101-CD-001-004

EOSDIS Core System Project

Project Management Plan for the EOSDIS Core System

Revision 1

June 1995

Hughes Information Technology Corporation
Upper Marlboro, MD

Project Management Plan for the EOSDIS Core System

Revision 1

June 1995

Prepared Under Contract NAS5-60000
CDRL Item 001

SUBMITTED BY

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Preface

This document is a formal contract deliverable with an approval code 1 and was approved by the Government for acceptance and use in August 1993. Once approved, contractor approved changes to approval level 1 documents are handled in accordance with Class I and Class II change control requirements described in the EOS Configuration Management Plan. The changes reflected in this revision are all Class II (i.e., no change to schedule or cost) and were reviewed and approved by the ECS Contractor Configuration Control Board (CCB). CN 01

This is a total revision of the ECS Project Management Plan that reflects recent changes to the ECS organizational structure: the Contractor integrated team of companies with assigned contributions are delineated with the overall internal organization structure (sections 5, 10). Further the Contractor's organization elements are matched with Government and external community counterparts that are the primary interfaces established to achieve the ECS-allocated portion of the EOS mission (section 7). Other updates/changes include section 3, the technical approach to system development, which now reflects the multiple release environment and section 4, which updates the project schedule and an overview of the manpower resources plans for ECS development.

This plan serves two purposes: 1) to internally guide the operations of the Contractor's project organization; and 2) to specify the framework for coordination between the Government and Contractor. The pervasive themes that dominate the project management approach are: 1) concrete planning for involvement of science users with measurement feedback on performance and satisfaction; and 2) achieving technical performance within cost and schedule constraints.

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Change Information Page

List of Effective Pages	
Page Number	**Issue**
Title	Final
iii through x	DCN No. 01
xi and xii	Final
1-1 and 1-2	Final
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1. Introduction

This revision to the Project Management Plan describes the management approach, processes, and mechanisms that the ECS Contractor employs to execute the ECS Statement of Work and other contractual specifications. The plan serves two purposes: 1) to internally guide the operations of the Contractor's project organization; and 2) when approved, to specify the framework for coordination between the Government and Contractor. The pervasive themes that dominate the project management approach are: 1) concrete planning for involvement of science users with measurement feedback on performance and satisfaction; and 2) achieving technical performance within cost and schedule constraints.

The following sections comprise this Project Management Plan:

Section 2, Related Documentation. Other parent, applicable, and information documents are cited.

Section 3, Technical Approach to System Development. The primary content is a system description, the multiple release environment, and the user and technical data bases that relate to the development process.

Section 4 ,Development Schedule. Defined in this section are the project schedule and an overview of the manpower resources plans for ECS development.

Section 5, ECS Contractor Organizational Structure. The Contractor integrated team of companies with assigned contributions are delineated here along with the overall internal organization structure. Section 10 furnishes more detail.

Section 6, Key Management Processes. The macro-level management processes that balance technical/cost/schedule performance are described. Included are risk management, cost/schedule management, and configuration management. Also included is the management reserve strategy designed to respond to unanticipated contingencies.

Section 7, Coordination with Government Personnel. The Contractor's organization elements are matched with Government and external community counterparts. These are the primary interfaces established to achieve the ECS-allocated portion of the EOS mission.

Section 8, User Involvement Approach. Science user interaction plans are described along with user modeling/characterization and collaborative prototype coordination.

Section 9, Subcontracting and Management Plan. The plan for allocating work products among subcontractors is delineated hee along with the approach to managing subcontractors.

Section 10, Internal Work Flow Management. The work flow, internal organization of each project Organization unit, and interactions with other units are described.

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2. Related Documentation

Figure 2-1 illustrates the relationships of ECS technical CDRL items. Section 2.1 lists Government documents specifying requirements from which this document's scope and content was derived. Documents prepared under this contract will utilize existing Hughes standard practices where applicable; these practices will be referenced and included within each document where utilized.

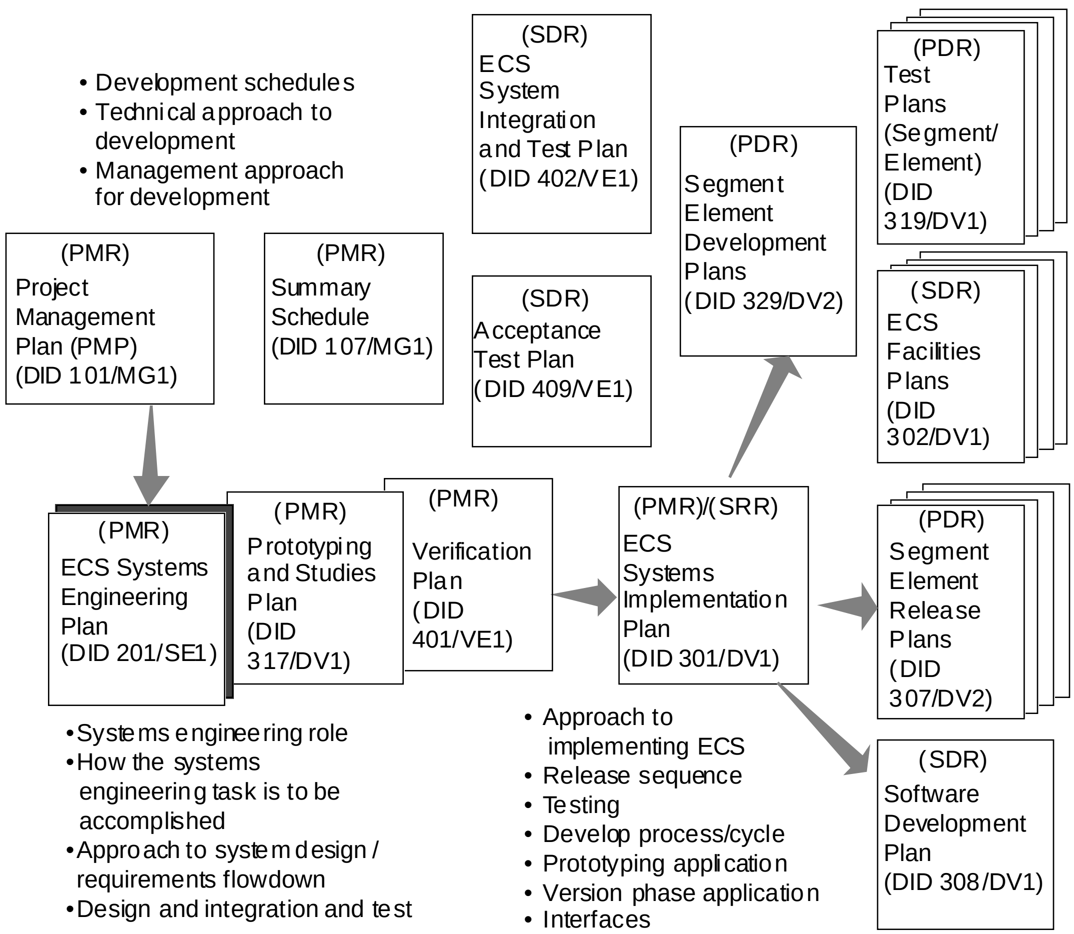

Figure 2-1. ECS Document Relationships

2.1 Parent Documents

The following documents are the parents from which this document's scope and content derive:

GSFC 420-05-03	Goddard Space Flight Center, Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System (ECS)
GSFC 423-41-01	Goddard Space Flight Center, EOSDIS Core System (ECS) Statement of Work
GSFC 423-41-02	Goddard Space Flight Center, Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System (ECS)
GSFC 423-41-03	Goddard Space Flight Center, EOSDIS Core System ECS) Contract Data Requirements Document
NASA-STD-2100-91	NASA Software Documentation Standard Software Engineering Program

2.2 Applicable Documents

The following documents are referenced herein and are directly applicable to this plan. In the event of conflict between any of these documents and this plan, this plan shall take precedence.

194-102-MG1-001	Configuration Management Plan for the ECS Project
194-106-MG1-001	Schedule Management Plan for the ECS Project 106-CD-001-004 DCN No. 01
107-CD-001-XXX	Level 1 Master Schedule for the ECS Project
101-110-MG2-001	Procurement Management Plan for the ECS Project
111-CD-001-XXX	Monthly Progress Report for the ECS Project
194-201-SE1-001	Systems Engineering Plan for the ECS Project
193-205-SE1-001	Science User's Guide and Operations Procedure Handbook for the ECS Project,
205-0CD-002-001	Science User's Guide and Operations Procedure Handbook for the ECS Project, Part 4: Software Developer’s Guide to Preparation, Delivery, Integration and Test with ECS,
194-207-SE1-001	System Design Specification for the ECS Project
210-CD-001-002	Risk Assessment Report for the ECS Project
214-CD-001-001	Security Plan for the ECS Project
193-215-SE1-001	Risk Analysis Report for the ECS Project

301-CD-002-003	System Implementation Plan for the ECS Project
194-302-DV2-001	ECS Facilities Plan for the ECS Project
194-317-DV1-001	Prototyping and Studies Plan for the ECS Project
319-CD-001-002	Flight Operations Segment (FOS) Integration and Test Plan for the ECS Project
319-CD-002-002	Science Data Processing Segment (SDPS) Integration and Test Plan for the ECS Project, Volume 1: Ir-1, Final
319-CD-003-002	CSMS Integration and Test Plan for the ECS Project, Volume 1: IR-1, Final
319-CD-004-002	CSMS Integration and Test Plan for the ECS Project, Volume 2: Release A, Final
319-CD-005-002	Science Data Processing Segment (SDPS) Integration and Test Plan for the ECS Project, Volume 2: Release A, Final
194-401-VE1-002	Verification Plan for the ECS Project
402-CD-001-002	System Integration and Test Plan for the ECS Project, Volume 1: Interim Release 1 (Ir-1), Final
402-CD-002-002	System Integration and Test Plan for the ECS Project, Volume 2: Release A, Final
409-CD-001-003	ECS Overall System Acceptance Test Plan for Release A, Final
503-CD-001-XXX	Performance Assurance Status Reports for the ECS Project
506-CD-001-001	ECS Audit Reports for the ECS Project
510-CD-001-XXX	Summary Reports of Contractor Reviews for the ECS Project
513-CD-001-002	Hazard Analyses for the ECS Project
514-CD-001-002	Security-Sensitive Items List for the ECS Project
520-CD-001-002	Software Critical Items List for the ECS Project

2.3 Information Documents

The following documents, although not directly applicable, amplify or clarify the information presented in this document, but are not binding.

222-TP-003-006	Release Plan Content Description for the ECS Project
151-TR-001-001	HAIS CCBs: Allocation of Authority and Responsibility
152-TR-001-002	ECS Document Management and Control Matrix

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3. Technical Approach to System Development

This section describes the EOSDIS Core System (ECS) in the context of NASA's Mission to Planet Earth (MTPE), and describes Hughes Applied Information Systems' (HAIS') ECS development process.

3.1 System Description

Mission to Planet Earth (MTPE) is a long-term, multi- and inter-disciplinary NASA research mission to study the processes leading to global climate change, and to develop a predictive capability for the Earth system on time scales of decades to centuries. To accomplish these objectives, researchers require a readily accessible collection of diverse observations of the Earth over an extended period of time, with the capability to create and add new data products to this collection based on improved understanding.

The Earth Observing System (EOS) is the centerpiece of MTPE. EOS includes a series of polar-orbiting and low-inclination satellites for long-term global observations of the land surface, biosphere, solid earth, atmosphere, and oceans. NASA's long-range plans include a new generation of satellites in geostationary orbit and additional Earth Probe satellites (defined as Earth observing missions that are not part of EOS) addressing specific Earth science investigations. EOS and Earth Probes will provide high spatial resolution global information, and geostationary platforms will provide a time-continuous database over the full earth.

As illustrated in Figure 3-1, EOS is composed of the following three principal components:

- The EOS Space Measurement System (EOSSMS)
- The EOS Scientific Research Program (EOSSRP)
- The EOS Data and Information System (EOSDIS)

The purpose of the EOSSMS is to acquire essential, global Earth science data on a long-term, sustained basis and in a manner which maximizes the scientific utility of the data and simplifies analysis. EOSSMS consists of a series of NASA spacecraft and instruments supplemented by spacecraft and instruments from International Partners (IPs). The European Space Agency (ESA), the Canadian Space Agency (CSA), and the Japanese National Space Development Agency (NASDA) are planning Earth observing missions that complement NASA's EOS program.

The purpose of the EOSSRP is to investigate processes in the Earth System and to improve predictive models. The EOSSRP includes three major categories of users of EOS data and information; (1) EOS science investigators, (2) non-EOS-affiliated science users, and (3) other users. EOS data policy will help transcend the traditional boundaries of access to mission data for these users. Unless distribution restrictions apply, EOS data and information will be made available to the user community without a waiting period in which the data are considered proprietary.

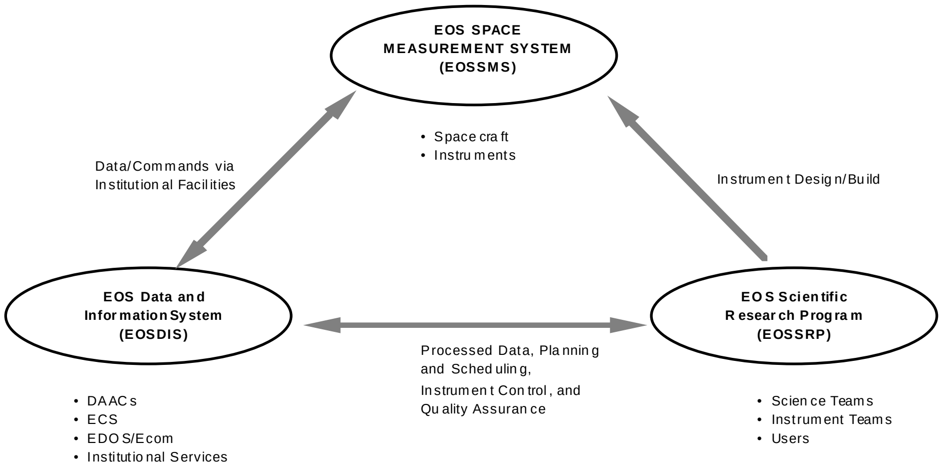

Figure 3-1. EOSDIS Components

The purpose of the EOSDIS is to provide the Earth science research community with easy, affordable, timely, and reliable access to the full suite of Earth science data from U.S. and International Partner (IP) spacecraft, and from other earth science data sources. EOSDIS will provide the ground system for the collection and analysis of EOS science data to support scientists in resolving the dynamics of the Earth's components and the processes by which they interact. The EOSDIS Core System (ECS) is the major component of the EOSDIS. The ECS will control the EOS spacecraft and instruments, process data from the EOS instruments, and manage and distribute EOS data products and other selected data sets.

The ECS provides the services and functionality to command and control the EOS spacecraft and instruments, to process data from the EOS instruments, and to manage and distribute EOS data products and other selected data sets. In addition to fully supporting the EOS series of spacecraft and instruments, the ECS provides information management and data archive and distribution functions for other Earth science missions.

3.2 Baseline Configuration

The ECS consists of three segments defined to support three major operational areas; flight operations, science data processing, and communications/system management. The three segments are briefly described below:

- The Flight Operations Segment (FOS) manages and controls the EOS spacecraft and instruments. The FOS is responsible for mission planning, scheduling, control, monitoring, and analysis in support of mission operations for U.S. EOS spacecraft and instruments.
- The Science Data Processing Segment (SDPS) receives, processes, archives and manages data from EOS and non-EOS missions. It provides support to the user community in accessing the data as well as products resulting from research activities that utilize this data. SDPS also promotes, through advertisement services, the effective utilization and exchange of data within the user community. Finally, the SDPS plays a central role in providing the science community with the proper infrastructure for development, experimental usage and quality checking of new Earth science algorithms.
- The Communications and System Management Segment (CSMS) provides for the interconnection of users and service providers, transfer of information between the ECS and many EOSDIS components, and monitoring and coordination of all EOSDIS components. It supports and interacts with the SDPS and the FOS.

Figure 3-2, ECS Baseline Configuration, illustrates the ECS segments in the context of EOS. Additional details on the ECS design and its architecture can be found in the ECS System Design Specification, 194-207-SE1-001.

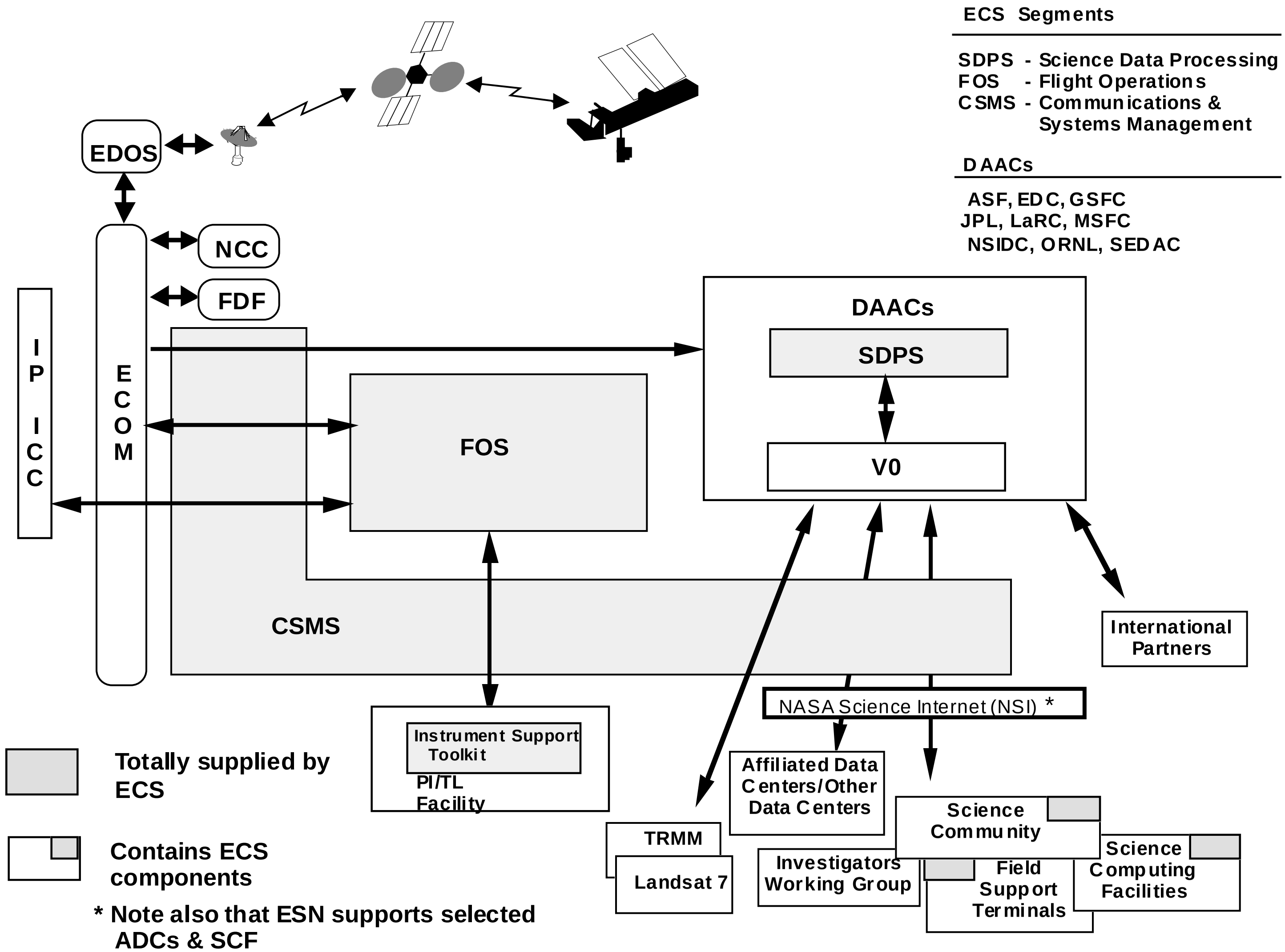

Figure 3-2. ECS Baseline Configuration

3.3 ECS Multiple Release Environment

The ECS will be developed using an evolutionary development process with multiple releases (see Figure 3-3). The multiple releases provide for a build-up of functionality as well as a means to evolve the system either to incorporate operational feedback or to allow technology insertion.

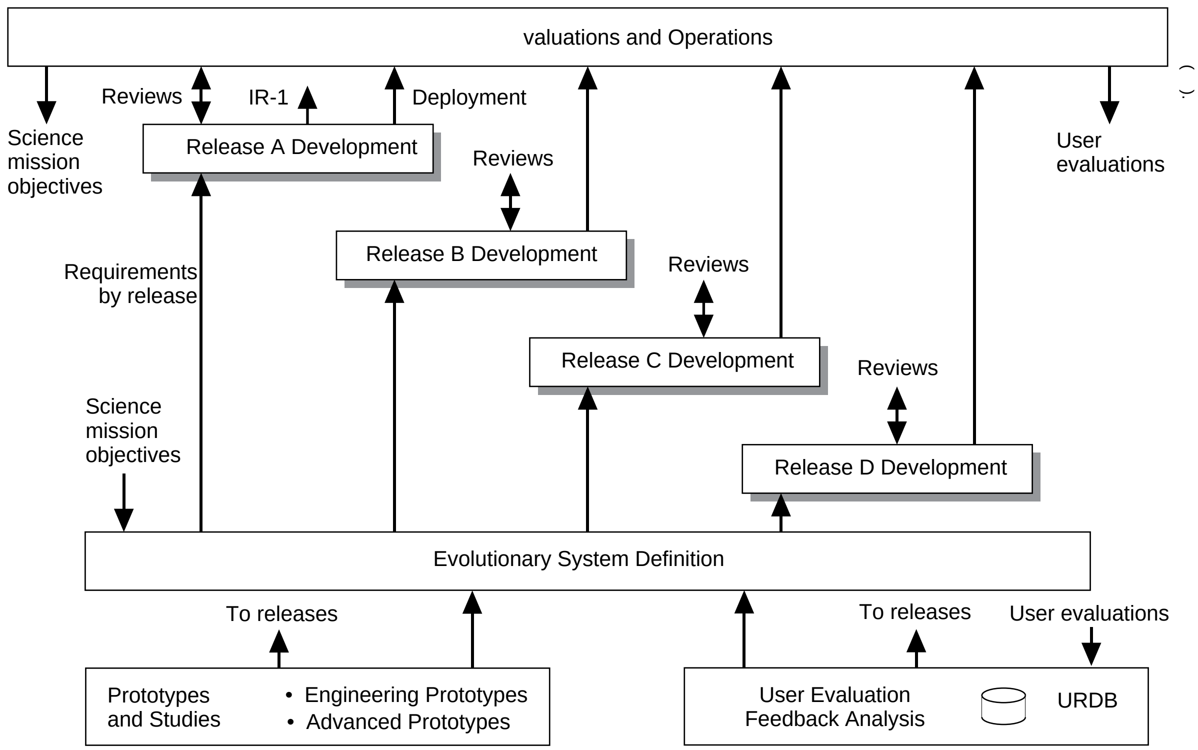

Figure 3-3. ECS Multiple Release Development Process

For a specific release, multiple development processes will be used (see Figure 3-4). The two main development approaches are Formal Development and Incremental Development. Although not strictly a development track, prototypes also provide concepts and designs which can feed the two main development tracks. The ECS approach to prototyping is described in the Prototype and Studies Plan (194-317-DV1-001).

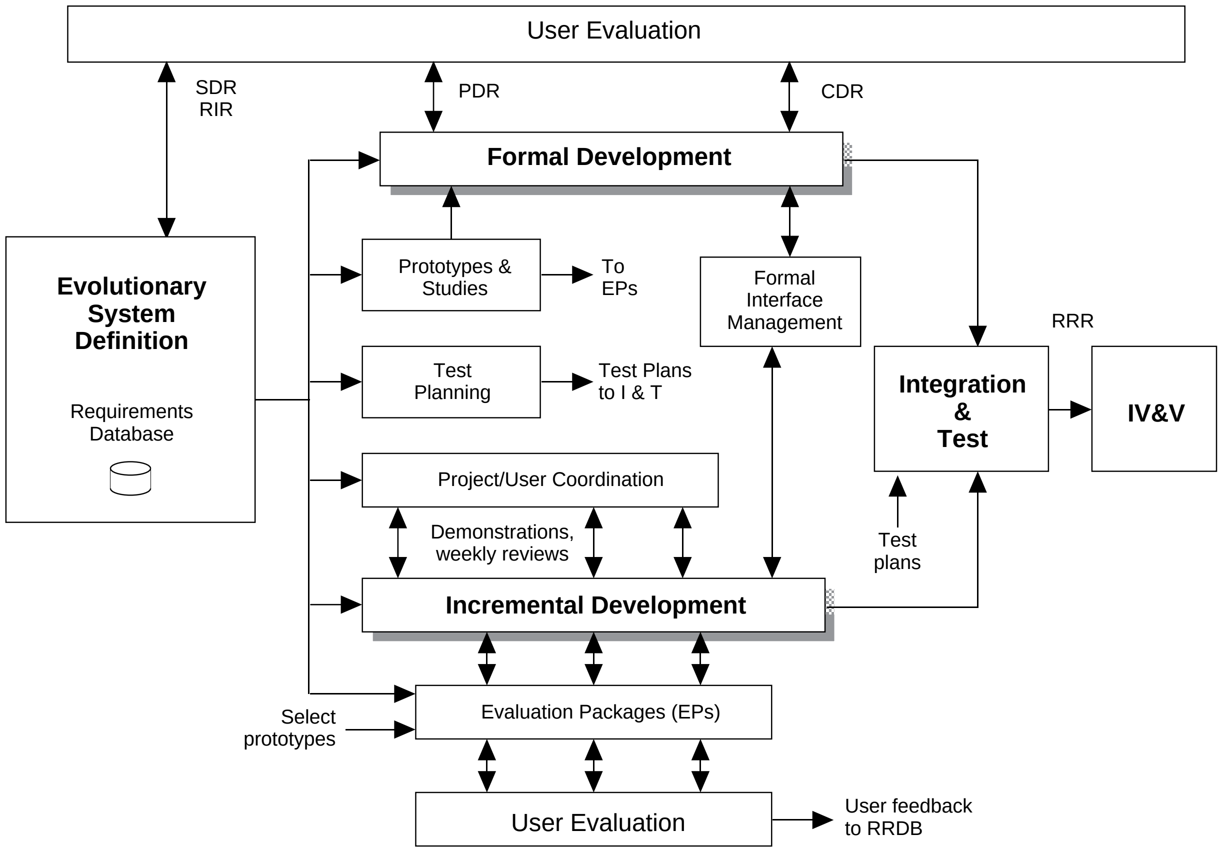

Figure 3-4. ECS Multi-Track Development Process for a Release

The approach is to use incremental development for those areas of the system where requirements are less well understood and formal development where requirements are believed to be more stable. The premise behind multi-track development for ECS is that these two differing requirement types can be best implemented through differing development processes tailored to their individual needs.

Both formal and incremental development tracks will be implemented in a way that provides: 1) a method for assuring compliance with acknowledged requirements, 2) traceability of requirements allocation to tracks, 3) provides a development methodology that allows modular development, 4) uses an integration process that brings the separately developed pieces together into an integrated whole, and 5) defines a process for control of interfaces that supports integration.

Formal Development and Incremental Development are described in more detail below. In summary form, Table 3-1 compares the major features of the two development approaches. Additional details can be found in the System Engineering Plan (194-201-SE1-001).

Table 3-1. Comparison of Formal and Incremental Development

	Formal	Incremental
Overview	Methodical process driven by defined requirements	Iterative process focused on early adaptation of implementation to user evaluation
Life Cycle Structure	Single waterfall of sub-phases each terminated by formal milestone review	Multiple waterfalls of identical sub-phases with on-going demonstrations and reviews
Reviews	Formal with large cross-section of community with RIDs	Weekly planning and status meetings Monthly Demonstrations EP Readiness Reviews
Feedback	Tirekicker involvement, Formal reviews, URDB, operational experience	Extensive demonstrations to tirekickers and others, URDB, operational experience
Interface Control	Formal ICDs both internal and external	Formal ICDs to any interfaces external to incremental developments
Specifications	Level 4 requirements and design developed prior to implementation, as-built materials for RRR	Draft Level 4 Specifications during development Final Level 4 Specifications developed as-built before CSR
Code	Developed to standards, assessed using metrics	Developed to standards, assessed using basic metrics
Integration and Test	System I&T to procedures based on Level 3 requirementsSegment I&T to procedures based on Level 4 requirements	For I&T for EP delivery: joint segment and system I&T to expert procedures based on increment objectives. For migration to formal release: Segment I&T to expert procedures based on increment objectives Prior field experience through evaluation packages System I&T to procedures based on Level 3 requirements
CM	Programmer and segment team leader control prior to TRR; CMO control thereafter	Programmer and segment team leader control prior to TRR; Site M&O and CMO control at evaluation sites
QA	Audits	Audits
Risks	Longer cycle time for user evaluation of implementation	Reliability of integration, Functionality for a release, Maintainability, Complexity of CM

3.3.1 Overview of Formal Development

Formal Development is composed of four stages (See Figure 3-5): Preliminary Design, Critical Design, Implementation, and the COTS procurement process. Formal interface management, although embedded in the stages for formal development, is displayed as a separate activity to highlight the criticality of interface management with the incrementally developed components.

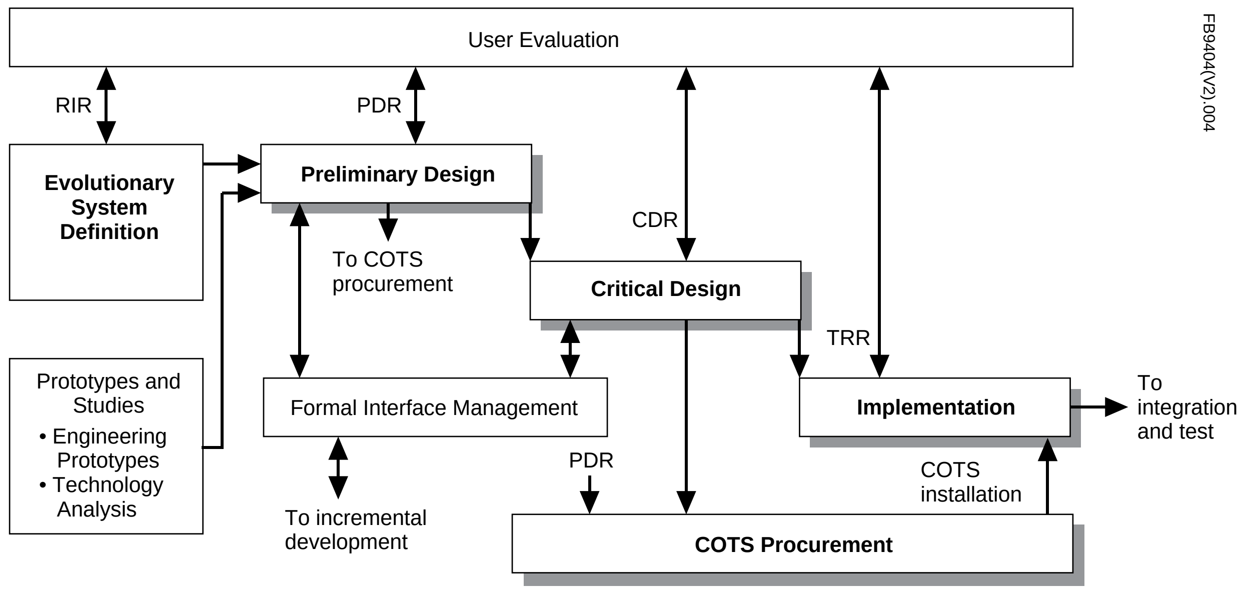

Figure 3-5. Formal Development Activities

The formal development process is a "traditional" waterfall development process. The first steps in the waterfall involve the definition and approval of requirements which meet the need of the mission which the system will support. The requirements are developed with a system concept in mind, but there is little effort spent on developing designs early in the waterfall. Once the system requirements are approved and a system design is determined, lower level requirements are developed, various design alternatives are considered, trade studies are conducted and a preliminary design is approved at the Preliminary Design Review (PDR). Detailed design and implementation are then developed anticipating minor changes in the requirements and top level design. This process is suited to a system where the mission is well defined and the challenge is to ensure the correct performance out of a system constructed from components which are developed in parallel.

Interim Release 1 shares the same PDR and CDR with Release A, but has its own unique ETR and CSR. IATO Acceptance Test and IV&V are performed on Releases A, B, C and D. They are not performed on Interim Release 1, since it is used to support early interface testing, and not flight operations, and is completely replaced by Release A.

The gateways between stages are formal reviews held with large user community attendance. The reviews are a major method for receiving user feedback via the Review Item Discrepancies (RIDs).

3.3.2 Overview of Incremental Development

The incremental development track allows evolution of emerging technology and rapid development of selected ECS software with minimal documentation generated during the development period. This evolutionary approach supports the iteration of design and implementation with the development of Level 4 requirements—initially stated as objectives. Instead of a single waterfall of sub-phases, the incremental process uses multiple incremental development cycles, including user evaluation prior, to integration with formally developed software. Figure 3-6 illustrates how multiple incremental development cycles support a release. The number of increments shown in Figure 3-6 is illustrative. The specific number of increments for a release is based on specific release plans. Figure 3-6 also shows the participation of the incremental development teams in formal interface management. Although not shown in the figure, the incremental development teams participate in the formal reviews.

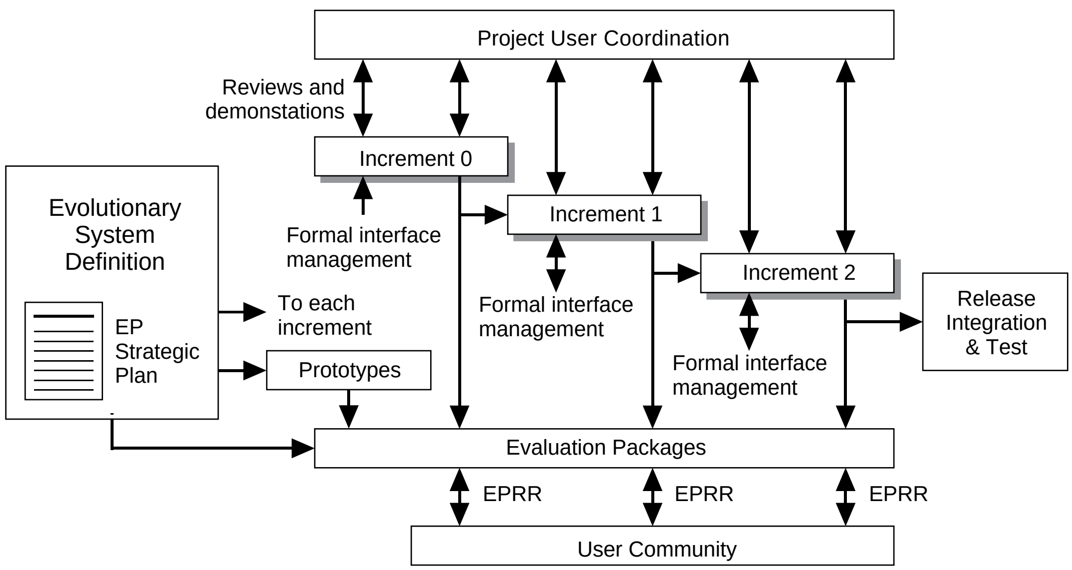

Figure 3-6. Incremental Developments for a Release

Incremental development is used to mitigate technical and development risks inherent in software with ill-defined requirements, with extensive interactive software, or with an immature technology or standards heritage. As such, toolkits, selected ECS components, and supporting infrastructure will be developed using the incremental process. Hardware will be implemented and tested only in so far as is necessary to implement incremental software. The incremental process will require early development of the infrastructure of the data management and communication components of the ECS system.

Products from the incremental track are first deployed as part of an Evaluation Package (EP) along with selected prototypes. All incrementally developed products flow to the User Evaluation arena as part of an Evaluation Package. They are re-released as part of a Formal

Release for operational status when they have been optimized through the EP process to meet external driving operational requirements. The Evaluation Package Strategic Plan White Paper (194-WP-922-001) includes a section outlining the process by which incremental products are evaluated by customers and users and their opinions and suggestions are gathered, analyzed, and fed back to engineering and development personnel in a structured, controlled process.

An incremental development approach involves a small customer selected segment of the user community in the process of product evaluation. Capabilities are demonstrated frequently in a "build and test a little, evaluate a little" development progression. Software built in one increment supersedes and provides more capabilities than the software in the previous increment. The incremental development process leads up to the integration of incrementally developed components into a formal release via conformance to design standards and the migration of documentation into the formal process. The direction and progress of the development is verified during each increment—verifying that user requirements are understood and correctly implemented. Lessons learned in one incremental development cycle may be used to improve software in the subsequent incremental development cycle. The amount of M & O required to be performed between increments is limited. The capabilities that are built and evaluated by a small group—customer-selected-users, ECS M&O and Science Office—are not yet operational nor available outside this selected group. Maintenance will be limited to customer selected/high priority items (versus maintenance of all problems that may occur after installation at the small number of selected sites). In addition, training of these selected users/tirekickers will not be necessary, due to their early involvement and demo experiences, and due to fact that the user interface itself must be self-evident/ user friendly so as not to require training nor an extensive user's guide/manual.

3.4 Integration and Test of Multiple Track Products

The Integration and Test (I&T) function is crucial to the success of the multi-track development process. There are two types of I&T in the multi-track process in addition to the Acceptance Test (AT) process. The first type of I&T is in support of the deployment of an increment and selected prototypes as part of an Evaluation Package (EP). The second type of I&T is the integration into a formal Release of incrementally developed components with formally developed components. This second type of I&T is performed as part of the Release I&T activity after the TRR and ending after the CSR with turnover of the Release to the IATO for acceptance testing. The IATO then conducts acceptance tests at the site to the Level 3 requirements assigned to that Release.

3.5 User Recommendations Data Base CN 01

The continual evaluation of user feedback is critical to the evolutionary development process. This feedback occurs during a variety of events in the project's activities: prototype evaluations, reviews, operations, etc. The User Recommendations Data Base (URDB) provides extensive interfaces with the user community, single point control of the flow of recommendations, and rapid and effective assessment of recommendations in a partnership environment. The URDB is the process used to collect, screen, and assess ECS user recommendations prior to presentation to the CCB. The objectives of the recommendation collection and analysis process are: CN 01

- To record and track all requirements recommended in formal interface meetings and reviews as well as recommendations that are generated in daily informal working relationships.
- To actively solicit and incorporate feedback and recommendations from users.
- To control, track, consolidate, and assess recommendations in a timely and efficient manner, and to ensure that appropriate recommendations are presented to the responsible CCB. CN 01

A comprehensive recommendations analysis process has been developed to meet these objectives (Figure 3-7). The process includes developing multiple interfaces, both formal and informal, and taking the responsibility for recording recommendations and entering them into a database. In addition, the Project team actively solicits new recommendations from NASA and the science community through prototype and operational evaluations, interviews, document analysis, and an on-line interface. Single point control of recommendations is provided through a database where all recommendations are entered, tracked, and updated after each assessment. CN 01

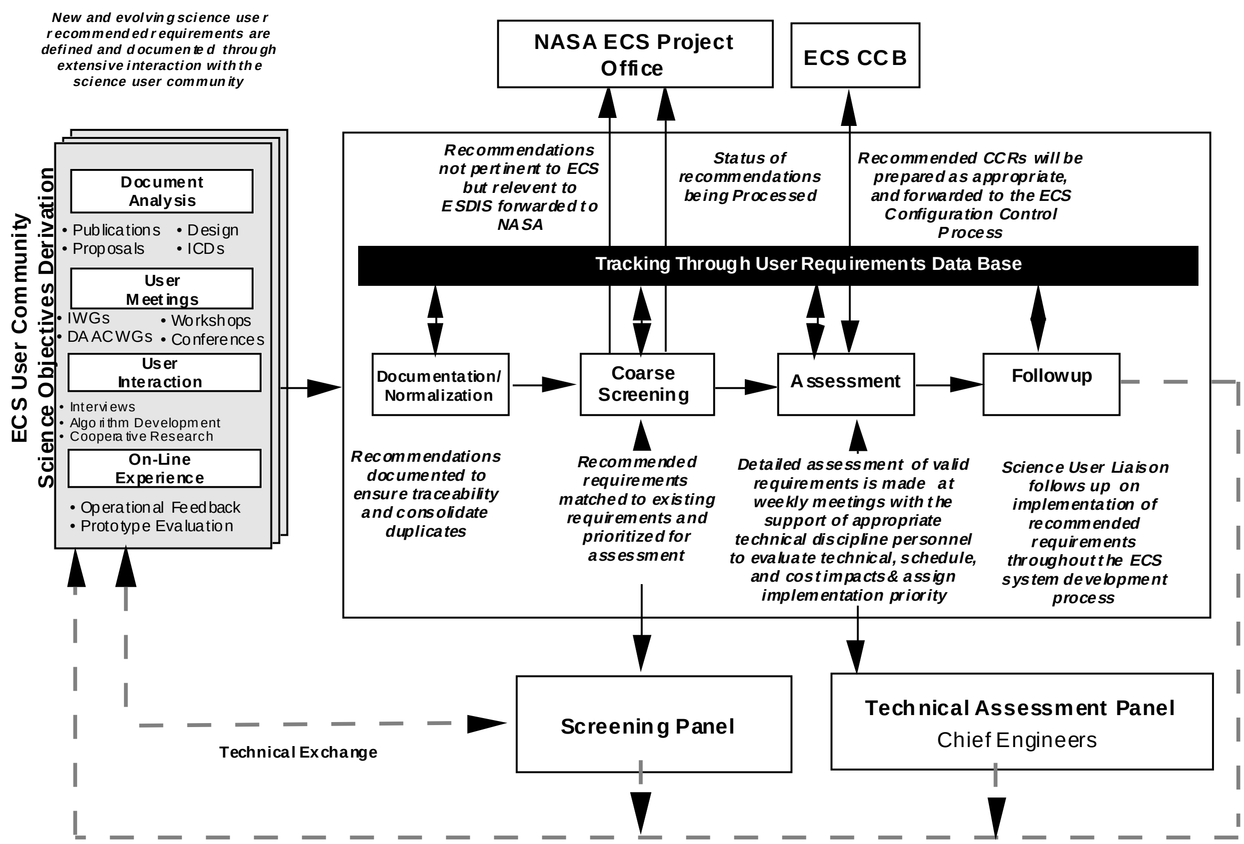

Figure 3-7. URDB Process

The recommendations undergo an engineering analysis and are taken to a screening panel for an initial review. Recommendations that are already part of the ECS baseline are closed. Those reflecting items that should be considered in the design are forwarded directly to the developers. If there is a potential cost impact, the recommendations are taken to the Technical Assessment Panel for review and impact. If appropriate, the Technical assessment Panel advocates CCRs to the ECS CCB. Throughout the process, the author and the general community are kept appraised of the status of the recommendation. CN 01

3.6 Technical Management Databases

The Technical Management Databases (TMDBs) illustrated in Figure 3-8 provide a repository and coordination mechanism for the design process. As ECS design evolves, traceability through multiple layers of allocated requirements is kept. The TMDB, as part of the ECS Data Handling System (EDHS), is accessible over the Internet World Wide Web. Requirements are mapped to subsystems, components, test threads, requirement type (functional, performance or input/output), and operator position. Requirements are further mapped to assumptions and vice versa, and text fields allow the engineer's interpretation to be documented. The TMDB also serves as a repository for the design baselines, associated modeling information, interface control, and data design.

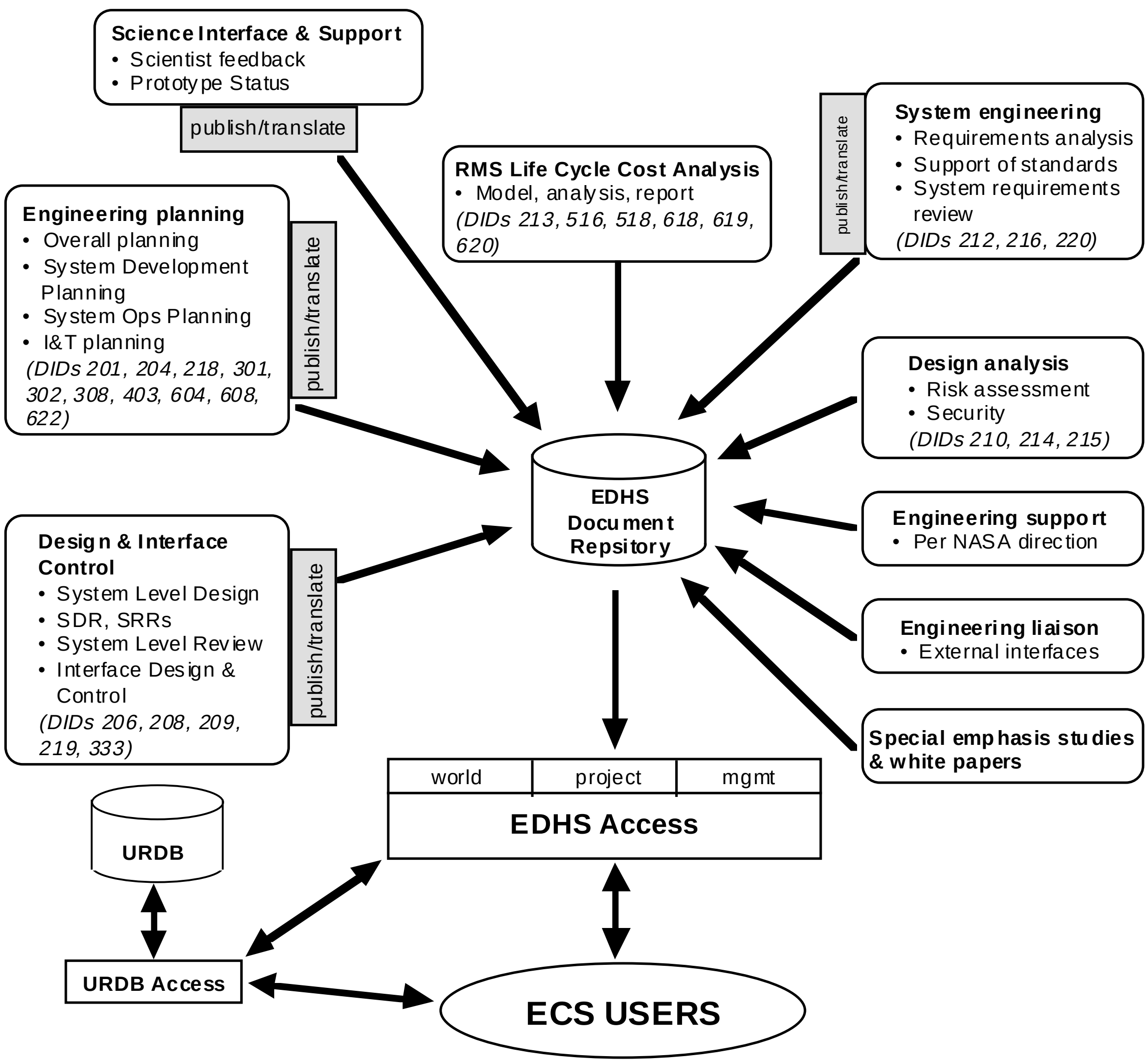

Figure 3-8. Technical Management Database

3.7 Security

ECS physical, personnel, information, communications, and ADP security represent special concerns that justify their own suite of documentation. The Systems Management Office (SMO), described in Section 10, is responsible for managing overall security, but to be effective, all offices of the ECS project must be sensitive to security issues. The major project documents associated with ECS security are:

- ECS Security Plan (214-CD-001-001)
- Risk Analyses Report (193-215-SE1-001)
- Operational Readiness Plan (DID 603)
- Security Sensitive Items List (514-CD-001-002)
- Software Critical Items List (520-CD-001-002)
- Hazard Analyses (513-CD-001-002)
- Audit Reports (506-CD-001-001)

The ECS Security Plan promulgates the overall ECS security policies.

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4. Development Schedule

4.1 Project Schedule

ECS is developed and brought into operations incrementally in five Releases (IR-1, A, B, C and D). Figure 4-1, ECS Master Schedule (107-CD-001-XXX), illustrates the project’s controlled milestones and the Release schedules. It is important to note that this schedule is the *current ECS contractual baseline* at the time this Project Management Plan is updated. Change orders are reflected in revised schedules when contractually approved, however Figure 4-1 will not be maintained current as the schedule evolves. The top several lines on the schedule exhibit key EOS, EOSDIS, and ECS project level milestones. The specific capabilities provided in Releases is summarized earlier in this document in Table 3-2. Releases A and B establish a complete operational capability preparatory to the EOS AM-1 launch. Releases C and D contain evolutionary upgrades based upon user feedback and evaluation from the Release A and B baseline.

Each Release is initiated by a Release Initiation Review (RIR) followed by a series of traditional design reviews. Each Release migrates to the DAACs upon approval of a Consent to Ship Review (CSR). At the DAAC the Release undergoes acceptance testing by the Independent Acceptance Test Organization (IATO) prior to the Release Readiness Review and turnover to Independent Verification and Validation (IV&V).

Figure 4-1 also depicts the delivery of five Evaluation Packages (EPs) and five toolkits. The EPs are prototypes developed during the requirements and prototyping phase for each Release. Toolkits provide an interface with the ECS and allow science software to be portable to different platforms at the DAACs. Additional information on EPs and toolkits and their roles in the ECS's evolutionary development process can be found in Section 3.

4.2 Staffing Plan/Manpower Loading

The Business Operations Office (BOO) maintains a plan keyed to the Project Schedule that projects the project's overall staffing hours by the Contract Work Breakdown Structure (CWBS) elements by calendar year. The full CWBS is included in Appendix A. Another plan projects the distribution of staffing hours by Hughes Team companies by calendar year. These projections are used as the baseline for tracking the project's actual man-hour expenditures.

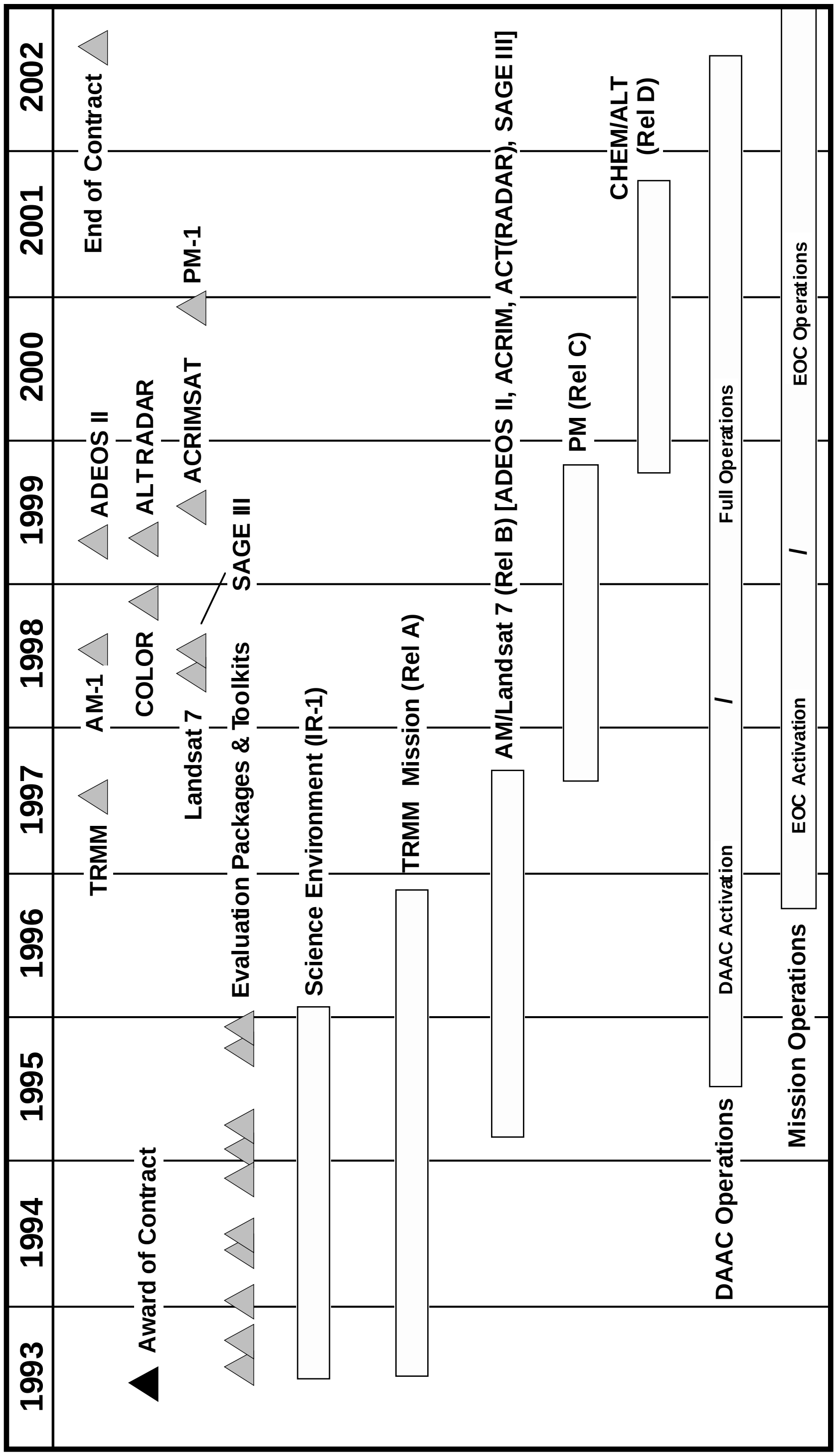


Figure 4-1. Project Schedule

5. ECS Contractor Organizational Structure

5.1 The Hughes Team Companies

The prime contractor, Hughes Applied Information Systems (HAIS), has assembled the following team of companies to develop and implement the ECS: Hughes, Loral AeroSys, Electronic Data Systems (EDS), Engineering and Science Studies Inc. (ESSi) (a subsidiary of Center for Space and Advanced Technology), Applied Research Corporation (ARC), NYMA, Inc. and Hughes Technical Services Company (HTSC). The major role of each organization is delineated below:

HAIS is responsible for overall management of the ECS including system engineering and integration. HAIS will develop the following items: the FOS Planning and Scheduling Subsystem, the Science Data Processing Segment, and the Communications and System Management Segment. HAIS also manages the overall Maintenance and Operations activity.

Loral AeroSys develops the Flight Operations Segment (FOS) and the SDPS Data Server and Ingest Subsystem. It also provides, operates, and maintains the FOS and the two SDPS subsystems as well as providing system engineering and performance assurance support.

EDS is responsible for all commercial hardware and software procurements plus integrated logistics support.

ARC performs science algorithm integration and provide science support including the Deputy Project Scientist. ARC will staff a scientist at each of the DAACs.

NYMA manages the Independent Acceptance Testing Organization, provides the interface to the IV&V contractor, furnishes performance assurance support, and provides maintenance and operations support at GSFC and MSFC.

ESSi (a subsidiary of CSAT) develops and maintains user profiles, a recommended requirements database, provides external interface support, and coordinates ECS training.

HTSC furnishes on-site maintenance and operations staffing.

The above companies also have subsidiary responsibilities within the Contractor organizational work units. This enables an integrated project team composed of the complete set of disciplines required to develop, operate, and maintain ECS.

5.2 Internal Organization Structure

The entire ECS team, including all subcontractors, is collocated in a dedicated facility at 1616 McCormick Drive, Landover, Maryland within 15 minutes from GSFC. This collocation promotes formal and informal intraproject communication that improves the overall understanding of ECS needs and objectives, creates an atmosphere of teamwork, and affords the opportunity to resolve technical and management issues within the team more rapidly. It also permits easy and frequent interaction with GSFC.

The ECS Project organization (Figure 5-1) is dedicated to ECS, and all team members are integrated into this single organization. It consists of the ECS Project Management and eight principal subordinate development organizations and offices, each responsible for a designated set of CDRL documents and WBS elements, with the corresponding budget allocation and accountability to achieve schedule, cost, and performance goals. Key features of the project organization are described below. Additional details on the specific roles and responsibilities of each office and development organization, and their subordinate organizations, can be found in Section 10.

- ECS Project Management consists of the HAIS Project Manager and the Deputy Project Manager. The HAIS Project Manager, with the assistance of the Deputy Project Manager, is responsible for the overall management of the project.
- A Science Office, which provides a focal point for project interactions with scientists and science advisory groups and infuses a consistent science perspective into the engineering offices.
- A Contracts and Procurement Office that is the authorized interface to the Government and to ECS Project subcontractors.
- A Systems Management Office (SMO) that provides system wide integration and coordination, and is also responsible for the development of new ECS Releases up to and including the IDR. A test and acceptance organization within the SMO is protected as an independent organization to ensure objectivity. SMO's responsibilities also include the ECS's external interfaces, coordination of the formal and working baselines with GSFC, dynamic and performance modeling, life cycle management, periodic assessment of the project's technical status, configuration management and risk management coordination. In addition, the SMO Manager is responsible for chairing the Risk Management Panel as described later in this plan.
- A Quality Office complemented with corporate quality oversight, which provides guidance to the project and instills a total quality perspective through continuous measurable improvement (cmi) into the project's processes and products.
- A Flight Operations Segment (FOS) development organization dedicated to the FOS development.
- A Science and Communications Development Organization (SCDO) dedicated to the development of the CSMS and SDPS segments through to turnover to the IATO at CSR.
- A Maintenance and Operations Office (M & O) that evolves from a small initial staff at each of the DAACs to support early tests and installations to a full operations staff in support of ECS operations.
- A Business Operations Office (BOO) that provides project-wide planning, control, and data management services.

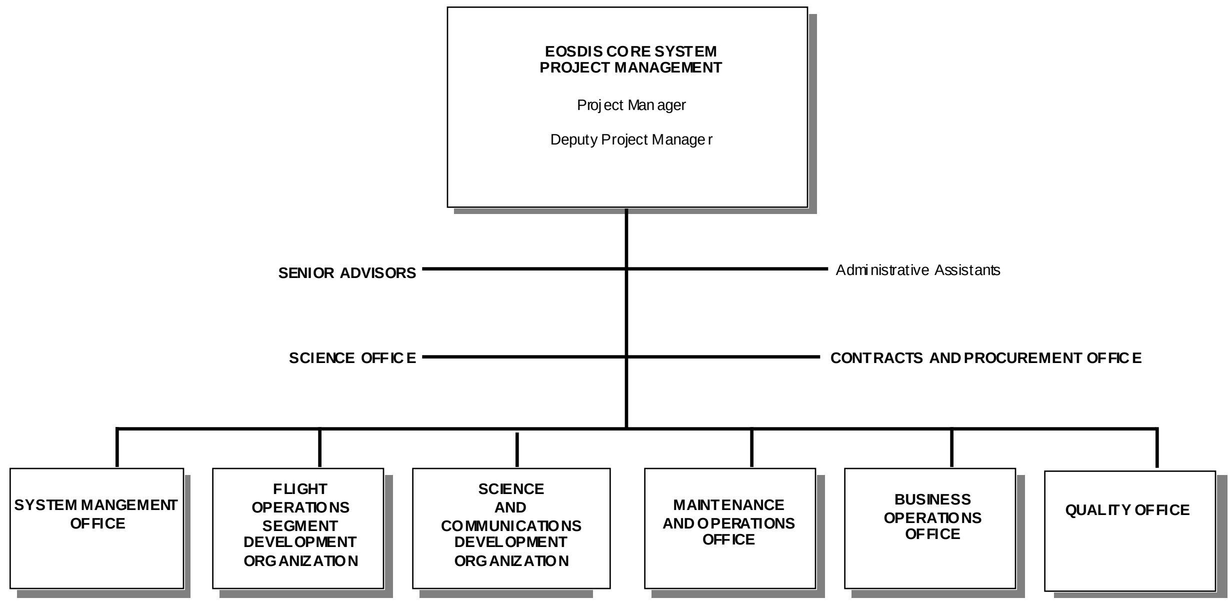


Figure 5-1. ECS Contractor Internal Organization Structure

In the integrated team approach, daily technical guidance is provided by each office or development organization manager to his/her staff regardless of company affiliation. This is supplemented by the subcontractor project manager’s responsibility to meet all subcontractor obligations.

Each development organization is allocated a unique set of requirements. Yet, development tasks are standardized by a Systems Management Office that promulgates common standards, tools, design, and implementation solutions; establishes an overall systems architecture; controls external interfaces; and focuses expertise in planning and replanning. SMO controls system performance by specifying system requirements and then accepting the delivered software from the development offices through the IATO. Similarly, the Science Office provides not only a focus for science requirements, but is the interpreter of science requirements to the engineering staffs within the organization, thus ensuring a consistent translation and understanding among the technical teams. This approach creates a good balance between the science perspective and the implementation responsibility of the system management and development organization staffs.

Detailed definitions of work responsibilities for each office are explained in Section 10, Internal Work Flow Management. The ECS project organization also serves as a blueprint for coordination points between the Contractor, Government, and science community. (See Section 7, Coordination with Government Personnel and Section 8, User Involvement Approach.)

5.3 Project Reviews and Staff Meetings

The current status of the ECS Project is reviewed periodically via a number of in-house review forums:

5.3.1 Project Management Reviews

The Project Manager, or designee, conducts a monthly project review to assess the cost, schedule, and technical status of the project. This meeting precedes and flows into the formal monthly progress review conducted each month with GSFC (see Section 7, Coordination with Government Personnel). The Project Manager reviews cost accounts with significant variances monthly and all cost accounts quarterly.

5.3.2 Senior Staff Meetings

A Senior Staff Meeting is held each week. The agenda includes a project technical assessment, special topics as required, and various administrative topics. The purpose of the meeting is to assess the status of the project at a high level and to address and resolve issues brought to the meeting from lower tier staff meetings. Each manager in the project organization shown on Figure 5-1 participates to assure an effective forum for discussion and resolution of programmatic and inter-organizational issues.

5.3.3 Office Level Staff Meetings

Detailed assessments of the project's status are reviewed at weekly staff meetings held by each office manager and development organization manager. The following topics are reviewed as necessary at these meetings:

- *Cost status.* Plan versus actual costs for a 12 month sliding window, including a discussion of labor costs (actuals vs. plan) plus other direct costs (e.g., travel, computer resources, procurement commitments). A detailed explanation of cost/schedule reporting follows in Section 6.2, Cost/Schedule Management Process.
- *Manpower status.* Plan versus actuals for a twelve month sliding window.
- *Staffing status.* Staffing plan for the next six months. This includes vacant positions, planned new hires, and relocations.
- *Schedule for next six months.* Status of meeting commitments for major milestones, prototype status, and CDRL status.
- *Subcontractor(s) activities.* Cost, schedule, and technical status.
- *Issues and concerns.* Matters to be brought to the attention of the Project Manager or brought to the Senior Staff Meeting for resolution with recommendations.

5.3.4 Chief Engineer Reviews

The Chief Engineer schedules a monthly meeting for an in-depth technical review of a selected portion of the project. These meetings, in turn, result in technical working sessions as participants implement direction given by the Chief Engineer.

5.4 Cross-Release Management

A number of the project's organizations and functions participate in cross-Release management and coordination:

5.4.1 Chief Engineer

The Chief Engineer is responsible for the project's over technical "vision", including its Release to Release evolution. He defines the overall system hardware and software architecture and provides the lead role in requirements interpretation.

5.4.2 Requirements by Release Management

SMO publishes the Release Plan Content Description document (222-TP-003-006) that identifies the ECS Releases and the missions supported by each Release; and provides a mapping of the project's driving requirements and milestones to Releases. The Functional and Performance Requirements Specification (F&PRS) Requirements (Level 3) are analyzed for the purpose of planning the Releases. This includes developing Level 3 Requiirements-by-Release, categorizing the requirements by priority, and assigning the system components to the appropriate development track based on requirements maturity.

5.4.3 Cross-Release Coordination

The SCDO staff function monitors the scientific appropriateness of each Release's design, evolvability from Release to Release, staff migrations from Release to Release, and cross-Release tradeoffs. SCDO also contains the Multi-Release Support (MRS) organization. MRS is responsible for providing specialty engineering and support services required by all Release teams and FOS; and for providing cross-Release continuity with respect to hardware, data engineering, and COTS procurement. MRS also leads prototyping activities that span Releases.

The BOO maintains the project's Integrated Logic Network (ILN), including by-Release ILNs and tracks the project's costs by Release.

5.4.4 Software Engineering Process Group

The Software Engineering Process Group (SEPG) is a multi-organizational team established to enhance the process of software development for the ECS project. The SEPG is the mechanism for the software development organizations to improve process quality by helping to assess current process status, plan and implement process improvements, and transfer technology to facilitate improvements in practice. The detailed roles and responsibilities of the SEPG can be found in PI SD-1-001, Software Engineering Process Group (SEPG) Charter.

5.4.5 Risk Management Panel

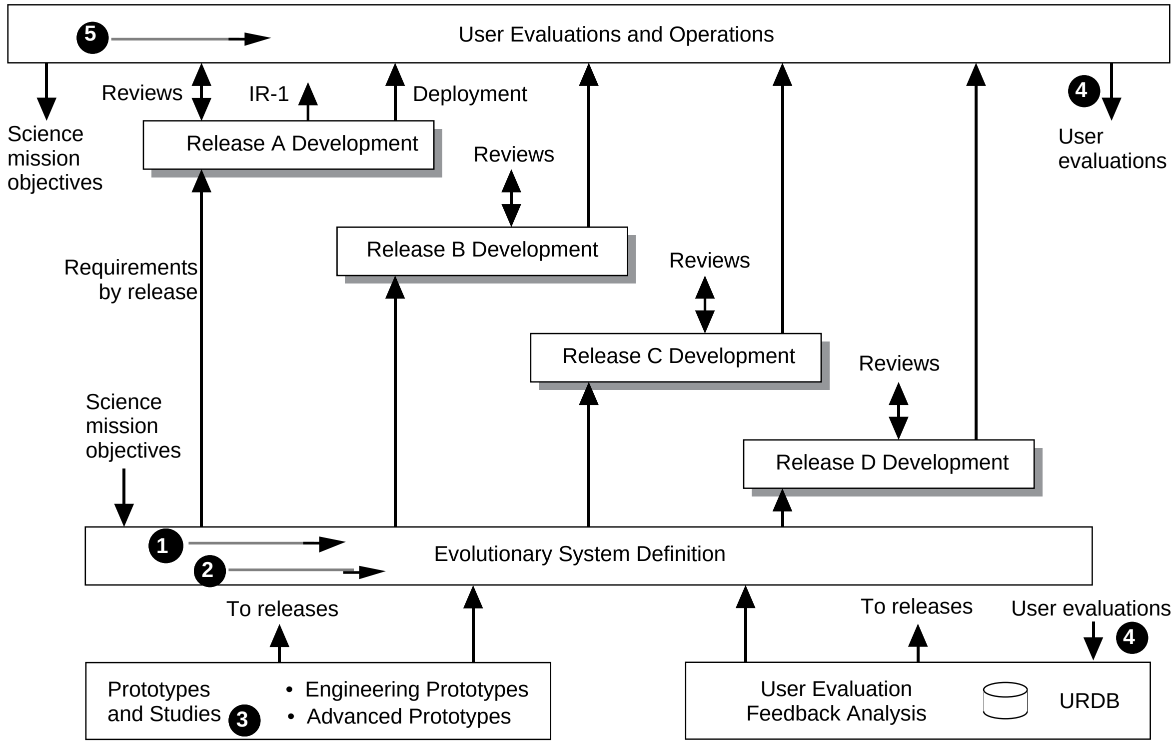
The Risk Management Panel (RPM) is a sustaining interdisciplinary panel that coordinates and measures the ongoing risk management activity. Additional information about the RPM and its duties can be found in Section 6, Key Management Processes.

5.5 Metrics Driven Management Approach

The previously described organizational structures support a measurement driven management approach where the critical factors of candidate system solutions are evaluated within frequent controlled cycles through metrics. The evaluations consider technical, cost/schedule, risk, and user satisfaction dimensions within an evolutionary life cycle.

The evolutionary ECS development life cycle process combines early user participation with specific risk controls to enable predictable life cycle cost by minimizing major field rework problems. This entails four key principles: 1) continuous system-level planning, requirements analysis, and system design activities that are responsive to user feedback metrics from field evaluations and system performance metrics, 2) system release-specific cycles consisting of a requirements/prototyping phase followed by implementation and transition phases with the direct participation of joint teams of systems developers, GSFC and other ECS program representatives, plus ECS science users; 3) Release implementation decision points that are dependent on validation of predefined risk-reduction metric thresholds, and 4) an incremental build and release process that allows user feedback to influence ongoing Release planning. These characteristics are represented by the multiple Release development model illustrated in Figure 5-2 showing the interaction of systems definition and Release development on through to Release operations. Figure 5-3 illustrates the systems development model in terms of the interactions between incremental and formal development.

Also indicated on Figure 5-2 and Figure 5-3 are the key points where metrics are accumulated and how they are used. The five areas overlap and are interrelated: 1) Earned value metrics are diagnostic measures of cost and schedule variances integrated with technical accomplishment; 2) Cost sensitive engineering metrics provide early warning indicators of downstream cost/schedule performance; 3) Risk metrics characterize risk management goals that must be achieved before a Release is committed to implementation; 4) User satisfaction information is gathered as metrics for guidance on evolutionary modifications; some of the risk management parameters are also user satisfaction measures; and 5) Discrepancy report data is centralized for trend analysis to identify systematic problem causes. Further, data from all five areas are utilized as process metrics to pinpoint enhancement areas likely to result in quality and productivity improvements over the course of the project. Additional details on ECS project metrics in the form of a goal-question-metric model can be found in ECS Project Instruction (PI) QO-1-014, ECS Project Metrics Process. Metrics are defined that have monthly reporting cycles as progress and warning indicators; others for improvement purposes have a per-Release periodicity.



- Earned value metrics measure cost and schedule performance indices which are inputs to estimate-to-complete process
- Cost/schedule sensitive early warning engineering indicators identify potential downstream problems
- Release-specific risk management metric thresholds achieved before fitness to implement decision
- User satisafaction measures influence downstream release content and evolutionary changes
- Discrepancy reports gathered, archived, and analyzed for trends

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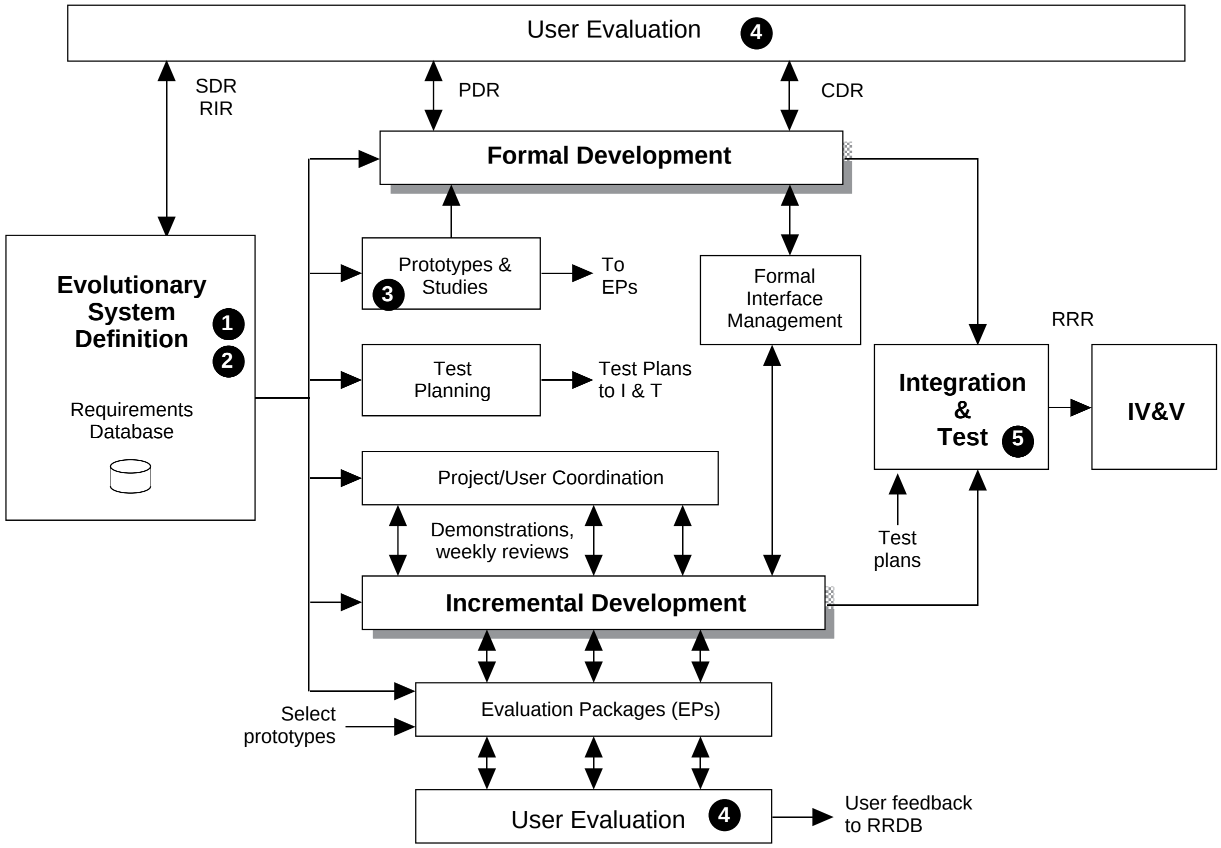
Metrics data utilized to improve engineering and business management processes

Figure 5-2. Metrics Accumulation in Multiple Releases



- Earned value metrics measure cost and schedule performance indices which are inputs to estimate-to-complete process
- Cost/schedule sensitive early warning engineering indicators identify potential downstream problems
- Release-specific risk management metric thresholds achieved before fitness to implement decision
- User satisafaction measures influence downstream release content and evolutionary changes
- Discrepancy reports gathered, archived, and analyzed for trends
- Metrics data utilized to improve engineering and business management processes

Figure 5-3. Metrics Accumulation in Incremental Development

6. Key Management Processes

Achieving balanced technical/cost/schedule performance on the ECS project pivots on three critical management processes: risk management, cost/schedule management and configuration management. This section describes the projects' approaches to those critical management processes.

6.1 ECS Risk Management

6.1.1 Risk Management Panel

The ECS Risk Management Panel (RMP) is a sustaining interdisciplinary panel that coordinates and measures ongoing risk management activity. The following sections describes its purpose, membership, and process.

6.1.1.1 Purpose

The RMP's purpose is to provide to project management advice and cross-disciplinary information to make risk management decisions. The panel provides accurate current data and multi-disciplinary input to project management so that informed decisions may be made to manage project risk. Integration of risk management across technical, cost, schedule, multi-activity, and contractor dimensions is a value-added benefit to the project.

6.1.1.2 Risk Management Panel Members and Responsibility

The System Management Office Manager chairs the RMP. The panel members are the ECS Project's office managers and development organization managers. The primary roles and responsibilities of these panel members are listed in Table 6-1, Risk Management Panel Membership, Roles and Responsibilities. Other subcontractors (team members) participate when matters pertinent to their allocated project tasks are on the agenda.

6.1.1.3 Risk Management Panel Process

The RMP acts as a reviewing body at each of the checkpoints of the iterative risk management process illustrated in Figure 6-1, Risk Management Process. The identified potential risks, estimates, evaluations, and resulting risks selected for management and monitoring are subject to the RMP's review. The RMP approves or redirects mitigation activities at each checkpoint in the risk management process. It is intended that management-level decision making and deliberation regarding risk management actions occur within the RMP. It is further intended that these decisions be reported to other relevant management forums, such as the Project Review, CCB, and monthly status meeting members. Issues or feedback emerging from these forums and requiring further deliberation on risk management actions are referred back to the RMP.

Table 6-1. Risk Management Panel Membership, Roles, and Responsibilities

Member	Role	Primary Responsibilities
Systems Management Office Manager	Chair, Risk management planning	Implements and coordinates the risk management process, performs tradeoffs, evaluates lifecycle costs, reports status to the RMP, and updates risk status reports. Evaluates SDPS/CSMS Release pre-IDR impact of all risk actions, and implements risk actions.
Chief Systems Engineer	System integrity advocate, system test and acceptance advocate	Integrates/evaluates proposed risk actions to ensure that system goals and objectives are achieved.
Quality Office Manager	General secretary	Ensures that the risk management process is applied, independently recommends corrective and preventive actions, and monitors risk performance metrics against plans
Project Scientist (Science Office Manager)	Science advocate	Evaluates science user community satisfaction impact on all risk actions
FOS Development Organization Manager	FOS advocate	Evaluates FOS impact of all risk actions, and implements allocated part of risk actions
Science and Communications Development Organization Manager	SDPS/CSMS advocate (post-IDR)	Evaluate**s** SDPS/CSMS Release post-IDR impact of all risk actions, and implements allocated part of risk actions
Operations and Maintenance (O&M) Office Manager	O&M advocate	Evaluates O&M impact on all risk actions, participates in lifecycle cost tradeoffs, and implements allocated part of risk actions
Test and Acceptance Organization Manager	System test advocate	Evaluates the testability and the Independent Verification and Validation (IV&V) interface impact of risk actions
COTS Procurement Manager	COTS technology advocate	Evaluates COTS availability and pricing impacts of risk actions
GSFC Representative	Customer	Provides GSFC's view and input on in-process risk decisions

6.1.1.4 Risk Planning Quality Checklist

Risk mitigation plans subscribe to the quality attributes delineated in Table 6-2, Risk Mitigation Planning Quality Checksheet, which can be employed as a checklist to evaluate the consistency and completeness of risk mitigation plans presented to the RMP.

Table 6-2. Risk Mitigation Planning Quality Checklist

Attribute	Quality Checklist Items
Description/Potential Impact	Is the source of the problem clearly stated? Is the impact clearly stated if the risk is not resolved? Are the activities, organizations, and system components potentially impacted stated?
Risk Factor	Is the risk factor value consistent with supporting failure probability and impact assessments?
Current Mitigation Plans	Do the mitigations listed address all of the impacts listed? Is a responsible party for each mitigation action stated? Are completion dates assigned to each mitigation action?
Monitoring Thresholds	Is an acceptable and objectively measurable success threshold specified? Are success thresholds and action thresholds traceable to mitigation actions?
Scale	Is a measurement scale specified? Is the source of the measurement data specified?

6.1.2 Risk Management Process

This section describes the steps in the risk management process illustrated in Figure 6-1. Overall coordination of this risk process is performed by the SMO in conjunction with the development organizations, Quality Office, and other affected offices. At each checkpoint, the process is reviewed by the RMP as chaired by the SMO Manager, who has authority for the team's risk decisions (including corrective actions) across cost, schedule, and technical dimensions.

6.1.2.1 Risk Identification

A list of risk items is maintained by SMO throughout the program. This list was created during the proposal and is updated continually during the course of the project by the risk management process. During the pre-proposal activities and the study phase, ECS requirements were analyzed for potential risk sources. Areas of potential risk in terms of technical, cost, and schedule impact were identified, categorized, and summarized. Additional risk sources have been identified through visits to ECS-related data centers; participation in Earth science community working groups; results from ECS team member Independent Research and Development (IR&D), prototyping, hardware benchmarking, performance modeling and simulation, and special trade studies and analyses; review of other EOSDIS-related reference documentation; review of team member historical lessons learned databases, and Review Item Discrepanciew (RIDs) generated as a result of the System Requirements Review (SRR), the System Design Review (SDR), the PDR, and the Critical Design Review (CDR). Risk items will continue to be identified in this manner for the duration of the ECS project.

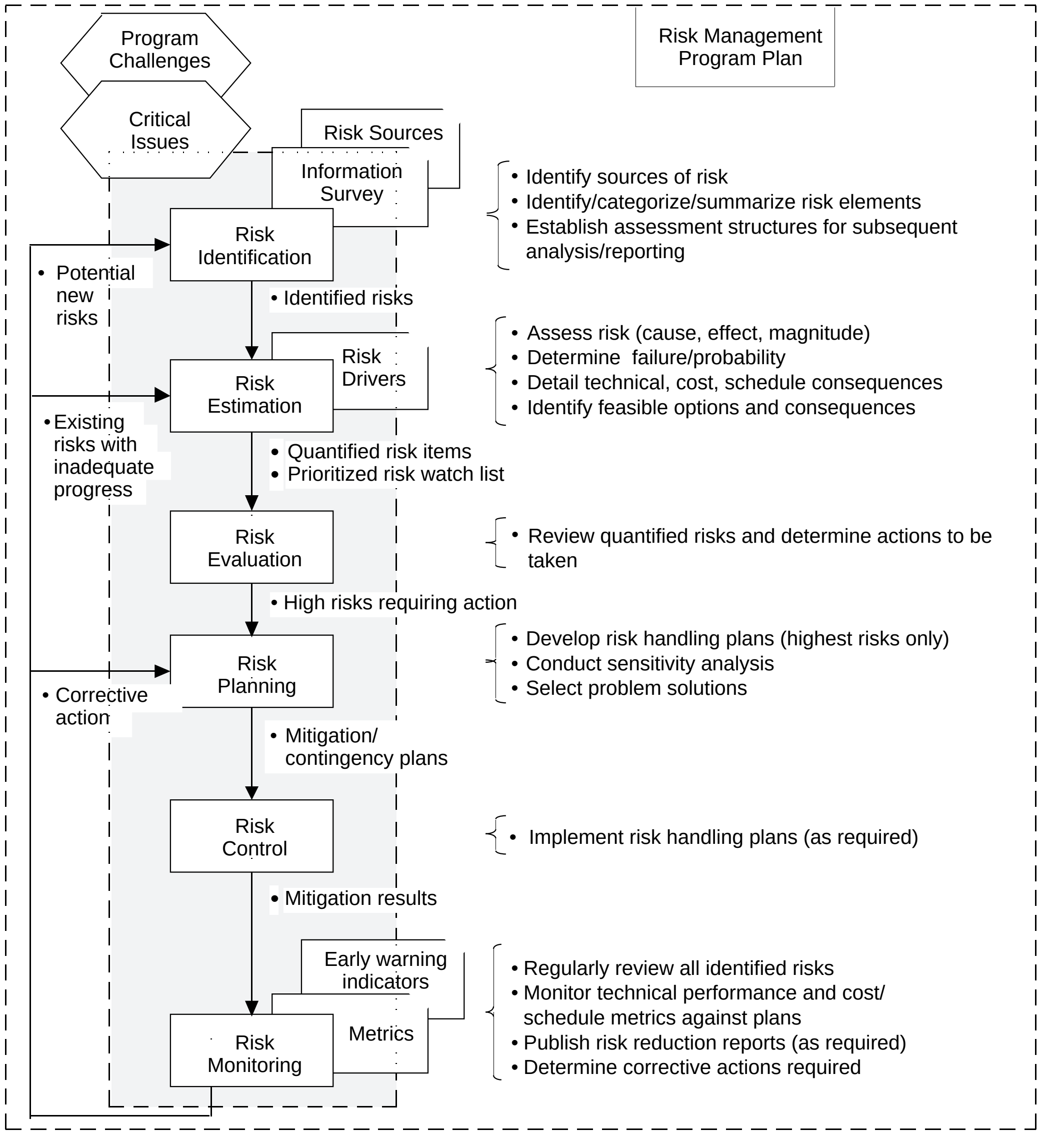


Figure 6-1. Risk Management Process

6.1.2.2 Risk Estimation

Detailed analyses of the identified risks and associated drivers (e.g., technology) are performed by the SMO staff supported by other members of the segment or element development, the Project Science Office, and O&M organizations. The analyses are conducted to discover the causes, effects, and magnitude of perceived risks. They consist of evaluating all technical, cost, and schedule consequences and of determining the failure probability of deliverable hardware and software products with respect to maturity, complexity, and dependency variables. After evaluating all factors and quantifying their relative magnitude, a risk factor is calculated for each risk item. The risk factor's relative order of magnitude for a given risk area serves as a project management decision aid. It determines the necessity and urgency of devising and implementing a series of increasing scope risk-handling and risk-monitoring activities to maintain system performance within projected ECS Project cost and schedule constraints.

Risk estimation products include quantified ECS risk items, identified project-specific causes of risk, and a prioritized risk watch list encapsulating for each risk area things such as indicators of the start of a problem and candidate risk mitigation techniques.

6.1.2.3 Risk Evaluation

The review and evaluation function previously discussed provides the management forum for the project management team and COTR to review the quantified risks and determine actions to be taken. Risks are evaluated at monthly project reviews as they are identified and quantified. Project-wide risk evaluation is performed in conjunction with the development and review of the risk assessment report for SDR, segment PDRs and subsequent segment IDRs. The risk evaluation function also interacts with risk planning to evaluate alternative strategies for mitigating risk and to select the best approach.

6.1.2.4 Risk Mitigation Planning

Much of the project organization, led by SMO participants, devises integrated risk mitigation plans. Alternative strategies and processes are developed, reviewed by project management, and refined. Finally, the appropriate mitigation approach is selected. Examples of mitigation and contingency plans include alternate vendor or product source selection, critical component prototyping, subcontractor performance and cost incentives, extensive development testing and EP assessment, and model or simulation development to predict performance. A detailed examination of each Work Breakdown Structure (WBS) category ascertains areas of greatest risk sensitivity. Related decision-support analyses, under project controls staff administration, help ECS project management to determine the preferred course of action. These analyses include:

- summarizing the technical, cost, and schedule implementation impacts for each alternative considered
- projecting the overall program cost and schedule if no risk reduction action is taken
- identifying the organization and personnel responsible to manage the risk
- defining a risk mitigation or abatement plan with measurable schedule, cost, and technical metrics and key decision points
- specifying criteria for closure of the specific risk activities
- outlining recommended backup or contingency plans.

6.1.2.5 Risk Control

Risk Control is accomplished through execution of the detailed mitigation plans developed in conjunction with the risk mitigation planning function.

6.1.2.6 Risk Monitoring

Each ECS Project functional organization manager is responsible for periodically reassessing identified risk items and identifying potential new ones. The SMO is responsible for tracking the status of open and potential risk areas. Technical, cost, and schedule performance of implemented risk mitigation plans are qualitatively assessed at each weekly internal project management review to ensure that risk areas, with appropriate resource priorities, are properly emphasized. Throughout the program, NASA personnel are apprised of each risk area through monthly progress reviews, major technical reviews, monthly progress reports, the tradeoff studies analytical data report, the security analysis report, and the Risk Management Report (210-CD-001-002).

6.2 Cost/Schedule Management Process

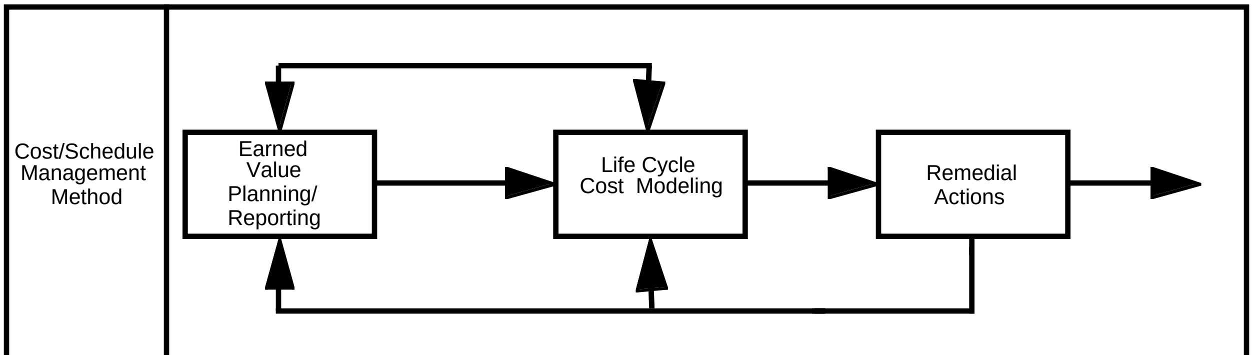
Basic control of cost and schedule are predicated on the following factors: risk management, baseline planning, earned value reporting, dynamic cost projection, and early remedial actions to redress imbalances. This combination of diagnostic, projective, and remedial factors integrate as shown on Figure 6-2. The process radiates from baseline planning allowing diagnostic earned value measures of integrated technical-cost-schedule performance. Dynamic Cost Projection periodically assesses cost/schedule sensitive metrics (including risk parameters) projecting downstream impacts of engineering options/decisions; this provides an operational implementation of a design to cost and implement to schedule strategy. Control actions when imbalances are identified may include negotiated allocations of management reserve budget and/or schedule reallocations that assure high value user operational capabilities are prioritized in implementation plans. The following paragraphs elaborate on major components of this cost/schedule management process.

6.2.1 Earned Value Progress Measurement and Reporting Plan

The entire ECS Project team utilizes the HAIS Performance Measurement System (PMS) . This system is based on earned value measurement principles.

6.2.1.1 Allocation of Responsibility and Authority

The ECS budget control process begins during the preparation of the proposal andcontinues throughout the project life cycle. During the proposal phase,the ECS Statement of Work (SOW) and all functional and performance requirements are translated into detailed designs, schedules, and budgets for ECS system implementation. The authorization for work on the ECS Project begins with contract award and is systematically and formally allocated and tracked by the budget control process from the contract through various management levels down to the cost account level. After contract award, the Hughes ECS Contracts Office issues a Contract Financial Brief (CFB) which documents the financial parameters which define the cost of work to be performed under the contract. The authorized Contract Target Cost (CTC) determines the overall project budget. This defines the Contractor's Budget Baseline (CBB). All detailed budget planning below the contract level is always directly reconcilable to the CBB. The Hughes ECS Project Manager determines the appropriate level of management reserve based on risk (see Section 6.2.3, Remedial Actions), and then formally allocates the remainder to each WBS. Each allocation documents the scope of work to be performed, the period of performance for each task, technical performance criteria, CDRL requirements, and total budget dollars for the tasks. The office manager, as well as the cost account managers (CAMs) have been delegated the responsibility, accountability, and the authority for performance on the allocated task(s) within the authorized budget.



Description	•Historic Cost and •Schedule Performance	•Identified Downstream •Cost/Schedule Risks	•Management Reserve Allocation •Risk Management •Schedule Reallocations
Metrics	•Schedule Performance Index •Cost Performance Index •Estimate at Completion	•Early Warning Indicators •Quantified Product Indicators	•Management Assessments
Review Cycle	•Earned Value: Monthly •Schedule/Rescources: Semi-Weekly •Actuals: Weekly	•Monthly	•Bimonthly

Figure 6-2. Overall Cost/Schedule Management Process

6.2.1.2 Schedule Tracking

All authorized work on the ECS contract is scheduled in a manner which represents a logical sequence of work, identifying all significant task interdependencies required to meet the overall objectives of the contract. To accomplish this, the Prestige tool provides schedule traceability from the contract level down to the work package level. The scheduling system provides a hierarchy of schedules, with each succeeding lower level more fully identifying and expanding the tasks necessary to meet ECS requirements. The various schedules depict a continuous flow of contract milestones from the Level 1 - ECS Master Program Schedule to the Level 2 - Intermediate Activity level schedules, down to the Level 3 - detailed cost account level schedules by which the day-to-day project activities are managed. All levels of schedule are bounded by control milestones. These are the contractual milestones plus any other milestones deemed critical by the Project Manager. Control milestones may be revised only with the approval of Project Management and the Government. This computerized scheduling system allows the Hughes ECS Project Office to evaluate the impacts of any changes, even at the work package level, on the entire network. This provides immediate insight into potential contract milestone impacts. It also provides a dynamic analysis capability for "what-ifs" and contingency planning at all levels of schedules for implementation of the ECS Project. This also permits integrated technical accomplishment/cost/schedule measurement producing earned value variances.

6.2.1.3 Budget Tracking

All authorized work on the ECS contract is budgeted to identify all significant resources required to meet the overall objectives of the contract. To accomplish this, the CAM provides calendarized resource plans in the form of planning and work packages. Planning and work packages depict the levels, timing, and type of resource required (i.e. labor, subcontract, ODC, etc.). Actual expenditures and project commitments are reported weekly (or as provided by specific company's accounting systems) for the prior period's activities and each month for the prior month’s activity as well as inception to date cost data. Included in these reported costs is sufficient detail to depict the cost elements, such as labor hours and dollars, overhead, subcontracts, travel, ODC, etc. Work packages are tracked through the integration of calendarized plans and their corresponding actuals via the Performance Measurement System (PMS) to determine the performance of the task in relation to the resource expenditure levels. Earned value cost and schedule variances are provided from the lowest calendarized activity level up to the work package level, and to successively higher levels, as the PMS rolls the data up to the ECS Project summary level.

6.2.1.4 Automated Project Management Tools

Two principal PMS tools at the working level are Microframe Project Manager (MPM) and the Prestige scheduling package. MPM and Prestige are cost effective, user friendly tools which together put a robust resource planning and scheduling package in the hands of our technical managers. These tools are used daily and weekly to track and evaluate their cost/work performance on their work packages. These PC/Mac based systems allow the Hughes ECS Project Office to evaluate the impacts of any variances in the work package level performance on the entire ECS Project. This provides the Hughes ECS PM immediate insight into potential contract cost and milestone impacts. It also provides a dynamic analysis capability for "what-ifs" and contingency planning at all levels within the ECS Project.

Prestige (supplied by ARTEMIS) is a concurrent multi-user project management system with a graphics interface. It is employed on ECS as a scheduling tool. It accepts resource-loaded schedules and produces network logic reports, critical path analyses, and schedule performance charts. The resource-loaded schedules produced in Prestige are downloaded into MPM.

MPM (supplied by Micro-Frame Technologies, Inc.) is the major performance measurement and reporting tool. It provides file management, earned value calculation, and report generation capabilities. It receives the detailed schedule data from MicroSoft Project and actuals from company financial systems to perform the earned value and variance calculations.

6.2.1.5 Corrective Actions and Controls

Budgetary corrective actions and controls are accomplished through the program review process, both internally and externally. Internal reviews are conducted monthly to status manpower loading, schedule performance and technical progress versus costs. Internal reviews are also conducted on a monthly basis to evaluate all aspects of programmatic performance, including a primary focus on budgetary items. Variance items are inspected in detail to identify areas that have experienced budgetary problems (relative to evaluation criteria) or have early warning indicators that point towards potential problems. All budgetary issues require the development and frequent status of a corrective action plan to mitigate and/or reduce budgetary variances. Contractor reviews with the customer will take place on a monthly basis (or more frequently if required) to provide program performance information, present variance analyses, and to agree on the appropriate corrective action plans to maintain ECS budgetary integrity.

6.2.2 Life Cycle Cost Modeling

While earned value reporting is very useful in diagnosing current cost/schedule status, it is still symptomatic of the later outcomes of decisions that had been made earlier. The cost/schedule management approach seeks to manage problems at their sources by identifying the probable downstream effects at the point where engineering judgments are made. In connection with this goal, Life Cycle Cost Modeling is a methodology for periodically assessing the downstream cost and schedule effect of early engineering decisions. ECS costs were derived using parametric models for each project discipline (engineering, software development, test, configuration management, etc.) which related ECS estimates to actual experience on previous programs. Life Cycle Cost Modeling employs many of the same parameters used in the original estimates to track quantifiable cost sensitivity metrics that serve as early warning indicators of potential downstream deviations. These metrics are used in conjunction with traditional earned value variances.

The ECS metrics include program size, number of requirements, stability of requirements, software lines of code, programming language experience, data volume requirements, processing requirements, and program duration, among others. These early warning parameters are periodically assessed by multiple organizations (e.g., engineering, development, test, subcontracts, quality) to evaluate the impacts of requirement and interface decisions on product development. The Risk Management Panel (see Section 6.1) is the forum where these evaluations are presented. Where divergence from the cost baseline is discovered, an opportunity to institute "design-to-cost" is strongly considered by Project Management early in the life cycle when it is still relatively easy to re-engineer the requirements. Alternative strategies to avoid potential overruns are identified, validated, and evaluated with the active participation of Project and NASA management. Two prime strategies are further described in the Remedial Actions section.

To recount, the approach to cost/schedule management as indicated in Figure 6-3 integrates diagnoses (earned value planning/reporting), projection (Life Cycle Cost Modeling), and remedial action factors to maintain a balance between technical scope and cost/schedule resources.

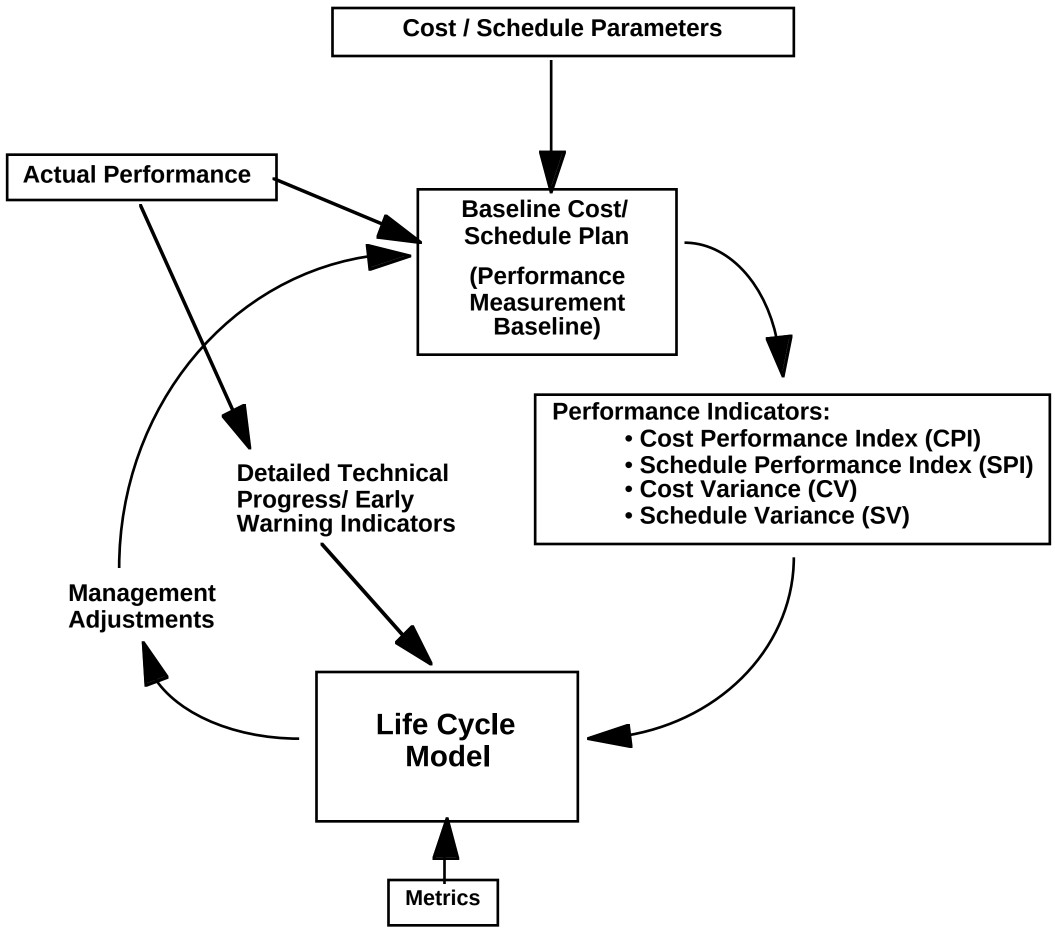


Figure 6-3. Life Cycle Cost Modeling

6.2.3 Remedial Actions

Through the visibility obtained from the risk management process and from the ongoing Dynamic Cost Projections, remedial actions will be concentrated at the problem sources before significant downstream effects occur. The risk management process and its associated Risk Management Panel provide Project Management with technical risk status, recommended technical actions, and projected cost/schedule impacts. Project Management, in approving technical risk management actions, can reallocate budget resources and adjust functionality within schedules in coordination with the Government. Key enabling tools to implement remedial actions are outlined below.

6.2.4 Management Reserve

It is a standard Hughes practice to allocate a percentage of total contract value across all organizations to a management reserve. These funds can be released only by the Project Manager for changes in scope of work which may be a result of emerging understandings of requirements, risk, and schedule issues. Information from several sources are considered by Project Management in applying management reserve: monthly budgetary reviews, recommended risk mitigation actions from the Risk Management Panel (which include cost impacts), Dynamic Cost Projection indicators, and feedback from design/prototyping reviews. The reserve pool is formally managed per normal cost control procedures and provides the flexibility to respond to changes whose sources cannot be fully anticipated in advance.

6.2.5 Contingency Schedule Planning

The approach to schedule contingency planning is to assure that the most important functionality to users is implemented in prioritized order both across Releases and within Releases. This may entail a redistribution of functionality between Releases and possible combination of Releases as contingencies. This ordering is continuously re-examined and negotiated as details on operational priorities emerge and, perhaps, change.

The thread implementation planning provides the flexibility to reorder, prioritize, or defer functionality with minimal complication. A thread is the implementation of a user scenario thus providing a complete increment of useful capability from the user perspective. This planning approach is illustrated in Figure 6-4. Interfaces between threads are minimally coupled thus allowing flexible replanning as the need arises. This need may derive from a revision in operational priorities or possible unanticipated implementation difficulties. In the latter case, it is usually possible to proceed to implementation of the next thread while the problem is addressed in parallel; serial dependencies are few. In all cases, the threads technique enables responsive contingency planning with very little overhead allowing implementation of the most important user capabilities to be protected.

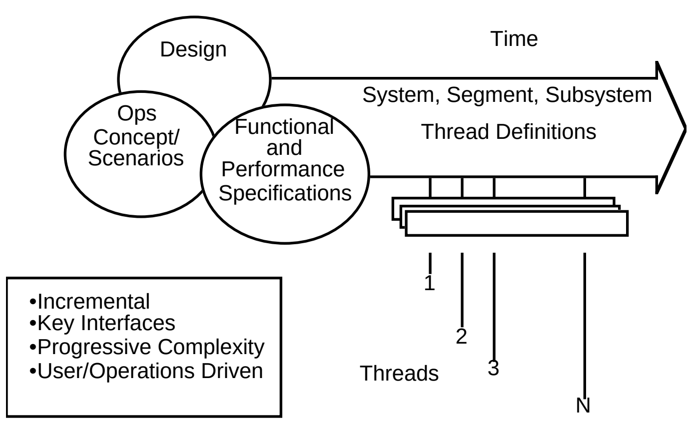


Figure 6-4. Build/Thread Planning Approach Implementing User Scenarios

6.3 Configuration Management

Configuration Management (CM) is a key management process that is critical to the project's success. The following sections summarize the project's CM process at a high level; additional details can be found in the ECS Configuration Management Plan (194-102-MG1-001).

6.3.1 Change Review Process

The ECS Project has a well-defined CCB hierarchy and a documented change control process. The ECS CCB is the only project board with the authority to make Class 1 change recommendations to the ESDIS CCB. The ECS CCB constitutes subordinate CCBs as appropriate and necessary and delegates well-delimited authority and responsibility for Class II changes to them. All CCB operations are under the direction of SMO's configuration management function and all CCBs use the project's Configuration and Data Management Tracking System (CDMTS) as their central configuration management tool. Specific CCB responsibilities for all controlled documentation, including design documents, are assigned by the ECS CCB.

Figure 6-5, ECS Configuration Control Boards, illustrates the ESDIS CCB at the highest level, followed by the Hughes ECS CCB, then the development organizations' CCBs and the ECS Development Facility (EDF) CCB. CCBs at the operational sites and non-ECS CCBs, such as those at Science Computing Facilities, either interact directly with the ESDIS CCB or maintain an affiliation with GSFC.

The Contracting Officer/Contracting Officer's Technical Representative (CO/COTR), or designees, may attend any of the project's CCB meetings at their option to ensure that technical and programmatic decisions and recommendations rendered by the CCBs are consistent with the ESDIS-controlled requirements and specifications. Proposed ECS changes are distributed to all ECS Offices and development organizations to ensure that all internal and external interface impacts have been addressed. The Office or development organization sponsoring each change is responsible for resolving technical, cost and schedule issues before change requests are submitted for disposition by the responsible CCB.

The CCBs are responsible for reviewing and dispositioning candidate changes to the ECS baseline. Their responsibilities are differentiated by change Classes (Class I or Class II) and by the documents allocated to them for control. A Technical Record (TR), HAIS CCBs: Allocation of Authority and Responsibility for the ECS Project (151-TR-001-001) allocates CCB responsibilities among the project's CCBs. The ECS Document Management and Control Matrix (152-TR-001-002) allocates the control of each CDRL document to a specific CCB. Both of these TRs are controlled by the ECS CCB.

6.3.2 Change Classes

Class I and Class II changes are defined in the Earth Observing System Configuration Management Plan, NAS5-60000, and are determined by the technical or contractual content of the change:

- Class I Changes are those that affect ECS Project controlled milestones, schedules, budget, costs and requirements. The ECS CCB has project-level approval authority for Class I changes. They are submitted to the ESDIS CCB for final approval.
- Class II changes are engineering changes that are not defined as Class I.

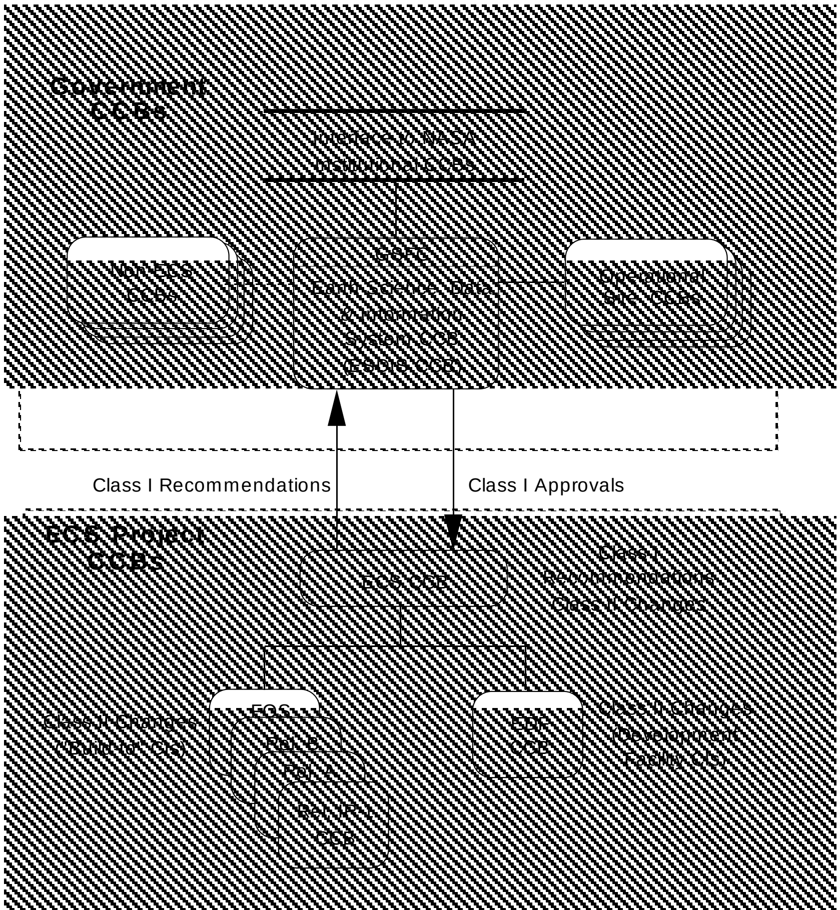


Figure 6-5. ECS Configuration Control Boards

6.3.3 Change Control Flow

The objective of ECS configuration change control is to ensure changes are adequately defined, assessed for technical, cost, and schedule impacts by all ECS Project segments and offices, and formally considered by the appropriate Project CCB. In addition, change control ensures that only approved changes are incorporated in the appropriate baseline in an orderly and systematic manner. The change process, including interactions with NASA, is illustrated in Figure 6-6.

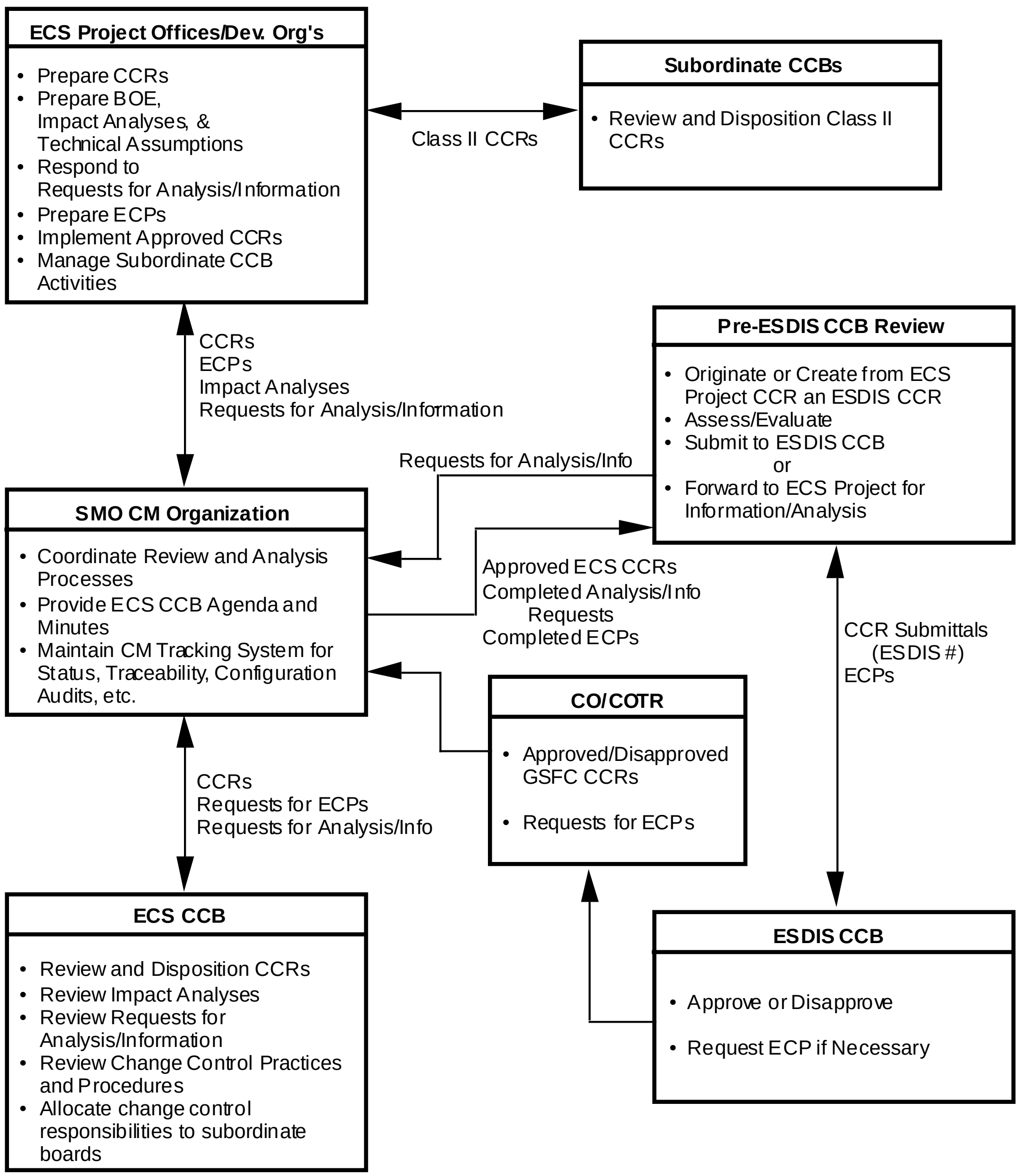


Figure 6-6. ECS Change Process

7. Coordination With Government Personnel

7.1 Contractor/Government/Community Interaction Points

In effectively executing ECS as an evolutionary project, interaction points are established with ECS stakeholders in the Government and science community. Evolution is a learning process thus necessitating enabling dialogue at all levels: project management, NASA science representatives, research science representatives, contracting officer, performance assurance, DAACs, specific technical contractor/Government technical counterparts, and business/resource management. The primary interaction points between the contractor's project organization, Government, and science community are indicated on Figure 7-1.

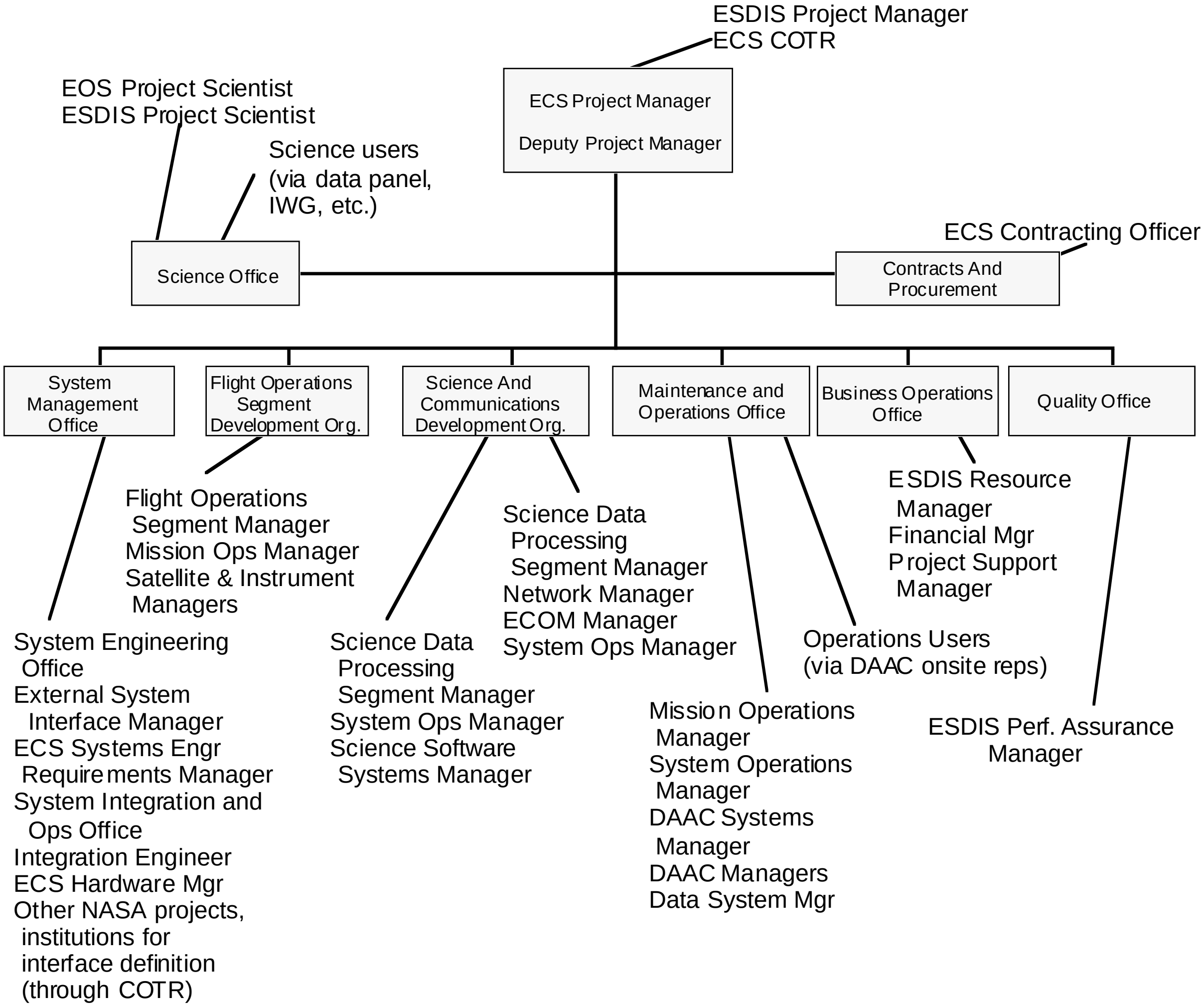


Figure 7-1. Primary Contractor/Government/Community Interaction Points

The contacts illustrated above occur via regular telephone contacts, in scheduled counterpart meetings, at the monthly project reviews, and at other ad hoc meetings and conferences.

7.2 Counterpart Meetings

Working level meetings between the Hughes Team and Government/community counterparts are established between the organizational entities illustrated in Figure 7-1. Specific interactions vary over time and by phase of the project as the work focus shifts. The following are example counterpart relationships, interactions, and regular meetings:

Project Science Office

- Meet monthly with EOSDIS Project Scientist
- Meet weekly with EOSDIS Science Office
- Attend Investigators Working Group (IWG) Meetings
- Attend DAAC User Working Group meetings

Business Operations Office

- Meet with ESDIS as required

System Management Office

- Weekly ESDIS SMO meeting
- Biweekly EOSDIS Ground System meeting
- Weekly Interface Control Working Group (ICWG) meeting

Quality Office

- Biweekly meeting with Government ECS Performance Assurance Manager

Flight Operations Segment Development Organization

- Weekly meeting with NASA FOS Manager
- Monthly coordination meeting with all FOS and NASA element managers

Science and Communications Development Organization

- Weekly or biweekly coordination meetings with GSFC segment (CSMS and SDPS) and element personnel (varies by element, by mutual agreement)
- Monthly technical exchanges (sometimes devoted to a specific topic)
- Support M&O's DAAC Manager meetings

Maintenance and Operations Office

- Weekly DAAC managers' teleconference
- Quarterly DAAC managers' meeting
- Weekly MOM/SOM meeting

Written summaries of counterpart meetings are prepared, submitted to Contractor Project Management, and passed to the COTR. Further, interactions and major issues with Government personnel are a standard agenda item at the weekly project review when each Office Manager and development organization reports. Major problems at the working level are surfaced to the proper level of management consideration while the issues are still embryonic through this process.

7.3 Monthly Reporting and Reviews

The ECS Project Manager and office/development organization managers meet monthly to review overall progress of the project and to discuss issues with the CO/COTR and the NASA office counterparts.

The Project Manager reviews overall project status, schedule progress against plan, program manpower/staffing status, and project priorities. Each office and development organization manager reports on technical status, issues and concerns, cost status, manpower/staffing status, accomplishments, near-term priorities, and special topics or other office specific issues. Near-term schedule, critical path analysis, and critical schedule issues are also discussed. Additionally, metrics are reported by release and at the project level (Global Metrics).

The cost status includes a discussion of planned vs. actual expenditures for the basic contract, and cost and schedule variances.

The Business Operations Office tracks any action items that result from this review. The view graphs for the monthly meetings are packaged and provided to all attendees, and serve as the primary input to the Monthly Progress Report (111-CD-001-XXX). The contents of the Monthly Progress Report are as follows:

- Monthly Review presentation to ESDIS management
- Status of all open action items
- Document Delivery Status
- Performance Assurance Status (503-CD-001-XXX, 510-CD-001-XXX)
- CCB Monthly Report

The report is submitted in two volumes. Volume one contains the five items listed above, with the cost and scheduling data removed from the presentation. Volume two includes all five items listed above.

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8. User Involvement Approach

The Hughes Team places the utmost importance on establishing an effective, direct and cooperative involvement of the science user in the design, development and operation of ECS. The focal point for user involvement is the ECS Science Office which acts as a bridge between ECS engineering and the EOS and Global Change Research community.

The mission of the Science Office includes: internal advocacy for the science user community and liaison with users concerning ECS design, development and operation. Functions of the ECS Science Office include: 1) interaction with NASA science organizations; 2) information exchange with EOS investigators and international partners; 3) collection of science user requirements and feedback; 4) DAAC science support; 5) support to EOS science algorithm development and integration; 6) coordination of ECS collaborative prototyping activities; 7) science data processing support; and 8) user modeling/characterization. Involvement of the EOS and Global Change Research community with ECS is depicted in Figure 8-1, ECS User Involvement Model, and below.

8.1 Interaction with NASA Science Organizations

Within the Hughes Team, the ECS Project Scientist is responsible for interaction with the NASA EOS Program and Senior Project scientists, the EOSDIS Project Scientist, the EOS IWG, and others in the EOS science community under the overall direction of the COTR. The ECS Project Scientist also provides liaison with the EOS international partners to understand their scientific interests and how they interface with, and relate to, engineering aspects of ECS.

8.1.1 EOS Program and Project Science Interfaces

The EOS Program and Senior Project Scientists reside at NASA HQ and GSFC, respectively. Further, the EOS Senior Project Scientist manages a GSFC office composed of the EOSDIS Project Scientist, the EOS platform project scientists (AM, PM, Color, Altimetry and Chemistry), and the Calibration Scientist. The ECS Project Scientist has lead responsibility in maintaining EOS Program and ECS Project science interfaces and in delegating actions relative to these interfaces to the ECS Science Office Staff. Because the EOS AM platform has the earliest EOS launch date (June 1998), a member of the ECS Science Office is delegated to serve as a more frequent interface to the EOS AM Project Scientist.

The EOSDIS Project Scientist is the direct NASA counterpart to the Hughes ECS Project Scientist. In order to coordinate EOS science related issues and policy, the EOSDIS Project and ECS Project scientists meet formally on a monthly basis. In addition, due to the importance of maintaining an open channel of communications between the science elements of both projects, it is important that informal (unscheduled meetings, telephone, e-mail, etc.) communications channels be frequently used to exchange information.

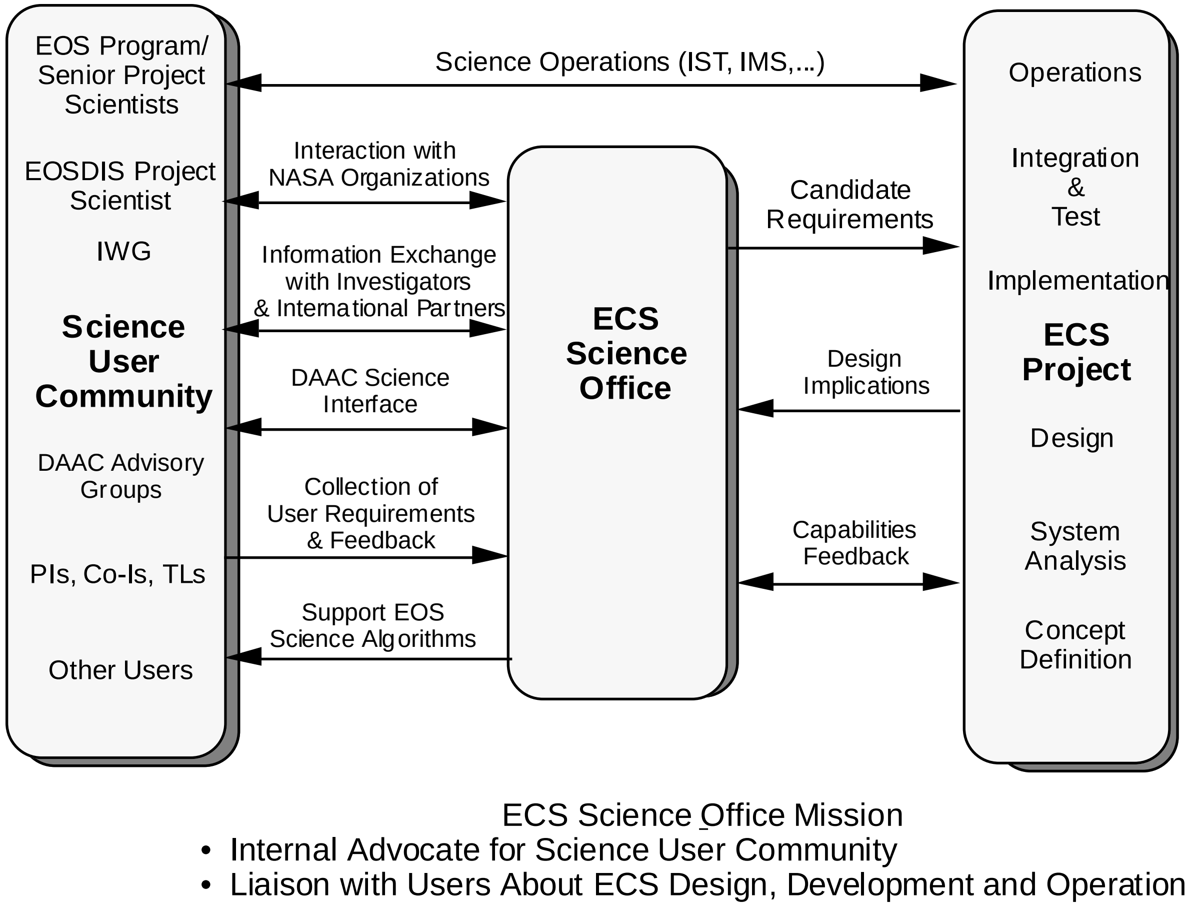

Figure 8-1. ECS User Involvement Model

8.1.2 Investigators Working Group

The EOS Program and Senior Project Scientists co-chair the Investigator Working Group (IWG). The members of the IWG include all selected Interdisciplinary Science Investigation Principal Investigators (PIs), Instrument PIs, Lead U.S. Co-Investigators for non-U.S. investigations, and Facility Instrument Team Leaders (TLs). Due to the importance of the IWG as a forum to resolve program wide science issues, the ECS Project Scientist and Deputy Project Scientist attend every IWG meeting (roughly every 6 months). Also the ECS Project Scientist and Deputy Project Scientist, after coordination with NASA, may develop and present reports relative to the ECS Project at the IWG meetings.

8.1.2.1 Investigators Working Group—Panels

The IWG presently consists of 12 panels grouped into the following three categories:

a. Disciplinary Panels
   - Atmosphere*
   - Biogeochemical Cycling
   - Land/Biosphere*
   - Oceans*
   - Solid Earth

b. Interdisciplinary Panels
   - Modeling*
   - Physical Climate and Hydrology

c. Functional Panels
   - Calibration/Validation
   - EOSDIS Advisory*
   - Instruments
   - Payload Advisory*
   - Precision Orbit Determination/Mission Design

The panels identified with an "*" are presently most active but the level of activity of all panels varies with time. In order to understand the science rationale behind the EOS data products, it is important that, at a minimum, the ECS Science Office maintain a close working relationship with the highlighted panels. This relationship includes: attending each panel meeting which occur at the IWG meeting and at other times throughout the year (each panel meets approximately every 6 months out of phase with the IWG), telephone communication, and e-mail correspondence with each panel chairperson. In some cases there may be specific technical discussions which must take place between ECS Science Office personnel and the panel chairs. To be most efficient, the ECS Science Office will attempt to hold technical discussions in conjunction with the panel meetings.

8.1.3 DAAC Advisory Groups

Each DAAC has established an advisory group composed of experienced science users with the primary purpose of providing feedback on their DAAC Version 0 and Pathfinder activities. Two of the DAACs, UAF and NSIDC, chose to form a joint advisory group, the Polar DAAC Advisory Group (PoDAG). All of the DAAC advisory groups have the potential of providing ECS with a wealth of information and lessons learned. Members of the ECS Science Office will attend advisory group meetings; witness prototype activities, as appropriate; and seek discussion of issues applicable to ECS.

8.2 General Science Community Outreach Activities

The ECS Science Office participates in many science community outreach activities. The Science Office participation in some of these activities is summarized below:

- EOSDIS exhibits - interface with scientists at major scientific conferences and other meetings.
- ECS Symposia for Scientists - sponsor symposia for scientists to assist them in learning about the ECS.
- Instrument Teams - interact with instrument teams, including assigning POCs for each instrument.
- Newsletter - publish a newsletter quarterly on the WWW with articles on ECS development.
- ECS Documentation - produce ECS brochures, white papers, and posters.
- ECSinfo - provide a server with ECS information for scientists on the WWW.
- Seminars - coordinate weekly/biweekly seminars to introduce ECS developers to scientists.
- Prototyping - ensure scientific consistency and incorporation of scientific data into prototypes.
- User Feedback - ensure that user comments and suggestions gathered at meetings are properly recorded, handed off to the appropriate developers, and tracked.

8.3 Collection of Science User Requirements and Feedback

The ECS Science Office supports collection of requirements and feedback with an internal ECS system for tracking and evaluating recommendations from the science community. The ECS Project Scientist, ECS Deputy Project Scientist and Science Office staff solicit recommendations and feedback from science users and other ECS-supported projects (e.g., Version 0, TRMM, Landsat 7, and other Earth probes). The Hughes Team records the recommendations and issues resulting from these science interfaces and enters the information into the User Recommendation Data Base where it is tracked, assessed, and applied to the systems engineering process after Configuration Control Board (CCB) approval. Some recommendations may be out of scope to the project baseline and would be implemented only if additional funding were approved by GSFC for the change.

8.4 DAAC Science Support

The ECS Science Office provides an ECS DAAC scientist at each DAAC to enhance interactions of the DAAC user community with ECS. The ECS DAAC scientists are resident at the DAAC and will provide day-to-day liaison with the individual DAAC science communities. DAAC scientists also play a role in coordinating V0 data migration to the DAACs.

8.5 Support to EOS Science Software Integration and Test

CN 01

The ECS Deputy Project Scientist is lead on science software integration within ECS. Through the Science Office staff, he maintains engineering liaison with EOS investigators developing ECS science software. Support to science software developers includes training in the use of science software development/integration tools, monitoring of science software for adherence to EOS standards and assistance during science software integration and testing. Further, the staff support science software maintenance and updates as provided by the EOS investigators. CN 01

8.6 User Modeling/Characterization

The purpose of user modeling is to provide the ECS developers and modelers with the information they need regarding the projected user community. Activities in this area include:

- Collection and analysis of information on the data products to be produced by the IDS teams, as well as data needed by the IDS teams
- Surveys of the science community for information on Relative Product Access Frequency
- Gathering of data from existing data centers to understand how scientists interact with current systems
- Analysis of the impact pull parameters have on sizing and other design parameters. Identification of parameters that have a high probability of changing (ie., size of the community) and assessment of the impact potential changes will have on the system
- Updating of user scenarios - review current scenarios and add those from Independent Architecture Studies; continue to collect and monitor information from the DAACs to modify and maintain the current base of information
- Monitoring of Headquarters policy decisions regarding the composition of the EOSDIS user community

8.7 Collaborative Prototype Coordination

The Science Office provides point of contact and overall strategy for ECS prototyping efforts and lead collaborative prototyping activities. In addition, the Science Office populates the Technical Management Data Base with current information on prototyping activities.

8.8 Science Data Processing Support

The Science Office provides support for establishing the ECS data handling requirements, including performance requirements for data processing, storage and distribution. Activities in this area include: coordination with the Ad Hoc Working Group on Production (AHWGP); interaction with Instrument Teams in collecting and verifying AHWGP data; incorporation of AHWGP data into ECS performance modeling effort and technical baseline; and development of static models for SDPS processing, I/O requirements, inter-DAAC traffic.

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9. Subcontracting and Management Plan

9.1 Subcontracted Items

The Hughes Management approach to subcontracting features a total team commitment to ECS utilizing the complementary team skills of Hughes, Loral AeroSys, Electronic Data Systems (EDS), Engineering and Science Studies Inc. (ESSi) (a subsidiary of Center for Space and Advanced Technology), Applied Research Corporation (ARC), NYMA, Inc. and Hughes Technical Services Company (HTSC), a subsidiary of Hughes Aircraft Company. The Hughes Team selections were based on these complementary team skills, with uniquely qualified personnel with highly relevant experience who have worked together on ECS since before Phase B, and with outstanding past performance, including cost and schedule management.

Four primary criteria were used in evaluating past performance with respect to Hughes ECS team selection. These were: 1) similarity of field of technical endeavor and its relevance to their designated role on ECS; 2) contracts having similar complexity to GSFC's requirements for ECS; 3) project maturity of cited experience to demonstrate proven performance; and 4) similarity between demonstrated performance on contracts to performance demands of ECS.

Hughes has management responsibility for all top-level project offices except the Flight Operations Office, which is assigned to Loral because of its rich heritage in satellite flight operations and control.

The remainder of this subsection describes the specific rationale and role that each individual team member will be contributing to ECS.

Loral AeroSys has a nationally recognized high technology capability with more than three decades of experience in flight operations. It has extensive experience in developing NASA related satellite operations and control systems, large volume science data management and processing systems, and has worked with NASA's NASCOM space network and Flight Dynamics Facility.

In addition to Flight Operations Segment (FOS) Development, Loral has the complementary responsibility for the engineering and integration of the FOS and the design/development of all FOS elements except for planning and scheduling. Loral will also be responsible for Data Server and Ingest Subsystem development, maintenance and operations.

EDS is one of the world's leading providers of information technology services. It has engineering experience translating information systems requirements into procurement specifications that are vendor independent for COTS hardware and software. EDS is the world's largest procurer of COTS products other than the U.S. Government.

Hughes utilizes EDS's COTS procurement and vendor influence by assigning them responsibility for COTS engineering support under the Systems Engineering and Integration Office, COTS maintenance, logistics and training under the M&O Office, COTS hardware and software procurement and related COTS configuration management under the Management Operations Office, and COTS related quality functions under the Quality Office.

ARC is a science-oriented, high technology company specializing in geophysics, atmospheric and space sciences, and computer-related services. ARC's scientists have supported NASA-Goddard scientists in research to understand relationships between climate and solar/atmosphere/surface radiation.

NYMA's background is in system engineering, software upgrades and maintenance, computer operations, and integration testing for NASA projects. It is the independent verification and validation (IV&V) contractor for the Polar Orbiting Platform flight software and associated test beds and has an excellent understanding of NASA development policies and standards. NYMA will provide the IV&V interface, independent system acceptance testing roles and performance assurance support based on their unique NASA IV&V experience.

ESSi's business base is focused on the civil space program with particular expertise interfacing with the science community. It has considerable experience with the NASA field centers. other federal agencies, universities, and international research organizations involved in global change research. ESSi will provide science support and science community feedback to the project.

HTSC is a technical services oriented company which provides cost-effective operations support personnel to a wide variety of Federal customers throughout the United States. Their staff includes computer operators, network controllers, hardware maintenance staff, system programmers, user support personnel, system administrators, and general administrative support staff. They will be providing this kind of support to the ECS team both at the Hughes EDF and at the DAACs.

9.2 Procurement Management Approach and Process

The ECS subcontract management effort radiates from the Hughes Procurement Management Office. The objective of this office is to ensure the proper planning, coordination and reporting of the subcontracted efforts. Each Subcontracts Administrator (SA) provides management with visibility and focus into all Subcontractor activities. The overall process and communications links are depicted on Figure 9-1. The Procurement Management Office has the formal authority to direct and control each of the subcontractors and to ensure that each subcontractor’s functional area is in synchrony with the overall project direction. It works closely with the appropriate office manager who provides daily direction and guidance to the subcontractors. With the degree of anticipated change, project communications are of paramount importance and the integrated, collocated team approach promotes the insertion of the highest quality into the final product by ensuring a maximum degree of participation and consensus building. Given the complexity and magnitude of ECS, an integrated team with mutually compatible objectives, strategies, plans, and incentives combined with well defined subcontractor responsibilities, reduces the risk and minimizes the conflict often experienced in large, multisubcontractor programs.

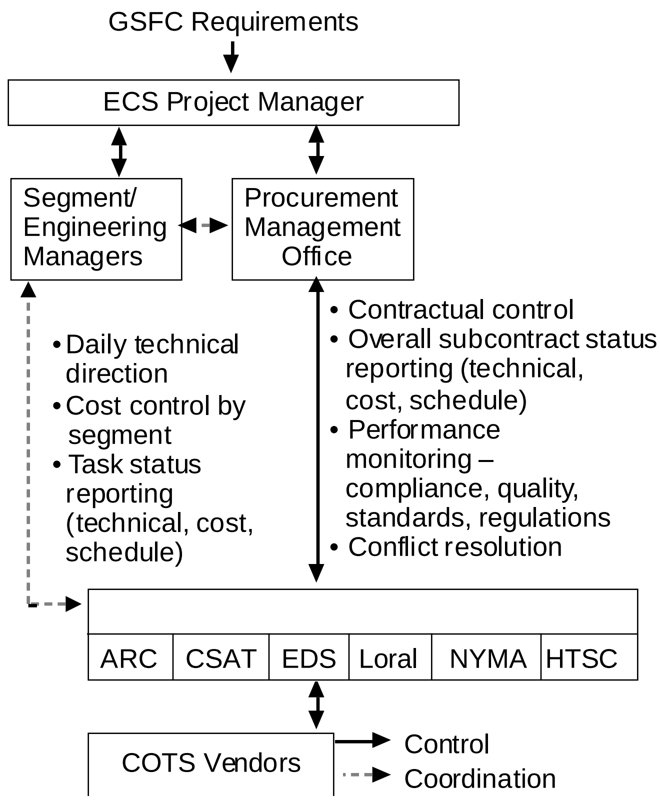

Figure 9-1. Procurement Management Process and Communications

The collocated team maximizes the general flow of information through shared documentation, data bases, tools, and an integrated information management system; the ready availability of team members for rapid decision making; and easy access to appropriate management levels for daily operational resource allocation and resolution of technical issues.

In conformance with the integrated team structure, subcontractors will receive two forms of communications: technical direction/clarifications, and formal directives. The first will come from the Technical Officer, primarily in the form of work direction. In designing and implementing each segment, technical office managers will direct the segment team which will be composed of Hughes and Subcontractor staff. Thus the flow down of requirements to the Subcontractors essentially becomes a relative non-issue since the design and development teams are comprised of prime and subcontractor staff.

Formal directives originate from the Technical Office managers or the Project Manager to the Subcontractor Administrators, such as conveying a formal requirements specification to the subcontractor or issuance of subcontract change orders or amendments. In this mode, the flowdown of out-of-scope requirements as they impact each subcontractor's SOW and project cost profile, needs to be reflected contractually. Formal signoff authority on subcontractor products resides within the Procurement Management Office with prior review by the appropriate Hughes technical managers. Additional detail may be found in the Procurement Management Plan (101-110-MG2-001), Section 5.

9.3 Problem Issues/Resolution Paths

In those cases where conflict does arise between the prime and a subcontractor or between subcontractors that cannot be resolved at the working group level, the Manager of Subcontracts serves as the focal point for mediation. In this capacity, the manager considers the issue from a broad, project perspective, assists in articulating the relative merits and tradeoffs, and facilitates a decision through consensus. Resolution of technical issues also involves the chief systems engineer, whereas cost issues may involve a representative from the Business Operations Office. If the issue still remains open, it is then presented to the ECS Project Manager's office, who has final decision making authority. The SMO has prime responsibility to ensure that subcontract problems are identified and resolved in a timely manner.

10. Internal Work Flow Management

10.1 Interoffice Work Flow Model

Figure 10-1 depicts the collaborative communication links among the offices and managers within the ECS project organization that was introduced in Section 5, ECS Contractor Organization Structure. Successful day-to-day conduct of such tasks as requirements analysis, requirements allocation, trade studies, and operations feedback relies heavily on the vitality of these links. Effective communications among these positions are critical to ECS success, and their location in a single facility near GSFC substantially aids this process. These communications are further enhanced by joint activities of the top participants such as the Risk Management Panel and the Software Engineering Process Group.

The following subsections summarize the project management tools used in project management activities, and furnish details on each project function and office/organization including organization structures, work summary/Contract Work Breakdown Structure (CWBS), and principal deliverables. The full CWBS is attached as Appendix A.

10.2 Automated Project Management Tools

The project will utilize a suite of automated tools for scheduling, performance measurement, procurement, configuration management, and data management. The specific tools selected by the project are listed in Table 10-1.

Table 10-1. Automated Project Management Tools

Function	Tool Name
Performance Measurement System	Microframe Project Manager (MPM)
Procurement Management Database	Vendor Costing Automated Tracking System (VCATS)
Configuration Management (CCB)	Configuration and Data Management Tracking System (CDMTS)
Configuration Management (Software)	ClearCase
Data Management : Data Tracking, Monitoring, and Retrieval Data Preparation and Transmission	Configuration and Data Management Tracking System (CDMTS), MSWord 5.1, MacDraw Pro, Excel 4, Power Point 3.0, Canvas, Framemaker 5, Adobe Illustrator, Adobe Workshop
Scheduling	Prestige, MS Project
Requirements tracking	Requirements and Traceability Management (RTM)

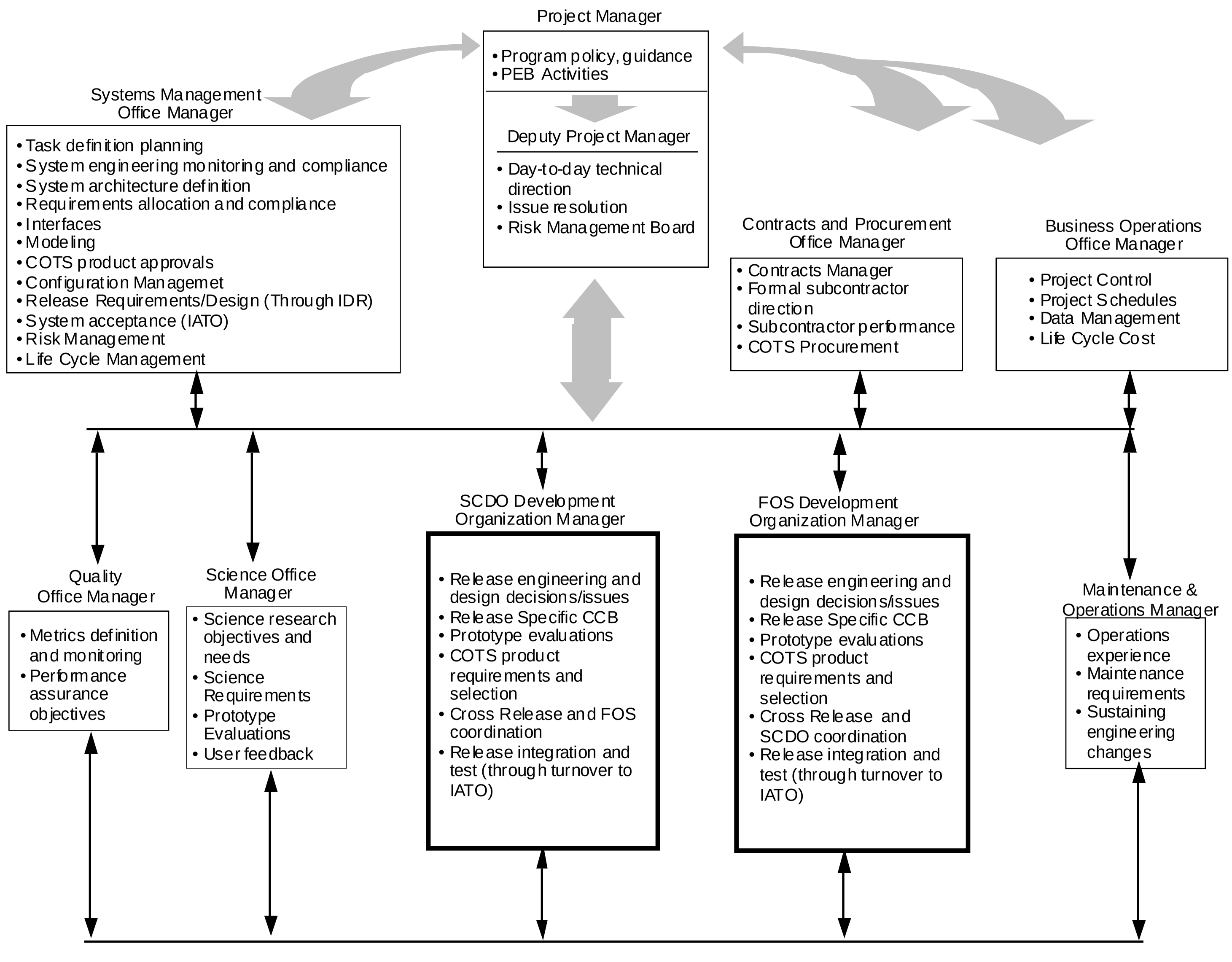

Figure 10-1. Collaborative Communications Links

10.3 Project Management

10.3.1 Work Summary/Structure

Project Management consists of the Project Manager and Deputy Project Manager. The Project Manager is responsible for overall project execution and performance. Through his managers, he defines project direction and objectives and controls the allocation of resources. He is the primary contact with the COTR, chairs the monthly reviews, has final authority in determining priorities and resolving conflicts, and provides the focused leadership essential for achieving ECS success. The ECS Project Manager is an indirect charge to the Contract in accordance with standard Hughes business management practices.

The Deputy Project Manager provides day-to-day technical direction and coordination on ECS implementation and establishes operating priorities. He also stands in for the Project Manager in his absence. In conjunction with the office and organization managers, he ensures a consistent engineering approach throughout the life cycle of ECS.

The work performed by the Deputy Project Manager is contained under WBS 1.1, Program Control.

10.3.2 Deliverables

There are no CDRL deliverables assigned to Project Management.

10.4 Contracts and Procurement Management Office

10.4.1 Work Summary

Contracts functions under WBS 1.0, Project Management. (Per standard Hughes business management practices, the Contracts function is indirect.) It is the role and responsibility of this office to interface directly with the Government Contracting Officer representing the Prime Contractor. This entails receiving formal contractual direction including changes. The Contracts Office is also responsible for dissemination of contractual requirements to the project organization. It ensures that deliverable requirements are understood and fulfilled in a timely fashion per contractual agreement. The Contracts Office produces no deliverables.

Procurement Management organization's objective is to ensure the proper planning, coordination and reporting of the subcontract and procurement efforts. Procurement Management has the formal authority to direct and control each of the subcontractors and suppliers to ensure that each subcontractor’s and/or supplier's functional area is in synchrony with the overall project direction. This work is performed under WBS 1.4, Procurement Management.

10.4.2 Internal Office Structure

The Manager of Procurement has the responsibility for overall performance of the subcontractors and suppliers across the project and serves as the formal management interface as well as the advocate for the subcontractors and suppliers in the ECS Project Office. The Procurement Management organization consists of the manager, three subcontract administrators, three COTS procurement buyers and two general purpose buyers. The organization structure is on Figure 10-3. Procurement management ensures subcontractor performance is compliant with the subcontract, SOW, ECS requirements and related documents. Pooling their collective experience assures the smooth operation of the Procurement Management Office. The subcontract administrator has responsibility for subcontractor activities, to monitor performance, and assists in resolving issues. In accordance with ECS project instructions subcontractor activities are monitored through the subcontract administrator's participation in technical review meetings, as appropriate, monthly subcontractor progress reviews, and reviews of the Performance Measurement System (PMS) reports. Involvement with subcontractor activities allows the subcontract administrator to understand potential implications for a subcontractor’s SOW and to appraise technical managers of areas that are out-of-scope or otherwise contractually non binding.

The subcontract administrator ensures the implementation of requirements contained in the subcontract. The statement of work, the Subcontractor's Data Requirements List (SDRL), and the procurement specification establish the primary baseline from which the subcontract is managed. Complete visibility and a thorough understanding of the subcontractor's overall operation, is maintained by the Hughes Subcontract Administrator. This is considerably simplified since all subcontractors will be using the same PMS package supplied by Hughes.

As part of the integrated team, subcontractors will staff the individual segments, but each subcontractor will also have designated WBS elements, and SDRLs that will enable the Segment and Engineering Managers to track performance at the detailed WBS level, and the Manager of Subcontracts to monitor the overall performance (cost, schedule and technical) of each Subcontract across the program.

The COTS procurement management group is responsible for the purchase of all COTS hardware and software. This function is executed by EDS but performs functionally through the Contracts and Procurement Management Office. They interface with the EDS system engineers to ensure a clear understanding of equipment specifications, requirements, delivery/installation deadlines and cost factors, and are the liaison to vendors. The COTS procurement management group also maintains vendor data on COTS life cycle costing, benchmark results, and product and environmental specifications, which allows segment design teams to "design to cost."

The general procurement function is responsible for the day to day procurement needs of the project. These procurements normally range from operating supplies to purchased labor and technical services agreements.

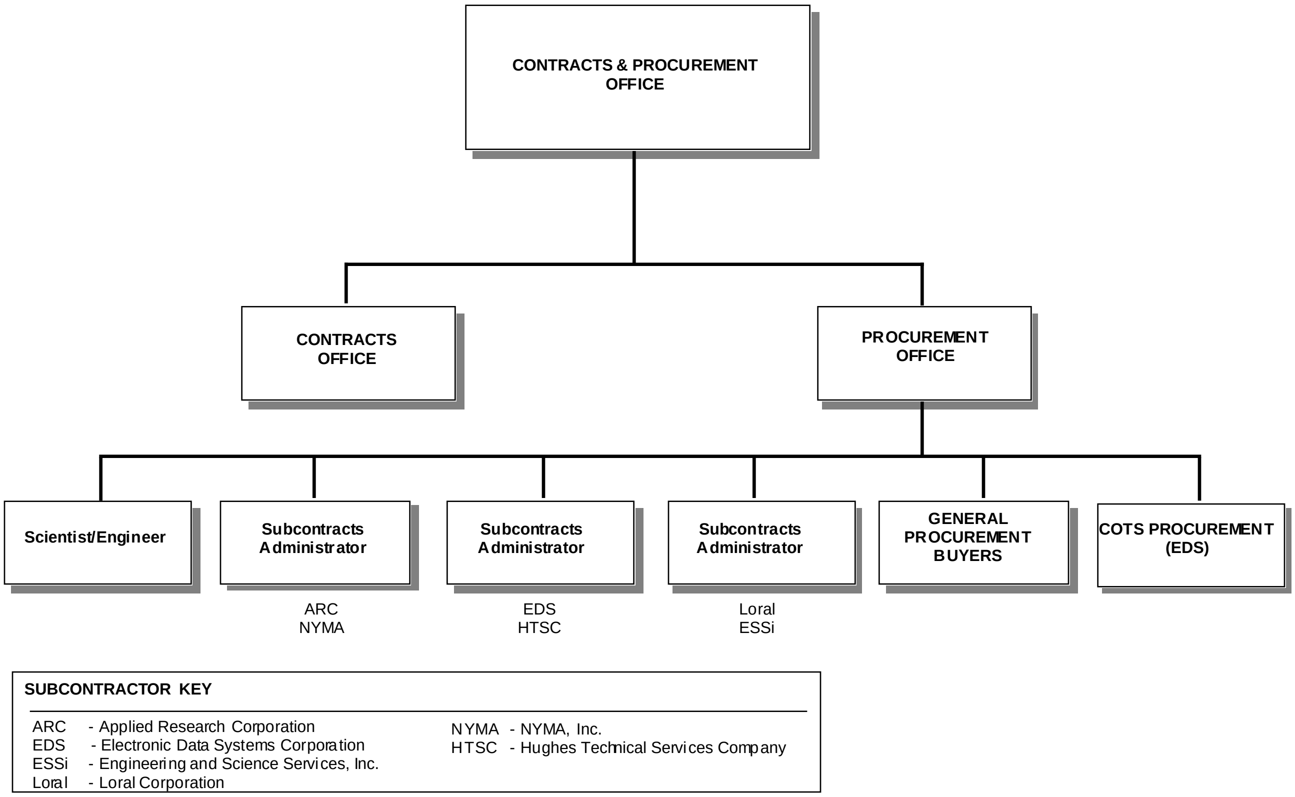

Figure 10-2. Contracts and Procurement Office Organization

Further detail on procurement management in terms of status and financial reporting, including application of the Performance Measurement System, may be found in the Procurement Management Plan (101-110-MG2-001), Section 5.

10.5 Business Operations Office

10.5.1 Work Summary

The Business Operations Office (BOO) provides project-wide services to achieve significant economies of scale and efficiency. Theses centralized management services include schedule and cost reporting, and data management (DM).

10.5.2 Internal Office Structure

The Business Operations Office is organized as shown in Figure 10-3 below.

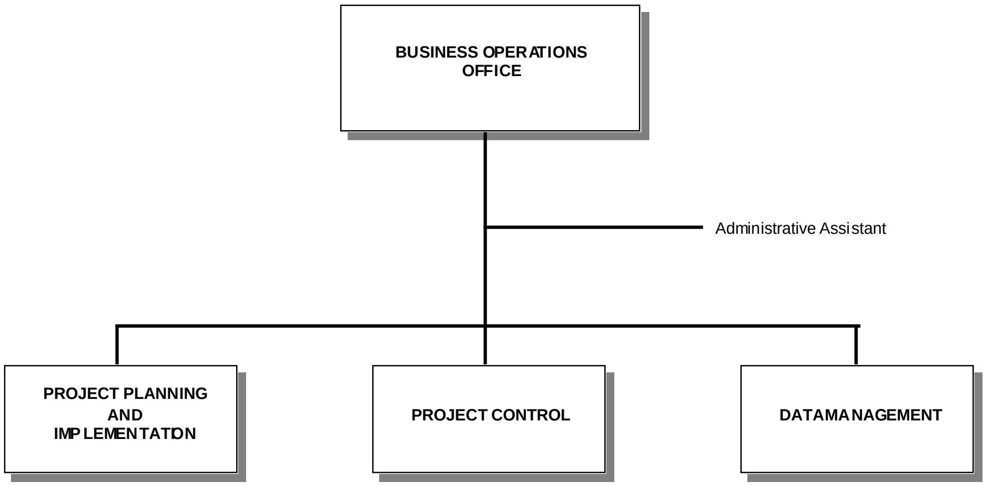

Figure 10-3. Business Operations Office Organization

The Data Management Office's goal is to provide the data services functions necessary to create, control, deliver, archive, and update data and additional non-deliverable documents relevant to development of the ECS, and to organize and provide easy access to these data.

The ECS contract requires full development and implementation of a NASA certified Performance Measurement System (PMS). It is the primary responsibility of the Project Planning and Implementation organization and the Project Control organization within the Business Operations Office to assure that the ECS contract has a fully implemented and smoothly operating PMS in place to track project performance against cost.

The Project Planning and Implementation organization is responsible for the development of project cost estimates, and the development and implementation of project scheduling activities. A full description of this organization's responsibilities is contained in the ECS Schedule Management Plan (194-106-MG1-001).

Once project schedules are established in accordance with instructions contained in the Schedule Management Plan, the Project Control staff takes assigned resources and allocates them to work packages, establishes milestones against which earned value is taken, and imports actuals from each company's accounting system to provide detailed cost and schedule performance status against project resources. The planning, budgeting, accounting, and analysis processes, and the revision process, are fully documented in Hughes Applied Information System's Cost and Schedule Management System Manual (Manual 601).

10.5.3 Deliverables

The Business Operations Office deliverables are indicated in the ECS Documentation Management and Control Matrix (152-TR-001-002).

Approval level 1 data items are considered key to establishing Business Operations Office policy. Once approved by GSFC, these plans undergo ECS change control, and serve as the basis for lower tier procedures due as contract required data.

10.6 Quality Office

10.6.1 Work Summary

The Quality Office coordinates the Performance Assurance program across the ECS Project assuring that GSFC's Performance Assurance Requirements are implemented. Actual execution of tasks are allocated to the technically best qualified office. The scope of the work performed by the Quality Office is in WBS 7.1, Performance Assurance Program and WBS 7.2, Software Quality Assurance. Further, the Quality Office coordinates the continuous measurable improvement (cmi) activity for the improvement of ECS engineering and business management processes.

10.6.2 Internal Office Structure

The Quality Office is organized into two major work activities (Figure 10-4): the operational Quality Assurance function and the longer range cmi process improvement function. Metrics data gathering and independent reporting to Project Management on project risk and quality status are key activities of the Quality Assurance function. One activity of the cmi function is to analyze trends in metrics data to identify process improvement areas. A major improvement thrust is in product reuse.

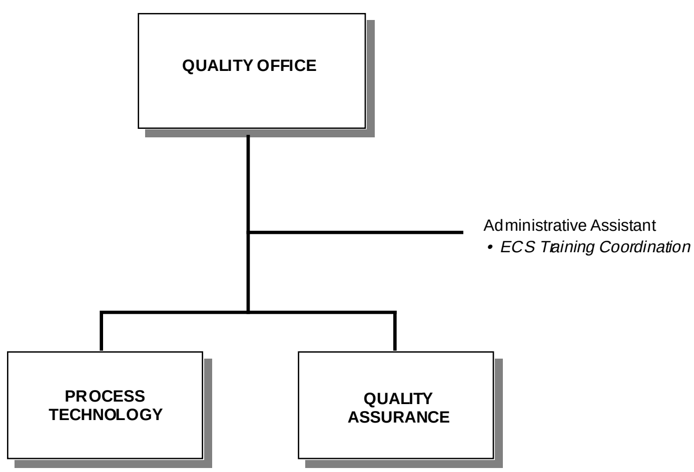

Figure 10-4. Quality Office Organization

10.6.3 Deliverables

The specific deliverables originating from the Quality Office are indicated in the ECS Documentation Management and Control Matrix (152-TR-001-002). A key item is the Performance Assurance Implementation Plan (PAIP). This plan describes the implementation approach for the entire set of Performance Assurance Requirements. A subset are implemented by the Quality Office with the balance implemented by other project offices and organizations.

10.7 Science Office

10.7.1 Work Summary

The Science Office staff maintain active information exchange through peer-level working liaison with the science community and Hughes engineering staff. Internal, weekly Science Office meetings allow the Science Office Manager to obtain status on open issues and action items, close action items, identify new issues, assign new action items, and assess the overall progress of the Science Office. Formal presentations are made by the Science Office Manager at the monthly ECS Project Reviews.

10.7.2 Internal Office Structure

The Science Office organization chart is presented in Figure 10-5. The Science Office is managed by the Science Office Manager and the Deputy Project Scientist. The Science Office Manager fulfills the dual roles of Hughes Project Scientist and Science Office Manager. Internally, the Science Office Manager serves as the science advocate to the Project Manager, providing science guidance and visibility into science user needs. The Science Office manager, directs a staff of scientists/analysts to ensure that science requirements are analyzed effectively and successfully translated into ECS development and operations. Externally, the Project Scientist directly interacts with the NASA EOS Program and Senior Project Scientists, the EOSDIS Project Scientist, the EOS Investigator Working Group (IWG), and others in the EOS science community under the overall direction of the COTR. In this manner, as the Hughes Project Scientist, the Science Office Manager provides a bridge between ECS engineering and the EOS and Global Change Research Community.

The Deputy Project Scientist (ARC) is responsible for DAAC science support, and algorithm development and integration support. The Deputy Project Scientist directs the activities of the ECS DAAC scientists resident at each DAAC. Activities include demonstrating ECS prototype capabilities to DAAC users and scientists, soliciting feedback on ECS Releases, updating DAAC science interface and processing needs, participating in science algorithm integration and test at the DAACs, and promoting information interchange between ECS engineering and the DAAC, through user groups, newsletters, bulletin boards, and other appropriate means. Establishing local presence at the DAACs allows a more local relationship between the ECS Science Office and the discipline community being served by the DAAC. Local presence also facilitates the interaction required to efficiently and accurately integrate the science algorithms from the SCFs into the DAACs. The Deputy Project Scientist regularly attends meetings of the IWG, and other science-related groups (e.g., standards panels, data users groups, etc.) in order to facilitate a dialogue on requirements, data, and algorithm development, as well as to improve effective technical support.

CN 01

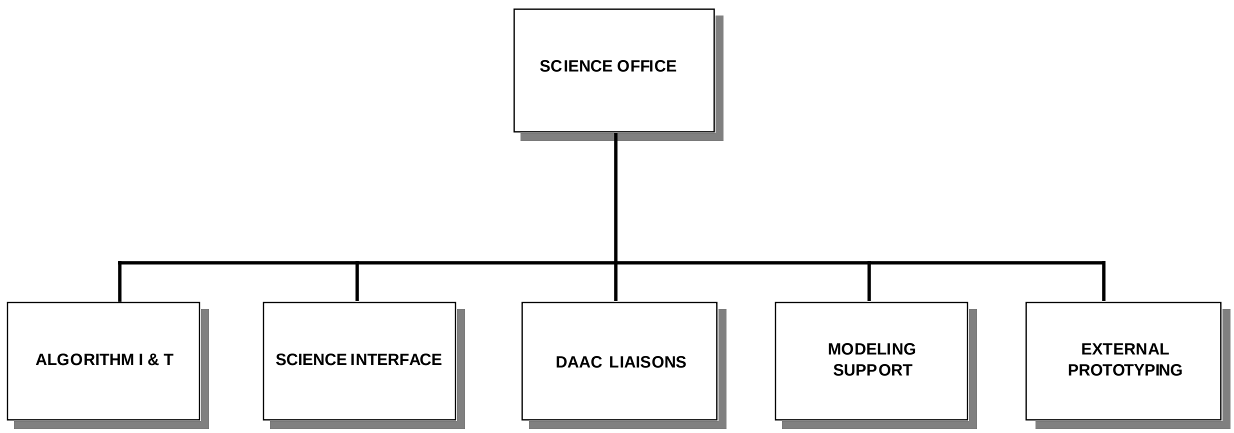

Figure 10-5. Science Office Organization

The subordinate functions in the Science Office are staffed by a combination of subcontractor and Hughes Personnel. Their performance against SOW elements and cost accounts is tracked and managed by the Science Office Manager. The roles and responsibilities of the subordinate functions have been described in Section 8 of this document. Table 10-2, Science Office Work Description, maps the Science Office functions to the roles and responsibilities described in Section 8.

10.7.3 Deliverables

The ECS Documentation Management and Control Matrix (152-TR-001-002) indicates two documents as the responsibility of the Science Office. These are the Science User's Guide and Operations Procedures Handbook (193-205-SE1-001, 201-CD-002-001) and the Contractor’s Release Experience Report (DID 332). The Science Office also reviews and provides comments on many other CDRLs to ensure that the project's science objectives are met.

Table 10-2. Science Office Work Description

Science Office Function	Paragraph Reference	Paragraph Title	
Science Software I&T	8.5 8.8	Support to EOS Science Algorithm and Test Science Data Processing Support	CN 01
Science Interface/Prototype Coordination	8.1 8.2 8.3 8.7	Interaction with NASA Science Organizations General Science Community Outreach Activities Collection of Science User Requirements and Feedback Collaborative Prototype Coordination	CN 01 CN 01
DAAC Science Liaisons	8.2 8.3 8.4	General Science Community Outreach Activities Collection of Science User Requirements and Feedback DAAC Science Support	CN 01
User Characterization/ Modeling	8.6	User Modeling/Characterization	CN 01

10.8 System Management Office

10.8.1 Work Summary

The System Management Office (SMO) provides consistency and control of the technical direction and integrity of the ECS. SMO serves as the driver for system and technology planning, overall architectural design and system acceptance. SMO establishes common hardware and software approaches, specifies external interfaces, defines engineering standards, employs concurrent engineering to affect proper technical tradeoffs, and ensures that ECS implementation is compliant with overall ECS requirements. SMO directly manages overall systems engineering activities; however, other project development organizations also manage systems engineering activities that are unique to their areas.

The SMO Office Manager serves as the internal ECS CCB chairperson, providing the focus for critical assessment and rationale for engineering changes. In addition, the SMO Office Manager is responsible for ensuring objectivity and independence of the acceptance testing.

The SMO work scope covers a broad spectrum. The work is covered principally in WBS 1, Program Management; WBS 2, Systems Engineering; and WBS 6, ECS Test and Evaluation.

10.8.2 Internal Office Structure

The SMO internal organization structure is shown in Figure 10-6 and described below:

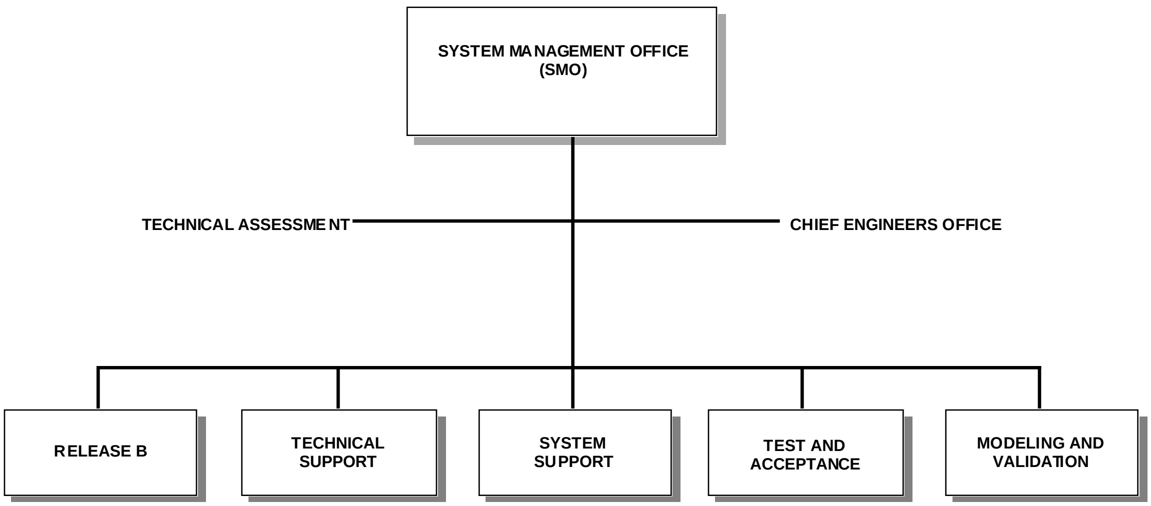

Figure 10-6. System Management Office Organization

The Chief Engineer provides the technical "vision" for the project. He is the focal point for system-wide technology evaluation and approval to ensure consistency and compatibility of the delivered system. The Chief Engineer defines the overall system hardware and software architecture and provides the lead role in requirements interpretation, including the preparation and maintenance of the current technical baseline that internally serves to direct the activities of the project's development organizations. The Chief Engineer also oversees the project's COTS cost modeling activities.

The technical assessment function is responsible for risk mitigation activities, the focus and vision of the Science and Technology Laboratory (STL), project standards, and for interfaces to corporate resources external to the project.

The Release B team is responsible for the Release B level 4 requirements and preliminary design through the Release B IDR. After the IDR, Release B is handed-off to the SCDO organization for continuation of development through the CSR. SMO will perform the same functions for the early development of the Releases following Release B.

The Technical Support Office provides engineering support for system architecture maintenance, evaluation of Release C/D evolutionary enhancements, CCR/Change Order analysis, and risk assessment. It conducts special studies and prototyping activities as needed to support these activities and coordinates with other SMO groups, SCDO, FOS, M&O, and the Science Office on issues related to evolutionary enhancement insertion, risk mitigation strategies, and evolvability of the ECS architecture.

The System Support function is responsible for ECS requirements definition and analysis, including controlling and managing the Requirements Traceability and Management (RTM) data base; and for all ECS external interfaces. Interface engineering is the project’s formal vehicle for establishing complete interface definitions for ECS external interfaces and controlling the interfaces between ECS segments. Interface engineers review all interface designs and implementation for compliance. In addition, System support is responsible for: system architecture definition and control, security requirements and planning, and for the project's DAAC liaison offices until that responsibility is assumed by M&O..

The Test and Acceptance organization (TAO) is responsible for the independent acceptance test of the ECS, and serves as the technical point of contact (POC) for the coordination of ESDIS Ground System (EGS) integration activities. In addition, TAO manages the ECS configuration management function including the software development library.

The Modeling and Validation team provides performance and RMA modeling for the ECS project. Validation of the models is performed in coordination with the IV&V contractor and independent consultants. The Systems Performance model is written in the Block Oriented Network Simulation (BONeS) language to assist in the design of the ECS system by providing dynamic simulation of the major components of the system architecture. The model allows exploration of alternative designs of capacity and end-to-end response times for processors, communications, and levels of storage with varying hardware characteristics and workloads. The Reliability, Maintainability, and Availability models are based on the hardware configuration at each DAAC and at the EOC.

10.8.3 Deliverables

SMO deliverables are indicated in the Documentation Management and Control Matrix (152-TR-001-002). The SMO deliverables include plans, system level requirements documents, study reports and presentation packages. In particular, SMO is responsible for this document, the Project Management Plan. This plan internally guides the operations of the ECS project organization and specifies the framework for coordination between the project team and NASA.

10.9 Flight Operations Segment (FOS) Development Organization

10.9.1 Work Summary

The Flight Operations Segment (FOS) is responsible for EOS-AM1 mission operations, including the planning, scheduling, commanding, and monitoring of the EOS-AM1 spacecraft and instruments. The FOS is composed of the EOS Operations Center (EOC) and Instrument Support Terminals (ISTs). The EOC is the GSFC element responsible for overall operations of the EOS-AM1 spacecraft and instruments. The ISTs consist of a tool kit of ECS software connecting remote site science investigators to the EOC in support of instrument control and monitoring.

The FOS office is responsible for the design, development, implementation, integration, test, and operation of the following FOS services:

Planning and Scheduling

Command Management Processing
Command Processing
Telemetry Processing
Observatory Analysis
Data Management
Element Management
User Interface

10.9.2 Internal Office Structure

The FOS office structure is depicted in Figure 10-7. The FOS office is lead by the FOS manager. The FOS manager is responsible for maintaining budget, schedule, and technical performance for all work under scope of the statement of work (SOW). The FOS organization has three major groups: FOS Development, FOS Integration and Test, and FOS Operations. The Development Manager leads the development of the FOS system and is supported by five subsystem supervisors for the following functional areas: real-time processing, off-line analysis, user interface, planning and scheduling, and sustaining engineering. The Integration and Test Manager coordinates the integration and test activities and is responsible for system turnover. The Operations Manager leads a group providing operational insight into the development process and eventual operation of the FOS system.

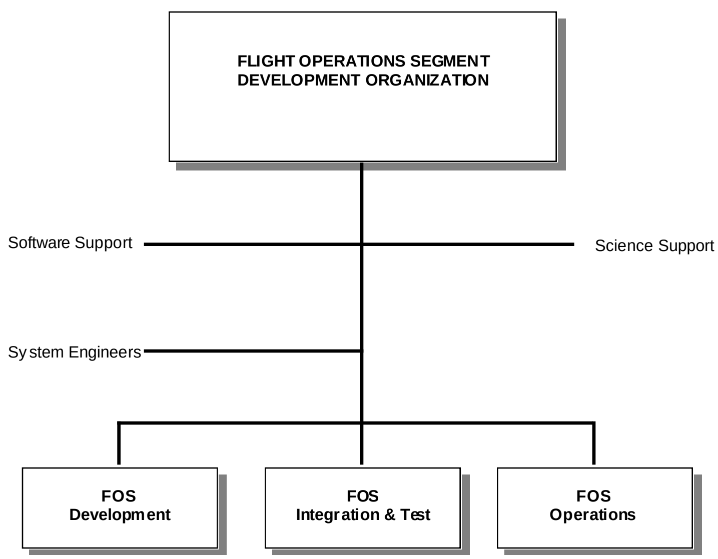

Figure 10-7. FOS Development Organization

10.9.3 Deliverables

FOS deliverables are indicated in the Documentation Management and Control Matrix (152-TR-001-002). One of the key sets of FOS deliverables are the FOS system releases. Release A will provide an initial set of FOS functional capabilities and support interface testing. Release B will provide full FOS functionality and will support AM-1 launch and subsequent operations.

10.10 Science and Communications Development Organization

10.10.1 Work Summary

The Science and Communications Development Organization (SCDO) is responsible for development of the Science Data Processing Segment (SDPS) and the Communications and System Management Segment (CSMS). The SDPS development includes the ingest, cataloging, processing, analysis, archival, searching, and retrieval of science data and data products. An adjunct to this activity is the support of algorithm development, integration, and test. The CSMS provides for the interconnection of users and service providers, transfer of information between the ECS and many EOSDIS components, and monitoring and coordination of all EOSDIS components. SCDO is responsible for the level 4 requirements, design, build, and test and integration of SDPS/CSMS Release A through the Consent to Ship Review (CSR) and turnover of Release A products to the Independent Acceptance Test Organization (IATO). As described earlier in this section, preliminary design of Release B and subsequent Releases will be the responsibility of SMO until each Release IDR when the Release products will be turned over to SCDO for completion until turnover to the IATO at CSR.

The SCDO work scope is covered principally in WBS 4, SDPS Development; and WBS 5, CSMS Development, and WBS 6.1 (System Integration and Test).

10.10.2 Internal Office Structure

SCDO is organized primarily by release, as shown in Figure 10-8. The TRMM Infrastructure Development Group develops all functions associated with early interface testing for the TRMM mission, including early testing of the AI&T environment. The TRMM Development Group develops all functions associated with operation of the TRMM mission itself, plus early interface testing for AM-1 and Landsat-7 missions. After the IDR-B milestone, SCDO will assume from SMO the staff, budget, and responsibility for development of all non-FOS ECS functions needed for operation of AM-1 and Landsat-7 mission. (Note: development of FOS is handled by a separate organization.) (Note: these descriptions of release scope are high-level - see the ECS Release Plan Content Description (222-TP-003-006) for more specific and inclusive descriptions.) Each release team performs its own system engineering, prototyping, software development, and integration and test.

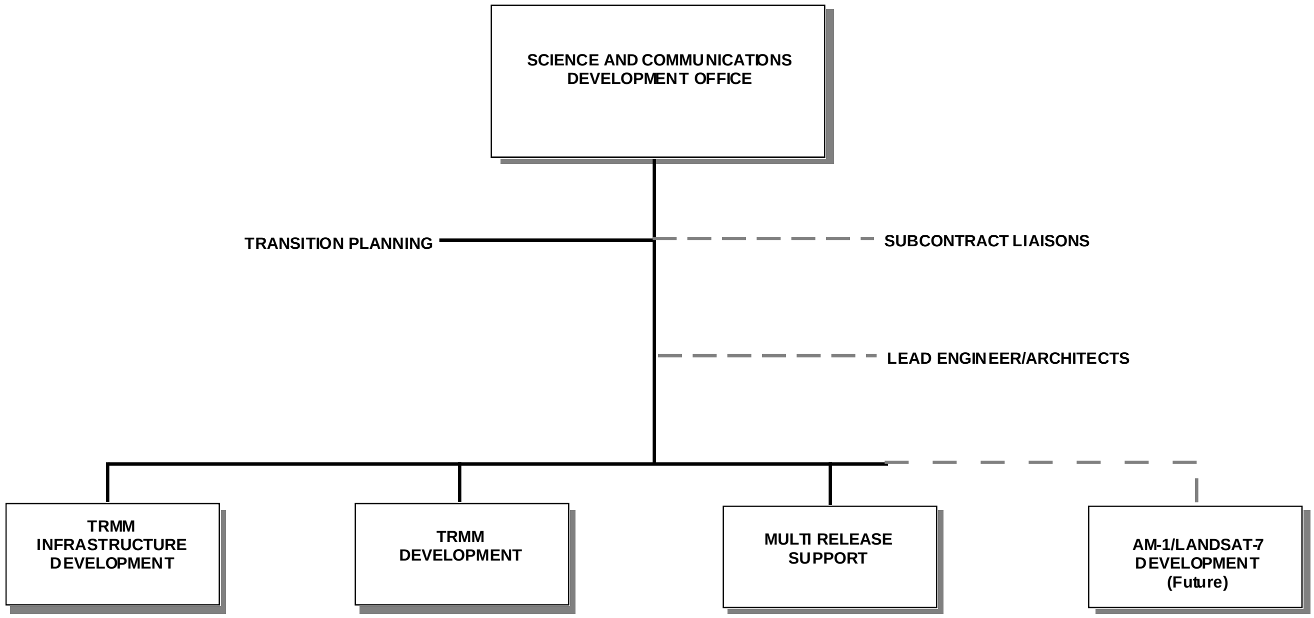

Figure 10-8. Science and Communications Development Organization

Supporting all release teams is the Multi-Release Support (MRS) Group, which provides selected services which for reasons of economy or minimization of rework are logically centralized. Working very closely with all affected release teams, MRS responsibilities include LAN engineering, WAN-related analyses, hardware engineering, COTS selections, data engineering, development environment, software CM through unit test, and non-release-specific prototyping. MRS also serves as focal point between SCDO and FOS, addressing FOS-unique needs for extensions to Release-developed common infrastructure.

The small SCDO staff function does cross-release management, monitoring for scientific appropriateness of each release's design, evolvability from release to release, staff migrations between releases, and cross-release tradeoffs. (As a transitionary step from the segment-based organization to the release-based organization, a small SCDO transition-planning group coordinates and executes the rebaselining of schedules and budgets.)

10.10.3 Deliverables

SCDO deliverables are indicated in the Documentation Management and Control Matrix (152-TR-001-002).

10.11 Maintenance and Operations (M&O) Office

10.11.1 Work Summary

The M&O Office provide management and technical resources to direct, control and perform maintenance and operations for the SDPS and CSMS elements at each of the ECS sites and in support of each of the hardware deliveries and software releases. The M&O Office also coordinates its maintenance and operations activities with FOS operations activities described earlier in this section. The scope of work is contained under WBS 8, System Maintenance and Operations. M&O management includes M&O control, property management, configuration management, security, operational readiness and performance assurance and general support. Science and Comm M&O includes the development of maintenance and operations materials, maintenance of hardware, software and sustaining engineering support, operations of the Science Data Processing and Communications and System Management Segments, training and certification of M&O personnel, implementation of physical security, and support for planned upgrades. In addition, the M&O organization is responsible for maintaining the ECS Development Facility (EDF) and for ECS Integrated Logistics Support.

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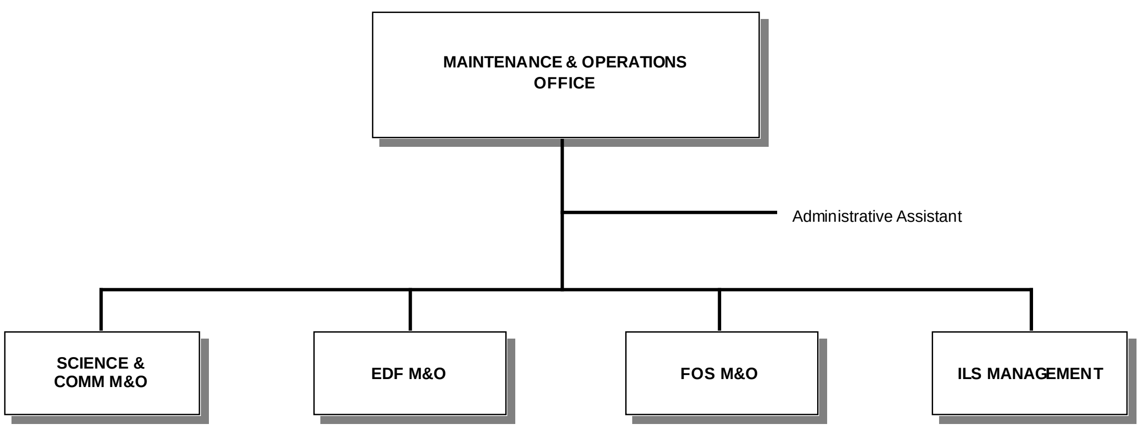

Figure 10-9. M&O Organization During Development

10.11.2 Internal Office Structure

Figure 10-9 shows the M&O organization during the early ECS development activities. That organization evolves to the organization shown in Figure 10-10 that integrates M&O activities and provides management direction during ECS operations. This organization is simple, with two levels of management and effective span of control. It facilitates inter-DAAC coordination, provides direct interfaces with the Mission Operations Manager (MOM), System Operations Manager (SOM) and the Ground System and Operations Project (GS&OP) as well as the segment developer organizations, includes planning and scheduling, and provides all the requisite staff functions.

10.11.3 Deliverables

M&O deliverable documentation is listed in the ECS Documentation Management and Control Matrix (152-TR-001-002)

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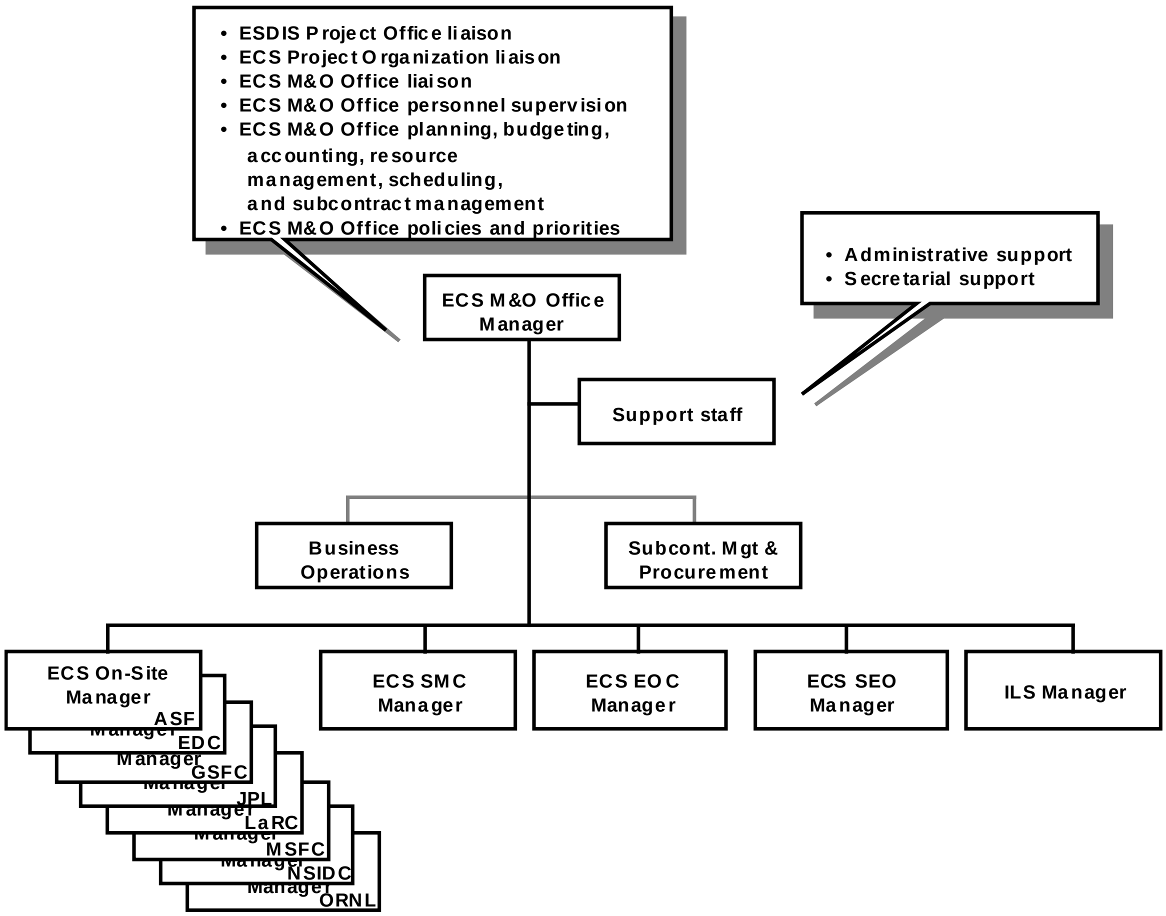

Figure 10-10. The FY 2000 M&O Organization

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Appendix A
Contract Work Breakdown Structure

WBS	WBS TITLE
1	PROGRAM MANAGEMENT
11	PROGRAM CONTROL
12	PROGRAM PLANNING REPORTING AND REVIEWS
13	FINANCIAL MANAGEMENT
14	PROCUREMENT MANAGEMENT
15	CONFIGURATION AND DATA MANAGEMENT
16	SCIENCE INTERFACE AND SUPPORT
17	ENGINEERING SUPPORT
2	ECS SYSTEMS ENGINEERING
21	REQUIREMENTS ANALYSIS AND STANDARDS
22	ENGINEERING PLANNING
23	DESIGN AND INTERFACE CONTROL
24	DESIGN ANALYSIS
25	LIFE CYCLE COST
3	FLIGHT OPERATIONS SEGMENT (FOS) DEVELOPMENT
31	FOS MANAGEMENT
32	FOS SYSTEM ENGINEERING
33	FOS PROTOTYPE DEVELOPMENT
34	FOS DEVELOPMENT
341	TELEMETRY DEVELOPMENT
342	COMMAND DEVELOPMENT
343	USER INTERFACE DEVELOPMENT
344	PLANNING AND SCHEDULING DEVELOPMENT

WBS	WBS TITLE
345	DATA MANAGEMENT DEVELOPMENT
346	COMMAND MANAGEMENT DEVELOPMENT
347	RESOURCE MANAGEMENT DEVELOPMENT
348	ANALYSIS
35	FOS INTEGRATION AND TEST
36	FOS COTS
4	SCIENCE DATA PROC. SEGMENT (SDPS) DEVELOPMENT
41	SDPS MANAGEMENT
42	SDPS SYSTEM ENGINEERING
43	SDPS PROTOTYPE DEVELOPMENT
44	SDPS DEVELOPMENT
441	CLIENT SUBSYSTEM
442	INTEROPERABILITY AND DATA MANAGEMENT SUBSYSTEM
443	DATA SERVER SUBSYSTEM
444	INGEST SUBSYSTEM
445	PLANNING AND DATA PROCESSING SUBSYSTEM
45	SDPS INTEGRATION AND TEST
46	SDPS COTS
5	COMM & SYSTEM MGMT SEGMENT (CSMS) DEVELOPMENT
51	CSMS MANAGEMENT
52	CSMS SYSTEM ENGINEERING
53	CSMS PROTOTYPE DEVELOPMENT
54	CSMS DEVELOPMENT
541	MANAGEMENT SUBSYSTEM
542	COMMUNICATIONS SUBSYSTEM
543	INTERWORKING SUBSYSTEM
55	CSMS INTEGRATION AND TEST

WBS	WBS TITLE
56	CSMS COTS
6	ECS TEST AND EVALUATION
61	ECS SYSTEM INTEGRATION AND TEST
62	SYSTEM ACCEPTANCE TESTING
63	SYSTEM TEST ANALYSIS
64	SUPPORT OF THE IVV PROGRAM
7	PERFORMANCE ASSURANCE
71	PERFORMANCE ASSURANCE PROGRAM
72	SOFTWARE ASSURANCE
73	RELIABILITY PROGRAM
74	MAINTAINABILITY PROGRAM
8	SYSTEM MAINTENANCE AND OPERATIONS
81	M&O MANAGEMENT
82	INTEGRATED LOGISTICS SUPPORT
83	M&O TRAINING
84	M&O SUSTAINING ENGINEERING
85	M&O PLANNED UPGRADES
86	FLIGHT OPERATIONS
861	FLIGHT OPERATIONS EQUIPMENT MAINTENANCE
862	EOC OPERATIONS
863	ICC OPERATIONS
87	SCIENCE OPERATIONS
871	GSFC
8711	GSFC EQUIPMENT MAINTENANCE
8712	GSFC SCIENCE OPERATIONS
8713	CSMS OPERATIONS

WBS	WBS TITLE
872	MSFC
8721	MSFC EQUIPMENT MAINTENANCE
8722	MSFC SCIENCE OPERATIONS
873	UAF
8731	UAF EQUIPMENT MAINTENANCE
8732	UAF SCIENCE OPERATIONS
874	EDC
8741	EDC EQUIPMENT MAINTENANCE
8742	EDC SCIENCE OPERATIONS
875	JPL
8751	JPL EQUIPMENT MAINTENANCE
8752	JPL SCIENCE OPERATIONS
876	NSIDC
8761	NSIDC EQUIPMENT MAINTENANCE
8762	NSIDC SCIENCE OPERATIONS
877	LaRC
8771	LaRC EQUIPMENT MAINTENANCE
8772	LaRC SCIENCE OPERATIONS

Abbreviations and Acronyms

AI&T	Algorithm Integration and Test
AHWGP	Ad Hoc Working Group on Production
ARC	Applied Research Corporation
BOO	Business Operations Office
CAM	Cost Account Manager
CBB	Contractor's Budget Baseline
CCB	Configuration Control Board
CCR	Configuration Change Request
CDMTS	Configuration and Data Management Tracking System
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CFB	Contract Financial Brief
CM	Configuration Management
cmi	continuous measurable improvement
COTR	Contracting Officer's Technical Representative
COTS	Commercial off the shelf
CSA	Canadian Space Agency
CSMS	Communications and System Management Segment
CSR	Consent to Ship Review
CTC	Contract Target Cost
CWBS	Contractor Work Breakdown Structure
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
DID	Data Item Description
DPM	Deputy Project Manager
ECS	EOSDIS Core System
EDF	ECS Development Facility
EDHS	ECS Data Handling System

EDS	Electronic Data Systems
EGS	ESDIS Ground System
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EOSSMS	EOS Space Measurement System
EOSSRP	EOS Scientific Research Program
EP	Evaluation Package
ESA	European Space Agency
ESDIS	Earth Science Data Information and System
ESSi	Engineering and Science Studies Inc.
F&PRS	Functional and Performance Requirements Specification
FOS	Flight Operations Segment
GSFC	Goddard Space Flight Center
GSOP	Ground System and Operations Project
HAIS	Hughes Applied Information Systems, Inc.
HTSC	Hughes Technical Services Company
I&T	System Integration and Test
IATO	Independent Acceptance Test Organization
ICD	Interface Control Document
ICWG	Interface Control Working Group
IDR	Incremental Design Review
ILN	Integrated Logic Network
IP	International Partner
IR&D	Independent Research and Development
IST	Instrument Support Terminal
IV&V	independent verification and validation
IWG	Investigators Working Group
M & O	Maintenance and Operations
MOM	Missions Operations Manager
MPM	Microframe Project Manager

MRS	Multi Release Support
MSFC	Marshall Space Flight Center
MTPE	Mission to Planet Earth
NASCOM	NASA Communications Network
NASDA	National Space Development Agency (Japan)
NSIDC	National Snow and Ice Data Center
ODC	Other Data Center
PAIP	Performance Assurance Implementation Plan
POC	Point of Contact
PDR	Preliminary Design Review
PI	Principal Investigator
PMR	Project Management Review
PMS	Performance Measurement System
PoDAG	Polar DAAC Advisory Group
QA	Quality Assurance
RID	Review Item Discrepancy
RIR	Release Initiation Review
RMA	releability, maintainability, availability
RMP	Risk Management Plan
RRR	Release Readiness Review
RTM	Requirements and Traceability Management
SA	Subcontract Administrator
SCDO	Science and Communications Development Organization
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
SDR	System Design Review
SDRL	Subcontractor Data Requirements List
SEPG	Software Engineering Process Group
SMC	System Management Center
SMO	System Management Office
SOM	Systems Operations Manager

SOW	Statement of Work
SRR	System Requirements Review
SMC	System Management Center
STL	Science and Technology Laboratory
T&C	telemetry and command
TL	Team Leader
TMDB	Technical Management Data Base
TR	Technical Record
TRMM	Tropical Rainfall Measuring Mission
TRR	Test Readiness Review
UAF	University of Alaska, Fairbanks
URDB	User Recommendations Data Base **CN 01**
VCATS	Vendor Costing Automated Tracking System
WBS	Work Breakdown Structure
WWW	World Wide Web