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NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) PREPARATORY PROJECT (NPP)

SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

March 22, 2000

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

INTEGRATED PROGRAM OFFICE
SILVER SPRING, MARYLAND

NPP System Engineering Management Plan (SEMP)

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NPP System Engineering Management Plan

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1.0 INTRODUCTION

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) is a joint mission being formulated by the National Aeronautics and Space Administration (NASA) and the NPOESS Integrated Program Office (IPO). The NPP mission provides remotely sensed land and atmospheric data that serves the meteorological and global climate change communities.

This document is the NPP System Engineering Management Plan (SEMP), identifying the system engineering activities to be performed during the NPP mission formulation phase.

1.1 NPP BACKGROUND

The NPP is a joint-agency mission intending to serve the NASA and IPO user communities. The decision to pursue a joint mission was a direct result of discussions between the IPO and NASA, and the NASA Earth Science Enterprise (ESE) Post-2002 Mission Planning Workshop held in August 1998 in Easton, Maryland.

The NPOESS is a collection of satellites and ground capabilities supporting the operational needs of the civilian meteorological, oceanographic, environmental, climatic, and space environmental remote sensing programs. NPOESS is the follow-on and convergence of the NOAA Polar Orbiting Environmental Satellites (POES) and the Defense Meteorological Satellite Program (DMSP). Additionally, the NPOESS provides global change data for systematic measurements used by NASA and the Earth science research communities. The first NPOESS flight is planned for 2008. NPOESS provides instruments and spacecraft as part of the Space Segment, spacecraft operations and ground receive capabilities via the Command, Control, and Communication segment, and operational data processing and distribution to identified Weather Centrals by the Interface Data Processing segment.

The NPP mission serves as bridge between Earth Observing System (EOS) and the NPOESS programs. The NPP mission is planned for late 2005. For NASA, NPP is part of the EOS program, providing extended observations for key sustained systematic, measurements identified in the EOS Science Plan. For IPO, NPP provides risk reduction as an opportunity to demonstrate and validate new instruments, algorithms, and pre-operational processing capabilities prior to the first NPOESS flight.

1.2 SYSTEM OVERVIEW

The NPP is a joint partnership between NASA and the NPOESS IPO whose mission is to accomplish the following objectives:

- Demonstrate and validate global environmental imaging and sounding instruments, algorithms and pre-operational ground systems in order to provide risk reduction to the first NPOESS flight.

- Provide continuity of the calibrated, validated and geo-located EOS Terra and Aqua systematic global imaging and sounding observations for NASA Earth Science research.

For mission definition and formulation purposes, the NPP System is defined at the highest level in terms of six segments. These segments are used for the purpose of describing the System with the understanding that some functions currently found within one segment may ultimately be implemented in another segment, should it be deemed appropriate. See Figure 1-1, NPP System Overview.

The NPP is planned for an 824 km polar, sun-synchronous orbit with a 10:30 am descending node, equatorial crossing time. Sensor data are acquired continuously, stored onboard and are subsequently downlinked to polar ground stations for capture, preprocessing, and routing to the processing sites within the United States. Additionally, a continuous, realtime direct broadcast capability is planned for transmitting all instrument, and auxiliary data to users equipped to receive these data.

- Space Segment

The Space Segment (SS) consists of the satellite and ground support equipment (GSE). The satellite is comprised of the spacecraft and instruments. The instrument complement includes: Visible-Infrared Imager Radiometer Suite (VIIRS), Cross-Track Infrared Sounder (CrIS), and the Advanced Technology Microwave Sounder (ATMS). The possibility of an instrument of opportunity (IOO) is still being evaluated.

- Command, Control and Communications Segment

The Command, Control and Communications Segment (C3S) provides the NPP satellite operations capabilities, communication routing of mission data and the ground receive stations. The C3 Segment also provides for the overall mission management, including coordinating the joint program operations needs. Mission Management represents both the operational and scientific communities.

- Interface Data Processing Segment

The Interface Data Processing Segment (IDPS) provides for ingest of raw sensor telemetry received from the polar ground stations. The artifacts from the communication routing are removed, providing raw data records (RDRs), which are subsequently processed to create Sensor Data Records (SDRs) and Environmental Data Records (EDRs). The RDRs, SDRs, and EDRs are made available to five meteorological Centrals for use in application specific weather related predictions. The five centrals are:

- National Environmental Satellite, Data, and Information Service (NESDIS)
- Air Force Weather Agency/55th Space Weather Squadron,
- Fleet Numerical Meteorology and Oceanography Center (FNMOC), and
- Naval Oceanographic Office (NAVOCEANO).

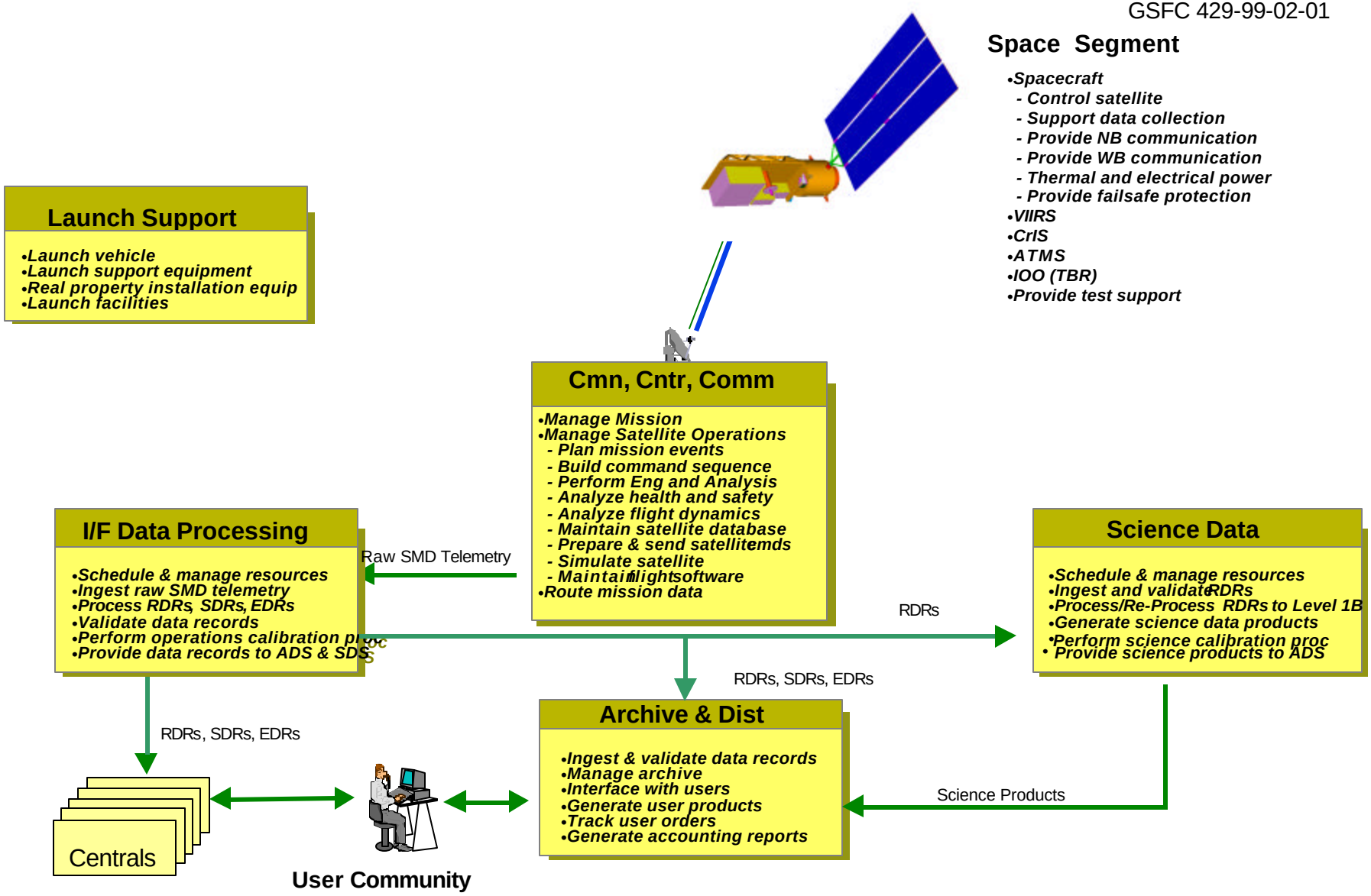

Figure 1-1. NPP Mission Overview

- Science Data Segment

The Science Data Segment (SDS) ingests the RDRs from the IDPS. The SDS validates format and volume/size of the RDRs, ensuring all data are received. The SDS processes the RDRs, creating a Level 1B product. The Level 1B is comparable to the IDPS SDR product, but is generated using, science algorithms. The RDRs are stored for the life of the mission, permitting reprocessing when improved science algorithms are made available from the science community. The Level 1B data are provided to a small, competitively selected science user group who are responsible for generating identified Level 2/3 science products. These products are unique to the science research community or represent a significant science improvement beyond the IDPS EDRs.

- Archive and Distribution Segment

The Archive and Distribution Segment (ADS) receives the RDRs, SDRs, and EDRs from the IDPS and the Level 1B and Level 2/3 products from the SDS. All of these data are archived, as are the associated metadata, upon which users may search and order data. Upon request, data products are distributed to users and billed for the cost of fulfilling the request.

- Launch Service Segment

The Launch Service Segment (LSS) provides those assets and services associated with the launch vehicle (LV) and the payload integration. Included along with the launch vehicle, are all ground support equipment, property, and facilities to integrate the spacecraft to the LV, verify their integration, and conduct pre-launch testing with the remainder of the ground system.

1.3 PURPOSE

The purpose of the NPP SEMP is to define the approach to planning and executing the System Engineering activities associated with the Formulation Phase of the NPP development life cycle. The SEMP will be updated once the Formulation Phase has been completed and transitioned to the Implementation Phase.

1.4 ROLES AND RESPONSIBILITIES

The NPP roles and responsibilities are based upon the Initial Implementation Agreement (IIA) between the NASA and the NPOESS IPO.

The IPO and the NASA Office of Earth Science shall jointly manage the program and assume the following division of responsibilities (summarized from the IIA):

<u>IPO:</u>

- Manage and fund the development of the CrIS
- Manage and fund the development of the augmented VIIRS

- Provide mission flight operations
- Provide the following ground system activities:
  - Stored mission data receive ground station
  - Primary and backup telemetry and command via National Oceanic and Atmospheric Administration (NOAA) Command and Data Acquisition (CDA) facilities, Air Force Satellite Control Network
  - Network services for data return to Continental United States (CONUS)
  - Prototype operational data processing
  - Prototype operational calibration and validation
  - Ground system integration

NASA:

- Perform mission System Engineering, integration and testing
- Manage and fund the development of the spacecraft bus
- Manage and fund the development of the ATMS
- Manage and fund the procurement of the launch vehicle
- Prepare for, conduct, and oversee launch and post-launch on-orbit checkout
- Provide the following ground system capabilities
  - Rate buffer subsystem for ground stations
  - Backup telemetry and command via Tracking and Data Relay Satellite (TDRSS)
- Provide engineering support for anomaly resolution for the life of the mission
- Participate with the IPO and NOAA in science level calibration/validation activities

Additionally, NASA is currently in negotiations with the IPO and NOAA regarding the development and operations of the data archive and distribution services. This activity will be addressed once an agreement on how to proceed is reached between NASA and the other parties.

1.5 PROGRAM REVIEW AND SCHEDULE

As defined by the NPG: 7120.5A NASA Program and Project Management Processes and Requirements, the management of the NPP will be conducted in three phases; Program Formulation, Program Implementation, and Program Evaluation. The NPP is currently in the Formulation Phase, which is scheduled to end approximately February 2001 with a Mission Confirmation Review. The Formulation Phase was preceded by a feasibility study, which ended with the approval for NPP to proceed to the Formulation Phase in May 1999.

For NPP, the Formulation Phase consists of three major activities: Mission System and Operations Concept Development, Mission Requirements Analysis, and Mission System Design. The Mission System and Operations Concept Development and the Mission Requirements Analysis culminated with the Mission Requirements Review (MRR) in March 2000. The Mission System Design begins after the MRR and results in the Mission Design Review (MDR)/Mission Confirmation Review (MCR) in February 2001.

1.6 APPLICABLE DOCUMENTS

Initial Implementation Agreement between National Aeronautics and Space Administration (NASA) and National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) for the NPOESS Preparatory Project (NPP), November 27, 1999

NASA GSFC, Recommended Approach to Software Development, Revision 3, Software Engineering Laboratory Series, SEL-81-305, June 1992, Greenbelt, Maryland.

NPG: 7120.5A, NASA Program and Project Management Processes and Requirements, NASA Procedures and Guidelines, April 3, 1998

ANSI/ASQC Q9001-1994, Quality Management and Quality System Elements – Guidelines, American Society for Quality Control Standards Committee for American Standards Committee Z-1 on Quality Assurance, 1994.

Application Portability Profile (APP) The U.S. Government's Open System Environment Profile Version 3.0, NIST Special Publication 500-230, National Institute of Standards and Technology, Systems and Software Technology Division, Computer Systems Library, February 1996, Gaithersburg, Maryland.

Open System Environment (OSE): Architectural Framework for Information Infrastructure, NIST Special Publication 500-232, Frederick Schulz, National Institute of Standards and Technology, Systems and Software Technology Division, Computer Systems Library, Gaithersburg, Maryland.

NASA Systems Engineering Handbook, National Aeronautics and Space Administration, June 1995

2.0 MISSION SYSTEM ENGINEERING

Mission System Engineering is only one of the processes that are executed during the formulation phase. Figure 2-1 illustrates the overall NPP Formulation Phase development process. Key system engineering elements of the Formulation Phase process include operations concept development, requirements development and analysis, architecture synthesis, and requirements allocation to segments.

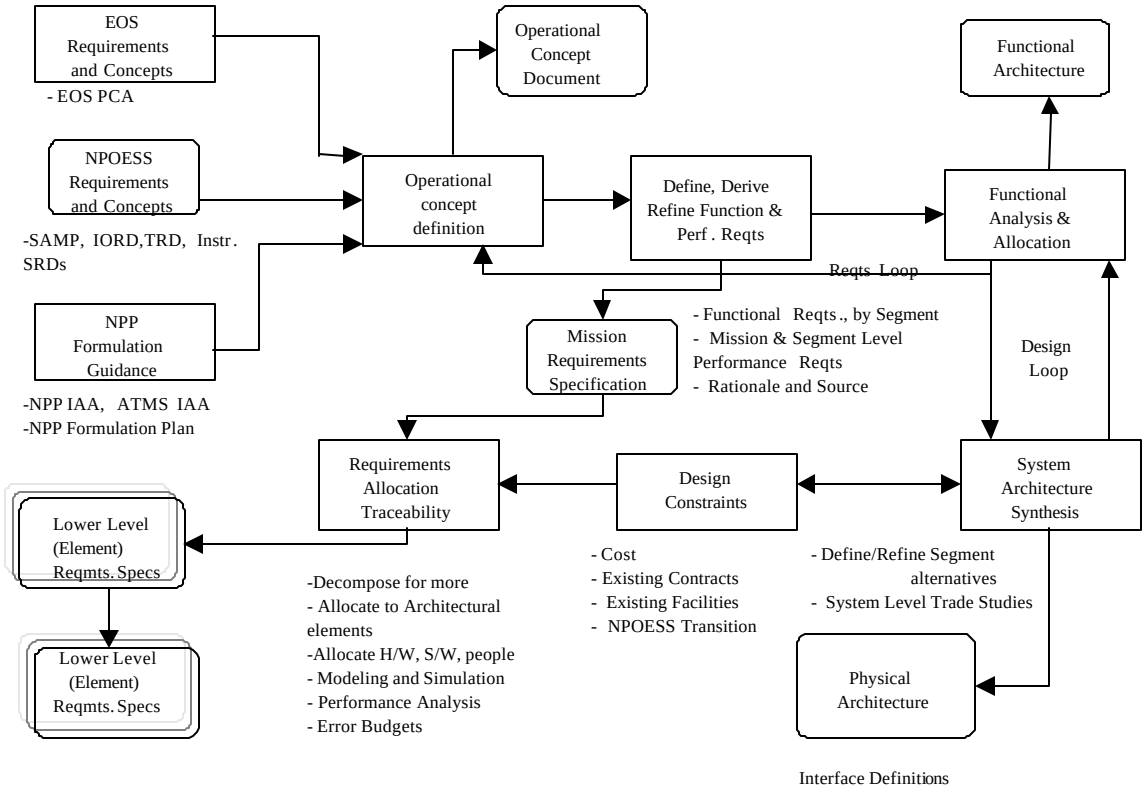

Figure 2-1. NPP Mission Formulation Process

The following paragraphs in this section describe the execution of the major Mission System Engineering processes and products that will support the development of the NPP Formulation Phase.

2.1 NPP MISSION SYSTEM ENGINEERING INTRODUCTION

For the NPP System Engineering effort, the Formulation and Implementation Phases are subdivided into the following activities:

- Formulation Phase
  - Mission System and Operations Concept
  - Mission System Requirements Analysis
  - Mission System Design

  The Mission System and Operations Concept and Mission System Requirements Analysis activities culminate with the MRR. The MRR approves such documents as

the Level 2 Mission Requirements and the System and Operations Concept along with other programmatic documentation.

The Mission System Design activity culminates with the MDR and the MRR. The MDR evaluates the next level of requirements, their allocation and design detail such as segment specifications and architecture descriptions.

The MCR is a programmatic review that either confirms the progression to the Implementation Phase or provides additional direction to the NPP Mission.

- Implementation Phase
  - Segment Design, Implementation and Test (Segment System Engineering)
  - Mission System Integration and Testing
  - Mission Operations and Maintenance

Figure 2-2 illustrates the NPP Formulation and Implementation phases and activities.

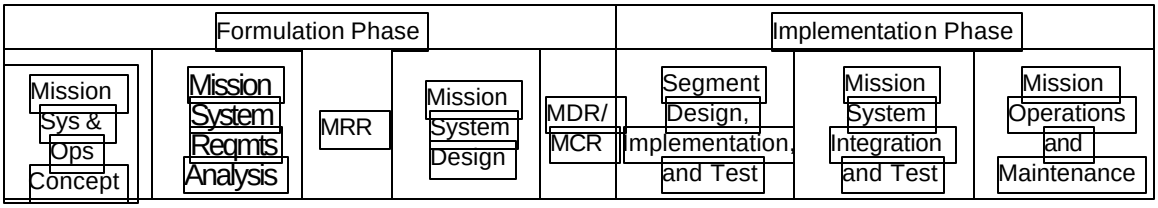

Figure 2-2. NPP Mission Phases

The Formulation Phase activities (Sys & Ops Concept, Mission Requirements Analysis, and Mission Design) have specific entry and exit criteria (as described in the following Activity Tables). However, certain aspects of each activity may be performed during other activities. For example, during the Mission Design activity, an architecture characteristic may change the System and Operations Concept that may lead to a change in Level 2 Mission Requirements.

2.2 PRODUCTS GENERATED DURING THE FORMULATION PHASE OF NPP

A large number of products are generated during the formulation phase. These include products generated by the Mission System Engineering effort, Project Management, and the products generated by segments of the NPP.
These are listed below:

2.2.1 Program Level Products

- NPP Program Requirements
  Level 1 NPP mission requirements

- ATMS Initial Implementation Agreement

Initial Implementation Agreement between NASA and IPO for ATMS, dated August 27, 1998. This IIA accomplishes the development, procurement, and delivery of a new NASA research ATMS instrument to the NPOESS IPO

2.2.2 Project Level Products

- NPP Formulation Plan
  The Project Formulation Plan (PFP) represents the agreement between the NASA Earth Observing System Program Office and the IPO for the work to be performed in support of the NPP Formulation. It defines the requirements and constraints imposed by the EOS Program Office and IPO and the services and products to be provided by the Project Formulation Manager (PFM).

- Configuration Management Plan
  Configuration Management Plan identifies the CM process including the various boards and the responsibilities, and provides the processes, forms, and board chairmanship.

- Transition Plan
  Transition Plan identifies the planning for the possible transitioning of operational, tool, system, and technology from the bridge mission for consideration/use by the NPOESS. Does not cover science observation transition from NPP to NPOESS; this is covered in the Science Plan.

- Technology Plan
  Technology Plan identifies the enabling and enhancing technologies being planned/considered for the mission and the activities and milestones for the technology development required to determine the feasibility of their use.

- Risk Management Plan
  Identifies the process to be used for the management of risks to the definition and implementation of the mission, including technical, cost, schedule, and programmatic.

- Safety and Security Plan
  Identifies activities to assure that all project safety responsibilities in program management system acquisition and mission execution are successfully discharged and that personnel, equipment and facilities are protected from hazardous conditions.

2.2.3 System Engineering Products

- System Engineering Management Plan (SEMP)
  SEMP identified the System Engineering approach for formulation; includes the SE processes, products, tools and working groups and includes all SE discipline areas. This document will be updated after MDR for the implementation phase.

- System and Operations Concept
  System and Operations Concept provides the functional model and associated operational scenarios upon which the model operates. Data flow diagrams, data

dictionary, functional description, and operational scenarios are also included in this document.

- NPP Mission Requirements (Level 2)
  NPP Mission Requirements document contains the Level 2 requirements based on the System and Ops Concept. It includes functional, performance, interface and operational requirements at the Mission Level.

- Performance Verification Plan
  Performance Verification Plan provides a system level verification plan, identifies the integration activities, sequencing, test phasing, and tool utilization.

- Architecture Description Document
  Architecture Description Document describes the NPP system architecture at the element level, as allocated from the segments; including hardware and software for those elements.

- SI&T Plan
  SI&T Plan describes the implementation plan for the system level integration, including the verification methods/criteria, test sequencing, and mapping to the mission level requirements.

- Segment Interface Documents
  These documents give the interface requirements, including performance specification for the data flow between the NPP Segments. The following Interface Requirement Documents (IRDs) have been identified.

  - SS to C3S IRD
    Identifies the interface requirements between the SS and the C3S.

  - SS to LSS IRD
    Identifies the interface requirements between the SS and the LSS

  - C3S to LSS IRD
    Identifies the interface requirements between the C3S and the LSS.

  - C3S to IDPS IRD
    Identifies the interface requirements between the C3S and the IDPS.

  - IDPS to SDS IRD
    Identifies the interface requirements between the IDPS and the SDS.

  - IDPS to ADS IRD
    Identifies the interface requirements between the IDPS and the ADS.

  - SDS to ADS IRD
    Identifies the interface requirements between the SDS and the ADS.

2.2.4 Science and Application Products

- Science Plan
  Science Plan identifies the approach for incorporating the science community involvement in the NPP mission

- Calibration and Validation Plan
  Calibration and Validation Plan identifies the approach for providing instrument calibration, characterization, trending and QA, and represents both operational and science calibration and validation objectives.

2.2.5 Space Segment Products

- Spacecraft Specification
  NPP Spacecraft documents contain the Level 3 requirements for the Spacecraft, based on the Level 2 mission requirements and System Ops Concept. It includes functional, performance, interface and operational requirements at the Segment Level.

- VIIRS Specification
  VIIRS specification identifies the detailed instrument and algorithm level specifications for the development of the instrument and algorithms. Also called the A-Spec.

- CrIS Specification
  CrIS specification identifies the detailed instrument and algorithm level specifications for the development of the instrument and algorithms. Also called the A-Spec.

- ATMS Specification
  ATMS specification identifies the detailed instrument and algorithm level specifications for the development of the instrument and algorithms. Also called the A-Spec.

- Launch Vehicle Specification
  Launch Vehicle specification identifies the spacecraft system requirements for use in launch vehicle studies, preliminary design, and detailed design.

2.2.6 C3 Segment Products

- C3S Operations Concept tailored for NPP
  C3S Operations Concept provides the functional model and associated operational scenarios upon which the model would operate. Data flow diagrams, data dictionary, functional description, and operational scenarios are also included in this document.

- C3 Segment Specification
  C3S Specification contains the Level 3 requirements based on the Level 2 Mission requirements and C3S Ops Concept. It includes functional, performance, interface and operational requirements at the Segment Level.

2.2.7 IDPS Products

- IDPS Operations Concept (Tailored for NPP)
  IDPS Operations Concept Document provides the functional model and associated operational scenarios upon which the model would operate, tailored for NPP. Data flow diagrams, data dictionary, functional description, and operational scenarios are also included in this document.

- IDPS Specification (Tailored for NPP)
  IDPS Specification contains the Level 3 requirements based on the Level 2 Mission requirements and IDPS Ops Concept. It includes functional, performance, interface and operational requirements at the Segment Level, tailored for NPP

2.2.8 Science Data Segment Products

- SDS Operations Concept
  SDS Operations Concept Document provides the functional model and associated operational scenarios upon which the model would operate. Data flow diagrams, data dictionary, functional description, and operational scenarios are also included in this document.

- SDS Specification
  IDPS Specification contains the Level 3 requirements based on the Level 2 Mission requirements and SDS Ops Concept. It includes functional, performance, interface and operational requirements at the Segment Level.

2.2.9 Archive and Distribution Segment Products

- ADS Operations Concept
  ADS Operations Concept Document provides the functional model and associated operational scenarios upon which the model would operate. Data flow diagrams, data dictionary, functional description, and operational scenarios are also included in this document.

- ADS Specifications
  ADS Specifications Document contains the Level 3 requirements based on the Level 2 mission requirements and ADS Ops Concept. It includes functional, performance, interface and operational requirements at the Segment Level.

Figure 2-3 illustrates the phased development and hierarchy for the NPP documents.

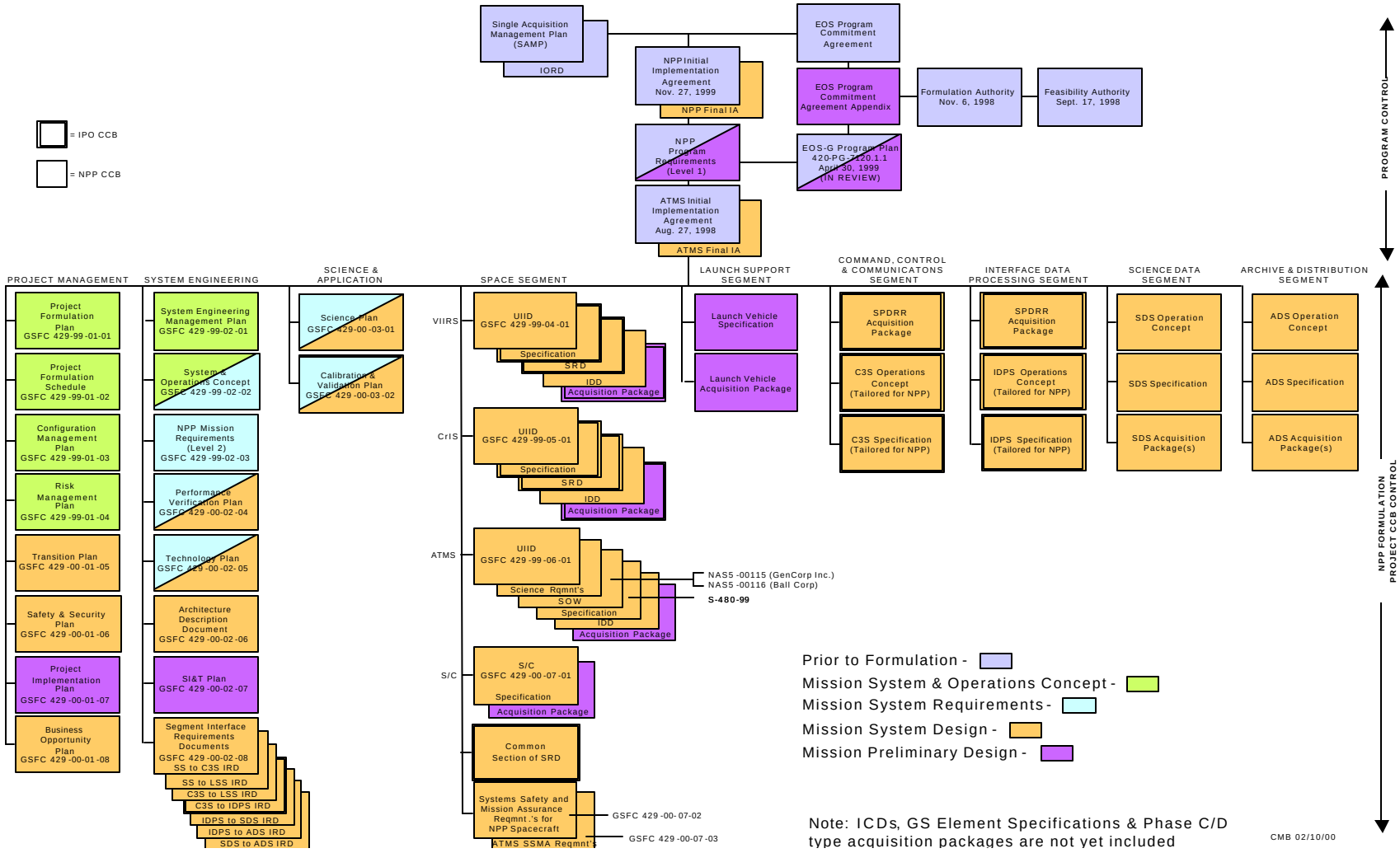

Figure 2-3. Phased development and hierarchy for the NPP documents

2.3 MISSION SYSTEM ENGINEERING PROCESS

This section describes the System Engineering process for the Formulation Phase of the NPP Mission.

2.3.1 Mission System and Operations Concept Development

This activity began with the identification of draft Level 1 NPP requirements, external interfaces, and the IIA. These inputs are the starting point for the development of the NPP Context Diagram and Data Flow Diagrams.

The Context Diagram depicts all the external interfaces to the NPP Mission. The Data Flow diagrams (DFDs) depict all the interfaces between external elements as well as internal interfaces between segments as defined in Section 1.1 System Overview.

Once the DFDs have reached maturity, operational scenarios are developed identifying the functional sequences of events and flow of information between functions. The operational scenarios aid in further maturation of the DFDs and the system concept collectively. The DFDs, operational scenarios and associated information comprise CONOPS. The Data Flows Diagrams and CONOPS are updated until all interfaces and functions of each segment are sufficiently defined in order to generate Level 2 requirements.

Figure 2-4 highlights the Mission System and Operations Concept activities.

2.3.2 Mission System Requirements Analysis

Requirements Development

Once the CONOPS becomes stable, the Level 2 Mission Requirements Document (MRD) is developed. The MRD contains overall mission and segment requirements. The CONOPS and MRD will be updated simultaneously to reflect consistency between operation concepts and Level 2 requirements. Additional inputs to the MRD may originate from NPOESS requirement specifications or other projects with similar Level 1 requirements or objectives.

After the CONOPS and MRD have become stable (i.e. no major changes are being processed), each Level 2 Mission Requirement is traced to Level 1 Requirements. Also, each Level 2 Mission Requirement is traced to a verification method.

Requirements Analysis

When the Level 1 and verification trace activities are complete, the Level 2 Mission Requirements will be analyzed for the following quality characteristics:

- Realistic - Requirements must be achievable

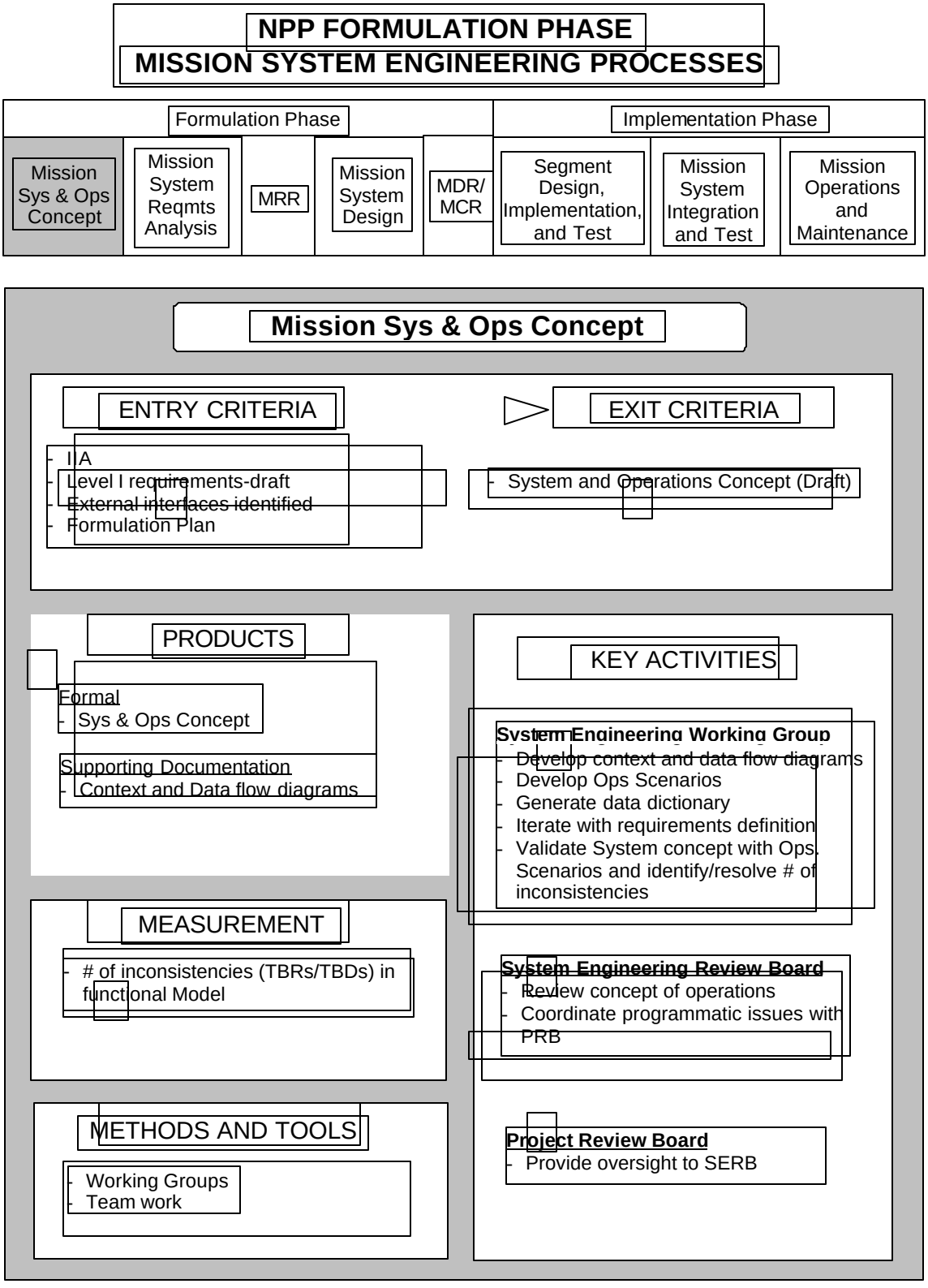

Figure 2-4. Mission System & Operations Concept

- Unambiguous – Requirements must be clearly stated and are not likely to be subjected to different interpretations
- Consistent - Requirements must use uniform notation, symbols, terminology, and structure and not contradict themselves technically
- Complete - The requirements should be at a level of detail that provides for translation of the requirement into design
- Testable (Verifiable) The requirements are verifiable by test/demonstration/analysis and can be translated into acceptance criteria
- Traceable - to some higher level requirements/specifications (Level 1).

Once this activity is compete, Level 1/2 and verification trace matrices are completed and updated CONOPS and MRD are produced. A Requirements Analysis Report is also generated describing any operations concept or requirements that remain incomplete, ambiguous, untraceable, or non-verifiable/testable. The Requirements Analysis Report also includes standard metrics such as number of requirements, number of requirements traced, number of TBDs, etc.

Trade Studies

As part of the Requirements Analysis phase, trade studies or independent analyses may be performed under the direction of mission management. The purpose of trade studies or independent analyses is to provide:
- Alternative operation scenarios or requirements
- Technology risk reduction
- Alternative architectures
- Operation scenarios/requirements validation
- Other.

Critical Technologies

The NPP Mission includes enabling and enhancing technologies. The Low Noise Amplifiers (LNAs) for ATMS is considered a mission enabling technology and serves to meet the mission objectives. Other technologies are considered mission enhancing technologies and serve to demonstrate key capabilities that are not in line to be used for mission success. These include:
- Ka-band phased array for data down link
- Spacecraft on-board processing
- Optical communication for rapid delivery of data to users

The NPP Technology Plan addresses the development and integration of these technologies into the NPP Mission.

Performance Verification Plan

Also during the Requirements Analysis Phase, a draft Performance Verification Plan (PVP) is developed. The PVP outlines the overall approach to integrating and testing all NPP segments, from development through integration and testing, and on-orbit operations.

Figure 2-5 highlights the Mission System Requirements Analysis activities.

NPP FORMULATION PHASE
MISSION SYSTEM ENGINEERING PROCESSES

Formulation Phase					Implementation Phase		
Mission Sys & Ops Concept	Mission System Reqmts Analysis	MRR	Mission System Design	MDR/ MCR	Segment Design, Implementation and Test	Mission System Integration and Test	Mission Operations and Maintenance

Mission System Requirements Analysis

ENTRY CRITERIA

- System & Operations Concept Document - Draft
- Level 1 Requirements -Draft

EXIT CRITERIA

- Level 2 Mission Requirements Doc - Review
- System & Operations Concept Doc - Review
- Performance Verification Plan - Draft
- Technology Plan - Draft
- Transition Plan-Draft
- Risk Management Plan-Review
- Cal/Val Plan-Draft

[redacted]

MEASUREMENTS

- # of inconsistencies in DFDs
- Percentage of L2 reqmts traced to L1 reqmts
- Percentage of L2 reqmts traced to verification method
- # TBDs and TBRs in L2s
- # of open trades

METHODS AND TOOLS

- Working Groups
- Trade Studies
- IMDC
- DOORS
- Teamwork

KEY ACTIVITIES

System Engineering Working Group

- Develop Mission Requirements
- Allocate requirements to segments
- Trace L2 Mission Reqmts to L1 Reqmts
- Trace L2 Mission Reqmts to verification method
- Conduct trade studies
- Define Performance Verification approach
- Update System & Ops Concept

System Engineering Review Board

- Review Sys & Ops Con, L2 Mission Reqmts
- Coordinate programmatic issues with PRB

NPP Review Board

- Provide oversight to SERB
- Review Sys & Ops Con, L2 Mission Reqmts

Figure 2-5. Mission System Requirements Analysis

2.3.3 Mission Requirements Review (MRR)

The Mission System and Operations Concept and Mission Requirements Analysis activities conclude with the Mission Requirements Review. All documents and associated products (analysis, trade studies, and technology assessments) for the System and Operations Concept, and Mission Requirements Analysis activities are reviewed by a panel chaired by GSFC Flight Assurance organization. The panel is comprised of representatives from IPO, other NASA organizations, science, and external parties.

Products are scrutinized for maturity, clarity as well as end item produceability. The NPP Mission System Engineering, Segment and Science teams are responsible for presenting to management the technical, cost and schedule aspects of the NPP Mission to management.

Figure 2-6 highlights the Mission Requirements Review activities.

2.3.4 Mission System Design

Mission System Design begins with the approval of the NPP MRR and the release of the baselined System and Operations Concept, Mission Requirements Document, and a draft version of the Performance Verification Plan.

Mission Scenarios and Mission System Architecture

At the beginning of the Mission System Design activity, an end-to-end Mission System Architecture is developed based on several factors such as: critical technologies, existing infrastructure, or new NPP capabilities, and Level 2 requirements allocation.

In parallel to the development of this architecture, Mission Scenarios are developed in order to validate the end-to-end architecture as well as the CONOPS and MRD. Both Mission Scenarios and the Mission System Architecture are iterated with the development of the other NPP products to be developed during the Mission System Design activity, such as the Interface Requirements Documents and the segment specifications.

Interface Requirements and Segment Specifications

Interface Requirements Documents (IRDs) are developed between the segments in parallel with the development of the segment specifications, such as the Spacecraft Specifications. (Segment specifications are produced by each segment developer).

Once the Mission Scenarios, Mission System Architecture and IRDs are stable, the final Performance Verification Plan and System Integration and Testing Plan are developed.

Figure 2-7 highlights the Mission System Design activities.

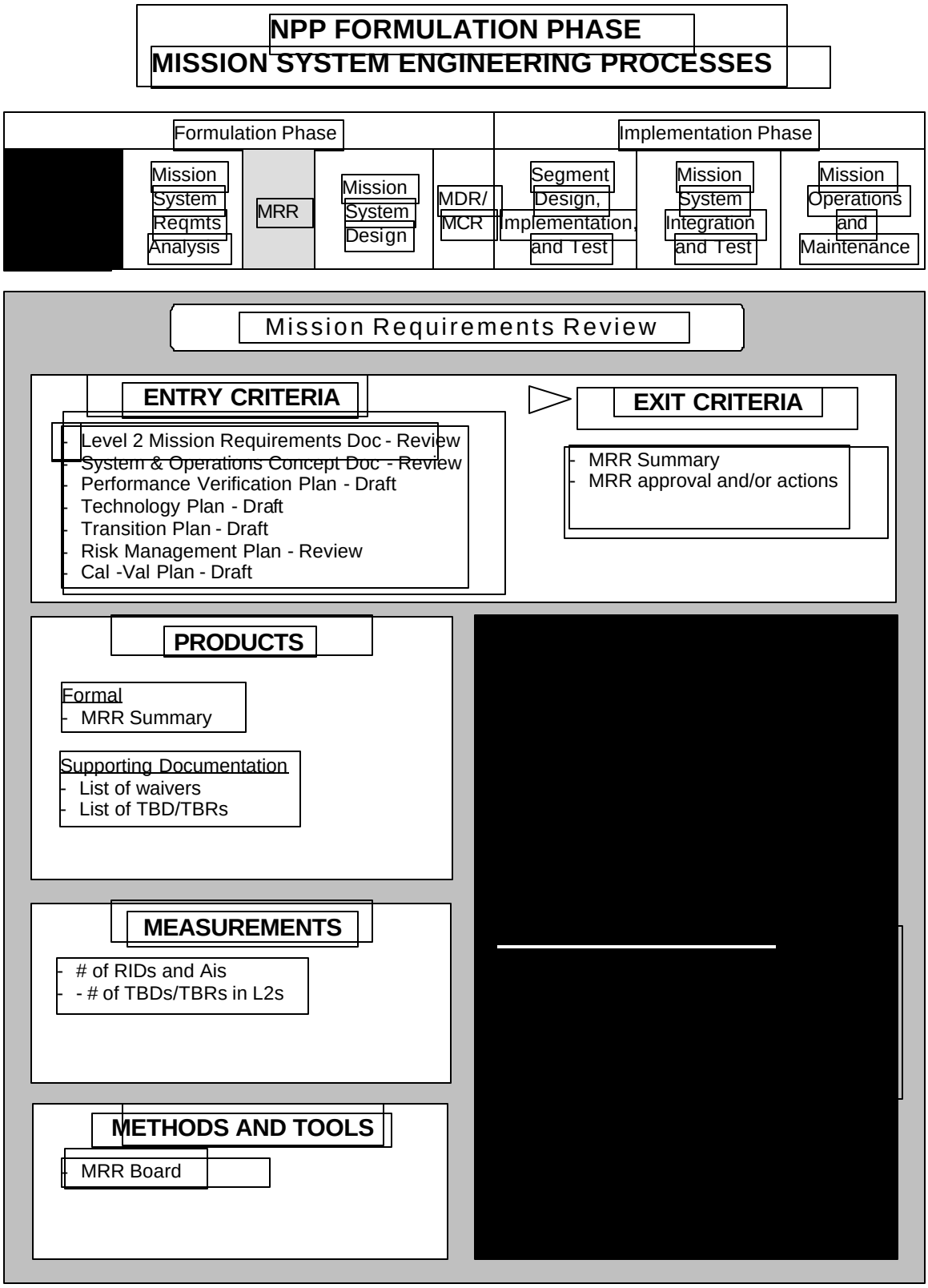

Figure 2-6. Mission Requirements Review

NPP FORMULATION PHASE
MISSION SYSTEM ENGINEERING PROCESSES

Formulation Phase					Implementation Phase		
Mission Sys & Ops Concept	Mission System Reqmts Analysis	MRR	Mission System Design	MDR/ MCR	Segment Design, Implementation and Test	Mission System Integration and Test	Mission Operations and Maintenance

Mission System Design

ENTRY CRITERIA

- NPP MRR approval
- Level 2 Mission Requirements Doc - Baselined
- System & Operations Concept Doc - Baselined
- Performance Verification Plan - Draft

EXIT CRITERIA

- All Segment Specs (L3) - Baselined
- All Segment Ops Concepts (L3) Baselined
- Performance Verification Plan Baselined
- Mission System Architecture Baselined
- Interface Reqmts Doc- Baselined
- System Integration & Test Plan - Baselined

[redacted]

MEASUREMENTS

- Percentage of L2 and L3 reqmts traced to each other
- Percentage of interfaces docs completed
- # of open TBD/TBRs per I/F Doc.

METHODS AND TOOLS

- Working Groups
- Trade Studies
- IMDC
- TBD tool

KEY ACTIVITIES

System Engineering Working Group

- Develop Mission System Architecture(s)
- Trace segment spec reqmts to L2 Mission Reqmts
- Conduct trade studies
- Update Performance Verification Plan
- Develop Interface Reqmts Docs
- Define System Integration & Test Approach

Systems Engineering Review Board

- Review Segment Specs, Sys Arch, Performance Verification Plan
- Coordinate programmatic issues with PRB

NPP Review Board

- Provide oversight to SERB
- Review Segment Specs, Sys Arch, Performance Verification Plan

Figure 2-7. Mission System Design

2.3.5 Mission Design Review/Mission Confirmation Review

The Mission System Design and the entire Formulation Phase concludes with the MDR and MCR. The purpose of the MDR is to review the complete NPP Mission, from requirements and specifications, to operations concepts, to architectures and risk from a technical, cost and schedule aspect. The MDR, like the MRR is chaired by the GSFC Flight Assurance organization with representatives from IPO, other NASA organizations, and science and external organizations.

The MCR is conducted at the Program level between NASA, IPO and NOAA. The purpose of this review is to evaluate the technical merits of the NPP Mission against each agencies budget and mission goals. Approval for proceeding to the Implementation Phase may be expected approximately 3 months after the MCR.

Figure 2-8 highlights the MDR/MCR activities.

2.4 CONFIGURATION MANAGEMENT (CM)

Configuration Management activities within the system engineering process will conform to the GSFC ISO and NPP Configuration Management Plan.

2.5 QUALITY

Products developed by the system engineering effort will conform to the GSFC and NPP ISO procedures and guidelines.

2.6 TEST AND VERIFICATION PLANNING

During the Implementation Phase, test and verification planning begins once a conceptual architecture is developed during the Mission System Design activities. The initial plan, the Performance Verification Plan (PVP), addresses the top-level plan and activities that are necessary to complete verification of the NPP mission. The PVP addresses development, integration, testing, launch integration, as well as on-orbit verification activities across all elements of the NPP.

2.7 RISK MANAGEMENT

Risk Management process for System Engineering activities are within the Project Risk Management activities. All System Engineering risk management activities are in direct support of the NPP Manager.

2.8 SYSTEM ENGINEERING AND PROJECT MANAGEMENT TOOLS

Due to the distributed nature of the NPP, commercially available tools have been selected to support the system engineering and project management process. The following tools and a brief description of their use are given below.

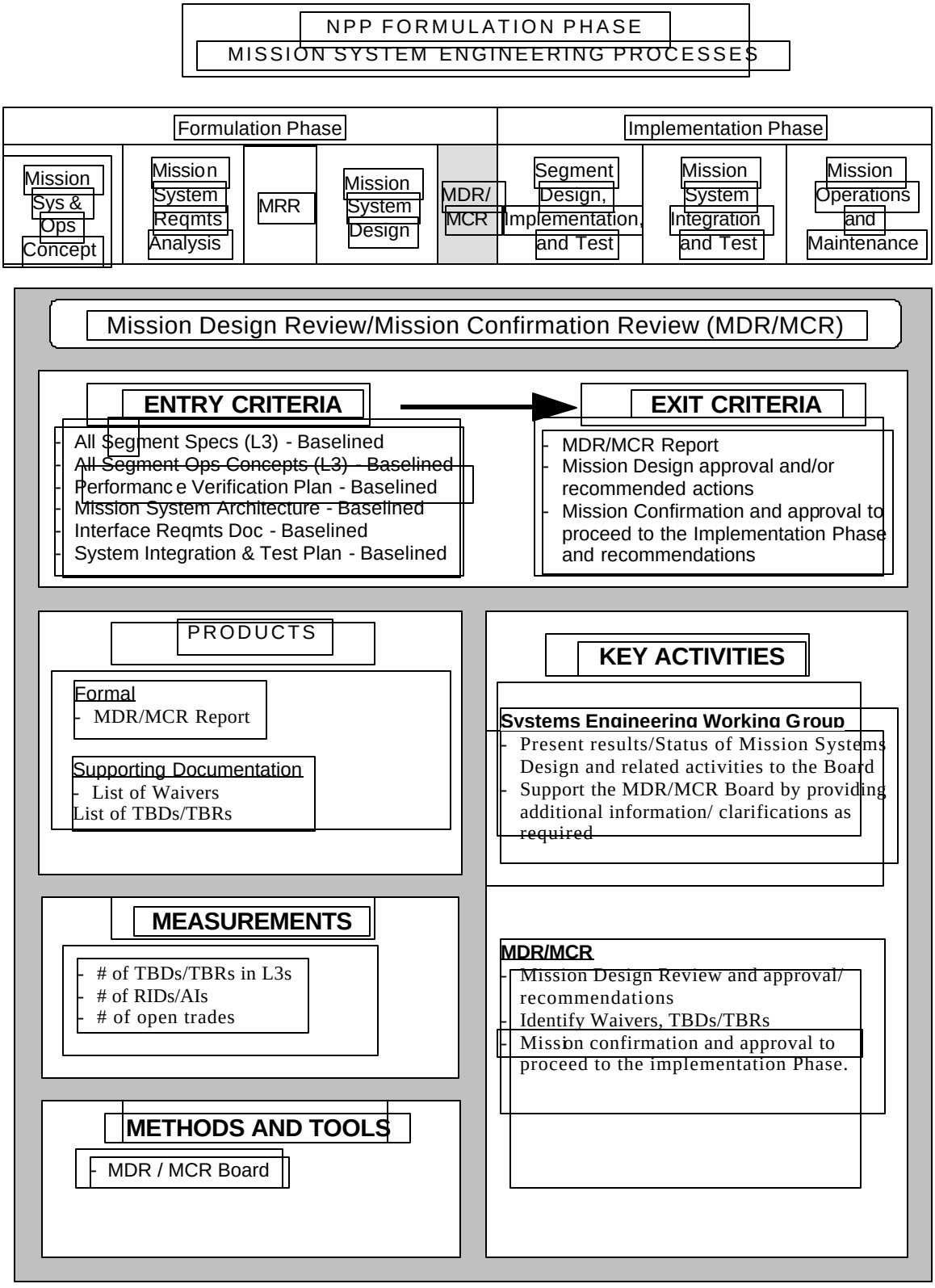

Figure 2-8. Mission Design Review/Mission Confirmation Review

“DOORS” – requirements data base, analysis and reports

“Teamwork” – data flow diagram development, analysis, reports, and data dictionary

“Mesa/Vista” – web-based integrated project management tool support for schedules, action items, risk management, configuration management, meeting coordination, on-line dialog.

3.0 REVIEW BOARDS AND WORKING GROUPS

3.1 PROGRAMMATIC/TECHNICAL REVIEW BOARDS

This section describes the NPP review boards. Figure 3-1 depicts the hierarchical relationship between the NPP technical and programmatic organizations.

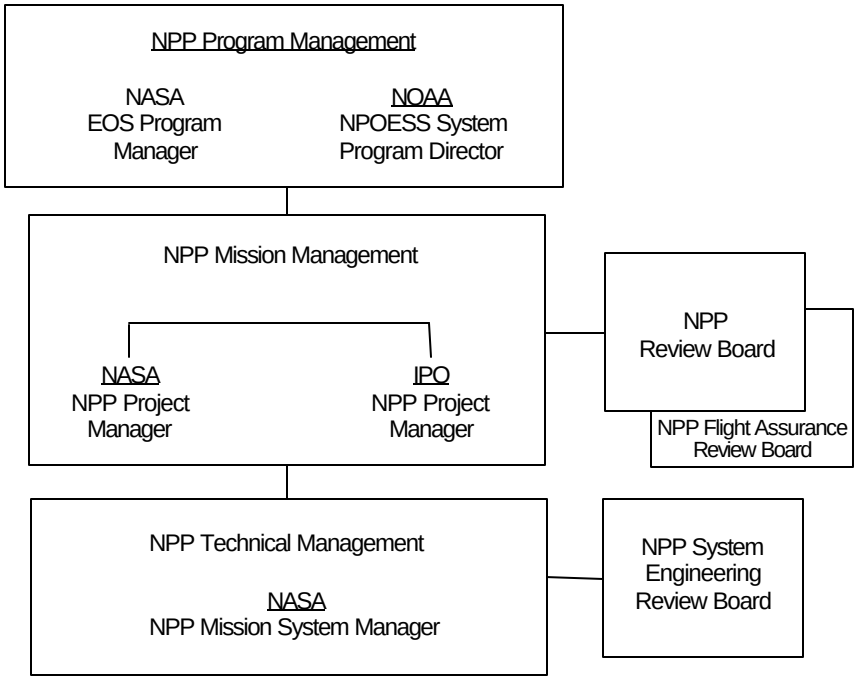

Figure 3-1. NPP Mission Formulation Organization

3.1.1 NPP Review Board (NRB)

The purpose of this review board is to evaluate and approve all products and schedules associated with the Formulation Phase and to evaluate the progress towards MRR milestones. The NRB also is responsible for the approval of the Integrated Master Schedule, and controls all Level 2 milestones, and formulation budget.

The NRB is led by the NPP Project Managers. The NASA Project Manager chairs the NRB, while the IPO Project Manager serves as the deputy chair. Issues that cannot be resolved at the NPP Mission Management level are brought to the attention of the NPP Program Management for resolution. Board members include representatives from the following:

- NPOESS IPO
- C3 Segment
- IDPS Segment
- Space Segment
- Science Data Segment
- Launch Segment

- Archive and Distribution Segment
- Interim Science Panel
- Mission System Engineering

The NRB nominally meets monthly.

3.1.2 Flight Assurance Review Board

The purpose of this review board is to evaluate the technical aspects of NPP. The board provides an independent assessment of the NPP progress at major reviews. The reviews (including MRR and MDR) are chaired by a member of the GSFC Flight Assurance Office and co-chaired by a member of the IPO. Additional board members include: field experts from other GSFC directorates/divisions and/or external organizations. Independent reviews leading up to the launch of NPP are described in the NPP Performance Verification Plan (PVP) and NPP Systems and Integration and Test Plan (SI&T).

3.1.3 NPP System Engineering Review Board (SERB)

The purpose of this review board is to evaluate the technical aspects and review milestones for all segments and interfaces. The SERB responsibilities include:

- Oversight of the system engineering process execution as described in Section 2.2
- Recommendation for approval to the NPP Mission Requirements, System and Operations Concept, and Performance Verification Plan to the NRB
- Resolution of technical issues
- Coordination with NRB for programmatic issues

The SERB is chaired by the NPP System Manager. An IPO representative serves as the deputy chair. Member representatives include:

- IDPS
- C3
- Science Data Segment
- Space Segment
- Archive and Distribution Segment
- Launch Segment
- Interim Science Panel

The SERB nominally meets once every two weeks.

3.1.4 Interim Science Panel

The purpose of the Interim Science Panel (ISP) is to provide scientific insight and recommendations to the requirements and design definition of the NPP instruments. The ISP is led by the NPP Formulation Scientist and is comprised of appointed members with directly applicable expertise.

3.2 WORKING GROUPS

This section describes the system engineering working groups that will execute the development of the system engineering products.

3.2.1 System Engineering Working Group

The System Engineering Working Group (SEWG) is responsible for executing the system engineering process (Section 2.2) and the development of the system engineering products (Section 2.1). The SEWG is led by the NPP System Manager. The System Manager assigns responsibility for the development of products to specific team members who have the responsibility for planning, organizing and developing those products. Documentation assignments are as follows:

The System Manager is responsible for facilitating the resolution of issues between segments as well as coordinating issues/progress with program management. The System Manager is the primary interface for technical issues related to science integration or operations.

The SEWG provides oversight for the IDPS Working Group, Interface Control Working Group, Test and Verification Working Group, Science Data Processing Working Group and the Archive and Distribution Working Group.

The SEWG coordinates science related issues with the Interim Science Panel.

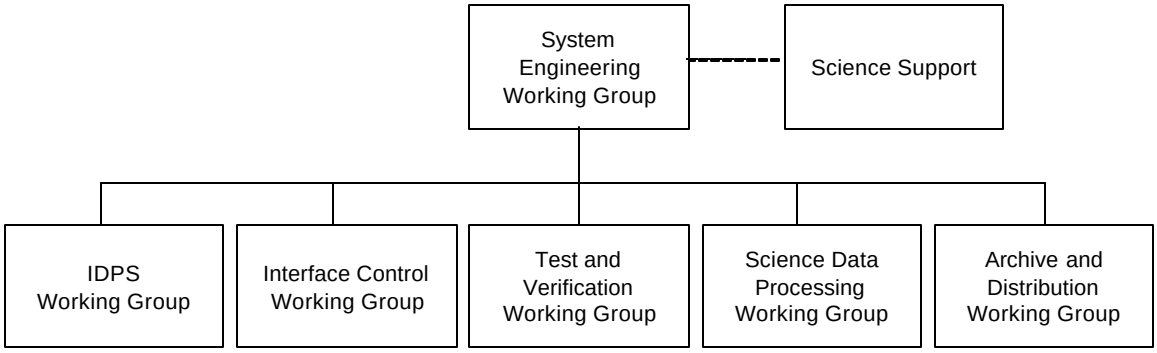

Figure 3-2. Working Groups

3.2.2 IDPS Working Group

The IDPS WG is responsible for the development of IDPS requirements, operations concepts and interfaces.

3.2.3 Interface Control Working Group

The Interface Control Working Group (ICWG) is responsible for the development and configuration control support for the Interface Requirements Documents and Interface Control Documents for all internal and external NPP interfaces. The ICWG identifies

interfaces between segments and has the responsibility to negotiate the technical details of each interface.

Membership on the ICWG includes all segments and parties that have interfaces internally or externally to the NPP.

3.2.4 Test and Verification Working Group

The Test and Verification Working Group (T&VWG) is responsible for development of the integration and testing activities between segments. The T&VWG works with each segment developer to understand each segment's verification process and schedule in order to develop an integrated test and verification plan and schedule that spans the NPP Mission from development, through integration and testing, to on-orbit operations.

Membership includes representatives from each segment, test facilities, launch processing facilities and operations.

3.2.5 Science Data Processing Working Group

The Science Data Processing Working Group is comprised of NASA and science climate research representatives. The purpose of this work is to develop and identify requirements, products and the architecture for the Science Data Processing Segment.

3.2.6 Archive and Distribution Working Group

The Archive and Distribution Working Group is comprised of NASA, IPO, and NOAA representatives. The purpose of this working group is to develop and identify requirements, products and the architecture for the Archive and Distribution Segment.

Appendix A

Acronym List

ADS	Archive and Distribution Segment
ATMS	Advanced Technology Microwave Sounder
C3S	Command, Control and Communications Segment
CDA	Command and Data Acquisition
CONOPS	System and Operations Concept
CONUS	Continental United States
CrIS	Cross-Track Infrared Sounder
DFD	Data Flow Diagrams
DMSP	Defense Meteorological Satellite Project
EDR	Environmental Data Recorder
EOS	Earth Observing System
ESE	Earth Science Enterprise
ICD	Interface Control Document
IDPS	Interface Data Processing Segment
IIA	Interim Interagency Agreement
IPO	Integrated Program Office
IRD	Interface Requirements Document
ISP	Interim Science Panel
MCR	Mission Confirmation Review
MDR	Mission Design Review
MMIC	Monolithic Microwave Integrated Circuits
MRB	Mission Review Board
MRD	Mission Requirements Document
MRR	Mission Requirements Review
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NRB	NPP Review Board
PVP	Performance Verification Plan
RDR	Raw Data Record
SERB	System Engineering Review Board
SEMP	System Engineering Management Plan
SEWG	System Engineering Working Board
SDS	Science Data Segment
SI&T	System Integration and Testing
SMD	Sensor Monitor Data
SS	Space System

TDRSS	Tracking and Data Relay Satellite System
T&VWG	Test and Verification Working Group
VIIRS	Visible-Infrared Imager Radiometer Suite