JPSS-1 Spacecraft Statement of Work JPSS-2 Spacecraft Statement of Work
8, 9	JPSS CGS to FVTS IRD
10, 11	JPSS CGS to GRAVITE IRD

6.3.7.3 Assumptions & Constraints

Suomi NPP and JPSS-1/2/3/4 spacecraft provide the following input to the Ground System for Attitude determination and sensor calibration:

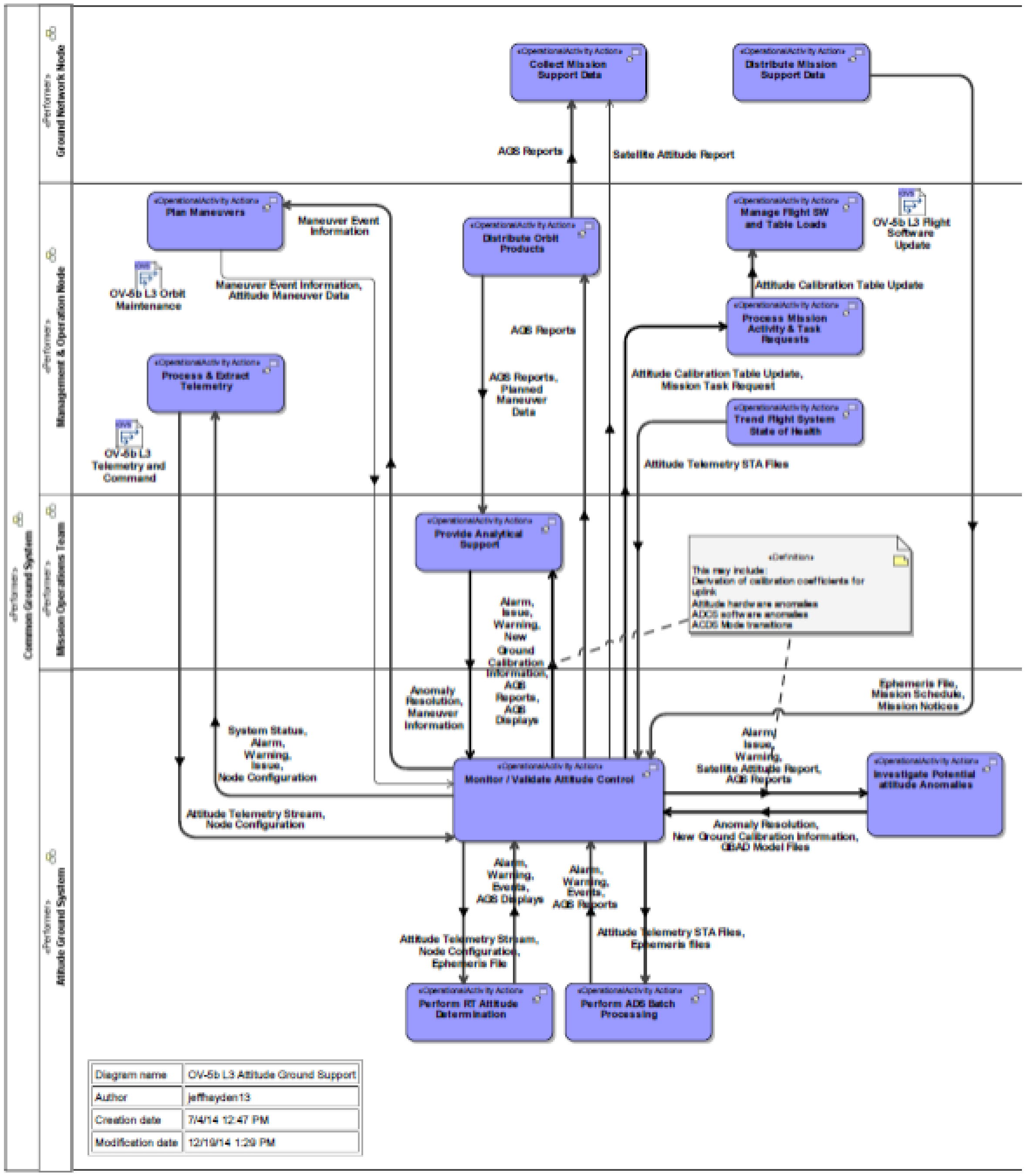
- Onboard-computed Kalman Filter quaternion solution
- Special attitude sensor time-tagging mnemonics
- Unprocessed (raw) Attitude Sensor counts
- Attitude Actuator measurements
- Onboard-computed sensor measurements

6.3.7.4 Pre-Conditions

- Receive telemetry with attitude hardware and ADCS data from the satellite.
- Receiving Attitude Telemetry streams in near-real-time to support real-time attitude determination (RTADS) and/or offline attitude determination (ADS).
- Received Attitude Telemetry datasets to support offline attitude determination utilizing ADS.
- Receive Definitive (and/or Predicted) Ephemeris from the Ground Network Node.

6.3.7.5 Operational Flow

Figure 6.3.7-2 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.7-2 Attitude Ground Support Operational Flow Diagram

6.3.7.6 Basic Flow

Table 6.3.7-3 defines the operational flow of Attitude Ground Support. The basic flow is supported by the autonomous periodic execution of the off-line ADS.

Table: 6.3.7-3 Attitude Ground Support Basic Flow

No.	Actors	Actions	Notes
1	CGS, ADS	The CGS Trend Flight System State of Health activity produces attitude TLM datasets. The datasets are delivered to ADS in response to a generic schedule specified by OSPO Sustainment documentation or upon analyst request. The CGS Distribute Orbit Products activity delivers predicted ephemeris (optionally definitive ephemeris) to AGS via the NAS. The AGS Monitor/Validate Attitude Control activity autonomously ingests attitude telemetry and ephemeris datasets.	See Telemetry & Command (T&C) thread for more details. Note AGS archived attitude TLM stream data may also be used, however, longer spans of continuous data provide for a more thorough assessment of the ADCS.
2	ADS	The AGS Monitor/Validate Attitude Control activity calculates satellite's attitude.	
3	ADS	The AGS Monitor/Validate Attitude Control activity compares the computed satellite attitude with the attitude parameters determined onboard. If the attitude deviation between ground-based and onboard determinations within pre-set thresholds, continue to Step 4. If the divergence and other checks indicate a possible attitude anomaly, alert the Attitude Analyst through AWE messages for further investigation and anomaly resolution, reference Alternate Flow. The Attitude Analyst may request additional support from AGST. Continue to Step 4 to continue the flow.	
4	ADS	The AGS Monitor/Validate Attitude Control activity trends satellite's attitude and derived parameters over time and periodically sends the Attitude Trend Report to the CGS Distribute Orbit Products activity for distribution to internal and external users. Generation of the Attitude Trend Report requires manual intervention to create the report. Trend data collected during each execution of the ADS is written to the AGS trend data file.	
5	ADS, CGS	The AGS Monitor/Validate Attitude Control activity generates the Attitude Validation Report and sends it to the CGS Distribute Orbit Products activity for distribution to the internal and external users.	See Mission Support Data Handling (MSD) thread for more details.

No.	Actors	Actions	Notes
		Return to Step 1 for monitoring.	
6	CGS, OA, AGST	The CGS Distribute Mission Support Data activity makes the AGS reports available for off-line analysis. Mission Notices also provided by this activity to support analysis of the reports.	

6.3.7.7 Alternate Flow

This section describes three alternate flows for the Investigation of Attitude Anomalies, Planning Maneuvers, and Monitor/Validate Attitude Control in Real-time.

Table 6.3.7-4 defines the flow of Attitude Ground Support - Investigate Potential Attitude Anomalies.

Table: 6.3.7-4 Attitude Ground Support Alternate Flow - Investigate Possible Attitude Anomalies

No.	Actors	Actions	Notes
1	Attitude Analyst, AGST, AGS	The MOT Investigate Potential Attitude Anomalies activity reviews Alarms, Warnings, Issues and attitude reports by the AGS.	AGST may be notified by the Attitude Analyst of a potential anomaly.
2	Attitude Analyst	The MOT Investigate Potential Attitude Anomalies activity determines attitude telemetry dataset spans for evaluation by the ADS.	Time spans for Ad Hoc Attitude STA Telemetry files.
2a	CGS	The CGS Trend Flight System State of Health activity produces attitude TLM datasets. The datasets are delivered to ADS in response to an AdHoc Request for STA Telemetry data.	See Telemetry & Command (T&C) thread for more details
2b	CGS	The CGS Distribute Orbit Products activity makes ephemeris data available to ADS. Predicted ephemeris is routinely available. Definitive ephemeris for the timespan may be produced upon request, if needed.	
3	AGS, CGS	The AGS Investigate Potential Attitude Anomalies activity ingests attitude telemetry and ephemeris information activity.	
4	Attitude Analyst, ADS	The AGS Investigate Potential Attitude Anomalies activity evaluates attitude data and analyzes system performance. If the analysis indicates any of the following possible needs: Uplink new calibration parameters, continue to Step 5 Resolve Attitude hardware anomalies, continue to Step 9 Support ADCS software anomaly investigation, continue to Step 14	

No.	Actors	Actions	Notes
		Evaluate performance while in non-nominal ADCS modes & their transitions, continue to Step 19. Otherwise, continue to Step 21.	
5	ADS	The AGS Investigate Potential Attitude Anomalies activity generates a new set of calibration parameters/tables for onboard sensors and flight software upgrade.	The attitude deviation between ground-based and onboard determinations exceeds pre-set thresholds
6	ADS, CGS	The ADS Investigate Potential Attitude Anomalies activity generates applicable attitude sensor Calibration Reports and sends them to the CGS Collect Mission Support Data activity for distribution to internal and external users.	
7	CGS, MOT	The attitude calibration tables are uploaded to the satellite.	See Flight Software Upgrade (FSU) thread for more details
7a	CGS, Attitude Analyst	The Attitude Analyst initiates a Mission Task Request (schedule request) for uplink of the new set of calibration parameters/tables to the CGS Process Mission Activity and Task Requests activity.	See the CGS Mission Planning and Scheduling ConOps thread for more details.
7b	CGS, Attitude Analyst	The CGS Manage Flight SW and Table Loads activity prepares the new set of calibration parameters/tables for uplink.	See the CGS Flight Software Update ConOps thread for more details.
8	AGST, Attitude Analyst, CGS	Monitor results from subsequent AGS Monitor/Validate Attitude Control activity to confirm attitude calibration results. Repeat steps 5-7 if further calibration is required. Otherwise, continue to Step 21.	
9	ADS	The AGS Investigate Potential Attitude Anomalies activity trends attitude hardware and ADCS performance.	
10	SMS, Attitude Analyst	The MOT Investigate Potential Attitude Anomalies activity evaluates trend data, isolates anomaly root cause and generates recommendations for corrective action.	
11	CGS, AGST, Attitude Analyst, SMS	The AGS Investigate Potential Attitude Anomalies activity generates Attitude Anomaly Reports and sends it to the CGS Distribute Orbit Products activity for distribution to the internal and external users.	See Mission Support Data Handling (MSD) thread for more details.
12	AGST, Attitude Analyst, SMS	The Attitude Analyst initiates a Mission Task Request (schedule request) supporting implementation of recovery steps to the CGS Process Mission Activity and Task Requests activity. If recovery includes activation of	Calibration of redundant attitude sensors may be necessary.

No.	Actors	Actions	Notes
		redundant sensors, execution of Steps 5-8 may be necessary.	
13	AGST, Attitude Analyst, SMS	Monitor results from subsequent AGS Monitor/Validate Attitude Control activity to confirm recovery results. Repeat steps 9-12 if further analysis is required. Otherwise, continue to Step 21.	
14	AGS, SMS	The AGS Investigate Potential Attitude Anomalies activity compares the computed satellite attitude with the attitude parameters determined onboard and trends the comparison.	
15	AGST, Attitude Analyst, SMS	The MOT Investigate Potential Attitude Anomalies activity evaluates trend data, identifies ADCS as anomaly source, and provides supporting information.	
15a	RTADS, AGST, Attitude Analyst, SMS	The AGS Investigate Potential Attitude Anomalies activity utilizes RTADS to obtain real-time attitude information to assist in identification of ADCS as anomaly source, provide supporting information, monitor satellite attitude during the anomaly and verify anomaly resolution.	
16	AGS, AGST, Attitude Analyst, SMS	The AGS Investigate Potential Attitude Anomalies activity generates satellite attitude reports and sends it to the CGS Distribute Orbit Products activity for distribution to the internal and external users.	See Mission Support Data Handling (MSD) thread for more details.
17	AGST, Attitude Analyst, SMS	Support subsequent anomaly resolution activities.	
18	AGST, SMS	Monitor results from subsequent AGS Monitor/Validate Attitude Control activity to confirm recovery results. Repeat steps 9-12 if further analysis is required. Otherwise, continue to Step 21	
19	AGS, SMS	The AGS Investigate Potential Attitude Anomalies activity compares the computed satellite attitude with the attitude parameters determined onboard and trends the comparison.	Analysis includes pre-mode transition, transitions and periodic evaluation while in non-nominal mode.
20	AGST, SMS	The MOT Investigate Potential Attitude Anomalies activity evaluates trend data, evaluates hardware and ADCS performance and provides mode performance assessment information.	
20a	RTADS, AGST, Attitude	The AGS Investigate Potential Attitude Anomalies activity utilizes RTADS to obtain real-time attitude information to assist in identification	

No.	Actors	Actions	Notes
	Analyst, SMS	of ADCS as anomaly source, provide supporting information, monitor satellite attitude during the anomaly and verify anomaly resolution.	
21	AGS, CGS	The AGS Investigate Potential Attitude Anomalies activity generates satellite attitude validation report and sends it to the CGS Distribute Orbit Products activity for distribution to the internal and external users.	See Mission Support Data Handling (MSD) thread for more details.
22	RTADS	The AGS Monitor/Validate Attitude Control activity may utilize RTADS for a period of time following resolution of the anomaly to compare the computed satellite attitude with the attitude parameters determined onboard in near real-time. RTADS generates alarms, warnings, and events to notify the Mission Operations team of ADCS status.	

Table 6.3.7-5 defines the flow of Attitude Ground Support - Planning Maneuvers. Attitude maneuvers are required orbit maneuvers and sensor calibration.

Table: 6.3.7-5 Attitude Ground Support Alternate Flow - Planning Maneuvers

No.	Actors	Actions	Notes
1	Orbit Analyst	The Orbit Analyst coordinates scheduling of the maneuver event with the Fleet Mission Planner.	See Mission Planning & Scheduling (MPS) thread for more details
2	Orbit Analyst	The Orbit Analyst determines that attitude maneuver(s) are required and their type. The results are received by the Attitude Analyst as Maneuver Data. If the determination indicates the following possible types: • Selection of a pre-loaded target quaternion, continue to Step 3 • Support for a single-axis maneuver, continue to Step 4 • Generation of a target quaternion, continue to Step 5 Otherwise, continue to Step 12.	
3	Orbit Analyst, CGS	The CGS Plan Maneuvers activity generates the orbit maneuver sequence and determines the attitude target quaternion in support of an orbit maneuver. Continue to Step 8	See Orbit Maintenance (OrM) thread for more details
4	AGS, CGS, Attitude Analyst, AGST	The AGS Monitor/Validate Attitude Control activity converts the angular input specification to an attitude quaternion in support of a single-axis attitude maneuver.	

No.	Actors	Actions	Notes
		This, along with our desired slew input parameters (acceleration percentage, coast percentage, slew duration, etc.), are passed to the CGS Process Mission Task & Events activity for subsequent FSW load build as part of a Special Mission Task. Continue to Step 7.	
5	Attitude Analyst	The AGS Monitor/Validate Attitude Control activity converts the target attitude input specification to an attitude quaternion in support of a multi-axis attitude maneuver. This, along with our desired slew input parameters (acceleration percentage, coast percentage, slew duration, etc.) are specified.	
7	Attitude Analyst	The target quaternion and supporting parameters in support of a multi-axis attitude maneuver are verified by Flight Software Maintenance and delivered for potential use.	See Flight Software Upgrade (FSU) thread for more details
6	CGS, Orbit Analyst, Attitude Analyst	The CGS Generate & Validate Satellite CMD activity builds the partial table load for subsequent testing and uplink.	
8	CGS, Attitude Analyst, ADS, FVTS	The CGS Check Calculated Maneuver Parameters activity verifies the maneuver parameters utilizing the FVTS and the ADS. The output is evaluated for body rate, sun and attitude violations.	See Flight Vehicle Simulation (FVS) thread for more details
9	CGS, Attitude Analyst, ADS	The AGS Monitor/Validate Attitude Control activity verifies the attitude maneuver parameters and performs Field Of View (FOV) constraint checks. The results are documented in the Sensor Interference Report. The CGS Collect Mission Data activity receives the Sensor Interference Report for distribution.	
10	Orbit Analyst, Attitude Analyst, Mission Planner	The CGS Define Mission Tasks & Events activity is exercised to schedule the maneuver. The Orbit Analyst reviews any applicable MPS task definitions with the Fleet Mission Planner and submits a new/modified task definition. Note: The slew is initiated via command (either ground or in the stored command table), with a command argument specifying the table entry for the target to maneuver to.	See Mission Planning & Scheduling (MPS) thread for more details
11	Orbit Analyst, Attitude	The Command Authorization Meeting is held. Information supporting the maneuver is presented, including simulation and constraint check reports.	

No.	Actors	Actions	Notes
	Analyst AGST, Fleet Mission Management		
12	Fleet Mission Management	The Fleet Mission Manager provides direction concerning the maneuver.	
13	RTADS, Attitude Analyst	The AGS Monitor/Validate Attitude Control activity may utilize RTADS to evaluate execution of the attitude maneuvers in near real-time. The AGS Monitor/Validate Attitude Control activity ingests attitude telemetry stream in near real-time from the CGS Process & Extract Telemetry activity. RTADS generates tabular and graphical displays to notify the Attitude Analyst of ADCS status.	

Table 6.3.7-6 defines the operational flow of Attitude Ground Support - Real-time ADS. This flow is supported by manual execution of the Real-time ADS (RTADS) on an as needed basis. This flow supports real-time monitor of maneuvers, non-nominal attitude control modes, mode transitions, etc.

Table: 6.3.7-6 Attitude Ground Support - Real-time ADS

No.	Actors	Actions	Notes
1	CGS, RTADS, MOT	The CGS Distribute Mission Support Data activity provides RTADS with spacecraft ephemeris information, Mission Notices, and Mission Schedules.	See Mission Support Data Handling (MSD) thread for more details.
2	MOT, CGS, RTADS	The MOT utilizes Mission Notices and Mission Schedules to determine the need to assess spacecraft attitude in real-time and configures RTADS to support the real-time contact under the AGS Monitor/Validate Attitude Control activity. RTADS nodal configuration information is provided to the CGS. RTADS may optionally ingest the Mission Schedule.	MOT is informed of contacts of interest via Mission Notices. Contact time are extracted from the Mission Schedule.
3	CGS, RTADS	The CGS Process & Extract Telemetry activity produces an attitude TLM stream. The data is delivered to RTADS in near real-time. The AGS Monitor/Validate Attitude Control activity ingests attitude telemetry from the CGS Process & Extract Telemetry activity when configured to do so.	See Telemetry & Command (T&C) thread for more details.
4	RTADS	The AGS Monitor/Validate Attitude Control activity calculates satellite's attitude and displays the results.	

No.	Actors	Actions	Notes
4.1	RTADS	The AGS Monitor/Validate Attitude Control activity compares the RTADS solution with the on-board estimate and displays the results.	
4.2	RTADS	The AGS Monitor/Validate Attitude Control activity compares the RTADS solution with the predicted attitude and displays the results.	This is useful in evaluating attitude maneuvers.
5	RTADS, AGST	The AGS Monitor/Validate Attitude Control activity compares the computed satellite attitude with the attitude parameters determined onboard. If the attitude deviation between ground-based and onboard determinations within pre-set thresholds, continue to Step 4. If the divergence and other checks indicate a possible attitude anomaly, the RTADS operator is notified via AWEs for further investigation and anomaly resolution. Continue to Step 4 to continue the flow.	
6	RTADS, AGST	The AGS Monitor/Validate Attitude Control activity displays attitude and derived parameters over the course of the telemetry flow.	

6.3.7.8 Post Condition

Satellite attitude is determined satisfactorily. The onboard calculation is consistent with independent ground-based calculations. Any necessary attitude corrections are submitted for scheduling.

6.3.7.9 Related Threads

Provide a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-020	Mission Planning and Scheduling
GS-NML-050	Orbit Maintenance
GS-NML-070	Flight Software Upgrade
GS-NML-080	Flight Vehicle Simulation
GS-NML-030	Telemetry and Command
GS-NML-140	Mission Support Data Handling
GS-NML-400	Integrated Support
GS-MAD-110	Launch Readiness Support
GS-MAD-120	Launch & Early Orbit

6.3.7.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-020-010	Space Operations

Thread ID	Thread Title
CGS-020-020	Orbit Operations

6.3.8 Mass Data Storage Playback

6.3.8.1 Description

The Mass Data Storage (MDS), (formerly Solid State Recorder (SSR)) Playback (GS-NML-102) provides a space-ground system-level operational thread that describes how Stored Mission Data (SMD) is played back from the onboard MDS. This operational flow applies to the S-NPP, JPSS-1 and JPSS-2/3/4 satellites, while the differences in their implementation of onboard mass data storage are discussed.

There are three goals that are guiding the design of MDS playback operations: first, to achieve the minimum data latency; second, to maximize the data availability, and third, to simplify operations. The data latency and data availability are the two performance parameters that are critical to the mission success. Simplified operations will reduce probability of human errors and improve system operational reliability.

The MDS Playback thread starts with planning of SMD contacts and playbacks by mission planners, proceeds with command generation and uploading, and ends at SMD being played back from the MDS and transmitted to the ground upon execution of commands.

6.3.8.1.1 Mass Data Storage Overview

JPSS-managed missions, such as S-NPP, JPSS-1/2/3/4 satellites, use MDS's to continuously store their mission data, including both environmental observation data and spacecraft/instrument telemetry, collectively known as SMD. These MDS's are capable of simultaneous record and playback operations. Typical MDS operations include continuous recording of SMD while orbiting and playing back SMD during ground contacts. The MDS is managed as a ring buffer, which means that the record and playback functions automatically return back to the beginning of memory array and continue sequentially from there after the end of the memory array is reached.

The MDS's on S-NPP and JPSS-1 have a capacity of 343 Gbits capable of storing at least five orbits of SMD. The MDS's on JPSS-2/3/4 have two partitions: an SMD Partition of 386 Gbits and a Sounder Partition of 91 Gbits. The SMD Partition is capable of storing all SMD for at least 8 hours. The smaller Sounder Partition is capable of storing the sounder data for at least 8 hours. The sounder data, comprising the observation data from the CrIS and ATMS instruments, is the subset of SMD that is most critical and time sensitive for weather forecast. Spacecraft telemetry necessary for producing data products can be stored in both the SMD and Sounder Partitions alongside the observation data. The management of the Sounder Partition is identical to but independent of that of the SMD Partition, making it possible to play back and process the stored sounder data at a higher priority.

On the S-NPP MDS and JPSS-1 MDS, there is one record pointer that indicates where in the memory array that data is currently being stored. There are two independent playback pointers for performing playback operations, the sequential playback pointer and the random playback pointer. During a sequential playback, the sequential playback pointer starts at where the

previous sequential playback stopped and advances sequentially until it reaches the record pointer value that was latched at the beginning of the playback. The random playback pointer is typically used for playbacks from anywhere in the memory when a specific section of memory, identified by a location and a length, needs to be read out and transmitted.

In addition to a record pointer and a playback pointer similar to that of JPSS-1, the MDS's on JPSS-2/3/4 also have capability to manage playback by the time when the SMD is recorded. The resolution of time is one minute.

There is a playback offset feature in the playback command that allows the playback pointer to move backward a specified amount before starting the playback. Since no bit lock is maintained when MDS starts playback, it is necessary to play back some previously transmitted data for bit locking before new data is transmitted. The Ground System is capable of identifying duplicate data from the downlink SMD stream and not forwarding them to the data processing nodes unless requested specifically.

S-NPP and JPSS-1/2/3/4, spacecraft's have no on-board knowledge of when they are going to fly over SMD receiving stations. All MDS playbacks are commanded from the ground by the stored commands and/or real-time commands. The Mission Operations Team (MOT) carefully schedules the MDS playback activities based on the available ground resources and associated ground contact windows. Typically these SMD playback opportunities are maximized in order to reduce data latency and ensure that all of the SMD is able to be downlinked during each scheduled pass.

The MDS is capable of performing tests on the memory to find and subsequently map these degraded regions out of the active memory array. Such memory test is conducted during early-orbit turn-on and initialization operations. Over the life of mission, it is possible that certain areas of memory will be degraded by aging or the space radiation environment. These damaged memories can be detected and mapped out using this memory test feature.

6.3.8.1.2 Terminologies

This section defines the MDS playback related terms used in this thread description.

Original Copy - refers to the SMD received on the ground that is played back from the MDS the first time

Duplicate Copy - refers to the SMD received on the ground that has been previously played back from the MDS

Original Transmission (OX) - refers to the SMD playback for the purpose of receiving an original copy

Retransmission (RX) - refers to the SMD playback for the purpose of receiving a duplicate copy

Sequential Playback (SP) - refers to the SMD playback using the Sequential Playback Pointer

Pointer-based Random Playback - refers to the SMD playback with data range specified by the Random Playback Pointer

Time-based Random Playback - refers to the SMD playback with data range specified by start and stop observation time

AoS - Acquisition of Signal

LoS - Loss of Signal

T&C - Telemetry and Command

6.3.8.1.3 Suomi NPP Mass Data Storage Playback

The S-NPP mission uses the KSAT ground station at Svalbard, Norway as its primary S-band T&C and X-band SMD downlink station. It also uses the Fairbanks Command and Data Acquisition Station (FCDAS) at Fairbanks, Alaska as an alternate station to back up or augment the Svalbard station. Due to its polar location (78.2 deg. N), the Svalbard station has excellent visibility to all S-NPP passes (14-15/day). Therefore a SMD playback can be conducted on every pass, transmitting mission data captured and stored during the previous orbit. The FCDAS (64.8 deg. N) is a high latitude station that can support about 10-11 passes a day. While the rest of this subsection describes S-NPP MDS playback at the Svalbard station, it generally applies to the FCDAS as well.

The commands to playback SMD are planned and generated well in advance based on S-NPP orbital data. They are uploaded daily as part of regular stored command loads. As shown in Figure 6.3.8-1, during a contact, at the time specified in the command, the S-NPP spacecraft turns on its X-band transmitter and commands the MDS to play back SMD in the memory from the location just prior to where it stopped playing the last time until it reaches the record pointer location when the current playback begins, i.e. near the beginning of contact. Figure 6.3.8-2 shows the SMD played back includes the mission data recorded during the previous orbit up to the beginning of current Original Transmission (OX).

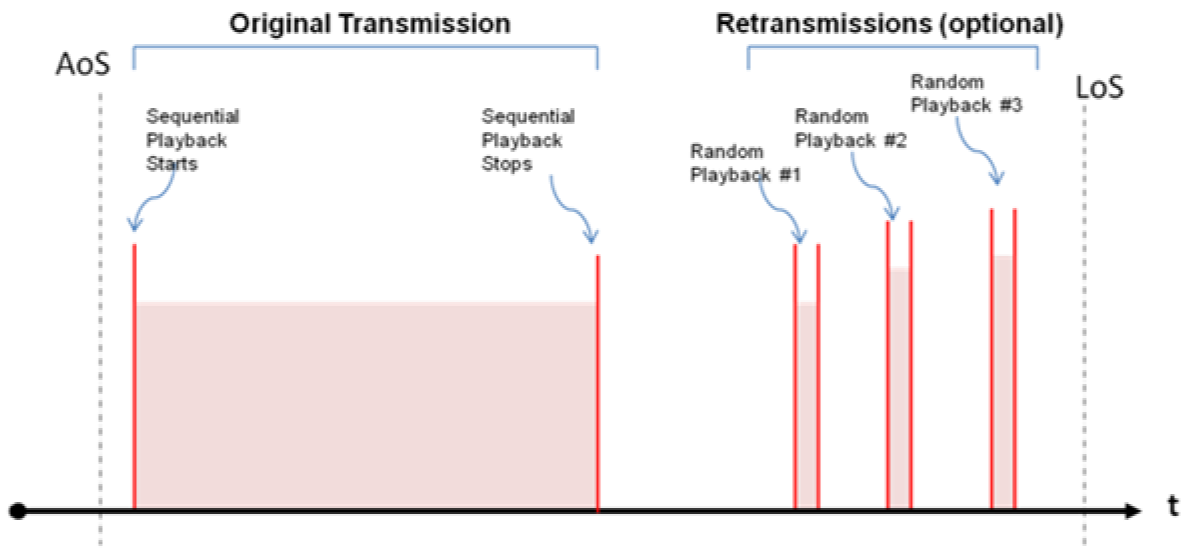


Figure: 6.3.8-1 Notional S-NPP MDS Playback Activities During a Contact

Nominally S-NPP spacecraft and instruments generate about 7 GBytes of data every orbit, including transport overhead. At a 300 Mbps downlink rate (262 Mbps information rate), it takes less than 4 minutes to play back one orbit worth of SMD. The passes over Svalbard station range from 6 to 13 minutes with an average of 11 minutes, providing sufficient time for a complete SMD downlink.

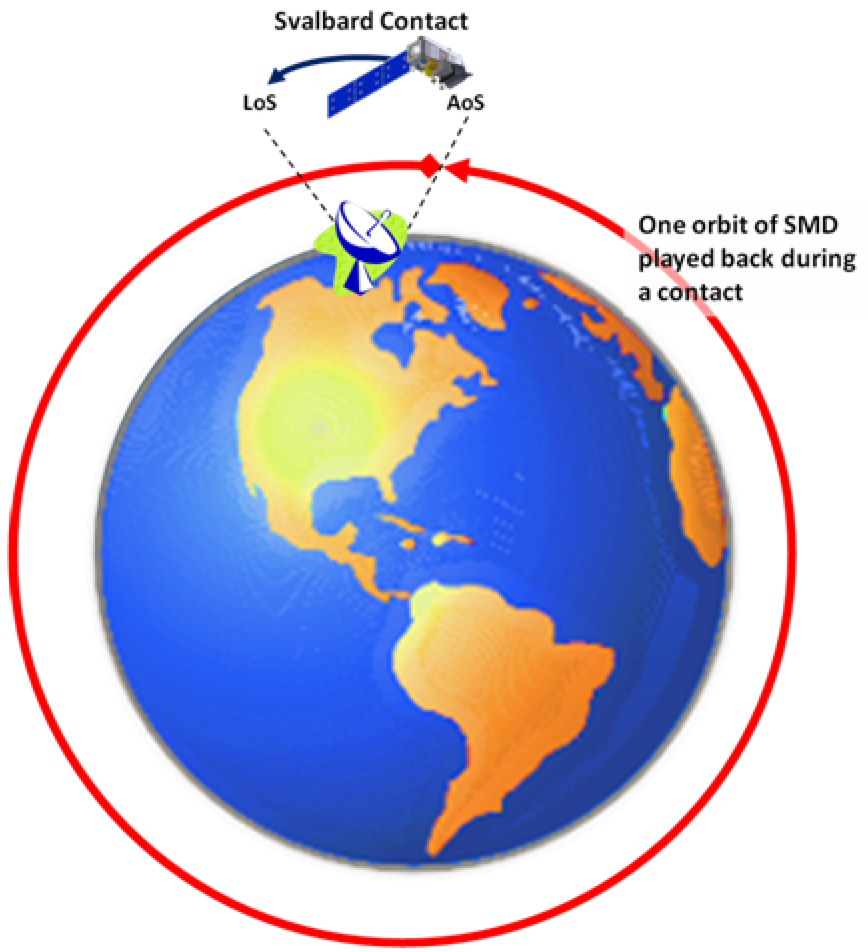


Figure: 6.3.8-2 Notional S-NPP SMD Played Back During a Contact

On occasions, some SMD are lost during transmission due to weather outages or ground equipment failures. In those cases, the ground system may request the S-NPP spacecraft to play back again portions of MDS where the lost data are stored. This is also known as SMD retransmission, as shown in Figure 6.3.8-1. SMD retransmission commands are prepared, automatically or by operators, with memory location and length information for the missing data. During a Svalbard contact, after the pre-scheduled SMD original playback is completed, the SMD retransmission command is uplinked to the S-NPP spacecraft. After command authentication and validation, the S-NPP spacecraft plays back the portion of SMD as specified in the command. Multiple SMD retransmission commands can be executed during a pass, assuming there is enough contact time. Care should be taken to ensure each SMD retransmission can be completed within the contact window. See the Data Accounting and Recovery thread for more details.

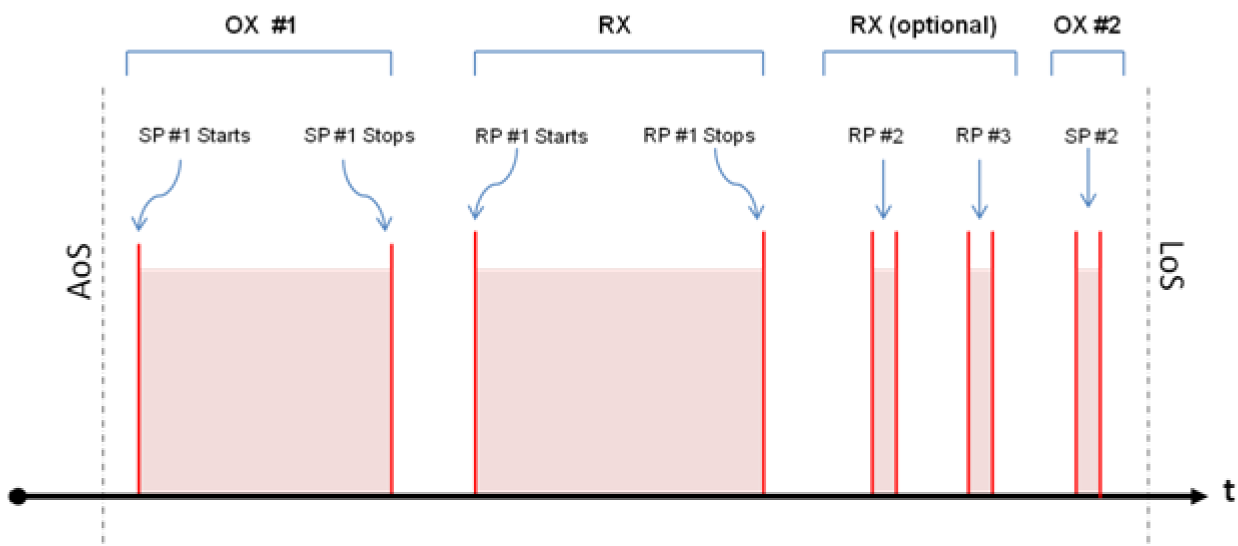
It should be noted that the onboard MDS has a capacity of 42 GBytes. Based on current S-NPP operations data, this is enough to hold at least five orbits of data. Therefore SMD retransmission can be accomplished effectively within the next four contacts. Beyond that the data of interests may be overwritten by newly recorded mission data.

It is possible that retransmission of multiple-orbits of SMD is required when one or more passes are missed due to weather or system outages. The MOT will schedule all ground resources available to retransmit the SMD as soon as possible. If not all SMD due for retransmission can be downlinked in a single pass, the MOT has to schedule them over multiple passes with the oldest data retransmitted first.

When the SMD playback is backed up, it not only adds extra loading on the ground stations and network, but also stresses the Data Processing Node (DPN). The DPN needs to process the current SMDs first to maintain the data latency while working off the SMD backlog with remaining system capacity. See the Data Accounting and Recovery thread for more details on the Recovery Processing.

6.3.8.1.4 JPSS-1 Mass Data Storage Playback

While JPSS-1 satellite uses a similar implementation of MDS as the S-NPP, there are significant differences in their SMD playback, as shown in Figure 6.3.8-3. First, JPSS-1 uses Ka-band for its SMD transmission. This enables JPSS-1 to use, in addition to Ka-band receptors at Svalbard, Ka-band receptors at McMurdo station, a south polar site (77.8 deg. S), which also has excellent visibility to every JPSS-1 pass. As a result of this dual polar receiving site topology, JPSS-1 is able to play back SMD from its MDS twice an orbit, significantly reducing its data latency. Second, JPSS-1 will play back the same SMD twice, once at each site, resulting in an original copy and a duplicate copy. Therefore the data lost at one site due to weather outage or ground station failure can be retrieved from the other site. In other words, the two polar stations will back each other up. All of these playbacks can be planned ahead and commanded through stored commands. This will reduce the need for real-time SMD retransmission from the satellite, thus simplifying mission operations and increasing operation robustness. In a rare event that some SMD were not captured at both sites, SMD retransmissions from Svalbard ground station using real-time commands can still be supported in the same way as described for the S-NPP.



Note: Optional Retransmissions (RX) executed by real-time commands is not available at McMurdo.

Figure: 6.3.8-3 Notional JPSS-1 MDS Playback Activities during a SMD Contact

Another technique that JPSS-1 employs to reduce its data latency is to add the second Original Transmission at the end of each contact, shown in Figure 6.3.8-3 as OX #2. Because of its design limitations, the MDS sequential playback stops at the record pointer location that is latched at the beginning of playback. Consequently, all mission data acquired and stored since the SMD playback begins, typically at the beginning of a contact, will not be played back till the next SMD contact, causing a long delay on the data. By adding another sequential playback near the end of a contact, the mission data acquired during the contact can be played back in near real-time, cutting delays on these data by up to 80 percent. Because of the fix timing on JPSS-1 orbit and ground contact schedule, these second original transmissions can be pre-planned and built into the stored command sequence.

NOTE: Currently there is a serious concern on the JPSS-1 Ka-band gimbal life as the gimbal 2X life test is still in progress and will not complete until after launch. Consequently during the JPSS-1 LEO&A activity, only an OX #2 demonstration will be executed for a few orbits once all the instruments are producing a full data load. OX #2 will not be regularly executed until the gimbals 2X life test is complete and the management/technical decision is made to proceed with the nominal use of OX #2.

Figure 6.3.8-4 and Figure 6.3.8-5, together with Figure 6.3.8-3, illustrate how the SMD are played back from JPSS-1 MDS at Svalbard and McMurdo, respectively.

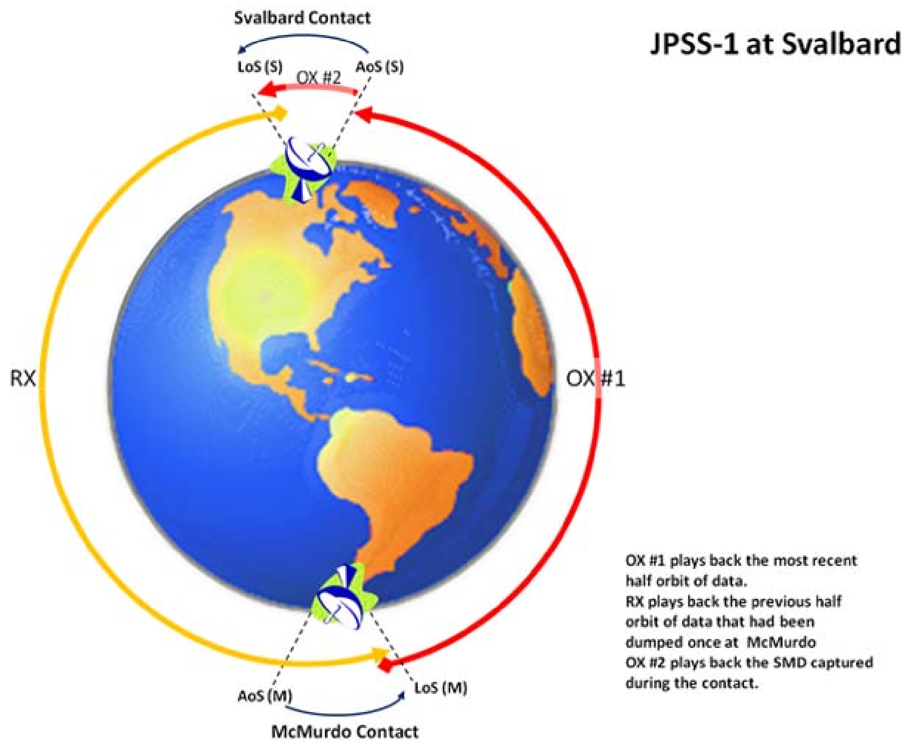


Figure: 6.3.8-4 Notional JPSS-1 MDS Playback Activities during a Svalbard SMD Contact

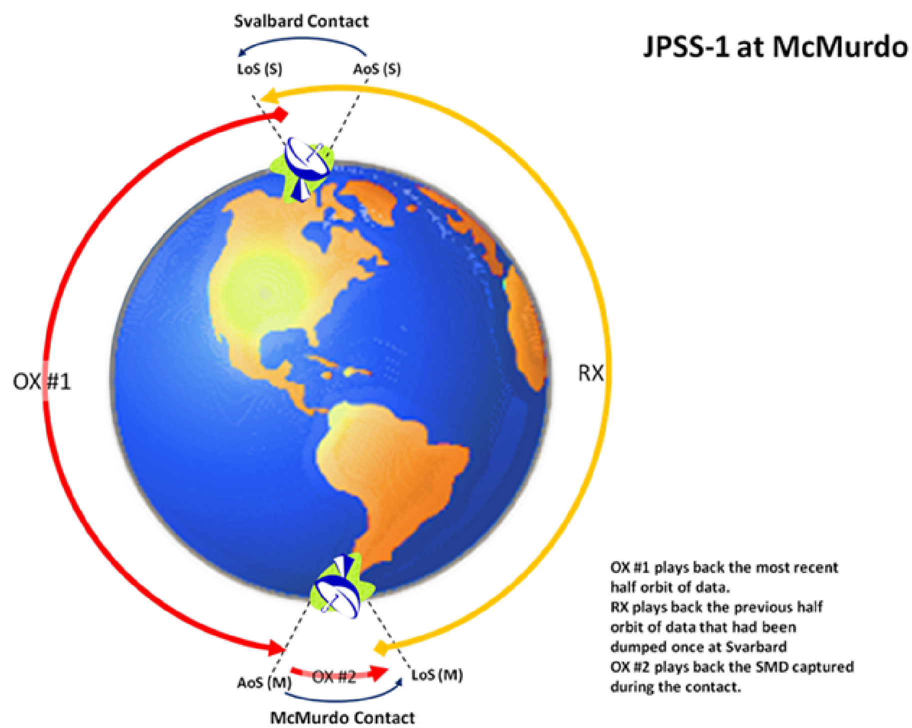
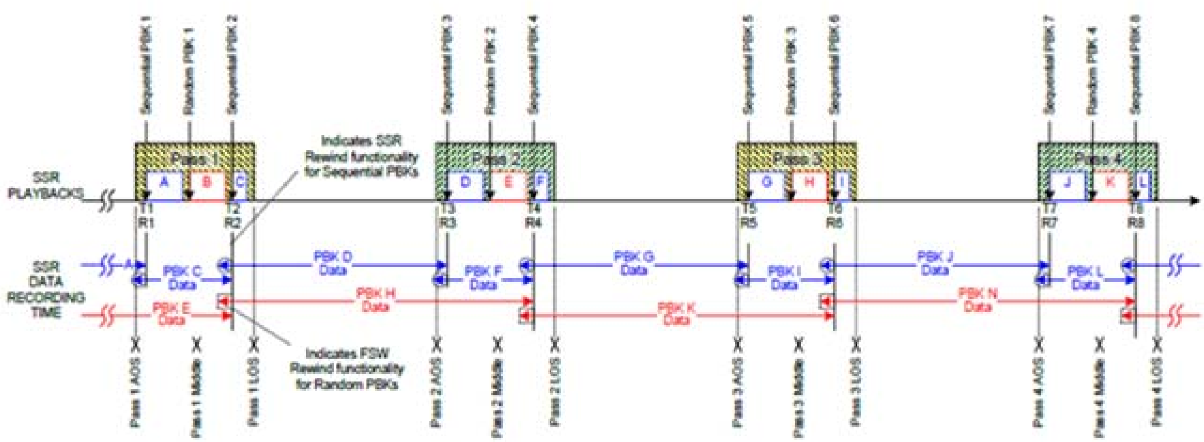


Figure: 6.3.8-5 Notional JPSS-1 MDS Playback Activities during a McMurdo SMD Contact

JPSS-1 spacecraft and instruments generate about 8 GBytes of data every orbit, including transport overhead. At 300 Mbps downlink rate (with convolutional encoding off), it takes about 2 minutes to playback 1/2 orbit worth of SMD since the last contact at the opposite polar site; and another 2 minutes to playback the ½ orbit of SMD prior. For a 10-minute contact, the second Original Playback (OX #2) will need 30 seconds to transmit the SMD captured during the contact. In case a scheduled contact does not have enough time to accommodate all three playback activities, the priority is given to the original data. The passes over Svalbard and McMurdo stations range from 6 to 13 minutes with an average of 11 minutes, providing sufficient time for complete SMD downlink operations.

To facilitate the replay of ½ orbit previously transmitted SMD, the JPSS-1 MDS management software provides knowledge of MDS Record Pointer as a function of time. Each time a sequential playback command is executed, the spacecraft automatically captures time-tagged record pointer value and saves it in an indexed table. The Random Playback command specifies a START time and a STOP time rather than specific locations. The spacecraft starts the playback from the last captured record pointer with a time-tag preceding the Random Playback START time and stops at the first stored record pointer with a time-tag that is later than the Random Playback STOP time. An example of this enhanced random playback operation is depicted in Figure 6.3.8-6.



(1) Sequential PBK commands for data FIRST COPY scheduled/loaded into CSM
--1st Sequential PBK for a pass occurs a few seconds after rising above 5 deg elevation
--2nd Sequential PBK for a pass occurs ~60 seconds before falling to 5 deg elevation (minimizes data latency)
--SSR Sequential PBK Rewind feature provides FIRST COPY overlap
--Example: Sequential PBK 3 (see block D) contains data from T2 (plus some rewind) to T3
(2) FSW Captures Time and SSR REC Pointer for every Sequential PBK executed
--Denoted as Tn, Rn pairs in this figure
--Allows FSW to have knowledge of REC pointer location as a function of time
(3) FSW Random PBK commands for data SECOND COPY scheduled/loaded into CSM
--scheduled approximately one minute after first Sequential PBK of a pass
--FSW PBK Command has START time and STOP time parameters
--FSW translates START/STOP times into SSR REC pointer values and executes SSR Random PBK
---uses nearest previous Tn, Rn pair for START PBK pointer value
---uses nearest subsequent Tn, Rn pair for STOP PBK pointer value
--Example: Random PBK H would use START = Pass 1 LOS (yields T2, R2), and STOP = Pass 2 Middle (yields T4, R4)
--FSW queues all SSR PBK commands (Random and Sequential) so that no SSR contention occurs
--FSW applies a table-driven "rewind" feature for Random PBK commands generated
--START/STOP times should be less than ~5 orbits old at execution time (Tn, Rn pairs are "perishable")

Figure: 6.3.8-6 An Example of Random Playback command with a START and a STOP time

In addition to the primary Ka-band ground receiving stations at Svalbard and McMurdo, JPSS-1 may also use alternate ground stations at Fairbanks and Troll. In case of an outage at Svalbard, Fairbanks can be scheduled to provide Ka-band SMD support. Similarly, Troll can be used to acquire Ka-band SMD when McMurdo is out of service. All stations have sufficient link margin to support 300 Mbps (CADU) downlink rates. However the SatCom bandwidth out of the Troll Ground Station is limited to 20 Mbps, at which it takes about 52 minutes to transfer all downlinked SMD back to NSOF for processing. For some contacts, the transfer of SMD from Troll to NSOF continues even after the next contact at Svalbard begins. As a result, the maximum data latency may increase by up to 5 minutes. Therefore it is recommended that when using Troll for SMD downlink, only play back the original data (OX #1 and OX #2), not duplicate copy (RX).

It should be noted that due to the narrow beam nature of Ka-band transmission, the SMD direct downlink can only be reliably conducted in the mission point mode, when the spacecraft pointing is stable.

If JPSS-1 loses its primary Ka-band direct-downlink capability or a ground resource is not available, it can downlink SMD via TDRSS by using a second Ka-band antenna mounted on its Zenith deck. In that case, JPSS-1 SMD support is scheduled with the Space Network. During scheduled TDRSS contacts, JPSS-1 plays back SMD from MDS and transmits it to the White Sand Complex (WSC) through the assigned TDRS in either the Atlantic Operational Region (AOR) or the Pacific Operational Region (POR). NASA Space Network (SN) plans to support JPSS with TDRSs: TDE in AOR, TDW and TD171 in POR. Combined with the masking of JPSS-1 zenith Ka-band antenna, these TDRSs provide a global coverage for JPSS-1 contacts as shown in Figure 6.3.8-7. Note that there is a large coverage gap over the Indian Ocean and some of Euro-Asian Continents because currently there is no SN support over the Indian Operational Region (IOR), although planning is being undertaken to provide the IOR support. Also there are gaps in the TDRS coverage over the Polar Regions.

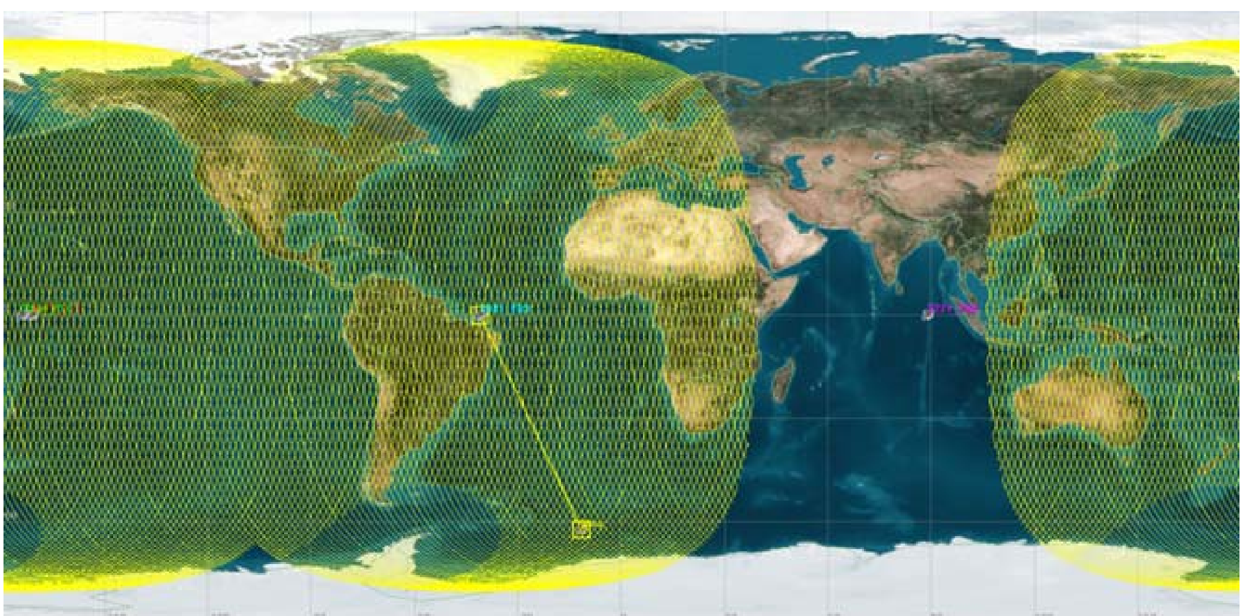


Figure: 6.3.8-7 TDRS-E and TDRS-W Ka-band Coverage for JPSS-1 Contacts

To meet the 80-minute data latency requirement for at least 95% of time, TDRS contacts need to be scheduled at the edges of large coverage gaps. Only the SMD collected since the last contact is downlinked in the TDRSS SMD scenario. When only TDRSS is used for SMD downlink, an average of 2.8 TDRSS contacts are scheduled each orbit using TDRS-E and TDRS-W to support the baseline 80 minute data product latency (based on GSFC Code 450 Representative TDRSS Support Profile: 622 contacts over 227 orbits in a 16-day repeat cycle). The Ka-band to TDRSS supports a data rate of 300 Mega symbol per second (Msps) or 150 Mbps CADU rate (after rate 1/2 convolutional decoding). The minimum duration for each SMD contact is 4 minutes and an average is 6 minutes. Concurrent S-band T&C contact and Ka-band SMD contact can be scheduled on TDRSS, making it possible to perform contingency SMD playback and ad hoc retransmissions through real-time commanding. In addition to the contact time, playback type (sequential or random) and associated parameters, the MDS playback through TDRSS commanding should also include the assigned TDRS ID and initial pointing vectors which the spacecraft uses to point the Ka-band antenna to the assigned TDRS. The spacecraft is capable of tracking TDRS during the contact.

The capability of SMD transmission through TDRSS is also used to augment the ground stations when one of them encounters an extended outage. TDRSS SMD support may be scheduled quicker to minimize the data latency impacts; and to fill in the contact gaps left by alternate Fairbanks or Troll stations during their blind passes. Furthermore, this capability makes it possible to reduce the data latency to 30 minutes (JPSS polar stations augmented by TDRSS) should it be required in the future.

Table 6.3.8-1 summarizes the TDRSS SMD support scenarios for JPSS-1.

Table: 6.3.8-1 TDRSS SMD Support to JPSS-1 Summary

Scenarios	1	2	3	4
Trigger	Loss of Nadir Antenna	Svalbard Outage	McMurdo Outage	Proficiency
Resources	TDRSS	FCDAS TDRSS (if FCDAS is not available) McMurdo	Svalbard Troll TDRSS (if Troll is not available)	TDRSS Svalbard McMurdo
Average TDRS TDRS Contacts/Orbit	2.8 (based on 622 TDRS contacts in 227 orbits in a 16-day cycle)	As needed to fill in the gaps	As needed to fill in the gaps	Twice a month

Figure 6.3.8-8 illustrates a notional TDRSS support scenario for Scenario 2, in which two TDRSS SMD contacts augment one McMurdo contact to provide complete coverage for one orbit.

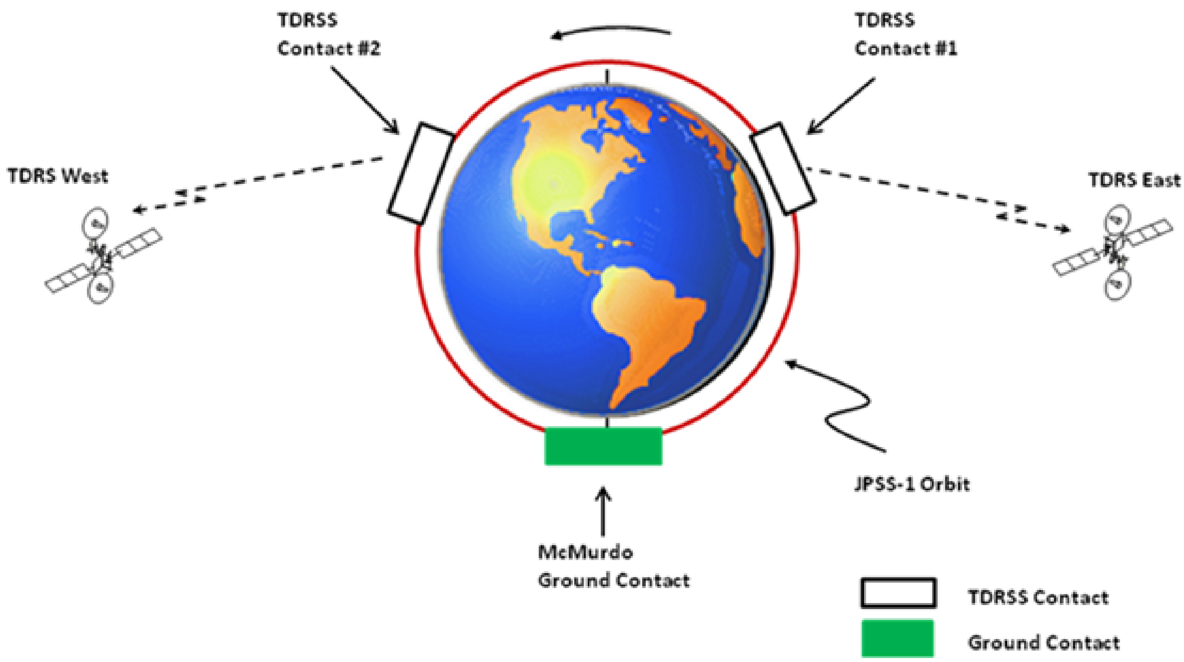


Figure: 6.3.8-8 Notional TDRSS SMD Supports with McMurdo Contact

6.3.8.1.5 JPSS-2/3/4 Mass Data Storage Playback

The JPSS-2/3/4 onboard Mass Data Storage (MDS) SMD Partition can store at least 8 hours of mission data. Configured as a ring buffer, it continues record mission data while, when commanded, plays back the Stored Mission Data (SMD) for transmission concurrently. The SMD playback can be managed in either of two schemes: 1) observation time, or 2) pointers. For the time-based playback, the MOT specifies the start and ending observation times of SMD to be played back without concerning physical addresses in the MDS. The time resolution is one minute. For the pointer-based sequential playback, the playback starts from where it left off last time and continues until it catches up to the recording. An offset pointer can be used to specify amount of data prior to the start address as part of playback.

Equipped with both nadir- and zenith-pointing Ka-band antennas like JPSS-1, JPSS-2/3/4 can transmit SMD at 150/300 Msps (131/262 Mbps information rate) either directly to a ground station or relayed via TDRSS. The zenith deck-mounted Ka antenna has a full -90/+90 degrees Field Of View (FOV).

The JPSS-2/3/4 satellites use an identical implementation of MDS playback as JPSS-1 as shown in Figure 6.3.8-9. JPSS-2/3/4 use Ka-band for its SMD transmission and JPSS-2/3/4 use Ka-band receptors at both Svalbard and McMurdo stations. As a result of this dual polar receiving site topology, JPSS-2 /3/4 are able to play back SMD from its MDS twice an orbit, significantly reducing data latency. JPSS-2/3/4 will play back the same SMD twice, once at each site, resulting in an original copy and a duplicate copy. All of these playbacks can be planned ahead and commanded through stored commands. In a rare event that some SMD were not captured at

both sites, SMD retransmissions from Svalbard ground station using real-time commands can still be supported in the same way as described for the S-NPP.

Figure 6.3.8-4 and Figure 6.3.8-5, together with Figure 6.3.8-3, illustrate how the SMD are played back from JPSS-2/3/4 MDS at Svalbard and McMurdo, respectively.

Table 6.3.8-2 summarizes the TDRSS SMD support scenarios for JPSS-2/3/4.

Table: 6.3.8-2 TDRSS SMD Support to JPSS-2/3/4 Summary

Scenarios	1	2	3	4	5
Trigger	Nominal	Loss of Nadir Antenna	Svalbard Outage	McMurdo Outage	Proficiency
Resources	Svalbard McMurdo	TDRSS	FCDAS TDRSS (when FCDAS is not available)	Troll TDRSS (if Troll is not available)	FCDAS Troll TDRSS
Average TDRS Contacts / Orbit	0	2.8 (based on 622 TDRS contacts in 227 orbits in a 16-day cycle)	As needed to fill in the gaps.	As needed to fill in the gaps.	Twice a month

An addition to the JPSS-2/3/4 is the capability of storing and managing the sounder (ATMS and CrIS) data independently. Table 6.3.8-3 summarizes data stored in two storages, referred to as the SMD partition and the Sounder partition. In the current baseline configuration, the SMD Partition will store all SMD, including the sounder data, while the Sounder Partition will store only sounder data. The spacecraft housekeeping (HK) telemetry (TLM) will be stored in both partitions alongside instrument data. During SMD contacts, only data in the SMD Partition will be played back.

For some spacecraft pre-launch and on-orbit test activities, the data may be stored differently than in the baseline. Specifically, the Sounder data would be stored only in the Sounder Partition, and not in the SMD Partition as in the baseline. The non-sounder SMD would continue to be stored on the SMD Partition, and the HK TLM would continue to be written to both partitions, as in the baseline. Both partitions would be played back as desired.

Table: 6.3.8-3 Data Storage in SMD and Sounder Partitions

Configuration		JPSS-2 Baseline		Selected JPSS-2 Testing	
Data	**Partition**	**SMD**	**Sounder**	**SMD**	**Sounder**
Non-Sounder SMD		X		X	
Sounder data (VCs 1 and 6)		X	X		X
Stored HK TLM (VCs 0 and 54)		X	X	X	X

Configuration		JPSS-2 Baseline		Selected JPSS-2 Testing	
Data playback		Yes	No	Yes	Yes

The potential benefits of using the Sounder Partition include: 1) reducing the sounder data latency by prioritizing the Stored Sounder Data (SSD) playback and processing over the rest of SMD; and 2) reducing SMD volume by downlinking only the SSD in the Southern hemisphere where system data backhaul capacity or operational cost may become a constraint. Possible ConOps for these applications will be examined further in the future.

6.3.8.1.6 Functional Allocation and Related Threads

The MDS playback operations are allocated to the Common Ground System (CGS) in the JPSS Ground System. The Mission Operations Team (MOT) at the Mission Management Center (MMC) plays a major role in monitoring MDS status, planning MDS playback schedules, building MDS playback commands and command updates, and uploading the commands to the satellites. The MOT also manages the SMD retransmissions, when required, that are commanded in real-time during a Svalbard contact.

There are other operational threads that are closely associated with the MDS Playback thread. These threads include the Mission Planning and Scheduling that details the contact schedule development; the Telemetry and Command thread that discusses command load uplink; the SMD Handling that describes the SMD acquisition and processing once received by the ground stations; and Data Accounting and Recovery that describes the process of SMD retransmissions. Section 6.3.8.9 provides a list of Related Threads.

6.3.8.2 Primary Interfaces

Figure 6.3.8-12 illustrates the actors and primary external interfaces involved in the execution of MDS Playback. Each interface illustrated in the figure, labeled with a number, is described in Table 6.3.8-4, along with the information about types of data, exchange method and characteristics. Table 6.3.8-5 lists relevant IRD/ICD.

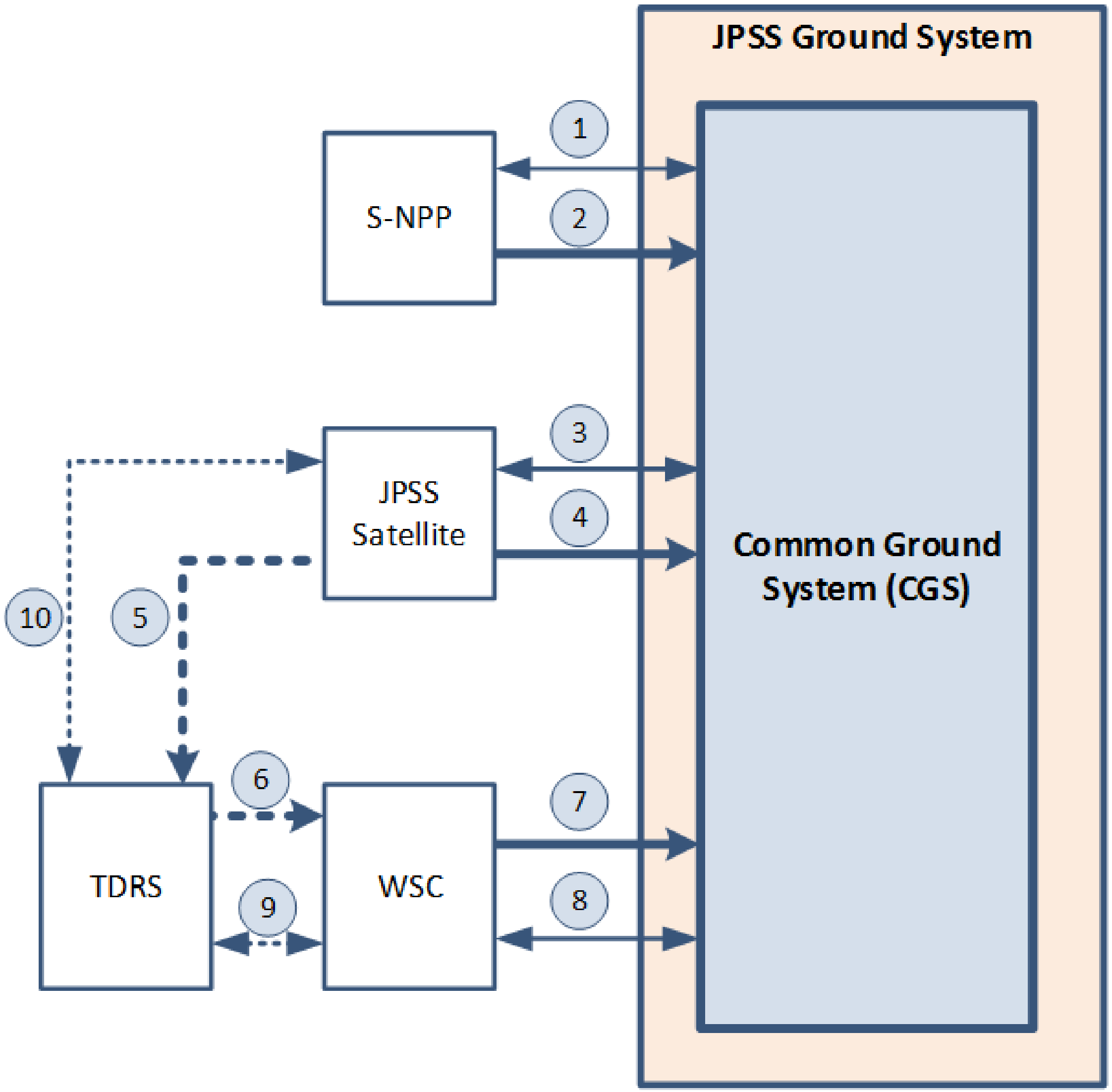


Figure: 6.3.8-9 Primary Interfaces for MDS Playback

Table: 6.3.8-4 Primary Interfaces for MDS Playback

No.	Type	Actors	Purpose
1	External	CGS, S-NPP	CMD upload for MDS Playback
	External	S-NPP, CGS	MDS status
2	External	S-NPP, CGS	SMD downlink
3	External	CGS, JPSS-1/2/3/4	CMD upload for MDS Playback
	External	JPSS-1/2/3/4, CGS	MDS status
4	External	JPSS-1/2/3/4, CGS	SMD downlink
5	Outside	JPSS-1/2/3/4, TDRS	SMD downlink (contingency only)
6	Outside	TDRS, WSC	SMD downlink (contingency only)
7	External	WSC, CGS	SMD downlink (contingency only)
8	External	CGS, WSC	CMD upload for MDS Playback

No.	Type	Actors	Purpose
		WSC, CGS	MDS status
9	Outside	WSC, TDRS	CMD upload for MDS Playback
		TDRS, WSC	MDS Status
10	Outside	TDRS, JPSS-1/2/3/4	CMD upload for MDS Playback
		JPSS-1/2/3/4, TDRS	MDS status

Table: 6.3.8-5 Primary Interface Documentation

No.	IRD/ICD
1	S-NPP Spacecraft S-band RF ICD to the Norway Ground Station S-NPP Spacecraft S-band Data Format ICD
2	S-NPP Spacecraft SMD ICD to the Norway Ground Station S-NPP Spacecraft X-band Data Format ICD
3	JPSS-1 Spacecraft TT&C to Ground Segment RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS IRD for RF Interfaces to and From JPSS Satellites 2 through 4 (470-00205) JPSS-2/3/4 TT&C to Ground Segment RF ICD (472-00336) JPSS-2/3/4 TT&C Data Format ICD (472-00290)
4	JPSS-1 Spacecraft SMD to Ground Segment RF ICD (472-00162) JPSS-1 Mission Data Format ICD (472-00163) JPSS IRD for RF Interfaces to and From JPSS Satellites 2 through 4 (470-00205) JPSS-2/3/4 SMD to Ground Segment RF ICD (472-00337) JPSS-2/3/4 Mission Data Format ICD (472-00289)
5, 10	RF ICD JPSS-1 Spacecraft and the Space Network and the Near Earth Network (450-RFICD-JPSS-1/SN/NEN) RF ICD JPSS-2 Spacecraft and the Space Network and the Near Earth Network (450-RFICD-JPSS-2/SN/NEN)
6, 9	N/A
7, 8	JPSS/SN PSLA

6.3.8.3 Assumptions & Constraints

- Aside from the direct broadcast, all environmental observation data are stored in the MDS first, hence the SMD, before being played back and transmitted to the ground.
- S-NPP satellite uses X-band for its SMD downlink with a rate of 300 Mbps.
- JPSS satellites use Ka-band for SMD downlink with a rate of 300Mbps to all polar/high latitude ground stations.
- JPSS-1/2/3/4 satellites use a second Ka-band as an alternate for its SMD downlink through TDRSS with a rate of 150/300 Msps.

6.3.8.4 Pre-Conditions

- S-NPP, JPSS-1/2/3/4 MDSs are operating as described in their design specifications
- SN is operational if a TDRSS SMD support is scheduled

6.3.8.5 Operational Flow

The operational flow of MDS Playback is illustrated Figure 6.3.8-10. This diagram is an OV-5b view that ties this thread into the rest of system architecture.

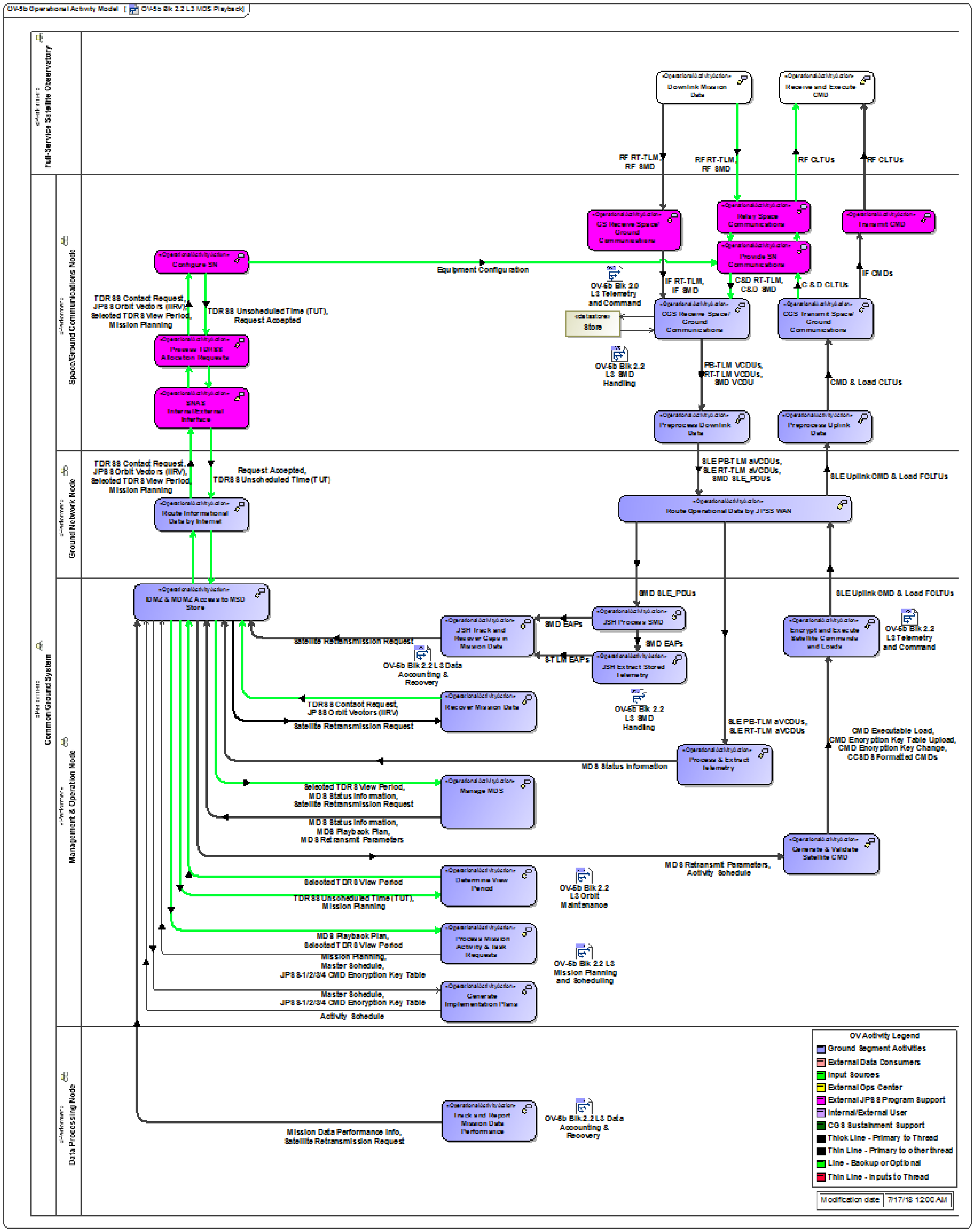


Figure: 6.3.8-10 S-NPP and JPSS-1/2/3/4 MDS Playback Operational Flow Diagram

6.3.8.6 Basic Flow - Polar Ground Station Support

Table 6.3.8-6 describes an operational flow of MDS playback by stored commands from any JPSS polar ground station using the activities and the actions associated with these activities. Additional steps to support retransmissions using the random playback pointer are included and noted for JPSS-1/2/3/4 only.

The MDS playback by real-time commands is detailed in the Data Recovery Basic Flow defined in the Data Accounting and Recovery thread (GS-NML-130).

Table: 6.3.8-6 Basic Flow of MDS Playback by Stored Commands

No.	Actors	Actions	Notes
1	MON JSH, DPN	The MON JSH Track and Recover Gaps in Mission Data activity or the DPN Track and Report Mission Data Performance activity send a Satellite Retransmission Request to the Recover Mission Data activity via the IDMZ & MDMZ Access to MSD Store activity	As data is being received by the JSH or received from the JSH by the DPN, either the JSH or DPN may discover that data is missing or corrupted. The JSH or DPN would then initiate a Satellite Retransmission Request for data from the MDS.
2	CGS	As part of mission planning, the CGS Determine View Period activity predicts the SMD contact access time.	The access time takes into account potential RF Interference (RFI) at a given ground station. TDRSS contact time is based on the confirmed TDRSS contact schedule, which also includes the assigned TDRS ID
3	CGS	The CGS Manage MDS activity plans MDS playbacks based on MDS status and SMD contact access time, and generates a MDS Playback Plan	The CGS OO should generate a TDRS initial pointing vector for each TDRS Ka contact that is included in the antenna position command. See Space Network Support thread for additional information
4	CGS	The CGS Process Mission Activity & Task Request activity integrates the MDS Playback Plan into the Master Schedule	See Mission Planning and Scheduling thread for details
5	CGS	The CGS Generate Implementation Plans activity produces spacecraft activity schedule based on the master schedule	
6	CGS	The CGS Generate & Validate Satellite CMD activity generates command loads.	See Mission Planning and Scheduling thread for details
7	CGS, S-NPP, JPSS-1	The CGS Execute Satellite Commands and Loads activity and Transmit Space/Ground Communication activity	See Telemetry and Command thread for details

No.	Actors	Actions	Notes
		upload the command load to S-NPP, JPSS-1/2/3/4 spacecraft, respectively.	
8	S-NPP, JPSS-1	At predefined time, S-NPP, JPSS-1/2/3/4 spacecraft command their MDS to play back SMD and transmit it to the ground directly.	See Space Network Support thread for scheduling TDRSS SMD support for JPSS-1/2/3/4
9	CGS	The CGS Receive Space/Ground Communications Activity receives the SMD downlink from the spacecraft.	See Stored Mission Data Handling thread for SMD reception and processing
10	CGS	The CGS Manage MDS activity receives MDS status from the CGS Process and Extract Telemetry activity and tracks the MDS playback operations over time. The CGS Manage MDS activity alerts the MOT if it determines that the mission data in the MDS that has not been transmitted is in danger of being overwritten	The Process and Extract Telemetry activity monitors the MDS SOH. The tracking includes history of sequential and random playback pointer locations and start/stop. JPSS-1/2/3/4 MDS status includes record and playback history consisting of mapping between the record pointer and time

6.3.8.7 Alternate Flow – TDRSS Support

Table 6.3.8-7 describes the operational flows of activities needed to support MDS playback using the Tracking and Data Relay Satellite System (TDRSS) that may occur during a contingency scenario.

Table: 6.3.8-7 Alternate Activity Flow for MDS Playback using the TDRSS.

No.	Actors	Actions	Notes
1	MON JSH, DPN	The MON JSH Track and Recover Gaps in Mission Data activity or the DPN Track and Report Mission Data Performance activity send a Satellite Retransmission Request to the Recover Mission Data activity via the IDMZ & MDMZ Access to MSD Store activity	As data is being received by the JSH or received from the JSH by the DPN, either the JSH or DPN may discover that data is missing or corrupted. The JSH or DPN would then initiate a Satellite Retransmission Request for data from the MDS.
2	MON, SGCN	The Recover Mission Data activity sends a TDRSS Contact Request along with JPSS Orbit Vectors (IIRV) to the TDRSS SNAS Internal/ External Interface activity via the IDMZ & MDMZ Access to MSD Store activity and the Internet.	Data recovery is initiated via the TDRSS.

No.	Actors	Actions	Notes
3	SGCN, MON	The TDRSS sends Request Accepted and the available TDRSS Unscheduled Time (TUT) to the MON Determine View Period activity via the TDRSS SNAS activity and the IDMZ & MDMZ Access to MSD Store activity.	The OO picks the best time from the TUT options for sending the command to download the MDS contents. TDRSS contact time is based on the confirmed TDRSS contact schedule, which also includes the assigned TDRS ID. The CGS OO should generate a TDRS initial pointing vector for each TDRS Ka contact that is included in the antenna position command.
4	MON	The Determine View Period activity sends the Selected TDRSS view Period via the IDMZ & MDMZ Access to MSD Store activity to the Manage MDS activity and the Process Mission Activity & Task Requests activity.	Manage MDS needs to know when the command will be sent so that it can choose the correct memory start point for the dump. Process Mission Activity & Task Requests needs the information to generate the schedule for the dump.
5	MON	The Manage MDS activity sends a MDS Playback Plan to the Process Mission Activity & Task Requests activity and sends the MDS Retransmit Parameters to the Generate & Validate Satellite CMD activity. Both are sent via the IDMZ & MDMZ Access to MSD Store activity.	The MDS Playback Plan is needed for Mission Planning. The Retransmit Parameters are needed for constructing the command string to obtain the MDS data dump.
6	MON	The Process Mission Activity & Task Requests activity provides the Master Schedule and JPSS-1/2/3/4 CMD Encryption Key Table to the Generate Implementation Plans activity via the IDMZ & MDMZ Access to MSD Store activity.	These data are used for building the Activity Schedule.
7	MON	The Generate Implementation Plans activity sends the Activity Schedule to the Generate & Validate Satellite CMD activity via the IDMZ & MDMZ Access to MSD Store.	Activity Schedule provides order to the process.
8	SGCN	The SGCN Process TDRSS Allocation Requests activity receives the JPSS Orbit Vectors (IIRV), Selected TDRS View Period, and Mission Planning	Obtain the MDS dump.

No.	Actors	Actions	Notes
		information from the SNAS Internal/External Interface activity via the IDMZ & MDMZ Access to MSD Store activity and uses the information to Configure SN for tracking the satellite, receiving SMD and TLM and for sending the commands to dump the MDS.	

6.3.8.8 Post Condition

As result of MDS playback, the mission data stored onboard S-NPP, JPSS-1/2/3/4 satellites are read back and transmitted to the ground receiving sites.

6.3.8.9 Related Threads

The following is a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-100	Stored Mission Data Handling
GS-NML-130	Data Accounting and Recovery
GS-NML-310	Ground Operations
GS-NNL-150	Space Network Support

6.3.8.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-010-020	Space Operations
CGS-020-010	Mission Planning and Scheduling
CGS-020-020	Orbit Operations
CGS-020-050	Stored Mission Data Handling
CGS-020-080	Data Accounting and Recovery

6.3.9 Reserved

Reserved

6.3.10 Sensor Operations and Payload Support

6.3.10.1 Description

6.3.10.1.1 Introduction

The Sensor Operations and Payload Support (SOaP) thread (GS-NML-500) provides a high level description of the process for ensuring proper operation of the spacecraft instruments. The goal of SOaP is to maintain calibration of the instrument sensors. This thread applies to all JPSS full service missions, such as S-NPP, JPSS-1/2/3/4.

6.3.10.1.2 Instrument Science Teams

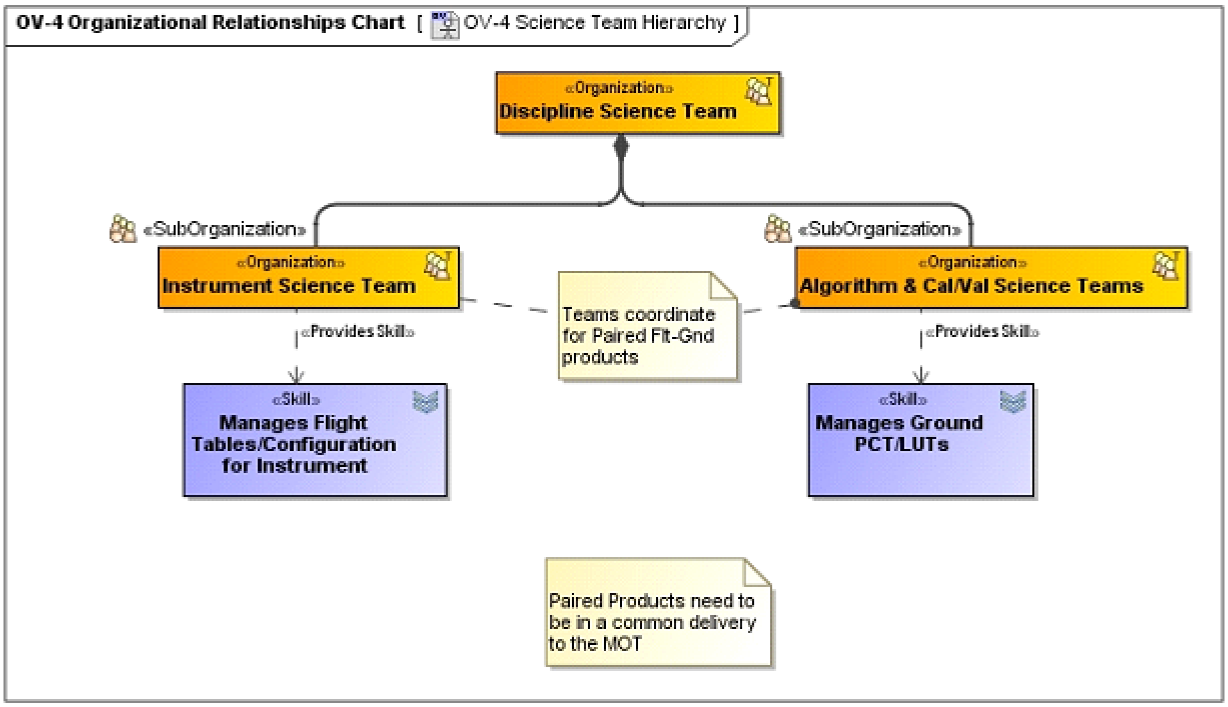


Figure: 6.3.10-1 Science Team Hierarchy

Each instrument on the spacecraft has an instrument science team (IST) that is responsible for maintaining proper calibration and function of the instrument. This is accomplished by monitoring instrument and spacecraft telemetry for anomalous conditions as well as tuning Sensor Calibration Tables or ground-related tables and limits to ensure the best operation of the instrument. The IST's relation to other science teams is shown in Figure 6.3.10-1. The IST may call upon the instrument manufacturer to provide engineering support when needed. If deemed necessary, the flight software of the instrument may be updated. The infrastructure used by the IST to perform their function is part of the Instrument Support Node (ISN). The operations of the S-NPP and JPSS-1 CERES instrument as well as JPSS-2/3/4 RBI instrument are a special case, where the NASA Langley Research Center (LaRC) handles all aspects of the operation and processing of CERES and RBI. The LaRC handles data processing, as well as telemetry monitoring, memory management and command table generation for the instrument. For S-NPP and JPSS-1, the MOT will then generate the spacecraft Detailed Activity Schedule (DAS), which includes CERES and is then verified by LaRC before upload. For JPSS-2/3/4, the MOT will generate the spacecraft Absolute Time Sequence (ATS), which includes RBI and is also verified by LaRC before upload. While LaRC monitors the CERES/RBI telemetry, the MOT is still the first line of action for maintaining health and safety of the instrument.

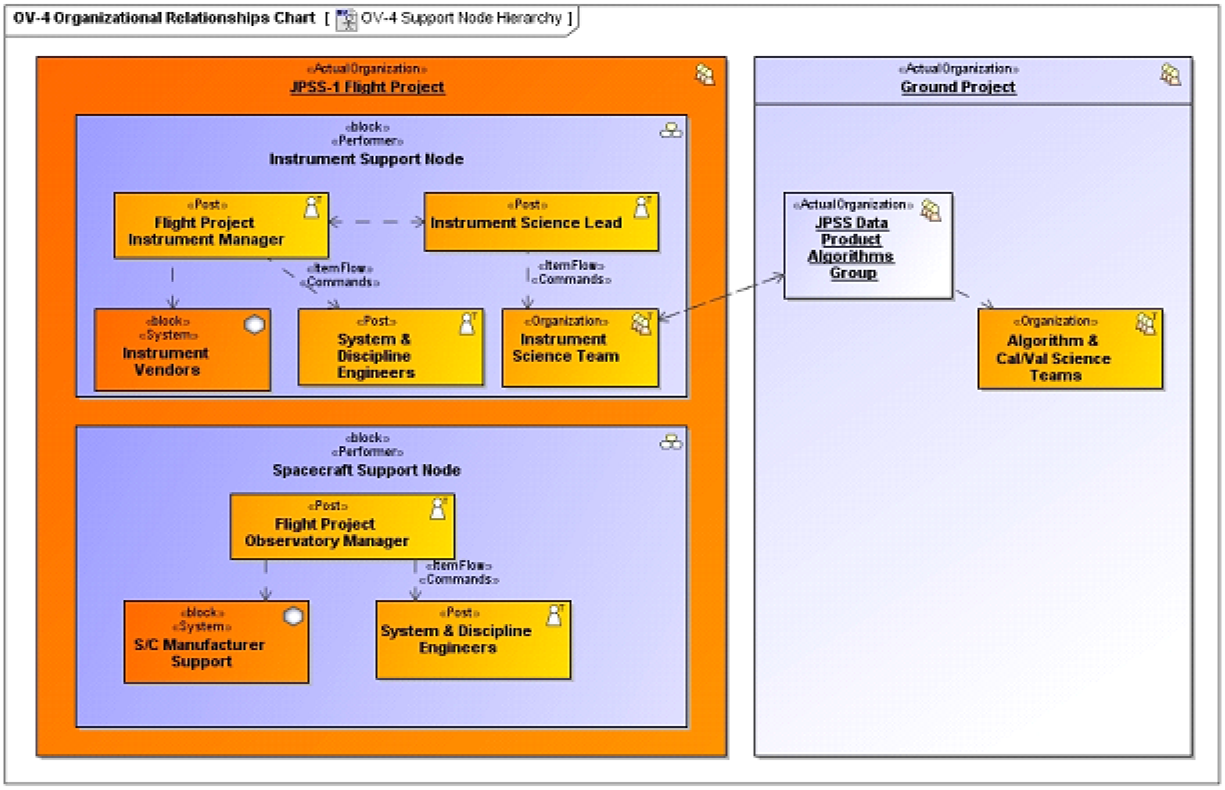


Figure: 6.3.10-2 Support Node Hierarchy

It should be recognized that the Instrument Science Teams for ATMS and CrIS do not have responsibility for any flight tables for the instrument. Those tables are all managed by their respective Instrument Vendor (IV). OMPS and VIIRS have some tables that are managed by the IST and others managed by the IV. For CERES/RBI, its IST directly interfaces with the IV, and JPSS has no interface to that vendor. The Flight Software and Table Update Delivery Process (FUDP), 474-00098, and the Flight Software Update thread document the configuration management of flight software and tables.

The Instrument Support Node (ISN) includes the infrastructure utilized by the IST to perform their roles. The ISN also includes the Instrument Vendors, the Instrument Manager, the Instrument Science Lead as well as relevant system and discipline engineers from the Flight project. The ISN, as illustrated in Figure 6.3.10-2, is managed under the JPSS Flight Project; and interacts with the Algorithm & Cal/Val Science Teams under the Ground project and the Spacecraft Support Node under the Flight project.

6.3.10.1.3 Payload Support

Before Block 2.0, RDRs are reprocessed back into Application Packets (APs) for processing by the Instrument Support Nodes. New capabilities in the Block 2.0 enable the ISNs to receive a complete view of all the received APs associated with the instrument and spacecraft telemetry, as well as the instrument science packets, from a Real-Time (RT) and Playback (PB) telemetry repository and a payload support data repository within the MON. This can allow the instrument

and/or spacecraft vendors to receive the relevant data series and use their in-house tools to help analyze a particular issue.

The RT and PB telemetry (raw or processed) extracted from the telemetry APs can be examined through the local or remote access to the RT and PB telemetry repository. If a sensor analyst needs the original telemetry APs, he/she needs to get an operator with access privilege to move the relevant files from the Life of Mission (LOM) telemetry store to a removable media.

The new payload support capability enables local and remote instrument analysts to access a complete view of relevant application packets as well as the support tools to analyze those packets. This capability will also be available at the alternate MON for continuity of operations if a COOP event is declared.

The payload support data repository captures APs from all JPSS-managed instruments as a separate stream of APs independent of any other AP processing functions. The data, consisting of Stored Mission Data (SMD) and Stored Telemetry (S-TLM), is used for integration and test activities, anomaly resolution, and sensor validation and checkout. The payload support data repository maintains enough storage space to accommodate a minimum of 7 days worth of APs and supports a minimum of twelve concurrent connections. If needed, the system operators can configure a retransmission of data from the Space/Ground Communications Node or JPSS SMD Hub (JSH) 7-day data stores. Users are able to retrieve APs by specifying the desired Application Process Identifier (APID) and time period. The new payload support capability does not perform any detailed analysis of APs. It will only provide users with a means to retrieve APs and view statistics (e.g. APIDS over a period of time) on APs acquired. The users are able to retrieve and transfer data to removable media for transport to another location external to the Ground System (GS) where a more detailed analysis can occur. A related operational thread that takes place in parallel with payload support operations is the Stored Mission Data Handling thread. After the APs are captured, all of the payload support operations are completed on a separate and non-interfering basis with the Stored Mission Data Handling thread.

6.3.10.1.4 Thread Context

In the context of related threads, Telemetry and Command and Mission Support Data Handling provide input telemetry and reports. The Cal/Val thread provides sensor calibration table updates for use in verifying operations, and manages the use of PCTs and LUTs. The FSW Upgrade thread discusses the maintenance of flight tables and ground tables. The Mission Planning and Scheduling thread discusses how the tasking requests generated by this thread are used in conjunction with CERES/RBI stored command and software uploads. The SMD Handling thread discusses the downlink and distribution of stored mission data.

6.3.10.2 Primary Interfaces

The primary interfaces for Sensor Operations and Payload Support is in Figure 6.3.10-3. This includes both external interfaces and inter-system interfaces within the Ground System. Table 6.3.10-1 identifies the types of interface, actors, purpose, types of data, exchange method and frequency, and Table 6.3.10-2 identifies the relevant IRDs/ICDs.

An outside interface is a flow between two external entities.

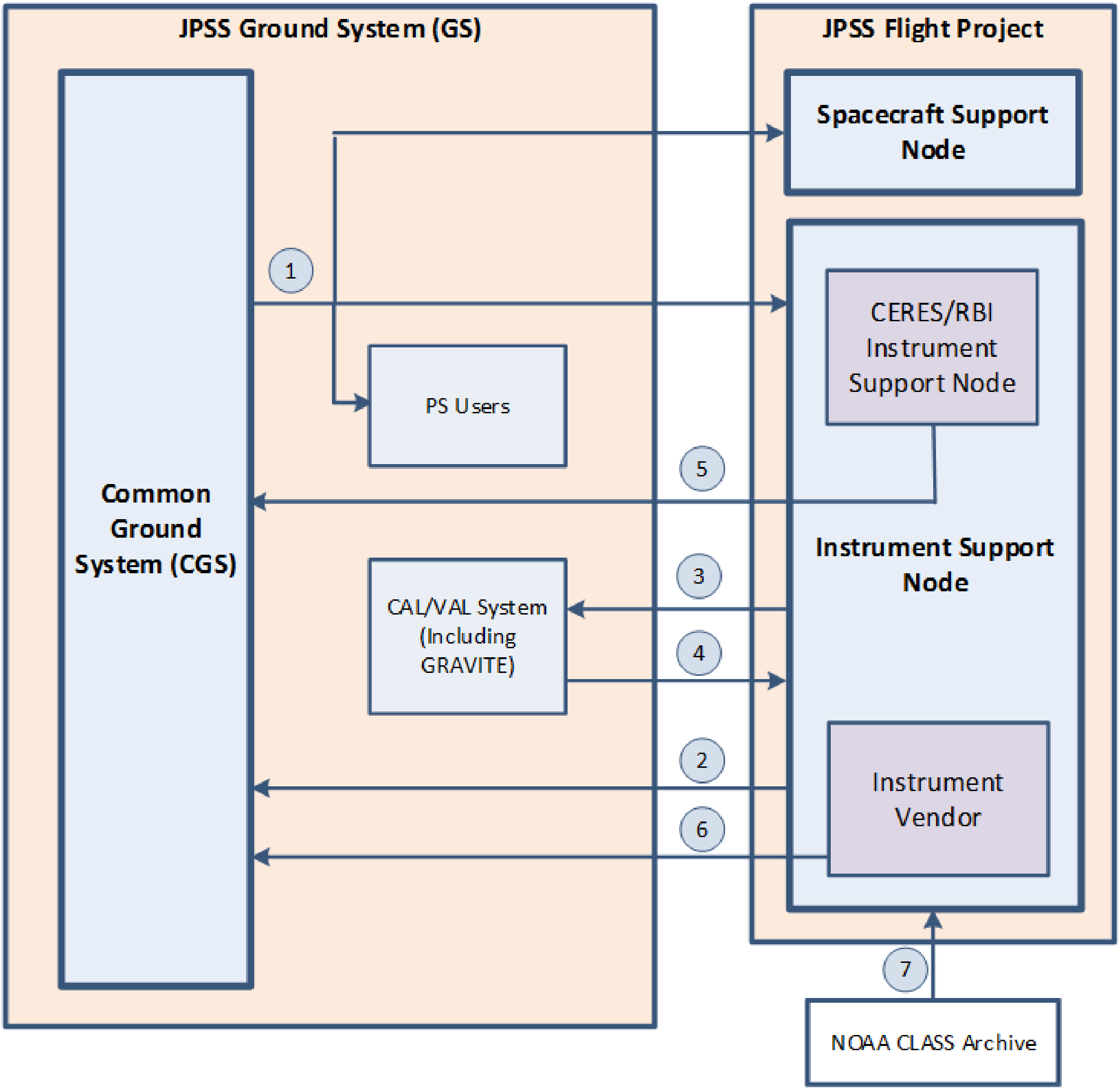


Figure: 6.3.10-3 Sensor Operations / Payload Support Primary Interfaces

Table: 6.3.10-1 Sensor Operations / Payload Support Primary Interfaces

No.	Type	Actors	Purpose
1	Internal, External	CGS to Instrument Support Node (including Instrument Vendors), Spacecraft Support Node & PS Users	Telemetry APs, Telemetry reports, Science APs, baseline Tables, Engineering data, requests for updates. Command Load Verification Report (CERES/RBI only)
2	Internal	CGS, Instrument Support Node	Flight Table updates & support data Instrument issues, anomaly support data and resolutions

No.	Type	Actors	Purpose
3	External	Instrument Support Node, GRAVITE	Request for PCT/LUT Updates
4	Internal	GRAVITE, Instrument Support Nodes	Request for Sensor Calibration Table updates, ≤ 34-day historic science data
5	External	CGS, CERES/RBI Instrument Support Node	CERES/RBI loads, CERES/RBI tasking
6	External	Instrument Vendor, CGS	Flight Software Updates & support data
7	Outside	Instrument Support Node/Instrument Vendor, CLASS	>34-day historic science data

Table: 6.3.10-2 Sensor Operations / Payload Support Primary Interface Documentation

No.	IRD/ICD
1 & 2	JPSS Ground Project to Flight Project IRD (474-00223)
3 & 4	JPSS Ground Project to Flight Project IRD (474-00223)
5	JPSS Ground Project to Flight Project IRD (474-00223)
6	JPSS Ground Project to Flight Project IRD (474-00223)
7	Outside Interface (Uses CLASS public interface)

6.3.10.3 Assumptions & Constraints

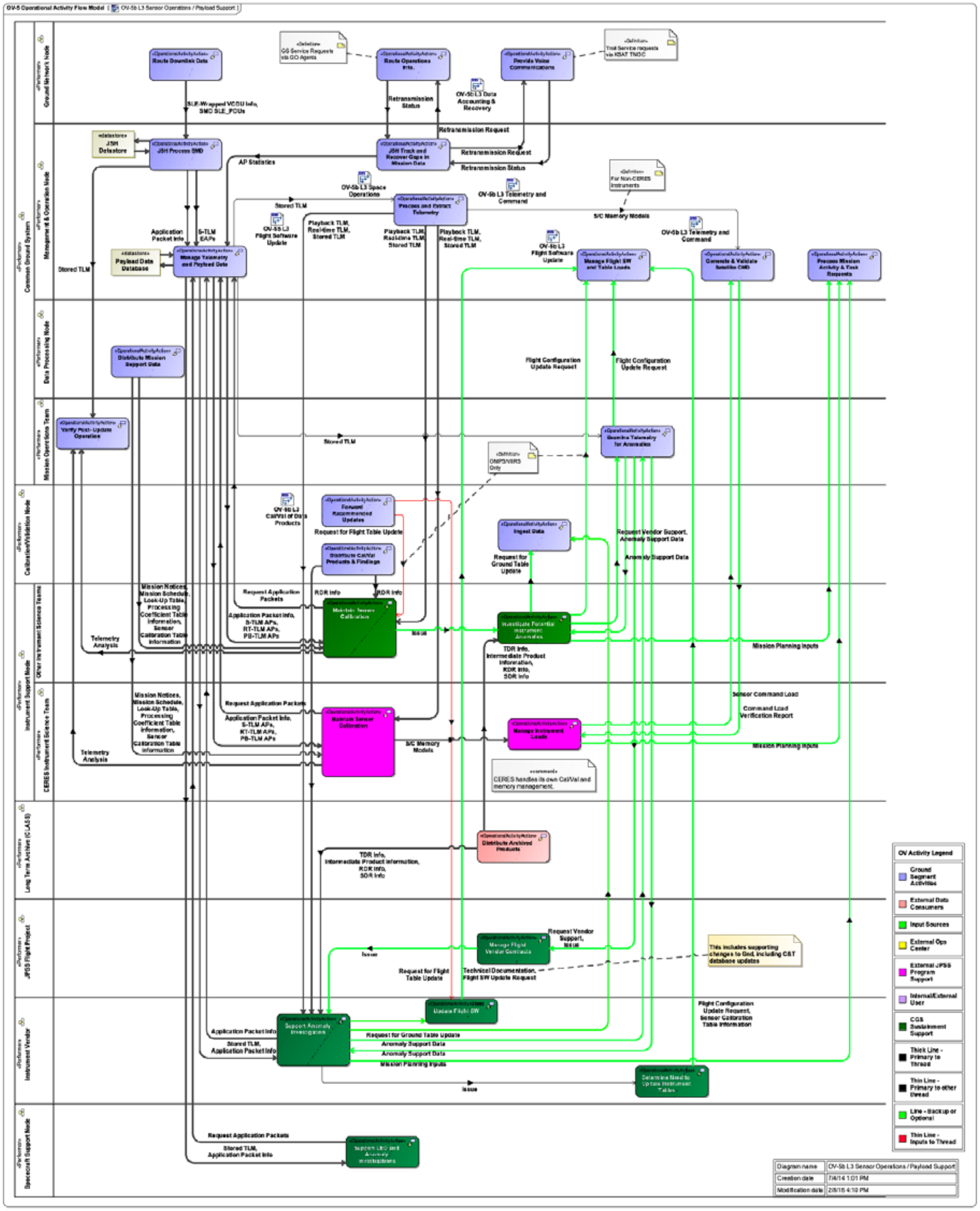
- Spacecraft and instrument telemetry successfully downlinked and routed to MMC.
- Retrieval of AP data will be ordered by time and packet sequence number.

6.3.10.4 Pre-Conditions

- An initial set of instrument tables exists within the ISN system and have been provided to flight operations at the MON into the Mission Support Data service.

6.3.10.5 Operational Flow

The operational flow for Sensor Operations and Payload Support is illustrated in Figure 6.3.10-4. This diagram is an OV-5b view that ties this thread into the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.3.10-4 Sensor Operations / Payload Support Operational Flow Diagram

6.3.10.6 Basic Flow

Table 6.3.10-3 lists a flow of actions performed by the sensor operations and payload support activities for normal data flow.

Table: 6.3.10-3 Sensor Operations / Payload Support Basic Flow (Non-CERES/RBI)

No.	Actors	Actions	Notes
1a	CGS, Instrument Support Node (ISN), Spacecraft Support Node (SSN)	The CGS Manage Telemetry & Payload Data activity disseminates instrument science packets and stored telemetry as available and configured following the processing of the SMD for each satellite pass, to the ISN Maintain Sensor Calibration activity and SSN Support LEO and Anomaly Investigations activity. The Payload Data store maintains data for a minimum of 7 days to allow for limited historical views for the satellite analysts.	The distribution of application packets is limited to 12 concurrent users, either internal or external, or a combination of both.
1b	CGS, Instrument Support Nodes	The CGS Process & Extract Telemetry activity disseminates real-time and playback telemetry, as available and configured following the processing of the T&C for each satellite pass, to the ISN Maintain Sensor Calibration activity.	
2		Reserved	
3		Reserved	
4	Instrument Support Nodes	The ISN Maintain Sensor Calibration activity analyzes instrument and spacecraft telemetry to verify and tune instrument performance. Out of limit violations and anomalous conditions are also identified for the instrument.	
5	Instrument Support Nodes, MOT	If an instrument issue is identified, the ISN Investigate Potential Instrument Anomalies activity will attempt to identify the root cause of the problem and devise courses of action to remediate the issue. The ISN will exchange anomaly support data with the MOT as needed to work the issue. Alternately, if tuning is required the IST will utilize the ISN to perform the necessary corrections. Voice communications may be used to coordinate between the MOT and the ISN(s).	
6	MOT, JPSS Flight Project	If needed by the MOT Examine Telemetry for Anomalies activity, a request for engineering support is made to the JPSS Flight Project's JFP Manage Flight Project Contracts activity by the MOT. This request may be internally generated by the MOT or may be triggered by a request of the IST. The JPSS Flight Project will determine if they will engage the vendor support from the Instrument Vendor	All ATMS and CrIS tables can only be updated through the vendor. Likewise, certain OMPS and VIIRS tables are under the control of their vendor.

No.	Actors	Actions	Notes
			Other tables are at the purview of the MOT and/or IST to modify. All Instrument FSW updates are performed by the vendor.
7	JPSS Flight Project, Instrument Vendor	The JPSS Flight Project engages the Instrument Vendor to provide engineering support in the investigation of anomalies, having the historical knowledge of having built the instrument. Test results and potential resolutions to anomalies are provided to the ISN.	
8	MOT, Instrument Support Node or Instrument Vendor, CGS	The ISN and/or IV will exchange Anomaly Support Data with the MOT as needed to investigate issues. Voice communications may be used to exchange some information, or coordinate activities. For some anomaly resolutions, a flight configuration update is generated and submitted to the CGS MON to update flight tables on the spacecraft and possibly associated ground tables.	See the Flight Software Upgrade thread for details on how the flight table updates are validated and prepared for upload.
9	Instrument Support Node & Instrument Vendor, GRAVITE	In some cases, in the process of resolving an anomaly, updates to the processing coefficients/look-up tables may be required. These updates would be forwarded by the respective ISN or IV to the Cal/Val Node's Ingest Data activity for validation before being fielded to the operational system. In certain cases as directed by the AERB, the validation step is bypassed and GRAVITE will forward the tables for expedited implementation.	See the Cal/Val of Data Products thread for details on how processing coefficients and look-up tables are maintained.
10	Instrument Support Node, JPSS Flight Project	If the sensor operations team determines it needs engineering support from the relevant vendor, the issue to forward to the JPSS Flight Project for them to determine the need to engage contract support from the vendor. If the Flight Project can fund the work, they forward the issue and relevant funding to the vendor to work with the Instrument Support Node to resolve the issue.	All CrIS & ATMS tables and certain tables for VIIRS and OMPS are under vendor control and only they can generate updates.
11	Instrument Vendor, CGS	In rare cases, in the process of resolving an anomaly, updates to the Instrument flight software are required. In these cases, the Instrument Vendor will develop the update and forward to the CGS Manage Flight SW and Table Loads activity for verification, validation and subsequent upload.	See the Flight Software Upgrade thread for details on how the software is validated and prepared for upload.

6.3.10.7 Alternate Flow - Payload Support at MON

Table 6.3.10-4 lists the alternate flows associated with the analyst access to the Payload Support function of the JPSS Ground System.

Trigger: As APs are being processed, the payload support capability will capture APs separately and independent of operational AP processing.

Table: 6.3.10-4 Payload Support Basic Flow

No.	Actors	Actions	Notes
1	CGS	The CGS Manage Telemetry & Payload Data activity captures APs from SMD (including S-TLM) and stores them for a minimum of 7 days.	
2	CGS	The CGS JSH Track and Recover Gaps in Mission Data activity generates statistics (e.g. APIDs over a period of time) on APs acquired. The acquisition statistics are forwarded to the CGS Manage Telemetry & Payload Data activity to store the statistics.	
3	CGS, Payload Support (PS) Users	PS Users retrieve APs and acquisition statistics (e.g. APIDS over a period of time) and are able to copy them to removable media. Users specify the desired APIDs for retrieval and a defined time period. Up to 12 concurrent retrievals for APIDs are supported at a time by the Payload Support function at the MON. Retrievals may be within the MON or authorized users outside the MON.	
4a	PS Users (Internal, I&T)	PS Users use the APs and statistics (e.g. APIDS over a period of time) retrieved from the CGS Manage Telemetry & Payload Data activity to support various tasks and analysis. These tasks generally include, but are not limited to, instrument analysis, anomaly resolution, integration and test events, and system checks.	
4b	PS Users (External, Instrument Vendors)	External PS Users use the APs and statistics (e.g. APIDS over a period of time) retrieved to removable media from the CGS Manage Telemetry & Payload Data activity. The removable media is forwarded to the pertinent users to support various tasks and analysis. These tasks generally include, but are not limited to, instrument analysis, anomaly resolution, integration and test events, and system checks.	

6.3.10.8 Alternate Flow - CERES/RBI Memory Management

Table 6.3.10-5 lists the alternate flows associated with the CERES/RBI instrument memory management. Unlike the other instruments, S-NPP and JPSS-1 CERES instruments as well as JPSS-2/3/4 RBI instruments are wholly managed by LaRC, including the memory & command loads for the instrument.

Table: 6.3.10-5 Sensor Operations / Payload Support Basic Flow (CERES/RBI)

No.	Actors	Actions	Notes
1	CERES/RBI Instrument Support Node	The CERES/RBI ISN Maintain Sensor Calibration activity also manages the usage of memory within the CERES/RBI instrument. A model of the CERES/RBI memory is maintained on the ground based on instrument telemetry received.	
2	CERES/RBI Instrument Support Node	The CERES/RBI ISN Manage Instrument Loads activity will verify CERES/RBI command uploads and flight software/table updates to the CERES/RBI instrument.	By routinely receiving RT-TLM, PB-TLM, and/or S-TLM
3a	CERES/RBI Instrument Support Node, CGS	When new commands are needed for CERES/RBI, the CERES/RBI ISN Manage Instrument Loads activity will submit a Mission Task Request including the requested action for the instrument. The MOT will generate the spacecraft DAS/ATS. A command load verification report is generated for the CERES/RBI operations group at LaRC to review. Upon their concurrence to the MOT, the upload is scheduled and executed.	See the Telemetry & Command thread for details on how the CERES/RBI command load is prepared for upload to the spacecraft. See the Mission Planning & Scheduling thread for details on how the command upload is scheduled.
3b	CERES/RBI Instrument Support Node, CGS	When software updates or table updates are needed for CERES/RBI, the CERES/RBI ISN Manage Instrument Loads activity will send the CERES/RBI flight software load or updated tables to the CGS Generate & Validate Satellite CMD activity for upload to the spacecraft.	See the Flight Software Upgrade thread for details on how the software is validated and prepared for upload.

6.3.10.9 Alternate Flow - Post-Update Verification

Table 6.3.10-6 lists the alternate flows associated with verification of instrument operations subsequent to any modification to the flight software of a JPSS-managed spacecraft.

Table: 6.3.10-6 Sensor Operations / Payload Support Post-Update Verification Flow

No.	Actors	Actions	Notes
1	Instrument Support Node	Subsequent to the upload of a new flight software or flight table load, the ISN Maintain Sensor Calibration activity will examine the instrument telemetry to determine if the instrument is still performing within requirements.	
2	Instrument Support Node, MOT	The MOT Verify Post-Update Operations activity will be notified of the results of the ISN analysis to determine if the update is deemed acceptable from an instrument perspective.	See the Flight Software Upgrade thread for more details.

6.3.10.10 Post Condition

The instrument has been calibrated or its operation verified.

6.3.10.11 Related Threads

The following is a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-150	Cal/Val of Data Products
GS-NML-170	Algorithm Development & Maintenance
GS-NML-140	Mission Support Data Handling
GS-NML-020	Mission Planning and Scheduling
GS-NML-070	Flight Software Upgrade
GS-NML-030	Telemetry & Command
GS-NML-100	Stored Mission Data Handling
GS-NML-130	Data Accounting and Recovery

6.3.10.12 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-040-060	Payload Operations Support

6.3.11 Key Management

6.3.11.1 Description

The Key Management thread (GS-NML-200) describes the capability for the JPSS Ground System to manage and execute secure uplink communication to the S-NPP, JPSS-1/2/3/4 satellites. The System Key Management Plan (SKMP) for the Suomi National Polar-Orbiting Partnership (SNPP) Block 2.0 (474-00595), JPSS-1 SKMP (472-00233), and JPSS-2/3/4 SKMP (472-00718) are the governing documents for key management process.

Command data uplinked to the S-NPP, JPSS-1/2/3/4 satellites, including commands and command loads, is encrypted during normal operations to prevent unauthorized knowledge of or interference with satellite tasking. For S-NPP and JPSS-1, unencrypted command data may be transmitted only in off-nominal conditions such as during spacecraft anomalies or during system testing. For JPSS-2/3/4, command data is always encrypted (except when on the launchpad, unencrypted command is used via the umbilical). S-NPP uses the CARIBOU encryption for command uplink that is certified and managed by the National Security Agency (NSA). JPSS-1/2/3/4 use the Advanced Encryption Standard (AES) algorithm in conjunction with a Counter with a Cipher Block Chaining-Message Authentication Code algorithm (CCM). This AES CCM implementation provides assurance of the confidentiality and authenticity of JPSS-1/2/3/4 command uplink data, and is certified to the National Institute of Standards and Technology (NIST) standards.

The command encryption keys are managed and distributed by the Key Management Authority (KMA). For S-NPP, the KMA is NSA. For JPSS-1/2/3/4, the KMA is the NASA Central Office of Record (COR) Electronic Key Management System (EKMS), hereafter referred to as the NASA EKMS. At each site, the COMSEC Account Manager (CAM) is the local COMSEC authority responsible for key material security.

The JPSS Program Office produces and maintains the plans that address safeguarding measures for the protection of the ground encryption/decryption and spacecraft decryption hardware and keys. These plans also provide guidance for the handling and the use of Government-furnished crypto keying material and outline delivery of command encryption keys (key types, givers/receivers) and command encryption/ decryption devices throughout the program lifecycle. For details of the key management, see the major plans listed below:

- System Key Management Plan (SKMP) for the Suomi National Polar-Orbiting Partnership (SNPP) Block 2.0 (474-00595)
- JPSS-1 System Key Management Plan (472-00233)
- JPSS-2/3/4 System Key Management Plan (472-00718)
- JPSS-1 Key Specification (472-00230)
- JPSS-2/3/4 Key Specification (472-00741)
- AES Nonce Management and Key Selection Recommendations for JPSS-1 System Engineering Report (BATC 2404579)
- AES Nonce Management and Key Selection Recommendations for JPSS-2/3/4 System Engineering Report (Orbital ATK TBS)

The approved encryption scheme is used to ensure satellite commands are sent with confidentiality, authentication, and integrity. While the S-NPP and JPSS-2/3/4 satellite have a fixed set of keys once launched, the JPSS-1 satellite has the capability to receive and use new command Traffic Encryption Keys (TEKs) (aka., command encryption keys) from the ground after launch, providing additional security by replacing command TEKs in the event one or more onboard TEKs become compromised during operations. There are two types of TEKs: the Plaintext (PT) TEKs and the Ciphertext (CT) TEKs. For use on the JPSS-1 satellite, each PT TEK is encrypted (“wrapped”) with a Key Encryption Key (KEK) to become a CT TEK, which is uplinked to the spacecraft as a table load, to ensure the TEKs remain secure during RF transmission. A predetermined number of KEKs are loaded onto each JPSS-1/2/3/4 command receiver prior to launch, and a KEK is used to wrap and/or unwrap any number of TEKs.

The approved encryption and decryption hardware encrypt and decrypt the S-NPP, JPSS-1/2/3/4 satellite commands. The CGS encryption/decryption hardware units are installed in the Mission Management Center (MMC) located at NOAA Satellite Operations Facility (NSOF), the Alternate MMC (AMMC) located at the Consolidated Backup Facility (CBU), and the CGS Support Node (aka the Ground System factory). The command decryption units are located onboard the S-NPP, JPSS-1/2/3/4 satellites, as well as on the flight simulators at MMC and the Ground System Factory. NSA, the S-NPP KMA, provided the CARIBOU keys for S-NPP to the CAMs at MMC, the Ground System Factory, and the Spacecraft Factory prior to launch. For

JPSS-1/2/3/4, the NASA EKMS delivers AES TEKs to the encryption/decryption device supplier, the Spacecraft Factory, MMC, and the Ground System Factory prior to launch and as needed during operations. These keys are stored in the approved security containers at these sites under the custody of local CAMs.

The operational command encryption keys for S-NPP were loaded onto the spacecraft decryption units before launch and cannot be altered as the satellite is on-orbit. The one-time load of operational KEKs and one set of operational CT TEKs must be loaded on the JPSS-1/2/3/4 satellite prior to launch. Additional CT TEKs and, if needed, replacement CT TEKs may be uploaded to the JPSS-1 satellite after launch. The operational keys are also loaded onto the CGS encryption/decryption devices at MMC and AMMC in accordance with the appropriate mission SKMP.

The test command encryption keys are provided to MMC, the Ground System Factory and the Spacecraft Factory to facilitate development, integration, and test activities. The test and operational keys are also used in the test and integration environments throughout the life of each mission. The test keys are also loaded to the FVTS (including FVS, J1Sim, and FSE (beginning in B2.2)).

S-NPP, JPSS-1/2/3/4 utilize an approved synchronous key encryption scheme. During operations, the CGS encrypts and uplinks command data with a command TEK on the ground that matches the TEK active onboard the spacecraft. Therefore to ensure a valid key is used to encrypt command data, CGS must have the knowledge of which command TEKs are active onboard the spacecraft through the telemetry, in which the index of each active TEK onboard the spacecraft is provided. In addition, command TEK change made at MMC must be replicated at AMMC, and vice versa, to ensure both MMC and AMMC have selected the command encryption key currently in use by the spacecraft.

This thread applies to the S-NPP mission and the JPSS-1/2/3/4 mission. The thread will be updated for other JPSS-managed missions when their designs become available. This thread may also need to be updated to reflect changes to the security or key management plans.

6.3.11.2 Primary Interfaces

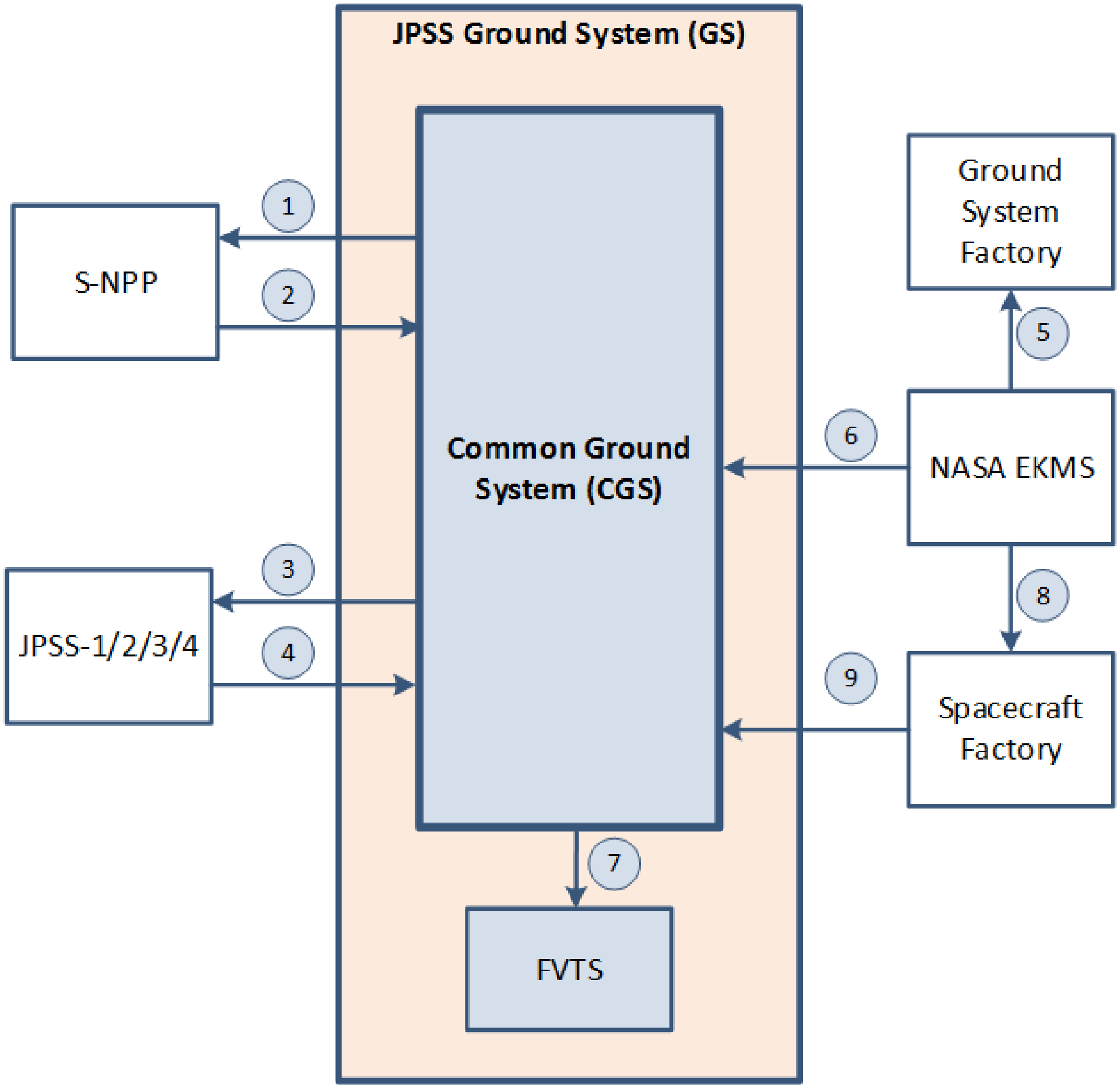


Figure: 6.3.11-1 Command Encryption Key Management Primary Interfaces

Table: 6.3.11-1 Command Encryption Key Management Primary Interfaces

No.	Type	Actors	Purpose
1	External	S-NPP, CGS	S-NPP CMD upload (encrypted)
2	External	S-NPP, CGS	S-NPP real-time TLM downlink
3	External	JPSS-1/2/3/4, CGS	JPSS-1/2/3/4 CMD upload (encrypted)
4	External	JPSS-1/2/3/4, CGS	JPSS-1/2/3/4 real-time TLM downlink
5	External	Key Management Authority (KMA), Ground System Factory	Operational and test command encryption keys KMA is NSA for S-NPP, and NASA EKMS for JPSS-1/2/3/4
6	External	KMA, CGS	Operational and test command encryption keys
7	Internal	CGS, FVTS	Test command encryption keys

No.	Type	Actors	Purpose
8	External	KMA, Spacecraft Factory	Operational and test command encryption keys
9	External	Spacecraft Factory, CGS	JPSS-1 FSW Table containing KEK-wrapped TEKs for uplink

Table: 6.3.11-2 Command Encryption Key Management Primary Interface Documentation

No.	IRD/ICD
1, 2	JPSS Ground Project to JPSS Flight Project IRD (474-00223) NPP Spacecraft S-Band RF ICD to Norway Ground Station (472-REF-00218) NPP S-Band Data Format ICD (472-REF-00055)
3, 4	JPSS Ground Project to JPSS Flight Project IRD (474-00223) JPSS-1 Spacecraft TT&C to GS RF ICD (472-00160) JPSS-1 TT&C Data Format ICD (472-00161) JPSS-2/3/4 Spacecraft TT&C to GS RF ICD (472-00336) JPSS-2/3/4 TT&C Data Format ICD (472-00290)
5, 6, 8	JPSS-1 SKMP (472-00233) JPSS-1 Key Specification (472-00230) NPP SKMP (I40003) JPSS-2/3/4 SKMP (472-00718) JPSS-2/3/4 Key Specification (472-00741)
7	JPSS CGS to FVTS IRD (474-00222) JPSS CGS to FVTS ICD (474-00424) NPP S-Band Data Format ICD (472-REF-00055) JPSS-1 TT&C Data Format ICD (472-00161) JPSS-1 SKMP (472-00233) JPSS-2/3/4 TT&C Data Format ICD (472-00290) JPSS-2/3/4 SKMP (472-00718)
9	JPSS Ground Project to JPSS Flight Project IRD (474-00223) JPSS-1 SKMP (472-00233)

6.3.11.3 Assumptions & Constraints

- Each spacecraft has a primary and a redundant decryption unit. Each unit contains a set of KEKs and TEKs. Commands will be received by both decryption units, but only the active decryption unit will accept and decrypt commands. Details on the encrypted commanding interface are provided in the S-NPP, JPSS-1/2/3/4 space segment to ground segment interface documents listed in Table 6.3.11-2.
- The NSA-provided S-NPP operational command encryption keys onboard the satellite cannot be changed after launch.
- The NASA EKMS--provided JPSS-1 operational command TEK onboard the satellite can be changed after launch, but the KEKs used to encrypt them for transport cannot be changed after launch. Note that JPSS-2/3/4 do not support this capability.
- For both missions, the key change is commanded by MMC at NASA/NOAA discretion. The spacecraft will not change keys autonomously.

- Test keys are loaded to the FVTS EDU only. Keys are not loaded to the software-based FVTS.
- The test keys are loaded onto FSE via the following method (TBS).
- For JPSS-1/2/3/4, the Nonce for each key must always increment and be unique in order for the spacecraft to accept the command, in accordance with the NIST AES standard. The Nonce must be tracked and shared accordingly among the various CAM (reference the AES SER, BATC 2404579, Reference to NGIS (TBS)).
- NASA EKMS doesn't generate CT TEKs. The spacecraft subcontractor generated these keys and retains the ability to re-generate the keys as needed.
- Future TEKs will not be generated until needed. The turn-around time for key generation is short.

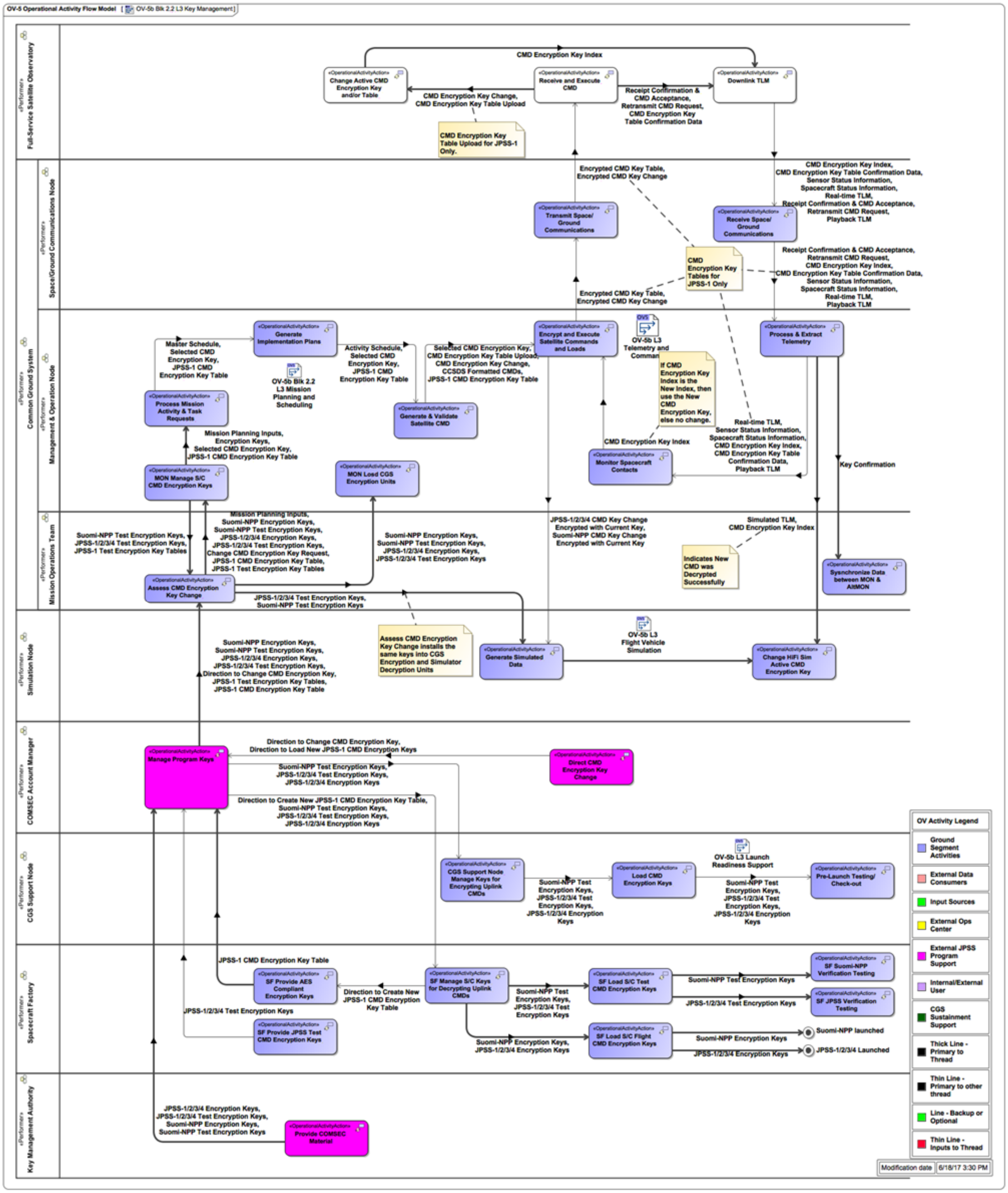
6.3.11.4 Pre-Conditions

- None

6.3.11.5 Operational Flow

The operational flow diagram below describes the events needed to change the command encryption key used onboard the S-NPP satellite, the JPSS-1/2/3/4 satellites, or the FVTS. It also shows interactions for delivery of and maintenance of command encryption keys and their use by spacecraft and ground factories. This operational flow depends on other scenarios and describes the aspects of these scenarios unique to uplink key management. The following actors are involved in this scenario:

- Key Management Authority (NSA for S-NPP, NASA EKMS for JPSS-1)
- COMSEC Account Manager (CAM)
- Mission Operations Team (MOT)
- Management & Operations Node (MON) - a logical representation for MMC and AMMC
- Simulation Node - a logical representation for FVTS
- Spacecraft Factory (SF)
- CGS Support Node (CSN) - a logical representation for the Ground System factory
- Space/Ground Communications Node (SGCN)
- Ground Network Node (GNN)
- Full Service Satellite Observatory (S-NPP, JPSS-1/2/3/4 Satellites)



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.11-2 Command Encryption Key Management Flow Diagram

6.3.11.6 Basic Flow

The series of operational flows below describes the sequence of events needed to initialize or change the command encryption key in use onboard the S-NPP satellite, the JPSS-1/2/3/4 satellite, or the FVTS. The flow starts with the initial delivery and installation of command encryption keys.

Table: 6.3.11-3 Initial Key Delivery and Installation Flow

No.	Actors	Actions	Notes
1	KMA, CAM	The KMA Provide COMSEC Material activity distributes the COMSEC material to CAMs at CGS, CSN, and SF in accordance with the SKMPs.	The COMSEC material includes either or both Operational and Test keys. KMA only provides PT TEKs.
2a	CAM, Mission Operations Team (MOT)	The CAM Manage Program Keys activity accepts the delivery of the COMSEC material. The CAM Manage Program Keys activity provides the keys to the MOT Assess CMD Encryption Key Change activity.	CAM approves and coordinates the loading of keys.
2b	CAM, CSN	The CAM at CSN accepts the delivery of the COMSEC material. The CAM at CSN provides the COMSEC material to the CSN Manage Keys for Encrypting Uplink CMDs activity.	CAM approves and coordinates the loading of keys.
2c	CAM, Spacecraft Factory (SF)	The CAM at SF accepts the delivery of the COMSEC material from KMA. The CAM at SF also accepts the delivery of the COMSEC material from the CAM at the encryption/ decryption device supplier. The CAM at SF provides the COMSEC material to the SF Manage S/C Keys for Decrypting Uplink CMDs activity.	CAM approves and coordinates the loading of keys. The encryption/ decryption device supplier provides the Ciphertext (CT) TEKs.
3a	MOT, MON {CAM oversight}	The MOT Assess CMD Encryption Key Change activity uses the CGS Manage S/C CMD Encryption Keys activity to load the COMSEC material into the ground encryption/decryption units. The CAM will have oversight of this activity and will ensure tamper proof mechanisms are in place.	MOT loads keys to ground system resources (CEPs).
3b	CSN {CAM oversight}	The CSN Manage Keys for Encrypting Uplink CMDs uses the CSN Load CMD Encryption Keys activity to load the COMSEC material into the ground encryption/decryption units to support development, testing, and integration.	

No.	Actors	Actions	Notes
3c	SF {CAM oversight}	The SF Manage S/C Keys for Decrypting Uplink CMDs activity uses the SF Load S/C Flight CMD Encryption Keys activity to load the operational command encryption keys into the spacecraft command decryption units prior to launch. The SF Manage S/C Keys for Decrypting Uplink CMDs activity uses the SF Load S/C Test CMD Encryption Keys activity to load the test command encryption keys into the factory command encryption/decryption units to support development, testing and integration.	Loads keys to spacecraft. For S-NPP the COMSEC material is the TEK. For JPSS-1/2/3/4, KEKs are loaded into flight PROM by the encryption/ decryption device supplier. The initial set of CT TEKs are loaded FSW by the spacecraft vendor

Table: 6.3.11-4 Encryption Key Selection Change Flow

No.	Actors	Actions	Notes
1	CAM, MOT	The CAM Manage Program Keys activity determines the need and provides the direction to change command encryption key to the MOT Assess CMD Encryption Key Changes activity.	The command encryption key is nominally changed once per year or as defined in OSPO operations procedure.
2	MOT, MON	The MOT Assess CMD Encryption Key Changes activity sends the Change CMD Encryption Key Request task to the CGS Manage S/C CMD Encryption Keys activity.	
3	MON	The CGS Manage S/C CMD Encryption Keys activity selects the new command encryption key. The CGS Process Mission Activity & Task Requests activity schedules the key change task.	See GS-NML-020, Mission Planning and Scheduling for scheduling details.
4	MON	The CGS Generate Implementation Plans activity validates the scheduled key change activity.	
5	MON, Space/Ground Communication Node (SGCN), Full Service Satellite Observatory	The CGS Generate & Validate Satellite CMD activity generates the key change command. The CGS Encrypt and Execute Satellite Commands & Loads activity source authenticates and encrypts the key change command with the current command encryption key and transmits it to the satellite via the CGS Transmit Space/Ground Communication activity.	See GS-NML-030, Telemetry and Command, for commanding details.

No.	Actors	Actions	Notes
6	Full Service Satellite Observatory, SGCN	The S/C Change Active CMD Encryption Key and/or Table activity decrypts the command using the current command encryption key, authenticates the key change command, executes the key change command, and sets the active command encryption key to the new key specified in the key change command. The key change command response is returned via downlink telemetry.	The satellite decryption units perform the command decryption, command authentication, and command execution.
7	MON	The CGS Process & Extract Telemetry activity extracts the new command encryption key index from the spacecraft telemetry and generates the engineering value of the new command encryption key index.	
8	MON, MOT	The CGS Monitor Spacecraft Contacts activity confirms the successful command encryption key change on the satellite based on the engineering value of updated command encryption key index. If the key change is confirmed, the CGS Manage S/C CMD Encryption Key activity updates the ground encryption/decryption units using the new command encryption key. If it cannot confirm the new command encryption key is active on the satellite, the CGS will continue using the current command encryption key.	The engineering value of the new command encryption key index is displayed and assessed.
9	MOT, MON	The MOT Synchronize Data between MON & AltMON activity synchronizes the active command encryption key at the MON and AltMON with the new active command encryption key onboard the satellite.	The active command encryption key for a given satellite is synchronized to minimize transition time from one site to another.

The operational flow in Table 6.3.11-5 describes the sequence of events needed to upload new command encryption keys for use on-board the JPSS-1 satellite, or in the FVTS. The flow starts with the delivery and installation of new command encryption keys.

Table: 6.3.11-5 JPSS-1 Command Traffic Encryption Key (TEK) Upload

No.	Actors	Actions	Notes
1	CAM, KMA	The CAM Direct CMD Encryption Key Change activity determines that it is necessary to load new command traffic encryption keys to the JPSS-1 spacecraft.	

No.	Actors	Actions	Notes
		The CAM Manage Program Keys activity sends a request to KMA for new keys.	
2	CAM, SF	The CAM Manage Program Keys activity directs the SF Manage S/C Keys for Decrypting Uplink CMDs activity to prepare one or more command encryption key tables for upload to the JPSS-1 satellite.	
3	KMA, CAM	KMA delivers the new keys to the CAM at SF KMA delivers the new keys to the CAM Manage Program Keys activity.	KMA only provides PT TEKs. KMA also delivers the new keys to the encryption/ decryption device supplier for generating the CT TEKs.
4	CAM, SF	The CAM at SF receives the new keys from KMA. The CAM at SF also accepts the delivery of the COMSEC material from the CAM at the encryption/decryption device supplier. The SF Provide AES Compliant Encryption Keys activity at the Spacecraft Factory prepares the new JPSS-1 command encryption key tables.	The encryption/ decryption device supplier provides the CT TEKs to SF.
5	CAM	The CAM at SF provides the new JPSS-1 command encryption key tables to the CAM Manage Program Keys activity.	
6	CAM, MOT	The CAM Manage Program Keys activity maintains the new command encryption keys and provides the new JPSS-1 command encryption keys and tables to the MOT Assess CMD Encryption Key Change activity. The CAM Manage Program Keys activity directs the MOT Assess CMD Encryption Key Change activity to upload new command encryption key tables.	
7	MOT, MON	The MOT Assess CMD Encryption Key Changes activity sends the key upload task to the CGS Manage S/C CMD Encryption Keys activity.	
8	MON	The CGS Process Mission Activity & Task Requests activity schedules the key upload task.	

No.	Actors	Actions	Notes
9	MON	The CGS Generate Implementation Plans activity validates the scheduled key upload task.	
10	MON, SGCN, Full Service Satellite Observatory (JPSS-1)	The CGS Generate & Validate Satellite CMD activity generates the key upload. The CGS Execute Satellite Commands & Loads activity source authenticates and encrypts the key upload and transmits it.	This command sequence is only valid for the JPSS mission.
11	Full Service Satellite Observatory (JPSS-1), SGCN.	The Satellite Change Active CMD Encryption Key activity receives the command encryption key upload and updates the SCP FSW CBM with the new key tables. The key upload command response is returned via telemetry.	JPSS-1 command encryption key changes are accomplished through the basic flow of this thread via a separate command from the command encryption key upload.
12	SGCN, MON	The CGS Process & Extract Telemetry activity receives telemetry containing key data (table dump) for new command encryption keys uploaded to the spacecraft.	In order to verify the upload, the CBM table must be dumped (Note that the keys, when dumped from CBM, will be KEK-wrapped).
13	MON	The CGS Monitor Spacecraft Contacts activity confirms the successful command encryption key upload on the satellite based on the engineering values of command encryption key data. If the command encryption key upload was not successful, another upload is scheduled per steps 8-12 above.	Command encryption key data is displayed and assessed.
14	MOT, MON	The CGS Load CGS Encryption Units activity loads the new command encryption keys into the active MON’s command encryption units.	Synchronize ground and satellite keys
15	MOT	The MOT Synchronize Data between MON & AltMON activity synchronizes command encryption keys within encryption units at the MON and AltMON with the new command encryption keys onboard the satellite.	All MON sites need to update command encryption units with the keys loaded onboard the satellite to ensure operations can transition from one site to another.

Table: 6.3.11-6 FVS/J1Sim/FSE Test Command Encryption Key Change Flow

No.	Actors	Actions	Notes
1	CAM	The CAM Manage Program Keys activity maintains the S-NPP and JPSS-1/2/3/4 test command encryption keys.	
2	CAM, MOT	The CAM Manage Program Keys activity provides the test command encryption keys to the MOT Assess CMD Encryption Key Change activity.	
3	MON, MOT, Simulation Node (SN)	The MOT Assess CMD Encryption Key Change activity loads the test command encryption keys into the SN Simulate Flight Vehicle activity. The MOT Assess CMD Encryption Key Change activity synchronizes the active command encryption keys in the SN Simulate Flight Vehicle activity and the ground command encryption/decryption unit.	
4	MOT	The MOT Assess CMD Encryption Key Changes activity determines the need to change test command encryption key for FVS, J1Sim, or FSE.	
5	MON, MOT	The MOT Assess CMD Encryption Key Changes activity selects a new test command encryption key for the FVS, J1Sim, or FSE The CGS Process Mission Activity & Task Requests activity schedules the key change task.	
6	MON	The CGS Generate Implementation Plans activity validates the scheduled key change activity.	
7	MON, SN	The CGS Generate & Validate Satellite CMD activity generates a key change command. The CGS Encrypt and Execute Satellite Commands & Loads activity source authenticates, encrypts the change key command with the current command encryption key, and transmits it to the SN Simulate Flight Vehicle activity.	
8	SN, MON	The SN Change HiFi Sim Active CMD Encryption Key activity decrypts the command using the current command encryption key, authenticates the key change command, executes the key change command, and sets the active command encryption key to the new key specified in the key change command. The key change command response is returned via simulated telemetry.	The FVS/J1Sim/FSE CMD decryption unit performs the command decryption, command authentication, and command execution.

No.	Actors	Actions	Notes
9	MON	The CGS Process & Extract Telemetry activity receives the new command encryption key index via telemetry and generates the engineering value of the new command encryption key index.	
10	MOT, MON	The CGS Monitor Spacecraft Contacts activity confirms the successful command encryption key change on the FVS, J1Sim, or FSE via the updated command encryption key telemetry point. If the key change is confirmed, the CGS Manage S/C CMD Encryption Key activity updates the ground encryption/decryption unit that interfaces with the SN using the new command encryption key. The MON will continue using the current command encryption key in the event it cannot confirm the new command encryption key is active in the FVS/J1Sim/FSE.	The engineering value of the new command encryption key index is displayed and assessed.

Table: 6.3.11-7 CGS Support Node Command Encryption Key Management

No.	Actors	Actions	Notes
1	CAM, CSN	CAM at CSN maintains the COMSEC material, including the operational and test keys.	Test keys are for the integration activities. Operational keys are for JCT and used only at the CSN Riverdale facility.
2	CAM, CSN	CAM at CSN provides the keys to the CSN Manage Keys for Encrypting Uplink CMDs activity.	
4	CSN	The CSN Manage Keys for Encrypting Uplink CMDs activity provides the CMD Encryption Key Table to the CSN Load CMD Encryption Keys activity.	
5	CSN	The CSN Load CMD Encryption Keys activity loads the CMD Encryption keys into the CGS Encryption units for the Pre-launch Testing / Check-out.	
6	CSN	The CSN Pre-Launch Testing /Check-out activity uses command encryption keys to verify CGS encryption unit CMD uplink encryption capabilities and to perform factory integration activities.	

6.3.11.7 Alternate Flow

None

6.3.11.8 Post Condition

The MON, AltMON and S-NPP satellite are using the same active command encryption key for the S-NPP command operations.

The MON, AltMON, JPSS-1/2/3/4 satellite have the same command encryption keys loaded for the JPSS-1/2/3/4 command operations.

6.3.11.9 Related Threads

The threads listed below are related to this thread and provide further understanding and clarification.

Thread ID	Thread Title
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-070	Flight Software Upgrade
GS-NML-080	Flight Vehicle Simulation
GS-NNL-130	System Fault Analysis
GS-SAD-110	Launch Readiness Support
GS-NML-220	Security

6.3.11.10 Child Threads

The list of child Operations Concept (OpsCon) threads below flow down from the key management ConOps thread.

Thread ID	Thread Title
CGS-040-010	CGS Key Management
CGS-030-060	Ground System Security

6.3.12 Flight Software Upgrade

6.3.12.1 Description

The Flight Software Upgrade (GS-NML-070) provides a ground system-level end-to-end operational thread that describes the process for changing the spacecraft and instrument Flight Software (FSW), flight tables, and associated ground tables. The process is necessitated by the need for routine maintenances, capability upgrades, and anomaly resolutions. Figure 6.3.12-1 shows the generic process for resolving system issues or anomalies and which ConOps threads activities are involved in this process.

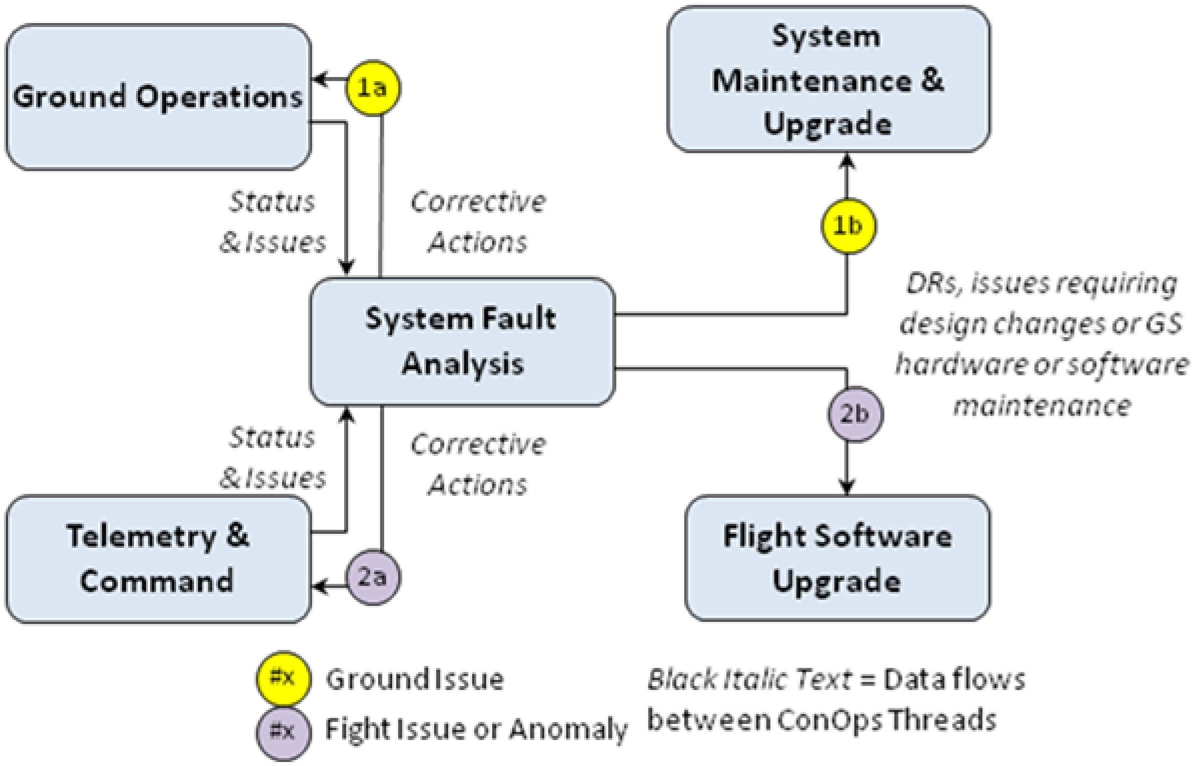


Figure: 6.3.12-1 JPSS Enterprise Issue Resolution Process Flow

As Figure 6.3.12-1 shows, status and issues are provided to the System Fault Analysis (SFA) thread. Activities in SFA determine the corrective action for issues or anomalies. The types of corrective actions from the flows in Figure 6.3.12-1 and the ConOps thread that describes the corrective actions are provided in Table 6.3.12-1:

Table: 6.3.12-1 Corrective Actions & Performing ConOps Threads

No.	Corrective Action	Performing ConOps Thread
1a	Routine commanding or configuration changes on the JPSS Ground System	Ground Operations
1b	Design changes or maintenance actions to the JPSS Ground System	System Maintenance and Upgrade
2a	Routine satellite commanding	Telemetry & Command
2b	Satellite or instrument software changes and/or tables	Flight Software Upgrade

The Flight Software Upgrade flow begins with the approval of change requests and covers through change development, testing and verification, and the version control at the Management and Operation Node (MON). The flow ends with the upload and successful confirmation of the changed FSW and/or installation of updated ground tables. FSW and flight tables encompass any uploadable tables including RAM and EEPROM tables. The destination can be the flight observatory as well as the flight simulator. The ground tables encompass any tunable processing parameters that are used by the Data Processing Node (DPN), and their destination can be the operational environment located at each data processing site as well as the Integration and Test

(I&T) environment. The scenario of the command and telemetry database update is not discussed in this thread but in JPSS Block 2.0 Command and Telemetry (C&T) Database Management Plan (474-00735)

The process outlined in this thread applies to all JPSS-managed satellites, including S-NPP, JPSS-1, JPSS-2 (B2.2), JPSS-3 (B2.2), and JPSS-4 (B2.2) satellites, although specific board names may vary.

There are two variations of processes outlined herein: the nominal process is followed for normal build deliveries, while the expedited process is used where a time-critical change is required.

"Master Copy" reference images are the official FSW code or table images that are maintained at the spacecraft or instrument facilities. Master copy references are the authoritative source and reference copy starting point for creating FSW code changes. Note that a few tables are not maintained by the instrument/spacecraft vendors (as specified in the FSW and Table Update Delivery Process 474-00098 - or FUDP); the Mission Operation Team's (MOT) configuration managed copy of these tables is therefore defined as the Master Copy. The FUDP appendix C specifies ground tables (e.g., Processing Coefficient tables (PCTs)) deliveries which are also addressed in this document. A list of organizations that are responsible for CM of the various Master Copies can be found in the FUDP Tables 3.2.1-2 and 3.2.1-3.

Primary and redundant methods of FSW and flight table file transfer are defined in the FUDP - typically a Secure File Transfer Protocol (SFTP) with JPSS eRooms and hard media transfer backups. For the ground tables, their deliveries are handled through the centralized data format management as described in Section 6.2.5, the Integrated Support thread.

This scenario defines the process and delineates the responsibilities for delivery of FSW and/or table updates after vendor delivery/certification through uplink to spacecraft (or Flight Simulator delivery). Basically, how a need for a FSW/table update should be processed is defined and then the steps to process the vendor deliverables for the update are described. Command tables that define nominal mission ops commanding (e.g., Command Storage Memory (CSM)) are not covered here.

There are special cases, where the flight software table update must be implemented in conjunction with a ground table (e.g., Cal/Val update), otherwise IDPS functionality and data product generation will be disrupted. For changes which impact both flight and ground look up tables, the Algorithm Engineering Review Board (AERB) is the governing group and generation and approval of a Discrepancy Report (DR) is required before implementation. A Work Request (WR) is written, but reference to the DR is necessary. The tables that have flight/ground interdependencies are listed in the JPSS Flight Software and Table Update Delivery Process (474-00098). The process for implementing, verifying and validating the ground system changes is not covered here; it is documented in the JPSS Algorithm Change Process (474-00058).

Flight Vehicle Simulation, Command and Telemetry and Mission Planning and Scheduling threads describe the detail of how updated software/tables are sent to Flight Simulator or satellite. The process GRAVITE uses to make changes to software is described in Cal/Val Data Products thread.

6.3.12.2 Primary Interfaces

Figure 6.3.12-2 illustrates the actors and primary external interfaces involved in the execution of Flight Software Upgrade. Each interface illustrated in the figure, labeled with a number, is described in Table 6.3.12-2 and 6.3.12-3.

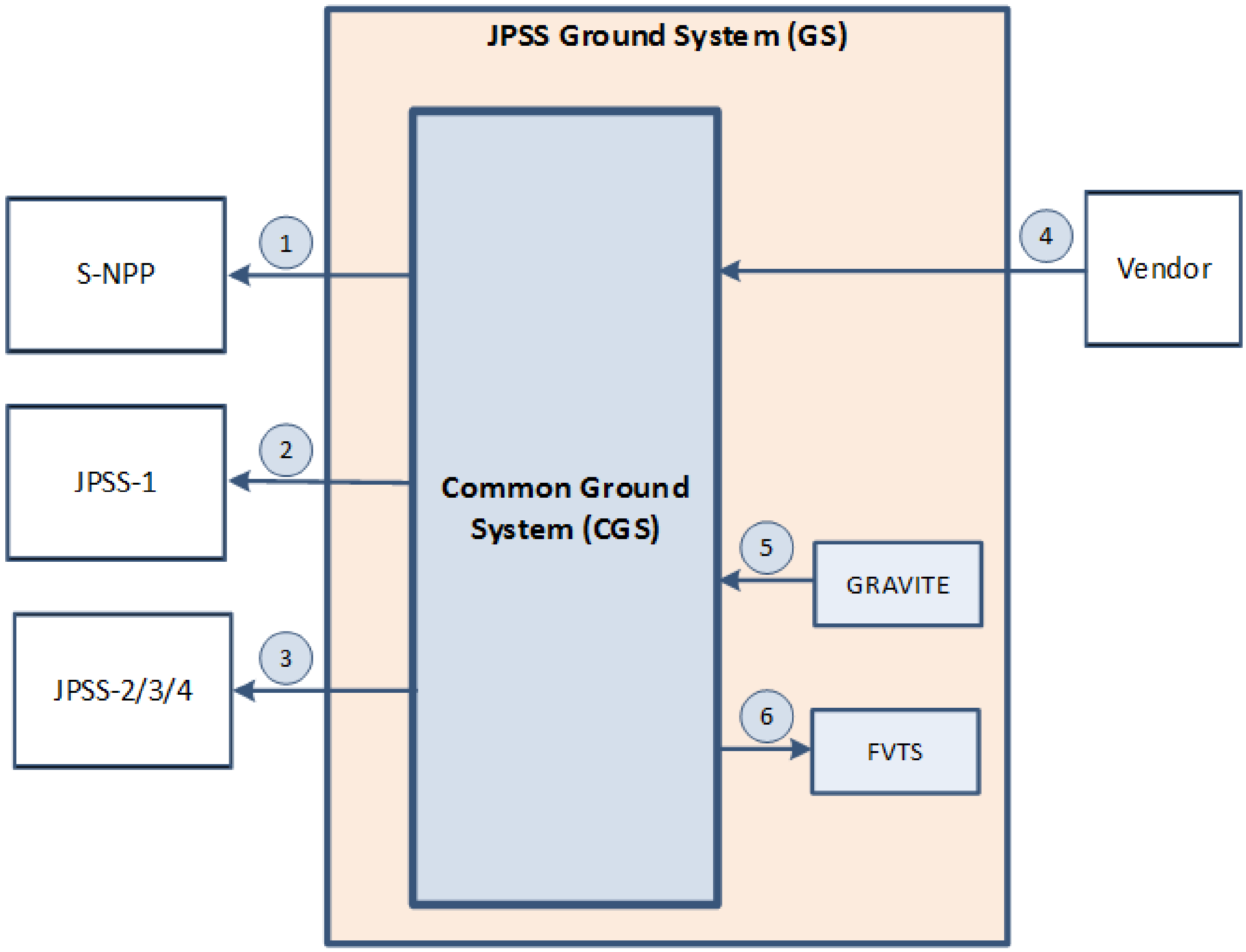


Figure: 6.3.12-2 Primary External/Internal Interfaces for Flight Software Upgrade

Table: 6.3.12-2 Flight Software Upgrade Primary Interfaces

No.	Type	Actors	Purpose
1	External	S-NPP, CGS	CMD upload for flight software upgrade, updated tables
2	External	JPSS-1, CGS	CMD upload for flight software upgrade, updated tables
3	External	JPSS-2/3/4 (B2.2), CGS	CMD upload for flight software upgrade, updated tables
4	External	Vendor, CGS	Request to upgrade flight software, updated flight software

No.	Type	Actors	Purpose
5	Internal	GRAVITE, CGS	Request to upgrade flight software, updated algorithm
6	Internal	Flight Simulator, CGS	CMD upload for flight software upgrade, updated tables

Table: 6.3.12-3 Flight Software Upgrade Primary Interface Documentation

No.	IRD/ICD
1	JPSS Space Segment to Ground Segment TT&C IRD S-NPP Spacecraft S-band RF ICD to the Norway Ground Station S-NPP Spacecraft S-band Data Format ICD S-NPP Command and Telemetry (C&T) XML Database (DB) S-NPP Memory Architecture XML DB
2	JPSS SS-GS TT&C IRD JPSS-1 TT&C to GS RF ICD JPSS-1 TT&C Data Format ICD JPSS-1 Spacecraft to JPSS CGS TT&C ICD JPSS-1 Spacecraft Data Format ICD JPSS CGS-SvalSat ICD JPSS-1 C&T XML DB JPSS-1 Memory Architecture XML DB
3	JPSS SS-GS TT&C IRD JPSS-2/3/4 (B2.2) TT&C to GS RF ICD JPSS-2/3/4 (B2.2) TT&C Data Format ICD JPSS-2/3/4 (B2.2) Spacecraft to JPSS CGS TT&C ICD JPSS-2/3/4 (B2.2) Spacecraft Data Format ICD JPSS CGS-SvalSat ICD JPSS-2/3/4 (B2.2) C&T XML DB JPSS-2/3/4 (B2.2) Memory Architecture XML DB
4	JPSS Ground Project to JPSS Flight Project IRD JPSS CGS to S-NPP & JPSS-1 Spacecraft Vendor ICD S-NPP/JPSS-1/JPSS-2/3/4 (B2.2) C&T XML DB S-NPP/JPSS-1/JPSS-2/3/4 (B2.2) Memory Architecture XML DB
5	JPSS CGS-GRAVITE IRD JPSS CGS-GRAVITE ICD JPSS Data Product Format XML Database
6	JPSS CGS to FVTS IRD JPSS CGS to FVTS ICD

6.3.12.3 Assumptions & Constraints

- System is up and running
- Software and tables are properly under Configuration Management (CM)

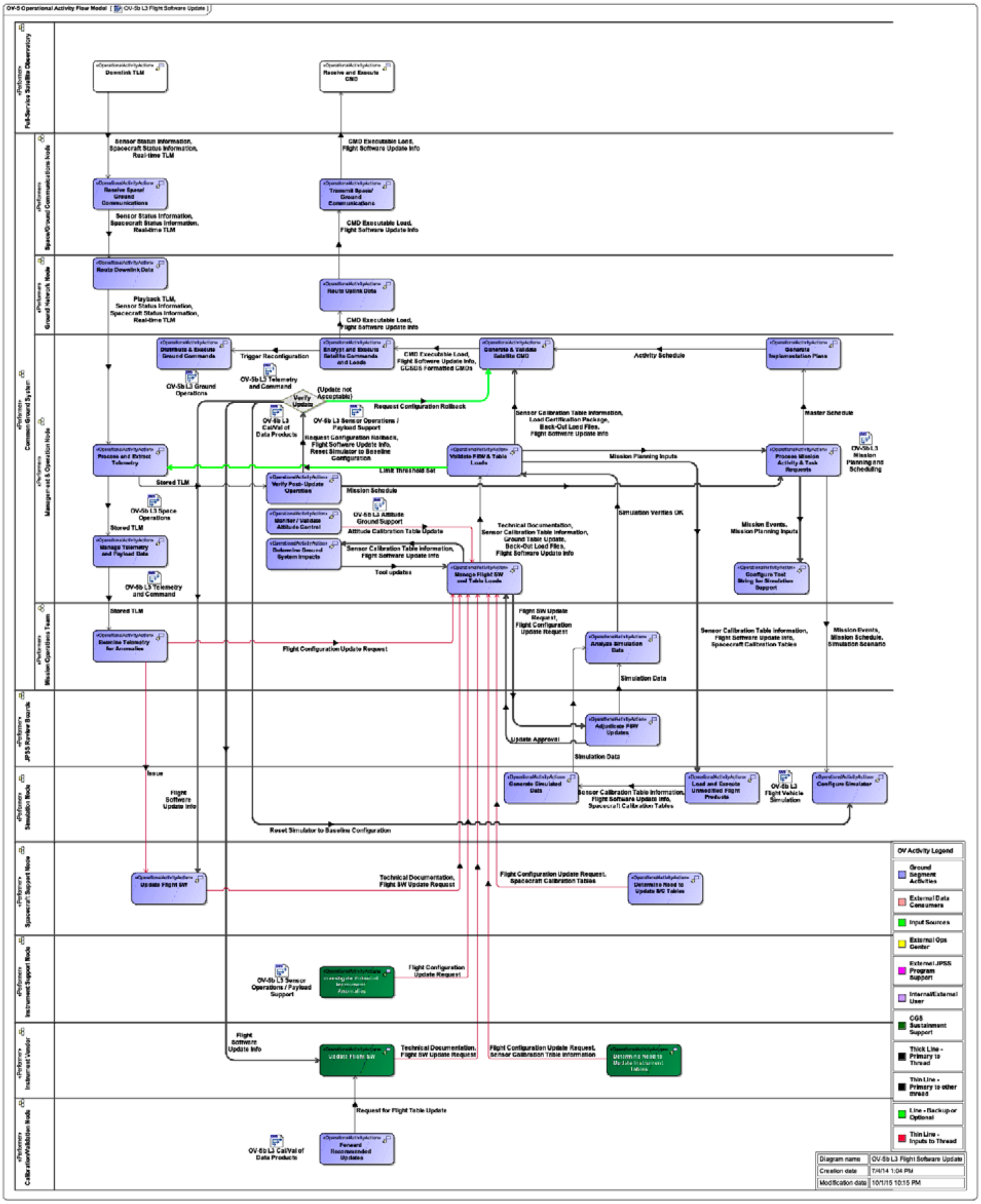
6.3.12.4 Pre-Conditions

- Flight software/table has a bug, or

- Flight software/table needs to be enhanced/updated (including APID/VCID mapping), or
- Extended missions find new re-purposing of on-board capability to add new science to a mission, or
- If associated ground table updates are needed to support ground data processing, they have already been validated by the Algorithm Management Project (AMP).

6.3.12.5 Action Flow

Figure 6.3.12-3 provides an illustration of system actions taking place in the basic flow of the scenario.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.12-3 Flight Software Upgrade Action Flow Diagram

6.3.12.6 Basic Flow

Trigger: Spacecraft support, Instrument Support, CGS MOT, or Cal/Val team needs to upgrade flight software and/or tables.

See FUDP Fig 3.2-1, FSW/Table Update Delivery Process, for the nominal flow.

If expedited/emergency FSW/Table updates are needed, the procedure described in the FUDP section 3.3 “Emergency S/C and Instrument FSW and Table Delivery Process” is to be followed.

6.3.12.7 Post Condition

Flight Software/Tables are upgraded

6.3.12.8 Related Threads

The following list provides the related JPSS Ground System threads that contain helpful information for understanding how specific steps in this thread act or relate to other threads.

Thread ID	Thread Title
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-080	Flight Vehicle Simulation
GS-NML-150	Cal/Val of Data Products
GS-NML-220	Security
GS-NML-400	Integrated Support

6.3.12.9 Child Threads

The following list provides the child threads that are traced to this system thread.

Thread ID	Thread Title
CGS-020-030	Telemetry and Command
CGS-010-020	Space Operations

6.3.13 Flight Vehicle Simulation

6.3.13.1 Description

Flight Vehicle Simulation (GS-NML-080) provides an end-to-end operational thread that describes the simulation needs, interfaces, and activities supporting JPSS Ground System development and integration testing, mission readiness, training, and mission operations. Additionally, this scenario maps the JPSS Ground System needs to two distinct classes of JPSS-1 flight vehicle simulators, and describes the number of planned instances of each class to be deployed. Multi-mission considerations are also addressed.

6.3.13.1.1 JPSS Ground System Needs Mapping to Simulator Class

This thread describes the overall JPSS Ground System data simulation needs, including development testing, system integration & testing, and both pre and post launch mission operations support as well as various simulation capabilities provided to address these needs.

This involves simulation of data produced by the instruments, spacecraft, and portions of the ground system itself.

The JPSS Ground System's Simulation Node provides satellite and ground system simulators to support mission operations as well as integration, test and verification of new capabilities to be fielded. The Flight Vehicle Test Suite (FVTS) performs the functions of the Simulation Node and is responsible for the definition, integration, deployment and sustainment of simulators that satisfy the Ground System data simulation requirements. The FVTS consists of the Flight Vehicle Simulator (FVS), Command and Telemetry Simulator (CTSIM), JPSS-1 Simulator (J1Sim) (B2.2), Flight Segment Simulator (FSE) (B2.2), Ground Link Simulator (GLS), and Simulator Control (SimCtrl) Infrastructure.

The FVS performs the functions of the Simulation Node for S-NPP spacecraft and instrument. The S-NPP Spacecraft CTSIM serves as a backup to the FVS with limited functionality. The J1Sim performs the functions of the Simulation Node for the JPSS-1 satellite. It consists of the OPS and EDU simulators for JPSS-1 and the SimCtrl App. The FSE (B2.2) performs the functions of the Simulation Node for the JPSS-2/3/4 satellite. It consists of the OPS simulator for JPSS-2/3/4 and the SimCtrl App.

The GLS simulates the functions of JPSS ground stations and provides a link between the satellite simulator and the JPSS Mission Management Center (MMC). The SimCtrl Infrastructure provides common functionalities to support the JPSS-1 and JPSS-2/3/4 simulation operations. The J1Sim and FSE share the GLS and SimCtrl Infrastructure.

The required class of a simulator varies according to the application. The most stringent applications for spacecraft and instrument simulators involve the validation of flight software loads and on-orbit anomaly investigations. These applications require the simulator to exhibit flight-like timing behavior of the onboard processing of the actual flight vehicle. Moreover, these hardware based simulators are needed to perform system integration & test verification activities which include Ground System Site Acceptance Tests and for Mission Compatibility Test dry-runs prior to test execution on the actual flight vehicle. These simulators are defined as the EDU-class simulators (which use engineering model unit (EMU) hardware).

Although hardware based EDU-class simulators are necessary for certain applications, their typical reliance on flight-like hardware has several disadvantages, including high cost and a limited ability to handle certain anomaly conditions useful in mission rehearsals and mission operator training. A software-based class of simulators, defined as the Ops-class, is sufficient for many test activities, including test procedure maturation, Factory Acceptance Tests, mission operational readiness preparation, and mission operator training. The following table maps the JPSS Ground System user needs and activity types to the appropriate simulator class. Some activities will use both classes of simulators, taking advantage of the strengths of each.

Table: 6.3.13-1 Mapping between J1 Mission Simulator Classes and Ground System Activities

Segment Support	Activity	Activity Type	Classes	
			Ops	**EDU**
Ground Systems Development (Block Specific)	RTN Integration Testing	Test Execution	x	

Segment Support	Activity	Activity Type	Classes	
	RTN Segment Qualification	Test Execution	x	
	RTN Factory Acceptance Testing	Procedure Development	x	
		Test Execution	x	
	GS Site Acceptance Testing (e.g., Functional Thread Testing)	Test & Procedure Development	x	
		Test Execution	x	x
	GS External Interface Testing	Test & Procedure Development	x	x
		Test Execution	x	x
Support for System Integration & Test (Mission Specific)	Mission Specific Interface Confidence Test (ICT) (e.g., ICT-GW1 for GCOMM-1)	Procedure Development	x	x
		Test Dry Run	x	x
		Test Execution	x	x
	Mission Specific JPSS Compatibility Test (e.g., NCT for NPP)	Procedure Development	x	
		Test Dry Run		x
		Test Execution	actual observatory	
	JPSS GS Regression Tests for System Upgrades (e.g., Block Ground System Test - BGST)	Procedure Development	x	
		Test Dry Run	x	x
		Test Execution	x	x
Support Mission Readiness (Mission Specific)	Mission Operational Readiness Exercise	Procedure Development	x	x
		Test Dry Run	x	x
		Test Execution	x	x
	Mission Operational Readiness Test	Procedure Development	x	x
		Test Dry Run	x	
		Test Execution	x	
	Mission Training & Procedure Certification	Procedure Development	x	x
		Training	x	x
		Certification	x	x
Support for Mission Operation Product	Procedures	Procedure Development	x	x

Segment Support	Activity	Activity Type	Classes	
Development (Mission Specific)				
		Procedure Validation (Change depending on PROC type and gate)	x, and actual observatory	x, and actual observatory
Support for On-orbit Operations	Flight Operations Support	Verification of Flight SW/Table Loads		x
		Anomaly Investigation & Troubleshooting	x	x

Both classes of simulators will simulate the telemetry and commanding for each instrument, the spacecraft, and a number of ground stations for a given mission.

In the course of testing the JPSS Ground System, it is desirable to have the capability to generate and inject data flows at key points in the end-to-end data stream. The Test Data Working Group develops or leverages mission data tools to support the generation of this test data (in the proper formats, of sufficient quality, and of the appropriate volume) at the interface of the GS unit under test to meet a given test objective(s).

The EDU and Ops simulators developed by the Flight Vehicle Test Suite team for the JPSS-1 Mission support the simulation needs for Integration & Test, Mission Readiness, Operations, Training and any other users. For the JPSS-2/3/4 missions, the decision has been made to upgrade the fidelity and capability of the software-based simulators to the point where EDU simulators are no longer necessary. This software based architecture will greatly enhance the programs ability to support high fidelity simulators for the very long projected mission life of the JPSS-2/3/4 missions.

6.3.13.1.2 Multi-Mission Testing and Operations Support

The JPSS Ground System provides a variety of services to multiple missions. It is assumed that EDU and Ops class simulators are needed for JPSS-1. JPSS-2/3/4 will only require an Ops class simulator while S-NPP will only require an EDU-class simulator. For missions whose Flight Operations are not supported (e.g., Metop, GCOM-W1, etc.), mission-specific data generator tools developed by the Test Data Working Group provide the simulated data streams to test the elements of the JPSS Ground System involved in providing the supported services (e.g., Data Acquisition, Data Routing, etc.) Opportunities and concepts for the collaborative use of the EDU and/or Ops class simulators with the mission data generator tools are currently being explored, including multi mission concepts.

The hardware based S-NPP Flight Vehicle Simulator (S-NPP FVS) was inherited from the NPP Program. It deviates substantially from the concept and architectural principles established for the FVTS EDU class simulators. For example, it does not contain high-fidelity instrument simulators (except the VIIRS simulator inherited from the NPOESS program), nor was it designed for sustainability and maintainability. It is therefore a fragile asset that principally supports the flight operations of the ongoing S-NPP mission.

EDU for S-NPP, both the EDU and Ops simulator classes for JPSS-1, and OPS for JPSS-2/3/4 are capable of accepting commands and flowing simulated telemetry data as would the actual flight vehicles. To support multi-mission operations, mission operators may simulate the configurations, commanding, telemetry processing, and simultaneous data flows of multiple satellites concurrently. This is possible because there are multiple instances of the JPSS-1 and the JPSS-2/3/4 Simulators at the NSOF. Each instance may be configured and operated independently.

6.3.13.1.3 Mission Effectivity and Simulator Architectural Evolution

This thread is applicable to the following missions: S-NPP, JPSS-1, and JPSS-2/3/4. Although this thread is primarily allocated to the J1Sim and FSE Systems, the high-fidelity flight vehicle simulation activities pertaining to the S-NPP mission are allocated to the existing EDU-class S-NPP FVS.

For a variety of technical and programmatic reasons, although the FVTS Team is involved in the monitoring and sustainment of S-NPP FVS, it is architecturally distinct from the FVTS System. The S-NPP FVS Simulator will continue to support the Ground Project as long as it is functional. Additionally, due to impacts associated with the JPSS Ground System Re-Architecture decision, modifications to the front end of the S-NPP FVS are necessary so that the S-NPP can continue to support flight operations. The Simulators Team will manage these changes.

Additionally, a software based Ops class S-NPP simulator may be developed to support S-NPP and JPSS-1/2 multi-mission operator training for Block 2.2.

The Test Data Working Group mission data generator tools are applicable to all JPSS Ground System supported missions. These tools have variable interface points along the end-to-end flow. Unlike the EDU and Ops simulators, the data generator tools are not a part of the operational Ground System. Therefore, they are not shown on the interface diagrams or operational activity flow architecture products. Opportunities for coordination and collaborative concepts between the FVTS simulators and Test Data Working Group mission data tools are currently under study.

The JPSS-1Sim String is comprised of the following elements: an observatory simulator (comprised of multiple instrument simulators and a spacecraft simulator), a shared ground-link simulator (GLS), which accepts Ground Operations commands, simulates ground anomalies, and is capable of outputting the simulated observatory telemetry in the data formats of various JPSS ground receptor sites, and an FVTS simulator control application (SimCtrl), which issues control directives, gathers reports, and various status information. The observatory and ground-link simulators each have EDU and Ops fidelity versions. An integrated observatory and ground-link simulator of matching fidelity combined with FVTS simulator control app is capable of supporting a single user at a time conducting testing or training activities. The FVTS Simulator Control module may be flexible enough to support one or more GLS and observatory simulator sets, but at this time the plan is to have one FVTS Simulator Control module per string. An FVTS Instance is a specific deployment (i.e., one or more sets of EDU and/or Ops strings) to a defined facility.

The table below provides the geographic location and configuration of each JPSS-1Sim and JPSS-2/3/4 FSE (B2.2) instance planned for the J-1 and J2/3/4 missions.

Table: 6.3.13-2 JPSS-1Sim and JPSS-2/3/4 FSE Planned Deployment and Applications

J1Sim	FSE	Site	GS Resource	User/Applications
OPS1	OPS1	GTIV	Mini#2 A	FVTS Team/Development
OPS2	OPS2	NSOF	I&T or NSOF A	GP/Verification MOT/Operations
OPS3	OPS3	Riverdale	SOL	RTN/Sustainment
OPS4	OPS4	NSOF	Mini#3 C	MOST/Pre-launch and LEO&A MOT/Operations
OPS5	OPS5	CBU	CBU C	MOST/Pre-launch and LEO&A MOT/Operations
OPS6	OPS6	NSOF	NSOF B or NSOF A	RTN/I&T MOT/Operations
OPS7	OPS7	GTIV	Mini#2 B	FVTS Team/Development
EDU	N/A	NSOF	Mini#3 or NSOF B	MOST/Pre-launch and LEO&A MOT/Operations

6.3.13.1.4 Simulator Users and Operations Summary

There are three specific simulator users in this thread: the Ground System Development Team, the JPSS System Integration & Test (I&T) Team, and the Mission Operations Team (MOT), as illustrated previously by the table "Mapping between JPSS Ground System Activities and Simulator Class". In this thread, the Mission Operations Team is identified as a specific user. For JPSS-1/2/3/4 launch readiness and LEO&A activities, the JPSS Program has defined the responsibilities of the Mission Operations Support Team (MOST) through launch plus at least 90 days till the JPSS-1/2/3/4 operations are transitioned from JPSS Program to NOAA OSPO. See the Launch Readiness Support (GS-MAD-110) and Launch and Early Orbit (GS-MAD-120) threads for more details.

The Ground System Development Team uses the FVTS System for procedure development and system test execution for the following test activities: integration testing, segment qualification, Factory Acceptance Testing (FAT), GS Site Acceptance Testing (SAT), and GS external interface testing. These are at the Functional Thread Tests (FTT) and/or Interface Confidence Test (ICT) levels within the overall GS scope. The JPSS System Integration & Test Team uses the FVTS System for procedure development and system testing including mission specific Interface Confidence Testing, end-to-end Mission Compatibility Testing, and regression testing for GS upgrades known as Block Ground System Testing (BGST). The Mission Operations Support Team uses the simulation capability for mission readiness, (including operational exercises, rehearsals and training), as well as procedure development and certification, procedure validation, verification of flight software and table loads products, and on-orbit anomaly investigation & troubleshooting.

Although each user has different needs, their operational interaction with the FVTS System is similar. Furthermore, from an operational perspective, there are no major architectural

differences envisioned between the Flight Operations supported missions. The simulation capabilities, activities, and interfaces within the JPSS Ground System do not vary significantly from mission to mission. Therefore, the detailed operational flow described in subsequent sections of this document is valid for all users and Flight Operations supported missions.

The operational flow begins with the selection and configuration of a particular FVTS String appropriate to the objective of the procedure development, test or operational support activity. The simulator will return appropriate real-time simulated telemetry, playback simulated telemetry, simulated stored mission data, and status information in response to user inputs (e.g., test or training procedures, configuration commands, software and table loads, etc.). The user is responsible for the observation, analysis, and evaluation of the returned telemetry or stored mission data. The operational flow ends with the restoration of the FVTS String to an approved baseline configuration following the procedure development, test or operational support activity.

6.3.13.1.5 Allocation of Flight Vehicle Simulation Capabilities

As discussed previously, although this thread is primarily allocated to J1Sim and FSE for all Flight Operations supported missions, high-fidelity simulation activities for the S-NPP mission are allocated to the existing hardware based S-NPP simulator, S-NPP FVS. Sustainment of the S-NPP FVS for the S-NPP mission lifetime will adhere to Block 1.N operational procedures and data formats, documented in the S-NPP FVS Operations Manual and following the C3S-FVS ICD or its JPSS Ground Project document equivalent (i.e., CGS-FVS IRD/ICD).

6.3.13.2 Primary Interfaces

The primary interfaces related to this thread involve that between the FSE System and the Common Ground System (CGS), J1Sim System and the CGS and S-NPP FVS and the CGS, and are shown in the figure below. Note that the FVTS System has no interfaces with entities external to the JPSS Ground System. Note that in its current configuration, S-NPP-FVS does not support status reporting to the JPSS Ground System. Each interface is labeled with a number and defined in more detail in tables below.

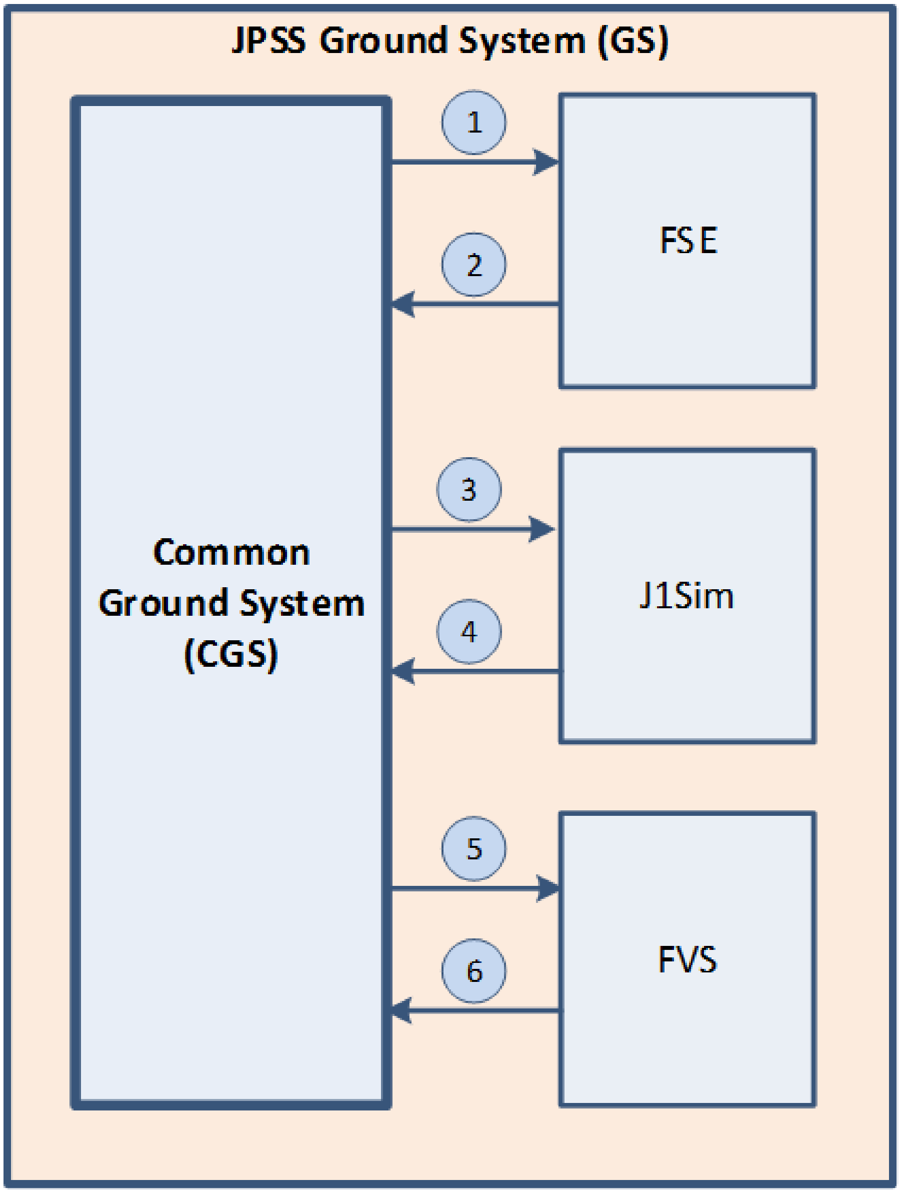


Figure: 6.3.13-1 Flight Vehicle Simulation Scenario Primary Interfaces

Table: 6.3.13-3 Flight Vehicle Simulation Thread Primary Interface Descriptions

No.	Type	Actors	Purpose
1	Internal	CGS → FSE	Flight Software Loads and Table Loads Observatory and Ground-link Commands FSE Control Directives Enterprise Management Data Security Data NTP
2	CGS ← FSE	Real time telemetry, Playback telemetry, and Stored Mission Data	Real time telemetry, Playback telemetry, and Stored Mission Data (Flight Vehicle and Ground-link)

No.	Type	Actors	Purpose
		(Flight Vehicle and Ground-link) Security Incident Sensing Data, Security Notification Enterprise Management Data	Security Incident Sensing Data, Security Notification Enterprise Management Data
3	Internal	CGS → J1Sim	Flight Software Loads and Table Loads Observatory and Ground-link Commands FVTS Control Directives Enterprise Management Data Security Data NTP
4	Internal	CGS → J1Sim	Real time telemetry, Playback telemetry, and Stored Mission Data (Flight Vehicle and Ground-link) Security Incident Sensing Data, Security Notification Enterprise Management Data
5	Internal	CGS → S-NPP-FVS	Flight Software/Table Product Load Flight Vehicle/Ground-link Commands S-NPP FVS Configuration and Control Directives
6	Internal	CGS ← S-NPP-FVS	Real-time, Playback and Stored Mission Data telemetry S-NPP FVS Status information

The table below describes the primary interface documentation for the J1Sim, FSE and S-NPP FVS.

Table: 6.3.13-4 Flight Vehicle Simulation Thread Primary Interface Documentation

No.	IRD/ICD
1, 2, 3, 4	JPSS CGS to FVTS IRD (has JPSS-1 and JPSS-2 effectivity) JPSS CGS to FVTS ICD (has JPSS-1 and JPSS-2 effectivity)
5, 6	JPSS C3S to S-NPP-FVS ICD

6.3.13.3 Assumptions & Constraints

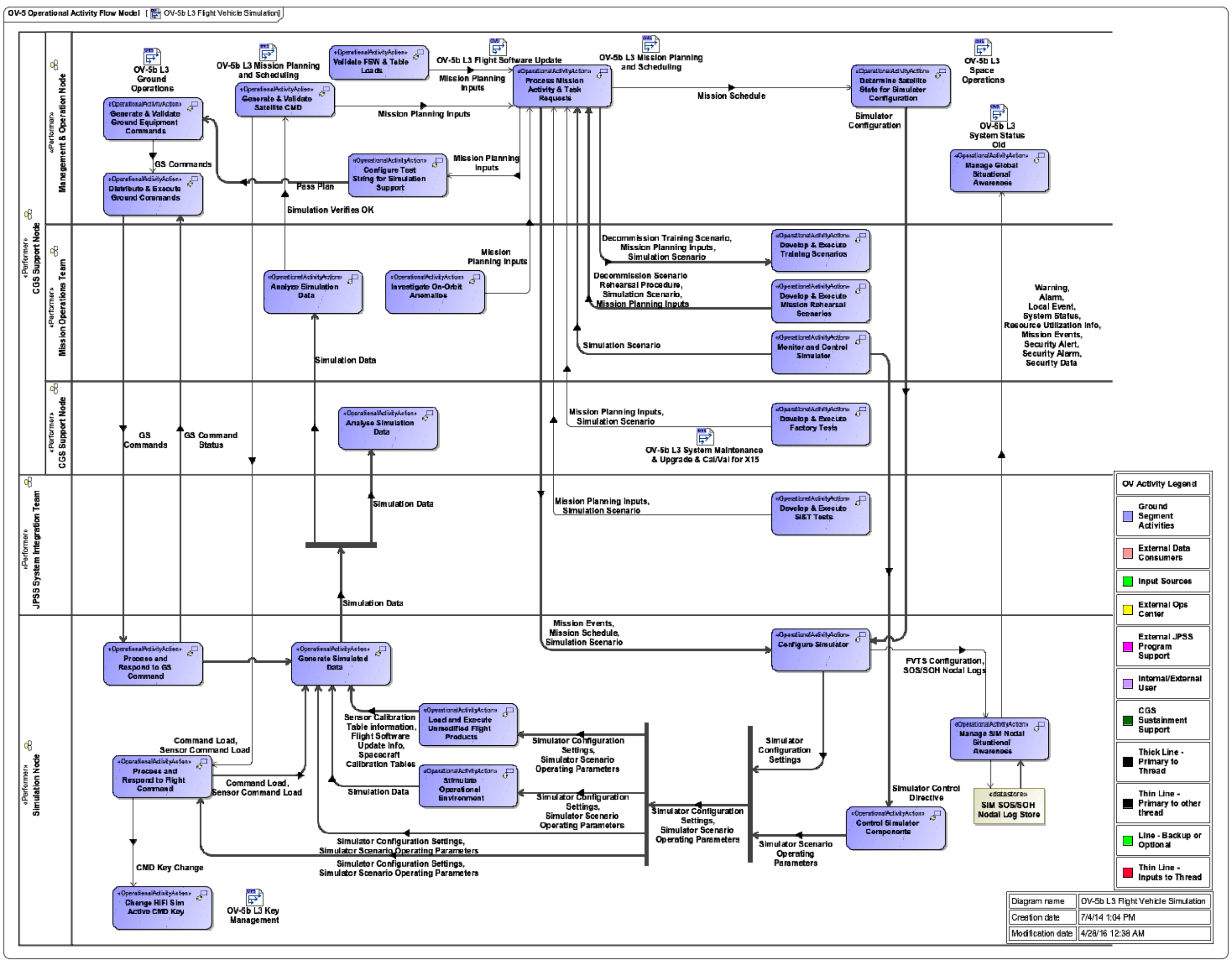
- The following flow does not apply to S-NPP FVS
- An FVTS Operator configures and controls the FVTS System to the appropriate procedure development, test event or operational support activity.
- The user of the flight vehicle simulator is responsible for observing, analyzing and evaluating the telemetry and stored mission data returned by the FVTS System in response to their inputs.

6.3.13.4 Pre-Conditions

- An appropriate FVTS String is available for the objective of the simulation activity.
- The FVTS String up and running, ready to be appropriately configured for the simulation activity to be performed.
- The FVTS user has configuration, test, or operational support procedures, or a flight software or table product load appropriate to the objective of the simulation activity available to be executed by the FVTS String.

6.3.13.5 Operational Flow

The Flight Vehicle Simulation operational activity flow is illustrated in the figure below. This DoDAF OV-5b view illustrates how the flight vehicle simulation thread is tied to other JPSS GS CONOPS thread activities.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.13-2 Flight Vehicle Simulation Operational Activity Flow Diagram

6.3.13.6 Basic Flow

The table below describes the operational activity flow of this scenario using the activities and the actions associated with these activities. The activities are (approximately) listed in time-sequenced steps. Branches describe different operations at a given stage. A rationale and references are contained in the notes column. Note that while the Mission Operations Team (MOT) is described in the table as a specific user, it could be other users such as the System I&T Team or MOST.

Table: 6.3.13-5 Basic Flow of the Flight Vehicle Simulation Thread

No.	Actors	Actions	Notes
1	Management and Operation Node (MON), CGS Support Node (CSN)	The CSN Develop and Execute Factory Tests activity creates and executes the simulation scenarios needed for the Ground System Factory tests. The resulting mission planning inputs, decommission training scenarios, and simulations scenarios are provided to the CGS Process Mission Activity & Task Requests activity for planning and scheduling of factory test events.	
2	MON, System Integration Team	The System Integration Team Develop and Execute SI&T Tests activity creates and executes the simulation scenarios needed for system integration testing. The resulting mission planning inputs and simulations scenarios are provided to the CGS Process Mission Activity & Task Requests activity for planning and scheduling of system integration test events.	
3	MON, Mission Operations Team (MOT)	The MOT Develop & Execute Training Scenarios activity creates and executes the simulation scenarios needed for training. The resulting mission planning inputs and simulations scenarios are provided to the CGS Process Mission Activity & Task Requests activity for planning and scheduling of mission training events.	The figure references the MOT, but it is expected that these functions will be predominantly performed by the MOST.
4	MON, MOT	The MOT Develop & Execute Mission Rehearsal Scenarios activity creates and executes the simulation scenarios needed for mission rehearsals. The resulting scenarios, procedures, and mission planning inputs are provided to the CGS Process Mission Activity & Task Requests for planning and scheduling of mission rehearsals.	While the diagram shows the MOT executing Mission Rehearsals, it is expected that this will be done by the MOST.
5	MON, MOT	The MOT Investigate On-orbit Anomalies activity creates and executes the simulation scenarios needed for on-orbit anomaly investigations. The resulting mission planning inputs are provided to the CGS Process Mission Activity & Task Requests activity for planning and scheduling of on-orbit anomaly investigations.	

No.	Actors	Actions	Notes
6	MON, Simulation Node	The CGS Process Mission Activity & Task Requests activity processes inputs from many different sources and users and sends the resulting mission schedule to the CGS Determine Satellite State for Simulator Configuration activity. It also generates mission planning inputs and sends it to the CGS Configure Test String for Simulation Support activity.	These inputs are used to configure the simulator, in addition to other simulator control directives that may be issued by the FVTS operator and/or the MOT.
7	MON, Simulation Node	The CGS Process Mission Activity & Task Requests activity produces the mission events, schedule and scenarios and sends them to the Simulation Node Configure Simulator activity. The CGS Determine Satellite State for Simulator Configuration activity processes mission schedules and sends the resulting simulator configuration to the Simulation Node Configure Simulator activity.	After interrogating the current satellite state, MON may determine that no change to the satellite state is needed for the specific simulation.
8	Simulation Node	The Simulation Node Configure Simulator activity configures the simulators based on the mission event, simulation scenario, mission schedule, and simulator configuration inputs. The resulting simulation configuration and simulation scenarios are forwarded to the appropriate Simulation Node activities.	
9	MOT, Simulation Node	The MOT Monitor and Control Simulator activity provides simulator control directives to the Simulation Node Control Simulator Components activity.	The control directives may be used to further configure the simulator or to inject anomalies.
10	Simulation Node	The Simulation Node Control Simulator Components activity manages appropriate simulator components based on the simulator control directives. The FVTS Simulator Control module will process the control directives. The resulting simulation configuration and scenarios are forwarded to the appropriate Simulation Node activities.	
11	MON	Using the mission planning inputs provided by the CGS Process Mission Activity & Task Requests activity, the CGS Configure Test String for Simulation Support activity generates the Pass Plan to set up the CGS Test String. It sends the resulting Pass Plan to the CGS Generate & Validate Ground Equipment Commands activity.	
12	MON	Using the Pass Plan, the CGS Generate & Validate Ground Equipment Commands activity produces and validates the GS commands to control the ground equipment. It outputs GS commands to the	

No.	Actors	Actions	Notes
		CGS Distribute & Execute Ground Commands activity.	
13	MON, Simulation Node	The CGS Distribute & Execute Ground Commands activity distributes the GS command to the Simulation Node Process and Respond to GS Commands activity, which provides the GS command Status in return.	
14	Simulation Node	The Simulation Node Process and Respond to GS Commands activity forwards the received GS commands to the Simulation Node Generate Simulated Data activity. These commands will be used to configure the simulation of ground stations.	
15	MON	The CGS Generate and Validate Satellite CMD produces the validated satellite command loads. It forwards the validated command loads to the Simulation Node Process and Respond to Flight Command activity for execution on the Simulator via the CGS Encrypt and Execute Satellite Commands & Loads activity.	
16	Simulation Node	The Simulation Node Process and Respond to Flight Command activity accepts the command loads and forwards them to the Simulation Node Generate Simulated Data activity. When dealing with encrypted command loads, it is sometimes necessary to change the encryption key. When that is necessary, the CMD key change request is sent to the Simulation Node Change HiFi Sim Active CMD Key activity.	
17	Simulation Node	The Simulation Node Change HiFi Sim Active CMD Key activity accepts the CMD key change request and uses that information to update the appropriate encryption keys.	
18	MON, Simulation Node	The CGS Validate FSW & Table Loads activity produces validated flight software and table loads and forwards the load to the Simulation Node Load and Execute Unmodified Flight Products activity via the CGS Generate & Validate Satellite CMD activity, the CGS Encrypt and Execute Satellite Commands & Loads activity, and the Simulation Node Process and Respond to Flight Command.	
19	Simulation Node	The Simulation Node Load and Execute Unmodified Flight Products activity accepts the flight software and table loads. The activity analyzes the loads and the information is then passed to the Simulation Node Generate Simulated Data activity.	The EDU simulator processes unmodified flight loads. Both the EDU and the Ops simulators are

No.	Actors	Actions	Notes
			expected to process unmodified tables.
20	Simulation Node	The Simulation Node Simulate Operation Environment activity uses the simulator configuration and simulation scenario inputs to update the internal models. The resulting simulation data is provided to the Simulation Node Generate Simulated Data activity.	
21.1	Simulation Node, CGS	The Simulation Node Generate Simulated Data activity takes the inputs from all of the various factors that affect the models and generates appropriate real-time, playback, and stored TLM as well as Stored Mission Data (SMD). The data is forwarded to the CGS Process & Extract Telemetry activity and the CGS Route Downlink Data activity for processing and analysis. If configured, the CGS Route Downlink Data activity forwards the simulated SMD to the CGS Ingest Mission Data activity for further processing and analysis.	
21.2	Simulation Node, CSN, MOT	The Simulation Node Generate Simulated Data activity takes the inputs from all of the various factors that affect the models and uses that data to generate simulation data. This data is provided to the CSN Analyze Simulation Data activity and the MOT Analyze Simulation Data activity for analysis.	
22	CGS, CSN	The CSN Analyze Simulation Data activity accepts the simulation data and assesses the outcome of the ground system test performed against the simulator.	Steps 22 and 23 involve assessing the outcome of the simulation, and are performed by the respective simulator users.
23	CGS, MOT	The MOT Analyze Simulation Data accepts the simulation data and assesses the outcome of the simulation activity.	
24	Simulation Node, CGS	The Manage SIM Nodal Situational Awareness activity collects enterprise management data and security data; and forwards them to the CGS Manage Global Situational Awareness activity.	
25	CGS	The CGS Manage Global Situational Awareness activity accepts the various enterprise management data and security data provided by the Simulation Node. This data is used to generate reports and further monitor the health and safety of the simulators.	

6.3.13.7 Alternate Flow

None identified.

6.3.13.8 Post Condition

The expected output from each simulation event is behavioral responses in simulated real-time, playback and stored mission data telemetry to support the various testing and training program activities identified previously.

6.3.13.9 Related Scenarios

The table below lists other Ground System threads related to the Flight Vehicle Simulation thread. The relevant activities (including data input/output and transformations) from each corresponding thread are illustrated in the OV-5b architectural diagram above.

Thread ID	Thread Title
GS-NML-310	Ground Operations
GS-NML-020	Mission Planning and Scheduling
GS-NML-070	Flight Software Update
GS-NML-300	System Status
GS-NML-320	Space Operations
GS-NNL-140	System Maintenance & Upgrade
GS-NML-200	Key Management
GS-NML-220	Security
GS-MAD-110	Launch Readiness Support
GS-MAD-120	Launch and Early Orbit

6.3.13.10 Child Threads

The FVTS System development team is conducting a number of studies and analyses to define lower-level child threads of nominal and anomalous FVTS System behaviors, based in part on the following documents and data sources: S-NPP Mission Rehearsal Plan, S-NPP Compatibility Test Procedures, S-NPP Flight Vehicle Simulator Lessons Learned Document, JPSS-1 System Fault Detection Systems Engineering Report. These threads will be used to develop the FVTS Concept of Operations and provide a basis for the integration and test scenarios.

Thread ID	Thread Title
CGS-020-040	FVS Operations
FVTS	System Power-up
FVTS	System Shutdown
FVTS	User Account Management
FVTS	Vulnerability Remediation
FVTS	Update Simulator Software
FVTS	Restore From Protected Backup
FVTS	Simulation Startup
FVTS	Launch Mode
FVTS	First Acquisition State
FVTS	Early Orbit

Thread ID	Thread Title
FVTS	Normal Operations
FVTS	Safehold
FVTS	Maneuver Planning/Operations
FVTS	FVTS Interface Configuration
FVTS	FVTS Connect for Use
FVTS	Freewheel
FVTS	Back-Orbit Dropout
FVTS	Anomaly Injection
FVTS	Flight Configuration Change
FVTS	FVTS System Troubleshooting
FVTS	Execute Self-Test
FVTS	On-Orbit Anomaly Investigation

6.3.14 Decommissioning

6.3.14.1 Description

The Decommissioning (DEC) thread (GS-MAD-150) describes the planning, scheduling, execution and close-out of a JPSS-managed satellite that reaches the end of its mission life. The thread addresses disposal of the spacecraft and disposition of related ground system components. The operational flows apply to all JPSS-managed satellites, including S-NPP, JPSS-1/2/3/4. The scope of this thread includes ground system activities during all phases of the mission relevant to decommissioning. This thread does not address other decommissioning activities executed by the project, such as close-out of contracts, etc. The flow of this thread is segmented into four stages as listed below.

- Planning & Preparations to the Transition to NOAA
- Operations & Sustainment to the Decommissioning Review
- Scheduling and Execution to the Disposal Review
- Passivation & De-Orbit to Mission Close Out

Operational control of the JPSS-managed satellites, orbits and ground system is allocated to the JPSS Common Ground System (CGS). The CGS capabilities include orbit prediction and control, mission planning & scheduling, mission support data collection, data distribution & archival, and ground system management (including IT Networks). While these same capabilities are exercised during normal operations, additional functionality and/or execution of specific tasks is required to support the Decommissioning phase.

This thread discusses the overall plan for decommissioning of the space and ground components for JPSS-managed missions as it applies to the utilization and maintenance of the JPSS Ground System. The information it contains is based on the requirements and guidelines presented in applicable and reference NASA/GSFC standards (STD), NASA Procedural Requirements (NPR) and GSFC Procedural Requirements (GPR) which apply while the mission is NASA-managed and are followed when NOAA-managed. Documentation produced as a result includes, at a

minimum, the Orbital Debris Assessment Report (ODAR), the End-of-Mission Plan (EOMP), Mishap Contingency Plan (MCP) and several subordinate documents or products.

This thread addresses the operational and ground system activities resulting from the items listed below related to the decommissioning and disposal of the satellite as called out by NPR 7120.5E NASA Space Flight Program and Project Management Requirements:

- Update and use of the End-of-Mission Plan (EOMP), including method and location of disposal, planned status of satellite after disposal, schedule, safety and environmental considerations, etc.;
- Use of the Mishap Contingency Plan (MCP) and pre-defined contingency/mishap scenarios;
- Notification of stakeholders and customers of the intent to decommission the satellite and subsequent decommissioning events and tasks;
- Archive of science, operations and engineering data;
- IT Network modifications to maintain communications security, if necessary;
- Disposition of applicable hardware, software and facilities remaining on the ground;
- Retaining capability for long-term processing / re-processing of data.

Decommissioning (DEC) interfaces with internal and external stakeholders, conducts long-term planning of satellite tasks such as satellite passivation and de-orbit maneuvers, provides data supporting mission management activities, archives MSD and provides the capability for future re-processing of the data. Examples of such management activities include presenting decommissioning artifacts at several agency-level reviews, determining need to decommission, notifying stakeholders of proposed/planned decommission activities, coordinating of space and ground operations, planning and execution of activities to delete spacecraft energy sources (i.e. spacecraft passivation), etc. Roles and responsibilities applicable to this process are defined in the mission Decommissioning Plan.

This thread supports the following reviews and events. NASA reviews and events relevant to decommissioning prior to transfer of the mission to NOAA include, but are not limited to:

- Mission Critical Design Review (MCDR)
- Key Decision Point- D (KDP-D)
- Safety & Mission Success Review (SMSR)

Entry criteria for these reviews include development and maintenance of several documents listed in the references.

Following transition of the mission, NOAA guidelines apply to the process. Utilization of the NASA review process is at the discretion of NOAA. The nominal sequence of decommissioning reviews & events is as follows:

- Decommissioning Review (DR)
- Formal Notice to Decommission

- Key Decision Point-F (KDP-F)
- Disposal Review

Inputs to the process come from the End-of-Mission Plan (EOMP), Mishap Contingency Plan (MCP) and other mission-specific documentation providing implementation details supporting the decommissioning activities.

Outputs support planning, scheduling, mission-level simulation, execution and final close-out. During this phase, a large number of products are produced servicing a large group of stakeholders requiring various levels of detail.

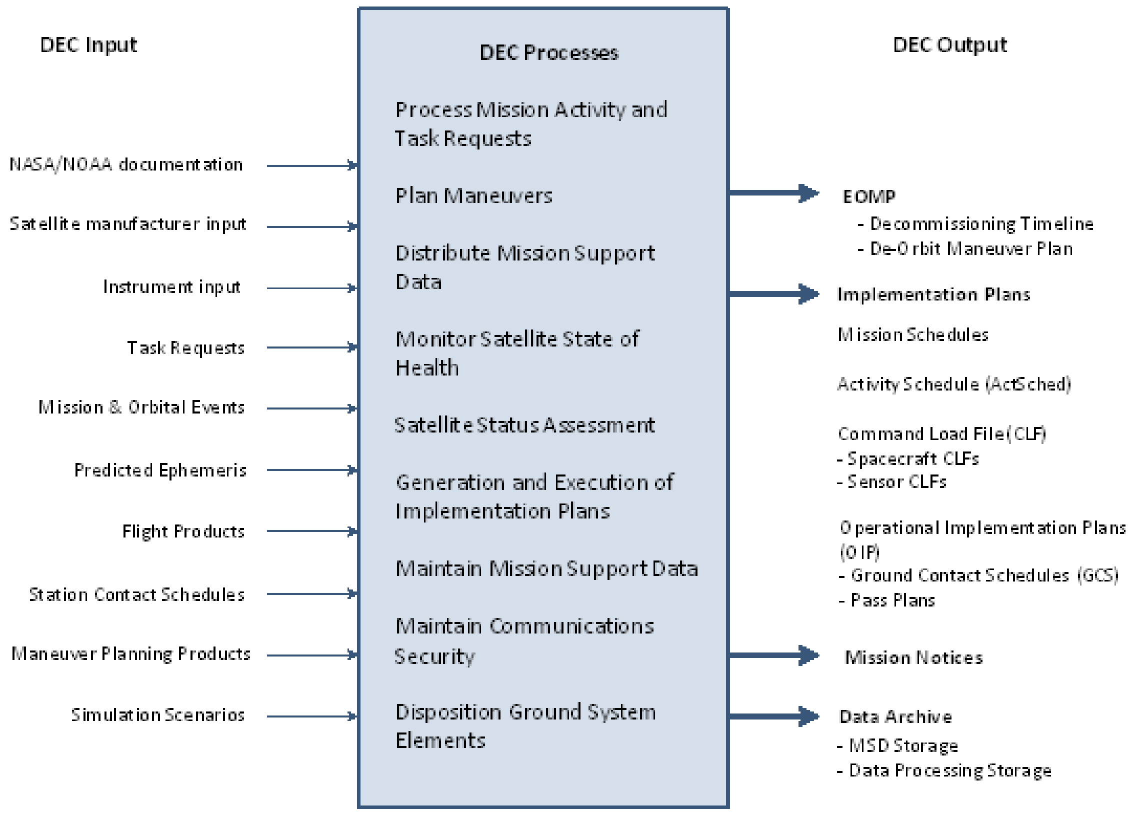


Figure: 6.3.14-1 CGS Processes and Context for Satellite Decommissioning

6.3.14.1.1 Decommissioning Processes

Decommissioning processes support execution of the core DEC functions, including:

- Process Mission Activity and Task Requests supporting End-of-Mission Planning
- Design and Plan Disposal Orbit Maneuvers
- Monitor Satellite State of Health
- Satellite Status Assessment
- Coordinate Events with External Parties
- Monitor the Collection and Distribution of Mission Support Data

- Support Management of Ground System Services

6.3.14.1.1.1 Process Mission Activity and Task Requests

Planning and Scheduling activities support Satellite Decommissioning throughout the entire process, from development of a Decommissioning Timeline through scheduling of ground system re-configuration.

All the functionality utilized during normal operations is exercised in this phase. The following capabilities may exceed those normally exercised:

- High density of special tasks and events
- Rapid re-plan of a large number of tasks
- Development and review of graphical timelines at various levels of detail (long to short term)
- Schedule development and review at the activity level
- Larger volume of input from external sources (Flight Project, satellite representatives, instrument representatives, etc.)
- Planning years to months into the future

6.3.14.1.1.2 Plan Maneuvers Activity

Orbit Maintenance activities support Satellite Decommissioning process from design of a planned de-orbit set of maneuvers (EOMP) through verification of satellite de-orbit.

All the functionality utilized during normal operations may be exercised in this phase. The following capabilities may exceed those normally exercised:

- Design of large-scale de-orbit delta-V maneuvers
- Generation of a sequence of maneuvers
- Maneuver design & evaluation for events years to months in the future

6.3.14.1.1.3 Distribute Mission Support Data Activity

This activity distributes Mission Support Data related to DEC.

All the functionality utilized during normal operations may be exercised in this phase. The following distributions may exceed those normally exercised:

- Extended stakeholder list
- Project-level documentation
- Additional MPS and OrM products
- External distribution of ITAR products, as permitted by NASA NPR 2190.1, Para 3.1 Procedures and Guidelines for the NASA Export Control Program
- External distribution of TLM files

6.3.14.1.1.4 Monitor Satellite State of Health

CGS capabilities are utilized to continuously assess satellite status. This is a broad and detailed evaluation of telemetry values and trends against predefined operational thresholds.

All the functionality utilized during normal operations is exercised in this phase. There is nothing unique in functionality or implementation unique to decommissioning. However, during this phase, the following should be expected:

- Increased frequency in component state changes
- Configuration to non-nominal states
- More rapid variation in operational limits
- Implementation and maintenance of limits related to DEC Triggers
- Implementation of DEC specific reports, their generation and distribution

6.3.14.1.1.5 Manage Fleet/Ground Operations Activity

CGS capabilities are utilized to continuously assess satellite status which is summarized and reported to the Flight Project where it is evaluated against a set of defined (EOMP) decommissioning triggers.

All the functionality utilized during normal operations is exercised in this phase. The following items are implemented in consideration of the decommissioning phase:

- Satellite (spacecraft and sensor) status collected and reported supporting the evaluation of decommissioning triggers

6.3.14.1.1.6 Maintain Mission Support Data Activity

CGS capabilities are used to archive the following on a routine basis. Archival continues until all applicable products, including those produced post-disposal, are deposited:

- MSD - Engineering data
- MSD - Operations data

6.3.14.1.1.7 Produce Data Products Activity

CGS capabilities are used to archive the following on a routine basis. Archival continues until all applicable products, including those produced post-disposal, are deposited:

- SMD data and products

6.3.14.1.1.8 Maintain Ground System Activity

Facility / ground system network, software, and equipment support is required to perform the final preparations for and execution of the DEC:

- Additional workstations for engineering support, NASA, NOAA, spacecraft vendor, instrument representatives and vendors, ground system during DEC activities
- De-integration of facilities, hardware and software, as needed, following DEC

- IT network modifications to maintain communications security

6.3.14.2 Primary Interfaces

Figure 6.3.14-2 illustrates external parties as the primary external interfaces involved in the execution of Fleet/Ground Management. Note that direction provided by Mission Management affects JPSS planning & Scheduling, Space Operations, and Ground Operations and Mission Support Data Handling.

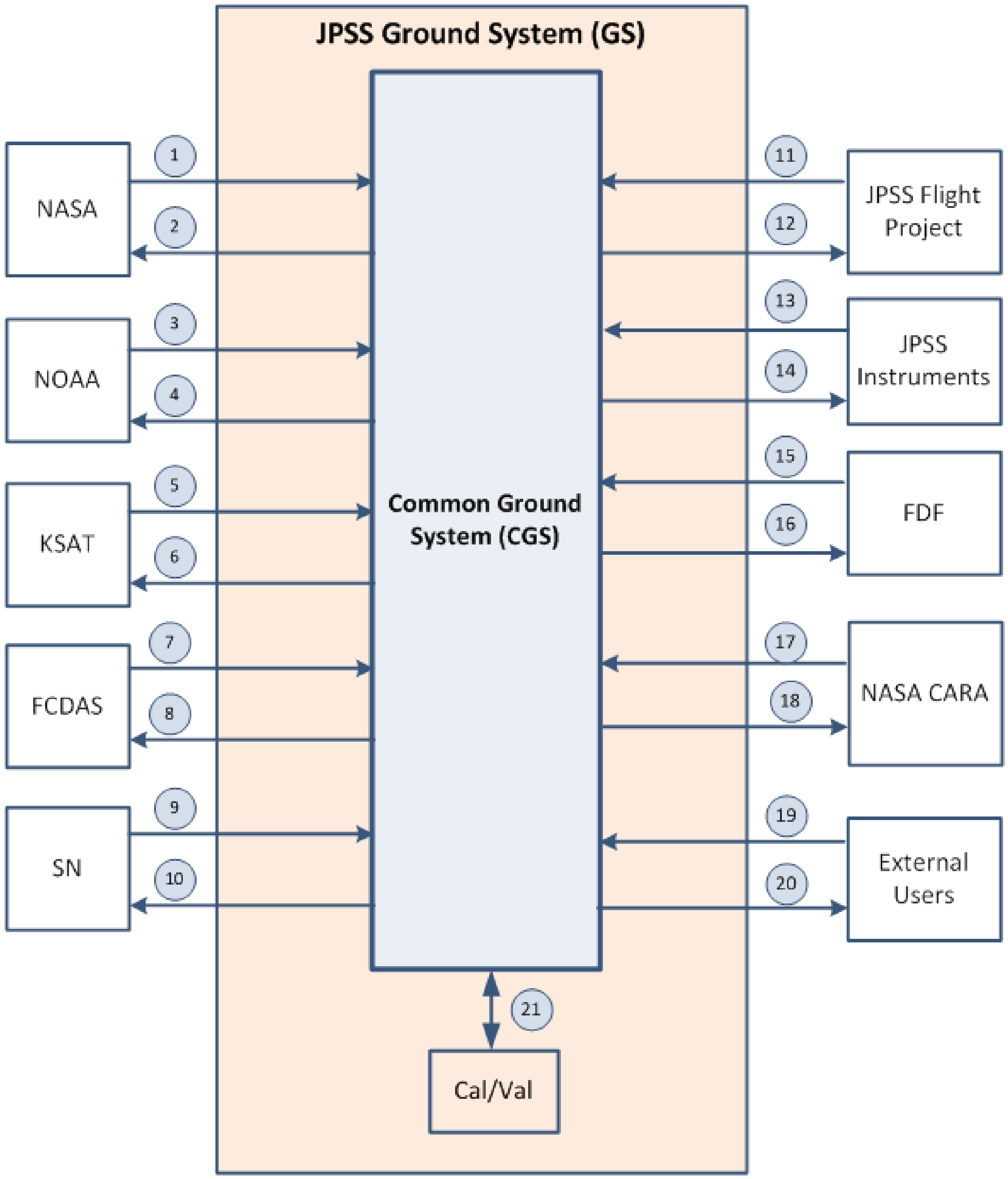


Figure: 6.3.14-2 Primary Interfaces for Decommissioning

Table: 6.3.14-1 Decommissioning Primary Interfaces

No.	Type	Actors	Purpose
1	Internal / External	NASA management, Mission Operations	NASA Management Directives, GSFC-STD-1001A Criteria for Flight and Flight Support Systems Lifecycle Review, NPR 7120.5E NASA Space Flight Program and Project Management Requirements
2	Internal / External	NASA management, Mission Operations	Analytical and operational products supporting the End of Mission Plans per NPR 8715.6/NASA-STD 8719.14, App B, Decommissioning /Disposal Plan such as the Decommissioning Timeline, De-Orbit Maneuver Plans
3	Internal / External	NOAA management, Mission Operations	NOAA Management Directives and Procedures
4	Internal / External	NOAA management, Mission Operations	Analytical and operational products supporting the End of Mission Plans per NPR 8715.6/NASA-STD 8719.14, App B, Decommissioning /Disposal Plan such as the Decommissioning Timeline, De-Orbit Maneuver Plans
5	External	CGS < KSAT	Station Status Information, Station Contact Schedule T&C support
6	External	CGS > KSAT	Schedule Requests, Mission Notices T&C support
7	External	CGS < FCDAS	Station Status Information, Station Contact Schedule T&C support
8	External	CGS > FCDAS	Schedule Requests, Mission Notices T&C support
9	External	CGS < SN	Station Status Information, Station Contact Schedule T&C support
10	External	CGS > SN	Schedule Requests T&C support
11	External	CGS < JPSS Flight Project	Satellite vendor information, Spacecraft or Sensor Status Information, Event & Task Requests, Mission Notices
12	External	CGS > JPSS Flight Project	Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
13	External	CGS < JPSS Instruments	Sensor Status Information, Event & Task Requests, Mission Notices
14	External	CGS > JPSS Instruments	Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
15	External	CGS < FDF	IIRV, Analytical and De-Orbit Verification Reports
16	External	CGS > FDF	De-Orbit Maneuver Plans
17	External	CGS < CARA	CA Summary Reports, High Interest Event Reports for De-Orbit Maneuvers
18	External	CGS > CARA	IIRV, Planned De-orbit Maneuver data

No.	Type	Actors	Purpose
19	External	CGS < External Users	Requests, reports
20	External	CGS > External Users	Management Reports, Timelines & schedules, Maneuver Plans, Mission Notices
21	Internal	CGS <> Cal/Val	Task Requests, Issues, Mission Notices

Table: 6.3.14-2 Decommissioning Interface Documentation

No.	IRD/ICD
1, 2	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223 Criteria for Flight and Flight Support Systems Lifecycle Reviews, GSFC-STD-1001A Process for Limiting Orbital Debris, NASA-STD-8719.14 NASA Space Flight Program and Project Management Requirements, NPR 7120.5E NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements, NPR 7120.7 NASA Systems Engineering Processes and Requirements, NPR 7123.1A Technical Probabilistic Risk Assessment (PRA) Procedures for Safety and Mission Success for NASA Programs and Projects, NPR 8705.5A NASA Procedural Requirements for Limiting Orbital Debris NPR 8715.6A
3, 4	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
5, 6	JPSS GS to KSAT IRD, 474-00109 JPSS GS to KSAT ICD, 474-00110
7,8	JPSS GS to NESDIS FCDAS IRD, 474-00305 JPSS CGS- NESDIS FCDAS ICD, 474-00413 JPSS Space/Ground Data Format XMT Database
9,10	SN-NIMO NRD SN-JPSS CGS ICD JPSS Space/Ground Data Format XMT Database
11,12	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
13, 14	JPSS CGS to SNPP & JPSS-1 S/C Vendor ICD, 474-00425 JPSS CGS to JPSS-2/3/4 S/C Vendor ICD
15, 16	NPP Project Service Level Agreement, 450-PSLA-NPP NPOESS NPP Network Requirements Document, 450-NRD-NPP NPP FDF-NSOF OA, FDF-00-011 JPSS-1 Project Service Level Agreement, 450-PSLA-JPSS-1 JPSS-1 Network Requirements Document JPSS-1 FDF-NSOF OA JPSS-2/3/4 Project Service Level Agreement, 450-PSLA-JPSS-2/3/4 JPSS-2/3/4 Network Requirements Document JPSS-2/3/4 FDF-NSOF OA
17	JPSS GS Conjunction Assessment IRD, 474-00300
18	Joint Polar Satellite System (JPSS) Ground Project (GP) to Flight Project Interface Requirements Document (IRD), 474-00223
19, 20	JPSS -CGS Services IDD

6.3.14.3 Assumptions & Constraints

The following assumptions are made for the successful performance of the Satellite Decommissioning functions:

- NOAA and NASA provide the following input to Decommissioning:
  - Agency-level documentation defining guidelines for the decommissioning process
  - Mission decommissioning triggers
- Mission Operations conducts Command Authorization Meetings prior to the execution of propulsive maneuvers
  - Includes CARA evaluation of planned maneuver data

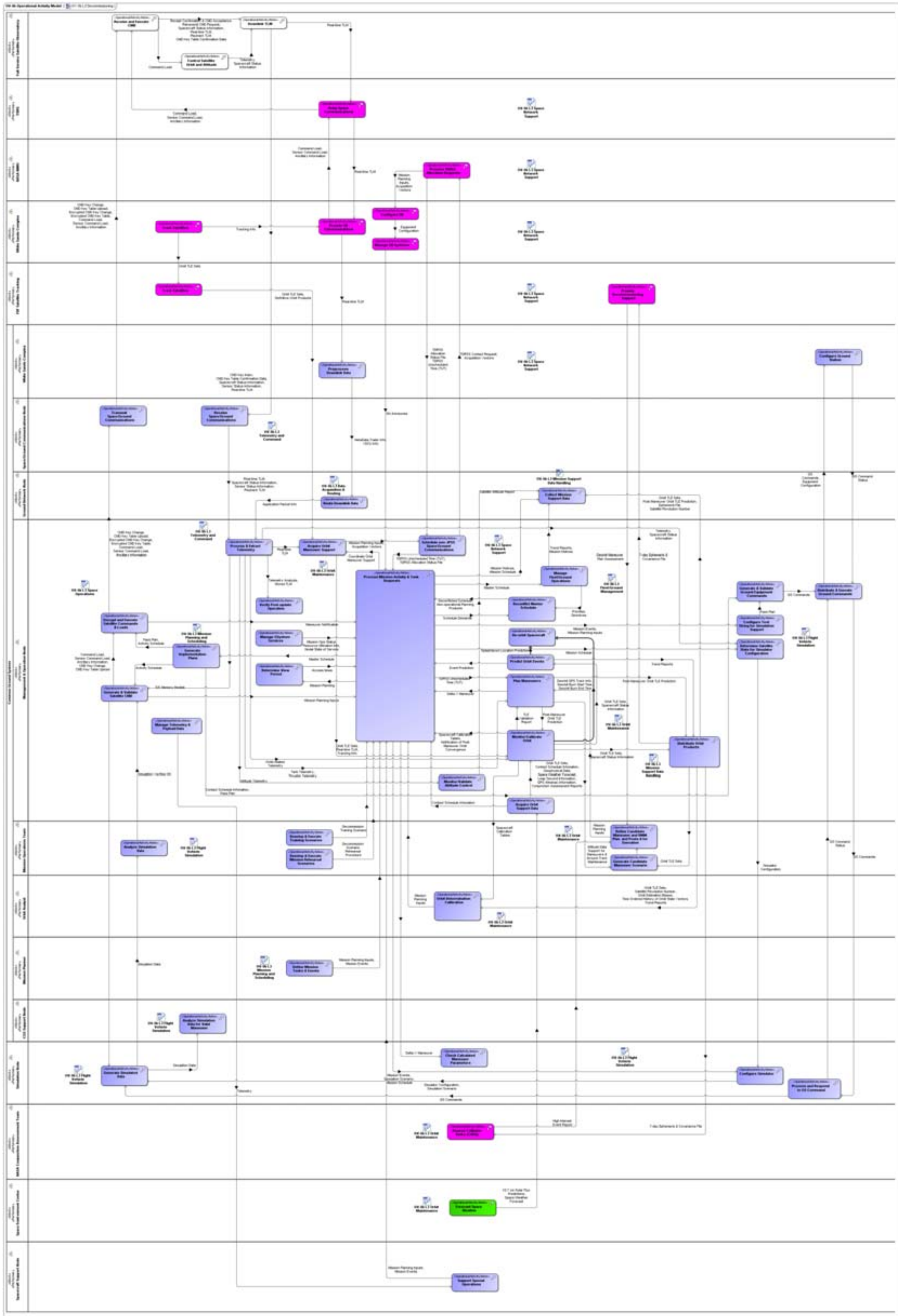
6.3.14.4 Pre-Conditions

The following pre-conditions apply to this thread:

- The satellite is in orbit.
- Telemetry and command is available to the ground system.
- The mission has met the de-orbit criteria.
- The satellites propulsion system is operational.
- The satellites propulsion system has sufficient propellant to meet the satellite de-orbit requirements as per NASA Procedural Requirements for Limiting Orbital Debris, NPR 8715.6A.

6.3.14.5 Operational Flow

Figure 6.3.14-3 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.3.14-3 Decommissioning Operational Flow Diagram

6.3.14.6 Basic Flow

Table 6.3.14-3 defines the operational flow of Satellite Decommissioning. This flow covers the four stages of the decommissioning process:

- Planning & Preparations to the Transition to NOAA
- Operations & Sustainment to the Decommissioning Review
- Scheduling and execution to the Disposal Review
- Passivation & De-Orbit to Mission Close Out

Table: 6.3.14-3 Decommissioning Basic Flow

No.	Actors	Actions	Notes
		Planning & Preparations	
1	NOAA, NASA, CGS	NOAA and NASA release documents providing decommissioning guidelines.	These are made available to the Management & Operations Node
2	JPSS Flight Project, CGS	The Flight Project releases documents defining processes and procedures for satellite decommissioning. This documentation includes: • Decommissioning Triggers • Notification Sequence • Draft End-Of-Mission Plan • Draft Mishap Contingency Plan • Draft Decommissioning Plan • Satellite vendor applicable documentation • Instrument vendor applicable documentation • Date specification for planning and simulation purposes	Steps 2-7 are executed periodically to produce baseline versions of the products as per NASA Space Flight Program and Project Management Requirements, NPR 7120.5E These documents are made available to the Management & Operations Node
3	CGS, Mission Planner	The Process Mission Activity and Task Requests activity generates a draft Decommissioning Timeline for the specified date.	Supports development and revision of the draft End-Of-Mission Plan. An overall Decommissioning Timeline may be developed as an Integrated Master Timeline (IMT) by the CGS Maintain IMT activity.
4	CGS, Orbit Analyst	The Plan Maneuver activity generates a draft De-Orbit Maneuver Sequence for the specified date.	Supports development and revision of the draft End-Of-Mission Plan.
5	CGS, Orbit Analyst, Mission Planner	The Process Mission Activity and Task Requests activity incorporates the draft De-Orbit Maneuver Sequence into the Decommissioning Timeline.	Supports development and revision of the draft End-Of-Mission Plan. Note: Evaluation of the De-Orbit Maneuver Sequence for

No.	Actors	Actions	Notes
			conjunction assessment is performed by CARA in step 31.1.
6	CGS, MOT	The Mission Operations Team generates operational products (displays, scripts & procedures) to support the passivation of the instruments and spacecraft.	Supports development and revision of the draft End-Of-Mission Plan.
7	CGS, MOT	The Mission Operations Team generates operational products to monitor satellite state of health, including evaluation of data related to the decommissioning triggers.	Supports Monitor Satellite State of Health
8	CGS, Orbit Analyst	The Orbit Analyst generates operational products to monitor attitude & orbit subsystem state of health and consumable resource utilization, including evaluation of data related to the decommissioning triggers.	Supports Monitor Satellite State of Health
9	Flight Project, MOT, Orbit Analyst, Mission Planner	Decommissioning products are reviewed and updated.	
10	Flight Project	The Flight Project makes decommissioning artifacts available for NASA reviews prior to transfer of the mission to NOAA. Reviews include, but are not limited to: • Mission Critical Design Review (MCDR) • Key Decision Point- D (KDP-D) • Safety & Mission Success Review (SMSR)	Formal agency-level review of draft decommissioning products.
11	Flight Project, MOT, Orbit Analyst, Mission Planner	The Flight Project executes a decommissioning simulation to validate and verify the DEC operational products and ground system capabilities.	
12	JPSS Flight Project, CGS	The Flight Project releases the baseline documents defining processes and procedures for satellite decommissioning. CGS makes them available to stakeholders. This documentation includes: • Baseline End-Of-Mission Plan • Baseline Mishap Contingency Plan • Draft Decommissioning Plan	These documents are made available to the Management & Operations Node
		Operations & Sustainment	

No.	Actors	Actions	Notes
13	MM,MOT, CGS	Mission Management periodically reviews and updates the DEC documentation and operational products. CGS makes them available to stakeholders. This documentation includes: • Updated End-Of-Mission Plan • Updated Mishap Contingency Plan • Draft Decommissioning Plan	DEC documents are periodically updated (See steps 2-7)
14	CGS	The CGS Analyze Status activity receives aggregated, formatted status information from the Collect Status activity. It applies logic/correlation algorithms of the status against standards, thresholds, and policies (configurations) that are established by the EOMP for evaluation of DEC triggers. This activity creates information which is used for report and warning/alarm message generation to alert staff.	Supports Satellite Status Assessment - collection & evaluation of data
15	CGS	The CGS Monitor Spacecraft Alarms, Warnings and Events activity generates AWEs and issues satellite related AWEs in near-real-time for receipt and subsequent processing by Fleet Ground Management.	Supports Satellite Status Assessment - AWEs
16	CGS	The CGS Customize Reports activity generates customized reports base on DEC specifications from the Flight Project. The Distribute Mission Support Data activity sends reports authorized for external consumption to external users via the External File Server, and makes internal reports available to Fleet Ground Management.	Supports Satellite Status Assessment - status reports
17	CGS	The CGS Monitor Spacecraft State of Health activity issues satellite related Mission Notices in near-real-time for receipt and subsequent processing by Fleet Ground Management.	Supports Satellite Status Assessment - Mission Notices
18	CGS,FGM	The CGS Manage Fleet / Ground Operations activity alerts Mission Management upon receipt of AWEs and/or reports meeting Decommissioning Trigger criteria.	Supports Satellite Status Assessment - verification of trigger event
19	CGS,FGM	The CGS Manage Fleet / Ground Operations activity issues DEC trigger related Mission Notices in near-real-time for receipt and subsequent processing by Fleet Ground Management.	Supports Satellite Status Assessment - report of trigger event

No.	Actors	Actions	Notes
20	NOAA, Instrument community	NOAA reviews satellite status and provides final approval for scheduling of a Decommissioning Review.	Supports Assessment & Notification of Status
		Scheduling & Execution	
21	JPSS Flight Project	The JPSS Flight Project releases the tentative decommissioning schedule.	
22	MM,MOT, CGS	Mission Management reviews and updates the DEC documentation and operational products in preparation for the Decommissioning Review. CGS makes them available to stakeholders. This documentation includes: • Updated End-Of-Mission Plan • Updated Mishap Contingency Plan • Updated Decommissioning Plan	
22a	FDF	FDF reviews the De-Orbit Maneuver Plan as part of the review and update process.	
23	NOAA, NASA	NOAA & NASA conduct the Decommissioning Review. Review panel provides recommendation to decommission.	Supports Assessment & Notification of Status
24	NOAA, NASA	NOAA HQ will coordinate with NASA HQ to obtain concurrence that the mission conditions warrant decommissioning.	Supports Inter-agency Coordination
25	NOAA	NOAA provides final approval for decommissioning and releases the formal Notice to Decommission.	Supports Assessment & Notification of Status
26	NOAA, NASA	NOAA contacts the science and engineering communities, NASA engineers, spacecraft & instrument specialists to solicit potential experiments to be conducted. Approved experiments are incorporated into the decommissioning plan.	Supports Solicitation and conduct of EOM experiments
27	CGS, MOT	The Mission Operations Team generates operational products (displays, scripts & procedures) to support the approved engineering tests.	Supports development and revision of the draft End-Of-Mission Plan.
28	CGS, Orbit Analyst	The Plan Maneuver activity generates a revised Perigee Lowering & De-Orbit Maneuver Sequence for the target de-orbit date.	Supports revision of the End-Of-Mission Plan.
29	CGS, Orbit Analyst, Mission Planner	The Mission Planner incorporates the revised Orbit Maneuver Sequence into the Decommissioning Timeline.	Supports revision of the End-Of-Mission Plan.
30	Flight Project, MOT, Orbit	The Flight Project executes a decommissioning simulation to validate and	

No.	Actors	Actions	Notes
	Analyst, Mission Planner	verify the DEC operational products and ground system capabilities.	
31	FDF, NASA Engineering, NOAA Engineering, SMS, MM,MOT	FDF performs an independent evaluation of the revised Orbit Maneuver Sequence and reports results. An Engineering Peer Review is held to review the sequence and results of the evaluation.	Supports revision of the draft End-Of-Mission Plan and preparations for the Decommissioning Review.
31.1	MOT, CARA	MOT provides the Orbit Maneuver Sequence to CARA for Conjunction Avoidance (CA) screening. The CARA Assess Collision Risks activity performs close approach analysis and delivers the CA analysis results to MOT.	
32	MM,MOT, CGS,SMS	Mission Management and Mission Operations teams review and update the DEC documentation and operational products in preparation for the decommissioning. CGS makes them available to stakeholders. This documentation includes: • Baseline End-Of-Mission Plan • Baseline Mishap Contingency Plan • Baseline Decommissioning Plan	
33	NOAA	NOAA provides final review of decommissioning plans and procedures and releases the final decision to Decommission.	Supports Assessment & Notification of Status
34	DEC Team	The Flight Project executes decommissioning simulations to rehearse execution of team supported decommissioning activities.	
35	CGS, Mission Planner	The Process Mission Activity and Task Requests activity suspends scheduling of SMD data collection.	Supports termination of routine SMD collection
36	CGS, Mission Planner	The Process Mission Activity and Task Requests activity schedules Instrument EOM engineering tests for execution.	Supports termination of routine SMD collection.
37	MM,MOT, CGS,SMS, Instrument Support	The Process Mission Activity and Task Requests activity schedules Instrument EOM engineering tests for execution.	Supports termination of routine SMD collection.
38	DEC Team	The Flight Project executes EOM engineering tests.	
39	DEC Team	The Flight Project executes the Perigee Lowering Orbit Maneuver Sequence.	
40	NOAA, NASA	NOAA & NASA conduct the Disposal Review. Review panel provides	Supports Assessment & Notification of Status

No.	Actors	Actions	Notes
		recommendation to proceed with satellite passivation and de-orbit.	
41	DEC Team	Plans, procedures and operational products are revised as per panel recommendations, if necessary.	
		Passivation & De-Orbit to Close-Out	
42	DEC Team	The JPSS Flight Project passivates the spacecraft, to the extent possible.	
43	DEC Team	Satellite de-orbit is initiated. Propulsion depletion delta-v to deplete remaining propellant and lower the spacecraft altitude to guarantee spacecraft atmospheric re-entry is performed.	Note CAM meetings are held prior to propulsive maneuvers.
44	DEC Team	The JPSS Flight Project configures the spacecraft for re-entry.	
45	DEC Team	The JPSS Flight Project track observatory to completion of de-orbit.	
46	DEC Team	The JPSS Flight Project releases ground stations from further tasking responsibilities.	
47	JPSS Flight Project	Data Distribution & Archive requirements are satisfied and verified.	
48	JPSS Flight Project	The Integrated Sustainment activity performs the Communications & Security modifications necessary.	
48a	JPSS Flight Project	The final disposition of the ground support hardware (operations consoles, test beds, etc.) is specified by the JPSS Flight Project no later than 30 days after mission termination. At least one operations console should be retained intact until the spacecraft has been proven to be permanently inert. The disposition of this equipment will be included in the final engineering report for reference.	
49	JPSS Flight Project	As a part of spacecraft termination, the history and final status of the principle spacecraft systems shall be documented in a final engineering report. The report is to be compiled by the JPSS Flight Project, and should be issued within 60 days of mission termination. The report shall contain a brief history of significant milestones, spacecraft anomalies, and achievements of the mission, as well as the final locations of the mission data archives and ground support equipment.	

6.3.14.7 Alternate Flow

Reserved

6.3.14.8 Post Condition

Decommissioning is determined satisfactorily. The satellite has been Passivated and has fully de-orbited. The ground system data products have been archived. Ground system components have been successfully re-configured, as necessary.

6.3.14.9 Related Threads

The following is a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-050	Orbit Maintenance
GS-NML-080	Flight Vehicle Simulation
GS-NML-310	Ground Operations
GS-NML-320	Space Operations
GS-NML-140	Mission Support Data Handling
GS-NML-400	Integrated Support
GS-NNL-150	Space Network Support
GS-NNL-120	Continuity of Operations
GS-NNL-140	System Maintenance and Upgrade

6.3.14.10 Child Threads

The following is a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-010-020	Space Operations
CGS-020-010	Mission Planning and Scheduling
CGS-020-020	Orbit Operations

6.4 Data Acquisition and Data Routing

6.4.1 Data Acquisition and Routing

6.4.1.1 Description

The Data Acquisition and Routing (DAcqR) thread (GS-NML-180) describes the Ground System data acquisition and data routing services under which mission data are acquired at polar ground stations, and then routed to the mission's Service Delivery Points (SDPs). By using these data acquisition and/or data routing services, a mission can achieve significantly reduced data latency. The DAcqR begins with coordination of support schedules between JPSS mission management and the mission to be supported, if applicable, then proceeds with acquiring mission data during supported passes at designated ground station, and finishes by routing the captured mission data to mission's SDP via JPSS Ground Network. The DAcqR is currently deployed to

support DMSP, Metop, Coriolis/WindSat, and NASA SCaN supported missions (including EOS).

The DAcqR is mostly allocated to the Common Ground System (CGS) as it primarily requires space/ground communications and/or networking. One exception is the space/ground communication support for Coriolis, which is provided by KSAT through the JPSS Ground Project. Related threads include the Mission Planning and Scheduling (MPS) that support schedule coordination and Ground Operations (GO) that manages and controls ground system resources.

6.4.1.1.1 Multi-mission Ground Stations

The ground stations at Svalbard, Norway and McMurdo, Antarctica provide support to JPSS missions and external missions and agencies.

6.4.1.1.1.1 Svalbard Ground Station

The Svalbard ground station supports the JPSS-managed missions such as S-NPP, JPSS-1, JPSS-2, JPSS-3, and JPSS-4, as well as non-JPSS-managed missions such as GCOM-W1. The Svalbard ground station also provides services to SCaN supported missions and Coriolis/WindSat. SCaN supported missions arrange satellite T&C and data acquisition independent of the JPSS GS. Coriolis/WindSat utilizes JPSS Ground Project (GP) contracted resources via KSAT for data acquisition and pre-processing independent of the JPSS Common Ground System (CGS). GCOM-W1 also uses JPSS GP contracted resources via KSAT for T&C and mission data acquisition independent of the JPSS CGS. JPSS CGS performs baseband and pre-processing of the GCOM-W1 mission data for JPSS use.

All missions use the JPSS CGS Ground Network for delivery of the mission data and other network services to JPSS and non-JPSS mission SDPs. The JPSS CGS network is augmented by the undersea fiber between Svalbard and mainland Norway. The undersea fiber was installed with funding by the U.S. Government with installation, operations and maintenance provided by the Norwegian Space Agency. The fiber provides communications services utilized by Svalbard residents, academic users, U.S., European, and other international government agencies and commercial entities.

There are two logically, and in some network segments, physically separate JPSS WAN links out of Svalbard. The undersea fiber between Svalbard (Longyearbyen) and Norway (Harstad) is utilized to provide network connectivity out of and into Svalbard using diversely routed primary and backup fiber. The Svalbard links terminate into the cloud based WAN access circuits at Oslo and Stockholm. The network is logically separated into JPSS and NASA SCaN traffic flows. The JPSS traffic includes the data processing missions (S-NPP, JPSS-1/2/3/4, and GCOM-W1) as well as Coriolis/WindSat. The nominal path for SCaN traffic is via either the Stockholm or Oslo link. The primary path for the JPSS traffic is via the other path from Svalbard into Oslo or Stockholm. The nominal bandwidth allocation for JPSS and NASA SCaN is 150 Mbps each on the independent paths. When the network is in a degraded mode with one of the Svalbard or shared CONUS links (GSFC and NSOF) unavailable, the bandwidth is shared between SCaN and JPSS at roughly 75Mbps each. The bandwidth allocations for SCaN and JPSS carried missions are managed by JPSS at both Svalbard and the GSFC/NSOF.

6.4.1.1.1.2 McMurdo Ground Station

The JPSS Ground Network provides data and voice transmission to and from McMurdo utilizing the NSF infrastructure to support the end-to-end network services. The NSF United States Antarctic Program (USAP) provides network connectivity via Microwave between McMurdo and Black Island where a USAP operated Satcom terminal enables CGS provided two-way Satcom transponder service between Antarctica and Australia. The primary ground station is located in Belrose, Australia with a backup Satcom ground station in Lockridge, Australia. The backup ground station is used at the discretion of the Satcom provider in case of weather or equipment induced outages at Belrose. Diverse access circuits into diverse WAN PoPs in Sydney, Australia provide the terrestrial communications onto the JPSS WAN cloud. Network traffic is routed via terrestrial links between Lockridge and Belrose by the Satcom provider when the backup ground station in Lockridge is being used. The global JPSS WAN cloud delivers traffic between Australia and CONUS and OCONUS SDPs for all McMurdo traffic via commercial fiber based packet switched network. In all cases the JPSS, SCaN and other mission traffic (Metop, DMSP, NSF) share the bandwidth between McMurdo and the WAN PoPs in Australia. The bandwidth allocations are dynamically managed by the JPSS Ground Network.

6.4.1.1.2 DMSP Support

The JPSS Ground System supports the DMSP mission with its two S/Ka dual-band receptors at McMurdo ground station in Antarctica and its global data network. It delivers DMSP data with reduced latency from McMurdo, Antarctica to the United States Air Force USAF 557th Weather Wing at Offutt AFB, NE. The service is provided to a maximum of two DMSP satellites, only one DMSP pass is supported at any given time. JPSS spacecraft contacts have schedule priority over DMSP on the McMurdo receptors. Figure 6.4.1-1 illustrates the DMSP data flow using the Data Acquisition and Routing service, where dotted lines indicate JPSS Ground System boundary.

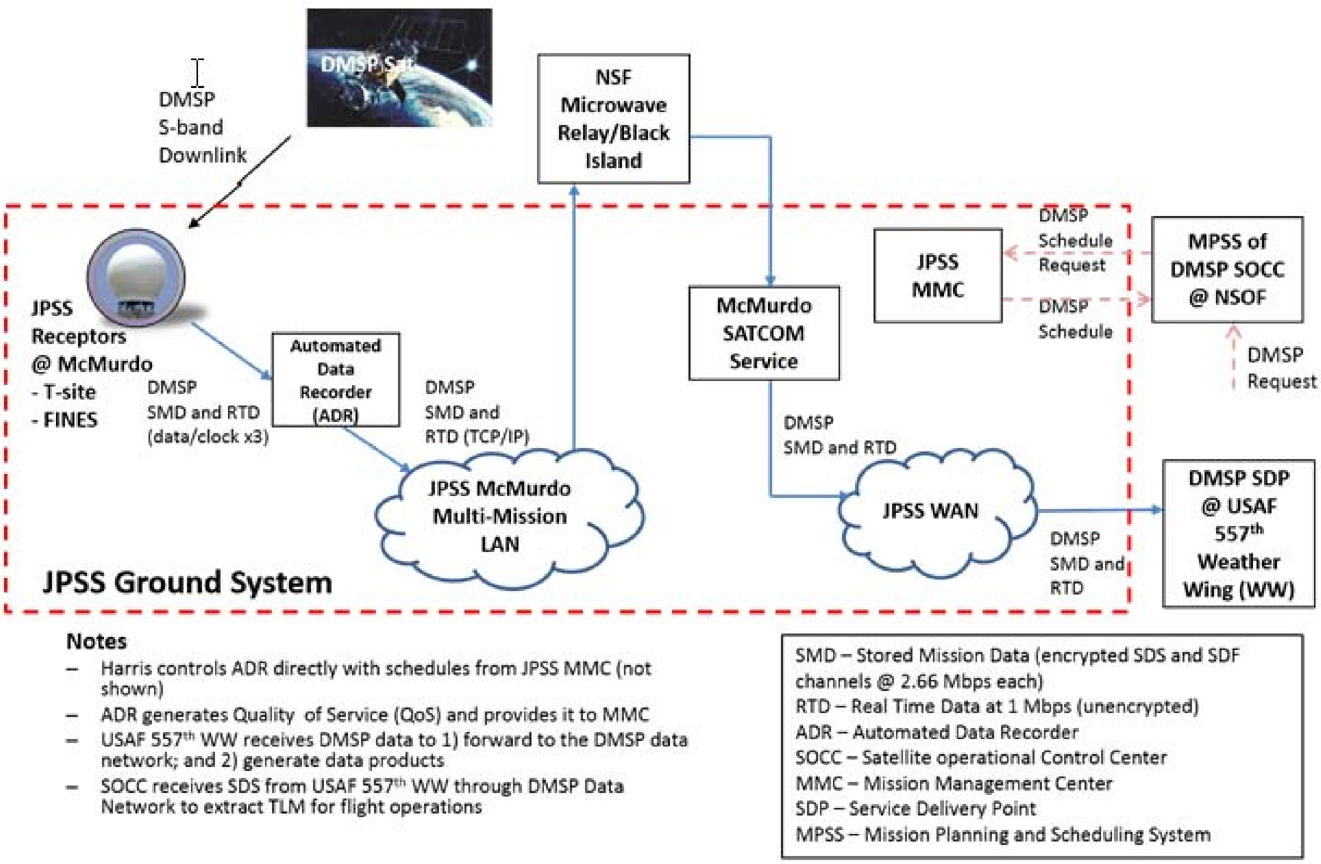


Figure: 6.4.1-1 DMSP Support Data Flow

DMSP contacts at McMurdo are scheduled by JPSS Mission Management Center (MMC) based on requests from the DMSP schedulers of the DMSP SOCC at NOAA NSOF. During a pass, the DMSP satellite transmits via S-band up to three channels of mission data at an aggregate data rate of 6.34 Mbps. These channels generally contain one real-time, and up to two SMD carriers (Fine and /or Smooth). All DMSP data received by the JPSS receptor at either T-site or Fine site are demodulated and bit synchronized then handed off to the JPSS Automated Data Recorder (ADR), where the data is buffered and stored. The ADR transfers the captured DMSP mission data to the DMSP SDP at USAF 557th Weather Wing via the JPSS-provided Multi-mission Communications System (MMCS), including McMurdo multi-mission LAN, SATCOM service, and JPSS WAN. The data is sent via TCP/IP connection for reliable delivery. The raw data is also stored at the ADR for at least 72 hours so that data can be transmitted or retransmitted after a communication outage

Beyond the JPSS Ground System, the Smooth data arriving at USAF 557th Weather Wing is forwarded on to the DMSP SOCs (SOCC/ESOC) via FCDAS so stored telemetry can be ingested and added to the telemetry database. Existing DMSP terrestrial communications are used to transfer the Smooth data to FCDAS. The data is transferred from FCDAS to both SOCs via existing DMSP Domestic Satellite communications (DOMSAT).

6.4.1.1.3 Metop Support

The JPSS Ground System supports Metop mission with its multi-mission network at McMurdo ground station in Antarctica and its global data network. It delivers Metop data with reduced latency from McMurdo, Antarctica to the Metop SDP at EUMETSAT Central Application Facility (CAF) in Darmstadt, Germany. The service is provided in conjunction with the NASA Near Earth Network (NEN) that provides NASA MG1 antenna services at McMurdo ground station. Figure 6.4.1-2 illustrates the Metop data flow using the Data Acquisition and Routing service, where dotted lines indicate JPSS Ground System boundary.

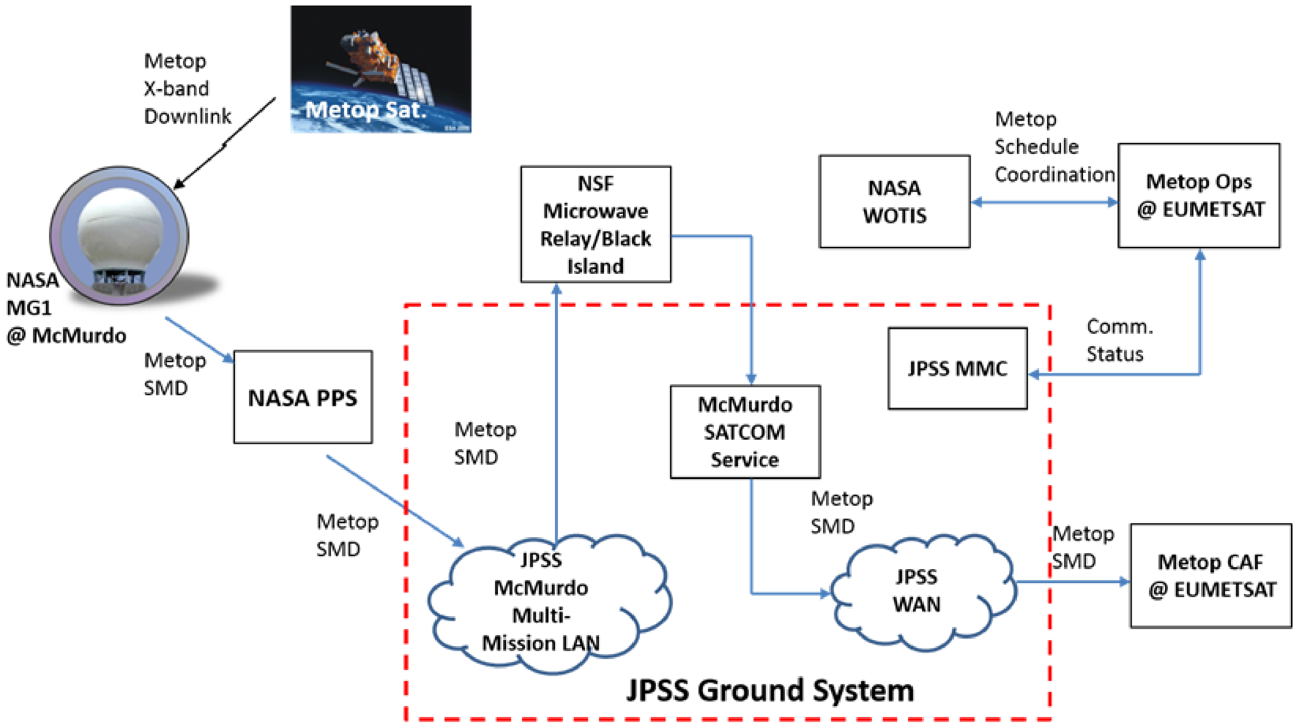


Figure: 6.4.1-2 Metop Support Data Flow

Metop contacts at McMurdo are scheduled by NASA Wallops Orbital Tracking Information System (WOTIS) based on requests from the Metop MOC at EUMETSAT. During a pass, the Metop satellite transmits via X-band Stored Mission Data (SMD) at a data rate of 70 Mbps. The downlinked Metop SMD is received by the NASA MG1 antenna and processed by the NASA Pre-Processor System (PPS), where VCDUs are extracted and appended with metadata trailers. The processed SMD is then handed off to the JPSS-provided Multi-mission Communications System (MMCS), including McMurdo multi-mission LAN, SATCOM service, and JPSS WAN for transferring to the Metop SDP at EUMETSAT CAF. The data is sent via TCP/IP connection for reliable delivery. The network status is provided to the Metop MOC.

6.4.1.1.4 Coriolis Support

The JPSS Ground System supports the Coriolis/WindSat mission with its L/S/X tri-band SG4 antenna at Svalbard ground station in Svalbard, Norway and its global data network. It acquires Coriolis satellite downlink data, from which WindSat payload mission data is extracted, and delivered to the Coriolis/WindSat SDP at NSOF. The service is provided on a resource available

basis as SG4 is a primary antenna supporting the S-NPP and JPSS satellites. Figure 6.4.1-3 illustrates the Coriolis/WindSat data flow using the Data Acquisition and Data Routing services, where dotted lines indicate JPSS Ground System boundary.

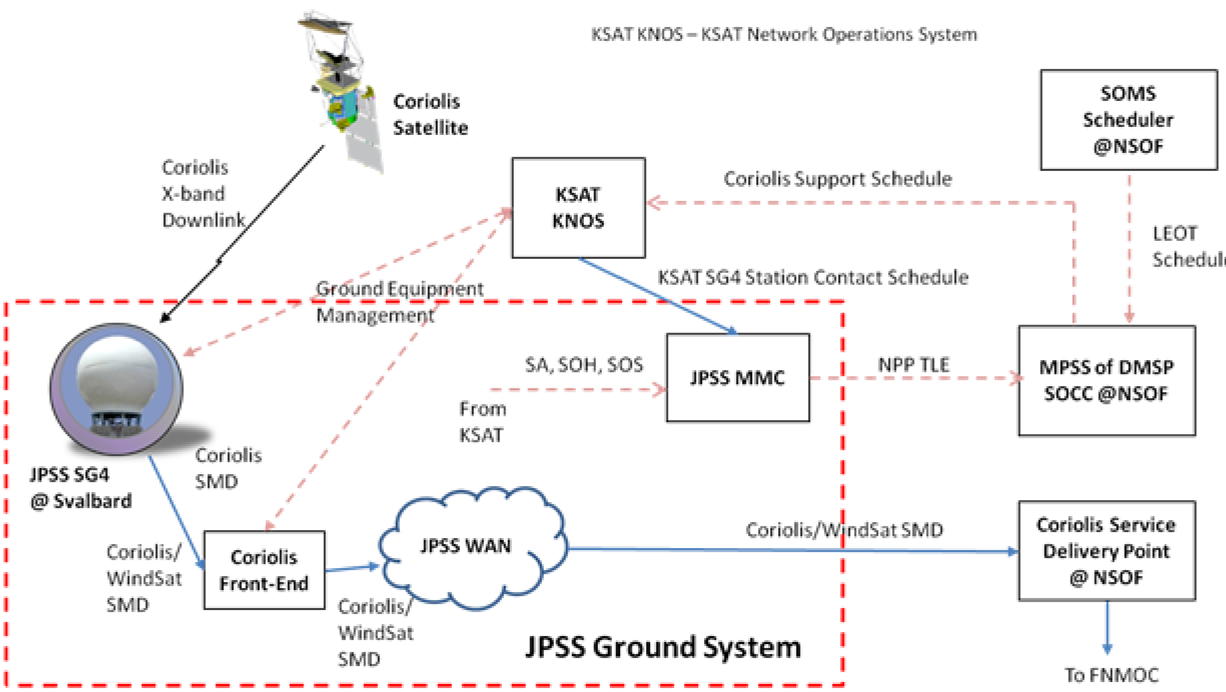


Figure: 6.4.1-3 Coriolis Support Data Flow

Coriolis contacts at Svalbard are scheduled by the Mission Planning and Scheduling System (MPSS) of the DMSP SOCC at NOAA NSOF. The DMSP SOCC schedules Coriolis support on behalf of Coriolis satellite operator, Navy's Blossom Point Field Site. It schedules SG4 antenna after S-NPP utilization has been determined. During a pass, the Coriolis satellite transmits via X-band Stored Mission Data (SMD) at a data rate of 25.6 or 51.2 Mbps, selectable by commands. The downlinked Coriolis SMD is received by JPSS SG4 antenna at Svalbard and processed by JPSS Pre-Processor (PPS). The SMD from WindSat instrument onboard Coriolis is extracted and forwarded via JPSS WAN to the Coriolis SDP at NOAA NSOF. The data is sent via TCP/IP connection for reliable delivery.

While the JPSS Ground System does not schedule ground resources to support Coriolis satellite, it receives KSAT SG4 contact schedule from KSAT and place it on the Master Schedule as part of situational awareness.

Beyond the JPSS Ground System, the Coriolis/WindSat data arriving at NSOF is automatically forwarded to FNMOC for data processing and dissemination. From FNMOC, the Coriolis/WindSat data is further distributed to many WindSat users, including Blossom Point Field Site and NRL.

6.4.1.1.5 Support to NASA SCaN-Supported Missions

NASA Space Communications and Navigation (SCaN) provides network services to a large number of NASA space missions (including EOS). Since this is a network service with pre-allocated bandwidths, no contact schedule is required. From Svalbard, the telemetry and mission data from the SCaN-supported mission are acquired and pre-processed by the KSAT ground station. The pre-processed mission data are then ingested into the JPSS Ground Network and routed to the SCaN SDP at GSFC. Command data for uplink is routed from the SCaN Service Entry Point (SEP) at GSFC to the KSAT ground station at Svalbard. Figure 6.4.1-4 illustrates the SCaN-supported mission data flow to and from Svalbard using the Data Routing service, where dotted lines indicate JPSS Ground System boundary.

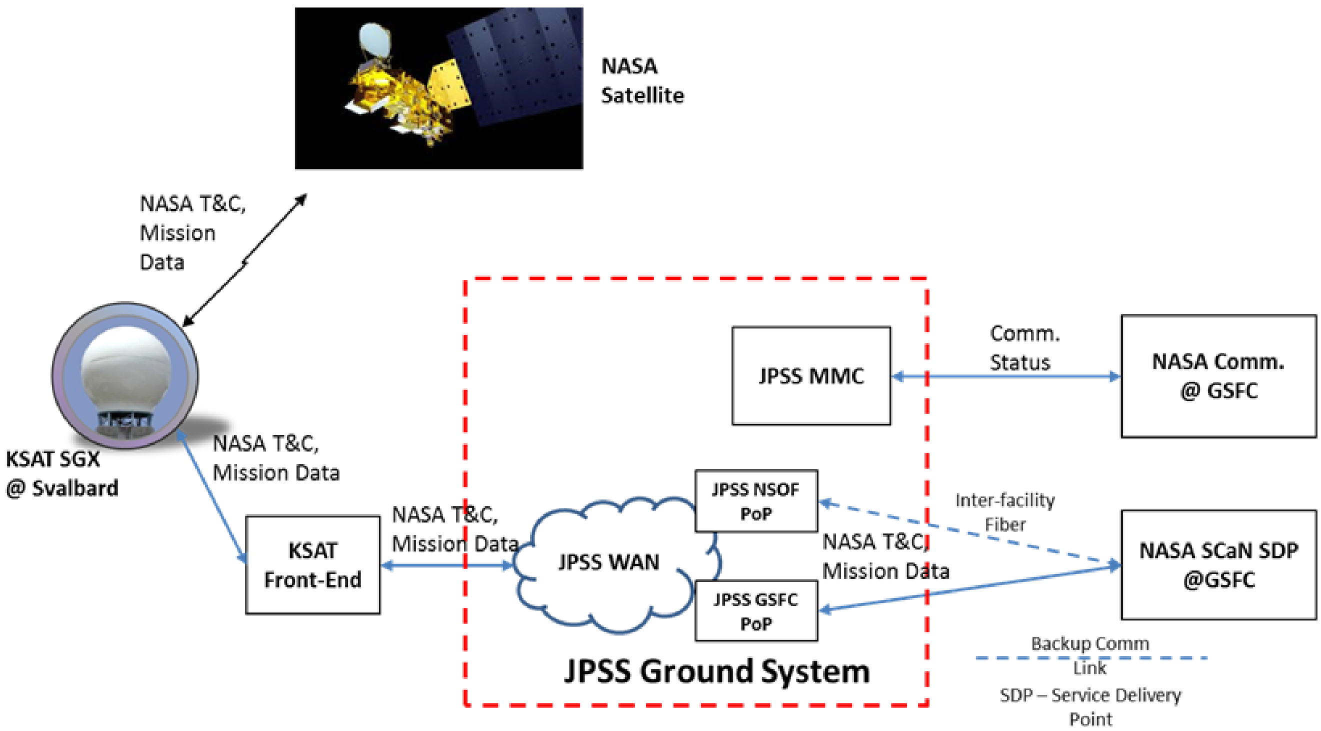


Figure: 6.4.1-4 SCaN-Supported Mission Data Flow to/from Svalbard

The telemetry and mission data from the SCaN-supported mission are acquired and pre-processed by the NASA ground station. The pre-processed data are then ingested into the JPSS Ground Network and routed to the SCaN SDP at GSFC. Command data for uplink is routed from the SCaN Service Entry Point (SEP) to the NASA ground station at McMurdo. Figure 6.4.1-5 illustrates the SCaN-supported mission data flow to and from McMurdo using the Data Routing service, where dotted lines indicate JPSS Ground System boundary. The bandwidth allocation for NASA at McMurdo is 512 Kbps inbound and 1 Mbps outbound.

The CONUS JPSS Ground Network connectivity in support of SCaN includes WAN access circuits into GSFC and NSOF. GSFC and NSOF are connected via fiber link to support communications between the two sites for purposes of shared redundancy. The nominal path for SCaN traffic between Svalbard or McMurdo and GSFC is through the GSFC access circuit. The primary path for the JPSS traffic is the NSOF access circuit. In the case of an access circuit

failure at GSFC or NSOF, the surviving access circuit is shared between the two users and network traffic is routed between the NSOF and GSFC as needed using the GSFC to NSOF fiber link.

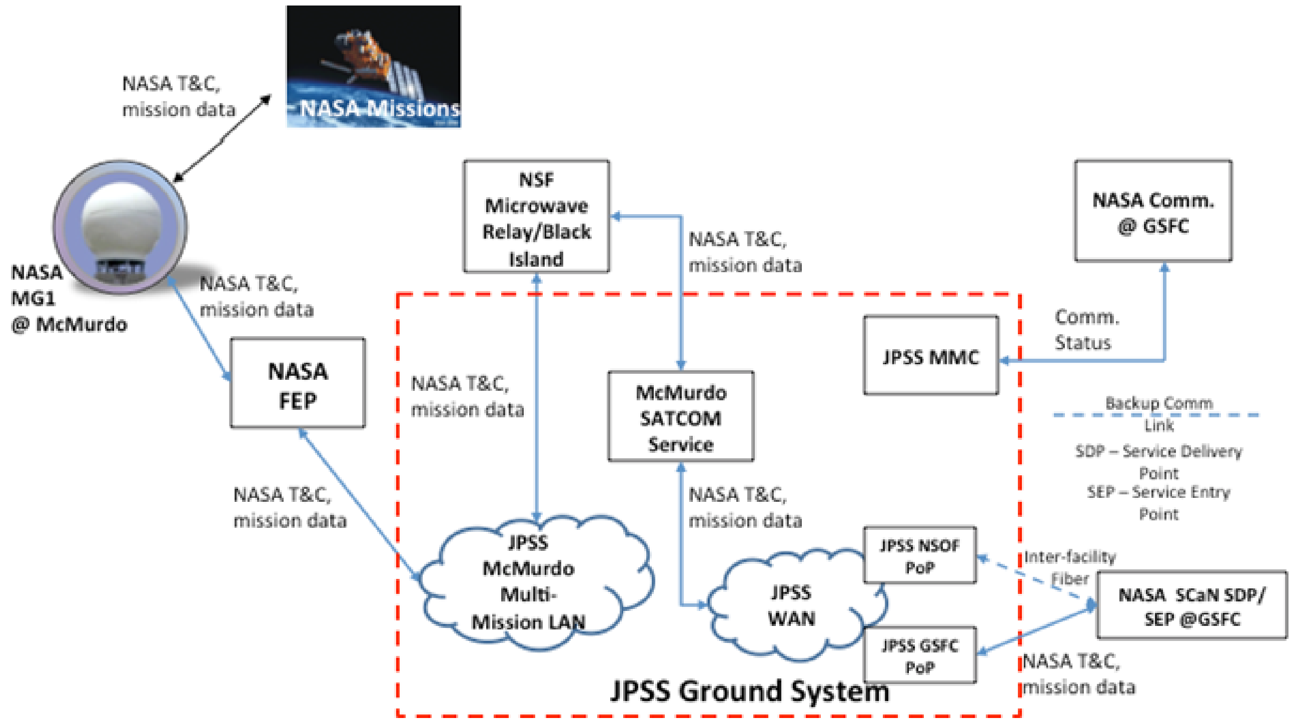


Figure: 6.4.1-5 SCaN-Supported Mission Data Flow to/from McMurdo

6.4.1.1.6 Support to NSF USAP

The NSF USAP operates the year-round facilities at McMurdo Station in Antarctica. Science and research support staff also reside at McMurdo performing polar related investigations and studies. During the austral summer, the population increases significantly by visiting research, maintenance and construction personnel. The USAP operations at McMurdo Station is supported by the USAP operations planning, maintenance and engineering facility in Centennial, CO.

Under agreements documented in a Program Service Level Agreement (PSLA) between NOAA and the NSF, JPSS provides communications services between McMurdo Station and other CONUS and OCONUS locations supporting the JPSS, NSF, NASA SCaN, EUMETSAT (Metop), and DMSP missions and programs operating at McMurdo Station. The JPSS communications services support the relatively high bandwidth demands of USAP operations as well as the science and research community at McMurdo Station. In addition to data, the USAP provisions voice communications (VOIP) between McMurdo Stations and Centennial, CO using the JPSS provided communications services. USAP has alternate voice communications capability using Iridium satellite service.

USAP is allocated a fixed 10Mbps outbound and a fixed 18Mbps inbound between McMurdo Station and Centennial. JPSS manages the overall bandwidth allocation while USAP manages the prioritization and QoS for the flows within the allocated bandwidth.

JPSS GS forwards Mission Notices to the USAP at Centennial and receives Mission Notices from the USAP. The Mission Notices provide operational awareness of the shared communications infrastructure to the cooperating programs.

6.4.1.2 Primary Interfaces

Figure 6.4.1-6 depicts the primary interfaces for this thread. The diagram shows the main external interfaces with the CGS, as well as other pertinent outside interfaces necessary to understand the entire flow of information exchanged and data flow dependencies. The external and outside interfaces are labeled with a number and defined in Table 6.4.1-1 with the interface types, actors, purpose, data rate, data type, frequency, and means of exchange. The legend provided helps distinguish the functions performed by the information exchanges depicted. Table 6.4.1-2 lists relevant IRDs/ICDs.

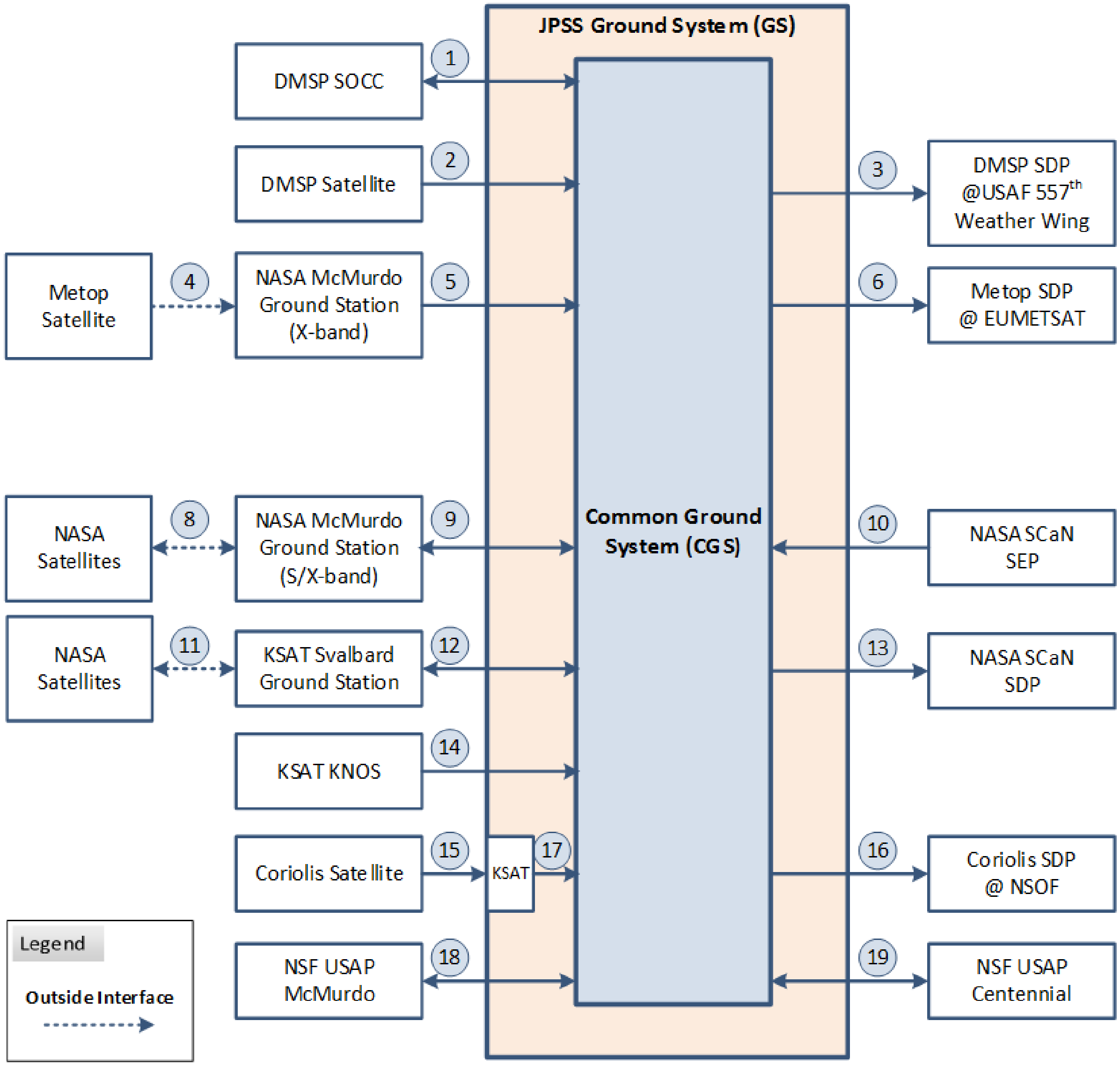


Figure: 6.4.1-6 Data Acquisition and Routing Primary Interfaces

Table: 6.4.1-1 Data Acquisition and Routing Primary Interfaces

No.	Type	Actors	Purpose
1	External	CGS, DMSP SOCC	Coordinate DMSP contact schedules
2	External	DMSP Satellite, CGS	DMSP S-band mission data downlink
3	External	CGS, USAF 557th Weather Wing	Deliver DMSP mission data
4	Outside	Metop Satellite, NASA MG1	Receive Metop mission data
5	External	NASA McMurdo PPS, CGS	Receive Metop mission data
6	External	CGS, EUMETSAT	Deliver Metop mission data

No.	Type	Actors	Purpose
7		Reserved	
8	Outside	NASA Satellite, NASA MG1	Transmit and receive SCaN-supported mission data
9	External	NASA MG1, CGS	Transmit and receive SCaN-supported mission data
10	External	SCaN Service Entry Point	Receive SCaN-support mission uplink data for transmission
11	Outside	NASA Satellite, KSAT Svalbard Ground Station	Transmit and receive SCaN-supported mission data
12	External	KSAT Svalbard Ground Station, CGS	Transmit and receive SCaN-supported mission data
13	External	CGS, SCaN Service Delivery Point	Deliver SCaN-supported mission data (including EOS SMD)
14	External	KSAT KNOS, CGS	Ingest KSAT SG4 contact schedule
15	External	Coriolis Satellite, KSAT Svalbard Ground Station	Receive Coriolis X-band downlink
16	External	CGS, Coriolis Service Delivery Point	Deliver Coriolis/WindSat mission data
17	Internal	KSAT Svalbard Ground Station, CGS	Receive Coriolis mission data
18	External	NSF USAP McMurdo, CGS	Transmit and receive user data
19	External	CGS, NSF USAP Centennial	Transmit and receive user data, Mission Notices

Table: 6.4.1-2 Primary Interface Documentation

No.	IRD/ICD
1, 2, 3	JPSS GS to DMSP IRD
4, 8, 11	Out of scope
5, 6	JPSS GS to EUMETSAT IRD JPSS GS to NASA SCaN IRD
9, 10, 12, 13	JPSS GS to KSAT IRD JPSS GS to NASA SCaN IRD
14	JPSS GS to KSAT IRD
15, 16, 17	JPSS GS to KSAT IRD JPSS GS to Coriolis/WindSat IRD
18, 19	JPSS GS to NSF IRD

6.4.1.3 Assumptions & Constraints

- Shared use of McMurdo (60/20 Mbps) SATCOM Services and ground resources are based on mission and resource priorities and allocations as agreed upon in OAs (ref. mission and site IRDs/ICDs).
- JPSS S/C contacts have schedule priority over DMSP on the McMurdo receptors.

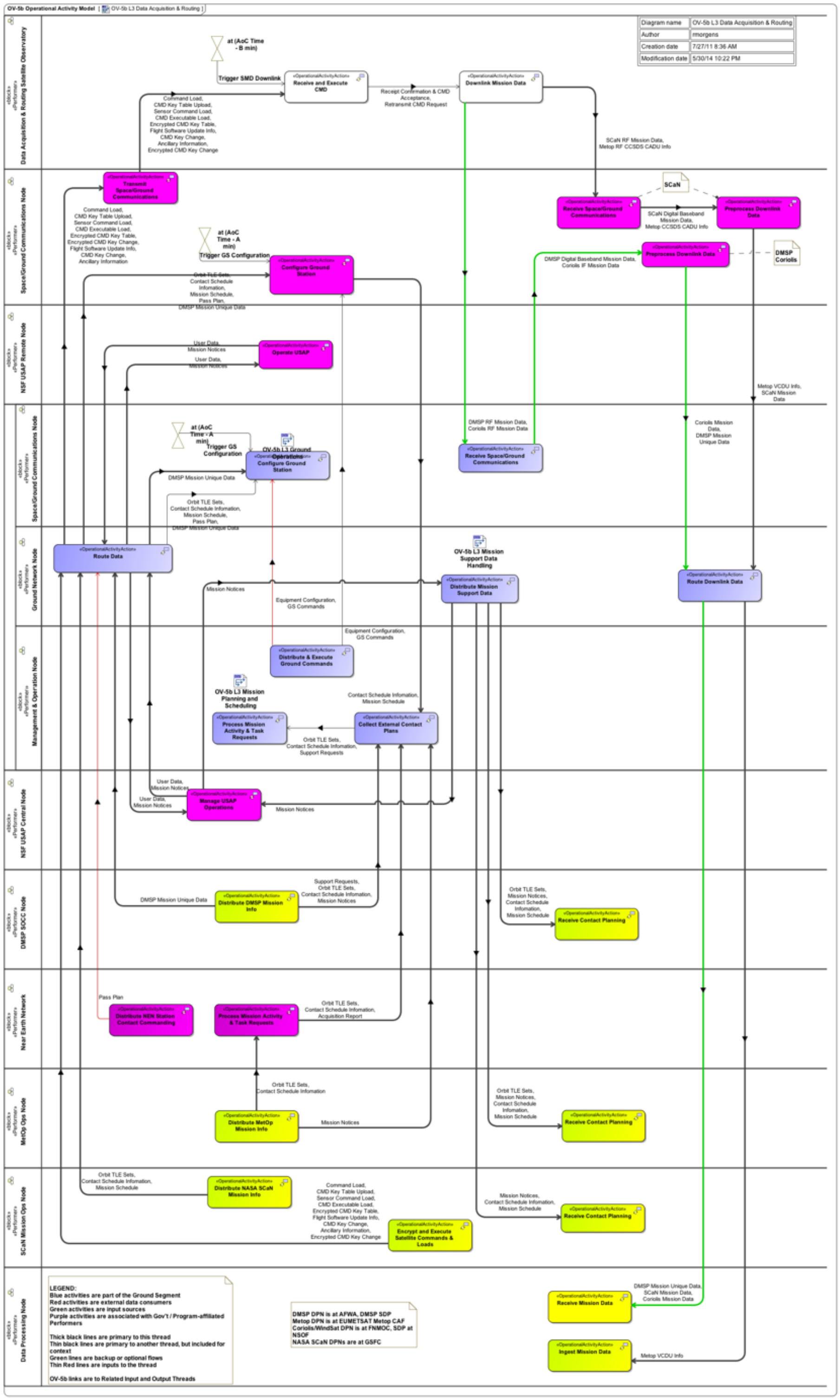
- Due to the extremely harsh Antarctic conditions and limited access to the McMurdo Station receptor sites, there is a potential long delay in restoring the function of a failed receptor. Therefore only one of the two receptors is designated for operational use, while the other is reserved as the backup. This means the resource availability for mission planning is based on a single receptor, not both. In case of a scheduling conflict, the JPSS spacecraft contacts have schedule priority over DMSP for the McMurdo Station receptor. Note that the two receptors will rotate on a monthly basis for the operational use to prevent deterioration due to the hush environment.
- S-NPP/JPSS missions have priority over Coriolis on the SG4 antenna. Coriolis mission ops supported at Svalbard will not interfere with the S-NPP/JPSS missions.

6.4.1.4 Pre-Conditions

- DMSP SOCC (space & ground support coordination) has provided contact schedule info, ground support request / plan, mission schedules / notices, and necessary TLE sets.
- A designated string of receptor equipment at a ground station (McMurdo, Svalbard) is available for a satellite contact and/or ground support (MMCs); including one of the designated (Primary or Alternate) receptors.
- The CGS WAN and ground stations are operational; the McMurdo, Svalbard LANs, and USAF 557th Weather Wing LANs; and other required network infrastructure are available to support ops.
- McMurdo Microwave and SATCOM Service is operational.

6.4.1.5 Operational Flow

The operational flow of DAcqR is illustrated in Figure 6.4.1-7 and ties this thread together with the rest of the system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.4.1-7 Data Acquisition and Routing Operational Flow Diagram

6.4.1.6 Basic Flow

Table 6.4.1-3 describes an operational flow of DAcqR using the activities and the actions associated with these activities. It is visualized in the architecture as depicted above in the OV-5b. The flows are more thoroughly described and listed in time-sequenced steps, and branches are used to describe different ops for different satellite missions at a given stage. Notes are added to provide rationale and references.

Table: 6.4.1-3 Basic Flow of DAcqR

No.	Actors	Actions	Notes
1	DMSP SOCC, Management & Operations Node (MON)	The CGS Collect External Contact Plans activity receives the DMSP support requests and contact schedules along with TLE sets.	
2	MON	The CGS Collect External Contact Plans activity forwards the received support requests and contact schedules to the CGS Process Mission Activity and Task Requests for conflict checking and integration into the Master Schedule.	See Mission Planning and Scheduling (MPS) thread for details.
3	MON	The CGS Collect External Contact Plans activity collects the KSAT SG4 Contact Schedule from KSAT KNOS. The CGS Collect External Contact Plans activity forwards the collected Contact Schedules to the CGS Process Mission Activity and Task Requests for integration into the Master Schedule	
4	Ground Network Node(GNN), DMSP SOCC	The CGS Distribute Mission Support Data activity distributes confirmed mission schedules to the DMSP SOCC's Receive Contact Planning activity for scheduled support.	DMSP support requests are subject to conflict resolution.
4.1	MON, SGCN	For the DMSP missions, the CGS Generate & Validate Ground Equipment Commands activity and the CGS Distribute & Execute Ground Commands activity generate and distribute the ground commands to the CGS Configure Ground Station activity for DMSP data acquisition based on the confirmed DMSP schedules. At	Reference the Ground Operations thread, the Operate Ground System flow, step 2C. The similar setup for the Coriolis/WindSat mission is performed by KSAT. The similar setup for the SCaN missions is performed by KSAT at

No.	Actors	Actions	Notes
		the scheduled time, the CGS Configure Ground Station activity configures the JPSS ground station equipment at McMurdo for receiving data from the DMSP satellites.	Svalbard and NASA at McMurdo. The similar setup for the Metop mission is performed by NASA.
5	Satellites, Space/Ground Communication Nodes (SGCN)	Receive satellite mission data.	
5a	Metop Satellite , External Ground Station (NASA)	During a pass, NASA MG1 antenna at McMurdo receives Metop X-band SMD downlink.	
5b	Satellites (SCaN-supported missions), External Ground Stations (KSAT, NASA)	During a pass, KSAT antenna at Svalbard or NASA antenna at McMurdo receives SMD downlink from the SCaN supported missions.	EOS satellites are some of the SCaN-supported missions.
5c	Satellites (DMSP, Coriolis), SGCN	During a pass, the CGS *Receive Space/Ground Communications* activity receives satellite downlink mission data.	
6	GNN, SGCN	Pre-process captured mission data. Acquisition & preprocessing of Metop / NASA mission data is accomplished outside the CGS. Next the CGS routes the preprocessed downlink data to the Data Processing Nodes (DPNs)	
6a	External Ground Station Node	External Pre-Processor System (PPS) processes Metop or NASA mission SMD.	VCDUs are extracted and metadata trailer appended
6b	SGCN	The CGS Preprocess Downlink Data activity processes DMSP SMD.	
6c	SGCN	The KSAT Preprocess Downlink Data activity processes Coriolis SMD and forwards Coriolis/WindSat data.	
7	GNN, SGCN	Route mission data.	
7a	GNN, EUMETSAT	The CGS Route Downlink Data activity transfers the Metop SMD to Metop SDP at EUMETSAT.	SDP - Service Delivery Point
7b	GNN, USAF 557th Weather Wing	The CGS Route Downlink Data activity transfers the DMSP data to DMSP SDP at USAF 557th Weather Wing.	

No.	Actors	Actions	Notes
7c	GNN, NSOF	The CGS Route Downlink Data activity transfers the Coriolis/WindSat data to the Coriolis SDP at NOAA NSOF.	
7d	GNN, SCaN	The CGS Route Downlink Data activity transfers the SMD from SCaN-supported missions acquired at Svalbard and McMurdo to the SCaN SDP at GSFC.	
7e	GNN, SCaN	The CGS Route Data activity transfers the SCaN-supported mission uplink data from the SCaN Service Entry Point at GSFC to the SCaN SDP at Svalbard and McMurdo.	
7f	GNN, NSF	The CGS Route Data activity transfers the user data from the NSF Service Entry Point at McMurdo to the NSF SDP at USAP in Centennial, CO.	
7g	GNN, NSF	The CGS Route Data activity transfers the user data from the NSF Service Entry Point at USAP in Centennial, CO to the NSF SDP at McMurdo.	

6.4.1.7 Alternate Flow

None

6.4.1.8 Post Condition

Metop data is delivered to the Metop SDP at EUMETSAT.

Downlink data from SCaN-supported missions is delivered to the SCaN SDP.

Uplink data from SCaN-supported missions is routed from the SCaN Service Entry Point to the Svalbard and McMurdo ground stations for uplink.

Coriolis data is delivered to the Coriolis SDP at NSOF.

DMSP data is delivered to the DMSP SDP at USAF 557th Weather Wing.

USAP user data is routed between USAP in Centennial, CO and NSF facility at the McMurdo station.

6.4.1.9 Related Scenarios

Provide a list of threads that area related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-010	Fleet and Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-140	Mission Support Data Handling
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-NNL-130	System Fault Analysis

6.4.1.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-050-010	Data Acquisition and Routing

6.5 Data Product Generation

6.5.1 Stored Mission Data Handling

6.5.1.1 Description

The Stored Mission Data Handling (GS-NML-100) provides a ground system level end-to-end operational thread that describes acquisition, routing and processing of Stored Mission Data (SMD) and distribution of mission environmental data products. This operational flow applies to the JPSS-managed satellites such as S-NPP, JPSS-1/2/3/4 satellites as well as JPSS-supported satellites such as GCOM-W1.

The SMD handling thread begins after the uploading of the spacecraft commands that direct the satellites to play back the SMD from the onboard Mass Data Storage (MDS), formerly Solid State Recorders (SSRs)),based on preplanned ground contact sequences. The downlinked SMD is acquired at the ground stations at one or more polar sites. At the ground station Virtual Channel Data Units (VCDUs) are extracted and then transferred to the JPSS SMD Hub (JSH) in CONUS in accordance with the CCSDS Space Link Extension (SLE) standard. JSH relays annotated VCDUs (aVCDUs) to the NASA Science Data Segment (SDS) for science processing. Furthermore, JSH extracts Application Packets (APs) from the VCDUs; and forwards them internally to the Data Processing Node (DPN) and MON at NSOF, as well as externally to FNMOC and NAVOCEANO, and to the Instrument Support Node (ISN) and Spacecraft Support node (SSN). Some locations only receive APs from select Virtual Channel IDs (VCIDs) (e.g., S-TLM VCIDs only to MON). Starting in B2.2, a subset of S-TLM from JPSS-2/3/4, called restricted S-TLM and identified by an unique VCID, is considered security-sensitive and its distribution is restricted to only MON. This data is never used in data processing, thus not delivered to DPN and other data consumers.

At DPN, the data are processed together with appropriate Mission Support Data (MSD) to produce JPSS data products and metadata. The JPSS data products include Raw Data Records

(RDR), Temperature Data Records (TDRs), Sensor Data Records (SDRs), Intermediate Products (IPs) and Environmental Data Records (EDRs) as defined in JPSS Level 1 Requirements Document (L1RD) Appendix A. The JPSS data products and associated metadata, selected based on the respective Operational Agreement (OA), are then distributed to configured recipients such as ESPC, GRAVITE, and CLASS. The recipients have the option of receiving xDR products compressed or uncompressed (RDRs are never compressed).

For the data rate and volumes of each mission, refer to Table 3.2.1-1, Summary of Missions Supported by the JPSS Ground System and Their Required Services.

The SMD handling is mainly allocated to the Common Ground System (CGS) in the JPSS Ground System. The S-NPP satellite uses X-band for SMD downlink once per orbit at the primary ground station in Svalbard, Norway to meet its 140 minutes data latency. The ground station at the NOAA Fairbanks Command and Data Acquisition Station (FCDAS) in Fairbanks, AK is the alternate for S-NPP SMD and T&C communications. JPSS-1/2/3/4 uses Ka-band for SMD downlink, with contacts during each orbit at each of the polar ground receptor sites at Svalbard and McMurdo in order to meet its 80 minutes data latency for product delivery. The Svalbard Satellite Stations (SvalSat) and the Troll Satellite Stations (TrollSat) ground stations are operated by KSAT. The KSAT SvalSat also hosts a NOAA 4m Ka-band receptor that is operated by the JPSS Ground System.

Under agreements among NOAA, NASA, JAXA and KSAT, the GCOM-W1 mission uses the SvalSat facility as its primary ground station. Contracted by the JPSS Ground Project, KSAT is responsible for GCOM-W1 SMD acquisition, pre-processing and distribution to JAXA. During each pass, GCOM-W1 SMD is transmitted to the ground using an X-band link at 20 Mega symbol per second (Msps) (10 Mbps after convolutional decoding). Two orbits' worth of SMD is routinely transmitted to increase data availability. The received SMD is processed into APID Sorted Data (ASD) files. At the completion of each pass, KSAT generates an acquisition result report file and one processing result report file for each ASD file generated. These files are made available to JAXA via a Secure File Transfer Protocol (S-FTP) interface.

In addition to providing data to JAXA, KSAT also makes acquired GCOM-W1 SMD available to CGS through Intermediate Frequency (IF) signal distribution. CGS demodulates the IF signal, extracts VCDUs and forwards them to the JSH in the same manner as the S-NPP and JPSS SMD (except GCOM-W1 aVCDUs are not relayed to SDS). GCOM-W1 APs are forwarded by the JSH to the DPN as well as FNMOC and NAVOCEANO. The DPN creates only GCOM-W1 RDRs and delivers them to ESPC and CLASS. Note that the format of GCOM-W1 RDR defers from that of S-NPP and JPSS RDRs. Instead of granule-based products, it contains the GCOM-W1 ASD. The GCOM-W1 TLEs, scheduling files, and reports are made available by KSAT to CGS via an S-FTP interface via the Internet. It should be noted that GCOM-W1 is a JAXA-managed satellite and therefore SMD recovery from on-board Mass Data Storage (MDS) is not under the control of JPSS.

SMD acquisition, processing and delivery are tracked for purposes of data availability accounting, data recovery, data latency accounting, and situational awareness. The Data Accounting and Recovery and System Status/Situational Awareness threads address these aspects of SMD handling.

The Mission Support Data (MSD) plays an important role in the SMD processing. Both the auxiliary and ancillary components of MSD are referenced as inputs to the SMD thread. The detailed acquisition, processing and distribution of auxiliary and ancillary data are addressed in the MSD Handling thread.

Metadata generated by the CGS segment describe the content, quality, and condition of sensor data and the resulting JPSS data products. It also captures the heritage of each CGS generated data product by documenting the versions of software, algorithms, and MSD used in the creation of each data product. The CGS automatically provides metadata with the delivery of JPSS data products.

This thread addresses nominal data flow and production as well as various non-nominal cases. Specifically the following scenarios are described in respective alternate flows:

- Ancillary data missing or expired
- Application packets missing
- Data Processing Node faults
- Missing SDR/EDR for EDRs produced from multiple input products from data from the same satellite

Other operational threads that take place in parallel with the SMD handling include Fleet & Ground Management, Mission Planning and Scheduling, Telemetry and Commanding (T&C), Data Quality Assurance, Cal/Val of Data Products, Algorithm Development and Maintenance, Sensor Operations and Payload Support, Launch and Early Orbit, and Ground Operations, as listed in the Related Threads section.

6.5.1.1.1 Sensor Constellation Operations (SCO)

The JPSS Ground System operates S-NPP and JPSS satellites in a constellation. It acquires and processes SMD from these satellites as well as GCOM-W1 concurrently. While the processing of each data streams is very similar to single mission SMD processing, unique issues arise from processing data streams from related missions concurrently.

This section describes how the JPSS Ground System supports sensor constellation operations with a focus on the sensors aboard three spacecraft: S-NPP, JPSS-1 and GCOM-W1. Initially, S-NPP and GCOM-W1 are operational supporting generation of all primary operational products. When JPSS-1 completes the Activation and Checkout activity, it moves into the Transition phase. The Transition phase supports the maturation of sensor data products moving from beta to fully validated status via the Intensive Calibration and Validation (ICV) process as described in the Cal/Val of Data Products thread. As JPSS-1 products or groups of related products become validated they may become the primary operational product under the direction of NOAA NESDIS, supplanting the corresponding S-NPP product(s). The supplanted S-NPP product(s) then become non-primary (produced from secondary mission sensors). At this point the applicable JPSS-1 and S-NPP products are concurrently produced and considered to be in the Concurrency phase. Because the sensors/products move through the ICV process asynchronously, the Transition phase may endure for an extended period of time for some products while other products are being produced concurrently. Typically, the S-NPP products

will continue to be produced well after entering the Concurrency phase as long as the mission sensor is viable and the products provide value to the user community.

The Sensor Failover Anomaly occurs during the Concurrency phase when both primary and non-primary products are nominally being produced. A JPSS-1 sensor anomaly results in degradation or loss of one or more primary products. Anomaly recovery can result in the promotion of non-primary products from another mission (i.e., S-NPP) to primary status so that JPSS can continue to produce a complete set of operational data products.

Figure 6.5.1-1 illustrates notional timeline for the Transition and Concurrency phases and the Sensors Anomaly Failover time period presented in this document.

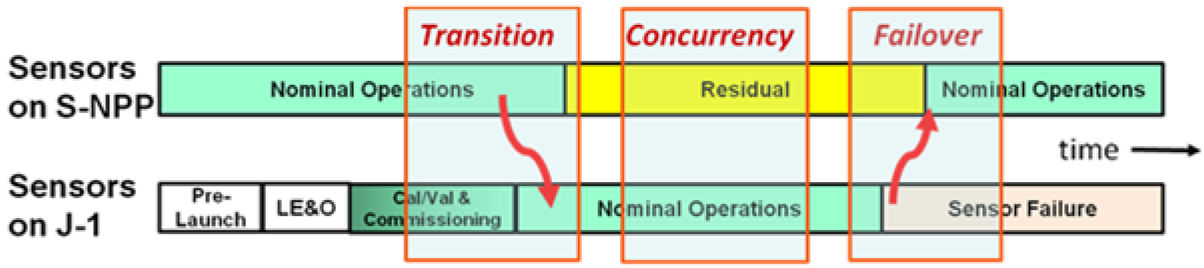


Figure: 6.5.1-1 Notional timeframes for Transition, Concurrency and Failover

The thread considers unique processing requirements for the SCO Concurrency phase. The other phases are described in the following alternate flows:

- SCO Transition to Operations
- SCO Sensor Failover Anomaly

While the example in this section describes the primary sensor transitions between S-NPP and JPSS-1, it can be generalized and apply to transitions from a current primary sensor to a new one, e.g., from one on JPSS-1 to another on JPSS-2.

6.5.1.1.1.1 Definitions

The following multi-mission terminologies are employed in this document:

- Series: JPSS, GCOM-W
- Mission: S-NPP, JPSS-1/2/3/4, GCOM-W1
- Sensor: Spacecraft + Sensor (e.g., S-NPP VIIRS)
- Product: Spacecraft + Sensor + Product Names (e.g., S-NPP VIIRS SST)
- Product Usage Mode: Either Primary (supports user primary operations) or Non-primary (available to supplement user operations, or as a fallback; synonymous with residual or secondary)
- Sensor Operational Modes: Either Primary (used to support creation of at least one Primary operational EDR) or Secondary (does not support any Primary operational

EDRs but may support creation of Non-primary xDRs). Primary sensors may reside on different spacecraft.

The intensive Cal/Val process is integral to the commissioning of new mission data products as they progress from beta to validated status. This process is described in the Cal/Val of Data Products thread.

The sole responsibility of identifying new or enhanced data products or retiring existing ones rests on NOAA NESDIS with its standing Satellite Products and Services Review Board (SPSRB) process.

6.5.1.1.1.2 Benefits of One Half Orbit Phasing Between Primary and Secondary Satellites

Starting with the launch of JPSS-1 satellite, there will be multiple satellites in the JPSS constellation, one designated as Primary, one as Secondary, and others as Residual. The primary satellite is separated from the secondary one along track by ½ orbit. For instance, JPSS-1 will be flying in the same orbit as that of S-NPP with ½ orbit separation. Assuming sensors onboard S-NPP are still functioning well, NOAA plans to use xDR products from both missions to enhance microwave and visible imagery products. The significant benefits from longer in-orbit separation include:

- Better global coverage, especially of higher spatial resolution pixels/field-of-views.
- Both ATMS/CrIS footprint growth minimized.
- VIIRS footprint size growth minimized as the edge of scan on JPSS-1 would be near nadir for the S-NPP follow up.

6.5.1.2 Primary Interfaces

Figure 6.5.1-2 illustrates the actors and primary external interfaces involved in the execution of SMD Handling. Each interface illustrated in the figure, labeled with a number, is described in Table 6.5.1-1, along with the information about relevant ICDs, types of data, exchange method and frequency.

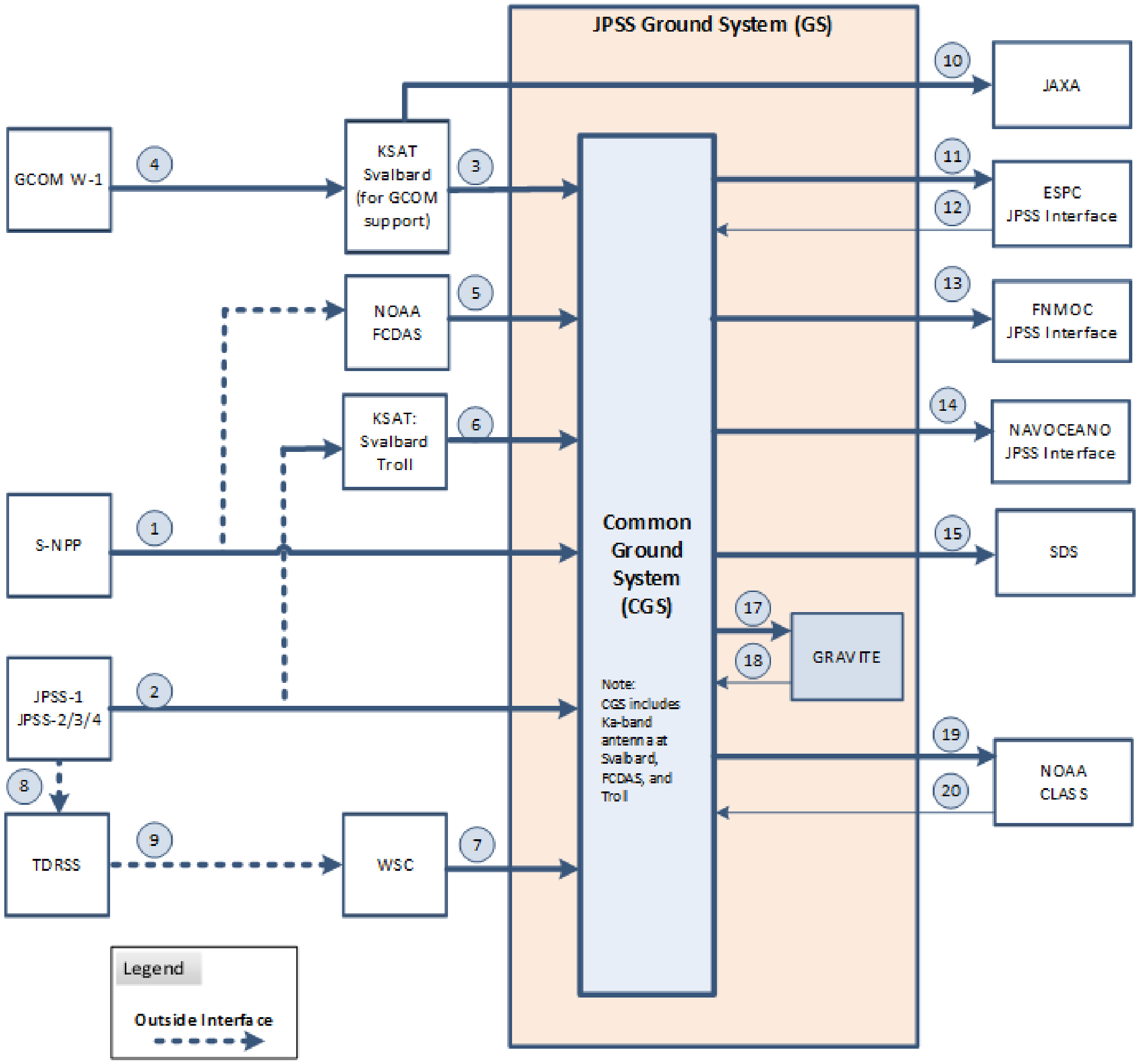


Figure: 6.5.1-2 Primary External Interfaces for Stored Mission Data Handling

Table: 6.5.1-1 Stored Mission Data Handling Primary Interfaces

No.	Type	Actors	Purpose
1	External	S-NPP, CGS	SMD downlink
2	External	JPSS-1, CGS JPSS-2/3/4, CGS	SMD downlink
3	External	KSAT (Svalbard), CGS	GCOM-W1 SMD downlink, GCOM-W1 schedules, TLEs and reports
4	External	GCOM-W1, KSAT (Svalbard)	SMD Downlink
5	External	FCDAS, CGS	S-NPP SMD downlink
6	External	KSAT (Troll), CGS	JPSS-1 SMD downlink
7	External	WSC, CGS	JPSS-1 SMD Downlink

No.	Type	Actors	Purpose
8	Outside*	TDRSS, JPSS-1	SMD Downlink
9	Outside*	WSC, TDRSS	JPSS-1 SMD Downlink
10	External	JAXA, KSAT	GCOM-W1 SMD files
11	External	CGS, ESPC	JPSS and GCOM-W1 xDRs, IPs, metadata, MSD
12	External	CGS, ESPC	JPSS and GCOM-W1 data product requests, Ancillary data
13	External	CGS, FNMOC JPSS Interface	JPSS and GCOM-W1 Application Packets (APs), MSD
14	External	CGS, NAVOCEANO JPSS Interface	JPSS and GCOM-W1 APs, MSD
15	External	CGS, SDS	JPSS SMD, MSD
16	Reserved		
17	Internal	GRAVITE, CGS	Alerts and supporting data related to product quality events. Ancillary data, JPSS xDRs, IPs, metadata, MSD
18	Internal	CGS, GRAVITE	JPSS data product requests
19	External	CGS, NOAA CLASS	JPSS xDRs, GCOM-W1 RDRs, IPs, metadata, MSD
20	External	CGS, NOAA CLASS	JPSS and GCOM-W1 data product requests

* An outside interface is between external entities. It is not directly connected to the JPSS ground system. It is included for information only.

Table: 6.5.1-2 Stored Mission Data Handling Interface Documentation

No.	IRD/ICD
1	• JPSS GP to JPSS FP IRD • JPSS GS to KSAT IRD • JPSS GS to NESDIS FCDAS IRD • S-NPP Spacecraft SMD ICD to the Norway Ground Station
2	• JPSS GP to JPSS FP IRD • JPSS GS to KSAT IRD • JPSS GS to NESDIS FCDAS IRD • JPSS GS to NSF IRD • JPSS-1 Spacecraft SMD to Ground Segment RF ICD (472-00162) • JPSS-1 Mission Data Format ICD • JPSS IRD for RF Interfaces to and From JPSS Satellites 2 through 4 (470-00205 • JPSS-2/3/4 SMD to Ground Segment RF ICD • JPSS-2/3/4 Mission Data Format ICD
3, 4	• JPSS GS to KSAT IRD • GCOM-W1 Mission Operations Interface Specification (MOIS)
5	• JPSS GS to NESDIS FCDAS IRD
6	• JPSS GS to KSAT IRD
7	• SN/WSC to JPSS CGS ICD • JPSS GP to JPSS FP IRD

No.	IRD/ICD
8, 9	Out of scope
10	• JPSS GS to KSAT IRD • GCOM-W1 MOIS
11, 12	• JPSS GS to NESDIS ESPC IRD
13	• JPSS GS to FNMOC IRD
14	• JPSS GS to NAVOCEANO IRD
15	• JPSS GS to NASA SDS IRD
17, 18	• JPSS CGS to GRAVITE IRD
19, 20	• JPSS GS to CLASS IRD

6.5.1.3 Assumptions & Constraints

- Satellites continuously collect mission data from on-board sensors and store it on Mass Data Storage (MDS).
- The S-NPP and JPSS MDS playback is controlled by the MON through stored or real-time commands. GCOM-W1 MDS playback is controlled by JAXA.
- There are two types of SMD playback from the MDS: the original playback and retransmission. As indicated by their names, the original playback transmits the SMD in the MDS for the first time to the ground, resulting in an original copy of the SMD. The retransmission transmits the SMD in the MDS that have been previously transmitted to the ground, resulting in a retransmission copy of this SMD.
- To prevent data loss at the beginning and ending of original playback, a section of overlap with the previous original playback is intentionally included in each original playback. As a result, there are redundant SMDs at the beginning of each original playback.
- Likewise, a retransmission may contain, towards its end, the SMD that has not been transmitted before.
- Retransmissions from spacecraft can be accomplished through either real-time commands or stored commands.
- VCDU and packet sequence counts always increase with time, except when a counter "rolls over".

SCO Assumptions and Constraints

- S-NPP, JPSS-1/2/3/4 will comprise a constellation at a 1325 LTAN, similar to the A-Train, with managed orbital separation between satellites
- After JPSS-1 is launched, the S-NPP and JPSS-1 nominal orbital positions will be separated by 1/2 orbit (50.75 minutes). After JPSS-2 is launched, JPSS-1 and JPSS-2 nominal orbital positions will be separated by 1/2 orbit, with S-NPP moved to a position ¼ orbit from JPSS-2
- Sensors do not get turned off if at least marginally operational

- The redundant sensor side (nominally B) does not get calibrated or used until the operational side (nominally A) fails
- There is only one complete set of primary operational xDRs to which the data availability and latency requirements apply. xDRs produced from Secondary Mission Sensors are produced on a best effort basis.
- During ICV, full product sets of xDRs are produced for each JPSS-managed mission
- NOAA NESDIS is responsible for identifying the operational EDR set through their SPSRB process (based on data product team recommendations)
- Raw Data Records (RDRs) are produced from observation data from secondary sensors; Housekeeping (HK) data from secondary sensors is extracted from the Stored Mission Data (SMD) and delivered to the MON for monitoring and trending
- SDRs are created as needed from secondary operational sensors in support of routine calibration to support a timely failover to primary operational mode
- CGS is required to produce one complete set of operational data products from the primary mission sensors and all RDRs from the secondary mission sensors and make them available to ESPC and to CLASS.
- Under nominal conditions, a complete set of non-primary products (xDRs beyond RDRs and Long Term Monitoring (LTM) driven SDRs) from the secondary mission sensors are routinely generated and made available to the NESDIS ESPC and CLASS. The FNMOC and NAVOCEANO receive APs from JPSS (including APs from secondary mission sensors) rather than RDRs. RDRs and additional products are created from the APs locally at their facilities. At a minimum, the ability to enable/disable generation of non-primary products will be configurable at the CGS DPN.
- For GCOM-W1, RDRs are always produced by CGS.
- In B2.2, JPSS-2 aVCDUs will be distributed to SDS to support early instrument testing.
- In B2.2, JPSS-2 Extended APs will not be distributed to FNMOC and NAVOCEANO. These deliveries will commence in TBD.
- For JPSS-2, only RDRs are generated and distributed to GRAVITE in B2.2.
- Generation of a data product with input from sensors on different satellites is out of scope.

6.5.1.4 Pre-Conditions

The system is configured for normal operations.

- The CGS mission planning and scheduling activity prepared detailed contact plans and resource scheduling based on the operational baseline.

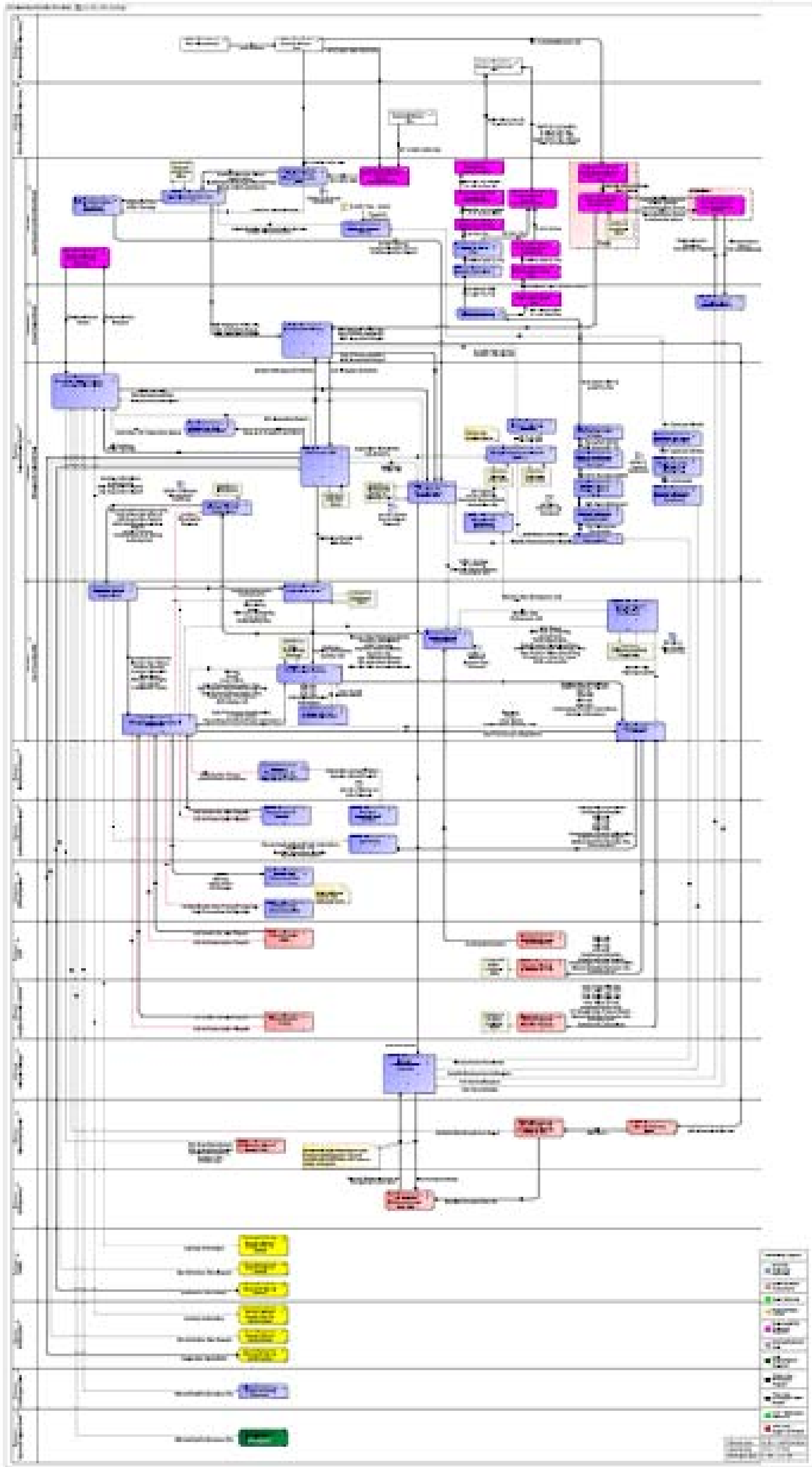
- The operational sensors on the latest JPSS satellite are primary and are the basis for the complete set of operation products made available to the users. The sensors on S-NPP and other JPSS satellites are secondary and are the basis for the non-primary data products made available to the users.
- The CGS Real-time mission operation activity has configured ground resources to acquire, route, process and distribute SMD. While some ground resources may need to be configured for each ground contact, others may be configured once and stay in the same operational state until reconfiguration is needed.
- All SMD (original and retransmitted from the spacecraft) received at a ground station is routinely forwarded to the JSH in CONUS. The SMD ground station provides the capability to perform SMD retransmissions to the JSH based on requests from the MON/MOT.
- The CGS real-time Mission Operations activity and Provide Space/Ground Communication activity have uploaded the stored commands to appropriate satellites to command the upcoming MDS playback on a previous contact (see the Telemetry and Command thread for more spacecraft commanding details).

Table: 6.5.1-3 Command Upload for MDS Playback

Satellite	Command Upload for MDS Playback	Notes
S-NPP	The CGS real-time Mission Operations activity and Provide Space/Ground Communication activity upload the stored commands to S-NPP to command it to playback SMD from the MDS at Svalbard or Fairbanks ground station using its X-band capability.	
GCOM-W1	None.	GCOM-W1 SMD downlink is controlled by JAXA.
JPSS	The CGS real-time Mission Operations activity and Provide Space/Ground Communication activity upload the stored commands to the JPSS satellites to command them to playback SMD from the MDS at available ground sites or to TDRSS using its Ka-band capabilities.	See /S-NPP/JPSS MDS Playback thread for details. To improve data availability performance, the CGS may command the satellite to downlink the same SMD more than once, resulting in multiple copies of SMD. All SMD received from the satellite at the ground station is transferred to the JSH.

6.5.1.5 Operational Flow Diagram

Figure 6.5.1-3 provides an illustration of system actions taking place in the basic flow of the thread.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.5.1-3 SMD Handling Operational Flow Diagram

6.5.1.6 Basic Flow

Trigger: At the specified time, the ground station is automatically activated to begin searching and acquiring the satellite SMD downlink signal.

At the time specified in the stored commands, the satellite turns on the transmitter and plays back SMD from specified locations in the MDS.

Note: there are two sub-numbering notations used in the basic flow: 1) #x, where # is a number and x a letter, denotes parallel sub-actions; and 2) #.# denotes sequential sub-steps in a step.

Table: 6.5.1-4 Stored Mission Data Handling Actions and Actors

No.	Actors	Actions	Notes
1		Reserved	
2	S-NPP/ JPSS/ GCOM-W1, Ground Stations	The various ground stations supporting SMD downlink for the support missions perform common activities of RF downlink receive, down-convert to IF, demodulate and bit-synchronize the signal in order to recover the bit-stream.	The ground stations, including SvalSat at Svalbard, TrollSat at Troll, FCDAS at Fairbanks, the receptors at McMurdo, and TDRSS at WSC are operated by different entities and have unique interfaces with the CGS as described in the following steps.
2a	JPSS, Space/ Ground Communic-ation Node (SGCN)	The CGS Receive Space/Ground Communication activity at the Svalbard ground station receives the Ka-band SMD RF. The CGS Receive Space/Ground Communication activity down-converts the RF signal to IF and processes the IF signal to recover the SMD bit-stream.	This Ka-band receptor is operated by the CGS.
2b	JPSS/S-NPP/GCOM-W1, KSAT, SGCN	The KSAT Receive Space/Ground Communication activity at the Svalbard ground station receives the X-band or Ka-band SMD RF downlink from the S-NPP, JPSS, and GCOM-W1 satellite. The KSAT Receive Space/Ground Communication activity down converts the RF downlink to IF and routes the IF signal to the CGS Receive Space/Ground Communication activity. The CGS Receive Space/Ground Communication activity processes the IF signal to recover the SMD bit-stream.	These X-band and Ka-band antennas are operated by KSAT.
2c	S-NPP, FCDAS, SGCN	FCDAS operations receives the X-band SMD RF downlink from the S-NPP satellite and down-converts the RF downlink to an IF signal that is routed to the CGS Receive Space/Ground Communication activity.	The X-band antenna is operated by FCDAS.

No.	Actors	Actions	Notes
		The CGS Receive Space/Ground Communication activity processes the IF signal to recover the SMD bit-stream.	
2d	JPSS, FCDAS, SGCN	The CGS Receive Space/Ground Communication activity at the FCDAS ground station receives the Ka-band SMD RF. The CGS Receive Space/Ground Communication activity down-converts the RF signal to IF and processes the IF signal to recover the SMD bit-stream.	The Ka-band receptor at FCDAS is operated by the CGS.
2e	JPSS, SGCN	The CGS Receive Space/Ground Communication activity at the McMurdo ground station receives the Ka-band SMD RF. The CGS Receive Space/Ground Communication activity down-converts the RF signal to IF and processes the IF signal to recover the SMD bit-stream	The Ka-band receptors at McMurdo are operated by the CGS.
2f	JPSS, KSAT, GNN	The antenna back-end and front-end equipment at Troll processes the RF/IF signals, extracting VCDUs from the downlink. The VCDUs are annotated and forwarded to the CGS Route Downlink Data activity via SLE. KSAT provides VCDU receive statistics to the CGS as described in the Data Accounting and Recovery thread. Continue to step 5.1.	The Ka-band antenna, baseband and front-end equipment at Troll are operated by KSAT. KSAT is providing a SLE compliant service for the delivery of SMD to the CGS. VCDUs are stored for at least 7 days at the Troll ground station.
2g	JPSS, WSC, SGCN	For JPSS SMD downlink, the space/ground communication is performed by the White Sand Complex (WSC) at White Sands, NM. WSC converts the SMD downlink RF to IF and routes the IF signal to the CGS Receive Space/Ground Communication activity. The CGS Receive Space/Ground Communication activity processes the IF signal to recover the SMD bit-stream.	JPSS SMD is relayed to WSC through TDRSS satellites. WSC can also send SMD to CGS as bit-stream through RS-422 interface
3	SGCN	The CGS Preprocess Downlink Data activity processes the SMD bit-stream to retrieve VCDUs per CCSDS TM Synchronization and Channel Coding standard (CCSDS 131.0-B-2)	Examples of the processing include: • convolutional decoding • de-randomization • frame synchronization • Reed-Solomon decoding • LDPC decoding The processing required for a given mission is specified in the mission specific RF ICDs and the GCOM-W1 MOIS.

No.	Actors	Actions	Notes
			For the S-NPP and JPSS-1 missions, convolutional decoding is nominally not required for SMD downlink over the polar ground stations. However it is required for SMD downlink via TDRSS due to marginal link margins.
4	SGCN	The CGS Preprocess Downlink Data activity, at the ground stations, annotates VCDUs with earth receive time and site ID information and checks VCDU sequence counts for gaps. The VCDUs, sorted by Virtual Channel Identifier (VCID), are stored locally for at least 7 days (from the time the data is stored) and are available for retransmission upon request.	S-NPP and GCOM-W1 have 24-bit VCDU sequence counters. JPSS-1 has 28-bit VCDU sequence counters which ensures unique values for all VCDUs stored on-board the JPSS MDS. See the Data Accounting and Recovery thread for data accounting information collection and application. The data storage at this stage is needed to support: • System outage protection • Retransmission
4.1	SGCN	The CGS Preprocess Downlink Data activity generates an Acquisition Report at the end of pass and sends it to the CGS Manage SGCN Nodal Situational Awareness activity. The Acquisition Report summarizes the data acquisition events, ground station status and data statistics for the pass.	See the System Status/Situational Awareness thread for more details.
5	SGCN, GNN	The CGS Preprocess Downlink Data activity delivers the VCDUs received during the pass (original and retransmitted from the MDS) to the CGS Route Downlink Data activity.	
5.1	GNN, MON	The CGS Route Downlink Data activity employs rate buffering and/or packet shaping on the SMD data (along with all other JPSS data in aggregate) to ensure the proper prioritization of various data flows and to ensure the aggregate data flows do not exceed shared WAN resources or impede the data communications of other non-JPSS users on a shared WAN resource.	Routing statistics are delivered in the context of the Data Accounting and Recovery Thread. The specific bandwidth limitation for JPSS in aggregate (SMD plus all other data communications) is a configurable value that can be

No.	Actors	Actions	Notes
		The CGS Route Downlink Data activity routes the SMD VCDUs to the JSH Process SMD activity for VCDU delivery, application packet extraction and distribution.	set for each shared WAN resource JPSS data traverses. SMD supporting secondary operational sensors in a Multi-mission sensor constellation may be prioritized below SMD from primary operational sensors to satisfy latency requirements.
6a	MON	For S-NPP and JPSS-1/2 data, the CGS JSH Process SMD activity relays all aVCDUs received from ground stations, with two exceptions, to the SDS JSH Process SMD activity. The two exceptions are JPSS-2 restricted TLM and Full-resolution Stored State of Health (FSSOH), both of which are identified by unique VCIDs. The CGS JSH Process SMD activity receives VCDUs, integrates data streams from multiple ground sites, time-orders and sorts VCDUs by VCID and removes redundant VCDUs, compiles VCDU statistics, and store the VCDUs in the JSH Data Store for at least 7 days. The CGS JSH Process SMD activity reconstructs time-ordered APs from the VCDUs, removes fill packets, and compiles AP statistics. The CGS JSH Process SMD activity adds annotation to the APs to make Extended APs (EAPs) and store them in the JSH Data Store for 7 days. Retransmitted SMD received from the ground station is combined with original SMD as needed in support of data recovery operations to fill gaps in the original SMD delivery.	JPSS delivers aVCDUs to NASA SDS for S-NPP and JPSS-1 sensor calibration and validation as well as climate research; and JPSS-2 testing. The JSH should filter out aVCDUs of JPSS-2 restricted TLM (VC54) and FSSOH (VC55) by their respective VCID and not to relay them to SDS. The JSH distinguishes between original and retransmitted SMD received from the ground station. VCDU and AP statistics are delivered in the context of the Data Accounting and Recovery Thread. The data storage at this stage is needed to support: • System outage protection • Retransmission • Sensor anomaly investigation support
6b	MON	For GCOM-W1 data, the CGS JSH Process SMD activity receives VCDUs, sorts VCDUs by VCID, and compiles VCDU statistics. The CGS JSH Process SMD activity reconstructs APs from the GCOM-W1 VCDUs, removes fill packets, and compiles AP statistics. The CGS JSH Process SMD	During each contact, GCOM-W1 nominally downlinks two orbits of SMD (the current orbit and the previous orbit), thus producing a redundant copy. CGS doesn't remove redundant GCOM-W1 data. Each APID-sorted data file (aka, ASD files)

No.	Actors	Actions	Notes
		activity sorts GCOM-W1 APs into APID-sorted data files and store them in the JSH Data Store for 7 days. Retransmitted SMD received from the ground station is combined with original SMD as needed in support of data recovery operations to fill gaps in the original SMD delivery.	consists of all APs of a given APID from a contact. In case of a missed contact, GCOM-W1 will downlink three orbits of SMD in the following contact.
6c	KSAT	The KSAT Route Downlink Data activity reconstructs APs from the GCOM-W1 VCDUs and stores APs in data files sorted by APIDs. The KSAT Route Downlink Data activity makes the APID sorted data files available to JAXA for retrieval.	Data processing for JAXA.
7a	MON, DPN	The CGS JSH Process SMD activity sends EAPs (including GCOM-W1 APID sorted data files) to the CGS Ingest Mission Data activity at the Data Processing Node.	All APs, except JPSS-2/3/4 restricted S-TLM, fill packets and duplicate S-NPP and JPSS packets, should be forwarded for RDR generation. The APs should be transferred in flat files in optimized file size for reliability, efficiency, and accountability. They can be sorted either by APID or by VCID (the VCID of the VCDUs from which the APs are extracted).
7b	MON	The CGS JSH Process SMD activity sends S-TLM, Dump APID, and JPSS-2/3/4 Full-resolution Stored State Of Health (FSSOH) EAPs and related statistics to the CGS Manage Telemetry and Payload Data activity at MON for telemetry analysis.	See the Telemetry and Command thread for further description of telemetry processing and trending.
7c	MON	The CGS JSH Process SMD activity sends selected S-TLM EAPs and payload EAPs to the CGS Process and Extract Telemetry activity at each Sensor Ops at MON.	See the Sensor Operations and Payload Support thread for further description.
7d	MON	The CGS JSH Process SMD activity provides VCDU tracking statistics and AP tracking statistics to the CGS JSH Track and Recover Gaps in Mission Data activity at MON.	
7e	MON, FNMOC JPSS Interface, NAVOCEA	The CGS JSH Process SMD activity sends S-NPP, JPSS-1, and GCOM-W1 EAPs (including GCOM-W1 APID sorted data files but excluding JPSS-2/3/4 restricted S-TLM) to FNMOC and NAVOCEANO.	FNMOC and NAVOCEANO process EAPs and produce xDRs on their own data processing systems.

No.	Actors	Actions	Notes
	NO JPSS Interface		The EAPs should be transferred in flat files in optimized file size for reliability, efficiency, and accountability. They are sorted by VCID (of VCDUs from which the APs are extracted).
7.5	DPN	The CGS Manage Product Generation and Distribution activity requests operations and data processing Ancillary and Auxiliary data from the CGS Distribute Mission Support Data activity.	
8a	DPN	The CGS Ingest Mission Data activity at the Data Processing Nodes receives APs from the CGS JSH Process SMD activity and stores the APs in the EAP Data Store for at least 7 days.	
8b	DPN	The CGS Ingest Mission Data activity at the Data Processing Nodes receives operations and data processing Ancillary and Auxiliary data from the CGS Distribute Mission Support Data activity and stores them in the Data Processing Storage for at least 7 days from the time the data is stored.	See the Mission Support Data Handling thread for further description of MSD generation and distribution.
9	DPN	The CGS Ingest Mission Data activity produces sensor Raw Data Records (RDRs) The CGS Ingest Mission Data activity checks product quality and constraints based on received payload data and telemetry, including spacecraft maneuver status. The CGS Ingest Mission Data activity indicates the product quality and constraints in each product's metadata.	This activity may involve the following steps: • Process SMD EAPs, along with S-TLM, auxiliary data and ancillary data, into sensor RDRs and associated metadata, and store the RDRs and metadata. • Process the S-TLM EAPs to extract calibration and auxiliary data Process and store auxiliary data RDRs, including metadata • Process and store ancillary data GCOM-W1 RDR has a product format different from that of other RDRs.

No.	Actors	Actions	Notes
			The spacecraft maneuver status is generated based on received telemetry and has 4 values: • Normal operations • Orbit correction maneuver • Calibration maneuver • Unknown
10	DPN	The CGS Ingest Mission Data activity stores the RDRs in the Data Processing Storage for at least 7 days from the time the RDR is stored.	
11	DPN	For GCOM-W1 AMSR2 S-NPP/JPSS-1 CERES, and all JPSS-2 instruments, only RDRs are produced. Go to Step 15 for product distribution. For others, continue to Step 12 for product generation	The NESDIS ESPC is responsible for generating AMSR2 SDRs/EDRs from RDRs delivered by the JPSS GS. LaRC is responsible for generating S-NPP/ JPSS-1 CERES and JPSS-2/3/4 RBI Level 1 products from Level 0 products delivered by SDS. See Alternate Flow #1 for more details. For B2.2, only JPSS-2 RDRs are generated and distributed to GRAVITE.
12	DPN	The CGS Manage Product Generation and Distribution activity manages the data processing configuration defined by MOT at the DPN. The CGS Manage Product Generation and Distribution activity acquires mission configuration updates, mission schedule updates, planned outages, and operation notices from the CGS Distribute Mission Support Data activity as described in the Mission Support Data thread. The CGS Manage Product Generation and Distribution activity receives data processing and data distribution status from the Ingest Mission Data activity, Produce Data Products activity and Distribute Data Products activity.	The data processing configuration may contain the following info: • Calibration configuration such as which type of ancillary data and what coefficient tables to use • Available data processing resources Examples of data and data processing status include: • Processor usage • Memory usage • I/O usage • Data availability for product generation • Product completion

No.	Actors	Actions	Notes
		The CGS Manage Product Generation and Distribution activity manages xDR product generation based on processing configuration, data availability, data quality and resource availability. The CGS Manage Product Generation activity reports product generation and distribution status to the Data Processing Node operator.	*A configurable scheme may be used to prioritize the processing of data products so that higher priority processing will be given most of the product creation resources without completely blocking lower-priority processing.* DP Node status and data processing statistics are reported back to the CGS MON in accordance with the Data Accounting and Recovery thread.
12.1	DP Node Operator, DPN	The Data Processing Node Operator manages production of non-primary SDRs by sending enable/disable SDR production configuration requests on a spacecraft/sensor-by-spacecraft/sensor basis to the CGS Manage Product Generation and Distribution activity. The Data Processing Node Operator manages production of non-primary xDRs by sending enable/disable TDR, IP, EDR production configuration requests on a spacecraft/sensor-by- spacecraft/sensor basis to the CGS Manage Product Generation and Distribution activity.	RDRs are required to be produced and distributed for all operational sensors-primary and secondary. Additional xDRs (SDRs, TDRs, IPs, EDRs) are nominally produced for all operable sensors-primary and secondary. The DP Node Operator may disable additional xDRs production when anomaly conditions require increased capacity for primary product production or the Data Processing capacity has been degraded below the capability to generate non-primary products. To ensure adequate Long Term Monitoring, SDR production is periodically required to maintain calibration and validation of the secondary sensors even when additional xDR production is disabled. The DP Node Operator has the ability to enable SDR only production for secondary mission sensors.
13b	DPN	The CGS Produce Data Products activity processes sensor RDRs, calibration data, ancillary data and auxiliary data to produce Temperature Data Records (TDRs), Sensor Data Records (SDRs), Intermediate Products	This activity may involve the following steps: • Decompress (as needed), byte-align and geo-locate

No.	Actors	Actions	Notes
		(IPs) and Environmental Data Records (EDRs). The CGS Produce Data Products activity stores the generated data products in the Data Processing Storage.	instrument specific RDR granules • Apply antenna and calibration coefficients as appropriate to processed instrument specific RDR granules to define and produce instrument specific IPs, TDRs and SDRs. • Produce engineering unit converted and limit-checked telemetry pseudo-SDRs from telemetry RDRs • Store IPs, TDRs, SDRs and TLM pseudo-SDRs, including metadata • Sort, interpolate, and coordinate transform global ancillary data to produce an EDR referenced ancillary data set.
14	DPN	The CGS Produce Data Product activity manages the Data Processing Storage so that the internal data products will be stored for at least 7 days from the time the data is stored.	The data storage supports • Product delivery • System outage protection (e.g. CLASS where only 8 by 5 support available)
14.1	DPN	The CGS Produce Data Product activity provides data products to the CGS Check Internal Consistency of Data activity for data quality monitoring.	See Data Quality Assurance thread for details.
15	DPN, GRAVITE, ESPC JPSS Interface, CLASS	The CGS Distribute Data Products activity receives standing requests and Ad-Hoc requests for data from one or more authorized users (GRAVITE, ESPC JPSS Interface, and CLASS). The CGS Distribute Data Products activity verifies the requests for data. It may accept or reject a request for data. Based on accepted requests for data, the CGS Distribute Data Products activity delivers data products (RDRs, TDRs, SDRs,	The data products are defined in JPSS L1RD Appendix A. A request may be rejected for one of following reasons: • Syntax error • Beyond retention time limit • Not authorized • *Redundant [future]* • Over an agreed-upon data transmission bandwidth

No.	Actors	Actions	Notes
		EDRs, IPs, and associated metadata) to the configured recipients. Each recipient has the option of requesting products in a compressed or uncompressed format. RDRs are never compressed. See steps 15a-15c for specifics for each type of recipients.	Support data includes delivery report, production reports, data quality reports, ANC, and AUX data. JPSS-2 RDRs are only distributed to GRAVITE to support JPSS-2 JCT2.
15a	DPN, ESPC JPSS Interface	The CGS Distribute Data Products activity processes service requests from the ESPC JPSS Interface for the produced data products and associated metadata. It then generates and delivers the requested products to the ESPC JPSS Interface.	The ESPC JPSS Interface retrieves JPSS Ground System products needed to generate their higher-level products.
15b	DPN, CLASS	The CGS Distribute Data Products activity processes service requests from CLASS for the data products, along with metadata, calibration and engineering conversion data sets, and related MSD. For CLASS, the CGS Distribute Data Products activity delivers a requested data product to CLASS only when the data product has been at least 6 hours "old" since its observation time.	CLASS receives products for long term archive storage. The 6-hour delay provides a time window during which a data product may be repaired based on additional data received. See "NOAA CLASS to CGS IRD" for more details. The observation time of a data product is defined as the time stamp of the most recent Application Packet that contributes to this data product. See the Data Accounting and Recovery thread for more details.
15c	DPN, GRAVITE	The CGS Distribute Data Products activity processes service requests from the GRAVITE for the xDRs, along with metadata, calibration and engineering conversion data sets, related MSD and IPs. It generates and delivers the requested products to the GRAVITE Ingest Data activity.	GRAVITE receives products for Cal/Val and Algorithm Support functions
16	DPN	The CGS Distribute Data Products activity stores every copy of distributed product in the Delivery Storage for at least 24 hours to support retransmission.	
General	MON, MOT	The CGS will provide MOT the status of SMD data acquisition, routing, processing and product delivery as well as that of	General activity.

No.	Actors	Actions	Notes
		system resources. The enable/disable status of non-primary products is included in the status.	See the System Status/Situational Awareness thread for general guidelines.

6.5.1.7 Alternate Flow #1 - CERES and RBI Data Processing

The S-NPP/ JPSS-1 CERES and JPSS-2/3/4 RBI data productions are the responsibility of the NASA Langley Research Center (LaRC) and follows an alternate route. The NASA LaRC handles all data processing and Cal/Val functions for the CERES and RBI instruments. From CGS provided aVCDUs, the NASA SDS generates CERES and RBI Level 0 data products and provides them to LaRC. Additionally, the Land Science Investigator-led Processing System (SIPS) provides some correlative VIIRS Level 1 data to LaRC for their data processing. CERES and RBI data products from LaRC are not distributed to the operational users or CLASS.

6.5.1.8 Alternate Flow #2 - Missing or Expired Dynamic Ancillary Data

This alternate flow describes how the data processing proceeds when the desired dynamic ancillary data is not available or expired.

6.5.1.8.1 Terminologies

Dynamic and Static - Dynamic ancillary is updated relatively frequently (e.g., every 6 hours). It is acquired automatically, as it becomes available, and used in the CGS to generate products. Static ancillary data is updated rarely, if at all. When it is updated, it is distributed via the Software distribution method to DPN that generates products. This means that, by definition, DPN has a copy of the static ancillary data.

Primary and Alternate - Primary ancillary data is simply the first choice of ancillary data to use when generating products. Alternate ancillary data is any fallback, or backup, choice. Alternate refers to the 2nd, 3rd… to last choice. The last choice is often climatology, a type of static ancillary data, thereby guaranteeing that at least one choice is available at DPN.

The JPSS Algorithm Specification for the Common Algorithm Software Requirements Specification (SRS) lists the order of ancillary to be used for each JPSS product. This list starts with the primary ancillary data through all alternate choices. The SRS only lists ancillary data choices for official products.

Official and Alternate - These terms refer to how the ancillary data is used rather than the data itself. Official JPSS products are made with the ancillary data as specified in the SRS. However, a processing site is free to deviate from the lists in the SRS. If they do, then they are generating alternate products, not official products.

When the primary ancillary data is unavailable, alternate ancillary data is used and the product is considered to be generated in “graceful degradation”.

Table 6.5.1-4 shows an example of ancillary data usages and product designations, where the SRS specifies that NCEP is the primary choice and NAVGEM the alternate choice for making official products.

Table: 6.5.1-5 An Example of Ancillary Data Usage and Product Designation

Ancillary data used in product generation when	NCEP Available	NCEP Not Available
NCEP	Official Product	N/A
NAVGEM	Alternate Product	Official Product in Graceful Degradation

6.5.1.8.2 Data Processing with Alternate Ancillary Data

Trigger: A fault event occurs that renders the up-to-date primary dynamic ancillary data unavailable.

Table: 6.5.1-6 Basic Flow for Data Processing with Missing or Expired Ancillary Data

No.	Actors	Actions	Notes
1	DPN	At the processing node, within the CGS, the up-to-date primary dynamic ancillary data is looked for and not found.	See the Mission Support Data Handling thread for further information
2	DPN	Each processing node selects the alternate ancillary data that it is configured to use.	
3	DPN	Products continue to be generated. Product metadata records what ancillary data was used to generate them. Product metadata also records that the products were made in “Graceful Degradation”, indicating that the primary choice of ancillary data was not available.	
4	DPN, MON	The CGS continues to generate and deliver products in Graceful Degradation.	This step continues while the MOT works to resolve the fault condition.
5	MON, MOT	The MOT may manually direct the CGS to acquire and distribute the most recent dynamic ancillary data from a backup source if available.	This step essentially resumes operations through alternate paths.
6	DPN	Each processing node finds the primary choice of ancillary data through an alternate source and generates products without Graceful Degradation.	Products will no longer be marked as Gracefully Degraded.
7	MON, MOT	When the fault condition is resolved, the MOT manually directs the CGS to acquire and distribute the most recent dynamic ancillary data from the ESPC PDA.	
8	DPN	Each processing node finds the primary choice of ancillary data through the primary source and generates products with that.	This step essentially resumes normal operation.

6.5.1.9 Alternate Flow #3 - Missing Sensor Data

This alternate flow addresses the fault events where some sensor data are temporarily lost. The loss could be due to:

- Temporary loss of the downlink
- Dropped or corrupted application packets

Also, the "loss" is at the point where the data is used to generate products in the processing nodes. The data may be present elsewhere in the system and recoverable from there.

Recovery of data is an independent activity for each processing node. Processing nodes do not share sensor data amongst themselves.

The Data Accounting and Recovery thread describes the detection of data gaps and the recovery of missing data from storages on the ground or from the spacecraft. This thread focuses on:

- Deliver as many products as possible during the fault event
- Recover and deliver as many products as possible once the fault is corrected

It should be noted that the processing of multiple-orbit data after an extended outage is a major interruption to the nominal data flow and requires significant Ground System resources. Care must be taken so that the recovered data can be processed without impacting the data latency performance of processing current data.

Trigger:

A fault event occurs that results in lost APs, intermittently or for an extended period.

Table: 6.5.1-7 Basic Flow for Missing Sensor Data Handling

No.	Actors	Actions	Notes
1a	DPN	During the fault event, CGS detects data gaps but continues to generate and deliver any partial products that have met a configurable completeness threshold.	This step occurs for products for which the missing data is a primary input
1b	DPN	During the fault event, CGS detects data gaps but continues to generate and deliver these products using predefined alternate inputs.	This step occurs for products for which the missing data is a secondary input. This is considered 'graceful degradation'. An example graceful degradation is the JPSS-1 VIIRS product generation processing utilization of ancillary data as input if JPSS-1 OMPS products are not available.
2	DPN	When recovered required input data is received, CGS will regenerate and deliver all missing or incomplete products previously impacted by the missing required input data.	This processing may be performed at a lower priority than the generation of current products to ensure latency requirements are met for current data. CGS does not re-generate products that were made using alternate inputs.

No.	Actors	Actions	Notes
			The JSH nominally manages the delivery of recovered input data (annotated APs) to the impacted DPN, FNMOC, or NAVOCEANO. In certain cases of extended outages or other unusual circumstances the MOT may manage the delivery of recovered input data to the impacted DPN, FNMOC, or NAVOCEANO.

6.5.1.10 Alternate Flow #4 - Resumption of Data Processing

This alternate flow describes how normal data processing operations are resumed after a severe outage that requires a restart of the Data Processing Node. The fault is assumed to occur only at one processing node and not affect the others.

Trigger:

MOT has resolved a fault and is ready to resume data processing operations.

Table: 6.5.1-8 Basic Flow for Resumption of Data Processing

No.	Actors	Actions	Notes
1	DPN, MOT	MOT restarts the processing node and may choose to resend the SMD input data (from the C3S segment) that was missed during the outage.	Requesting a resend on startup is called a "Warm Start". MOT manually may request up to 24 hours of past data. If MOT chooses not to request past data, but rather chooses to start processing data from "now" forward, the startup is called a "Cold Start".
2	DPN, MON/MOT	The processing node generates a request to the JSH Process SMD activity for the desired data. Retransmitted data is delivered such that it can be processed by DPN in observation time order within the context of the retransmit request.	(applicable to warm start only) A manual process also exists for MOT to deliver the required SMD from MON storage to SDS, DPN, FNMOC, and/or NAVOCEANO.
3	DPN	The processing node resumes product generation, working on three distinct kinds of data in parallel.	See sub-steps
3a	DPN	The processing node resumes product generation from the real-time (current) incoming data.	If needed due to processing capacity limitations, the current data is given the highest priority, in order to maximize latency performance.
3b	DPN	The processing node generates and delivers any higher order products that haven't yet	For example, if RDRs were in storage at the time of the fault, but higher level products (e.g.,

No.	Actors	Actions	Notes
		been generated from the data that is currently in storage.	SDRs, EDRs) have not been produced, they will be when the processing node resumes operation.
3c	DPN	The processing node generates and delivers products made from the data that in the order that it is received as a result of the warm start retransmit request.	
4	DPN	Any products not yet delivered to external users are delivered.	This is true for both newly generated products (regardless of the three sources in step 3) and for products that were interrupted by the fault and have been made more complete (repaired).

6.5.1.11 Alternate Flow #5 - SCO Transition to Operations

At the onset of the Transition phase, the following conditions exist, with a focus on those products either fully or partially generated from Visible/Infrared Imager Radiometer Suite (VIIRS) data.

- The S-NPP VIIRS is in Operational mode
- The JPSS-1 VIIRS has just completed Activation
- GCOM-W1 Advanced Microwave Scanning Radiometer 2 (AMSR2) is in Operational mode
- The JPSS Ground System is operational

The JPSS Ground System is generating the full suite of products on a continual basis for the S-NPP VIIRS, the JPSS-1 VIIRS, and the GCOM-W1 AMSR2 (RDR only). Some S-NPP OMPS use S-NPP VIIRS products as input. Per the Graceful Degradation (GD) functionality, some S-NPP VIIRS algorithms use S-NPP OMPS products as input; the JPSS-1 VIIRS algorithms use ancillary data as input, since the JPSS-1 OMPS products have not yet been validated. Figures 6.5.1-4 and 6.5.1-5 below and Figures 6.5.1-6 through 6.5.1-9 in Section 6.5.1.15.1 illustrate the basic sequence of events during transition, through one of many possible paths. This flow focuses on the VIIRS instrument. JPSS-1 VIIRS ICV proceeds and leverages multiple sources, including ground targets (e.g., White Sands, Tahoe), ICV of JPSS-1 VIIRS Canary EDRs (e.g., Ocean Color, Cloud Top Temperature, and other products that highlight potential SDR issues), and comparison of JPSS-1 VIIRS SDRs with S-NPP VIIRS SDRs. When the JPSS-1 VIIRS SDR reaches Validated (Stage 1) status, depending on the quality of S-NPP VIIRS SDRs, JPSS-1 VIIRS may be designated the primary instrument for SDRs. Meanwhile, JPSS-1 VIIRS EDRs, one by one, reach Provisional status; at this stage, JPSS-1 VIIRS EDRs may be used as inputs to JPSS-1 OMPS EDRs. Subsequently, JPSS-1 VIIRS EDRs, one by one, reach Validated (Stage 1) status; at this stage, depending on the quality of S-NPP VIIRS EDRs, the Algorithm Management Project (AMP) may recommend JPSS-1 VIIRS be designated the primary

instrument for a given EDR. Upon reaching Validated (Stage 1) status, JPSS-1 OMPS EDRs may be used as inputs to JPSS-1 VIIRS EDRs (replacing ancillary inputs).

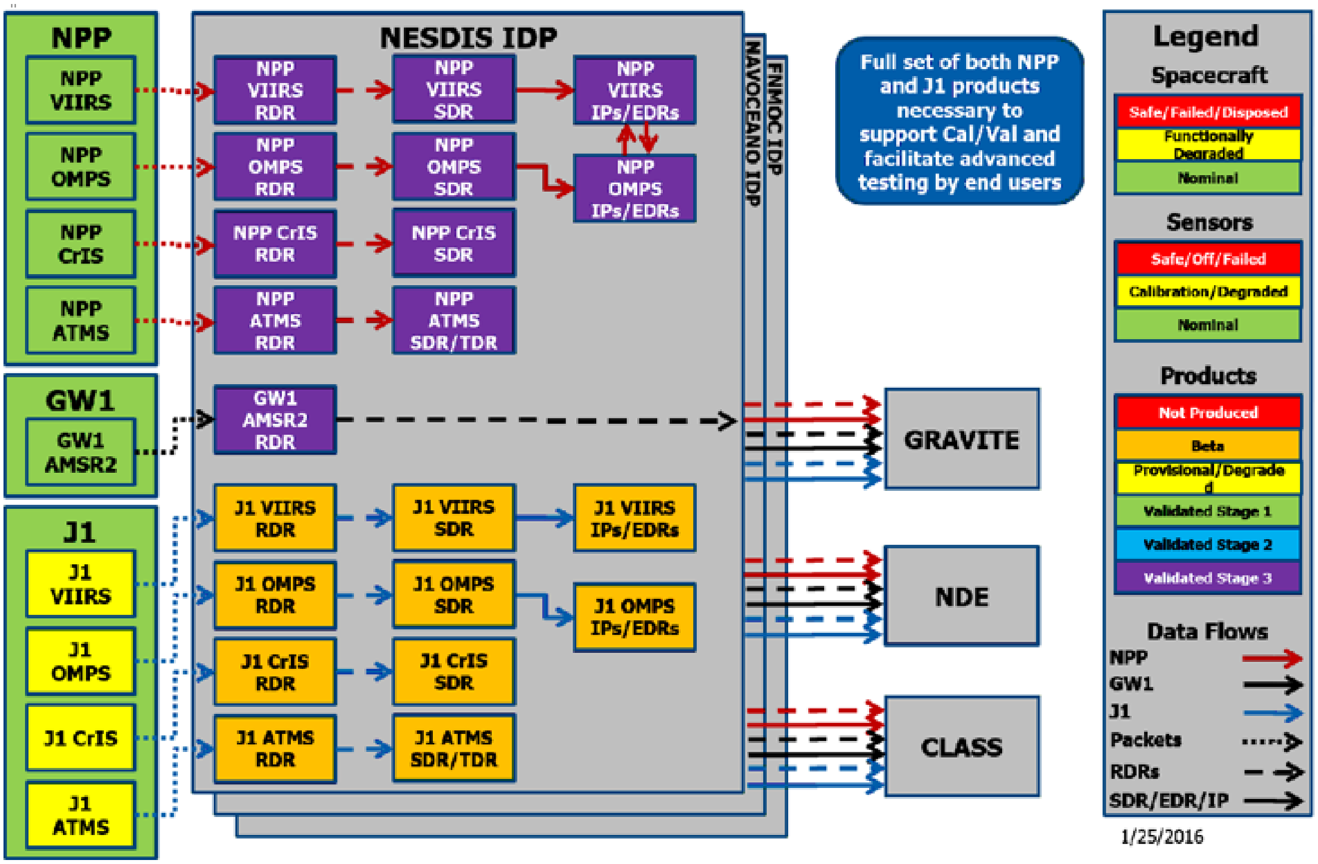


Figure: 6.5.1-4 Transition Phase, Step 1 (Initial State)

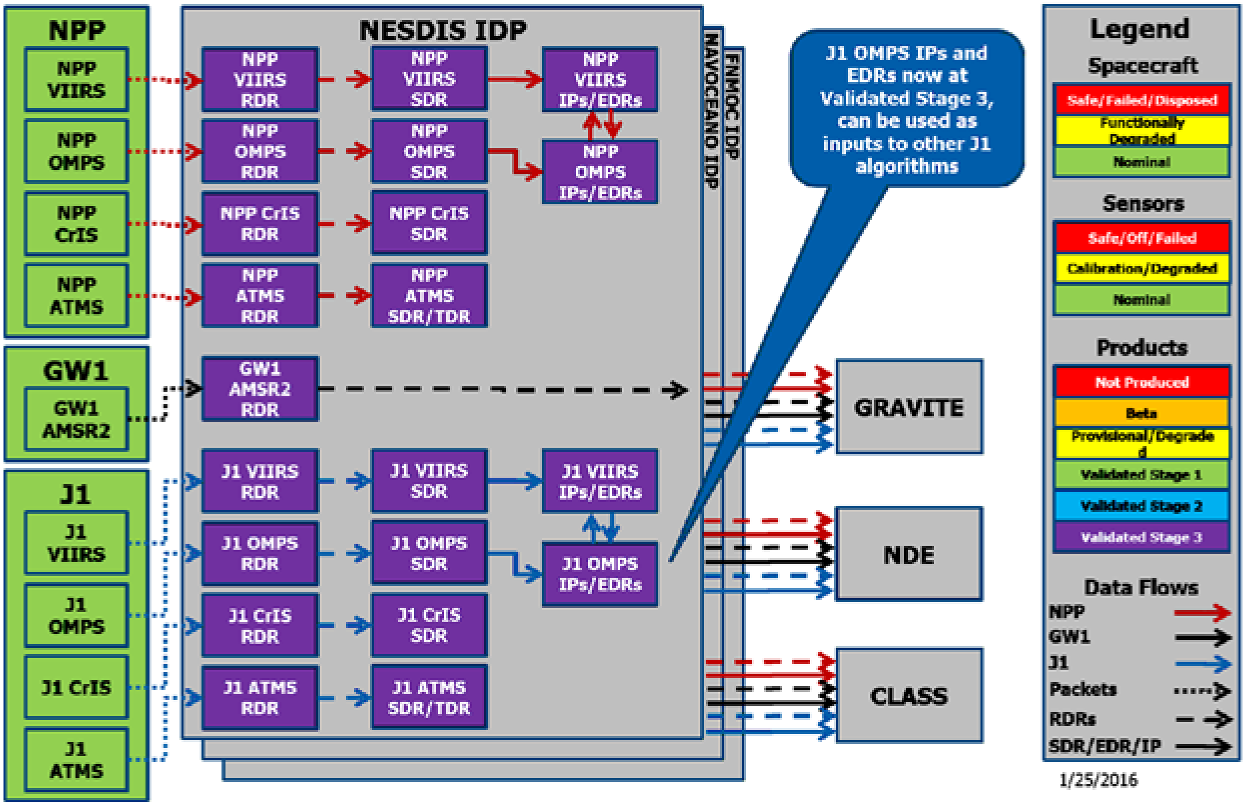


Figure: 6.5.1-5 Transition Phase, Step 6 (End State)

At the conclusion of this phase, both S-NPP VIIRS and JPSS-1 VIIRS are in Normal Operations. The Ground System is generating all products from JPSS-1 VIIRS as the operational products and from S-NPP VIIRS as the non-primary products. S-NPP OMPS algorithms use S-NPP VIIRS products as input, and JPSS-1 OMPS algorithms and potentially GCOM-W1 AMSR2 algorithms use JPSS-1 VIIRS products as input. Per Graceful Degradation, S-NPP VIIRS uses S-NPP OMPS products as input, and JPSS-1 VIIRS uses JPSS-1 OMPS products as input.

6.5.1.12 Post Condition

At the time specified in the stored commands, the satellite turns off the transmitter and terminates the contact.

The Stored Mission Data is delivered to SDS, FNMOC, and NAVOCEANO. The processed science data products are delivered to the ESPC JPSS Interface, CLASS, and GRAVITE. The data status, processing status and data quality are gathered and reported to the management activities.

6.5.1.13 Related Threads

The following list provides the related JPSS Ground System threads that contain helpful information for understanding how specific steps in this thread act or relate to other threads.

Thread ID	Thread Title
GS-NML-140	Mission Support Data Handling
GS-NML-110	Data Quality Assurance
GS-NML-102	S-NPP/JPSS Mass Data Storage Playback
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command
GS-NML-310	Ground Operations
GS-NML-110	Data Accounting and Recovery
GS-NML-300	System Status/Situational Awareness
GS-NNL-130	System Fault Analysis
GS-NML-150	Cal/Val of Data Products
GS-NML-170	Algorithm Development and Maintenance
GS-NML-500	Sensor Operations and Payload Support
GS-MAD-120	Launch and Early Orbit

6.5.1.14 Child Threads

Thread ID	Thread Title
CGS-020-050	Stored Mission Data Handling
CGS-050-030	GCOM Data Handling

6.5.1.15 Additional Thread Flow Diagrams

6.5.1.15.1 SCO Transition to Operations

The following figures represent additional steps within the Transition Phase.

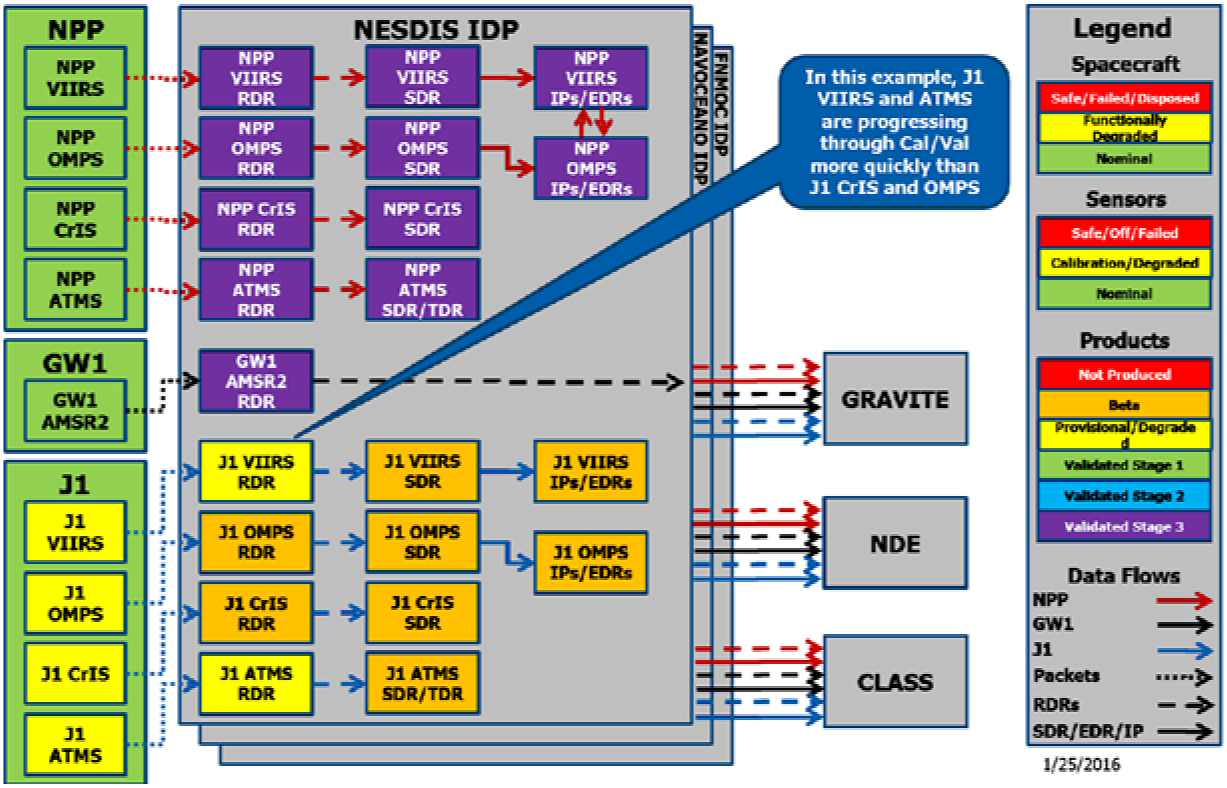


Figure: 6.5.1-6 Transition Phase, Step 2

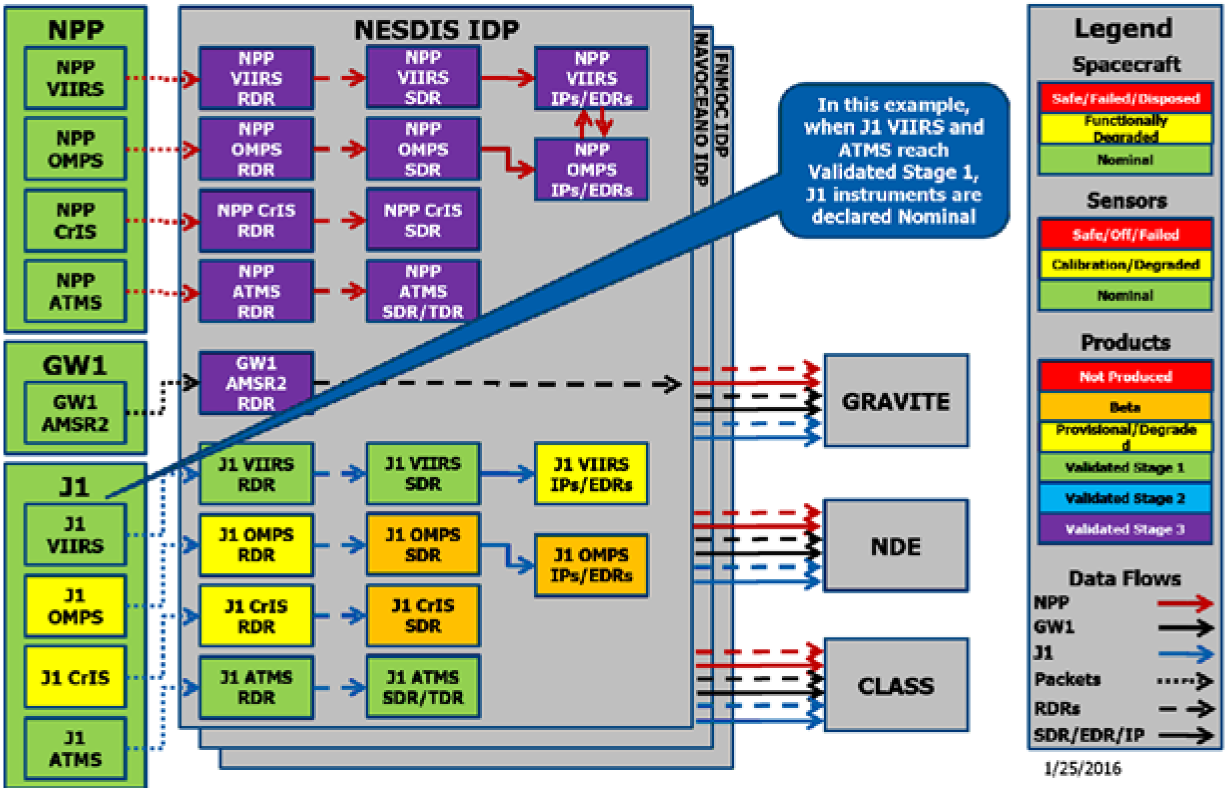


Figure: 6.5.1-7 Transition Phase, Step 3

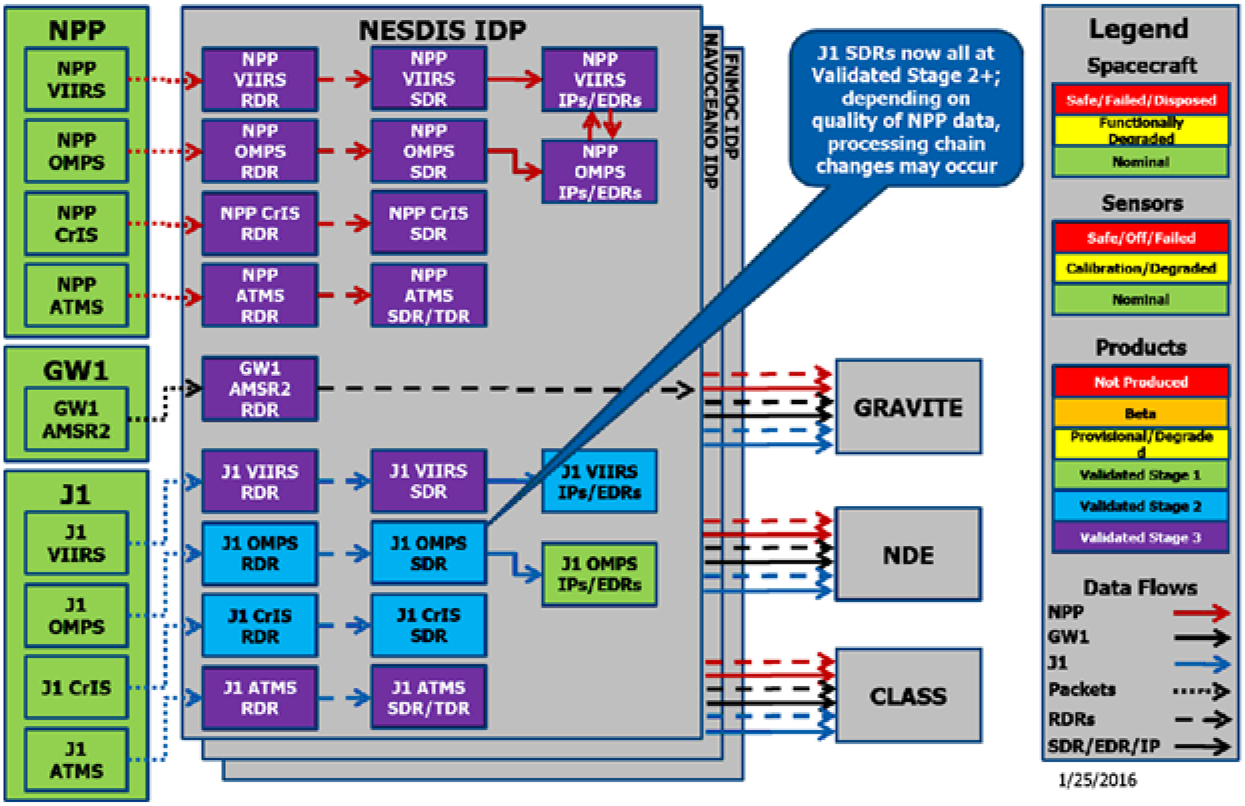


Figure: 6.5.1-8 Transition Phase, Step 4

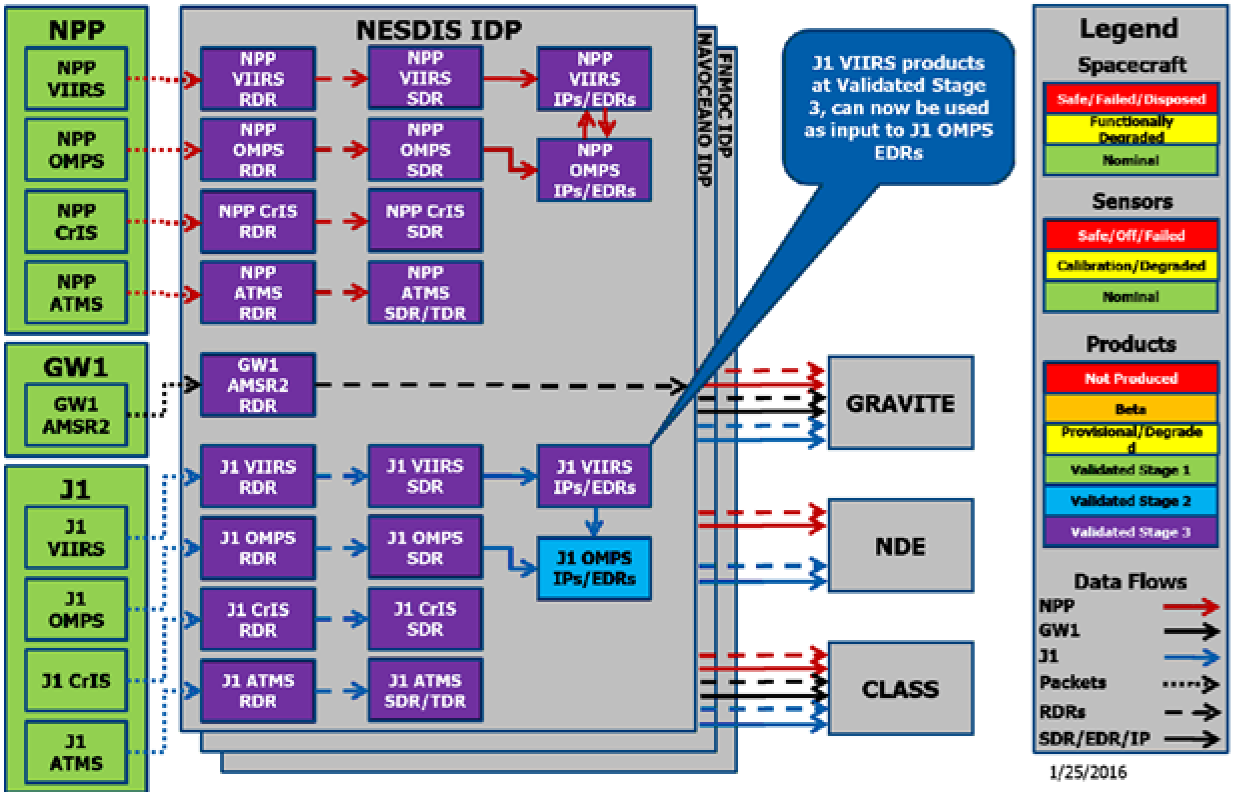


Figure: 6.5.1-9 Transition Phase, Step 5

6.5.2 Data Accounting and Recovery

6.5.2.1 Description

6.5.2.1.1 Overview

The Data Accounting and Recovery thread (GS-NML-130) provides a system-level overview of mission data accounting operations and data recovery operations within the JPSS Ground System. These operations are necessary for measuring the data availability and data latency, two key system performance parameters, and for minimizing data product gaps due to data losses along the Stored Mission Data (SMD) downlink, network transfer and processing paths. Data accounting and recovery operations apply to the JPSS-managed satellites such as S-NPP, JPSS-1/2/3/4 as well as JPSS-supported satellite such as GCOM-W1. S-NPP, JPSS-1/2/3/4 support retransmission of SMD from the spacecraft under Mass Data Storage (MDS) the management of the CGS MON. For S-NPP and JPSS-1, this MDS is also known as Solid State Recorder (SSR) in B2.0. For JPSS-2/3/4, the MDS is known as Flash Memory Card (FMC). The GCOM-W1 mission does not support CGS managed data retransmission from the spacecraft but provides routine and JAXA-managed spacecraft retransmissions that enable ground based recovery operations.

The mission data accounting and data recovery operations are carried out along the SMD Handling thread. As the SMD is being transmitted and processed, it is tracked and stored at the Space/Ground Communication Node (SGCN), Management & Operations Node (MON) and

Data Processing Node (DPN) for 7 days as shown in Figure 6.5.2-1. A reliable data transmission protocol such as TCP/IP is used across the JPSS Ground Network to minimize intermittent data loss on transfer from the SGCN to the MON co-located with the DPN. However, when a data gap is detected, a retransmission may be initiated to recover the missing data from the nearest available storage location. If the missing data cannot be located on the ground, a retransmission from the onboard MDS may be initiated. All SMD from the spacecraft, including retransmitted data, is routinely transferred from SGCN to the MON at the NSOF. In order to measure subset operational data latency and support data tracking and recovery operations, data is time-tagged at various points along the SMD handling path.

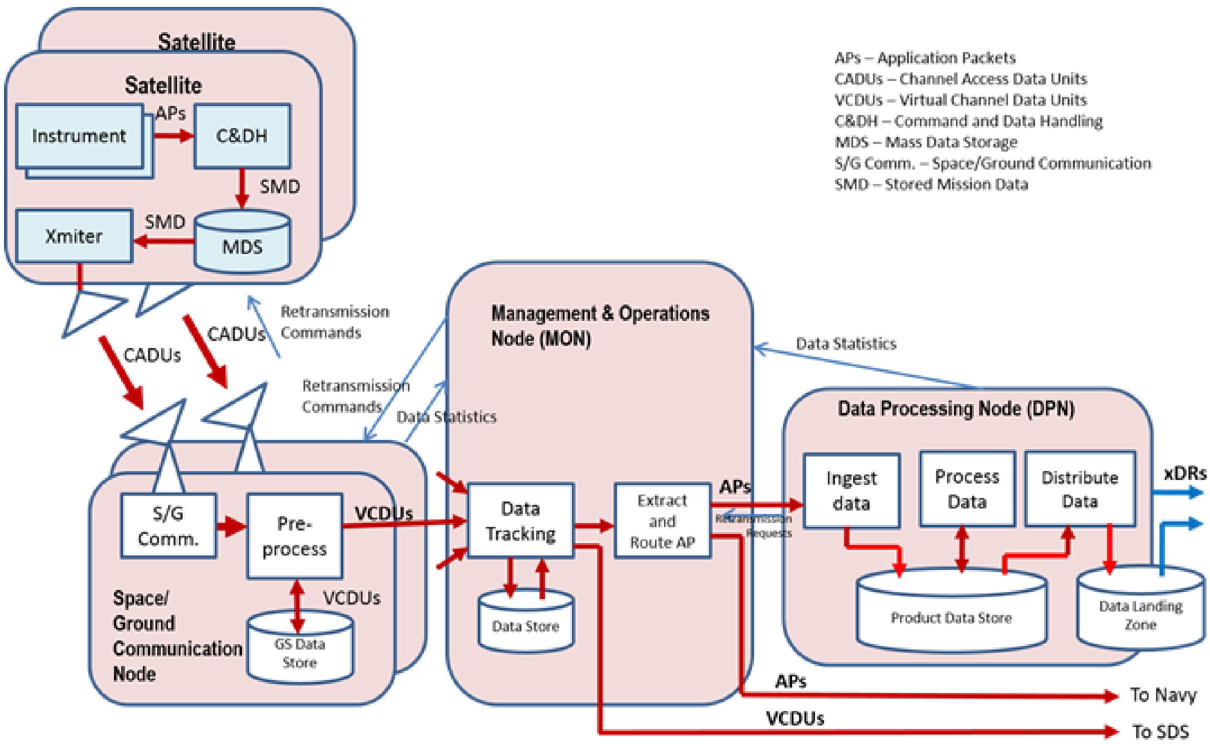


Figure: 6.5.2-1 Data Stores along the SMD Path for Recovery

For the JPSS Ground System, the data availability and data latency are defined as the following:

- Data Availability: Data Availability is the percentage of data collected by operational sensors on each JPSS satellite that is delivered to the JPSS data processing system. Data Availability is calculated daily for the 30 day period ended 7 days ago to ensure all retransmission activities are completed and accounted for. To better model the SMD delivery and processing flow, Data Availability is specified as ARD for raw data (VCDUs, APs and APs in RDRs) and APD for product data (RDRs, SDRs, TDRs, EDRs, IPs and MSD).
- Data Latency: Data Latency is defined as the period from the time of observation of all requisite data by the satellite until the data product (e.g. SDR, EDR) produced from those data is available to the user at the Ground System/User interface. Data Latency is

calculated daily for the 30 day period ended 7 days ago to ensure all retransmission activities are completed and accounted for.

Since the SMD handling is mainly allocated to the Common Ground System (CGS) in the JPSS Ground System, the data accounting and recovery are primarily operations in the CGS. The main external interfaces are with the spacecraft for manual retransmissions of SMD from onboard MDS on the JPSS-managed satellites. The details of MDS SMD operations as controlled by the ground system are described in the MDS Playback thread.

For clarity, the data accounting and recovery operations are described in three separate but closely related threads:

- Data accounting for completeness (availability)
- Data recovery
- Data accounting for latency

The data tracking information collected in the data accounting for completeness is used for determining the data availability. In addition, this tracking information provides basis for recovering missing data. The recovery of missing data covers not only the environmental observation data, but also the stored telemetry (S-TLM). As a subset of the SMD, S-TLM is handled along the same processing path with additional application packet distribution requirements.

The data recovery thread focuses on recovering data from gaps within a data set received during a SMD contact. The data recovery operations from a ground station (SGCN) and from the MDS are performed under the supervision of the MOT. SMD gaps are identified by any JPSS SMD Hub (JSH) receiving SMD, but the primary JSH at the MON co-located with the DPN is responsible, by configuration, to identify recovery opportunities. Data source(s) to fill the gaps are identified by the primary JSH and may include an SGCN and/or the MDS for the JPSS-managed missions. In some cases, such as for JPSS-1, routinely scheduled retransmits can occur at the next pass so a recovery operation may not be required to fill identified gaps. All SMD received from the spacecraft, whether original (OX) or retransmitted (RX) is forwarded to the primary JSH, eliminating the need to request retransmitted SMD from the ground station. When a recovery is deemed necessary to fill a gap, the CGS produces the parameters associated with the recovery as well as the options for the source of the missing data. Recovery status and statistics will be available to MOT. The MOT also has the capability to manually insert recovery data sets captured on removal media into the processing/distribution path.

The recovery processing of multi-orbit backlog is discussed in Section 6.5.2.1.2.

The data accounting for latency thread focuses on measuring data latencies for JPSS data products such as APs, VCDUs, RDRs, SDRs, TDRs and EDRs that are delivered to end users. For xDRs, an end-to-end data latency is the time lapse between the observation time and delivery time. While an xDR typically contains observation data from multiple Application Packets (APs) collected during an observation period, the observation time used for latency calculations is defined as the timestamp of the latest AP that contributes to the xDR. Moreover, several check points are identified along the SMD delivery and processing path so that latencies associated with each segment can be determined and characterized.

For GCOM-W1, the JPSS Ground System does not control nor command the satellite. Furthermore, the JPSS Ground Project is only responsible from the RF acquisition of the GCOM-W1 data to the delivery of RDRs to ESPC for higher-level product generation. As such, the JPSS Ground System measures the data latency beginning with the Earth Receive Time (ERT) of VCDUs received at the SGCN. Ground System raw data availability begins at the ground station with the receipt of the RF signal.

In addition, for the purpose of reporting mission performance, the JPSS Ground System also measures and reports the end-to-end data latency for GCOM-W1 APs and RDRs. However it should be noted that GCOM-W1 AMSR2 Application Process Identifier Sorted Data (ASD) and RDRs are processed as full orbit (vice granule-based) files in the Ground System B2.0 implementation and, as such, the JPSS Level 1 granule-based Data Latency definition that defines the reporting start time stamp as the time of receipt of "...all requisite data..." cannot be directly applied. Instead adjustments to the reported end-to-end latency values should be made to account for onboard aging of the AMSR2 data. See Section 7.3 for more details.

In addition to the SMD Handling thread, the Data Accounting and Recovery thread interacts with several other operational threads. For example, the data recovery operations depend on operations described in the Mission Planning and Scheduling thread, the Telemetry and Command thread and the S-NPP/JPSS-1/2/3/4 MDS Playback thread for data retransmission from a spacecraft. Likewise, the data availability and latency status and reports will be sent to activities defined in the Ground Operations thread for trending analysis, logging and distribution. The Related Threads section provides a list of these relevant threads.

6.5.2.1.2 Recovery Processing

Under certain conditions (e.g. double failures), the system may be unable to transmit, acquire, transfer, and/or process SMD for an extended period, i.e., over multiple orbits. Consequently, unprocessed SMD collected over multiple orbits may be in either onboard MDS or inaccessible ground storages. This SMD is called the backlog. After the system capability is restored, the system will process the backlog concurrently with the current data, while ensuring the data latency of the current data meets the requirements. The processing of backlog is called the recovery processing.

The failure scenarios and their recoveries are summarized in Table 6.5.2-1. Although data latency requirements may not be met for these scenarios, multi-layers of redundancy built into the system should permit data availability requirements to be met for the JPSS-managed missions.

Table: 6.5.2-1 Scenarios for Recovery Processing

Scenario	Mission	Recovery	Max. Backlog
A spacecraft anomaly that prevents SMD from being read out of MDS and/or transmitted to the ground	S-NPP, JPSS-1/2/3/4	SMD is retransmitted from the spacecraft once the operation is restored	The most recent 42 Gbytes or ~5 orbits, as constrained by the MDS capacity

Scenario	Mission	Recovery	Max. Backlog
Svalbard ground station extended outage (including communication outage)	S-NPP	Switch to alternate station at Fairbanks (FCDAS), but the outage may coincide with 4 blind passes daily at FCDAS. For SNPP only, SMD is retransmitted from the spacecraft once the SMD downlink capability is restored at either FCDAS or Svalbard.	S-NPP 5 orbits
Svalbard ground station extended outage (including communication outage)	JPSS-1/2/3/4	Schedule FCDAS support starting within the next orbit, augmented by TDRSS for blind passes at FCDAS. Missed SMD is retransmitted from the spacecraft to McMurdo as a part of routine operations.	1 orbit
McMurdo ground station extended outage (including communication outage)	JPSS-1/2/3/4	Schedule Troll support starting within the next orbit, augmented by TDRSS if needed. Missed SMD is retransmitted from the spacecraft to Svalbard as a part of routine operations.	1 orbit
Loss of all JPSS SMD Hub (JSH) functionality at NSOF	S-NPP, JPSS-1/2/3/4, GCOM-W1	Switch to the backup JSH at CBU. The JSH routinely forwards SMD received at the NSOF to the alternate JSH at the CBU in order to keep the CBU in sync. SMD not received at the CBU via the synchronization process is retransmitted from ground stations once the alternate JSH is up and running.	DPN backlog of 8 orbits (12 hours or 7 orbits transition time, as specified in the COOP requirements, plus 1 orbit decision time)
Data Processing Node (DPN) at NSOF extended outage	S-NPP, JPSS-1/2/3/4, GCOM-W1	Switch to the backup DPN at CBU. The JSH routinely forwards SMD received at the NSOF to the alternate JSH at the CBU in order to keep the CBU in sync. SMD not received at the CBU via the synchronization process is retransmitted from ground stations once the alternate DPN is up and running.	DPN backlog of 8 orbits (12 hours or 7 orbits transition time, as specified in the COOP requirements, plus 1 orbit decision time)

The data in the table shows that the worst case backlog is no more than 8 orbits of data. The backlog is processed by the operational string. The recovery processing (of 24 hours backlog) should be completed within 5 days of original observation time, even though the data latency on these products may have been exceeded and is no longer a concern. The SGCN at Svalbard ground station is capable of transferring stored SMD to removal media that can be shipped to a JSH location where the SMD is manually inserted into the processing stream.

6.5.2.2 Primary Interfaces

Figure 6.5.2-2 illustrates the actors and primary external interfaces involved in the execution of data accounting and recovery. Each interface illustrated in the figure, labeled with a number, is described in Table 6.5.2-2, along with the information about types of data. Table 6.5.2-3 lists relevant interface documents.

The primary external interfaces for this thread are with the spacecraft for autonomous or manual retransmission of SMD from onboard MDS amongst JPSS-managed missions.

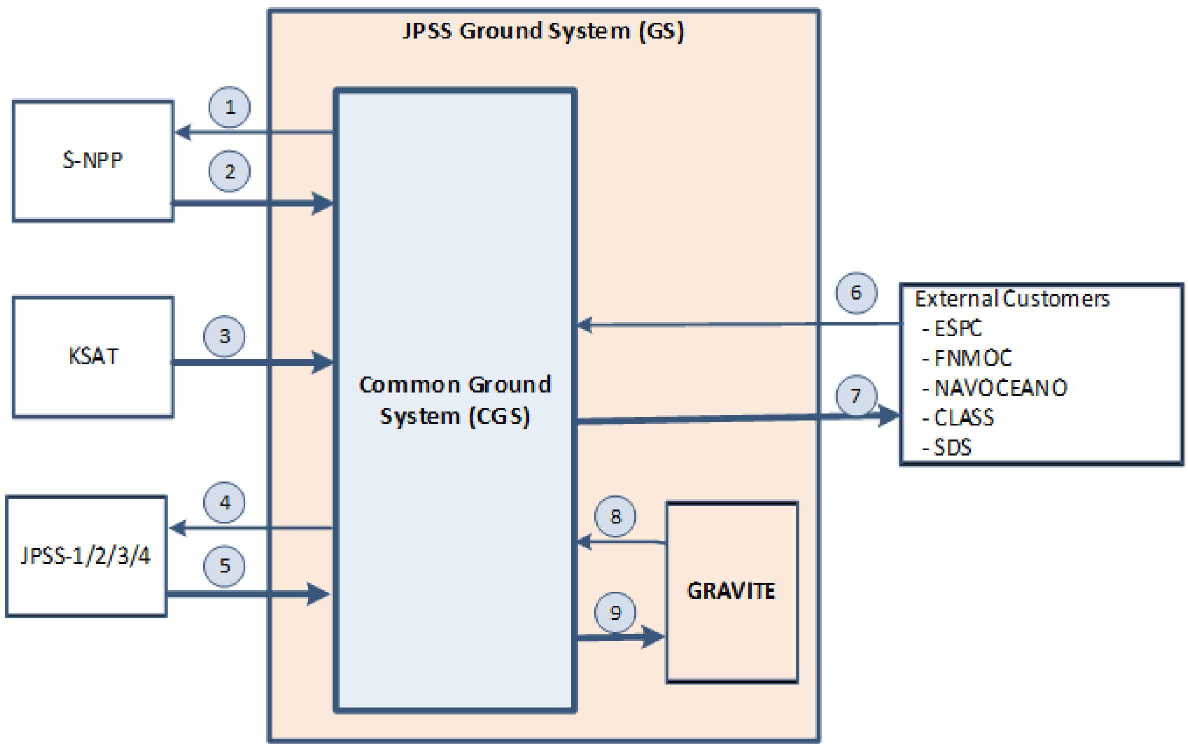


Figure: 6.5.2-2 Primary External Interfaces for Data Accounting and Recovery

Table: 6.5.2-2 Data Accounting and Recovery Handling Primary Interfaces

No.	Type	Actors	Purpose
1	External	CGS>S-NPP	CMD upload for SMD retransmission
2	External	S-NPP>CGS	Retransmitted SMD
3	External	KSAT>CGS	Retransmitted GCOM-W1 SMD

No.	Type	Actors	Purpose
4	External	CGS>JPSS-1/2/3/4	CMD upload for SMD retransmission
5	External	JPSS-1/2/3/4>CGS	Retransmitted SMD
6	External	External Customers> CGS	Retransmission Request Subscriptions to repaired data products
7	External	CGS>External Customers	Retransmitted SMD Repaired data products
8	Internal	GRAVITE> CGS	Subscriptions to repaired data products
9	Internal	CGS>GRAVITE	Repaired data products

Table: 6.5.2-3 Primary Interface Documentation

No.	IRD/ICD
1	JPSS Ground Project (GP) to Flight Project (FP) IRD JPSS Ground System to KSAT IRD JPSS Ground System to NESDIS FCDAS IRD SN/WSC to JPSS CGS ICD
2	JPSS GP to JPSS FP IRD JPSS Ground System to KSAT IRD JPSS Ground System to NESDIS FCDAS IRD
3	JPSS Ground System to KSAT IRD GCOM-W1 Mission Operations Interface Specification (MOIS) JPSS CGS Services IDD JPSS Ground System Services Specifications
4	JPSS Ground Project to Flight Project IRD JPSS Ground System to KSAT IRD JPSS Ground System to NESDIS FCDAS IRD SN/WSC to JPSS CGS ICD
5	JPSS GP to JPSS FP IRD JPSS Ground System to KSAT IRD JPSS Ground System to NESDIS FCDAS IRD SN/WSC to JPSS CGS ICD
6, 7	JPSS Ground System to NESDIS ESPC IRD JPSS Ground System to FNMOC IRD JPSS Ground System to NAVOCEANO IRD JPSS Ground System to NASA SDS IRD JPSS Ground System to CLASS IRD
8, 9	JPSS CGS to GRAVITE IRD JPSS CGS to GRAVITE ICD

6.5.2.3 Assumptions & Constraints

- Instruments stamp each Application Packet with spacecraft time, which will be used as the sensor observation time for the data latency measurement.
- Spacecraft collect the sensor and telemetry Application Packets (APs) and multiplex them into Virtual Channel Data Units (VCDUs).

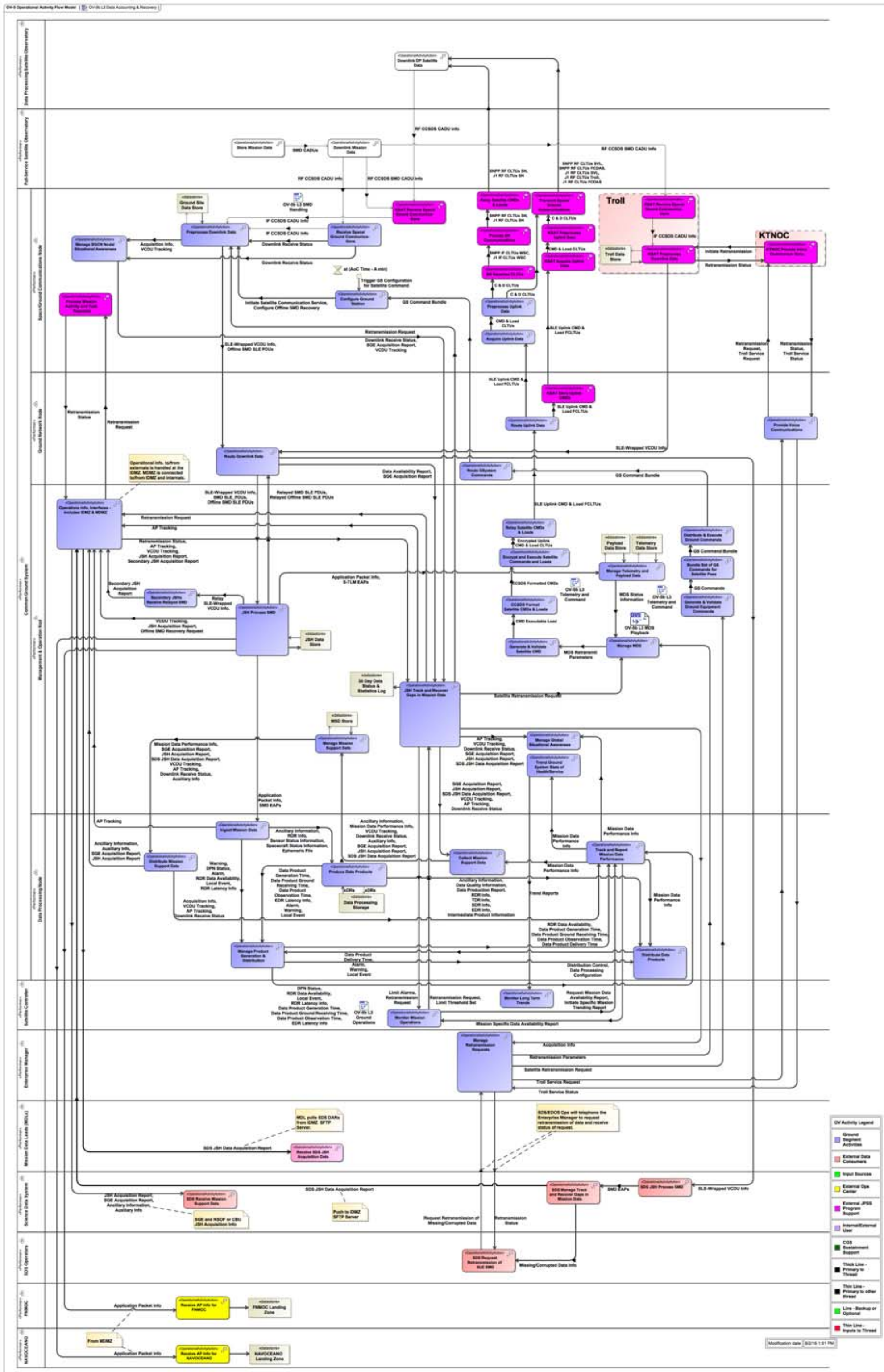
- Spacecraft generate contiguous Virtual Channel (VC) sequence counts which will be used for data accounting and recovery. Sequence counter rollover by the spacecraft is handled by the JPSS Ground System.
- For the purpose of data availability accounting, it is assumed that the SMD in the MDS represents ALL data collected by operational instrument sensors.
- Based on the current S-NPP on-orbit operational record, the S-NPP and JPSS-1/2/3/4 MDS can hold SMD for at least 5 orbits, providing support for retransmission in case of space-to-ground transmission failures.
- GCOM-W1 is a JAXA-managed satellite. JPSS Ground System does not manage SMD retransmission from GCOM-W1 satellite.
- There is sufficient contact time during a satellite commanding contact to support real-time SMD retransmissions.
- All SMD (original and retransmitted) downlinked and received at the SGCN during a pass is forwarded to the primary JSH (JPSS SMD Hub). The primary and alternate JSH refers to all JSH instantiations available for operations at a location (i.e., NSOF and CBU). Internal redundancy may exist that allows local recovery from the failure of a single JSH instantiation.
- The primary JSH forwards all received SMD to the alternate JSH at the CBU via a daisy chained SLE Provider/User interface. The alternate JSH will be manually switched to the SGCN SLE Provider interface upon failure of the primary JSH to obtain downlinked SMD.
- While the data recovery from the ground stations are normally handled through the SLE offline services without going through scheduling process, the recovery from the Troll Satellite Station (TrollSat) requires MOT to coordinate it through the KSAT's integrated network operations center (TNOC).

6.5.2.4 Pre-Conditions

- The ground system is configured for and operates in nominal operations.
- The CGS mission planning and scheduling activity has prepared detailed contact plans and resource scheduling based on the operational baseline.
- The CGS satellite operations activity has generated, verified, and uploaded spacecraft stored commands to control MDS playback.
- The CGS ground operation activity has configured ground resources to acquire, route, process and distribute SMD.

6.5.2.5 Operational Flows

Figure 6.5.2-3 provides an illustration of system actions taking place in the data accounting and recovery scenarios.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.5.2-3 Data Accounting and Recovery Basic Flow Diagram

6.5.2.5.1 Data Accounting for Completeness Basic Flow

Table 6.5.2-4 provides a narrative description of actions associated with the data accounting for completeness threads.

Trigger: the thread begins at the Acquisition of Signal (AoS) of each SMD contact.

Table: 6.5.2-4 Data Accounting for Completeness Basic Flow

No.	Actors	Actions	Notes
1	S-NPP, JPSS-1/2/3/4, KSAT (GCOM-W1), Space/Ground Communication Node (SGCN)	The CGS Receive Space/Ground Communication activity and CGS Preprocess Downlink Data activity receive the downlink of SMD and process it into VCDUs.	See the SMD Handling thread for a more detailed description of SMD processing. VCDU is renamed to Transfer Frame (TF) in CCSDS 732.0-B-2, which is used by JPSS-2/3/4.
2	SGCN	The CGS Preprocess Downlink Data activity stamps each VCDU with the Earth Receive Time (ERT) and the Ground Station ID to create annotated VCDUs (aVCDUs), sorts the VCDUs by virtual channels and identifies gaps. The CGS Preprocess Downlink Data activity stores the VCDUs locally for at least 7 days for the purpose of retransmission on request.	Any discontinuities in VCDU sequence counts indicate potential data losses during space-to-ground SMD transmission. They could also indicate retransmitted data being down linked. VCDU ERT can be used to correlate a segment of VCDUs to their locations on the MDS.
3	SGCN, Management and Operations Node (MON)	The CGS Preprocess Downlink Data activity monitors the local data storage and provides data (VCDU) statistics as configured to the CGS JSH Track and Recover Gaps in Mission Data activity via the CGS Manage SGCN Nodal Situational Awareness activity.	
4	SGCN, Ground Network Node (GNN), MON	The CGS Preprocess Downlink Data activity transfers the downlinked aVCDUs to the CGS JSH Process SMD activity in the primary JSH at the MON (nominally at the NSOF) via the CGS Route Downlink Data activity in the JPSS Ground Network WAN. The transfer is performed in accordance with the CCSDS Space Link Extension (SLE) standard using a reliable protocol (eg, TCP/IP). The CGS JSH Process SMD activity provides VCDU tracking information to the CGS JSH Track and Recover Gaps in Mission Data activity.	All received aVCDUs (original and retransmitted) are transferred to the JSH via the CGS Route Downlink Data activity. aVCDUs can be received from multiple ground stations.

No.	Actors	Actions	Notes
5	MON	The CGS JSH Process SMD activity (primary JSH) receiving the aVCDUs from the SGCN forwards received aVCDUs using the SLE protocol to secondary JSH locations that subscribe to the SMD. The CGS JSH Process SMD activity at the secondary JSH locations provides VCDU tracking information to the CGS JSH Track and Recover Gaps in Mission Data activity.	Discrepancies between the data transferred and received indicate potential data losses along the transfer path. Nominally, the alternate JSH at the CBU is a secondary subscriber of the SMD received at the primary JSH (NSOF). Other secondary subscribers such as the CGS Support Node and non-operational strings at the NSOF may also be configured as secondary subscribers.
5.1	MON	For S-NPP and JPSS-1/2/3/4 data, the CGS JSH Process SMD activity (primary JSH) relays all aVCDUs received from ground stations to the SDS JSH Process SMD activity.	JPSS delivers S-NPP and JPSS-1/2/3/4 aVCDUs to NASA SDS.
6	MON	The CGS JSH Track and Recover Gaps in Mission Data activity analyze the VCDU tracking information to determine data loss at each receiving location.	
7	MON	The CGS JSH Process SMD activity extracts APs from the aVCDUs. The CGS JSH Process SMD activity sorts APs by APIDs, checks the packet sequence count for gaps and compiles AP statistics. APs are annotated with additional information to become Extended APs (EAPs) to support accounting, tracking, and recovery activities. The CGS JSH Process SMD activity provides AP tracking information to the CGS JSH Track and Recover Gaps in Mission Data activity.	Packet sequence count check must be correlated with VCDU sequence count to filter out the packet sequence gaps generated by the instruments.
8	MON	The CGS JSH Process SMD activity at the primary JSH forwards EAPs to the co-located Data Processing Node (DPN), to the MON (S-TLM and Dump APIDs only), and to the FNMOC JPSS Interface and NAVOCEANO JPSS Interface. The CGS JSH Process SMD activity provides EAP delivery statistics to the CGS JSH Track and Recover Gaps in Mission Data activity. The CGS JSH Track and Recover Gaps in Mission Data activity provides the VCDU and AP tracking information as well as acquisition reports to the CGS Track and Report Mission	The EAPs should be transferred in flat files in optimized file size for reliability, efficiency, and accountability. Successful completion of file transfers should be confirmed by the receiving sites.

No.	Actors	Actions	Notes
		Data Performance activity via the CGS Collect Mission Support Data activity, CGS Manage Mission Support Data activity and CGS Distribute Mission Support Data activity.	
8.1	MON, SDS	The CGS JSH Track and Recover Gaps in Mission Data activity provides the aVCDU and AP tracking information to the SDS Receive Mission Support Data activity via the CGS Operations Info. Interface for each contact/retransmission.	The aVCDU and AP tracking information is contained in the SGE and JSH acquisition reports.
8.2	SDS, MON	The SDS JSH Track and Recover Gaps in Mission Data activity provides the aVCDU and AP tracking information to the CGS Operations Info. Interface after each contact/retransmission.	The aVCDU and AP tracking information is contained in the SDS data acquisition reports.
8.3	SDS Operator, MOT	If SDS detects data gaps and recognizes their existences at the primary JSH based on the CGS provided aVCDU and AP tracking information, SDS operator may contact the CGS MOT to request retransmission of the missing data from the primary JSH.	The CGS primary JSH always tries to recover SMD from spacecraft and/or ground stations to fill data gaps. These recovered SMD will be automatically forwarded to SDS.
8.4	DPN	The CGS Track and Report Mission Data Performance activity calculates the Raw Data Availability for the FNMOC site and for the NAVOCEANO site as a total number of packets delivered to the site versus the total number of expected packets.	The total number of packets delivered includes the retransmitted packets that fill in initial gaps. The total number of expected packets is based on the packet sequence count, excluding gaps that exist before the data is stored in the MDS. For GCOM-W1, the total number of expected packets is based on the total number of packets received at the ground station.
9	MON	For S-NPP and JPSS-1, the CGS Process and Extract TLM activity extracts MDS status from S-TLM and forwards it to the CGS Manage MDS activity. From the received MDS status, the CGS Manage MDS activity tracks the MDS sequential playback pointer over time.	The timeline for the MDS sequential playback pointer will be used for locating missing data locations in conjunction with VCDU sequence counts. JPSS-2/3/4 use time-based playback
10	DPN	The CGS Ingest Mission Data activity produces sensor Raw Data Records (RDRs) from received EAPs.	

No.	Actors	Actions	Notes
11	DPN	The CGS Ingest Mission Data activity provides the Raw Data Availability information (a total number of packets made into the RDRs versus the total number of expected packets) to the CGS Track and Report Mission Data Performance activity via the CGS manage Product Generation & Distribution activity.	The total number of packets made into the RDRs includes the retransmitted packets that fill in initial gaps. The total number of expected packets is based on the packet sequence count, excluding gaps that exist before the data is stored in the MDS. For GCOM-W1, this excludes the packets that never reach the ground.
12	DPN	The CGS Produce Data Products activity processes sensor RDRs, calibration data and auxiliary data to produce JPSS data products (xDRs).	For GCOM-W1, SMD is not processed beyond RDRs. Also, under certain anomaly conditions, xDR products beyond RDRs may not be created for non-primary instruments.
13	DPN	The CGS Track and Report Mission Data Performance activity collects and processes all data status and statistics to maintain the knowledge in the Performance Data Repository. The CGS Track and Report Mission Data Performance activity keeps all data status and statistics information for at least 90 days.	The retention period of data statistics should be configurable.
14	DPN	For each mission, the CGS Track and Report Mission Data Performance activity reports the Raw Data Availability on a 30 day sliding window ended 7 days ago. The reports should contain, as minimum, the total number of expected APs, of non-duplicate APs that are contained in RDRs, of missing APs, and the Raw Data Availability in percentage.	The 7-day delay ensures that the recovered data is accounted for. The Raw Data Availability is based on the APs in the RDRs delivered to CLASS.
15	DPN	For each mission and each data consumer, the CGS Track and Report Mission Data Performance activity reports the Product Data Availability on a 30 day sliding window ended 7 days ago. The reports should contain, for each type of products, the total number of expected products that should be generated from the APs in the MDS as well as IPs and MSD, the total number of products that are made available to each user at the JPSS/User interface, and the Product Data Availability in percentage. The calculation	The 7-day delay ensures that the recovered data is accounted for.

No.	Actors	Actions	Notes
		excludes the products not requested by the user or failed delivery due to a user side anomaly.	
16	DPN, MOT	Upon operator's request, the CGS Track and Report Mission Data Performance activity can generate mission-specific Data Availability Report based on MOT-specified starting time, duration and reporting frequency.	This report can be set one-time or repeating at a fixed interval.
17	DPN, MON	The CGS Track and Report Mission Data Performance activity sends all mission data performance information to the CGS Manage Global Situational Awareness activity and the CGS Trend Ground System State of Health/Service activity.	See the System Status thread for more on system wide status and situational awareness.
18	Mission Data Lead, MON	The Mission Data Lead (MDL) retrieves SDS aVCDU and AP tracking information from the CGS Operations Info. Interface and calculates/reports the S-NPP, JPSS-1/2/3/4 Data Availability for SDS daily on a 30 day sliding window.	

6.5.2.5.2 Data Recovery Basic Flow

Along the path of SMD downlink transmission, ground acquisition and routing data flow, there are variety of causes for data losses. Examples are weather-related or RF-conjunction-induced space to ground communication outages, ground station equipment or configuration failures, network outages, data corruption, and buffer overflow in data pipelines. The use of a reliable transfer protocol from the ground station to the processing location should eliminate sporadic packet loss encountered in the network unless the loss is sufficient to result in connection failure. To recover from these potential data losses, data storages are placed along the SMD flow onboard the spacecraft, at the ground stations (receptors) and at the processing locations. Upon discovery of a data loss, the missing data can be retransmitted from an upstream data storage node where the data is available.

The ground contact for retransmissions based on real-time commanding is nominally constrained to once per orbit, limiting the ability to recover missing data from the MDS and increasing operational complexity. The SN and FCDAS (S-NPP, JPSS-1/2/3/4) and Troll (JPSS-1/2/3/4) may be employed to provide additional T&C opportunities to direct additional spacecraft retransmissions for S-NPP, JPSS-1/2/3/4. To improve the data availability and simplify data recovery, JPSS-1/2/3/4 downlinks the same SMD from the MDS twice over different ground receptors so that two copies of SMD may be routinely received by the ground station and forwarded to the MON at the primary JSH. These are detailed in the S-NPP/JPSS-1/2/3/4 MDS Playback concepts of operations threads.

It should be noted that since the sensor data and stored telemetry are processed along the same path until AP delivery, they share the same data recovery process described here.

Table 6.5.2-5 provides a narrative description of actions associated with the data recovery thread. The specific steps for correlating requested data and their onboard MDS locations are MDS for

S-NPP and JPSS-1 spacecraft only. JPSS-2/3/4 use observation time to identify SMD to be retransmitted and the spacecraft will map the time to their MDS locations.

Trigger: the thread begins when an automatic or manual request for missing data is received or initiated by the CGS Track and Recover Mission Data activity

Table: 6.5.2-5 Data Recovery Basic Flow

No.	Actors	Actions	Notes
1a	MON, MOT	The CGS JSH Track and Recover Gaps in Mission Data activity provides MOT retransmission request information for missing data upon detection of data gaps based on configurable rules. MOT decides whether to proceed with the retransmission.	The request should identify SC ID, VC ID, starting VC sequence count, number of VCDUs, estimated earth receive time, and spacecraft time (for JPSS-2/3/4). This includes the request information from a secondary JSH to retransmit SMD from the primary JSH.
1b	MOT, MON	MOT initiates a request for missing data to CGS JSH Track and Recover Gaps in Mission Data activity.	MOT may initiate this request upon an IDP "warm start". An IDP "warm start" indicates starting SMD processing from a time in the past. A "cold start" indicates starting SMD processing from time now. This is not considered a recovery process per se but simply a retransmit request. During the typical recovery process, missing data is automatically sent to subscribers (VCDU or AP recipients).
2	MON	The CGS JSH Track and Recover Gaps in Mission Data activity identifies a data store on the ground and/or on the MDS where the recovery data is available. The MOT is provided the opportunity to select an available recovery source (ground or MDS). For ground-based recovery a retransmission request is coordinated between the ground source and the JSH. If a MDS recovery is selected, The CGS JSH Track and Recover Gaps in Mission Data activity sends a retransmission request to the CGS Manage MDS activity (There is a 5-8 hours' time window for retransmission before the data in an MDS is overwritten).	The pertinent activity managing the data stores are the CGS Preprocess Downlink Data activity at the Space/Ground Communication Node, the CGS Route Downlink Data at the Ground Network Node or the CGS Ingest Mission Data activity at the Data Processing Node. The MOT has the option of inhibiting automated recoveries by requiring operator approval of the

No.	Actors	Actions	Notes
		The search for the closest data store on the ground follows the following order: - Data Storage at MON. Go to Step 13. - Data Store at the Space/Ground Communication Node (SGCN). Go to Step 11. - Data Store onboard the spacecraft. Continue to Step 3.	recovery of autonomously identified gaps.
3a	MON	For S-NPP and JPSS-1, the CGS Manage MDS activity maps the requested data to the onboard MDS pointer locations and generates the MDS Retransmission Parameters.	The requested data identified by SCID, VCID and VC sequence counts, and estimated ground receiving time are mapped to onboard MDS pointer locations through their correlations to the ground receiving time.
3b	MON	For JPSS-2/3/4, the CGS Manage MDS activity maps the requested data to the spacecraft time and generates the MDS Retransmission Parameters.	JPSS-2/3/4 flight SW maps requested start and end time to MDS pointer locations
4	MON	The CGS Manage MDS activity sends the Satellite Retransmission Parameters to the CGS Generate and Validate Satellite Command activity.	The parameters should include SCID, MDS pointer location (for S-NPP and JPSS-1) and a number of CADUs to be retransmitted or spacecraft times for start and end (for JPSS-2/3/4).
5	MON	The CGS Generate and Validate Satellite Command activity builds and verifies corresponding real-time spacecraft data retransmission commands automatically and inserts them into a pass activity plan for the next command contact.	KSAT Svalbard ground station and NOAA FCDAS are the stations where the commands can be uploaded, therefore the places where real-time retransmission can take place for S-NPP and JPSS-1/2/3/4. In addition, JPSS-1/2/3/4 may use Troll and TDRSS for SMD retransmission.
6	MON, MOT	Prior to the contact, MOT is alerted for the retransmission requests.	MOT has the options to verify the commands manually.
7	MON, MOT	During the contact, MOT has the option to manually control the retransmission proceedings. The CGS Execute Satellite Commands and Loads activity and Transmit Space/Ground Communication activity executes the pass activity plan, upload the data retransmission	

No.	Actors	Actions	Notes
		commands one at a time, and monitors real-time telemetry for completion.	
8	Spacecraft	The spacecraft receives the data retransmission command and executes the command; retrieving the requested data from the MDS and downlinking it to the ground. At the completion of retransmission command, the spacecraft will indicate the successful command execution through real-time MDS status telemetry.	The down linked SMD is processed as nominal SMD data described in the SMD Handling thread.
9	MON	If there are more real-time data retransmission commands in the pass activity plan, go back to Step 7 to execute the next command. Otherwise continue to Step 10.	
10	SGCN, GNN, MON	The retransmitted data received from the spacecraft is saved in a data store at the Space/Ground Communication Node. The CGS Preprocess Downlink Data activity transfers the retransmitted data to the CGS JSH Process SMD activity via the CGS Route Downlink Data activity. The CGS Preprocess Downlink Data activity provides data (VCDU) statistics as configured to the JSH Track and Recover Gaps in Mission Data activity via the CGS Manage SGCN Nodal Situational Awareness activity. Continue to Step 13.	
11	SGCN, MON	Prior to the retransmission begins, the CGS Distribute & Execute Ground Commands activity and the CGS Configure Ground Station activity configure ground resources for data transfer (i.e., SLE Offline Service) The CGS Preprocess Downlink Data activity receives the data retransmission request and retrieves the requested aVCDUs from the data store, The CGS Preprocess Downlink Data activity transfers the requested data to the CGS JSH Process SMD activity via the CGS Route Downlink Data activity.	The required recovery data exists in the SGCN Data Store. See the Ground Operations ConOps for details on set up ground resources. Based on the SLE implementation, a recovery from the SGCN would only be required in multiple failure scenario since all data received will be forwarded to the JSH via reliable delivery protocol. This type of recovery will be a manual process initiated by the operators.
12	MON	The CGS JSH Process SMD activity provides data transfer statistics to the CGS JSH Track and Recover Gaps in Mission Data activity. Continue to Step 14.	

No.	Actors	Actions	Notes
13	MON, DPN	The CGS JSH Process SMD activity receiving the data retransmission request retrieves the requested data from the data store or from a removable storage media produced at the Svalbard ground station and mailed to NSOF.	The required recovery data exists in the MON Data Processing Storage.
14	DPN, MON	The CGS JSH Process SMD activity extracts APs from the retransmitted aVCDU data, using initial data (aVCDUs) as needed to augment the retransmitted data to fully assemble the missing EAPs for recovery. The CGS JSH Process SMD activity forwards the recovered EAPs to the Ingest Mission Data activity at the DPN, the Receive AP Data activity at the Navy data processing sites and the Process and Extract TLM activity at the MON. The CGS JSH Process SMD activity provides VCDU and AP statistics to the CGS JSH Track and Recover Gaps in Mission Data activity.	
15	DPN	The CGS Ingest Mission Data activity produces sensor RDRs from the recovered EAPs. The CGS Ingest Mission Data activity provides the Data Availability information to the CGS Track and Report Mission Data Performance activity.	Previously generated RDRs may be reprocessed with new data filling gaps. The re-processed RDRs are also known as repaired products.
16	DPN	The CGS Produce Data Products activity processes retransmitted sensor RDRs, calibration data and auxiliary data to produce JPSS data products (xDRs).	Previously generated xDRs may be reprocessed with new data filling gaps. The re-processed xDRs are also known as repaired products.
17	DPN	The CGS Track and Report Mission Data Performance activity includes recovered data statistics in data accountability and data latency reports provided to the CGS Manage Global Situational Awareness activity and the CGS Trend Ground System State of Health/Service activity.	
18	MON	For MOT initiated or approved retransmit requests, the JSH Track and Recover Gaps in Mission Data activity provides status of retransmission requests to the MOT.	

6.5.2.5.3 Data Accounting for Latency Basic Flow

Latencies for products produced from S-NPP instruments are specified originally in the NPP Mission Requirement Specification and now in the JPSS Ground System Requirement Document. Latency is specified for various products derived from JPSS-1/2/3/4 and GCOM-W1 instrument data in the JPSS L1RD and is specified uniquely for each primary operational sensor.

Products produced from secondary sensor SMD are not subject to the latency requirements and are delivered on a best effort basis.

For example, the JPSS Ground System applicable latencies specified for APs ranges from 70 minutes from observation to delivery for ATMS, CrIS, VIIRS, and OMPS-L/N, and 15 minutes for AMSR2 (from ground RF reception to delivery). The JPSS Ground System applicable latencies for xDRs (RDRs, SDRs, TDRs, and EDRs) range from 70 minutes to 140 minutes.

xDRs are produced from a collection of sensor data embedded in a set of one or more Application Packets generated by an instrument or instruments. Thus the "time of observation" of an xDR can be defined as the spacecraft time of the last packet (AP) in the set that contributes data to the xDR.

Table 6.5.2-6 provides a step by step narrative description of actions associated with the data accounting for latency thread.

Trigger: the thread begins at the Acquisition of Signal (AoS) of each SMD contact.

Table: 6.5.2-6 Data Accounting for Latency Basic Flow

No.	Actors	Actions	Notes
1a	SGCN	For JPSS missions, the CGS Receive Space/Ground Communication, the KSAT Receive Space/Ground Communication, the NOAA Receive Space/Ground Communication or the SN Receive Space/Ground Communication activity receives the RF/IF SMD downlink signals and forwards the IF signal to the CGS Preprocess Downlink Data or the KSAT Preprocess Downlink Data activity.	At Svalbard some antennas are operated for the JPSS Ground Project by KSAT and the Ka-band receptor is operated by CGS. At Troll the antenna(s) are operated for the JPSS Ground Project by KSAT. At FCDAS the antennas are operated by NOAA. At WSC, the SN operates the antennas receiving the SMD via RF downlink. At Troll, KSAT performs the Preprocessing activity on behalf of the JPSS Ground Project.
1b	KSAT, SGCN	For GCOM-W1, the KSAT Receive Space/Ground Communication activity forwards the IF signal to the CGS Preprocess Downlink Data activity.	
2	SGCN	The CGS Preprocess Downlink Data or the KSAT Preprocess Downlink Data activity extracts VCDUs from the SMD signal and tags each VCDU with ground receiving time and site ID information.	At Troll, KSAT performs the Preprocess Downlink Data activity on behalf of the JPSS Ground Project. VCDU ground receiving time will be used later for the measurement of ground system data latency.

No.	Actors	Actions	Notes
			For GCOM missions, the JPSS is only responsible for the ground system data latency.
3	SGCN	The CGS Preprocess Downlink Data or KSAT Preprocess Downlink Data activity transfers the VCDUs to the CGS JSH Process SMD activity via the CGS Route Downlink Data activity.	At Troll, KSAT performs the Preprocess Downlink Data activity on behalf of the JPSS Ground Project.
4	MON	The CGS JSH Process SMD activity extracts APs from VCDUs. The CGS JSH Process SMD activity stamps each AP with the packet receive time in the extended AP header to form an EAP. The packet receive time is the earth receive time of the VCDU from which the packet was extracted. The CGS JSH Process SMD activity sends EAPs sorted by VCID or APID in files to the CGS Ingest Mission Data activity, the FNMOC and NAVOCEANO Receive AP Data activity and the CGS Process and Extract TLM activity per their respective subscriptions.	If a packet is extracted from multiple VCDUs, the ground receiving time of the latest VCDU is used. Not all recipients subscribe to all APIDs or VCIDs.
4a	MON	For AP file delivery to FNMOC and NAVOCEANO, each file is assigned an observation time, which is the packet generation time extracted from the oldest packet. The FTP status provides the data delivery time. The latency for packets in the file is the difference between the observation time and delivery time.	
5	DPN	The CGS Ingest Mission Data activity receives EAPs and produces sensor Raw Data Records (RDRs).	
5.1	DPN	The CGS Ingest Mission Data activity stamps each RDR with a RDR observation time. The RDR observation time is the packet generation time extracted from the packet that contributes the most recent observation data to that RDR, i.e., using the latest time. The CGS Ingest Mission Data activity stamps each RDR with a ground receive time. The RDR ground receive time is the packet receive time extracted from the packet that contributes the last piece of observation data to that RDR, i.e., using the last or most recent time stamp in the RDR. The CGS Ingest Mission Data activity stamps each RDR with a generation time. The generation time is when the RDR is generated and written into the Data Processing Storage.	

No.	Actors	Actions	Notes
5.2	DPN	The CGS Ingest Mission Data activity sends the data latency information, including observation time, ground receive time, and generation time for each RDR, to the CGS Manage Product Generation and Distribution activity.	
6	DPN	The CGS Produce Data Products activity processes sensor RDRs, calibration data and auxiliary data to produce JPSS data products (xDRs), including SDRs, TDRs, IPs, and EDRs.	For GCOM-W1, SMD is not processed beyond RDRs. Also, under certain anomaly conditions, xDR products beyond RDRs may not be created for non-primary instruments.
6.1	DPN	The CGS Produce Data Products activity stamps each JPSS data product with an observation time. The observation time is extracted from the contributing data product. For example, when an SDR is generated from an RDR, the RDR observation time (defined in step 5.1) becomes the observation time of that SDR. When there are multiple data products contributing to a new data product, the latest observation time among the multiples should be used. The CGS Produce Data Products activity stamps each JPSS data product with a ground receive time. The ground receive time is extracted from the contributing data product. For example, when an SDR is generated from a RDR, the RDR ground receive time (defined in step 5.1) becomes the ground receive time of that SDR. When there are multiple data products contributing to a new data product, the latest ground receive time among multiples should be used. The CGS Produce Data Products activity stamps each JPSS data product with a generation time. The generation time is when the product is generated and written into the Data Processing Storage.	
6.2	DPN	The CGS Produce Data Products activity sends the data latency information, including observation time, ground receive time, and generation time for each xDR, to the CGS Manage Product Generation and Distribution activity.	
7	DPN	The CGS Distribute Data Products activity delivers each JPSS data product to a Data Landing Zone (DLZ) where the ESPC JPSS Interface has access to; receives a time-stamped	The delivery of data products to the DLZ is subject to space availability of the DLZ. The cleanup of this

No.	Actors	Actions	Notes
		acknowledgement message upon each successful delivery; and records the message time as the delivery time for the product.	DLZ is outside the control of the JPSS project In the future, the data delivery to the ESPC will be based on FTP. A FTP status will indicate the product delivery time.
7.1	DPN	The CGS Distribute Data Products activity sends the delivery time for each product to the CGS Manage Product Generation and Distribution activity.	
8	DPN	The CGS Manage Product Generation and Distribution activity sends the observation time, ground receive time, generation time, and delivery time of each JPSS data product to the CGS Track and Report Mission Data Performance activity.	
9	DPN	The CGS Track and Report Mission Data Performance activity logs the observation time, ground receive time, generation time, and delivery time of each JPSS data product for at least 90 days. The CGS Track and Report Mission Data Performance activity calculates the difference between the observation time and delivery time of each data product as its data latency through the end-to-end space/ground systems. The CGS Track and Report Mission Data Performance activity calculates the difference between the ground receive time and delivery time of each data product as its data latency through the ground system.	The retention period for the data statistics should be configurable.
10a	DPN	For each of S-NPP/JPSS missions, the CGS Track and Report Mission Data Performance activity generates Data Latency Reports for all data products produced and delivered at the Data Processing Node on a 30 day sliding window ended 7 days ago. The delay ensures that the latency of recovered data is accounted for.	To meet JPSS-1/2/3/4 mission data latency requirement, data latency values of at least 95% APs, SDRs, TDRs and EDRs, as specified in the L1RD Supplement, should be less than 80 minutes on a 30 day basis. S-NPP SDRs, TDRs and EDRs should be less than 140 minutes. In addition, JPSS-1/2/3/4 APs and RDRs should be less than 70 minutes. S-NPP

No.	Actors	Actions	Notes
			APs and RDRs should be less than 120 minutes.
10b	DPN	For GCOM-W1 mission, the CGS Track and Report Mission Data Performance activity generates Data Latency Reports for all RDRs produced and delivered at the Data Processing Node on a 30 day sliding window ended 7 days ago. The delay ensures that the latency of recovered data is accounted for. The GCOM-W1 Data Latency Reports should include both the end-to-end system latency measured from the sensor observation time, and the ground latency measured from the ground RF reception time. The JPSS Ground System is only responsible for the performance of the latter.	Only RDRs are produced for GCOM-W1. GCOM-W1 RDR latency should be less than 12 minutes for the segment from RF acquisition to RDR delivery that the Ground Project is responsible.
11	DPN	Upon operator's request, the CGS Track and Report Mission Data Performance activity generates mission-specific Data Latency Trending Report based on operator-specified site, product types, starting time and duration, and reporting frequency.	This report can be set one-time or repeating at a fixed interval.
12	DPN, MON	The CGS Track and Report Mission Data Performance activity sends all data latency status and reports to the CGS Trend Ground System State of Health/Service activity and the CGS Manage Global Situational Awareness activity.	See the System Status/Situational Awareness thread for more on system wide status and situational awareness.
13	MON, MOT	The CGS Global Situational Awareness activity provides the nodal latency contribution information to MOT (B2.1).	The nodal contribution to the end-to-end data latency will be available on display

6.5.2.6 Alternate Flow

None.

6.5.2.7 Post Condition

The missing data are detected and recovered, if possible. The Data Availability and Data Latency performance metrics are generated and reported to the management activities.

6.5.2.8 Related Threads

The following list provides the related JPSS Ground System threads that contain helpful information for understanding of how specific steps in this thread act or relate to other threads.

Thread ID	Thread Title
GS-NML-100	Stored Mission Data Handling

Thread ID	Thread Title
GS-NML-102	S-NPP and JPSS-1/2/3/4 Mass Data Storage Playback
GS-NML-030	Telemetry and Command
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-NML-010	Fleet Ground Management

6.5.2.9 Child Threads

The following list provides the child threads that are traced to this system thread.

Thread ID	Thread Title
CGS-020-080	Data Accounting and Recovery

6.5.3 Data Quality Assurance

6.5.3.1 Description

The Data Quality Assurance (DQA) thread (GS-NML-110) describes a part of the JPSS Ground System data product Calibration and Validation (Cal/Val) operations. As shown in Figure 6.5.3-1, the DQA function provides operational monitoring of the product quality; and quality issue triage and support. The DQA function is provided by online and offline components. The DQA Online component provides a means to check data quality inline, to alert the operators of quality anomalies, and to distribute the data quality notifications (To the DQA Offline only in B2.0. To other authorized users in B2.1). The DQA Offline component provides analysis and trending capabilities to support data quality issue identification and resolution. It generates and distributes Data Quality Reports (DQR) to notify data users of the identified quality issues.

The Data Quality Engineer (DQE) is at the frontline of the DQA function, focusing on daily data quality operations and providing supports to the users. The Data Quality Support Team (DQST) investigates issues raised by the DQE, takes short-term actions (triage) as needed, and escalates those issues that require configuration or algorithm changes to the Algorithm Management Project (AMP). The DQE and the DQST also performs product comparisons to identify quality issues in the operational products. Long term monitoring is provided by NOAA STAR and other members of the Algorithm & Cal/Val Science Teams through AMP. They provide more detailed analysis of product quality as well as calibration of the algorithms.

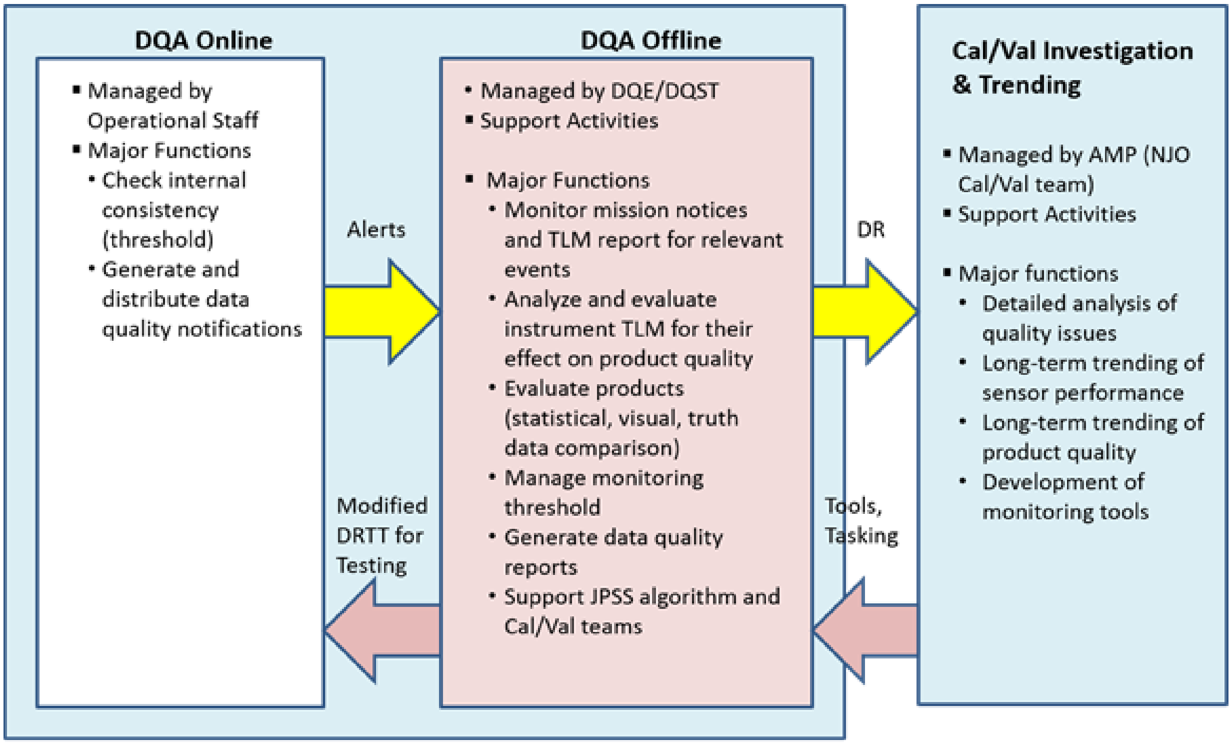


Figure: 6.5.3-1 JPSS Data Product Quality Assurance Phases

The Data Quality Assurance thread focuses on the Near Real-time Monitoring tier of the Cal/Val operations. It describes how the Ground System performs quality monitoring during the product generation and generates quality alerts when quality issues are identified. It further describes the interactions between Near Real-time Monitoring function and Operations Triage & Support function. The rest of Cal/Val operations are covered in a separate thread, the Calibration and Validation of Data Products (GS-NML-150). In addition, the product processing monitoring such as the data latency and data availability is covered in the Data Accounting and Recovery thread (GS-NML-130).

The Data Quality Assurance of the Cal/Val operations is allocated to CGS and GRAVITE. The online portion of DQA is provided by the Data Processing Node. The offline portion of DQA is provided by the Cal/Val Node. Since the Cal/Val Node is not supported at the CBU location due to the temporary nature of operations there, DQE will need to wait until the products are available on CLASS and use remote LCF resources for limited assessment capabilities. The automated evaluations and trending will not occur during a COOP event.

This scenario is applicable to the JPSS Missions, for which the JPSS Ground System produces sensor and environmental data products.

6.5.3.1.1 Data Quality Assurance Overview

The Data Quality Assurance consists of five major operations for monitoring product quality:

- Check internal consistency (online)
- Generate and distribute data quality alerts and notifications (online)

- Monitor mission notices and TLM reports for relevant events (offline)
- Evaluate products (offline)
- Generate and distribute data quality reports (offline)

The types of products being monitored include RDR, SDR, TDR, EDR, selected Gridded Intermediate Products (GIP), and selected Retained Intermediate Products (RIP).

6.5.3.1.1.1 Check Internal Consistency

In this online operation, products are checked for things such as out of limit conditions, data losses, etc. Parameters in the products are tested against the monitoring thresholds, and notifications generated in a variety of cases. Exclusions (alerts not generated) are also available, based on conditions such as Day/Night, temporal and spatial ranges, and terrain types. Quality events are detected automatically, in-line with product generation using threshold tests. The CGS has the ability to set and maintain multiple monitoring thresholds against which data quality is monitored. Unique monitoring thresholds are maintained per product and per satellite, so that the same product, originating on different satellites, can be monitored independently from each other.

The baseline set of data quality thresholds, known as the Data Quality Threshold Table (DQTT), is CM controlled, approved by the Algorithm Engineering Review Board (AERB), and distributed to the Data Processing Node from the CGS Support Node (CSN). The thresholds in this baseline version are set to nominal levels and used in the operational environment for quality monitoring. This set is archived in CLASS.

At NSOF, DQE may modify the thresholds to run in an integration and test environment to support their investigative tasks. These DQE-modified thresholds are not used in the operational environment and are not archived in CLASS. These test thresholds will likely be accompanied by a reduced distribution list interested in the issue being explored.

6.5.3.1.1.2 Generate and Distribute Data Quality Alerts and Notifications

Once a data quality threshold is breached, a Data Quality Notification (DQN) is automatically generated. The IDPS operator is informed of data quality issues. The DQN is sent to the Cal/Val Node, where it will be stored and analyzed for further action.

The Users will be informed of significant data quality issues in near real-time by automated Alerts/Warnings/Events (AWE) notifications (B2.1).Based on the approved procedures, the operational staff may turn off the data quality notification for certain events during which it's known that data quality alerts will be triggered by, for example, planned satellite activities.

6.5.3.1.1.3 Monitor Relevant System Events

DQE is kept up-to-date on current and planned flight and data operations to assess their potential impacts, on the data product quality (e.g., TLM reports on spacecraft and instrument state of health, the Mission Notices about upcoming orbit or calibration maneuvers, etc.).

6.5.3.1.1.4 Evaluate Products

In this offline operation, qualitative and quantitative analysis such as statistical evaluation, trending and visualization is performed to check for things such as algorithm performance, temporal/spatial consistency, etc. It also supports the investigation of on-going quality issues as well as the issues associated with the past data products as results of user's validation or feedback.

The GRAVITE capabilities include access to data products and other data files in near real-time, reprocessing of data products, and provides tools for automated (24x7) and ad hoc (8x5) quality assessments, including:

- Trending (typically in days, longer if needed)
- Visualizations
- Data comparisons (including correlative truth data /reference data comparisons)
- Statistical analysis (e.g., qualitative analysis on granule, scan, metadata, etc.)

If a data quality issue is identified, GRAVITE will notify DQE, DQST, and the users through the Data Quality Reports (see Section 6.5.3.1.1.5).

6.5.3.1.1.5 Generate and Distribute Data Quality Reports

The offline DQA function analyzes the DQNs received from the DQA online function as well as the quality issues identified by the offline data quality monitoring (see Section 6.5.3.1.1.4) and, if deemed necessary based on configured rules, generates Data Quality Reports (DQRs). The selectable DQRs are sent to DQEs, DQST, and other data users who subscribe to the service.

DQE subscribes to all DQRs and utilize them to identify product granules and to investigate issues. The DQST is notified so that they can further investigate the issues and take corrective action. And as a result of their actions, The Cal/Val team may request that the quality monitoring activities be modified in some way. This is essentially a feedback path that may result in changes to any of the overall monitoring operations described above.

6.5.3.1.2 Staff Roles involved with Product Monitoring

Data Quality Assurance is a combination of manual and automated functions for both qualitative (such as data visualization) and quantitative analysis, including statistics generation and trending.

Performance of the manual functions involves participation by different staff positions within the Operational Staff. These staff positions include the Interface Data Processor's (IDP) Operators, Data Quality Engineer (DQE), and the Instrument Engineer. Their responsibilities include:

- DQE - DQE resides at NSOF making use of the GRAVITE support system for detailed investigation. It is an 8 to 5 weekday position (may be called in during off-hours to resolve data issues). DQE is responsible for performing day to day, near real-time product quality assessment. Examples include:
    - Configuring and monitoring data quality monitoring procedures
    - Checking automatically generated quality alerts to filter out false alarms
    - Evaluating statistical data of selected product parameters

  - Performing visual data inspections
  - Serve as the point of contact on data quality issues for operational users such as ESPC and FNMOC, during normal work hours
  - Communicating data quality information to the Cal/Val team and other internal users
  - Providing support to the Cal/Val and sensor science teams, as managed by the OSPO Management

- IDP Operator - The IDP Operator resides at NSOF. It is a 24x7 position. The IDP Operator's primary responsibilities are related to the data processing and distribution on the operational system. However, the IDP Operator provides an off-hours human presence for quality issues.
  - Elevates critical alarms due to automated quality alerts
  - Monitors the IDPS quality monitoring software health and status
  - Serve as the point of contact on data quality issues for operational users such as ESPC and FNMOC, after normal work hours
- Instrument Engineer - The Instrument Engineer resides at NSOF. It is an 8x5 weekday position. The Instrument Engineer is responsible for monitoring and maintaining the health of the instruments onboard the spacecraft.
  - Maintains instrument calibration and software
  - Monitors instrument health and status
  - Performs Stored Telemetry Analysis (STA) and Reporting
- The Data Quality Support Team (DQST), managed by the JPSS Data Products Engineering and Services (DPES), provides technical support to DQE. When engaged by DQE, DQST analyzes the data quality issues, eliminates false alarms, addresses minor issues, and escalates major issues to the Cal/Val team in the form of Discrepancy Report. Furthermore, DQST performs the offline data quality monitoring support in collaboration with the Cal/Val and Instrument Science Teams by conducting medium term evaluation, monitoring and planning activities over longer time periods, which include:
  - Analyzing and evaluating instrument telemetry for their effect on product quality
  - Performing data product assessments over longer time periods and over larger regions
  - Performing comparisons to correlative truth data
  - Working with DQE to optimize near real time procedures and monitoring thresholds
  - Developing and integrating of Cal/Val analysis tools
  - Providing support to the JPSS algorithm and validation teams

6.5.3.2 Primary Interfaces

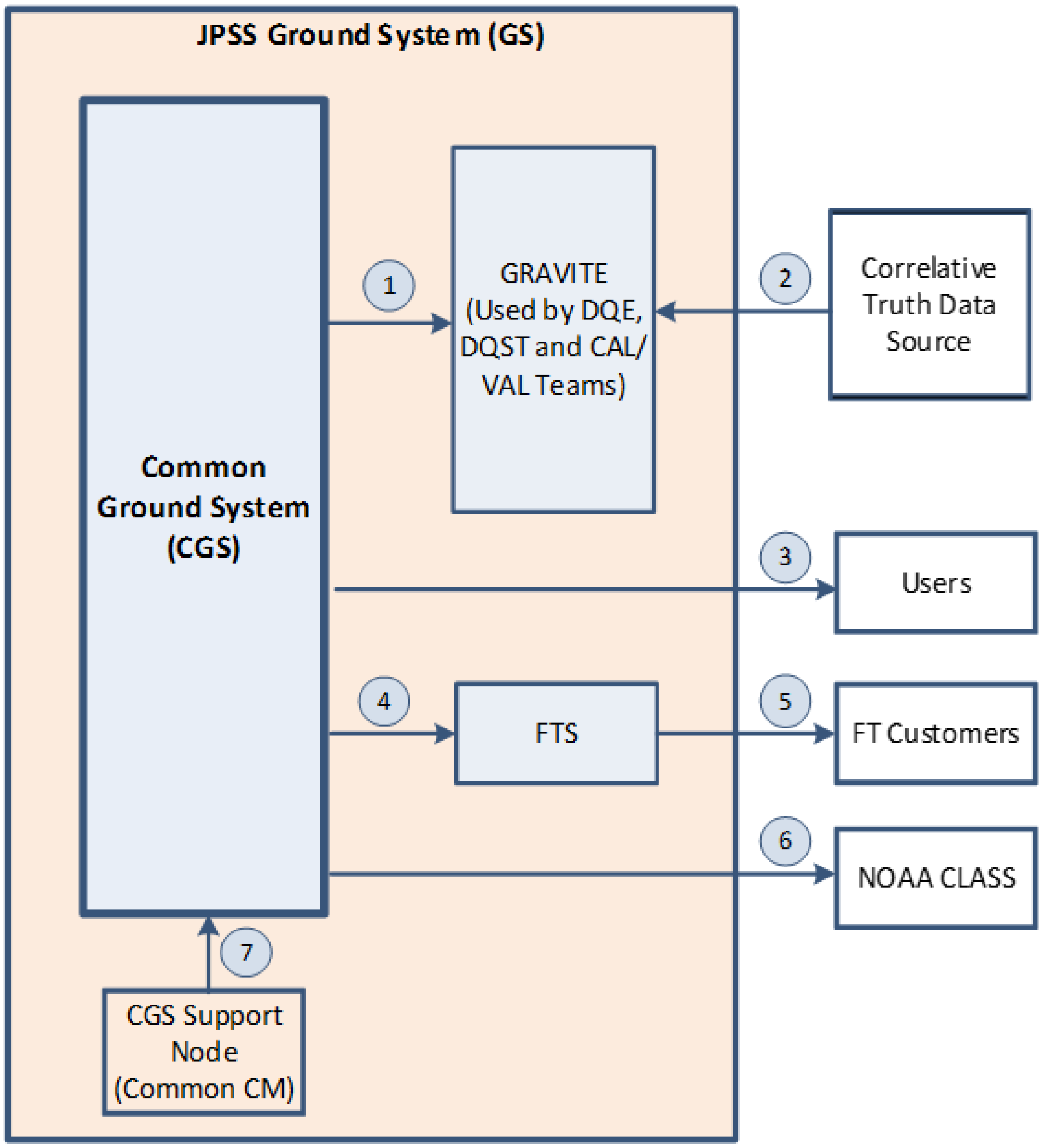


Figure: 6.5.3-2 Data Quality Assurance Interface Diagram

Table: 6.5.3-1 Data Quality Assurance Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	CGS -> GRAVITE	Provide data quality notifications, reports and supporting data to DQE/DQST/ACVSTs
2	External	Correlative data sources -> GRAVITE	Receive correlative truth data from public sources
3	External	CGS, Users	Provide data quality notifications
4	Internal	CGS -> FTS	Provide data quality notifications (through mission notices)

No.	Type	Actors	Purpose
5	External	FTS, FT Customers	Provide data quality notifications (through mission notices)
6	External	CGS, NOAA CLASS	Provide baseline DQTT for archive
7	Internal	CSN, CGS	AERB-approved DQTT

Table: 6.5.3-2 Data Quality Assurance Primary Interface Documentation

No.	IRD/ICD
1	JPSS CGS to GRAVITE IRD (474-00200)
2	Internet & CLASS Consumers IDD
3	JPSS CGS Services IDD (IC60917-SEIT-002)
4	JPSS CGS Services IDD (IC60917-SEIT-002)
5	JPSS FTS Services IDD (474-00380)
6	JPSS GS to CLASS IRD (474-00302)
7	JPSS CGS Data Format Control Book Vol. 6

6.5.3.3 Assumptions & Constraints

- The Data Quality Assurance (DQA) function is performed for the products produced on the Data Processing Nodes.
- DQA is not supported at the Consolidated Back-Up (CBU) site.

6.5.3.4 Pre-Conditions

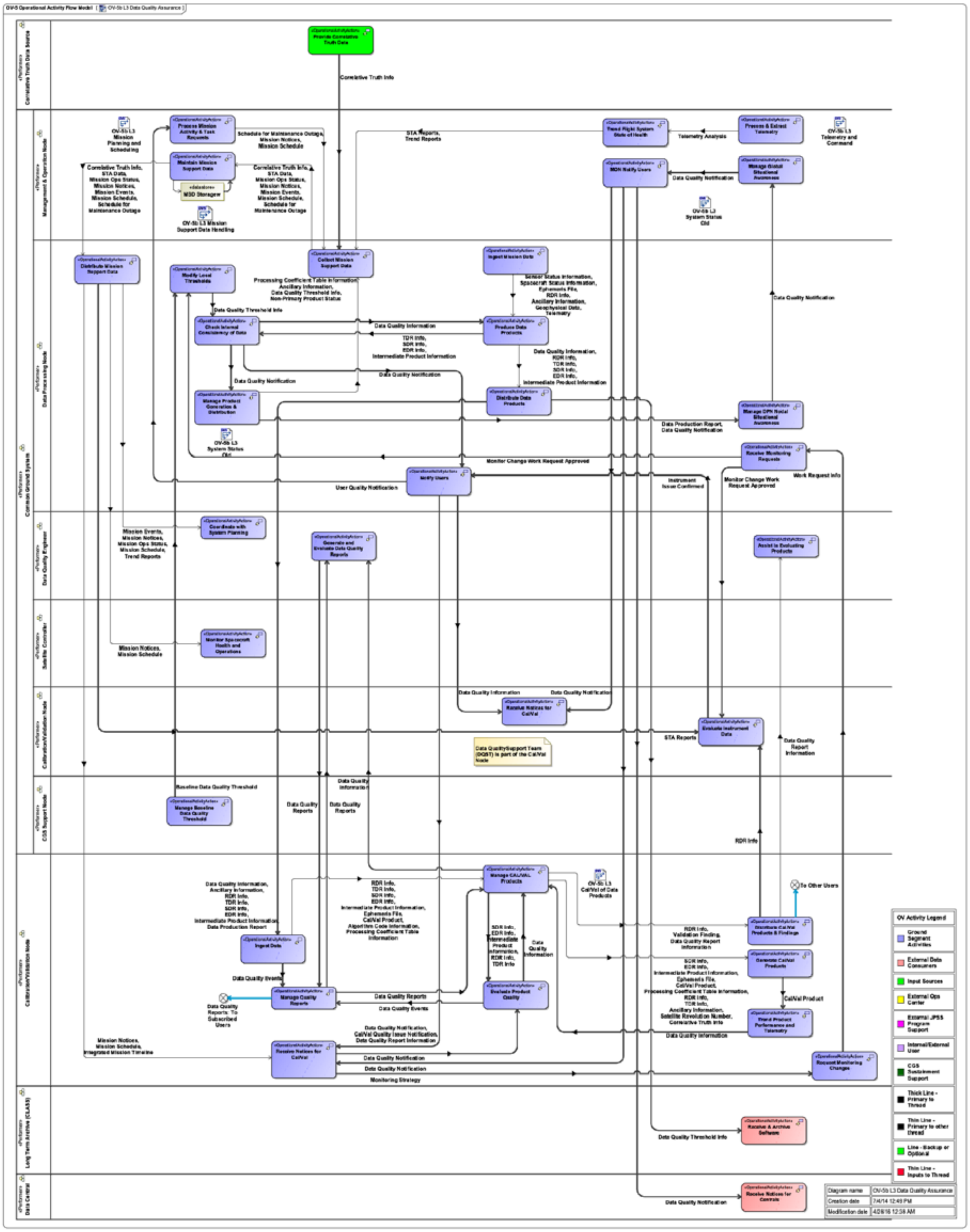
- The CGS is operational and producing products.
- The CGS-GRAVITE interface is configured and operating nominally.

6.5.3.5 Operational Flow

Figure 6.5.3-3 shows the flow of data quality assurance operations and their interactions with other operations inside and outside of system. The major operations are:

- Check internal consistency
- Distribute data quality notification
- Monitor relevant system events
- Evaluate products
- Generate data quality reports

Although they are organized as though you were going through the process once, each of these parts may be performed as needed to update information or respond to system needs.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.5.3-3 Data Quality Assurance Operational Flow Diagram

6.5.3.6 Basic Flow

Table 6.5.3-3 lists a flow of actions performed by the data quality assurance activities.

Table: 6.5.3-3 Data Quality Assurance Basic Flow

No.	Actors	Actions	Notes
1	CGS Support Node (CSN)	The CGS Manage Baseline Data Quality Threshold activity creates baseline versions of the monitoring thresholds.	This is a factory activity. The modification to the thresholds is subject to the approval of the Algorithm Engineering Review Board (AERB)
2	CSN	The CGS Manage Baseline Data Quality Threshold activity distributes the baseline monitoring thresholds to all internal locations that need it. The CGS Manage Local Threshold activity ingests the baseline monitoring threshold for checking data quality. The CGS Manage Local Threshold activity may modify the baseline monitoring threshold for Non-operational use.	Supports both Ops and non-ops activities such as Factory, I&T, algorithm development, parallel ops.
3	CGS	The CGS Check Internal Consistency of Data activity performs comparison of product parameters against quality thresholds as the CGS Produce Data Products activity produces the products. If no threshold violation is detected, go to step 7. If threshold violation is detected, a Data Quality Notification (DQN) is generated automatically.	Automated alerts are generated in real time as products are being created by performing tests of product parameters against the monitoring thresholds.
4	DPN, DPN Operational Staff , Cal/Val Node	The CGS Check Internal Consistency of Data activity reports DQNs to the CGS Manage DPN Nodal Situational Awareness activity via the CGS Manage Product Generation & Distribution activity. The CGS Manage DPN Nodal Situational Awareness activity aggregates DQNs, alerts the DPN operational staff of data quality	These notifications will be in the form of alerts that can be text messages, pages, phone calls, and/or emails (B2.1). The recipients can choose the type of notification(s) and to whom they are sent.

No.	Actors	Actions	Notes
		issues, and reports the alerts to the CGS Manage Global Situational Awareness activity. Subsequently, the CGS Manage Global Situational Awareness activity alerts subscribed users [B2.1]. The CGS Check Internal Consistency of Data activity provides DQNs to the CGS Produce Data Products activity. The CGS Distribute Data Products sends the Data Quality Information (DQNs) to the CAL Ingest Data activity as part of the ordered auxiliary data subscription.	
5	DPN, MON, DQE, MOT	If the notification is about a product that is of interest to a large number of users, it may be distributed via a Mission Notice. In this case, the CGS Notify Users activity notifies the CGS Process Mission Activity & Task Requests activity the data quality issue. The CGS Process Mission Activity & Task Requests activity creates the mission notice and distributes it via the CGS Distribute Mission Support Data activity.	Mission notices are generated at discretion of MOT.
6	Cal/Val Node	The CAL Ingest Data activity receives the Data Quality Information (DQNs) from DPN. The CAL Ingest Data activity extracts the data quality information from DQNs and forwards it to the CAL Manage Cal/Val Products activity. The CAL Ingest Data activity generates data quality events and forwards them to the CAL Manage Quality Report activity.	

No.	Actors	Actions	Notes
		Go to Step 8.	
7	DQE/DQST, Cal/Val Node	The CAL Evaluate Product Quality activity evaluates data quality routinely, and when a quality issue needs to be confirmed. The activity performs: 1) acquiring the data products of interest and performing the data re-processing if needed. 2) running qualitative and quantitative evaluations such as visualizations and statistical analysis 3) comparing the data to the correlative truth data 4) trending the data over several days, longer if needed The routine data quality evaluation is conducted automatically.	
7.1	Cal/Val Node	When a data quality issue is identified, the CAL Evaluate Product Quality activity generates a data quality event and forwards it to the CAL Manage Quality Report activity.	
8	Cal/Val Node	The CAL Manage Quality Report activity analyzes the data quality events received both from the CAL Ingest Data activity and the CAL Evaluate Product Quality activity. The CAL Manage Quality Report activity generates the Data Quality Reports (DQRs) based on a set of configurable rules.	
9	Cal/Val Node	The CAL Manage Quality Report activity distributes the DQRs to DQE and authorized users to alert them of data quality issues. The CAL Manage Quality Report activity sends the DQRs to the CAL Manage Cal/Val Products activity for storage and dissemination.	

No.	Actors	Actions	Notes
10	Cal/Val Node, DQE, Authorized Users	The CAL Manage Cal/Val Products activity provides DQE, DQST and the authorized users access to the data quality information to support their investigation of the data quality issues. DQE may generate DQRs based on the data quality information received, and provide the DQRs to the CAL Manage Cal/Val Products activity via the CAL Manage Quality Report activity for storage and dissemination.	
11	DPN, Cal/Val Node,	The CGS Receive Monitoring Requests addresses the changes in one or more of the major operation of product monitoring.	Changes may include: • Changes to the products being evaluated • Changes to the types of evaluation

6.5.3.7 Alternate Flow

None.

6.5.3.8 Post Conditions

- Data quality alerts are provided to the operators in near real-time.
- Offline Data Quality Reports are sent to all stakeholders who subscribe them.
- DQTTs have been incorporated correctly into CGS.

6.5.3.9 Related Threads

A list of threads that are related to this thread is provided below for further understanding and clarification.

Thread ID	Thread Title
GS-NML-100	Stored Mission Data Handling
GS-NML-140	Mission Support Data Handling
GS-NML-150	Cal/Val of Data Products

6.5.3.10 Child Threads

A list of child Operations Concept (OpsCon) threads to which this ConOps thread flows down is provided below.

Thread ID	Thread Title
CGS-020-050	Stored Mission Data Handling
CGS-030-010	Status and Situational Awareness

Thread ID	Thread Title
CGS-040-040	Data Cal Val
GRAS-P&DQ-01	GRAVITE Support for Data Quality Support Team Monitoring
GRAS-P&DQ-02	GRAVITE Support for Identification of Data Quality Issues

6.5.4 Mission Support Data Handling

6.5.4.1 Description

Mission Support Data Handling (GS-NML-140) provides a ground system-level end-to-end operational thread that describes acquisition, management and distribution of Mission Support Data (MSD) to support mission operations and data product generation. This thread applies to the JPSS-managed satellites such as S-NPP, JPSS-1/2/3/4 and non-managed missions such as GCOM-W1.

The scope of MSD includes all the data, with exception of sensor-produced observation and engineering data, which are required to produce JPSS data products or ascertain mission status. The MSD is categorized into two parts based on its source. The MSD produced externally to the JPSS program is called “Ancillary” (ANC) data; and the MSD produced internally to the JPSS is called “Auxiliary” (AUX) data. This thread focuses on AUX data that is delivered externally.

During mission operations, the JPSS Ground System periodically collects ancillary data from external sources and produces auxiliary data internally. The primary source for ancillary data is the NESDIS ESPC, which makes the ancillary data available at both NSOF, the primary site, and Consolidated Backup (CBU) facility, the alternate site. The system uses both ancillary and auxiliary data for internal data production needs. The MSD is also distributed to external users, including Field Terminal (FT) customers, via internet. In addition, the MSD is delivered to the NOAA CLASS for long term archive storage.

Table 6.5.4-1 provides a list of mission support data and their attributes, including data type, name, source, distributor, and update frequency. The static ancillary data is distributed as a part of data processing software release; and is not considered further in this ConOps thread.

Table: 6.5.4-1 Mission Support Data

Note: the information collected in this table is representative and subject to change. It should be used for information only.

Type			Item	Producer	Distributor	Media	Frequency	Note
Environmental Ancillary (ANC) Data	Static	Static Ancillary Data	Climatology and Space Environment	GSFC	GSFC	Software drop	Infrequent	Provided to Integrated Support Facility (ISF)
			MODIS Land-Water Mask	GSFC Code 614.5	GSFC	Software drop	When updated by ACCB	Provided to Integrated Support Facility (ISF)
			NIMA Vector Map Level 0			Internet	As available	Provided to ISF
			UV Surface Reflectivity	Herman, J. R. and Celarier, E Al. 1997. "Earth Surface Reflectivity Climatology at 340 nm to 380 nm from TOMS Data," Journal of Geophysical Research 102, pp. 28003-28011	GSFC	Software drop	Static	
			Nitrate Depletion Temperature database	Kendall Carder of University of South Florida	??	Software drop	As needed	Provided to Integrated Support Facility (ISF)
			Planetary Ephemeris	JPL	JPL	Internet	Not until 2039	DE200
			EGM96 Geoid Model	NASA	NASA	Internet		
			Earth Resources and Digital Elevation Maps	US Geological Survey (USGS)	USGS	Software drop	Infrequent	Provided to ISF
	Dynamic	Official Dynamic Ancillary Data (ODAD)	NCEP GFS 3-Hour Interval Forecast	National Center for Environmental Prediction (NCEP) – Global Forecast System (GFS)	NESDIS ESPC	TBD for secured access	Every 6 hours	8 files for each update
			FNMOC NAVGEM 3-Hour Interval Forecast	Fleet Numerical Meteorology and Oceanography Center (FNMOC) Navy Global Environmental Model (NAVGEM)			Every 6 hours	8 files for each update
			NAAPS 3-Hour Interval Forecast	FNMOC Navy Aerosol Analysis and Prediction System (NAAPS)			Every 6 hours	8 files for each update
			Earth Orientation Bulletin A	International Earth Rotation and Reference System Service (IERS)		USNO website	Weekly	

Type			Item	Source	Distributor	Media	Frequency	Note
Auxiliary (AUX) Data	Aux Generated by C3S	Mission Planning and Scheduling	Mission notice	C3S			As needed	
			Mission schedule	C3S			Every 3-4 days	
			KSAT Svalbard ground contact schedule	C3S			Every 7 days	Including S-NPP, GCOM-W1, Coriolis, JPSS-1
			Ground contact schedule	C3S			Every 7 days	Up to 15 sites
			McMurdo MG1 contact schedule	C3S				
			TDRSS Support Schedule	C3S				
		Status Report	End of contact report	C3S			After each contact	
			HRD/LRD monitoring report	C3S			After each Svalbard contact	
			System data availability report	C3S			Daily	
			System latency report	C3S			Daily	
			Segment latency report	C3S			Daily	
			EM Report	C3S			Weekly	
			Network service operational statistics	C3S			Daily	
		Orbit Products	Two line elements (TLEs)	C3S			Daily	From Orbit Ops
			Satellite revolution numbers for S-NPP, JPSS-1, GCOM-1	C3S			Daily	From Orbit Ops
			Ephemeris files	C3S			Weekly	From Orbit Ops
			Predicted post maneuver TLE sets and definitive post maneuver TLE sets	C3S			As needed	From Orbit Ops
		Telemetry Reports						
			Various Telemetry Checking and Trending Reports	C3S				
		CERES Data	CERES LEO&A APID telemetry files	C3S			After each contact	CERES Telemetry
			CERES Solar Ephemeris	C3S			As needed	
			Spacecraft configuration database update	C3S				TBD
Auxiliary (AUX) Data	Aux Generated by IDPS		CrIS Correction Matrix	CrIS Ops Team	IDPS		As needed	
			VIIRS solar diffuser history	VIIRS Ops Team	IDPS		As needed	
			OMPS automatic processing coefficients	OMPS SOC	IDPS		As needed	
			OMPS calibration table	OMPS SOC	IDPS		As needed	
			Processing coefficients	Cal/Val	IDPS		Infrequent	
			Sensor Calibration Coefficient updates	Cal/Val	IDPS		Infrequent	
			Data Quality Threshold Tables (DQTTs)	DQE	IDPS		Infrequent	
			VIIRS Calibration F-Tables	VIIRS Ops Team	IDPS		Infrequent	

A Mission Notice is a management message generated by the mission management. It is typically used to broadcast significant internal and external system events that have impacts on system operations and data users. Examples include spacecraft anomalies, communication outages, planned orbit maneuvers, post-maneuver confirmations, system start-ups and shutdowns, system configuration changes, etc.

There are other system operations that take place in parallel with the MSD handling. These include Stored Mission Data (SMD) Handling, Integrated Support, Ground Operations, Telemetry and Command, and Mission Planning and Scheduling. They are detailed in respective ConOps threads as listed in the Related Threads section.

6.5.4.2 Primary Interfaces

Figure 6.5.4-1 illustrates the actors and primary external interfaces involved in the execution of MSD Handling. Each interface illustrated in the figure, labeled with a number, is described in Table 6.5.4-2 with the information about actors, types of data, and purpose. Table 6.5.4-3 lists relevant documents for each of the interface.

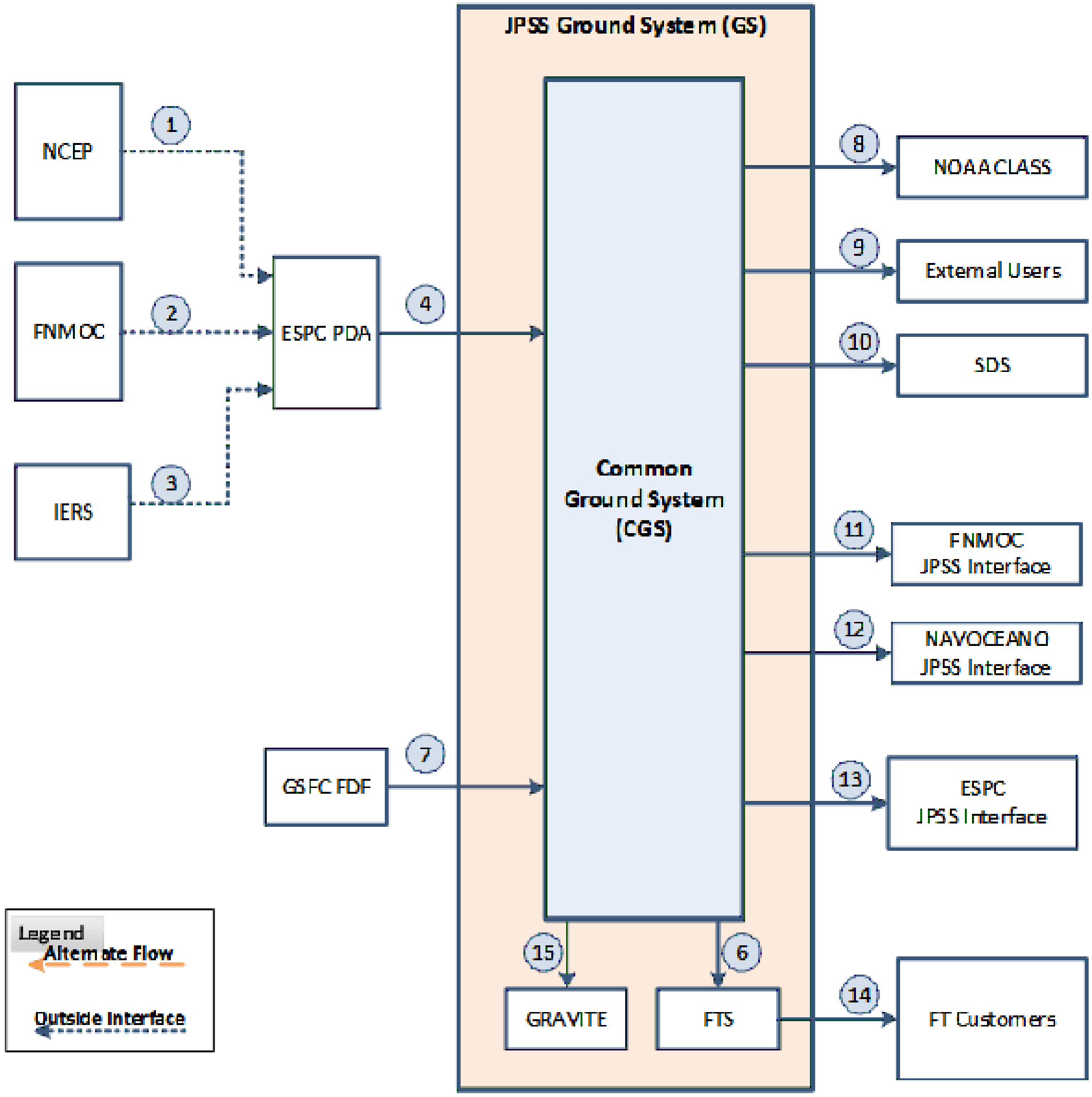


Figure: 6.5.4-1 Primary External Interfaces for Mission Support Data Handling

Table: 6.5.4-2 Mission Support Data Handling Primary Interfaces

No.	Type	Actors	Purpose
1	Outside[1]	NCEP -> ESPC PDA	Global Forecast System (GFS)
2	Outside[1]	FNMOC -> ESPC PDA	NAVGEM, NAAPS
3	Outside[1]	IERS -> ESPC PDA	Earth Orientation Bulletin
4	External	ESPC PDA -> CGS	Ancillary Data through ESPC interface presented at both NSOF and CBU, Space Weather
5		Reserved	
6	Internal	CGS -> FTS	MSD
7	External	FDF -> CGS	Two Line Elements

No.	Type	Actors	Purpose
8	External	CGS -> NOAA CLASS	MSD
9	External	CGS -> External Users	MSD
10	External	CGS -> SDS	MSD
11	External	CGS -> FNMOC JPSS Interface	MSD
12	External	CGS -> NAVOCEANO JPSS Interface	MSD
13	External	CGS -> ESPC JPSS Interface	MSD
14	External	FTS -> FT Customers	MSD
15	Internal	CGS -> GRAVITE	MSD

Note 1 - An outside interface is between external entities. It is not directly connected to the JPSS ground system. It is included for information only.

CLASS - Comprehensive Large Array-data Stewardship System
ESPC - Environmental Satellite Processing Center
FDF - Flight Dynamics Facility
FNMOC - Fleet Numerical Meteorology and Oceanography Center
FT - Field Terminal
GRAVITE - Government Resource for Algorithm Verification, Independent Testing and Evaluation
GSFC - Goddard Space Flight Center
IERS - International Earth Rotation and Reference System Service
NAAPS - Navy Aerosol Analysis and Prediction System
NAVGEM - Navy Global Environmental Model
NCEP - National Center for Environmental Prediction
NESDIS - NOAA Environment Satellite Data and Information System
PDA - Product Distribution & Access
SDS - Science Data Segment

Table: 6.5.4-3 Mission Support Data Handling Primary Interface Documentation

No.	IRD/ICD
1, 2, 3	Out of scope
4	JPSS GS to NESDIS ESPC IRD JPSS CGS to NESDIS ESPC ICD
6	JPSS CGS Service IDD
7	NSOF - NASA FDF PSLA
8	JPSS GS to CLASS IRD
9	JPSS CGS Services IDD
10	JPSS GS to NASA SDS IRD
11	JPSS GS to FNMOC IRD
12	JPSS GS to NAVOCEANO IRD
13	JPSS GS to NESDIS ESPC IRD
14	JPSS FTS Services IDD
15	JPSS CGS to GRAVITE IRD

6.5.4.3 Assumptions & Constraints

- The ESPC PDA is the distributor for the NCEP-GFS, FNMOC-NAVGEM, FNMOC-NAAPS, and IERS Earth Orientation Bulletin components of the Environmental Ancillary Data subset. Its interface to the JPSS Ground System are presented at both NSOF and CBU.
- If the ESPC PDA interface at CBU is not available (e.g.; for maintenance), then the JPSS Ground System at CBU will connect to the ESPC PDA interface at NSOF to acquire the Ancillary data.

6.5.4.4 Pre-Conditions

System is up and running.

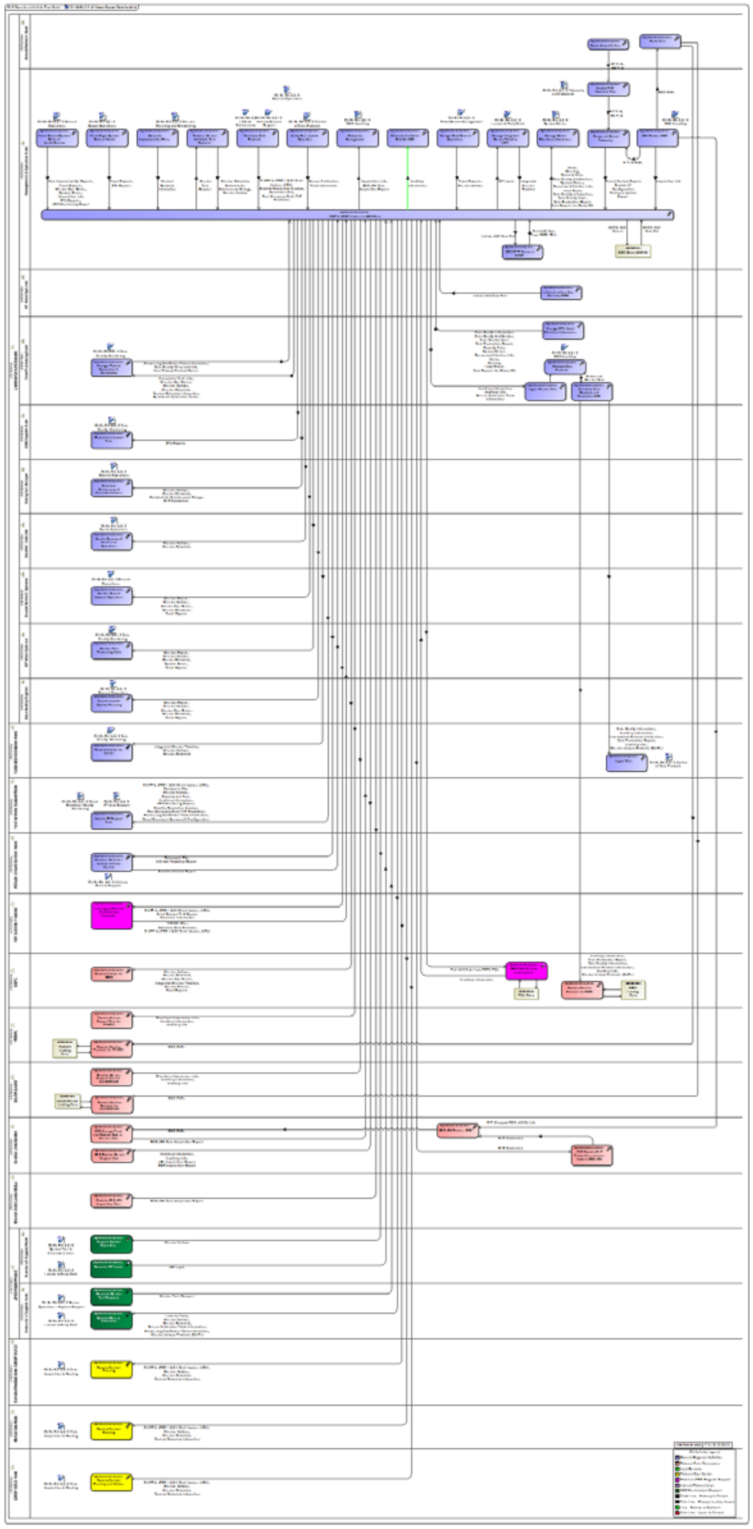
6.5.4.5 MSD Handling Flow

Figure 6.5.4-2 provides an illustration of system activities taking place in the basic flow of the scenario.

In CGS, the Management & Operation Node (MON) and Data Processing Node (DPN) are assigned responsibility for acquiring, storing, managing and distributing a set of MSD as defined by the JPSS GS Control Board.

Many activities in MON produce AUX for mission operations, as shown in the MON swim-lane on the top, which are collected by the Collect MSD activity in DPN, along with AUX for data production produced by DPN. DPN also acquires dynamic ANC produced by external ANC providers. The acquired MSD are stored and distributed by DPN.

Internal nodal distribution of MSD is carried out through DPN to configured internal destinations. External distribution of MSD, including both ANC and AUX, are through DPN to authorized users either as part of subscription-based product delivery or via a web interface. The MSD “Product” distribution is restricted by “user” role, operator’s role, or ICDs. The MSD acquisition and maintenance statuses are provided to MON.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.5.4-2 MSD Handling Activity Flow Diagram

6.5.4.6 Basic Flow

Trigger: No specific trigger. Continued operations once started.

Table: 6.5.4-4 Mission Support Data Handling Basic Flow

No.	Actors	Actitivies	Notes
1	DP Node operator, MON, ESPC PDA	The DP Node Operator's Initiate Ancillary Data Pull from ESPC activity sends Initiate ANC Data Pull to the MSD SFTP Server in MDMZ activity in the IDMZ & MDMZ Access to MSD Store activity. The MSD SFTP Server in MDMZ activity then pulls ANC data from the ESPC's ESPC PDA Provide Ancillary Data activity's PDA Store and stores it in the MSD Store (MSDS) database of the IDMZ & MDMZ Access to MSD Store activity.	The DP Operator periodically starts the extraction of ANC data from the ESPC PDA. The ANC data is moved to and stored in the MSD Store (MSDS) for access by the DPN and Authorized Users.
2	DPN, MON	The DP Node Operator accesses the MSD SFTP Server in MDMZ activity to pull Ancillary Information, Auxiliary Info, and Sensor Calibration Table information from the MSD Store (MSDS) database via the IDMZ & MDMZ Access to MSD Store activity and routes it to the DPN Ingest Mission Data activity.	The DP Node Operator pulls the ANS, AUX, and Sensor Cal Mission Support Data needed to process the next satellite download and directs it to the IDPS. See the Stored Mission Data Handling thread for graceful degradation in product generation if the required dynamic ancillary data cannot be obtained in time.
2	DPN	The DPN Ingest Mission Data activity passes the Ancillary Information, Auxiliary Info, and Sensor Calibration Table information to the DPN Produce Data Products activity to be used for processing the next satellite pass's data.	
3	DPN,	The DPN Produce Data Products activity passes the processed data to the DPN Distribute Data Products and Production MSD activity.	
4	DPN, ESPC, Cal/Val	The DPN Distribute Data Products and Production MSD activity sends the Mission Unique Products (MUPs) (processed data) along with the Ancillary Information, Auxiliary Info, Sensor Calibration Table information, Intermediate Product Information, and Data Production Report to the Calibration/Validation Node and the ESPC.	The ESPC also passes the data to CLASS. Note: the data sent to Cal/Val and ESPC are sent directly to them. All other authorized users of the MSD obtain the data from the IDMZ or MDMZ servers.

No.	Actors	Actitivies	Notes
5	MON	The activities above the bar that represents the IDMZ & MDMZ Access to MSD Store activity, the DP Node Operator, and the DPN software are internal to the MON and represent Internal suppliers and users of the Auxiliary data. These activities receive data from or send data to the MDMZ via internal networks.	Internal operators or software packages connect to the MSDS via the MDMZ.
6	All performer s (swim lanes) below the DPN	The activities performed in the swim lanes below the DPN are External suppliers and users of the Auxiliary data. These activities receive data from or send data to the IDMZ via the Internet.	External entities access the MSD via the IDMZ from the Internet.
7	MON	The MON IDMZ & MDMZ Access to MSD Store activity maintains a log of all MSD file transactions, including ingestions, distributions, and deletions.	The log is a part of system operations log and follows the same policies for on-line retention and off-line archive.
8	MON	The MON IDMZ & MDMZ Access to MSD Store activity maintains a list of all current MSD files available and makes it available to internal and external users.	
9	MON	The MON IDMZ & MDMZ Access to MSD Store activity purges MSD files from the MSD storage based on configurable retention rules.	

6.5.4.7 Post Condition

The Mission Support Data (MSD) is acquired, managed, and distributed to designated recipients for use in the mission operations and data product generation.

6.5.4.8 Related Threads

The following list provides the related JPSS Ground System threads that contain helpful information for understanding how specific steps in this thread act or relate to other threads.

Thread ID	Thread Title
GS-NML-100	Stored Mission Data Handling
GS-NML-400	Integrated Support
GS-NML-050	Orbit Maintenance
GS-NML-060	Attitude Ground Support
GS-NML-150	Cal/Val of Data Products
GS-NML-300	System Status/Situational Awareness
GS-NML-310	Ground Operations
GS-NML-010	Fleet Ground Management
GS-NML-020	Mission Planning and Scheduling
GS-NML-030	Telemetry and Command

Thread ID	Thread Title
GS-FTS-110	Field Terminal User Support

6.5.4.9 Child Threads

The following list provides the child threads that are traced to this system threads.

Thread ID	Thread Title
CGS-020-060	Mission Support Data Handling
CGS-030-050	Internal Data Management

6.5.5 Algorithm Development and Maintenance

6.5.5.1 Description

6.5.5.1.1 Introduction

The Algorithm Development and Maintenance (ADM) (GS-NML-170) thread provides a high level description of the process for enhancing existing and creating new environmental data product algorithms. The goal of ADM is to ensure data products are generated to the performance level specified in the JPSS Ground System Requirements Document. This thread applies to all JPSS missions for which the ground system processes mission data and produces data products, including JPSS-managed satellites such as S-NPP, JPSS-1, JPSS-2, JPSS-3, and JPSS-4. This thread is particularly relevant to the addition of algorithms for new data products as later missions are added to the JPSS fleet.

The same process is used to change existing algorithms or add new algorithms into the JPSS operational data processing. The Algorithm Discrepancy Report (ADR) is a means to track the change as it proceeds through the system from concept, to realization, to test, to approval, to implementation, to fielding.

A government-led Cal/Val organization is responsible for the planning and execution of the Cal/Val operations. Section 6.6.1.1.4 provides an overview of Cal/Val organization, along with its roles and responsibilities.

The ADM thread makes extensive use of the GRAVITE system described in Section 6.6.1.1.5. Supporting organizations outside the JPSS Program also have additional computing infrastructures referred to as Local Computing Facilities (LCF). The NASA SDS provides a number of LCFs to support SNPP algorithm Cal/Val and development.

The Investigator Computing Facility (ICF) in GRAVITE is a general-purpose computing facility to enable on-site and off-site science investigators to perform analyses of the data products and PGE outputs.

In addition to the Cal/Val thread, there are several other threads that provide context or support to the ADM operations. The FSW Upgrade thread discusses the maintenance of flight tables and ground tables, some updates are generated by this thread and flow through the Sensor Operations & Payload Support thread. The System Maintenance & Upgrade thread illustrates the enterprise view of how a software update is fielded in the system. This includes how the algorithm is integrated into the software build for the data processing system. The Integrated Support thread

covers the maintenance of the project-supported tools used for Cal/Val and algorithm development.

More details for the algorithm update process can be found within the JPSS Algorithm Change Management Plan (474-00058).

6.5.5.1.2 Formulation of Solutions

NOAA JPSS-STAR (JSTAR), via its Algorithm & Calibration/Validation Science Teams (ACVSTs) is responsible for maintaining the data processing algorithms for the S-NPP and succeeding JPSS satellites. The science associated with an algorithm is described by an Algorithm Theoretical Basis Document (ATBD). The implementation of current algorithms is documented in Operational Algorithm Descriptions (OADs). New algorithms will have requirements defined in an Algorithm Software Requirements Specification (SRS) and their implementation documented in a Product Specification jointly developed by the algorithm vendor and the CGS contractor. The intent of the Algorithm SRS is to document the required performance of the algorithm as well as how to verify this performance.

Figure 6.5.5-1 illustrates a high-level overview of the nominal algorithm change process. The ACVST either identifies discrepancies with existing algorithms, or generates updates associated with new requirements. These changes are reviewed by the NOAA JPSS Office (NJO) Algorithm Management Project (AMP) group which formulates a preliminary configuration change request (CCR) which is forwarded to JPSS DPES to verify and test the proposed update. The JPSS review boards will review the tested proposed change. If approved, the algorithm change package, along with the associated documentation and funding are passed to the CGS contractor to update the software implementation of the Data Processing Node. Once that is complete, the update is fielded to the site where it is checked out before transitioned to operations.

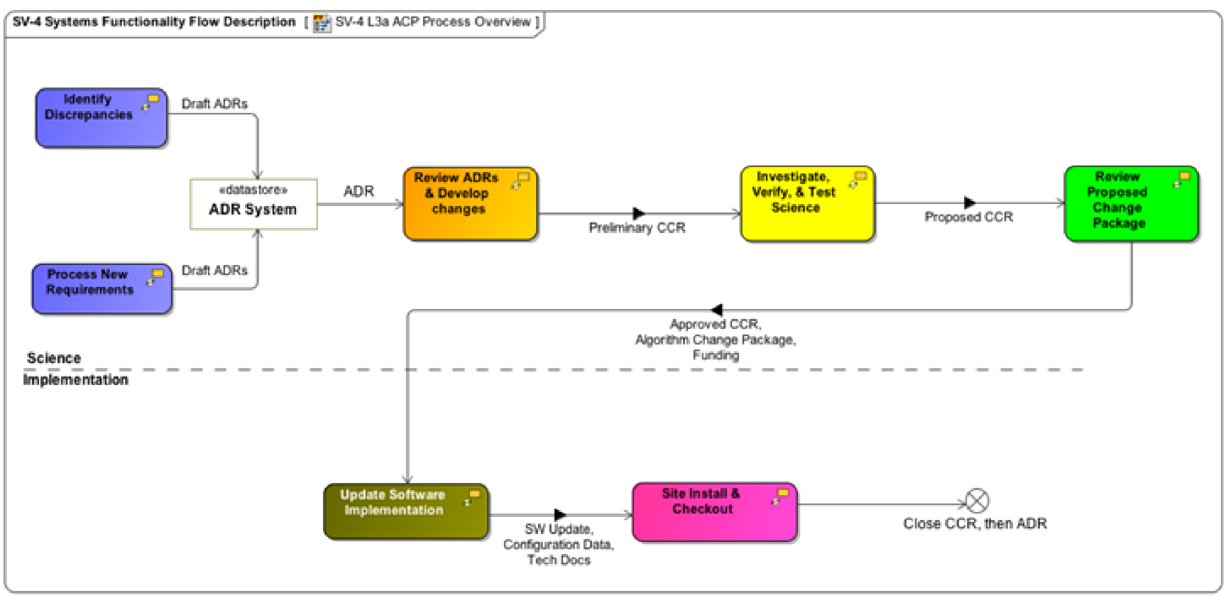


Figure: 6.5.5-1 Algorithm Change Process Overview

To make changes to existing algorithms or to create new algorithms, an Algorithm Discrepancy Report (ADR) is generated to document the issue to be addressed. ADRs are adjudicated by the Discrepancy Report Action Team (DRAT), as an agent of the Algorithm Engineering Review Board (AERB), for action. The DRs are categorized into three types:

Type 1 - Changes in Scope

Type 2 - Performance Deficiencies

Type 3 - Operational Deficiencies

Type 1 and 2 issues involve generating some fix to the algorithm. Type 3 issues tend to be configuration changes and have an expedited path to resolution. Once Type 3 issues are approved, a request is generated to make the resolution in the operational system. For some Type 3 issues, the DRAT may determine the issue to be an implementation problem and not an algorithm problem, upon which the ADR is forwarded to CGS to rectify.

To help coordinate issues, the AMP group has established JPSS Algorithm Managers (JAMs) to act as a liaison between each ACVST and the JPSS ground project. The JAM coordinates proposed ADRs for submission to the DRAT and then track the ADR as it progresses through the update process until the ADR is finally closed after transition to operations. The JAMs also keep the ACVSTs abreast of significant developments within the JPSS ground project.

The AMP group has three means to resolve data product performance issues:

- Look-up table (LUT) changes
- Processing Coefficient Table (PCT) changes
- Algorithm changes

Once the solution to the problem is devised, an algorithm change proposal is generated and submitted to JPSS Data Product Engineering and Support (DPES) for implementation.

6.5.5.1.3 Operational Implementation of New Solutions

Algorithm change proposals (Algorithm code, Lookup Tables or PCTs) are verified for completeness and DPES determines the scope of testing needed based on the updates proposed, after which the change proposal is passed to the Algorithm Integration & Transition Team (AIT) to ensure it performs as intended with the operational system. The AIT will supplement the change proposal with additional test cases and exercise the draft algorithm change package to ensure it resolves the science issue and does not introduce new issues into the system. The G-ADA is used to test the package. Once approved, the algorithm change package is passed to the CGS contractor to operationalize the code, as needed. This testing again verifies performance of the update, as well as examining the implementation aspects, such as latency, to ensure algorithm performance. Any identified problems during G-ADA testing of code will pass it back to its originator for resolution

Table updates are also tested in G-ADA. Identified problems will be passed back to the originator for resolution.

Once a change package is approved by the AIT and the JPSS Ground Project CCB for implementation, it is passed to the CGS contractor to fold into the release schedule.

Once implemented, the MOT will place any new baseline ground tables on the MSD server. The MSD system will then have the responsibility for ensuring the Common CM has a copy of those tables. The MSD system will provide a means for people to determine the currently operating tables. Historic tables will be maintained within the Common CM system.

6.5.5.2 Primary Interfaces

The primary interfaces for Algorithm Development and Maintenance is in Figure 6.5.5-2. This includes both external interfaces and inter-system interfaces within the Ground System. Table 6.5.5-1 identifies the types of interface, actors, purpose, types of data, exchange method and frequency, and Table 6.5.5-2 identifies the relevant IRDs/ICDs.

An outside interface is a flow between two external entities.

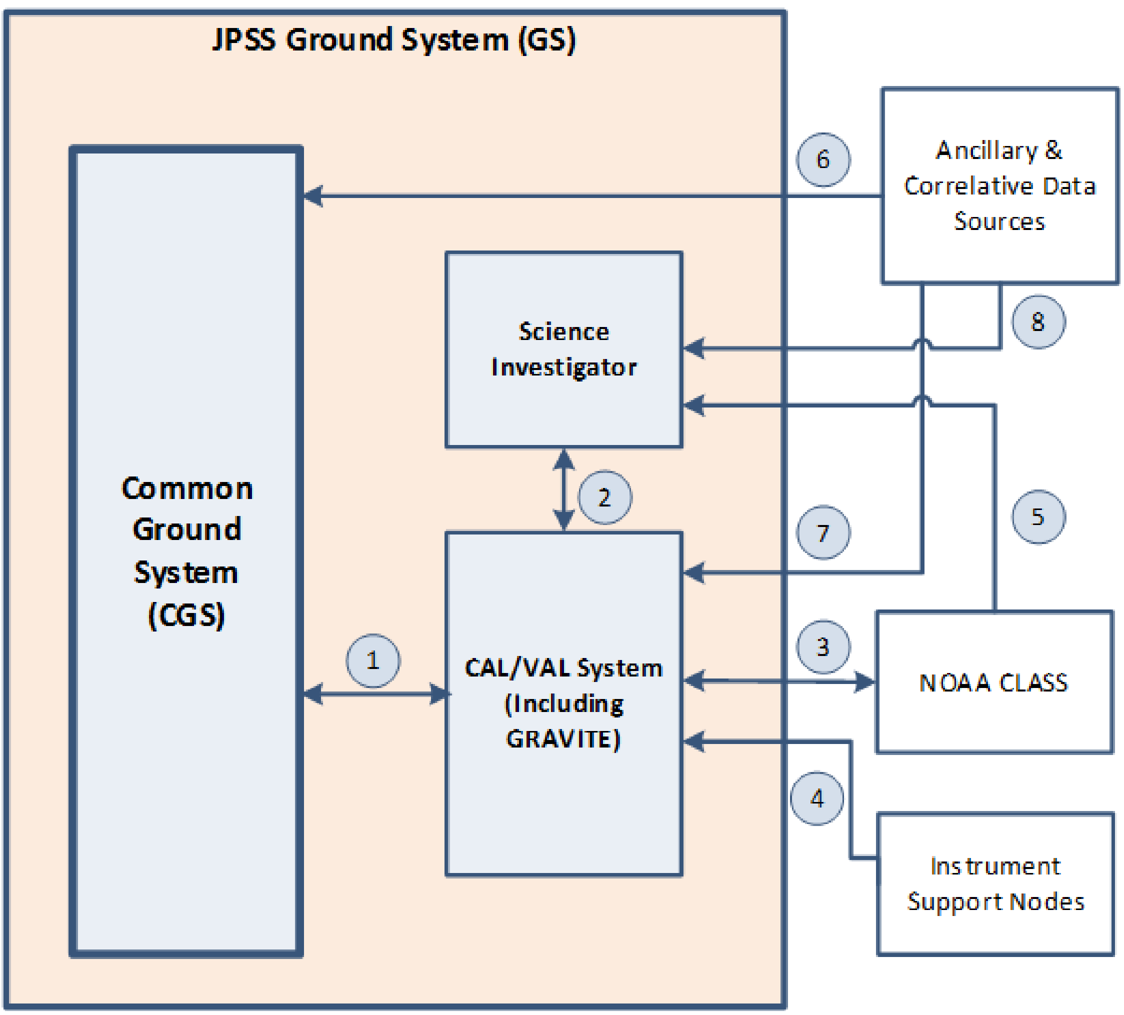


Figure: 6.5.5-2 Algorithm Development & Maintenance Primary Interfaces

Table: 6.5.5-1 Algorithm Development & Maintenance Primary Interfaces

No.	Type	Actors	Purpose
1	Internal	GRAVITE, CGS	Data Products, Algorithm & ASF updates
2	Internal, External	GRAVITE, Science Investigator	Data Products, Product Generation Executables (PGEs), Correlative Truth Data, ADRs, Validation Findings, Algorithm Code, ASFs
3	External	GRAVITE, CLASS	Validation Findings to be archived
3	External	CLASS to GRAVITE (through CLASS public interface)	Archived Data Products, Correlative Truth data
4	External	GRAVITE, Instrument Support Node	ADR for table updates
5	Outside	Science Investigator, CLASS	Archived Data Products, Correlative Truth data
6	External	Ancillary Data Sources to CGS	Ancillary data
7	External	Correlative truth data source to GRAVITE	Correlative Truth data
8	Outside	Ancillary Data Sources to Science Investigator	Correlative Truth Data and ancillary data

Table: 6.5.5-2 Algorithm Development & Maintenance Primary Interface Documentation

No.	IRD/ICD
1	JPSS CGS to GRAVITE IRD JPSS CGS to GRAVITE ICD
2	IPS User Manual? UG60822-IDP-035 IDPS ADA User Manual 474-00058 Joint Polar Satellite System (JPSS) Algorithm Change Management Plan 474-000429 GRAVITE to Services Interface Definition Document (IDD)
3	JPSS GS to CLASS IRD JPSS GRAVITE to CLASS ICD
4	JPSS Ground Project to Flight Project IRD JPSS GRAVITE to ATMS Support Node ICD JPSS GRAVITE to CrIS Support Node ICD JPSS GRAVITE to OMPS Support Node ICD JPSS GRAVITE to VIIRS Support Node ICD
5	Outside interface
6	JPSS GS to NOAA/NESDIS ESPC IRD
7	Public interfaces used
8	Outside interface

6.5.5.3 Assumptions & Constraints

- CLASS and other sources have available correlative truth data.
- Science Investigator roles have been determined and funded.

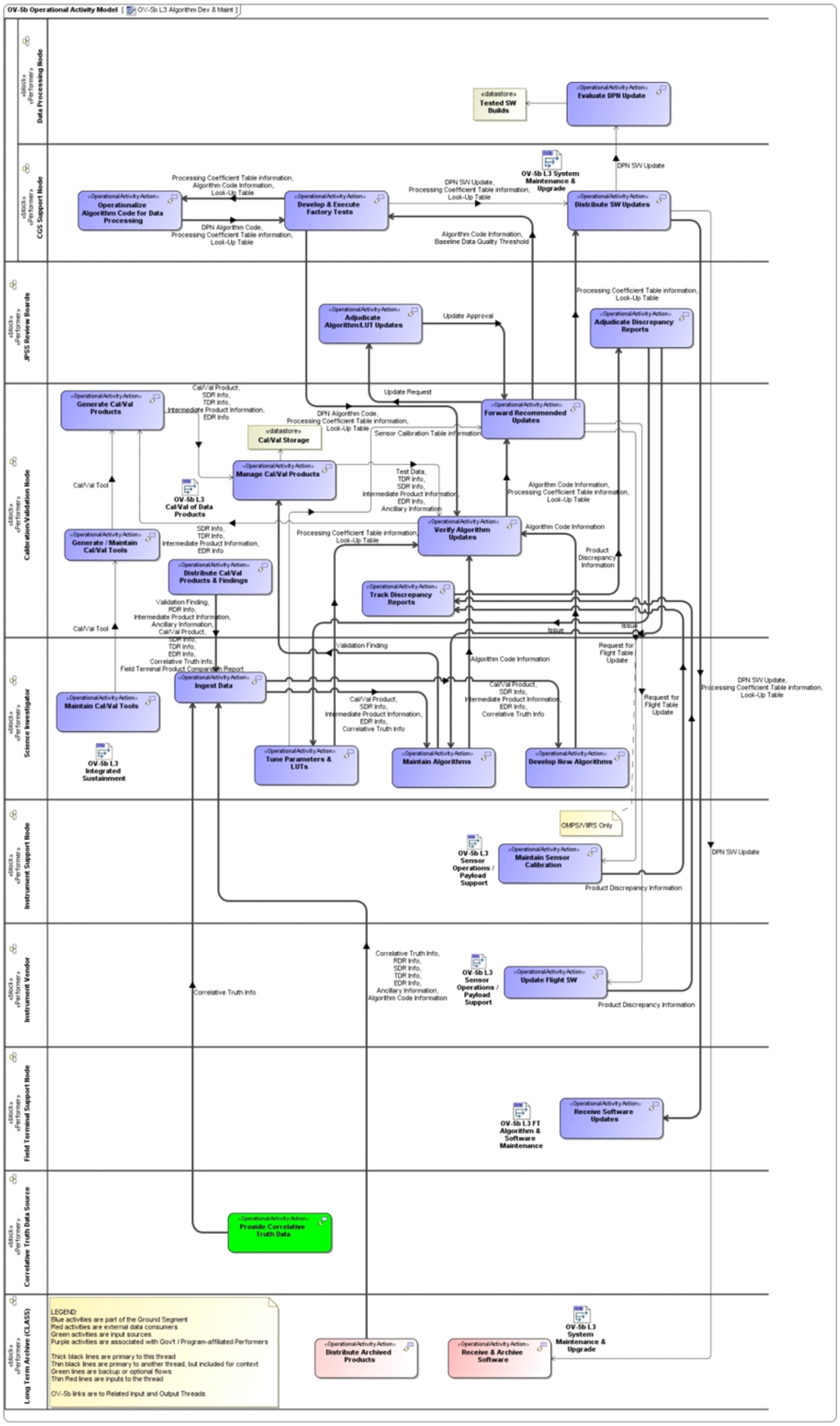
- The CGS is capable of delivering all RDR, TDR, SDR, EDR, or IP to GRAVITE.

6.5.5.4 Pre-Conditions

- An initial set of algorithms exists within the system.

6.5.5.5 Operational Flow

The operational flow for Algorithm Development & Maintenance is illustrated in Figure 6.5.5-3. This diagram is an OV-5b view that ties this thread into the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.5.5-3 Algorithm Development & Maintenance Operational Flow Diagram

Figure 6.5.5-4 illustrates the time-ordered activity sequencing within the OV-6c Operational Event Trace Description diagram for the thread. The details for steps 11+ of the figure are described in the System Maintenance and Upgrade thread. This documents the full process. There are decision points that can short-cut the process. If the change is just a table update for which the AERB has already approved an expedited process, the DRAT will directly forward the table for implementation upon its approval of the ADR. In some cases, the DRAT may decide the CGS Support Node should perform some factory-level testing on the change before fielding to operations.

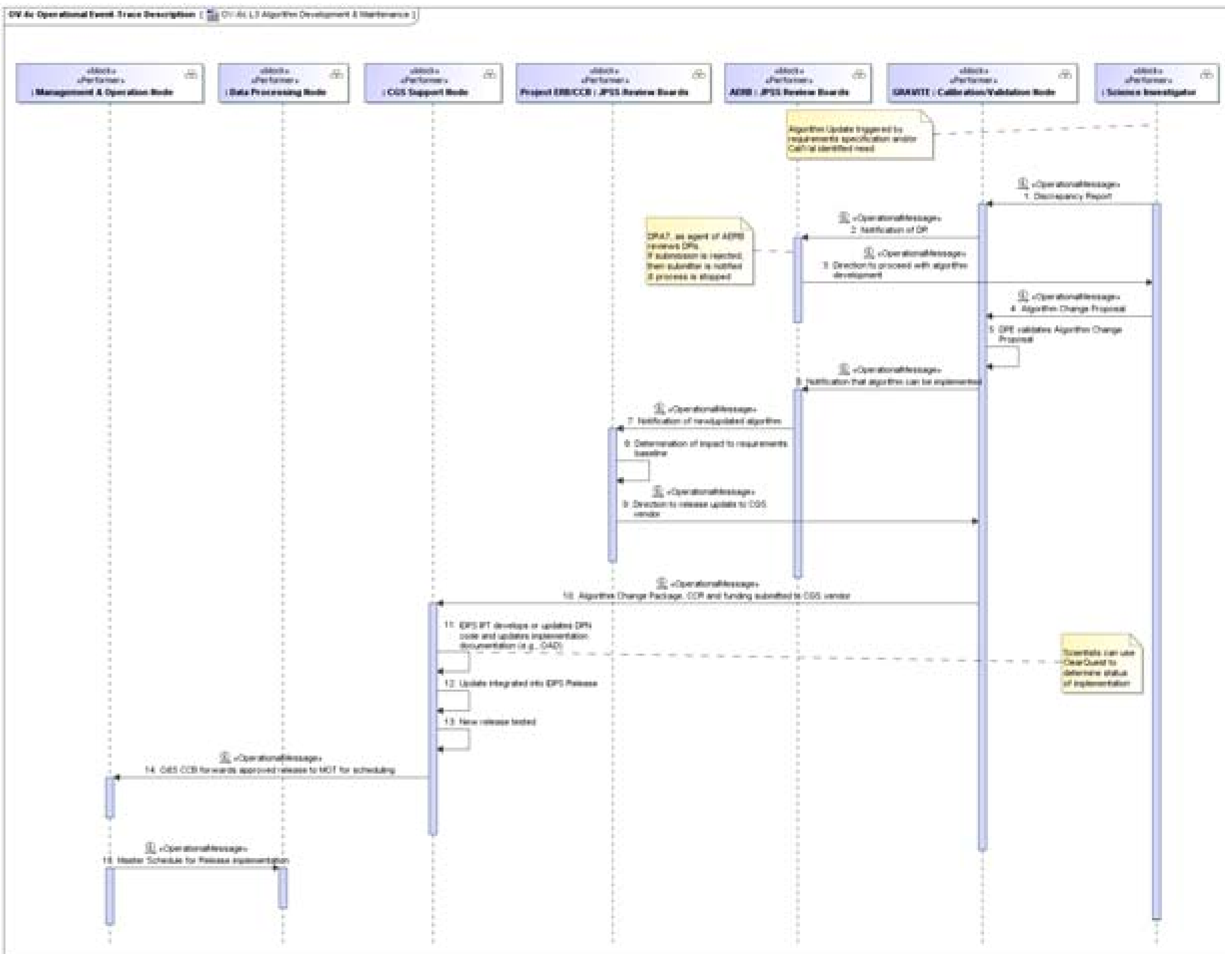


Figure: 6.5.5-4 OV-6c Algorithm Development & Maintenance Operational Event Trace Description Diagram

6.5.5.6 Basic Flow

Table 6.5.5-3 lists a flow of actions performed by the algorithm development and maintenance activities for normal data flow. Table 6.5.5-4 lists the alternate flows associated with the development and maintenance activities associated with ASF updates. Table 6.5.5-5 lists the flow of actions associated with the verification of the algorithm and ASF updates.

Table: 6.5.5-3 Algorithm Development & Maintenance Basic Flow

No.	Actors	Actions	Notes
1	Science Investigators	The SI Maintain Algorithms activity receives issues and related information from the DRAT. Alternately, the Science Investigators may determine the need to improve or generate new algorithms.	The issues are generated in the Cal/Val of Data Products thread.
2	Science Investigators, Cal/Val Node	The SI Maintain Algorithms activity, if DRAT-initiated, or the SI Develop New Algorithms activity, if self-initiated, will make data requests of the Cal/Val Node (GRAVITE) if additional historic or correlative data is required. The scientists may also acquire external data sources, as needed.	
3	Science Investigators, Cal/Val Node	The SI Ingest Data activity will collect the necessary data needed from the CAL Distribute Cal/Val Products & Findings activity and forward to the SI Maintain Algorithms/Develop New Algorithms activity	
4	Science Investigators, Cal/Val Node	The SI Maintain Algorithms/Develop New Algorithms activity updates the ADR as appropriate to the CAL Track Discrepancy Reports activity.	
5	Science Investigators, Cal/Val Node	The Cal/Val tools are maintained as part of the SI Maintain Cal/Val Tools activity and forwarded to the CAL Generate Cal/Val Products activity for execution.	
6	Cal/Val Node	The CAL Schedule Cal/Val PGEs activity is data-driven. A configuration is developed for the Investigator Processing System (IPS) within the CAL Generate Cal/Val Products activity that correlates the availability of particular products with executable PGEs as well as defining where the output is stored or forwarded. This configuration prioritizes the various needs for cal/val products versus the available processing capability and data available. This may trigger a reiteration of Step 3 to distribute the updated products to the science investigators.	
7	Science Investigators, Cal/Val Node	After reaching major maturity milestones, the Science Investigator will document the validation findings in a container which is sent to the CAL Ingest Data activity for archival and distribution.	

No.	Actors	Actions	Notes
8	Science Investigators, Cal/Val Node	Upon completion of the analysis, the Science Investigator sends the algorithm code updates to the CAL Verify Algorithm Updates activity for verification and subsequent implementation. The flow picks up at step 11 in Table 6.5.5-5.	

Table: 6.5.5-4 ADM Algorithm Support Function (ASF) Update Flow

No.	Actors	Actions	Notes
9	Science Investigators	The SI Tune Parameters & LUT activity receives an issue to be resolved and related information from the DRAT. This will trigger an analysis to determine the appropriate table or parameter update. Alternately, the generation of some ASF parameters/tables is scheduled to provide periodic updates to the data processing operations.	
10	Science Investigators, Cal/Val Node	Upon completion of the analysis, the Science Investigator proposes the ADR be resolved, as appropriate. The Science Investigator sends the ASF updates to the CAL Verify Algorithm Updates activity for verification and subsequent implementation. The flow picks up at step 11 in Table 6.5.5-5.	

Table: 6.5.5-5 Cal/Val Update Verification Flow

No.	Actors	Actions	Notes
11	Cal/Val Node	The AIT will use the CAL Verify Algorithm Updates activity to verify proposed updates to determine they perform as expected and cause no other issues with the system. The G-ADA (or other offline IDPS implementation) executes the proposed table and/or algorithm updates within the operational data processing code base.	
12	Cal/Val Node, JPSS Review Boards	When there are new or modified algorithm products proposed for inclusion within the system, the JRB Adjudicate Algorithm/LUT Updates activity receives requests for updates & AIT test results and determines whether to proceed with the change. If additional funding is required to implement the change, the Ground CCB will need to approve the change.	

No.	Actors	Actions	Notes
13	Cal/Val Node	Upon approval, the change is forwarded for implementation.	
13a	Cal/Val Node, CGS Support Node	For changes requiring development and/or further test, the Configuration Change Request (including relevant documentation updates) and algorithm change package (including proposed code updates, reference G-ADA output and necessary test cases for verification) is distributed to the CGS Support Node via the CAL Forward Recommended Updates activity.	
13b	Cal/Val Node, CGS Support Node, Instrument Support Node	The table updates are distributed to the Common CM system within the Common Ground System Support Node. The CAL Forward Recommended Updates activity can then notify the relevant Instrument Support Node(s) and the CGS Manage Flight SW activity of the availability of the tables from Common CM. Skip to step 16.	
14	CGS	If necessary, the CGS Operationalize Algorithm Code for Data Processing activity will operationalize and/or harden the algorithm code. This may include adding quality flags and implementation details needed for a production system. The CGS Develop & Execute Factory Tests activity will then perform factory testing to ensure proper operation of the code. This testing will incorporate the same test data used by AIT in the G-ADA and is identified in the change package pushed to the Common CM function. DPES and AMP will utilize the Common CM to monitor the progress with the implementation of the change.	
15	Cal/Val Node, CGS	Given review board approval, the CGS Distribute SW Updates activity will make algorithm code available for fielding at the site(s).	The details of how the build is scheduled are part of the System Maintenance & Upgrade thread.
16	Reserved		
17	Cal/Val Node, Instrument Support Node	Given review board approval, the CAL Forward Recommended Updates activity may, when necessary, request proposed sensor table updates to the ISN Maintain Sensor Calibration activity at the relevant instrument support node for generation of a new instrument flight load. The table will be	The details of what is done with the instrument tables are described in the Sensor Operations / Payload Support thread.

No.	Actors	Actions	Notes
		sent to the Instrument Science Team or Instrument Vendor depending on who has control of the particular table of interest. Similarly, if the ISN or vendor determines the need to update a paired table, they will submit an ADR to trigger the generation of the ground table as described earlier in the ConOps.	
18	Cal/Val Node	The CAL Distribute Cal/Val Products & Findings activity sends Validation Findings to CLASS for long-term archival storage.	The CGS Support Node is responsible for code and table archival in CLASS storage per the System Maintenance & Update thread.

6.5.5.7 Fast Track Alternate Flow

For certain table updates where the impacts are well understood and will be made routinely, such as VIIRS F and H tables, there is an expedited process to field the change. Once the ADR is accepted and the tables are generated, the tables are checked on the G-ADA via DPES and then forwarded to the AERB for approval. Once approved, then an Operations Work Request is generated and the tables are passed to the MOT for implementation.

For other urgent changes needed, AMP can make a call to bypass the DPES testing and forward a change directly to an out-of-board AERB chair review. These changes must be limited in scope or so critical as to not further endanger the operations of the ground system to justify the lack of testing before forwarding to the CGS contractor for implementation. This type of change would be covered by step 13a above.

6.5.5.8 Paired Tables Alternate Flow

Certain instrument tables are paired with ground tables for proper operation of the system. Coordination between the flight operations group uploading the instrument tables and the data operations group loading the ground tables is necessary for proper data processing. The Algorithm ERB oversees these updates. The Flight Software Upgrade thread discusses this operation. The Flight Software and Tables Update Delivery Process (FUDP), 474-00098, documents the process.

6.5.5.9 Post Condition

A new or enhanced algorithm and/or a revised LUT and PCT table is fielded in the operational data processing system.

6.5.5.10 Related Threads

Provide a list of threads that area related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-070	Flight Software Upgrade

Thread ID	Thread Title
GS-NML-150	Cal/Val of Data Products
GS-MAD-400	Launch and Early Orbit
GS-NML-500	Sensor Operations/Payload Support
GS-NNL-140	System Maintenance & Upgrade
GS-FTS-110	Field Terminal User Support

6.5.5.11 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-040-050	Algorithm Development
474-00104	JPSS GRAVITE Operations Concept
474-00058	JPSS Algorithm Change Management Plan
474-00150	JPSS Algorithm Change Management Plan Technical Supplement
474-00098	Flight Software and Tables Update Delivery Process (FUDP)
CL60917-O&S-001	O&S Approval Authority for Operational Products

6.6 Data Products Calibration and Validation

6.6.1 Calibration and Validation of Data Products

6.6.1.1 Description

6.6.1.1.1 Introduction

The Calibration and Validation of Data Products (GS-NML-150) thread provides a high level description of ground system operations to maintain calibration and validate environmental data products. The goal of Calibration and Validation (Cal/Val) operations is to establish and maintain the performance of these data products to the level specified in the JPSS Ground System Requirements Document. This thread applies to all JPSS missions for which the ground system processes mission data and produces data products beyond the RDR level, including JPSS-managed satellites such as S-NPP, JPSS-1, and JPSS-2/3/4.

The Cal/Val operations begin in the prelaunch phase and last through the entire operational life-span of the JPSS satellites. For each product in a new mission, the Cal/Val operations evolve in four phases: Pre-launch (PL), Early Orbit Checkout (EOC), Intensive Cal/Val (ICV) and Long Term Monitoring (LTM), as illustrated in Figure 6.6.1-1. During the PL phase, which occurs throughout integration and test of the spacecraft, the focus on Cal/Val operations is to characterize instrument performance, as well as preliminary calibration of the instruments. During the EOC phase, which starts after instrument activation and initialization, the focus of Cal/Val operations is to verify basic instrument functionality. During the ICV phase, which starts after EOC, the focus of Cal/Val operations is to bring the product performance up to the required level. As each product is deemed validated, it transitions into the LTM phase where the focus is to maintain the product performance within the specification throughout the mission life. Each product matures based on specific activities and schedule laid out in documented Cal/Val

plans. For S-NPP, the LTM phase is tentatively planned to begin at L+18 months, while for JPSS-1/2/3/4 missions, the LTM is expected to start in much shorter timeframe.

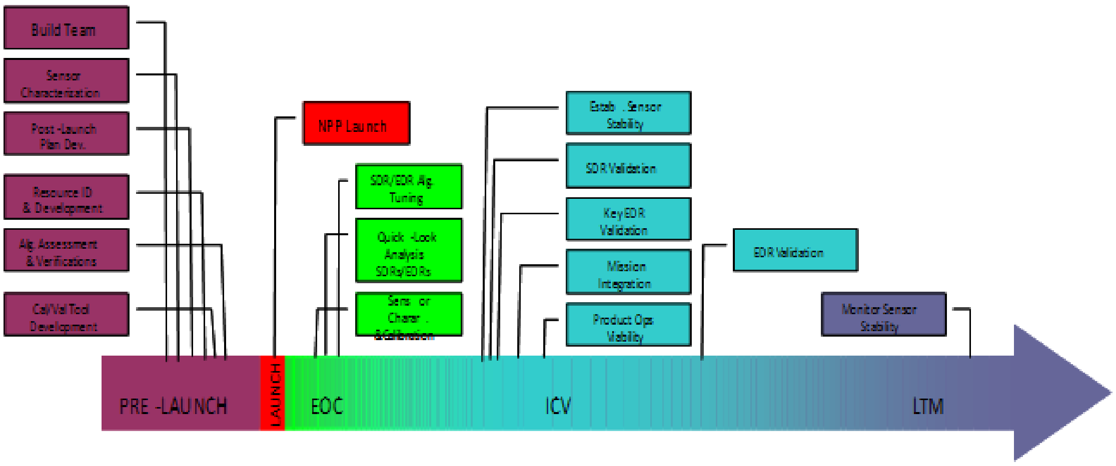


Figure: 6.6.1-1 Calibration / Validation Phases

The purpose of the ICV phase is to mature the data products. The product maturation starts with the SDRs and moves to the EDRs. The product maturity transitions from Beta to Provisional to Validated, and in the case of EDRs, Validated status is broken down into stages 1, 2, and 3. Beta is an early release product with initial calibration applied, minimally validated and may still contain significant errors (rapid changes can be expected. Version changes will not be identified as errors are corrected, as the on-orbit baseline is not established). Products are available to allow users to gain familiarity with data formats and parameters. The data product is not appropriate as the basis for demonstration of requirements or quantitative scientific publications studies and applications.

At the Provisional stage, product quality may still not be optimal. Incremental product improvements are still occurring as calibration parameters are adjusted with sensor on-orbit characterization (versions will be tracked). The general research community is encouraged to participate in the quality assurance (QA) and validation of the product, but need to be aware that product validation and QA are ongoing. Users are urged to contact the NOAA JPSS Office (NJO) Algorithm Management Project (AMP) / Cal/Val Team representatives prior to use of the data in publications. Products (EDR, IP) may be replaced in the CLASS archive storage when the validated product becomes available, but that function is the responsibility of NCDC and outside the scope of JPSS.

Validated is when the on-orbit sensor performance is characterized and the calibration parameters are adjusted accordingly in the SDR. For EDRs, the product uncertainties are well defined over a range of representative conditions. Validated EDR products are ready for use by the operational users and in scientific publications. There may be later improved versions, which will have strong version control with documentation of all changes. For EDRs, this phase is further broken down into three validation stages:

> Stage 1 Validation: Product accuracy has been estimated using a small number of independent measurements obtained from selected locations and time periods and correlative-truth/field program effort.

Stage 2 Validation: Product accuracy has been assessed over a widely distributed set of locations and time periods via several correlative-truth and validation efforts.

Stage 3 Validation: Product accuracy has been assessed and the uncertainties in the product well established via independent measurements in a systematic and statistically robust way representing global conditions.

Once a product is validated, the main activities involved in the Cal/Val operations include the following iterative steps, which will be discussed in details later in this section.

- Continuous monitoring of product quality and early detection of anomalies;
- Investigation of anomalies;
- Formulation of solutions for quality deficiencies;
- Operational implementation of corrective solutions.

The last two bullets are described in the Algorithm Development and Maintenance (ADM) thread.

The JPSS Ground Project, Data Products and Algorithm branch, supported by Algorithm and Cal/Val teams led by scientists from the NOAA Center for Satellite Applications and Research (STAR), is responsible for the planning and execution of the Cal/Val operations. Section 6.6.1.1.4 provides an overview of Cal/Val organization, along with its roles and responsibilities. Detailed information on the planning, coordination and management processes can be found in the S-NPP and JPSS Community Collaborative Calibration/Validation Plans and NPOESS Community Collaborative Calibration/Validation Plan for the NPOESS Preparatory Project Overview (I30001).

The Cal/Val operations require a computing infrastructure that includes a large data repository, associated data management, and competent processing resources. Known as the Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE), this infrastructure is developed by the government and used to support JPSS Cal/Val operations and Algorithm development. Section 6.6.1.1.5 provides a brief overview of GRAVITE. Supporting organizations outside the JPSS Program also have additional computing infrastructures referred to as Local Computing Facilities (LCF).

In addition to the ADM thread, there are several other threads that provide context or support to the Cal/Val operations. The SMD Handling thread illustrates product generation. The MSD thread illustrates the generation and distribution of mission notices, which convey communication from mission operations and data processing regarding the state of the spacecraft and data products. The FSW Upgrade thread discusses the maintenance of flight tables and paired ground tables, some updates are generated by this thread. The DQA thread overviews near real-time quality monitoring of data products. The SOAP thread discusses the sensor operations and calibration. The Integrated Support thread illustrates the enterprise view of system maintenance and operations. The Launch and Early Orbit thread discusses the activities associated with launch, instrument activation and checkout.

6.6.1.1.2 Continuous Monitoring of Product Quality

The JPSS Ground System has 3 levels of data product quality monitoring as is illustrated in Figure 6.6.1-2. The DQA function within the CGS provides operational monitoring of the products. The Data Quality Support Team (DQST) in Riverdale, MD receives a copy of raw products as well as any product flagged by the DQA function for further investigation and provides triage of the quality flag related parameters. The interaction of DQA and the DQST are covered in the Data Quality Assurance thread. The DQST investigates issues raised by the DQA function and escalates those issues that require configuration or algorithm changes to AMP. The DQST also performs product comparisons to identify quality issues in the operational products. The DQST acts as the intermediary between the operational DQA function and the detailed science investigation. Long term monitoring is provided by NOAA STAR and other members of the Algorithm & Cal/Val Science Teams through AMP. They provide more detailed analysis of product quality as well as calibration of the algorithms.

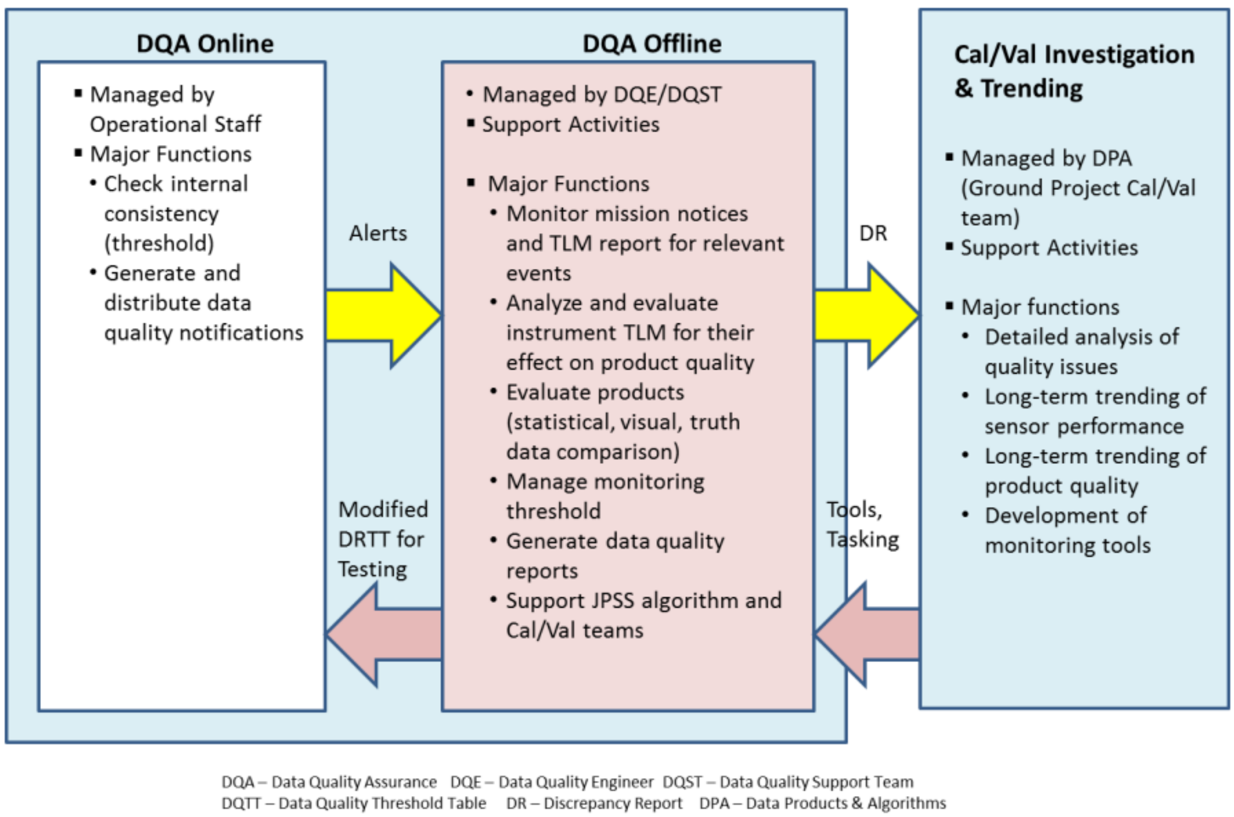


Figure: 6.6.1-2 Data Quality Assurance Phases

There are a variety of players who identify potential data product anomalies for JPSS. This could be the sensor operations team, the Data Quality Engineer (DQE)/DQA, the DQST, the data consumers (e.g., NWS), or science investigators. The conduct of the sensor operations team is discussed in the Sensor Operations / Payload Support thread. The conduct and interaction of the DQE/DQA and DQST are covered in the Data Quality Assurance thread. When necessary, the DQST will file algorithm deficiency reports (DRs) to escalate product issues to AMP. The consumers of the data products may also file algorithm DRs that are evaluated by the Discrepancy Report Action Team (DRAT), which may lead to anomaly investigation. Science

investigators who are supporting Cal/Val or conducting algorithm development may also file a DR for potential issues with products.

The Cal/Val system performs four types of explorations to monitor data product performance and identify anomalous behavior:

- Evaluate and Improve Geolocation Accuracy
- Evaluate Instrument Calibration Systems
- Evaluate and Improve Instrument/Algorithm Performance
- Trend Product Performance and Telemetry

Evaluation of geolocation accuracy is an on-going function throughout the phases of Cal/Val. During EOC and ICV, the baseline accuracy on-orbit will be determined, including characterizing how long it takes to stabilize following spacecraft maneuvering. Improvements to geolocation accuracy will be accomplished by making adjustments to geolocation algorithms processed in the CGS. During LTM, this phase is more about monitoring the accuracy for anomalies and for notifying the operations group post-maneuver that products are back within specified operating parameters.

Evaluation of instrument calibration systems is to verify that any on-board calibration system within an instrument is performing as desired. The EOC and ICV phases will characterize the performance of the on-board calibration systems in various planned events, as well as nominal orbital operations. During LTM, this becomes a maintenance task to determine if any updates are needed to keep the calibration system performing as intended.

Evaluation of instrument/algorithm performance involves comparing the data products with correlative truth data and other methods to determine the algorithms and instruments are performing as desired. Algorithm performance will be improved through implementation of algorithm changes in response to discrepancies. Evaluation of formatting and functionality is included here primarily performed in the EOC phase of a product. This is when the format of the products and range checking of values is performed.

6.6.1.1.3 Investigation of Anomalies

The Algorithm and Cal/Val Science Teams, staffed with science investigators, will identify and investigate potential anomalies in algorithm performance. The investigators can utilize the ICF within GRAVITE and/or their own LCF to perform the analyses. Golden Data Sets that provide data that is well characterized, either as nominal performance, or specific aberrant cases, will be maintained by the JPSS Data Product Engineering and Support (DPES) on GRAVITE, as well as by science investigators in their LCFs. Related correlative truth data around the test sets may also be maintained. GRAVITE will maintain a 34 day store of JPSS data products, including IPs, RDRs, SDRs, TDRs, and EDRs. If older products are needed to support the analysis, CLASS can be accessed, either directly or via GRAVITE.

6.6.1.1.4 Organization, Roles and Responsibilities of Cal/Val Participants

A Science Investigator is any science user of JPSS-provided data. This includes the Algorithm Management Project (AMP) group under NJO, the Algorithm and Calibration/Validation

Science Teams (ACVST), the Instrument Science Teams (IST) and the end users of the data products. The AMP group manages the Cal/Val activities for JPSS data processing. The AMP group funds the ACVSTs who provide subject matter expertise for the algorithm science. The ISTs help the flight project maintain science performance of the satellite instruments.

The Cal/Val organization includes ACVSTs for each discipline. These disciplines are broken down into Sensor Data Record (SDR) teams and Environmental Data Record (EDR) teams. These teams are tasked out of the NJO AMP for purposes of Cal/Val and Algorithm Development. The SDR teams deal with the check out and validation of the SDR products and characterization of the sensor. The EDR Teams are responsible for the validation and maintenance of the EDRs, along with the development of any new products, which is covered by the ADM thread. NOAA STAR provides technical expertise and management for the ACVSTs. The science community consisting of supporting research organizations, universities, and interested government entities participate with these teams as well.

As a sister organization, the JPSS DPES provides the Algorithm Integration & Testing Team (AIT). The AIT is responsible for the validation of changes to algorithms and the verification of algorithm implementations before being integrated into the operational data processing system.

JPSS DPES also manages the Data Quality Support Team (DQST) which acts as an interface between the operational Data Quality Engineers and the ACVSTs. The DQST is a CGS contractor-provided group out of Riverdale, MD to support the DQA function within the DPN. While the DQE is the operational component of data quality oversight providing identification of potential issues, the DQST provides the triaging of issues. They perform offline functions that allow time to more deeply investigate issues to determine if the system acted as expected, or if there is an issue that needs rectifying. The DQST receives the notifications from the DQE and performs investigations to determine if there is a problem that needs the attention of the ACVSTs. They may also forward implementation problems directly to the CGS contractor for remediation. The DQST is responsible for the generation of the Data Quality Reports. They also provide operations and implementation support to the ACVSTs, as needed.

The NJO AMP, DPES and IDPS organizations operate a Discrepancy Report Action Team (DRAT), whose job is to adjudicate proposed Algorithm Discrepancy Reports (ADRs) and determine necessary actions.

The NASA Atmospheric Sciences Data Center (ASDC) at Langley Research Center (LaRC) supplies the Cal/Val function for the CERES/RBI instrument products. The Ozone PEATE of the SDS also provides Cal/Val functions for the OMPS Limb Profiler (LP) instrument, in addition to its data processing role.

NOAA’s Satellite Products and Services Review Board (SPSRB) adjudicates which products are qualified as NOAA operational products. After JPSS-1/2/3/4 go operational, this board will determine which satellite’s product will be used for the official data products. The JPSS Cal/Val effort will make recommendations as quality changes whereby an alternate source may be recommended to be used as the official product.

6.6.1.1.5 The Cal/Val Data Management and Processing Resources

The JPSS Ground System provides a number of assets to support Cal/Val Data Management as well as utilizing NOAA capabilities and processing centers of the science community. The Government Resource for Algorithm Verification, Independent Testing, and Evaluation (GRAVITE) is a part of the JPSS Ground System which provides the JPSS Program with a technical infrastructure to conduct Calibration and Validation (Cal/Val). GRAVITE supports the following functions:

- Provision of a technical infrastructure to support sensor calibration and product validation activities as directed by the discipline science teams.
- Provision of a technical infrastructure to support collection and analysis of pre-launch instrument characterization data.
- Production of Algorithm Support Function (ASF) artifacts such as Look-Up Tables (LUTs) or Parameter Coefficient Files (PCF) required to maintain the operational precision and accuracy of CGS Algorithm software.
- Test platform for verification of proposed enhancements to Algorithm or Algorithm Support artifacts and regression testing.
- Technical infrastructure to support Algorithm software development, verification and software delivery to the CGS.
- Distribution of JPSS mission data, correlative data, and Product Generation Executable (PGE) outputs to the Algorithm and Cal/Val teams.

GRAVITE is composed of three primary elements, the Investigator Processing System (IPS), the GRAVITE Algorithm Development Area (G-ADA), and the Investigator Computing Facility (ICF).

IPS is a sub-system of GRAVITE responsible for production of Algorithm Support Function (ASF) products and Cal/Val support products using "product generation executables". The PGEs are automated tool scripts to generate matchup and intermediate products needed to support ASF maintenance and to perform calibration or validation functions of the product algorithms. The IPS also plays the role of a data server to the Algorithm and Cal/Val teams through its web portal, both for JPSS mission data and PGE outputs. The GRAVITE Algorithm Development Area (G-ADA) is an offline instantiation of the CGS data processing chain using the actual hardware available to CGS. This allows for high fidelity test of algorithm and ASF updates. The Investigator Computing Facility (ICF) is a general-purpose computing facility to enable on-site and off-site science investigators to perform analyses of the data products and PGE outputs. The ICF is also a data server for the ACVSTs.

Off-site science investigators may also use their own Local Computing Facility (LCF) for their general-purpose processing needs.

The science investigators have access to the CGS data processing software configuration management system to assist in maintaining the algorithm code and to be able to understand the status of proposed updates within the system implementation.

Science investigation requires access to historic and correlative data. GRAVITE will maintain a 34-day store of JPSS data products that it has received or locally generated. Additional products

can be ordered from the NOAA/NCDC CLASS data archive. If needed, correlative data may be acquired from other sources, such as the National Snow and Ice Data Center (NSIDC).

6.6.1.2 Primary Interfaces

The primary interfaces for Cal/Val of Data Products is in Figure 6.6.1-3. This includes both external interfaces and inter-system interfaces within the Ground System. Table 6.6.1-1 identifies the types of interface, actors, purpose, types of data, exchange method and frequency, and Table 6.6.1-2 identifies the relevant IRDs/ICDs.

An outside interface is the one between two external entities.

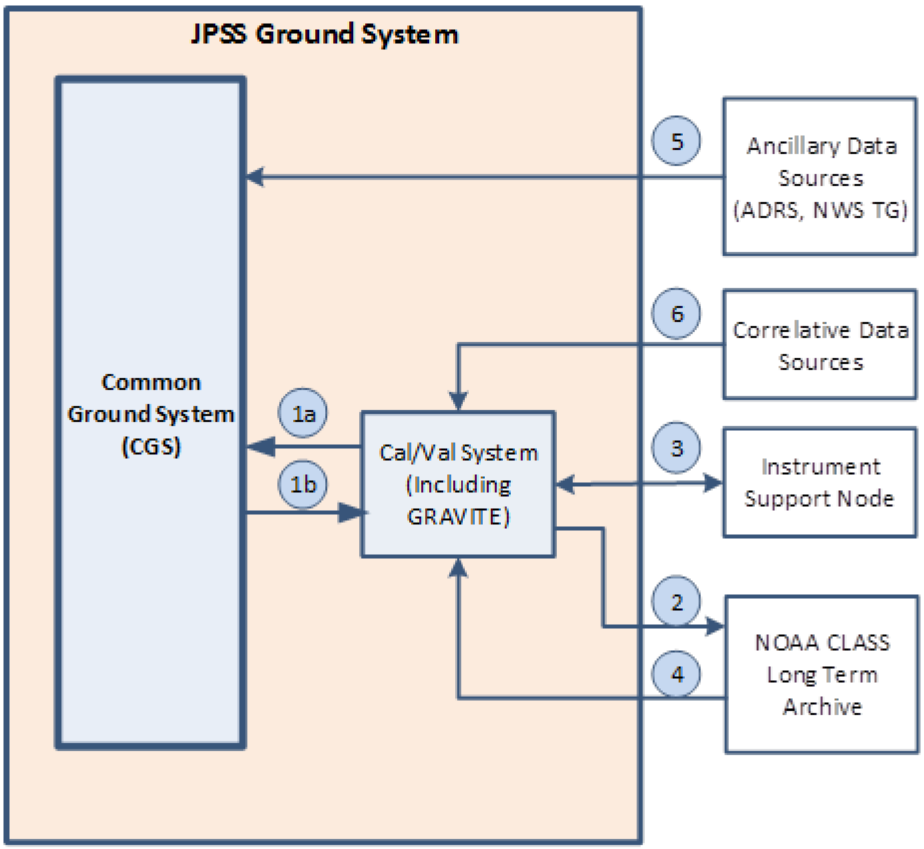


Figure: 6.6.1-3 Cal/Val of Data Products Primary Interfaces

Table: 6.6.1-1 Cal/Val of Data Products Primary Interfaces

No.	Type	Actors	Purpose
1a	Internal	GRAVITE > CGS	Algorithm & ASF updates
1b	Internal	CGS > GRAVITE	Data Products, Ancillary Data, Data Quality Notification (DQN)
2	External	GRAVITE, CLASS	Findings
3	External	GRAVITE, Instrument Support Node	Table Coordination, Algorithm DRs for table and algorithm updates, Pre-launch test data collection
4	External	GRAVITE, CLASS	Archived Data Products, Correlative Truth data, documentation, operational software, LUTs, PCs

No.	Type	Actors	Purpose
5	External	Ancillary Data Sources to CGS	Ancillary data
6	External	GRAVITE, Correlative Data source	Correlative Truth data

Table: 6.6.1-2 Cal/Val of Data Products Primary Interface Documentation

No.	IRD/ICD
1a, 1b	JPSS CGS to GRAVITE IRD JPSS CGS to GRAVITE ICD
2	JPSS GS to CLASS IRD JPSS GRAVITE to CLASS ICD
3	JPSS Ground Project to Flight Project Support Node IRD JPSS GRAVITE to ATMS Support Node ICD JPSS GRAVITE to CrIS Support Node ICD JPSS GRAVITE to OMPS Support Node ICD JPSS GRAVITE to VIIRS Support Node ICD
4	JPSS GS to CLASS IRD JPSS GRAVITE to CLASS ICD
5	JPSS GS to NESDIS/ESPC IRD JPSS CGS to ESPC/ADRS ICD
6	Public interfaces

6.6.1.3 Assumptions & Constraints

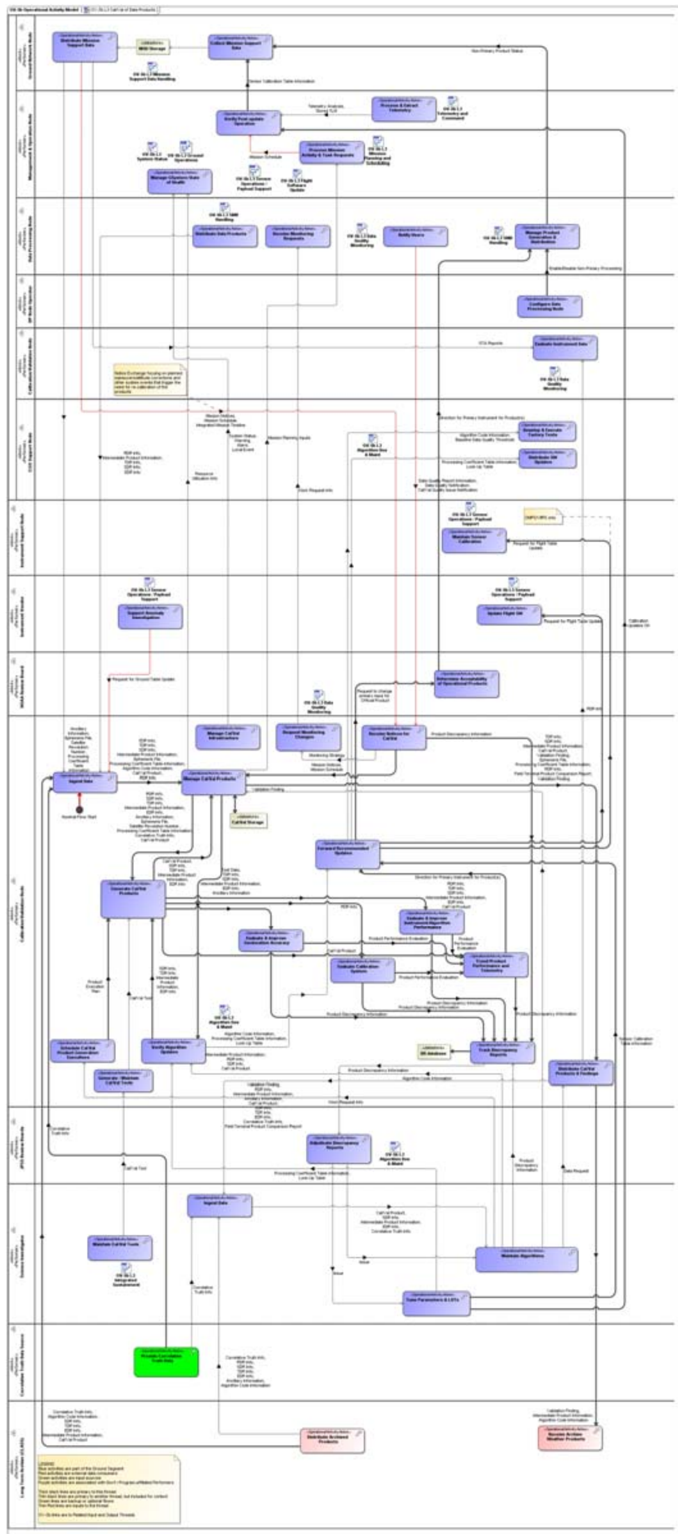
- Correlative truth data is available from its various sources. The CGS is capable of delivering any RDR, TDR, SDR, EDR or IP to GRAVITE
- LCFs are considered part of the Cal/Val Node and are used by the Science Investigators.

6.6.1.4 Pre-Conditions

- DQA has provided relevant Cal/Val notifications
- MSD has distributed the Mission Schedule and Mission Notices indicating spacecraft outages or planned/on-going/completed maneuvers.
- GRAVITE standing subscriptions to CGS have been entered by DQE.
- PGEs are available to support current Cal/Val and ASF maintenance needs

6.6.1.5 Operational Flow

The operational flow for Cal/Val of Data Products is illustrated in Figure 6.6.1-4. This diagram is an OV-5b view that ties this thread into the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.6.1-4 Cal/Val of Data Products Operational Flow Diagram

6.6.1.6 Basic Flow

Table 6.6.1-3 lists a flow of actions performed by the Cal/Val of data products activities for normal data flow. Although they are organized as though you were going through the process once, each of these parts may be performed as needed to update information or respond to system needs. The flow describes the variations applicable during the different phases of Cal/Val.

Table 6.6.1-4 continues the flow for when a problem is identified. The Algorithm Development and Maintenance thread describes how the updates are generated and verified for implementation.

Table: 6.6.1-3 Cal/Val of Data Products Basic Flow

No.	Actors	Actions	Notes
1	CGS to Cal/Val Node	The CGS Distribute Data Products activity sends RDRs, TDRs, SDRs, EDRs and IPs to the CAL Ingest Data activity. As needed, GRAVITE can order additional products on an Ad Hoc basis, within the limitations of the bandwidth available to CGS.	
2	CGS to Cal/Val Node	The CGS Distribute Mission Support Data activity makes Ancillary weather data, spacecraft ephemeris data, satellite revolution number, Lookup Tables and Processing Coefficient Tables in use available to the CAL Ingest Data activity.	
3	CLASS to Cal/Val Node	The CAL Ingest Data activity acquires archived data products and support data as well as correlative truth data as needed from the LTA Distribute Archived Products activity.	CLASS data is pulled regularly based on scheduled PGEs and scientist requests. Other data is pulled as requested.
4	Cal/Val Node	The CAL Manage Cal/Val Products activity will store input data for 34 days nominally. Particular data sets may be identified as particularly useful for anomaly investigation or baselining updates and will be kept for the life of the program.	
5	Cal/Val Node	The CAL Generate Cal/Val Products activity executes the configured PGEs as the input data becomes available to generate Cal/Val products used for analysis by the science investigators. Some analysis may be as simple as recognizing flagged errors, and other analysis requires use of tools outside IPS and the ICF. Steps 6-9 describe the details of what is done with these products.	See the Algorithm Development and Maintenance thread for details on the configuration of PGEs This operation primarily runs on IPS and ICF of GRAVITE
6a	Cal/Val Node	The CAL Evaluate & Improve Geolocation Accuracy activity is an on-going function throughout the phases of cal/val. During EOC and ICV, the baseline accuracy on-orbit will be determined, including characterizing	

No.	Actors	Actions	Notes
		how long it takes to stabilize following spacecraft maneuvering. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
6b	Cal/Val Node	During LTM, the CAL Evaluate & Improve Geolocation Accuracy activity is more about monitoring the accuracy for anomalies and for notifying the operations group post-maneuver that products are back within specified operating parameters. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
7a	Cal/Val Node	The CAL Evaluate Calibration System activity verifies that any on-board calibration system within an instrument is performing as desired. The ICV phase will characterize the performance of the on-board calibration systems in various planned events, as well as nominal orbital operations. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
7b	Cal/Val Node	During LTM, the CAL Evaluate Calibration System activity becomes a maintenance task to determine if any updates are needed to keep the calibration system performing as intended. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
8a	Cal/Val Node	During EOC, the CAL Evaluate & Improve Instrument/Algorithm Performance activity involves comparing the data products with correlative truth data and other methods as an early look at the algorithm and instrument performance.	
8b	Cal/Val Node	During ICV, the CAL Evaluate & Improve Instrument/Algorithm Performance activity involves comparing the data products with correlative truth data and other methods to generate a baseline performance set for the algorithms and instruments. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
8c	Cal/Val Node	During LTM, the CAL Evaluate & Improve Instrument/Algorithm Performance activity involves comparing the data products with correlative truth data, historic performance and other methods to determine the algorithms and instruments are performing as desired. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
9a	Cal/Val Node	During EOC, the CAL Trend Product Performance and Telemetry examines the performance of the instrument	

No.	Actors	Actions	Notes
		over time to determine if the instrument is operating as expected. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
9b	Cal/Val Node	During ICV and LTM, the CAL Trend Product Performance and Telemetry activity will look for longer term changes in operations or performance of the instruments and/or algorithms. Any identified issues will generate a proposed Algorithm Discrepancy Report.	
10	Cal/Val Node	The CAL Distribute Cal/Val Products & Findings activity sends Cal/Val products and data to the science investigators.	

Table: 6.6.1-4 Algorithm Discrepancy Identification Flow

No.	Actors	Actions	Notes
11	Cal/Val Node	The CAL Receive Notices for Cal/Val activity gathers external issue reports and events potentially impacting Cal/Val activities to generate necessary Algorithm Discrepancy Reports.	The DQA thread documents its means of sending Cal/Val notifications to GRAVITE. The MPS thread documents how Mission Notices are generated, which include events of interest to Cal/Val.
12	Cal/Val Node	The CAL Track Discrepancy Reports activity manages the Algorithm Discrepancy Reports and supporting data.	
13	JPSS Review Boards	The JRB Adjudicate Discrepancy Reports activity has the DRAT accessing the DR database to classify the various submitted DRs and to determine whether or not action is needed to correct a problem with the algorithms or supporting look-up tables and processing coefficients. The DRAT may also determine that it is an implementation problem and refer the issue to the System Maintenance Upgrade thread for resolution. If further investigation is required, the appropriate individuals are identified and tasked. Proceed to Table 6.3.15-3 for algorithm updates and Table 6.3.15-4 for ASF updates.	The Algorithm Development and Maintenance thread handles the flows after the DRAT adjudicates the ADR (see below). Alternately, the System Maintenance Upgrade thread covers implementation issues. Note: The algorithm discrepancy report (ADR) is a means to track the change as it proceeds through the system from concept, to realization, to test, to approval, to

No.	Actors	Actions	Notes
			implementation, to fielding.

6.6.1.7 Alternate Flow

6.6.1.7.1 Post Update Operations

Prerequisite: Mission Planning has sent out an Activity Schedule indicating an upcoming maneuver that may impact data product performance/geolocation. The Mission Schedule and Mission Notices should also document this impending operation.

Table: 6.6.1-5 Post-Maneuver Validation Flow

No.	Actors	Actions	Notes
1	Cal/Val Node, CGS	The CAL Receive Notices for Cal/Val activity should extract the planned event occurrence from the Mission Schedule and Mission Notices distributed by CGS.	The Distribute MSD activity sends out the Mission Schedule and Mission Notices.
2	Cal/Val Node	The CAL Manage Cal/Val Products activity should trigger the necessary PGE execution to generate Cal/Val Products to determine when the data product performance has returned to within specification.	
		Steps 5-10 are executed to generate the necessary products.	
		If the investigations above find a problem where performance is not within specification, Steps 11-13 of this thread, and steps 10-17 of the ADM thread are exercised if an update is needed in one or more tables.	
18	SI, ISN	The Science Investigator will notify the appropriate Instrument Science Team lead that the instrument/data product has returned to calibrated operation.	
19	ISN, CGS	The Instrument Science Team will coordinate with the CGS to notify that the instrument appears to have returned to nominal operations.	
20	CGS	The CGS Verify Post-Update Operation activity shall perform the analysis necessary to verify the implementation of a flight update after which it releases updated baseline Sensor Calibration Table(s), Processing Coefficient Table(s), and/or Look Up Table(s) to the CGS Collect Mission Support Data activity for distribution.	The MSD thread handles the distribution of the baseline SCT/PCT/LUT to the appropriate users. The Integrated Support thread handles the maintenance of tables within Common CM, which is used to maintain and control the latest versions of the ground software and the Processing Coefficient Tables

No.	Actors	Actions	Notes
			(PCTs) and Look-Up Tables (LUTs)

6.6.1.7.2 CERES/RBI Cal/Val

The NASA Atmospheric Sciences Data Center (ASDC) at the NASA Langley Research Center (LaRC) handles all data processing and Cal/Val functions for the CERES instrument on S-NPP and JPSS-1, and RBI on JPSS-2/3/4. The CGS forwards CERES/RBI SMD to the NASA SDS, which generates CERES/RBI Level 0 products and provide them along with some correlative VIIRS Level 1 products to the NASA LaRC. The ASDC correlates the CERES/RBI data with the other CERES/RBI instruments in orbit as well as comparing with other relevant science data to bring the quality up to what is needed for climate data record usage.

6.6.1.7.3 Sensor Constellation Operations

Prerequisite: Multiple JPSS-managed satellites have achieved LTM phase for one or more products.

Table: 6.6.1-6 Sensor Constellation Arbitration Flow

No.	Actors	Actions	Notes
1	Cal/Val Node	The CAL Trend Product Performance and Telemetry activity will compare product performance of operational data products that have achieved validated status between the different on-orbit satellites that have common instruments. This comparison will be used to make recommendations for changing the primary instrument associated with a particular operational data product.	
2	Cal/Val Node, NOAA Review Board	The CAL Forward Recommended Updates activity will make recommendations to the NOAA Review Board regarding the selection of primary instrument for a particular operational data product.	
3	NOAA Review Board	The NRB Determine Acceptability of Operational Products activity will adjudicate which instrument is determined to be primary for each given operational data product for which there is a choice.	The SPSRB is the relevant NOAA Review Board.
4	NOAA Review Board, CGS	The DPN will be notified of any changes in the primary selection for a given data product.	The SPSRB will likely notify AMP who will forward the direction to the JPSS IDPS Lead for implementation.

6.6.1.8 Post Condition

The performance of all data products are stable and within the quality specifications.

6.6.1.9 Related Threads

Provide a list of threads that area related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-170	Algorithm Development and Maintenance
GS-NML-100	Stored Mission Data Handling
GS-NML-140	Mission Support Data Handling
GS-NML-020	Mission Planning and Scheduling
GS-NML-110	Data Quality Assurance
GS-NML-400	Integrated Support
GS-MAD-120	Launch and Early Orbit
GS-NML-500	Sensor Operations / Payload Support
GS-NML-300	System Status/Situational Awareness
GS-NNL-140	System Maintenance & Upgrade
GS-FTS-140	Direct Broadcast Quality Monitoring

6.6.1.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
474-00104	JPSS GRAVITE Operations Concept
	VIIRS SDR OpsCon
	CrIS SDR OpsCon
	ATMS SDR OpsCon
	OMPS SDR OpsCon
	Imagery EDR OpsCon
	Oceans EDR OpsCon
	Cryosphere EDR OpsCon
	LST EDR OpsCon
	VCM IP OpsCon
	OMPS EDR OpsCon
CL60917-O&S-001	O&S Approval Authority for Operational Products
CGS-040-040	Data Cal/Val

6.7 Field Terminal Support

6.7.1 Field Terminal User Support

6.7.1.1 Description

The JPSS Program supports the Field Terminal user community by providing telemetry and payload data via the direct broadcast signal (known as High Rate Data (HRD)), data processing algorithm and software, documentation, mission status, HRD link status, as well as the Mission Support Data (MSD) to the Field Terminal (FT) customers. The JPSS Program is not responsible for developing, testing, or deploying any JPSS capable field terminal. With their

own equipment, the FTS customers can acquire and process JPSS direct broadcast data to properly create JPSS data products such as Raw Data Records (RDRs), Sensor Data Records (SDRs) and Environmental Data Records (EDRs). This Field Terminal User Support Thread (GS-FTS-110) describes the basic concept of operations for the JPSS Ground System to provide this support.

The S-NPP and JPSS-1 spacecraft provide HRD via X-band at 15 Mbps (CADU rate) and JPSS-2/3/4 at 25 Mbps.

The JPSS Ground System monitors the quality of the direct broadcast (See GS-FTS-140 Direct Broadcast Quality Monitoring) and makes the Svalbard Link Monitoring report available to the FTS customers as part of MSD, which also includes the mission notices. For additional information on MSD, see the Mission Support Data Handling thread (GS-NML-140).

In addition, the JPSS Program supports the NASA GSFC Direct Readout Laboratory (DRL) and University of Wisconsin (UWisc) Cooperative Institute for Meteorological Satellite Studies (CIMSS) to enable users to integrate the algorithms into their remote terminals. The support the JPSS Program provides to these institutions will demonstrate the ability to produce ready-to-use products from the HRD link and provide risk reduction effort at a minimal cost. With the JPSS program support and via their own FTS customer interface, NASA GSFC DRL and UWisc CIMSS will:

- Provide software package for the FTS customer community to produce at a minimum JPSS KPPs using the High Rate Data (HRD) link.
- Prepare QA/QC and compare in-house produced KPPs with CLASS (Gold standard reference product) and provide results to FTS customer community.
- Provide specifications and suggest hardware field terminal configurations to the FTS customer community. (This is being provided on the FTS portal.)
- Provide User's Guide and FAQs to support the respective FTS customer community.
- Monitor the HRD link at their receiving sites and provide reports to the FTS customer community.
- Support on-orbit check out and special tests as planned.
- Maintain a list of registered users and provide it to the JPSS Program.
- Develop software (RT-STPS) that produces RDRs that are consistent with IDPS and therefore compatible with the ADL unpacker (NASA GSFC DRL only).
- Maintain the RT-STPS software and provide updates to the JPSS Program (NASA GSFC DRL only).

6.7.1.2 Primary Interfaces

Figure 6.7.1-1 illustrates the actors and primary internal and external interfaces involved in the FTS customer support operations. Each interface illustrated in the figure, labeled with a number, is described in Table 6.7.1-1. Table 6.7.1-2 lists relevant IRDs/ICDs.

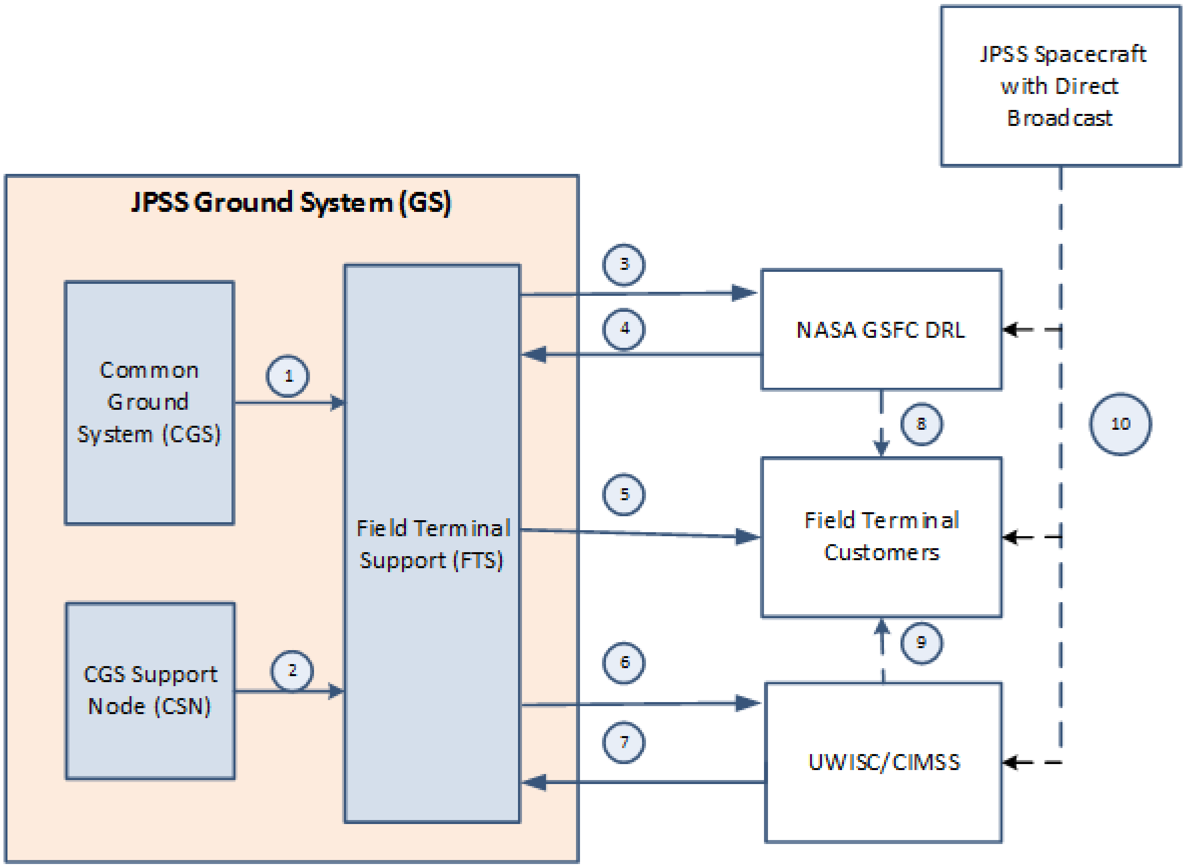


Figure: 6.7.1-1 Primary Interfaces for Field Terminal User Support

Table: 6.7.1-1 Primary Interfaces for Field Terminal User Support

No.	Type	Actors	Purpose
1	Internal	CGS > FTS	Mission Support Data (MSD)
2	Internal	CSN > FTS	Software (ADL and documentations)
3	External*	FTS > NASA GSFC DRL	Software (ADL), MSD
4	External*	NASA GSFC DRL > FTS	List of registered FTS customers, Product compare results, RS-STPS software updates
5	External	FTS > FTS customers	Software (ADL and documentations), Recommended hardware specifications, MSD
6	External*	FTS > UWISC CIMSS	Software (ADL), MSD
7	External*	UWISC CIMSS > FTS	List of registered FTS customers, Product compare results
8	Outside	NASA GSFC DRL > FTS customers	Software release packages, Product compare results, user support
9	Outside	UWISC/CIMSS > FTS customers	Software release packages, Product compare results, user support
10	Outside	JPSS Spacecraft > FTS customer	Direct Broadcast RF signal

* There is no direct link for these interfaces.

Table: 6.7.1-2 Primary Interface Documents for Field Terminal User Support

No.	IRD/ICD
2	JPSS CGS Service IDD
3, 5, 6	JPSS FTS Services IDD
8, 9	N/A
10	NPP HRD RF ICD JPSS IRD for RF interface To and From the JPSS Satellites JPSS-1 Spacecraft HRD to Direct Broadcast Stations (DBS) RF ICD JPSS-1 Mission Data Format ICD JPSS-2/3/4 Spacecraft HRD to Direct Broadcast Stations (DBS) RF ICD JPSS-2/3/4 Mission Data Format ICD

6.7.1.3 Assumptions and Constraints

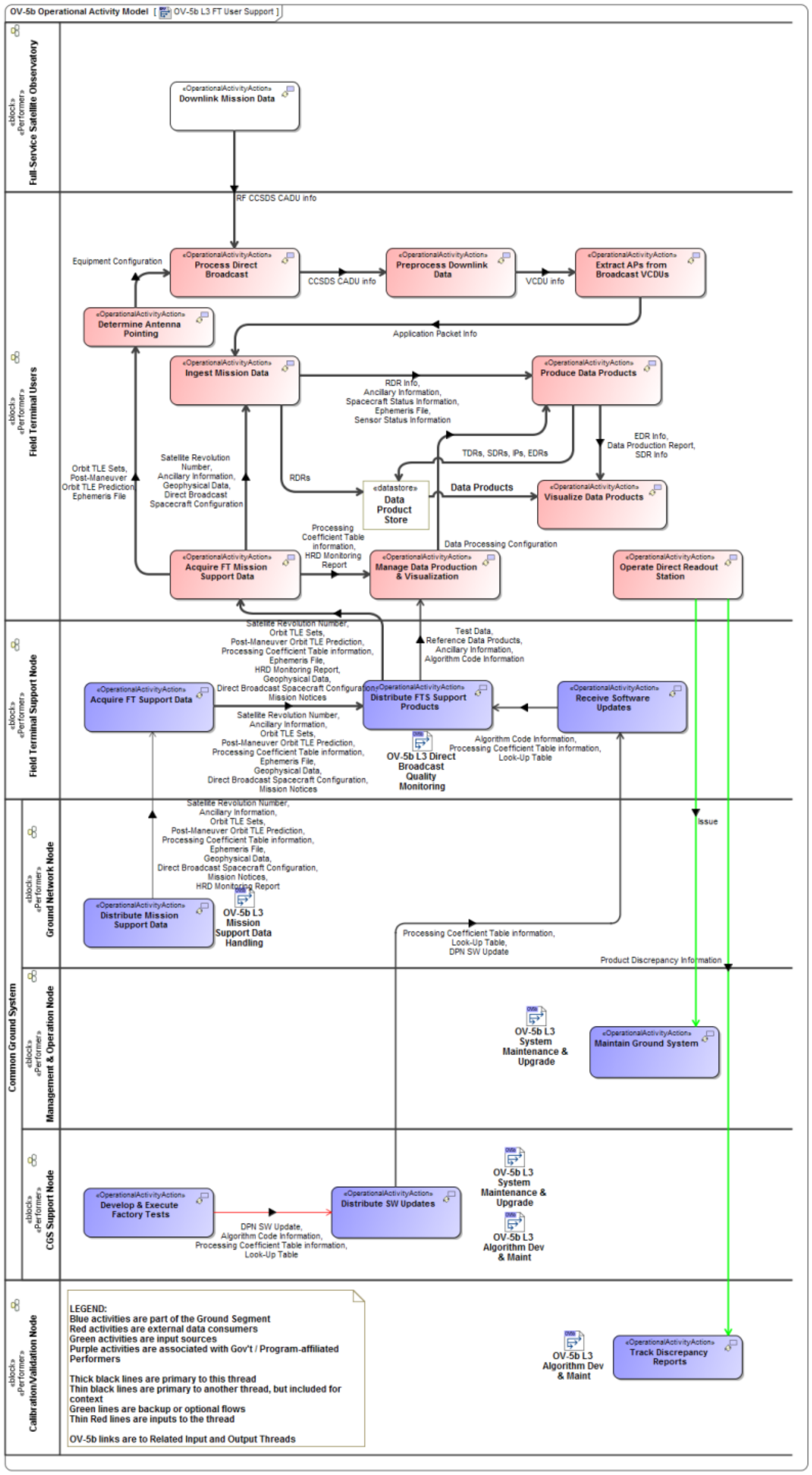
- FTS customer support access requires registration with FTS.

6.7.1.4 Pre-Conditions

- FTS customer is already registered with FTS, including authenticated access to the FTS Web Portal
- FTS customer Link Receiver system has been set up to acquire direct broadcast signal
- FTS customer has downloaded the necessary software to process the direct broadcast data stream into the desired xDR data products.
- FTS customer Front-end system and processing system have been set up to process direct broadcast contact.

6.7.1.5 Operational Flow

Figure 6.7.1-2 provides an illustration of system activities taking place in the basic flow for Field Terminal user support.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333).

Figure: 6.7.1-2 Field Terminal User Support Flow Diagram

6.7.1.6 Main Flow

Trigger: None. Mission Support Data activities are asynchronous, depending on update times of external MSD sources. Mission Data activities are asynchronous, depending on satellite downlink contacts.

Table: 6.7.1-3 Field Terminal User Support Main Flow

No.	Actors	Activities	Notes
1	CGS Support Node, Field Terminal Support Node (FTSN)	The CGS Distribute SW Updates activity makes JPSS data processing software (ADL) and updates available to the FTS Receive Software Updates activity.	This activity happens as each software (ADL) is delivered.
2	FTSN	The FTS Receive Software Updates activity forwards the software (ADL) and updates to the FTS Distribute FTS Support Products activity.	
3	FTSN, FTS customer	The FTS Distribute FTS Support Products activity makes the software (ADL) and updates to the FTS customers (via the FTS Web Portal).	
4	Management and Operations Node (MON), FTSN	The FTS Acquire FT Support Data activity retrieves the FT support MSD and Global Gridded IPs from the CGS Distribute Mission Support Data activity.	FT support MSD comprises numerical prediction ancillary data, TLE data (normal and post-maneuver), revolution number tables, processing coefficients, and geophysical ancillary data. It also includes the Svalbard Link Monitoring Report and mission notices.
5	FTSN, FTS customer	The FTS Distribute FTS Support Products activity and makes MSD and Global Gridded IPs available to FTS customers (via FTS Web Portal).	

6.7.1.7 Alternate Flow

None.

6.7.1.8 Post Conditions

JPSS data processing software (ADL) (including updates) and MSD (including the Svalbard Link Monitoring Report and Mission Notices) are made available to FTS customer.

6.7.1.9 Related Threads

Thread ID	Thread Title
GS-FTS-140	Direct Broadcast Quality Monitoring
GS-NML-140	Mission Support Data Handling

6.7.1.10 Child Threads

Thread ID	Thread Title
CGS-020-060	Mission Support Data Handling
FTS-DAO-01	FTS Data Acquisition and Organization
FTS-DD-01	FTS Data Distribution
FTS-URR-01	FTS User Registration and Reporting
FTS-SSH-01	FTS System Status & Health

6.7.2 Direct Broadcast Quality Monitoring

6.7.2.1 Description

The Direct Broadcast Quality Monitoring (DBQM) thread (GS-FTS-140) provides a high level description of JPSS Ground System operations to monitor the quality of direct broadcasting High Rate Data (HRD) from JPSS-managed satellites, including S-NPP and JPSS-1. The thread begins with the acquisition of HRD signal, proceeds to measuring RF signal characteristics and accounting VCID/APID mapping, and ends with the distribution of HRD Monitoring reports. The RF signal performance metrics, link content and pass AoS/LoS data are provided in an HRD Monitoring report. The HRD Monitoring report is made available to external entities such as the Field Terminal customers via the Field Terminal Web Portal over the Internet. MOT monitors the report and in case of a link anomaly, may issue a Mission Notice to inform internal and external users.

The DBQM function is allocated to the Field Terminal Support Node, the Space/Ground Communication Node, the Ground Network Node, and MON.

For references, the Field Terminal User Support thread provides additional information on the distribution of support data to the Field Terminal customers.

6.7.2.2 Primary Interfaces

Figure 6.7.2-1 illustrates the HRD capable satellites (S-NPP and JPSS-1) as RF input sources for HRD downlink. The HRD Monitoring reports are made available to external users (e.g., Field Terminal customers) through the FTS Web Portal. Each interface illustrated in the figure, labeled with a number, is described in Table 6.7.2-1. Table 6.7.2-2 provides relevant IRDs/ICDs information.

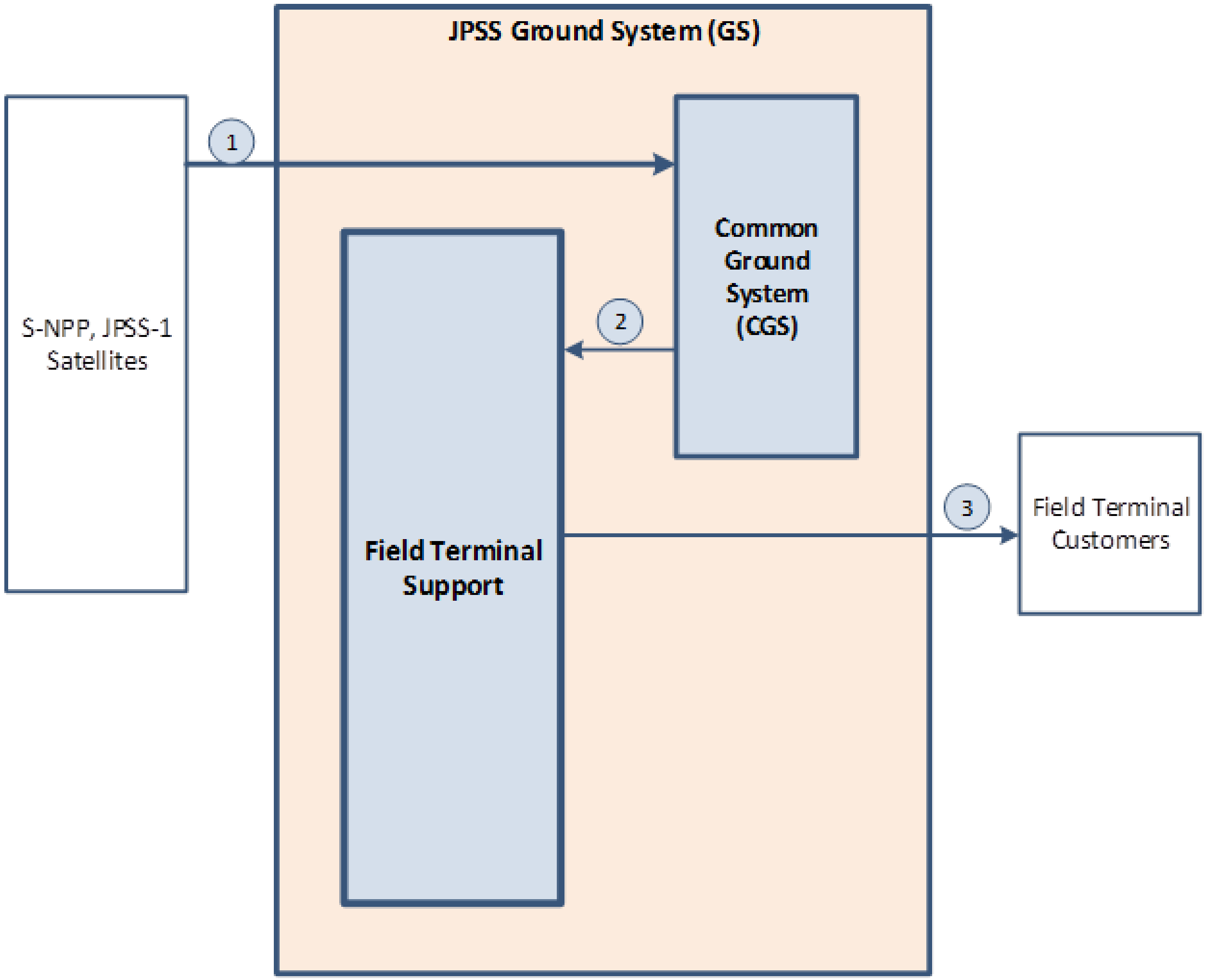


Figure: 6.7.2-1 Primary Interfaces for Direct Broadcast Quality Monitoring

Table: 6.7.2-1 Direct Broadcast Quality Monitoring Primary Interfaces

No.	Type	Actors	Purpose
1	External	Satellites (S-NPP, JPSS-1) -> CGS	Receiving High Rate Data
2	Internal	CGS -> FTS	HRD Monitoring Report, Mission Notices
3	External	FTS -> FT Customers	HRD Monitoring Report, Mission Notices

Table: 6.7.2-2 Direct Broadcast Quality Monitoring Interface Documentation

No.	IRD/ICD
1	IRD for RF Interface to and from the JPSS Satellites JPSS-1 Spacecraft High Rate Data (HRD) to Direct Broadcast Stations RF ICD S-NPP HRD RF ICD
2	JPSS CGS Services IDD
3	JPSS FTS Services IDD

6.7.2.3 Assumptions & Constraints

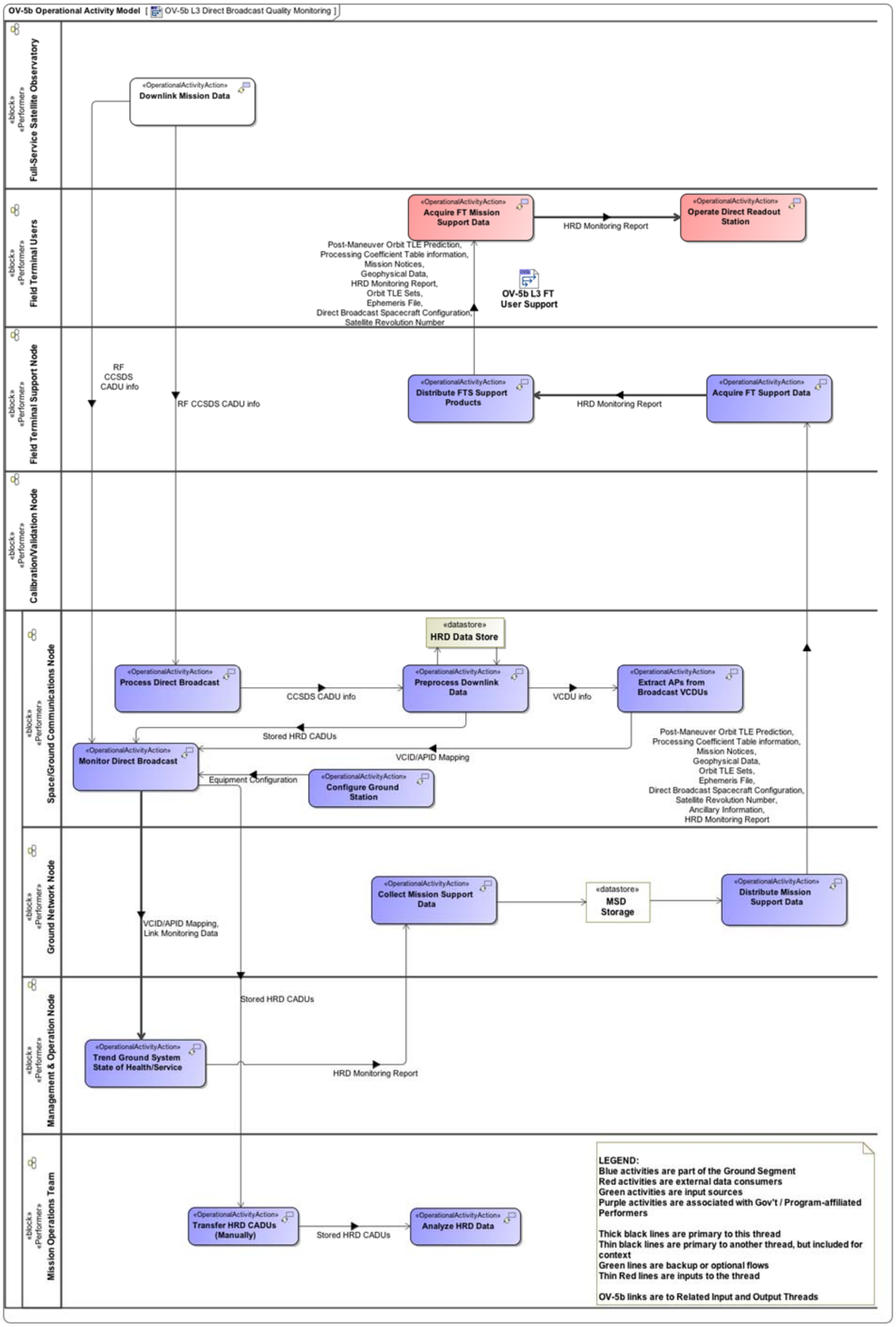
- The direct broadcast quality monitoring is nominally performed on every pass by the Space/Ground Communication Node at Svalbard Ground Station with a minimum of 3 passes per day for each satellite.

6.7.2.4 Pre-Conditions

- The Svalbard Ground Station has been set up to acquire the HRD signal and to measure its performance parameters.

6.7.2.5 Operational Flow

Figure 6.7.2-2 illustrates the operational flow. This diagram is an OV-5b view that ties this thread to the rest of system architecture.



Note: A higher resolution version of this diagram can be found in the JPSS Ground System Architecture Description Document (474-00333)

Figure: 6.7.2-2 Direct Broadcast Quality Monitoring Operational Flow Diagram

6.7.2.6 Basic Flow

Table 6.7.2-3 defines the operational flow of Direct Broadcast Quality Monitoring.

Table: 6.7.2-3 Direct Broadcast Quality Monitoring Basic Flow

No.	Actors	Actions	Notes
1	Space/Ground Communication Node (SGCN)	The Monitor Direct Broadcast activity monitors HRD RF performance and collects HRD RF downlink performance parameters during each HRD contact.	Monitoring and collection occur while tracking lock is maintained. Parameters monitored include receive signal strength, signal to noise ratio, spectral power distribution, and frame statistics. HRD performance metrics are nominally collected on every pass.
2	SGCN	The Process Direct Broadcast activity acquires HRD signals during the HRD contact and converts RF signal to baseband bit stream.	
3	SGCN, MOT	The Preprocess Downlink Data activity extracts CADUs from downlink bit stream; and extracts VCDUs from CADUs. The Extract APs from Broadcast VCDUs activity extracts Application Packets (APs) from the VCDUs and generates a VCID/APID mapping. HRD CADUs are stored at the ground station until the next HRD contact. When needed, MOT can manually transfer the stored HRD CADUs from the last contact to NSOF for further analysis.	
4	MON, GNN	The Trend Ground System State of Health/Service activity receives the HRD RF downlink performance parameters and VCID/APID mapping from the CGS Monitor Direct Broadcast activity and generates HRD monitoring reports. The Collect Mission Support Data activity gathers the HRD monitoring reports and forwards it to the Distribute Mission Support Data activity through the MSD Storage.	
5	GNN, FTSN	The FTS Acquire FT Support Data Activity acquires the HRD monitoring	

No.	Actors	Actions	Notes
		reports from the CGS Distribute Mission Support Data activity.	
6	FTSN	The Distribute FTS Support Products activity makes the HRD Monitoring Report available to FT customers.	HRD Monitoring reports are nominally made available to FT customers for seven days by the FTS email list and FTS Web Portal.

6.7.2.7 Alternate Flow

None.

6.7.2.8 Post Condition

The HRD Monitoring Report is available to MOT and FT customers.

6.7.2.9 Related Threads

Provide a list of threads that are related to this thread for further understanding and clarification.

Thread ID	Thread Title
GS-NML-140	Mission Support Data Handling (MSD)
GS-NML-300	System Status/Situational Awareness (SyS)
GS-NML-310	Ground Operations (GO)
GS-NNL-130	System Fault Analysis (SFA)
GS-FTS-110	Field Terminal User Support

6.7.2.10 Child Threads

Provide a list of child Operations Concept (OpsCon) threads to which the ConOps thread flows down.

Thread ID	Thread Title
CGS-020-070	Direct Broadcast Quality Monitoring

7 TECHNICAL PERFORMANCE MEASURES

7.1 Overview

To satisfy the needs of JPSS missions, the JPSS Ground System not only provides functional capabilities, but also performs these functions within required time and quality constraints, known as Technical Performance Measures (TPMs). The TPMs are designed to measure how fast the system can deliver data products, how well the product qualities are, how reliable the system can operate, how quickly the system can react to certain unplanned events, and how much margin in the system to ensure system operations against uncertainties.

Table 7.1-1 summarizes the TPMs for the JPSS Ground System that are tracked as the system requirements and managed according to the JPSS System Engineering Management Plan (470-00001).

Table: 7.1-1 JPSS Ground System Technical Performance Measures

TPM ID	Name	Spec	Primary Level 2 Requirements
GT-Ld-01	S-NPP AP Data Latency	120 min for 95% over 30 days	GSR-3309
GT-Ld-02	S-NPP RDR Data Latency	120 min for 95% over 30 days	GSR-3377
GT-Ld-03	S-NPP SDR Data Latency	140 min for 95% over 30 days	GSR-3378
GT-Ld-04	S-NPP TDR Data Latency	140 min for 95% over 30 days	GSR-3379
GT-Ld-05	S-NPP EDR Data Latency	140 min for 95% over 30 days	GSR-1421
GT-Ld-06	JPSS AP Data Latency	70 min for 95% over 30 days	GSR-3310
GT-Ld-07	JPSS RDR Data Latency	70 min for 95% over 30 days	GSR-3373
GT-Ld-08	JPSS SDR Data Latency	80 min for 95% over 30 days	GSR-3371
GT-Ld-09	JPSS TDR Data Latency	80 min for 95% over 30 days	GSR-3372
GT-Ld-10	JPSS EDR Data Latency	80 min for 95% over 30 days	GSR-1422
GT-Ld-11	GCOM-W1 AP Data Latency (from RF Reception)	12 min for 95% over 30 days	GSR-3314
GT-Ld-12	GCOM-W1 RDR Data Latency (from RF Reception)	12 min for 95% over 30 days	GSR-1562
GT-Ad-01	S-NPP Raw Data Availability to CLASS	99% over 30 days	GSR-1246
GT-Ad-02	S-NPP Raw Data Availability to FNMOC	99% over 30 days	GSR-3307
GT-Ad-03	S-NPP Raw Data Availability to NAVOCEANO	99% over 30 days	GSR-3308
GT-Ad-04	S-NPP Product Data Availability to CLASS	99% over 30 days	GSR-3383
GT-Ad-05	S-NPP Product Data Availability to ESPC	99% over 30 days	GSR-3384
GT-Ad-06	S-NPP Raw Data Availability to SDS	99% over 30 days	GSR-3385
GT-Ad-07	JPSS Raw Data Availability to CLASS	99% over 30 days	GSR-1246
GT-Ad-08	JPSS Raw Data Availability to FNMOC	99% over 30 days	GSR-3307

TPM ID	Name	Spec	Primary Level 2 Requirements
GT-Ad-09	JPSS Raw Data Availability to NAVOCEANO	99% over 30 days	GSR-3308
GT-Ad-10	JPSS Product Data Availability to CLASS	99% over 30 days	GSR-3383
GT-Ad-11	JPSS Product Data Availability to ESPC	99% over 30 days	GSR-3384
GT-Ad-12	JPSS Raw Data Availability to SDS	99% over 30 days	GSR-3385
GT-Ad-13	GCOM-W1 Raw Data Availability to CLASS (from RF Reception)	99.9% over 30 days	GSR-1696
GT-Ad-14	GCOM-W1 Raw Data Availability to FNMOC (from RF Reception)	99.9% over 30 days	GSR-3369
GT-Ad-15	GCOM W1 Raw Data Availability to NAVOCEANO (from RF Reception)	99.9% over 30 days	GSR-3370
GT-Ad-16	GCOM-W1 Product Data Availability to ESPC (from RF Reception)	99.9% over 30 days	GSR-1697
GT-Ao-01	CGS Operational Availability	99% over 30 days	GSR-1243
GT-Ao-02	SGCN Operational Availability	99.5% over 30 days	GSR-1554
GT-Ao-03	GNN Operational Availability (Mission-based Ao: S-NPP, JPSS-1, JPSS-2, GCOM-W1, Coriolis)	99.9% over 30 days	GSR-1306
GT-Ao-04	GNN Operational Availability (Mission-based Ao: DMSP, MetOp, NSF, SCaN from McMurdo)	99.5% over 30 days	GSR-3352
GT-Ao-05	GNN Operational Availability (Mission-based Ao: SCaN from Svalbard)	99.95% over 30 days	CGS-1663
GT-Ao-06	MON Operational Availability	99.9% over 30 days	GSR-1307
GT-Ao-07	DPN Operational Availability	99.9% over 30 days	GSR-1308
GT-So-01	GS Scalability @ B2.0 TTO (JPSS-Managed Missions)	3 baseline + 4 additional	GSR-3211
GT-So-02	GS Scalability @ B2.0 TTO (Data Processing Services Missions)	1 baseline + 4 additional	GSR-3211
GT-So-03	GS Scalability @ B2.0 TTO (Data Acquisition and Routing Missions)	5 baseline + 2 additional	GSR-3211
GT-Mo-01	DPN Throughput Margin @ B2.0 TTO	50%	GSR-3229

TPM ID	Name	Spec	Primary Level 2 Requirements
GT-Mo-02	CGS Storage Capacity Margin @ B2.0 TTO	25%	GSR-3230
GT-Mo-03	MON Peak CPU Utilization Margin @ B2.0 TTO	20%	GSR-3231
GT-Mo-04	MON Peak Memory Utilization Margin @ B2.0 TTO	20%	GSR-3232
GT-TT-01	Transition Time from Primary to Alternate Facility (MON/DPN)	12 hours	GSR-402

The quality of JPSS data products is monitored and reported by the JPSS Cal/Val Node, as described in the JPSS Calibration and Validation Plan. The rest of this section describes the JPSS system Key Performance Parameters (KPPs) and detailed definitions of and approaches for the Data Latency, Data Availability, Operational Availability, System Margin, and System Scalability.

7.2 JPSS Key Performance Parameters (KPPs)

The full system success requires all JPSS data product (Application Packets, Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), and Environmental Data Records (EDRs)) requirements be met or exceeded.

The minimum system success of JPSS missions requires all four performance attributes identified as Key Performance Parameters (KPPs) listed below to be met. KPPs are, as defined in the JPSS Program Level 1 Requirement (L1RD), those polar system capabilities that if they cannot be met, would compromise NOAA's weather mission to provide essential warnings and forecasts to protect lives and property, and would be the cause for program reevaluation or cancellation.

The JPSS KPPs are:

- ATMS TDRs
- CrIS SDRs
- For latitudes greater than 60ºN in the Alaskan region, VIIRS Imagery EDR at 0.64µm (I1), 1.61µm (I3), 3.74µm (I4), 11.45µm (I5), 8.55 µm (M14), 10.763 µm (M15), 12.03 µm (M16), and Near Constant Contrast EDR
- 96 minute data latency for the ATMS TDRs, CrIS SDRs, and the VIIRS Imagery EDR channels specified above, of which 80 minutes are allocated to the JPSS Ground System

In addition, the JPSS L1RD identifies the following system TPMs:

- Data Availability (data delivery requirements)
- Operational Availability

The JPSS Ground System collects, measures, trends, and reports the system TPMs, including the KPPs, Data Latency, Data Availability, and System Margins. Note that the Operational Availability is, by definition, a design parameter measuring the probability of success.

7.3 Data Latency

The JPSS L1RD defines data product latency as the period from the time of observation of all requisite data by the satellite until the product produced by those data are available at the JPSS/User interface. The data products include APs, RDRs, SDRs, TDRs and EDRs. Note that the data latency requirement does not apply to deliverable IPs and mission support data.

Table 7.3-1 lists data latency requirements for the JPSS missions and their allocations to the JPSS Ground System. The measured data latency should be less than specified values at least 95% of time calculated over any 30-day period (with exceptions specified in the JPSS L1RD Supplement). The Ground System data latency allocations are measured from the product observation time to the time the data product is made available to the JPSS/User interface. Note that, with exception of GCOM-W1, this allocation includes the time the data is stored in the Mass Data Storage (MDS), Solid State Recorder (SSR) in Block 2.0, since the ground system manages when the Stored Mission Data (SMD) is played back from the MDS, downlinked and processed. The frequency of MDS playback, thus the onboard storage delay, largely depends on the number and locations of ground receiving sites available.

Table: 7.3-1 JPSS Data Latency

Mission	Mission Data Latency (minutes)	Ground System Data Latency Allocation (minutes)	Notes
S-NPP	180	AP: 120 RDR: 120 SDR: 140 TDR: 140 EDR: 140	
GCOM-W1	AP: 114 RDR: 117	AP: 12 RDR: 12	AP and RDR only. The Ground System latency is measured from RF signal acquisition to when AP/RDR is made available to the users.
JPSS-1/2/3/4	AP: 80 xDR: 96	AP: 70 RDR: 70 SDR: 80 TDR: 80 EDR: 80	

The individual data product latency is calculated based on the time stamp of the most recent packet and the delivery time of the product. For a given mission, the data latency is calculated for all delivered data products over a 30-day period. Repaired products, products delivered on late requests, and late deliveries due to interface failures caused by the user side outages are exceptions to the data latency calculations.

For GCOM-W1, AMSR2 Application Process Identifier Sorted Data (ASD) and Raw Data Records (RDRs) are processed as full orbit (vice granule-based) files in the Ground System B2.0

implementation and, as such, the Level 1 granule-based Data Latency definition that defines the reporting start time stamp as the time of receipt of "...all requisite data..." cannot be directly applied. The L1RD granule-based definition assumes the timespan of each granule is a small contributor to Data Latency, an assumption that does not apply to AMSR2 full-orbit data. In the special case of AMSR2 ASD and RDRs, JPSS System Technical Performance Metrics (TPM) granule-based measurement and reporting does not reflect the nominal AMSR2 on-board observation aging of 3 to 101 minutes for a full orbit of first-copy data. For a sample ground data transmission and processing delay of 12 minutes when the RDR is delivered to ESPC, Ground System TPM reporting will, by Level 1 definition, show the data latency for this RDR as 15 (3+12) minutes, not 113 (101+12) minutes. Analyses and conclusions drawn from Ground AMSR2 Data Latency reporting need to recognize and include the time associated with the on-board aging of AMSR2 data.

While tracking the end-to-end data latency, the JPSS Ground System also measures and trends the latencies at the Space/Ground Communication Node, at the Ground Network Node, and at the Data Processing Node to characterize and optimize the system performance.

Because JPSS does not manage GCOM-W1 onboard MDS operations, the JPSS Ground System is only responsible for the latency from the GCOM-W1 SMD RF reception to its product delivery to the JPSS/User interface. However, the JPSS Ground System still measures and reports the end-to-end system latency for the GCOM-W1 mission.

In order to achieve the data latency of 80 minutes or less for the JPSS-1 mission, two SMD contacts each orbit near the opposite poles are planned. During each contact, in addition to a MDS playback at the beginning of contact, a second MDS playback is commanded near the end of contact so that the most of observational data acquired during the contact can be downlinked instead of waiting till the next contact. The initial modeling of JPSS-1 SMD playback shows that the average data latency can be reduced by 16% by the additional SMD downlink.

If one of the polar ground stations suffers an extended outage, JPSS-1/2/3/4 can still maintain the data latency performance, using the Zenith-mounted Ka-band antenna to transmit SMD through TDRSS to the ground. The NOAA FCDAS or KSAT Troll Ground Station may also be used to augment the SMD operations in contingency.

7.4 Data Availability

Data Availability is the percentage of data collected by operational sensors on each JPSS-managed satellite that is made available to the JPSS users. Table 7.4-1 lists mission data availability requirements and their Ground System allocations. For a given mission, the data availability is calculated for each JPSS user for all deliverable data averaged over a 30-day reporting period.

For GCOM-W1, the Data Availability is the percentage of data received at the Svalbard ground station that is made available to the authorized JPSS users. It should be noted that:

1. JPSS Ground System doesn't manage GCOM-W1 mission data downlink, thus has no control of its retransmissions for data recovery.
2. GCOM-W1 mission routinely downlinks a duplicate copy of stored mission data from the previous orbit; and this duplicate copy is delivered to the JPSS users as part of AMSR2

ASD and RDR. Therefore a data loss in this duplicate copy may not represent a loss of observation data collected by the AMSR2 instrument if it was already received during the previous contact. Similarly, a data loss in the original copy may not represent a permanent loss of the AMSR2 observation data if it is in the duplicate copy received in the following contact.

Table: 7.4-1 JPSS Data Availability

Mission	Mission Data Availability Requirements	Ground System Data Availability Allocation	Notes
S-NPP	98%	99%	Over a 30-day reporting period
GCOM-W1	99%	99.9%	The Ground System Data Availability is measured from where the mission data is received at Svalbard to where the data is delivered to the authorized JPSS users over a 30-day reporting period.
JPSS	99%	99%	Over a 30-day reporting period

The data availability is divided into two categories: the Raw Data Availability (A_{RD}) and the Product Data Availability (A_{PD}). The A_{RD} measures the completeness of raw data capture and delivery, while the A_{PD} measures the completeness of product generation and delivery on the granule basis.

The Raw Data Availability (A_{RD}) can be measured either based on Virtual Channel Data Units (VCDUs) or Application Packets (APs). For the JPSS/SDS interface, the A_{RD} is defined as the number of VCDUs provided to SDS vs. the number of expected VCDUs minus exceptions. The number of VCDUs expected is what is stored on the MDS as indicated by Virtual Channel Sequence Counts. The exceptions include VCDUs not provided due to interface outages for which SDS is responsible.

For the JPSS/CLASS interface, the A_{RD} is defined as the number of Application Packets (APs) delivered (and saved in the RDRs) to CLASS vs. the number of expected APs minus exceptions. The number of APs expected is what is stored on the MDS as indicated by Packet Sequence Counts, which is susceptible to continuity glitches caused by counter reset by the instrument electronics. Therefore its use should be correlated with the Virtual Channel Sequence Counts. The exceptions include APs not requested by CLASS and APs not delivered due to failures caused by user side outages. The A_{RD} also applies to FNMOC and NAVOCEANO as they receive APs from the JPSS Ground System.

The Product Data Availability for each mission is measured at each JPSS/User interface based on the total number of products delivered over the expected products minus exceptions. The expected products such as xDRs are based on APs stored in the MDS intended for xDR generation. The exceptions include products not requested by the user and products not delivered due to failures caused by user side outages. The Product Data Availability is reported per product category, including RDR, SDR, TDR, EDR, IP and Mission Support Data (MDS).

There are many factors that may cause data losses, chiefly among them adverse weather conditions during a ground contact, Radio Frequency Interference (RFI) during a ground contact,

network outages and equipment failures. The approach for achieving high data availability over the ground network is to use reliable data transportation protocols such as TCP/IP, sFTP, and FTPs.

For space-ground links where reliable data transfer may not be available, several options can be implemented. For S-NPP, retransmission from onboard MDS can be initiated manually to fill the data gaps. For JPSS-1/2/3/4 mission, downlink of a duplicate copy of stored mission data at the next contact is planned to improve the data availability. Data lost during one polar contact can be readily retrieved after the next contact at the other polar site. TDRSS may also be used to recover data in anomaly scenarios.

Moreover, the primary ground stations are augmented by the alternate ground stations and TDRSS supports so that SMD stuck in the onboard MDS due to an extended outage at one of the primary ground stations can be downlinked through alternate ground stations within the next four orbits before being overwritten.

7.5 Operational Availability

JPSS L1RD defines the Operational Availability, Ao, as a measure of the probability that a system is operationally capable (ready for tasking) of performing an assigned mission (e.g., delivering a KPP) at any given time. Once on orbit, the JPSS satellites are assumed to operate 24 hours a day, 365 days a year for the mission lifetime. The JPSS Ground System Operational Availability is a composite value that includes the command, control and communication capabilities as well as data processing capability essential for the production and delivery of all required data products within required data latencies. It is measured based on actual system performance as:

$$Ao = MTBDT / (MTBDT+MDT)$$

where MTBDT = Mean Time Between Down Time, MDT = Mean Down Time

It should be noted that the planned data outages due to satellite operations such as spacecraft maneuvers and instrument calibrations are excluded from the Ground System operational availability calculations. They are allocated to the flight system. Also non-essential ground system segments such as FVTS, GRAVITE and FTS are not included in the Ao calculations for the Ground System. They have their respective Ao requirements.

Table 7.5-1 lists mission Operational Availability requirements and their Ground System allocations.

Table: 7.5-1 JPSS Operational Availability

Mission	Mission Operational Availability	Mission Operation and Ground System Allocation	Notes
S-NPP	0.381 or better		Required at the end of five years for the JPSS Program
S-NPP		99%	Averaged over a 30-day period for the JPSS Ground System
JPSS	70% or better		Probability of success of meeting the KPPs at the end of 5 years

Mission	Mission Operational Availability	Mission Operation and Ground System Allocation	Notes
JPSS	98% or better (excluding on-orbit failures)		Averaged over a 30-day period for the mission lifetime. Including planned outages such as orbit maneuvers and instrument calibrations
JPSS		99%	Averaged over a 30-day period for the JPSS Ground System
DMSP	Not Applicable (USAF SMC responsibility)	99.5%	Averaged over a 30-day period

The approaches for achieving high operational availability for the Ground System include:

- Built-in redundancy for quick failover
- Redundant strings for minimum downtime system maintenance and upgrade
- Alternate ground stations and network paths to weather extended outages at a ground station
- Alternate CGS for continuity of operations in catastrophic failures
- T&C backup by the NASA Space Network
- SMD backup by the NASA Space Network (for JPSS-1/2/3/4 satellites)
- Careful planning to minimize planned outages (e.g. spacecraft maneuvers)

7.6 System Operational Margin

Managing system capacity as it evolves through the lifecycle is a key to JPSS mission success. System operational margin describes deployed capacity to account for uncertainty and to accommodate limited growth in capacity needs during the mission lifecycle. Since the current system design incorporates the lessons learned from the on-going S-NPP mission, the uncertainty factor is fairly limited for the JPSS missions. Therefore the consideration for operational margins is mainly about unknown but anticipated growth:

- New algorithms
- Added complexity to existing algorithms
- Tighter latency requirements for some products
- “Small” new missions.

Table 7.6-1 summarizes the system operational margins at Block 2.0 Transition To Operations (TTO).

Table: 7.6-1 JPSS Ground System Operational Margins

System	Margins	Notes
Data Processing Node (DPN) Throughput	50%	Including all CPU, memory, storage Input/Output (I/O) and network I/O necessary to achieve the 50% throughput margin.
CGS Storage Capacity	25%	
Management & Operations Node (MON) Peak CPU Utilization	20%	CPU margin is measured while performing on-line and off-line tasks described in the CGS requirements document and is the aggregated of resources needed by all the servers within the MON.
Management & Operations Node Peak Memory Utilization	20%	Memory utilization is measured while performing on-line and off-line tasks described in the CGS requirements document and is the aggregated of resources needed across the MON.

The DPN throughput margin measurement includes all CPU, memory, storage I/O and network I/O under the nominal load of S-NPP, GCOM-W1, and JPSS-1 data processing (including product distribution). In addition, the load includes the required recovery processing at a rate of processing a 24-hour backlog in 5 days. The margin is determined by the following equation:

$$\text{Margin (\%)} = ((t_{max} - t_{ops})/t_{100}) * 100$$

Where:

t_{max} is the maximum data processing time the system is allowed to process a SMD download from a contact, while meeting the data latency requirements and leaving sufficient processing time to meet the data recovery requirement (for S-NPP, t_{max} = 84.6 minutes and for JPSS-1, t_{max} = 42.3 minutes);

t_{ops} is the average time over a 7-day period for processing a SMD download from a contact during operations; and

t_{100} is the average time over a 7-day period for processing a SMD download from a contact at the Site Acceptance Test (SAT). It establishes a baseline against which the margin is calculated.

Because of slower WAN connection may render DPN under-loaded thus skew the measurement of DPN throughput, the measurement is station-specific. Different t_{100} should be established for each of Svalbard, FCDAS, and WSC station and individual report generated during operations.

For the requirement verification, the initial DPN throughput margin at SAT, $((t_{max} - t_{100})/t_{100}) * 100$ (%), should be measured using the SMD download from Svalbard contacts.

7.7 System Scalability

JPSS is a multi-mission program lasting through 2025. Its capacities will be developed and deployed in multiple phases. As such, the JPSS Ground System is designed to evolve and expand to accommodate new missions. The system operational scalability is defined as overall

deployable capacity for significant growth during system lifecycle without changing the fundamental architecture. This include both hardware and software scalability considerations.

For planning purpose, future missions are classified into light and heavy categories based on anticipated data processing loads for these missions, hence their demands on system capacities. Table 7.7-1 lists the current and planned/anticipated JPSS managed and JPSS supported missions to provide a scope for the system scalability.

Table: 7.7-1 List of Current and Planned JPSS Missions for System Scalability

	JPSS-Managed Missions	Data Acquisition, Routing and Processing Missions	Data Acquisition and Routing Service Missions
Baseline Scope			
Block 2.0	S-NPP JPSS-1	GCOM-W1	NSF DMSP Metop SCaN Coriolis/WindSat
Block 2.2	JPSS-2		
Post-Block 2.2	JPSS-3/4		
Baseline Subtotal	5	1	5
Future (for Scalability)			
Future (Light)	2 small missions	GCOM-W2 GCOM-W3	1 POES Class
Future (Heavy)	DOD WSF Unknown (JPSS class)	2 Unknowns (GCOM-C class)	Unknown (Metop-B class)
Future Subtotal	2 small missions 2 JPSS class	2 GCOM-W class 2 GCOM-C class	1 POES class 1 Metop-B class

Notes:

1. Like SCaN, DMSP and Metop use fixed levels of service. So Metop-C is not counted.
2. There is a possibility that S-NPP still flies when JPSS-2 launches so JPSS-2 is counted as an addition for flight operations and data capture.
3. GCOM-C data processing is similar to that of GCOM-W1 (RDR only) except at a much higher data rate of 138.76 Mbps.

7.8 Fault/Failure Event Impacts on System TPMs

In the process of system TPM monitoring and evaluation, it is necessary to classify the relationship between potential fault/failure events and the associated TPMs that are affected. Certain faults/failures may impact more than one system TPM, such that it is necessary to properly assess the impacts in order to avoid over-penalization of system TPM performance. This is best illustrated from the mission TPM perspective where every event is accounted for. Table 7.8-1 provides a list of possible mission-level events and identifies the mission TPMs affected. For example, a missed ground station contact pass (weather-related) is counted against the data latency TPM, and not the operational availability TPM.

Table: 7.8-1 Fault/Failure Event Impacts on Mission TPMs

Events	Satellite Reliability	Mission Ao	Ground System Ao	Data Availability	Data Latency	Notes
On-orbit anomalies, failures, and recoveries	X					No mission data generated or mission data generated but not stored in MDS
Ground System anomalies, failures, and recoveries		X	X		X	Only when it is affecting delivery of data products
Spacecraft maneuvers, instrument calibrations, table loads		X				No observations or no product generated
Spacecraft maneuvers, instrument calibrations, and other onboard activities that result in products not meeting specified quality		X				Products are flagged for those onboard activities
Missed pass (weather-related)					X	Data recovered later
Missed pass (system-related)		X	X		X	Data recovered later
Missed pass (operator-related)		Not modeled	Not modeled		X	Data recovered later
Network failure		X	X		X	Data recovered later
Data loss due to Ground System failure		X	X	X		In case of a ground outage, recovery processing can be done within 7 days. Latency is not accounted for the data never delivered.

Appendix A. Mission Effectivity Matrix and L3-to-L4 Traces

Table: A-1 Mission Effectivity Matrix

Thread ID	Thread Title	NSF	Coriolis	SCaN Supporte d	Metop	DMSP	GCOM-W1	S-NPP	JPSS-1	JPSS-2/3/4
GS-MAD-110	Launch Readiness Support	No	No	No	No	No	No	Yes	Yes	Yes
GS-MAD-120	Launch & Early Orbit	No	No	No	No	No	No	Yes	Yes	Yes
GS-MAD-150	Decommissioning	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-010	Fleet Ground Management	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-020	Mission Planning and Scheduling	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-030	Telemetry and Command	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-050	Orbit Maintenance	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-060	Attitude Ground Support	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-070	Flight Software Upgrade	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-080	Flight Vehicle Simulation	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-100	Stored Mission Data Handling	No	No	No	No	No	Yes	Yes	Yes	Yes
GS-NML-102	Mass Data Storage Playback	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-110	Data Quality Assurance	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-130	Data Accounting and Recovery	No	No	No	No	No	Yes	Yes	Yes	Yes
GS-NML-140	Mission Support Data Handling	No	No	No	No	No	Yes	Yes	Yes	Yes
GS-NML-150	Cal/Val of Data Products	No	No	No	No	No	No	Yes	Yes	Yes

Thread ID	Thread Title	NSF	Coriolis	SCaN Supported	Metop	DMSP	GCOM-W1	S-NPP	JPSS-1	JPSS-2/3/4
GS-NML-170	Algorithm Development and Maintenance	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-180	Data Acquisition and Routing	Yes	Yes	Yes	Yes	Yes	No	No	No	No
GS-NML-200	Key Management	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-220	Security	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-300	System Status/Situational Awareness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-310	Ground Operations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-320	Space Operations	No	No	No	No	No	No	Yes	Yes	Yes
GS-NML-400	Integrated Support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NML-500	Sensor Operations and Payload Support	No	No	No	No	No	No	Yes	Yes	Yes
GS-FTS-110	Field Terminal User Support	No	No	No	No	No	No	Yes	Yes	Yes
GS-FTS-140	Direct Broadcast Quality Monitoring	No	No	No	No	No	No	Yes	Yes	Yes
GS-NNL-120	Continuity of Operations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NNL-130	System Fault Analysis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NNL-140	System Maintenance and Upgrade	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GS-NNL-150	Space Network Support	No	No	No	No	No	No	Yes	Yes	Yes

Table: A-2 L3 ConOps Thread to L4 OpsCon Scenario Traces

L3 Thread ID	L3 Thread Title	L4 Child Scenario ID	L4 Child Scenario Title
GS-MAD-110	Launch Readiness Support	CGS-040-030	Pre-Launch, Launch and Early Orbit Support
GS-MAD-120	Launch & Early Orbit	CGS-040-030	Pre-Launch, Launch and Early Orbit Support
GS-MAD-150	Decommissioning	CGS-010-020	Space Operations
		CGS-020-010	Mission Planning and Scheduling

L3 Thread ID	L3 Thread Title	L4 Child Scenario ID	L4 Child Scenario Title
		CGS-020-020	Orbit Operations
GS-NML-010	Fleet Ground Management	CGS-010-010	Ground Operations
		CGS-010-020	Space Operations
		CGS-020-010	Mission Planning and Scheduling
		CGS-030-010	Status and Situational Awareness
GS-NML-020	Mission Planning and Scheduling	CGS-020-010	Mission Planning and Scheduling
		CGS-030-010	Status and Situational Awareness
GS-NML-030	Telemetry and Command	CGS-020-030	Telemetry and Command
GS-NML-050	Orbit Maintenance	CGS-020-020	Orbit Operations
GS-NML-060	Attitude Ground Support	CGS-010-020	Space Operations
		CGS-020-020	Orbit Operations
GS-NML-070	Flight Software Upgrade	CGS-010-020	Space Operations
		CGS-020-030	Telemetry and Command
GS-NML-080	Flight Vehicle Simulation	CGS-020-030	Telemetry and Command
		CGS-020-040	FVS Operations
		474-00542	JPSS FVTS ConOps
GS-NML-100	Stored Mission Data Handling	CGS-020-050	Stored Mission Data Handling
		CGS-050-030	GCOM Data Handling
GS-NML-102	Mass Data Storage Playback	CGS-010-020	Space Operations
		CGS-020-080	Data Accounting and Recovery
GS-NML-110	Data Quality Assurance	CGS-020-090	Data Quality Monitoring
		474-00104	JPSS GRAVITE OpsCon
GS-NML-130	Data Accounting and Recovery	CGS-020-080	Data Accounting and Recovery
		CGS-030-010	Status and Situational Awareness
GS-NML-140	Mission Support Data Handling	CGS-020-060	Mission Support Data Handling
		CGS-030-050	Internal Data Management
GS-NML-150	Cal/Val of Data Products	CGS-040-040	Data Cal/Val
		474-00104	JPSS GRAVITE OpsCon
GS-NML-170	Algorithm Development and Maintenance	CGS-040-050	Algorithm Development
		474-00104	JPSS GRAVITE OpsCon
GS-NML-180	Data Acquisition and Routing	CGS-050-010	Data Acquisition and Routing
GS-NML-200	Key Management	CGS-040-010	Key Management
		CGS-030-060	Security
GS-NML-220	Security	CGS-030-060	Security
		CGS-010-010	Ground Operations

L3 Thread ID	L3 Thread Title	L4 Child Scenario ID	L4 Child Scenario Title
GS-NML-300	System Status/Situational Awareness	CGS-030-010	Status and Situational Awareness
GS-NML-310	Ground Operations	CGS-010-010	Ground Operations
		CGS-030-040	Fault Detection and Recovery
GS-NML-320	Space Operations	CGS-010-020	Space Operations
GS-NML-400	Integrated Support	CGS-030-030	Integrated Support
		CGS-030-050	Internal Data Management
GS-NML-500	Sensor Operations and Payload Support	CGS-030-070	Payload Operations Support
GS-FTS-110	Field Terminal User Support	CGS-020-060	Mission Support Data Handling
		CGS-020-070	Direct Broadcast Quality Monitoring
GS-FTS-140	Direct Broadcast Quality Monitoring	CGS-020-070	Direct Broadcast Quality Monitoring
GS-NNL-120	Continuity of Operations	CGS-010-030	Continuity of Operations
GS-NNL-130	System Fault Analysis	CGS-030-040	Fault Detection and Recovery
		CGS-010-010	Ground Operations
		CGS-010-020	Space Operations
GS-NNL-140	System Maintenance and Upgrade	CGS-030-020	Maintenance and Upgrade
GS-NNL-150	Space Network Support	CGS-040-020	Space Network Operations
		CGS-020-050	Stored Mission Data Handling

Appendix B. System Parameters

Table: B-1 Estimated Nominal Mission Data Rates and Volumes at Svalbard Ground Station

Mission	Downlink CADU Rate (Mbps)	Passes/Day	Average Data Volume per Pass (GB)	Average Data Volume per Day (GB)	Effective Outbound Rate (Mbps)	Time to Transfer SMD Out Each Pass (Minutes)	Notes
S-NPP	300	14	7	100	120	8	
JPSS-1	300	14	3.9 (original) 3.9 (duplicates)	55 (original) 55 (duplicates)	120	8.7	Both original and duplicates are transferred out to the JPSS SMD Hub at NSOF.
JPSS-2	300	14	2.7 (original) 5.4(duplicates)	38 (original) 76 (duplicates)	120	9	Same as above.
GCOM-W1	10	14	0.11 (original) 0.11 (duplicate)	1.6 (original) 1.6 (duplicate)	120	15 seconds	Total time required if all data is received then transferred at full rate. Both original and duplicates are transferred out to the JPSS SMD Hub at NSOF

Notes:

1. The listed WAN rates are nominal rates. The actual rates may be lower depending on other concurrent activities over the network. In case of an outage in one of two WAN connections, the rates may be cut by half as JPSS and NASA SCaN would share the same connection.

Table: B-2 Estimated Mission Data Rate and Volumes at McMurdo Ground Station

Mission	Downlink CADU Rate (Mbps)	Passes/Day	Data Volume per Pass (GB)	Data Volume per Day (GB)	Effective Outbound Rate (Mbps)	Time to Transfer SMD Out Each Pass (Minutes)	Notes
JPSS-1/2/3/4	300	14	3.9 (original) 3.9 (duplicates)	55 (original) 55 (duplicates)	40	26	Both original and duplicates are transferred out to the JPSS SMD Hub at NSOF.
DMSP	7	14	0.43	6	1-7	63-9	Bandwidth dynamically allocated

Mission	Downlink CADU Rate (Mbps)	Passes/Day	Data Volume per Pass (GB)	Data Volume per Day (GB)	Effective Outbound Rate (Mbps)	Time to Transfer SMD Out Each Pass (Minutes)	Notes
Metop	70	14	1.5	21	5-20	40-10	Bandwidth dynamically allocated

Table: B-3 Reserved

Table: B-4 Estimated Daily Mission Data Volumes (TB) at Data Processing Node (DPN) at NSOF

Mission	RDR	Product Generation	Product Delivery	Notes
S-NPP	0.1	2.4 (compressed)	~10	
JPSS-1	0.11	2.7 (compressed)	~11	
JPSS-2	0.11	2.7 (compressed)	~11	
GCOM-W1	0.002	0.002	0.008	

Notes:

1. The products include IPs
2. DPN at NSOF delivers the products to GRAVITE, CLASS, and ESPC.
3. Data volumes will change post-Block 2.2 based on pending JPSS Ground Segment architecture changes.

Table: B-5 Bandwidth Allocation (Mbps) per Mission at McMurdo Station

Mission	Outbound Min	Outbound Max	Inbound Min	Inbound Max	Notes
NSF	10	10	18	18	
JPSS	43	43	1	2	
NASA SCaN	1	1	0.512	0.512	
EUMETSAT	5	20	0.256	1	
DMSP	1	7	0.256	1	
Total	60	n/a	20	n/a	

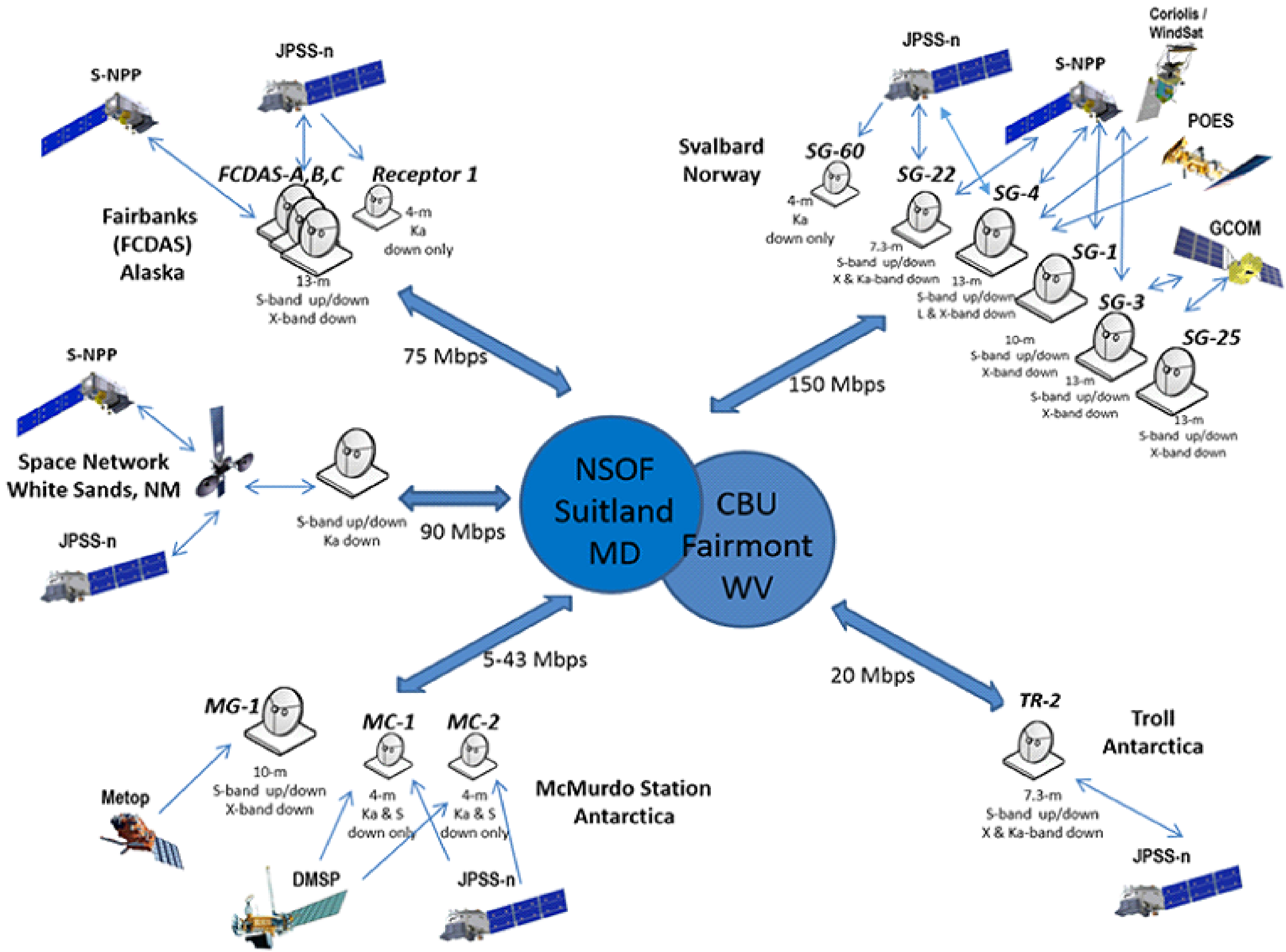


Figure: B-1 JPSS Ground Station Network Overview

Table: B-6 Summary of JPSS Space/Ground Communication Capacity

Station	Location	Operated by	Raw Ground Comm. Capacity	Antenna	Bands	Usage
SvalSat	Svalbard, Norway	KSAT	JPSS: 150 Mbps SCaN: 150 Mbps	SG4 13m	Rx: X, S, L Tx: S	S-NPP (Primary): TT&C, SMD, HRD JPSS-1/2/3/4 (Primary): TT&C, HRD GCOM-W1 (Backup): TT&C, SMD Coriolis: SMD
				SG1 10m	Rx: X, S Tx: S	Back up to SG4
				SG3 13m	Rx: X, S Tx: S	Back up to SG4 and SG25
				SG22 7.3m	Rx: X, S, Ka Tx: S	JPSS-1 (Primary): TT&C, SMD
				SG25 13m	Rx: X, S Tx: S	GCOM-W1 (Primary): TT&C, SMD
		JPSS		SG60 4m	Rx: Ka	JPSS-1 (Secondary): SMD JPSS-2/3/4 (Primary): SMD (Note: EUMETSAT Ka-band antenna will also be used to support JPSS-2/3/4. More details in B3.0)
McMurdo	McMurdo, Antarctica	JPSS	JPSS: 43 Mbps NSF: 10 Mbps	MC1 4m	Rx: Ka, S	DMSP (Primary): SMD JPSS-1 (Primary): SMD JPSS-2/3/4 (Preferred Secondary): SMD
			Metop: 5-20 Mbps DMSP: 1-7 Mbps	MC2 4m	Rx: Ka, S	Backup to MC1
		NASA		MG1 11m	Rx: X, S Tx: S	Metop: SMD SCaN: TT&C, SMD
FCDAS	Fairbanks, Alaska	NOAA	75 Mbps	A 13m B 13m C 13m	Rx: X, S, L Tx: S, L	S-NPP (Secondary): TT&C, SMD JPSS-1/2/3/4 (Secondary): TT&C

Station	Location	Operated by	Raw Ground Comm. Capacity	Antenna	Bands	Usage
						DMSP, EOS, JASON-2, LDCM
		JPSS		Receptor 1 4m	Rx: Ka	JPSS-1/2/3/4 (Secondary): SMD
TrollSat	Jutulsessen, Antarctica	KSAT	JPSS 20 Mbps	TR2 7.3m	Rx: Ka, X, S	JPSS-1/2/3/4 (Secondary): TT&C, SMD
WSC	White Sands, New Mexico	NASA	JPSS: 1.5 Mbps for TT&C 90 Mbps for SMD	Six 18m	Rx: Ka, Ku, S Tx: Ka, Ku, S	S-NPP (Contingency): TT&C JPSS-1/2/3/4 (Contingency): TT&C, SMD

Appendix C. ConOps to Requirement Mapping

NOTE: THIS APPENDIX IS NOT UNDER THE JPSS GROUND CM CONTROL. IT IS PROVIDED FOR INFORMATION ONLY.

Each ConOps thread consists of one or more logical functional flows that describes system concept of operations in a set of steps. In each step, a system Activity performs one or more Actions (functions), from which the system functional requirements are derived. This linkage is captured in a set of ConOps to Requirement mapping files, one for each ConOps thread.

These mapping files can be found in JPSS Document eRooms at:

https://jpss-erooms.ndc.nasa.gov/eRoom/JPSSGroundSystemEngineering/SEITWorkingGroups/0_a1d96

In the mapping file, each ConOps step, its primary Activity and specific Actions are traced to one or more level 2 Ground System Requirement (GSR), applicable level 3 requirements as well as Interface Requirements. The level 3 requirements cover CGS, AGS, FVTS, GRAVITE, and FTS. The file also traces the ConOps steps to the Ground SI&T Test Scenarios for system verification.

Table C-1 provides a list of all ConOps threads and their corresponding mapping files.

Table: C-1 List of ConOps to Requirement Trace Tables

Threads	File Name of ConOps to Requirement Trace Table
Fleet Ground Management	FGM ConOps Thread to Scenario Requirements Mapping
Mission Planning and Scheduling	MPS ConOps Thread to Scenario Requirements Mapping
System Status/ Situational Awareness	SSA ConOps to Requirements Mapping
Ground Operations	GO ConOps to Requirements Mapping
Integrated Support	Integrated Support ConOps to Scenario to Req Mapping
System Maintenance and Upgrade	SMU ConOps to Scenario to Req Mapping
Continuity of Operations	COOP ConOps to Req Mapping
System Fault Analysis	N/A
Security	N/A
Launch Readiness Support	N/A
Launch and Early Orbit	LEO ConOps Thread to Scenario Requirements Mapping
Telemetry and Command	TnC ConOps to Requirements Mapping
Space Operations	SO ConOps to Requirements Mapping
Space Network Support	SNS ConOps Thread to Scenario Requirement Mapping
Orbit Maintenance	OrM ConOps Thread to Scenario Requirements Mapping
Attitude Ground Support	AGS ConOps Thread to Scenario Requirements Mapping
S-NPP and JPSS-1 SSR Playback	N/A
Sensor Operations and Payload Support	SOaP ConOps to Req Mapping

Threads	File Name of ConOps to Requirement Trace Table
Key Management	Key Management ConOps to Scenario to Req Mapping
Flight Software Upgrade	Flight Software ConOps to Scenario to Req Mapping
Flight Vehicle Simulation	Simulator ConOps Thread to Scenario Requirements Mapping
Decommissioning	N/A
Data Acquisition and Routing	Route_Mission_Data_X16_ConOps_to_Req_Mapping
Stored Mission Data Handling	SMD ConOps to Scenario to Req Mapping
Data Accounting and Recovery	DAccR ConOps to Req Mapping
Data Quality Assurance	DQA ConOps to Req Mapping
Mission Support Data Handling	MSD ConOps to Scenario to Req Mapping
Algorithm Development and Maintenance	ADM ConOps to Req Mapping
Calibration and Validation of Data Products	CalVal ConOps to Req Mapping
Field Terminal User Support	FTS ConOps to Scenario to Req Mapping
Direct Broadcast Quality Monitoring	DBQM ConOps to Scenario to Req Mapping