456-TP-001-001

ECS Project Training Material Volume 1 Introduction and System Overview

Technical Paper

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RESPONSIBLE ENGINEER

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Abstract

This is Volume 1 of a series of 10 volumes containing training material for the Pre-Release B Testbed of the Earth Observing System Data and Information System (EOSDIS) Core System (ECS). This lesson provides an introduction to the training course and an overview of the ECS.

Keywords: training, instructional design, course objective, Testbed, V0, Science Data Processing Subsystem, Communications and System Management Subsystem, COTS

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Introduction

Identification

Training Material Volume 1 is part of a series of Technical Papers that will be used to teach Maintenance and Operations (M&O) concepts to the M&O staff at the following Distributed Active Archive Centers (DAACs): Langley Research Center (LaRC), National Snow and Ice Data Center (NSIDC) and EROS Data Center (EDC).

Scope

Training Material Volume 1 includes descriptions of the ECS Pre-Release B Testbed ("Testbed") mission, goals, objectives, structure, functions, products, services, and users. In addition, it provides an opportunity to gain some familiarity with an actual ECS facility and the ECS desktop. This lesson is designed to provide the operations staff with sufficient knowledge and information to satisfy all lesson objectives.

This document reflects the August 23, 1995 Technical Baseline maintained by the contractor Configuration Control Board (CCB) in accordance with ECS technical direction #11, dated December 6, 1994.

Purpose

The purpose of this Technical Paper is to provide a detailed course of instruction that forms the basis for a general understanding of the ECS. Lesson objectives are developed and will be used to guide the flow of instruction for this lesson. The lesson objectives will serve as the basis for verifying that all lesson topics are contained within this Student Guide and slide presentation material.

Organization

This document is organized as follows:

Introduction:	The Introduction presents the document identification, scope, purpose, and organization.
Student Guide:	The Student Guide identifies the core elements of this lesson. All Lesson Objectives and associated topics are included.
Slide Presentation:	Slide Presentation is reserved for all slides used by the instructor during the presentation of this lesson.

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Overview of the Introduction and System Overview Lesson

Lesson Overview

This lesson will provide you with an introduction to the ECS training course and an overview of ECS. It includes descriptions of the ECS mission, goals, objectives, structure, functions, products, services, and users. In addition, it provides an opportunity to gain some familiarity with an actual ECS facility and the ECS desktop.

Lesson Objectives

Overall Objective - The overall objective of the Introduction and System Overview lesson is for Science and Communications Maintenance and Operations (M&O) personnel to describe the mission, goals, objectives, structure, functions, products, services, and users of the Earth Observing System (EOS) Data and Information System (EOSDIS) Core System (ECS).

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview*.

Standard - The student will describe specified characteristics of ECS without error in accordance with the lesson content.

Specific Objective 1 - The student will describe the mission of ECS, including its relationships to the Mission to Planet Earth, the Earth Observing System and the EOS Data and Information System.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe the mission of ECS without error in accordance with the lesson content.

Specific Objective 2 - The student will describe the ECS Pre-Release B Testbed support for EOS AM-1 and Landsat-7 Science Software Integration and Test (SSI&T).

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe the ECS Pre-Release B Testbed support for EOS AM-1 and Landsat-7 SSI&T without error in accordance with the lesson content.

Specific Objective 3 - The student will describe how the ECS functions in terms of general data flow and ECS operations centers/locations.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS functioning in terms of general data flow and ECS operations centers/locations without error in accordance with the lesson content.

Specific Objective 4 - The student will describe ECS operational software configuration of the Science Data Processing Segment (SDPS) and the Communications and Systems Management Segment (CSMS).

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS operational software configuration of the SDPS and the CSMS without error in accordance with the lesson content.

Specific Objective 5 - The student will describe the ECS operation hardware configuration.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe the ECS operation hardware configuration without error in accordance with the lesson content.

Specific Objective 6 - The student will describe commercial off-the-shelf (COTS) software used in ECS.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS COTS software without error in accordance with the lesson content.

Specific Objective 7 - The student will describe ECS operational processes, i.e., system operations management activities and science operations activities.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS operational processes, i.e., system operations management activities and science operations activities, without error in accordance with the lesson content.

Specific Objective 8 - The student will describe ECS facility layout and the locations of ECS components within the facility.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS facility layout and the locations of ECS components within the facility without error in accordance with the lesson content.

Specific Objective 9 - The student will log in to ECS.

Condition - The student will be given appropriate access codes (e.g., user identification, password), access to ECS (through a workstation or terminal) and a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will perform without error the steps involved in logging in to ECS without error in accordance with the applicable procedure.

Specific Objective 10 - The student will describe the features of ECS.

Condition - The student will be given a copy of 456-TP-001-001, *ECS Training Material Volume 1: Introduction and System Overview.*

Standard - The student will describe ECS features without error in accordance with the lesson content.

Importance

This lesson applies to students who will be ECS operators (including support staff). The lesson will provide them with the knowledge and skills needed for taking subsequent ECS training lessons and for communicating with other ECS personnel about the system in general. They will need the knowledge and skills on the job when they encounter ECS hardware, software, documentation or procedures. The lesson describes the ECS mission, goals, objectives, structure, functions, products, services, and users. In addition, it provides them some familiarity with an actual ECS facility.

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ECS Overview

ECS Mission

Mission to Planet Earth (MTPE) and the Earth Observing System (EOS)[1]

The Mission to Planet Earth (MTPE) is a long-term, multi-disciplinary, and inter-disciplinary research mission by the National Aeronautics and Space Administration (NASA). The Mission to Planet Earth uses space-, ground- and aircraft-based measurement systems to allow:

- studying the processes leading to global climate changes.
- development of a predictive capability for Earth systems on time scales of decades to centuries.

The Mission to Planet Earth is NASA's contribution to the U.S. Global Change Research Program (USGCRP). The USGCRP is the focal point of U.S. activities in support of the worldwide research collaboration now under way to study global change. The goal of MTPE is to advance scientific understanding of the entire Earth system by developing a deeper comprehension of the components of the system and the interactions among components.

The principal element of MTPE is the Earth Observing System (EOS), which is designed to collect Earth Science data, with emphasis on long-term, sustained data sets from carefully calibrated instruments on satellites in low Earth orbits. Accordingly, the goal of EOS is to provide quantitative data from systematic, continuous satellite observations from low-Earth orbit for a minimum of 15 years. EOS's broad mission objectives in support of the goal are to:

- Create an integrated scientific observing system that will enable multidisciplinary study of the Earth's critical, life-enabling, interrelated processes involving the atmosphere, oceans, land surfaces, and polar regions, and the dynamic and energetic interactions among them.
- Develop a comprehensive data and information system, including a data retrieval and processing system, to serve the needs of scientists contributing to an integrated, multidisciplinary study of planet Earth.
- Acquire and assemble a global database of remote-sensing measurements from space as key to understanding global climate change, including:
  - — the role of clouds, radiation, water vapor, and precipitation.
  - — the productivity of the oceans, their circulation, and air-sea exchange.

  the sources and sinks of greenhouse gases, and their atmospheric transformations.

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[1] Information in this section has been extracted from Asrar, G. and Greenstone, R., 1995: 1995 EOS Reference Handbook. NASA Headquarters.

— changes in land use, land cover, primary productivity, and the water cycle.

— the role of polar ice sheets and sea level.

— the coupling of ozone chemistry with climate and the biosphere.

— the role of volcanoes in climate change.

The physical-modeling and data-gathering activities over the planned 15 or more years of the EOS Program are intended to make a major contribution to establishing the distinction between natural variability in the Earth system and changes that are introduced by human activities. The choices of intervention strategies to mitigate possible undesirable changes or their impacts will have to be based at least in part on the findings of MTPE- and EOS-supported scientists in the U.S. and their counterparts around the world.

The three primary components of the EOS program are shown in Figure 1. The purpose of each segment is as follows:

- **EOS Space System** — acquire essential global Earth Science data on a long-term sustained basis and in a manner that maximizes the scientific utility of the data and simplifies data analysis.
- **EOS Ground System (EGS)** — provide the Earth Science research community with easy, affordable, and reliable access to the full suite of Earth Science data from U.S. and International Partner (IP) platforms.
- **Integrated Scientific Research Program** — investigate processes in the Earth System and improve predictive models.

Earth Observing System Data and Information System (EOSDIS)

As previously mentioned, in addition to collecting Earth Science data, MTPE and EOS are committed to providing the Earth Science community with easy, affordable, and reliable access to EOS and other Earth Science data. The EOS Data and Information System (EOSDIS) is NASA's overall Earth Science discipline data system. In conjunction with NASA Institutional Facilities and participating programs, EOSDIS provides the ground system for the collection and analysis of science data to support scientists in resolving the dynamics of the Earth's components and the processes by which they interact. For example, EOSDIS supports the following EOS activities:

- Planning, scheduling, and control of the EOS series of spacecraft.
- Exchanging commands, data and algorithms with the European Space Agency (ESA), Japan, Canada, the National Oceanic and Atmospheric Administration (NOAA), and any other non-NASA entities involved in the overall EOS mission.
- The coordination of these activities with other data-gathering systems.

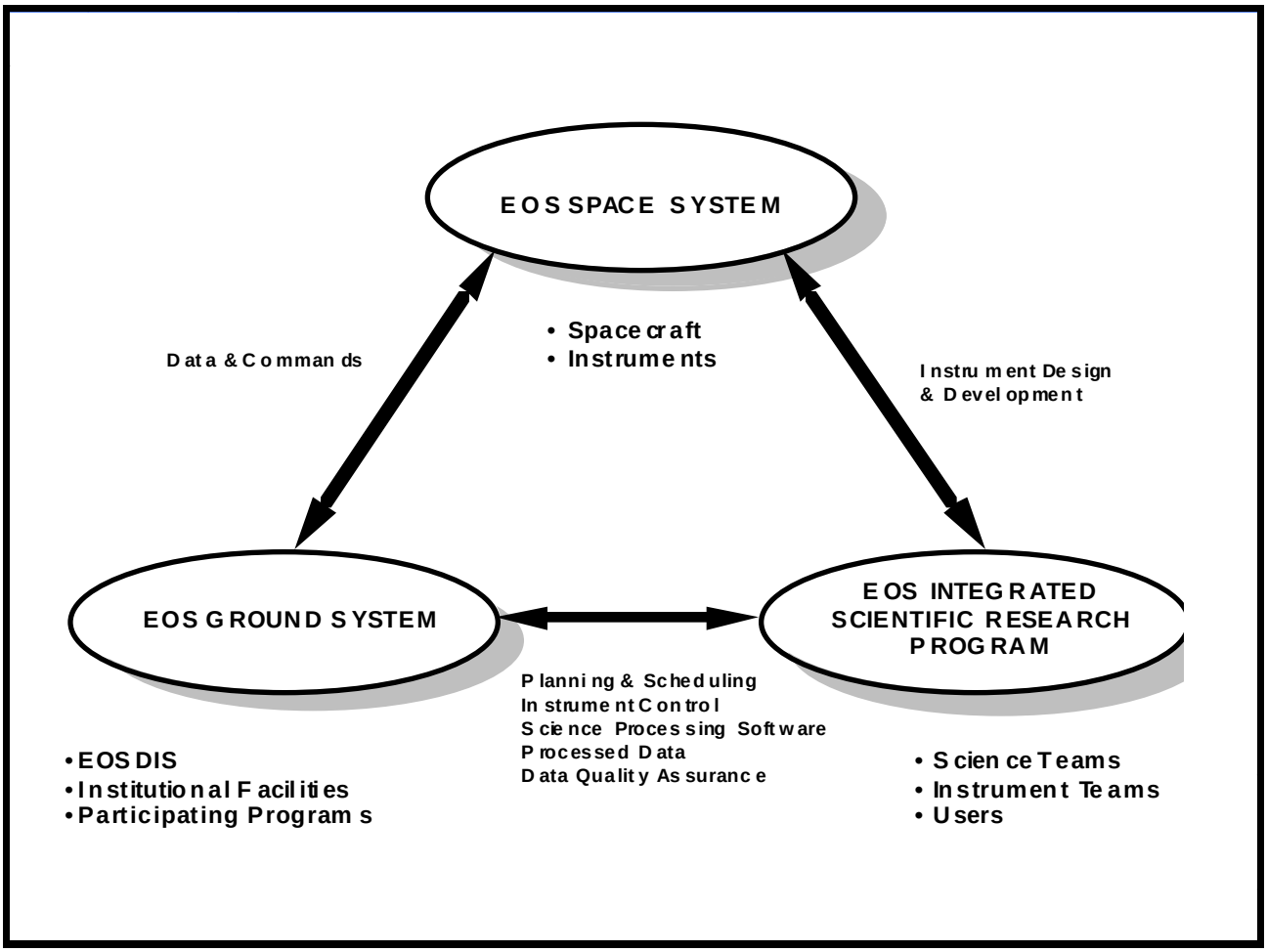

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Figure 1. EOS Segments

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- The transformation of the observations into physical variables, providing for higher levels of processing.
- Presenting the data to users in forms that facilitate and stimulate interactive scientific research.

The EOSDIS is being developed under the direction of the Earth Science Data and Information System (ESDIS) Project. An initial (prototype) version called Version 0 (V0) has been in operation since August 1994, meeting NASA's commitment to the Earth Science community. An integrated scientific research program investigates processes in the Earth system and uses this information to improve predictive models. Current V0 capabilities include:

- management of data from NASA's past and current Earth Science research satellites and field measurement programs.
- data archiving, distribution, and information management services.

During the EOS era EOSDIS will command and control satellites and instruments, and will generate useful products from orbital observations. Furthermore, EOSDIS will generate data sets made by assimilation of satellite and *in situ* observations into global climate models. System upgrades and data migration plans include:

- Parallel operation and interoperability with Version 0 until the data from Version 0 have migrated into a subsequent version and the Version 0 hardware components have become obsolete.
- "Launch-ready" version for EOS AM-1, Color, and Landsat-7 satellites scheduled for launch in 1998.
- Support of pre-launch testing for the flights mentioned and support of operations after the launches occur.

Subsequent versions of EOSDIS will supplement capacity and services as required by EOS spacecraft launches. EOSDIS capabilities will evolve based on continuing evaluation by the research community, and technology will be enhanced as the need arises.

EOSDIS Services. The EOSDIS services include user support, data archive management and distribution, information management, product generation, spacecraft command and control, data capture and telemetry processing.

- **User Support**. Users interact with EOSDIS via Distributed Active Archive Centers (DAACs) using human-machine interfaces. The DAACs, described in subsequent sections, assist users in data acquisition, search, access, and usage.
- **Data Archive Management and Distribution.** EOSDIS will store all standard and special products computed from EOS and non-EOS instruments and distribute requested information to users electronically. Other information such as product generation algorithms, software, documentation, calibration data, engineering, and other ancillary data are stored and provided to users upon request.
- **Information Management.** EOSDIS provides an intuitive system that provides convenient mechanisms for locating and accessing subsets of products of interest. EOSDIS provides an extensible set of tools and capabilities that allow investigators to provide access to special products from their own computing facilities.
- **Product Generation.** EOSDIS will support data product generation from EOS instrument observations.
- **Spacecraft Command and Control.** EOSDIS will perform EOS spacecraft and instrument planning and scheduling, and command and control.
- **Data Capture and Telemetry Processing.** EOSDIS will be able to capture data from all EOS spacecraft and process them to remove telemetry errors, eliminate any artifacts, and create "raw" data as measured by the instruments.

EOSDIS Data Products. EOSDIS data products may be conceptualized as arranged in a pyramid or hierarchy, with "raw" data at the bottom level (Level 0) and increasing levels of refinement through Level 4 at the top. The data levels are:

- Level 0 – "raw" data products that are reconstructed, unprocessed instrument/ payload data at full resolution with all communications artifacts (e.g., synchronization frames, communications headers, duplicate data) removed.
- Level 1A – reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters, e.g., platform ephemeris, computed and appended but not applied to the Level 0 data.
- Level 1B – Level 1A data that have been processed to sensor units (not all instruments will have a Level 1B equivalent).
- Level 2 – derived geophysical variables at the same resolution and location as the Level 1 source data.
- Level 3 – variables mapped on uniform space-time grid scales, usually with some completeness and consistency.
- Level 4 – model output or results from analyses of lower-level data, e.g., variables derived from multiple measurements.

EOS instruments provide long-term collection of data and allow for measurement of Earth over the long-term to help detect climate changes and reasons for those changes, Data collected using these instruments will be the first "new" data; this will be in addition to the DAACs V0 historical data. Figure 2 shows some examples of EOS instruments and the kinds of measurements they make.

EOSDIS Core System (ECS)

The EOSDIS Core System (ECS) is the major component of the EOSDIS. The ECS mission is "to provide centralized mission and instrument command and control functions, and distributed (but common) product generation, archiving, and information management functions" for the EOSDIS. As previously mentioned and as shown in Figure 3, capabilities also exist outside of the core, including the following functions:

- Spacecraft data capture and distribution functions performed by the EOS Data and Operations System (EDOS).
- Data communication services provided by the EOSDIS Backbone Network (EBnet).

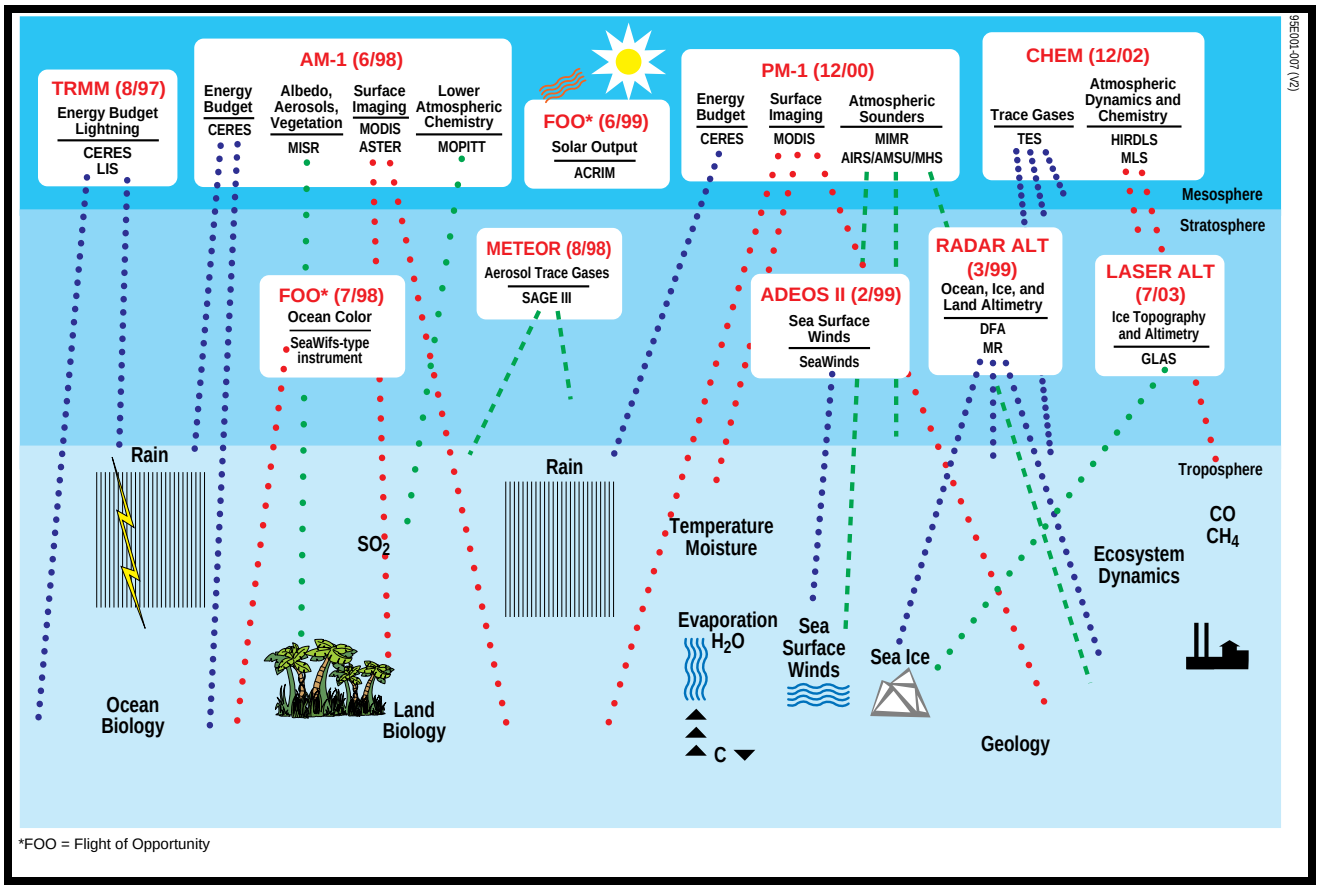

Figure 2. Sample EOS Instruments and Measurements

The main functions of ECS are to provide control of the EOS spacecraft and instruments; process data from the EOS instruments; and manage and distribute EOS data products and other selected data sets to the scientific community. The relationship of ECS to EOSDIS, EOS, MTPE, and global change research is depicted in Figure 4.

The ECS is divided into the following three major functional components/segments:

- Science Data Processing Segment (SDPS).
- Communications and System Management Segment (CSMS).
- Flight Operations Segment (FOS).

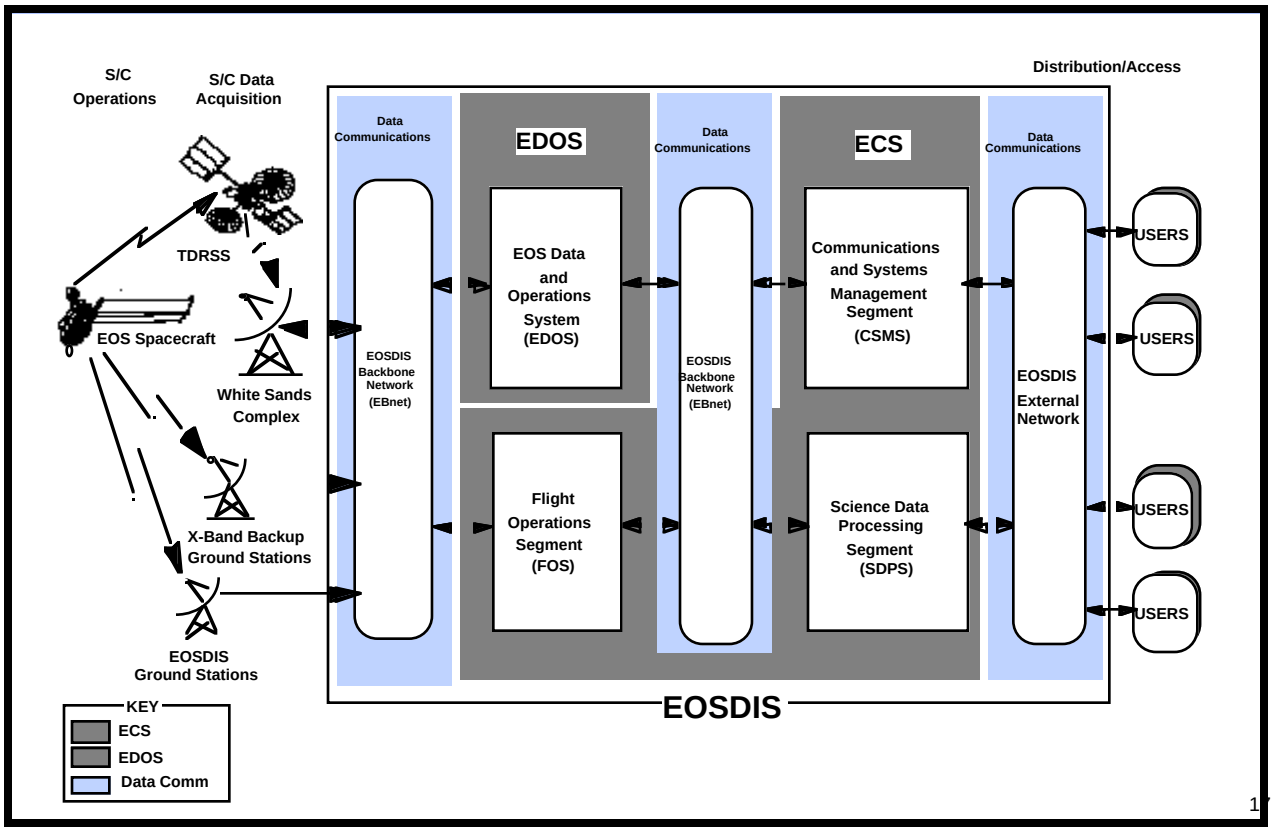

Figure 3. EOSDIS Principal Components

The **Science Data Processing Segment (SDPS)** functions and features include:

- receiving, processing, archiving and managing all data from EOS and other NASA Probe flight missions.
- providing support to the user community in accessing the data as well as products resulting from research activities that utilize this data.
- promoting, through its advertising service, the effective utilization and exchange of data within the user community.
- playing a central role in providing the science community with the proper infrastructure for development, experimental usage and quality-checking of new Earth Science algorithms.
- being structured as a distributed system with its components eventually to be located at eight DAACs.

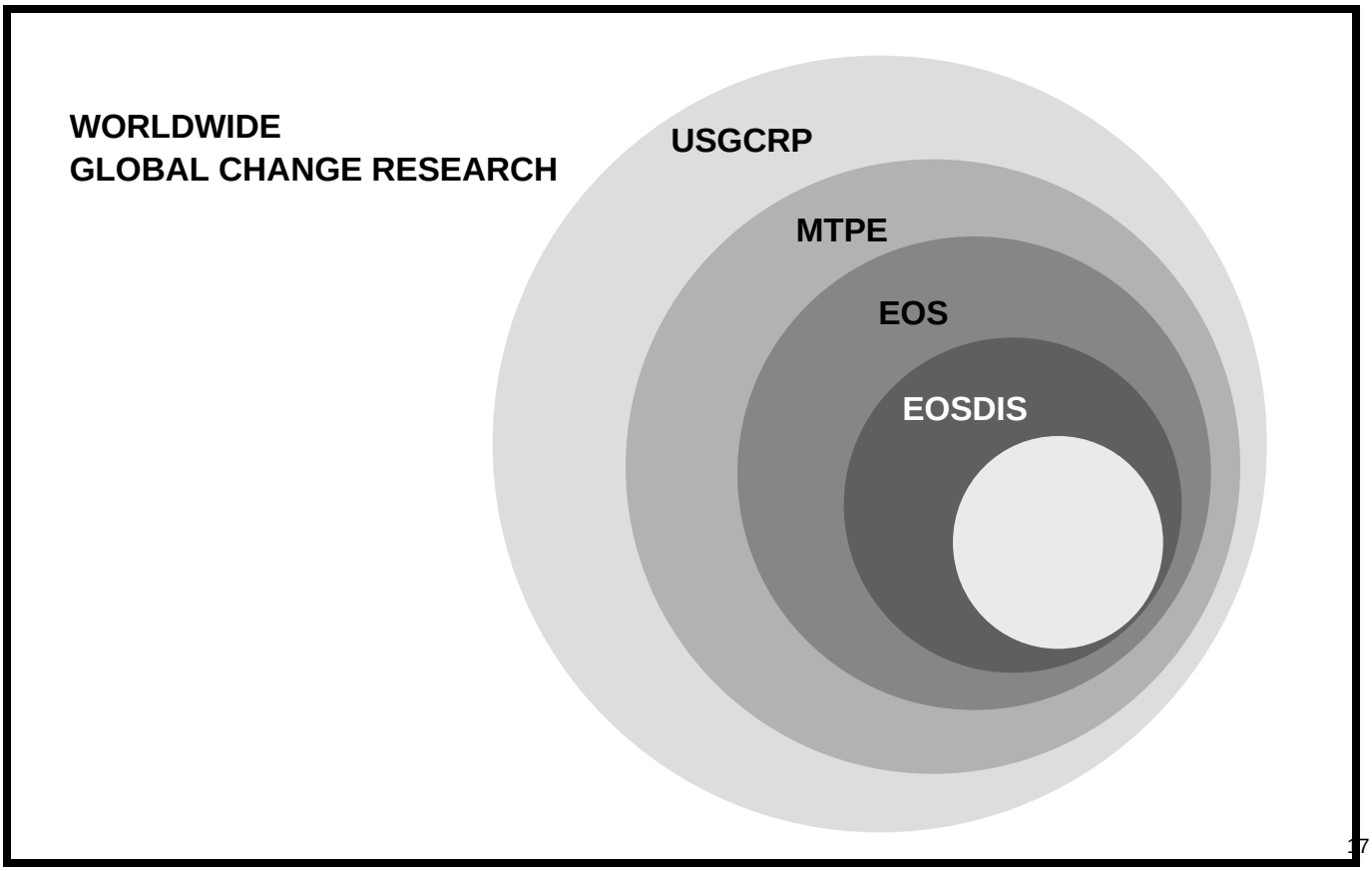

Figure 4. Relationship of ECS to Global Change Research

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. The CSMS provides ECS operations, management and maintenance personnel with local and in cases remote access to its enterprise management services. These interfaces support reporting of a wide range of status information, coordination, and performance of administration and maintenance services. Within ECS, CSMS supports SDPS and FOS with physical network connectivity for their workstations, servers and peripheral components. The CSMS is composed of the following three major subsystems:

- Systems Management Subsystem (MSS).
- Communications Subsystem (CSS).
- Internetworking Subsystem (ISS).

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. NASA institutional facilities like the Flight Dynamics Facility (FDF) and the Network Control Center (NCC)/Space Network Control (SNC) interact with the FOS. The FOS consists of the following two major elements:

- EOS Operations Center (EOC).
- Instrument Support Terminal (IST).

The EOC focuses on the command and control of the flight segment of EOS and the interaction it has with the ground operations of the ECS. The Instrument Support Terminal (IST) connects a Principal Investigator (PI) or Team Leader (TL) facility to the FOS in remote support of instrument control and monitoring. PI/TL facilities are outside the FOS, but connected to it by way of the EBnet.

FOS is not a function of the Maintenance and Operations (M&O) Organization for which this training course has been developed. Consequently, relatively little emphasis is given to the FOS in the remainder of this lesson.

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Pre-Release B Testbed

The ECS is being developed and released for installation and operation in phases. ECS development phases include the following releases:

- Interim Release 1 (Ir1) – preliminary release for concept validation and testing (January 1996).
- Pre-Release B Testbed – deployed in May-June 1997 at four DAACs to support science software integration and test (SSI&T) in support of Instrument Teams (ITs) for Landsat-7 and EOS AM-1 missions. (Based on the canceled Release A, which was originally scheduled for January 1997 and which was to have supported the Tropical Rainfall Measurement Mission (TRMM). The TRMM launch was postponed from the original August 1997 date.)
- Releases B, C and D - support for future EOS missions, such as EOS AM-1 and EOS PM-1.
  - incorporate evolutionary changes such as new processing and storage technologies.
  - provide expanded and increasingly enhanced data search and access, based on feedback from the science community.

Pre-Release B Testbed

The Pre-Release B Testbed is a set of ECS functions that is being made available to support certain Instrument Teams (IT) and their DAACs in science software integration and test (SSI&T) efforts. Testbed support of SSI&T starts with the delivery of science software to the DAACs and ends with either the successful integration of all expected science software packages into the ECS Pre-Release B Testbed or the scheduled end date for SSI&T support (September 1, 1997). ECS Release B.0 is scheduled to be available in January 1998.

SSI&T will be supported by the Testbed as installed at the following DAACS:

- Goddard Space Flight Center (GSFC)
- Langley Research Center (LaRC)
- Earth Resources Observation Systems (EROS) Data Center (EDC)
- National Snow and Ice Data Center (NSIDC)

The DAACs will perform SSI&T on science software delivered for the following instruments on the EOS AM-1 satellite (projected launch in June 1998):

- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

- Clouds and the Earth's Radiant Energy System (CERES)
- Multi-angle Imaging SpectroRadiometer (MISR)
- Moderate-Resolution Imaging Spectroradiometer (MODIS)
- Measurements of Pollution in the Troposphere (MOPITT) (instrument provided by the Canadian Space Agency)

The Landsat-7 satellite (scheduled for launch in December 1998) has the following single instrument:

- Enhanced Thematic Mapper Plus (ETM+)

In addition, SSI&T will be performed for the following instrument on the Meteor 3M-1 satellite (projected launch in August 1998):

- Stratospheric Aerosol and Gas Experiment (SAGE) III

The Meteor 3M-1 spacecraft, launch and operations are being provided by the Russian Space Agency.

Table 1 lists SSI&T support by instrument and DAAC.

Table 1. Instrument-Specific Support

Mission	Instrument	DAAC
EOS AM-1	ASTER	EDC
	CERES	LaRC
	MISR	LaRC
	MODIS	EDC
	MODIS	GSFC
	MODIS	NSIDC
	MOPITT	LaRC
Landsat-7	ETM+	EDC
Meteor 3M-1	SAGE III	LaRC

Science data processing in the ECS will be performed using science software that is developed independently of ECS by Instrument Teams at their local Science Computing Facilities (SCFs). The science software may be developed on a variety of computer platforms using many versions of compilers and operating systems. The ECS Project allows the software to be coded in C, FORTRAN 77, FORTRAN 90, or Ada. All software must comply with ESDIS requirements, which include the following standards:

- American National Standards Institute (ANSI) standards.
- Sets of allowed functions.

- ECS Science Data Processing (SDP) Toolkit libraries, which must be used for the following types of functions:
  - File access.
  - Error handling.
  - Process control.

SSI&T is the process by which science software developed by Instrument Teams (ITs) at local SCFs is tested and integrated into the ECS at the DAACs. The SSI&T process has the following goals:

- Ensure that the delivered PGEs conform to ESDIS Project standards.
- Load the PGEs on DAAC computers.
- Integrate the PGEs with the DAAC version of the SDP Toolkit and execute them using the ECS Planning and Data Processing Subsystem.
- Verify that the data products and results are the same as those produced at the SCFs.

Release B

Release B is the first operational release of the ECS. It will be delivered in two phases. Release B.0 is scheduled to be completed on December 30, 1997; Release B.1 will be delivered on September 1, 1998.

Release B.0 will consist of all functions critical to mission success at launch and for initial science activities related to support of the AM-1 and Landsat-7 satellites and their instruments. Release B.1 will provide all remaining Release B functions.

Release B.0 has the following mission objectives:

- Support AM-1 operations.
- Support Landsat-7 operations.
- Perform science data processing.

Release B.1 has the same mission objectives as Release B.0 plus the following additional objective:

- Support Advanced Earth Observing Satellite (ADEOS) II operations.

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System Functional Overview

EOSDIS Data Flow

The ECS supports the collection and distribution of data from space-, ground- and aircraft-based measurement systems to provide the scientific basis for understanding global change. To accomplish this requires:

- ECS data product generation, archive, distribution, and information management services.
- command and control functions for EOS spacecraft and instruments.
- internal interfaces among elements which are responsible for the operation of the distributed elements of the ECS at their respective sites:
  - DAACs.
  - System Monitoring and Coordination functions.
  - EOS Operations Center (EOC).

Figure 5 shows data flow through the EOSDIS, including ECS components, other EOSDIS components and external elements. The figure indicates key interfaces and interactions in the system, as follows:

- Data from EOS AM-1 satellite instruments are transmitted from EOS satellites through the Tracking and Data Relay Satellites (TDRS) to the receiving station at White Sands, New Mexico.
  - generally (nominally) transmitted in a single, combined telemetry stream.
  - From White Sands, the data are transmitted via EOSDIS Backbone Network (EBnet) circuits to the EDOS Level Zero Processing Facility (LZPF) at the Goddard Space Flight Center (GSFC), where the data are processed to recover the raw instrument data.
- For EOS missions subsequent to AM-1, the science data will be transmitted to the LZPF from high-latitude X-band EOSDIS ground stations in Alaska and Norway.
- International Partner (IP) satellites downlink directly to the International Partner Ground Systems (IPGSs) via their ground receiving stations. Data from NASA instruments on the IP platforms are transmitted to GSFC via commercial networks or sent on hard media (disk or tape).

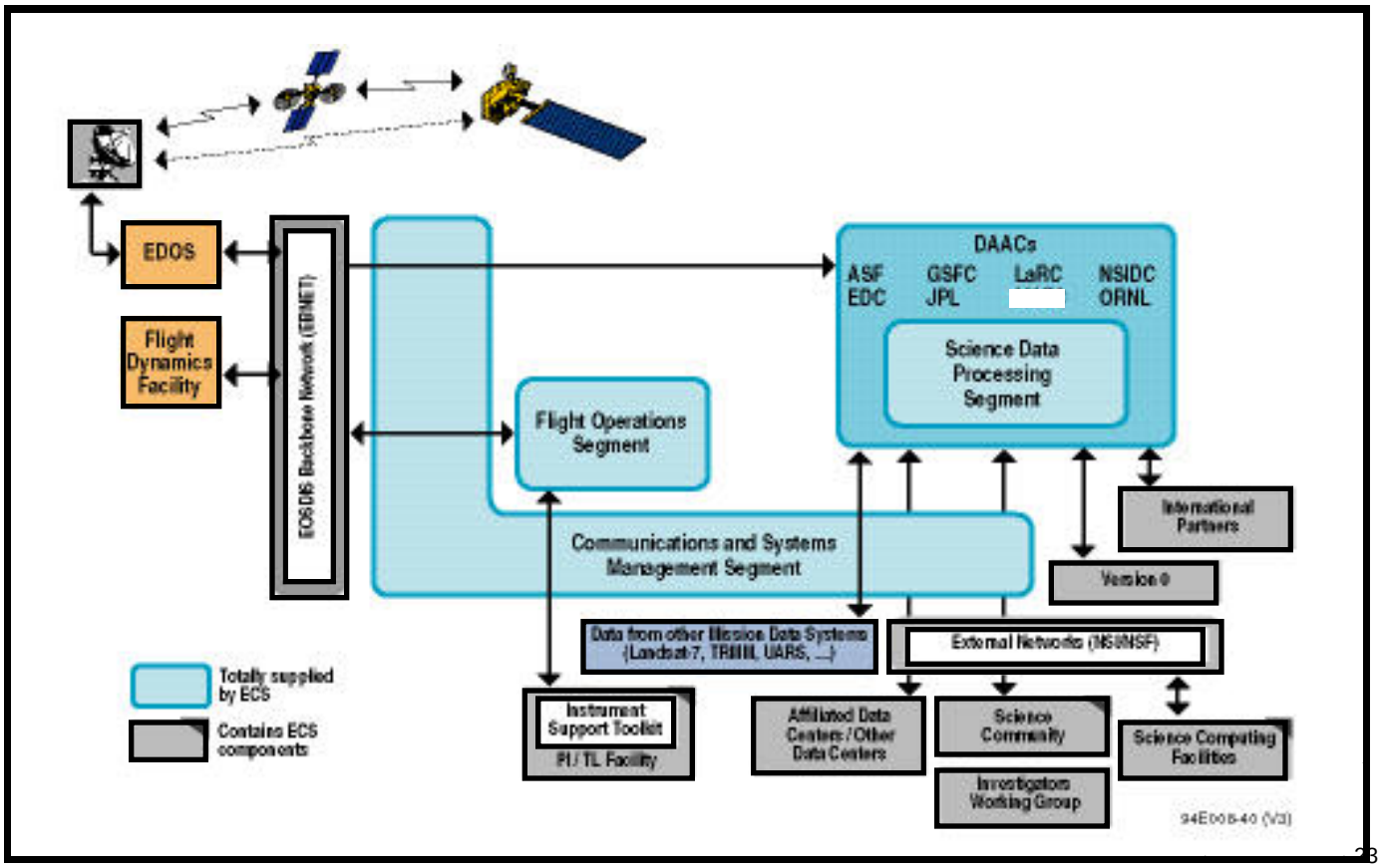

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Figure 5. EOSDIS Data Flow

- Landsat-7 transmits downlink data directly to the Landsat-7 Ground Station (LGS) at the Earth Resources Observation Systems (EROS) Data Center (EDC) and to International Ground Stations.
- EDOS is responsible for spacecraft data capture and distribution.
  - — Processes satellite data to recover the raw, Level 0 instrument data.
  - — Distributes Level 0 instrument data for archiving and processing to the ECS SDPS, specifically to the designated DAACs, via EBnet.
  - — Provides archive services for Level 0 data at the EDOS Data Archive Facility (DAF) in Fairmont, West Virginia.

- — Provides space and ground interfaces between the EOS spacecraft via the Space Network (SN)/Tracking and Data Relay Satellite System (TDRSS) and the EOS Ground System (EGS), the EOC, and DAAC elements of EOSDIS.
- — Provides an interface for the uplink (transmission to the spacecraft) of commands.

- In addition to data from EOS satellites, each DAAC may receive data products from non-EOS suppliers at Affiliated Data Centers (ADCs), from other mission data systems, or from Other Data Centers (ODCs).
  - — Interfaces between SDPS (at the DAACs) and ADCs allow access to non-EOS data sets to satisfy ECS user queries and to provide ancillary data for the generation of ECS standard products.
  - — The National Environmental Satellite Data and Information Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA) is an example of an ADC.
  - — Ancillary data are transferred over external networks; e.g., NASA Science Internet (NSI) or National Science Foundation (NSF) Internet.
  - — Landsat Processing System (LPS) is an example of an "other mission data system." (ECS provides user access, and product archive and distribution functions for Landsat-7 data and information.)
- The DAACs house the ECS computing facilities and operational staff needed for product generation and managing and storing EOSDIS data, as well as the associated metadata[2] and browse[3] data required for effective use of the data holdings (SDPS functions).
  - — The DAAC receives requests for data products and other archived information from the users, and distributes the requested data.
  - — Most science users access EOS data products at the DAACs via external networks such as the NASA Science Internet (NSI) or the National Science Foundation (NSF) Internet. Open access to the EOS data by all members of the science community distinguishes the EOS from previous research satellite

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[2] Metadata are data about data sets, i.e., information that is provided to the ECS by the data supplier or the generating algorithm and which provide a description of the content, format, and utility of the data set. Metadata may be used to select data for a particular scientific investigation.

[3] Browse data are subsets of a larger data set, other than the directory and guide, generated for the purpose of allowing rapid interrogation (i.e., browsing) of the larger data set by a potential user. For example, the browse product for an image data set with multiple spectral bands and moderate spatial resolution might be an image in two spectral channels, at a degraded spatial resolution. The form of browse data is generally unique for each type of data set and depends on the nature of the data and the criteria used for data selection within the relevant scientific disciplines.

projects, where selected investigators have had proprietary data rights for a number of years after data acquisition.

— ECS users include facilities and organizations not participating directly in the EOS Program. They include users of other NASA data systems and archives, other government data systems and archives, university research users, international investigators/data centers and commercial data systems. These users may acquire ECS-provided tool sets permitting them to search for and order data.

— System management functions and communications services, such as local area network (LAN) services and connectivity to external networks, are provided to the DAACs and FOS by CSMS.

- When necessary, the DAACs exchange data via the EBnet. A DAAC may receive data products generated at other DAACs which it needs as inputs to its own processing. The DAAC likewise distributes the data products which it produces to other DAACs which need those products as inputs.

- EBnet provides wide-area communications circuits and facilities between and among various EOS Ground System (EGS) elements to support mission operations and to transport mission data between EOSDIS elements.

  — Transports spacecraft command, control, and science data nationwide on a continuous basis, 24 hours a day, 7 days a week. Real-time data include mission-critical data related to the health and safety of on-orbit space systems and raw science telemetry as well as prelaunch testing and launch support. Science data include information collected from spacecraft instruments and various levels of processed science data including expedited data sets, production data sets, and rate-buffered science data.

  — Serves as the interface to other systems such as DAACs, users, and the NSI.

  — Includes a campus interface (as shown in Figure 6), which provides communications between the Wide Area Network (WAN) and Local Area Network (LAN).

- The ECS provides interfaces to instrument and interdisciplinary investigator Science Computing Facilities (SCFs).

  — The SCFs, located at science investigator facilities, develop science data processing software and perform scientific research, provide data archiving and distribution capabilities, and employ a user interface that facilitates browsing, requesting, and delivering data from archives to investigators.

  — ECS provides “toolkits” to support the SCFs’ activities.

    - The Science Data Processing (SDP) Toolkit is used for developing and validating science algorithms at the SCF and transferring the algorithms to the DAACs.

- The Instrument Support Terminal (IST) Toolkit, available at some SCFs, is provided by the ECS to support planning and scheduling of spacecraft instruments.

— Scientific quality assurance of EOS data products is performed at the applicable SCFs for the investigators responsible for those products.

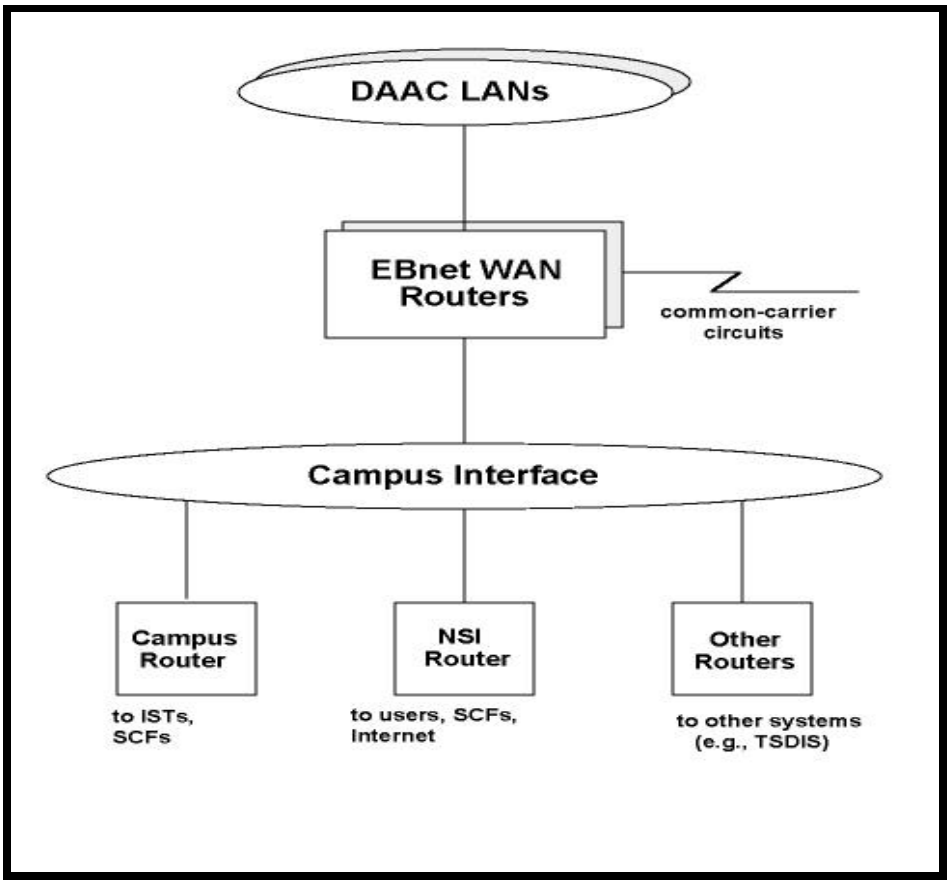

Figure 6. EOSDIS Backbone Network (EBnet)

- Software for EOS standard science data product generation is developed by the science investigators responsible for those products at their facilities.

  — Investigator-developed software and algorithms for EOS **standard** products are integrated with the ECS and installed at the DAACs for routine production.

  — **Special** products are produced at the investigator facilities.

  — Investigator-developed software and algorithms for EOS special products that become community-accepted become standard products through an Investigator Working Group (IWG)-determined assessment, and later become integrated into the production environment at the DAACs.

- EOS missions are coordinated from the EOC; flight operations (including spacecraft and instrument operations) are conducted from the EOC.
  - Non-U.S. instruments on U.S. platforms are operated and monitored through IP Instrument Control Centers (ICCs).
- ECS FOS (at the EOC) maintains spacecraft and instrument health and safety and monitors spacecraft performance (among other functions).
- EOC (FOS) interfaces with EDOS for the following functions:
  - Provides spacecraft and instrument uplink data to EDOS.
  - Receives real-time or spacecraft recorder and instrument housekeeping data, spacecraft and instrument command status data, and spacecraft processor memory dump data from EDOS.
  - Exchanges accounting, fault coordination, data operations status, and planning information with EDOS.
  - Coordinates data delivery services with EDOS.
- EOC interfaces with the Flight Dynamics Facility (FDF) for the following functions:
  - Receives predicted orbit data, including predicted ground track for scheduling from the FDF.
  - Receives contact scheduling data from the FDF.
  - Cooperates with FDF in the development of plans for corrective firings for spacecraft maneuvers.
  - Receives, schedules, and implements plans from FDF.
  - Provides attitude sensor data to the FDF for determining spacecraft attitude.
- FDF monitors the spacecraft attitude and navigation system performance and provides orbit and attitude products to support both flight operations and science processing.
- EOC provides the SDPS with the following types of information:
  - Spacecraft information, including orbit data.
  - Acquisition plans and schedules.
- EOC exchanges planning and scheduling information with the IP-ICCs, sends mission status to the IP-ICCs, and receives instrument commands and status from the IP-ICCs.
- EOC exchanges instrument planning and scheduling information with the IST (consistent with the concept of global access to planning and scheduling information).
- Instrument team (which is responsible for the contents of its instrument microprocessor loads) uses the IST to generate instrument uplink data.

- EOC accepts instrument uplink data from the IST, validates them at a high level, and integrates them. EOC receives instrument status information from the IST to perform high-level monitoring.
- Via the SMC (CSMS), the EOC receives EOS management and operation directives, including science policy and guidelines from the IWG plan. In return the EOC furnishes EOC management and operations status.
- EOSDIS Version 0 (V0), an early "working prototype" of selected EOSDIS functionality, is hosted and operated by the DAACs to provide data ingest, archive, catalog, distribution, and user support services (including cross-DAAC catalog for interdisciplinary users).
  - It interconnects existing data systems at the DAACs via electronic networks, integrates catalogs, and provides common data distribution procedures to ensure access to data.
  - V0 does not have all the functional capabilities, fault tolerance, or reliability provisions of the ECS. It has been used and evaluated by the users to provide feedback regarding the required functional capability of the ECS.
  - SDPS provides interoperability with V0 during the ECS early development phases and will facilitate the migration of V0 data to ECS.

EOS, like many other NASA projects, makes use of NASA institutional services, which consist of several ground system elements that provide generic services plus some project-unique services. Table 2, NASA Institutional Services, summarizes the NASA elements included as institutional services.

Table 2. NASA Institutional Services

INSTITUTIONAL SERVICE	SUMMARY OF SERVICES
Space Network (SN): Tracking and Data Relay Satellite System (TDRSS), Ground Terminals, Network Control Center	Space and ground communications and tracking services; scheduling for TDRSS support.
Flight Dynamics Facility (FDF)	Predictive and definitive orbit, attitude, and navigational computational support services in the spacecraft.
NASA Communications (NASCOM), NASCOM Operational Local Area Network (NOLAN)	NASCOM provides communications and data transport services between White Sands Complex (WSC) and ground-located elements; and communications support for end-to-end spacecraft simulations and training. NOLAN is used for transporting science and ancillary data from NASA data processing facilities (such as the GSFC Sensor Data Processing Facility (SDPF)) to the DAACs for designated NASA missions.

Table 2. NASA Institutional Services

INSTITUTIONAL SERVICE	SUMMARY OF SERVICES
Deep Space Network (DSN)	Tracking and data acquisition support , including backup radio-frequency (RF) communication services for relaying housekeeping telemetry and low bit-rate commands.
Ground Network (GN)	Backup transmission services to and from the spacecraft, in case of TDRSS malfunction.
X-Band Backup Ground Stations	Provide backup science data communications services for AM-1.
Wallops Orbital Tracking Station (WOTS)	Backup low-rate spacecraft communications services.
Program Support Control Network (PSCN)	Backbone for programmatic communications.
Sensor Data Processing Facility	Data distribution facility.

ECS Operations Locations

This section describes the ECS operations locations and their roles. **Eventually** ECS elements will be deployed to the following institutions:

- Distributed Active Archive Centers (DAACs):
  - — Alaska Synthetic Aperture Radar (SAR) Facility (ASF): University of Alaska, Fairbanks, Alaska
  - — EROS Data Center (EDC): Sioux Falls, South Dakota
  - — Goddard Space Flight Center (GSFC): Greenbelt, Maryland
  - — Jet Propulsion Laboratory (JPL): Pasadena, California
  - — Langley Research Center (LaRC): Hampton, Virginia
  - — National Snow and Ice Data Center (NSIDC): University of Colorado, Boulder, Colorado
  - — Oak Ridge National Laboratory (ORNL): Oak Ridge, Tennessee
  - — Socioeconomic Data Applications Center (SEDAC): Consortium for International Earth Science Information Network (CIESIN), University Center, Michigan
- System Monitoring and Coordination Center (SMC): GSFC Building 32 (not active for the Testbed)
- EOS Operations Center (EOC): GSFC Building 32
- ECS Sustaining Engineering Organization (SEO): GSFC Building 32
- ECS System Integrated Logistics Support Organization (ILS): GSFC Building 32

In addition, ECS will have interfaces with the following institutions:

- Science Computing Facilities (SCFs)
- International Partners' Instrument Control Centers
- Instrument Support Terminal Sites
- Affiliated Data Centers
    - — NOAA/National Environmental Satellite, Data, and Information Service (NESDIS).
    - — National Center for Environmental Prediction (NCEP).
    - — Space Science and Engineering Center of the University of Wisconsin.
    - — Incorporated Research Institutions for Seismology (IRIS) Data Center.

Distributed Active Archive Centers (DAACs)

It is the goal of EOSDIS to provide end-to-end services from EOS instrument data collection to science data processing to full access to EOS and other Earth Science data holdings. Eventually eight DAACs across the U.S. will process, archive, and distribute EOS and related data, and provide a full range of user support. The DAACs provide a link between the EOS program and the user community. The Pre-Release B Testbed for SSI&T is to be deployed at the following four DAACs:

- EROS Data Center (EDC)
- Goddard Space Flight Center (GSFC)
- Langley Research Center (LaRC)
- National Snow and Ice Data Center (NSIDC)

The DAACs chosen by NASA demonstrated expertise in specific disciplines and long-term commitments to the corresponding user communities. DAAC areas of specialization are shown in Table 3.

- The DAACs provide the facilities, the management and operations support for the production, archiving, and distribution of EOS Standard Products.
- At the DAACs, users can expect a level of service which would be difficult to maintain in a single data center attempting to serve the extraordinarily wide range of scientific disciplines encompassed by the EOS program.
- A user interacting with any given DAAC can access data from all the DAACs.

Table 3. DAAC Summary

DAAC	Science Discipline Assignments Made	Mission/Platform	Instrument/Experiment
Alaska SAR Facility (University of Alaska - Fairbanks)	Synthetic Aperture Radar Study, Polar Processes	ERS and JERS series RADARSAT	SAR SAR
EROS Data Center (USGS)	Land Processes Imagery	AM-1 Landsat-7	ASTER and MODIS (L2+/land) ETM
Goddard Space Flight Center (NASA)	Upper Atmosphere, Atmospheric Dynamics, Global Biosphere, Geophysics	TRMM SEASTAR ADEOS-I AM and PM series PM series Laser Altimeter CHEM-1 Flight of Opportunity (FOO)	VIRS (a/d) PR (a/d), TMI (a/d), GV (a/d) SeaWiFS TOMS (a/d) MODIS AIRS, AMSU, MHS, AMSR GLAS (LO/1) HIRDLS, MLS SOLSTICE III
Jet Propulsion Laboratory Interaction (Cal Tech)	Ocean Circulation and Air-Sea Interaction	ADEOS-I ADEOS-II Radar-Altimeter	NSCAT (a/d) Seawinds MR, POD, DFA
Langley Research Center Tropospheric (NASA)	Radiation Budget, Aerosols, Chemistry	TRMM AM-1 AM-2 PM series, FOO FOO FOO, Meteor, and Space Station CHEM-1	CERES CERES, MISR, and MOPITT CERES, MISR, EOSP CERES ACRIM SAGE III TES
National Snow and Ice Data Center (U. of Colorado)	Cryosphere (Non-SAR)	AM-1 and PM-1 PM-1 Laser Altimeter	MODIS AMSR GLAS (L2+)
Oak Ridge National Laboratory (DOE)	Biogeochemical Dynamics	None	None
Socio-Economic Data Applications Center (CIESIN)	Policy/Decision Making Applications of Combined MTPE and Socio-Economic Data	None	None

DAAC Main Functions:

- Integration and test of the science software, in order to verify that the software will run properly, i.e., will not interfere with other software or DAAC operations. The integration and test activity will also allow the SCF to verify that the software will run correctly (i.e., produce scientifically correct results) in the production environment.
- Archiving all source files, documentation, test information, and other files associated with the science software.
- Supplying the operational environment for the science software and running the software in an ongoing production mode to generate data products.
- Archiving and distributing the data products.
- Distributing source files, documentation, test information, and other files associated with the science software to authorized users.
- Accepting, archiving, and distributing special products generated by other facilities.
- Advertising data and providing user support.

System Monitoring and Coordination Center (SMC)

Although not active as an organization during the Pre-Release B Testbed period, at least some System Monitoring and Coordination (SMC) functions are part of the Pre-Release B Testbed. Release B.0 will include an SMC organization located at GSFC.

The CSMS provides a set of services at the SMC that are collectively referred to as Enterprise Monitoring and Coordination (EMC). (Services provided by CSMS at DAACs and the EOC are collectively referred to as Local System Management (LSM).) The MSS provides M&O staff with a system-wide management view for monitoring and control purposes. The CSS provides useful services (e.g., electronic mail and bulletin boards) for coordination.

SMC Main Functions:

- Performance Management: The DAACs' local area network (LAN) LSM provides real-time performance monitoring and reporting and post analysis and reporting through the database management system. The SMC receives summary reports and provides system-wide performance analysis.
- Security Management: Initially MSS provides limited security services to support intrusion detection, file access attempts, log-on authentication and authorization, and virus detection. The SMC's primary functions include evaluating site reports and detecting system-wide trends or related intrusion incidents.
- Configuration Management: Software, hardware and document configuration management is provided by a commercial off-the shelf (COTS) package configured for each site. Each individual site maintains information regarding the particular site and the SMC maintains system-wide and baseline configurations. Site changes to the baseline are coordinated with the SMC.

Sustaining Engineering Organization (SEO)

The ECS Sustaining Engineering Organization (SEO), housed at GSFC, provides a system-wide M&O function that is responsive to the ESDIS Project Office and the Project Scientist. Where the ECS DAACs are focused on the issues, tasks and priorities of their individual centers, the ECS SEO provides a **system** perspective on maintenance, sustaining engineering and training. Supported by the other M&O organizations, the ECS SEO organization also provides the focus for development organization interactions and assuring that ECS Science goals are met.

SEO Main Functions:

- Analysis of ways to accommodate needed improvements to ECS, including the integration of new technologies and new concepts. Making recommendations to the ESDIS Configuration Control Board (CCB) concerning system modifications based on changing technology or in response to system-wide problems.
- Evaluating user inputs, conducting operational readiness reviews and performing regular monitoring of M&O activities to assure ECS reliability, maintainability and availability.
- Identifying and (as authorized by the CCB) implementing needed improvements to the current operational version of the ECS hardware, software and/or firmware.
- Providing ECS software support through such activities as planning ECS system integration of science software, developing new ECS custom software, producing, delivering and documenting corrections, modifications and enhancements to ECS software (including commercial off-the-shelf (COTS) software and/or adapting or incorporating COTS software for ECS use.
- Installing and tuning ECS software, COTS packages, operating systems, compilers, tools, utilities, networks and databases.
- Testing new and upgraded ECS software and participating in the operations integration and testing of software at the DAACs, in particular evaluating the results of integration and test to verify that the software will run safely, i.e., will not interfere with other software or DAAC operations.
- Working with DAAC personnel to analyze system requirements, problems, and anomalies and formulate recommended solutions.
- Coordinating the resolution of ECS system-level problem reports and providing support for the problem resolution process.
- Defining the ECS science operation objectives, priorities, performance metrics/satisfaction criteria and performance reporting.

- Performing ECS configuration management; i.e., maintaining control of ECS baseline-configured hardware, documents, databases and software; ensuring that changes to the ECS system hardware, databases, software and procedures are

properly documented and coordinated; and tracking the status and facilitating the implementation of system-wide changes.

- Managing the ECS M&O training program, including planning, scheduling and conducting all ECS training courses; developing the curriculum to support the training courses; coordinating all training activities with the DAACs and SMC; developing and maintaining the certification skills plan; and managing the COTS training program.

Integrated Logistics Support (ILS) Organization

The Integrated Logistics Support (ILS) organization has system-wide responsibility for the management of logistics operations in support of ECS objectives and the science support missions. The organization is concerned with the **system-level** logistics support, especially the installation, maintenance and training functions associated with the procurement of commercial off-the-shelf (COTS) hardware and software.

ILS Main Functions:

- Determining requirements for, procuring, and accounting for spares, repair parts and consumable items used to support ECS operations. This includes receiving, inventorying, storing, issuing and replenishing spares, consumable items, tools and test equipment (if any), and end items stocked at the SEO, SMC and EOC.
- Planning, coordinating and monitoring all installations of ECS equipment at ECS sites.
- Managing and accounting for ECS contractor-purchased, vendor-loaned, and government-furnished equipment and software, including managing COTS software licenses and software maintenance contracts.
- Planning and coordinating vendor-provided training related to COTS equipment and software.
- Planning, coordinating and managing the installation of ECS COTS hardware and software.
- Controlling contractor and government ECS property at the SEO, the SMC and the EOC and maintaining a continuous audit trail from receipt of a COTS item until accountability has been transferred.
- Receiving failed ECS HW from the SMC/EOC Maintenance Coordinator and shipping it to the appropriate maintenance vendor for repair or replacement.
- Monitoring vendor repair actions and the return of repaired or replaced item(s) to the SMC or EOC.

EOS Operations Center

The EOC is located at the Goddard Space Flight Center in Greenbelt, Maryland, and is operated by the Flight Operations Team (FOT). The Flight Operations Team is responsible for maintaining spacecraft and instrument health and safety, monitoring spacecraft performance,

performing spacecraft engineering analysis, performing high-level monitoring of the mission performance of the instruments, and providing periodic reports to document the operations of the spacecraft and instruments. The EOC is the EOS mission control center and is responsible for the mission planning, command and control of the U.S. EOS spacecraft and the instruments onboard. The EOC supports the entire EOS mission life cycle, which includes pre-launch, launch, and on-orbit operations that occur in parallel with operator simulations training as well as interface tests, system tests, and end-to-end tests. It supports concurrent operations with maintenance, system upgrades, and sustaining engineering activities, and supports command, control, and analysis of multiple spacecraft and their instruments simultaneously.

EOC Main Functions:

- Coordinating multi-instrument, multi-organization observations.
- Resolving any scheduling conflicts that exist between the instruments/organizations.
- Providing the final science conflict resolution.
- Exercising ultimate authority in decisions regarding spacecraft and instrument health and safety.
- Generating a detailed activity schedule for the spacecraft based on instrument operations requests received from PIs and TLs via their ISTs, and information received from the Network Control Center (NCC) and the Flight Dynamics Facility (FDF).
- Forwarding instrument command data and spacecraft command data to the EDOS for uplink to the spacecraft.
- Maintaining spacecraft and instrument health and safety.
- Monitoring spacecraft performance.
- Performing spacecraft sustaining engineering analysis
- Performing high-level monitoring of the mission performance of the instruments.
- Providing periodic reports to document the operations of the spacecraft/instruments.

Science Computing Facilities (SCFs)

The Principal Investigators and/or the Instrument Team Leaders reside in the Science Computing Facilities (SCF), where new algorithms are developed and updated, special data sets are produced, and data quality checking is performed. ECS software is provided for use by local SCF operators.

- SCFs, located at EOS investigators' home institutions, are used to develop and maintain scientific algorithms and software, calibrate the EOS instruments, validate algorithms and products, generate Special Products, provide data and services to other investigators, and analyze EOS and other data in pursuit of the MTPE science objectives.

- The SCFs are established directly by the EOS investigators, and may consist of a single workstation or a large data center.
- Software toolkits are provided to the SCFs and other users to facilitate data access, transformation and visualization, and for algorithm development.
- The developer may reside at the SCF, or may deliver software to the SCF for integration with other software before delivery to the DAAC.

SCF Main Functions:

- Developing the science software and delivering it to the DAAC.
- Assisting the DAAC in planning for production readiness, including the integration and test of the science software.
- Supplying documentation of the science software to the DAAC for production, to serve as an archived record in case maintenance responsibilities later are transferred to someone else, and as information for users to determine that the data meets user requirements.
- Supplying the mandatory core and product-specific metadata.
- Supplying test cases and input test data and expected test output to the DAAC in order to verify that the software runs correctly in the operational environment.
- Participating in the integration and test of the science software at the DAAC, in particular the evaluation of the results of integration and test.
- Making corrections to the science software that are indicated by integration and test at the DAAC.
- Validating the algorithms and data products.
- Assessing the quality of the data products.
- Enhancing the science software.
- Maintaining the science software in response to evolving ECS hardware and/or software environments.

International Partners Instrument Control Centers

Each International Partner (IP) may provide an Instrument Control Center (ICC), or equivalent facility, for their instrument(s) on-board an EOS spacecraft. For example, Japan will provide an IP-ICC for its ASTER instrument on-board the AM-1 spacecraft. Each IP-ICC will work with the EOC in planning and scheduling the use of spacecraft resources to support the desired operation of its instrument(s).

IP-ICCs provide instrument plans and schedules to the EOC, and coordinate scheduling conflicts with the EOC when they arise. The EOC sends planning aids, integrated mission plans and schedules to IP-ICCs for analysis to refine instrument scheduling. IP-ICCs also can send instrument commands to the spacecraft via the EOC. The EOC validates the commands sent from IP-ICCs and builds the command bit pattern. The EOC then sends the commands to the

spacecraft via EDOS, and reports on the uplink status to the IP-ICCs. In addition, the EOC can send commands to the spacecraft on behalf of the instrument (e.g., to "safe" the instrument). In this situation, the EOC notifies the IP-ICC with a command notification message.

Instrument Support Terminal Sites

ISTs are software toolkits delivered by the ECS to the PI and TL sites for U.S. EOS instruments. ISTs provide interfaces between the PIs/TLs and the EOC and enable them to participate in the planning, scheduling, commanding, and monitoring of their instruments. IST functions are available through a terminal or workstation at the PI/TL sites and/or other designated sites. Currently, all identified U.S. EOS instruments will be managed at the EOC with access provided to the PIs/TLs via ISTs.

Affiliated Data Centers

Affiliated Data Centers (ADCs) are non-EOS data centers with which NASA has agreements to provide access to non-EOS data or to non-EOSDIS services required by EOS. ADC services include aiding in algorithm and software development for data processing. The ADCs also receive selected EOS data sets from the DAACs. The following ADCs have been identified:

- NOAA National Environmental Satellite Data and Information Service (NESDIS).
  - — Makes available data from geostationary and polar-orbiting meteorological satellites.
- National Center for Environmental Prediction (NCEP).
  - — Provides routine weather and climate forecasts for the U.S.
- Space Science and Engineering Center of the University of Wisconsin.
  - — Maintains a long-term archive and distribution function for Level 1 data from NOAA Geostationary Operational Environmental Satellites (GOES).
- Incorporated Research Institutions for Seismology (IRIS) Data Center.
  - — Receives Wide Band Data Collection System data from the EGS. NSF uses the data for analysis and collection of seismic and other scientific data.

Operational Software Configuration Overview

As previously mentioned, the major functional components of ECS that affect the M&O Organization are the Science Data Processing Segment (SDPS) and the Communications and System Management Segment (CSMS):

- Science Data Processing Segment (SDPS) includes ECS applications that provide:
  - Data management and archiving functions.
  - A processing environment for the execution of science software.
  - External interfaces for the acquisition of data for processing or archiving.
  - Functions which support the search and retrieval of ECS-managed data by science and other users.
- Communications and System Management Segment (CSMS) is responsible for all communications, networking, and enterprise management functions, including:
  - A distributed applications and operating system infrastructure.
  - Various communications services such as electronic mail and file transfer.
  - Monitoring and management of networking, system, and application resources.
  - Access control and security management.
  - Local area network services and external network connectivity.

Science Data Processing Segment (SDPS)

The Science Data Processing Segment consists of the following subsystems as shown in Figure 7:

- Client Subsystem (CLS)
- Interoperability Subsystem (IOS)
- Data Management Subsystem (DMS)
- Data Server Subsystem (DSS)
- Ingest Subsystem (INS)
- Planning Subsystem (PLS)
- Data Processing Subsystem (DPS)

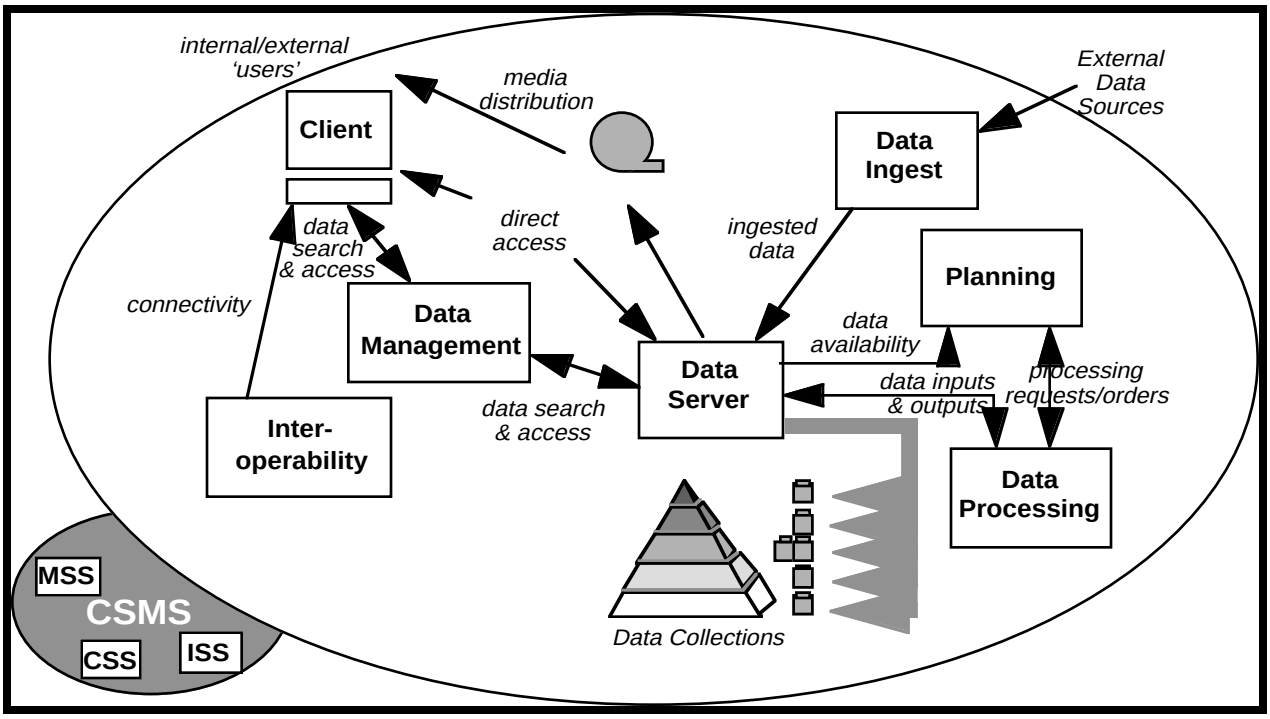

Figure 7. Science Data Processing Segment (SDPS)

SDPS Subsystems. The seven subsystems of the SDPS can be grouped into 4 main categories:

- **Data Storage and Management** as represented by the Data Server Subsystem (DSS), provides the functions needed to archive science data, search for and retrieve archived data, manage the archives, and stage data resources needed as input to science software or resulting as output from their execution.
- **Data Search and Retrieval** (also called the "Data Pull Side" of the system) is represented by the science user interface functions in the Client Subsystem (CLS), data search support functions in the Data Management Subsystem (DMS), and capabilities in the Interoperability Subsystem (IOS) which assist users in locating services and data of interest to them and their projects.
- **Data Processing** (considered a part of the "Data Push Side" of the system) is represented by a processing environment (the Data Processing Subsystem or DPS) for the science software; and capabilities for long and short term planning of science data processing, as well as management of the production environment provided by the Planning Subsystem (PLS).
- **Data Ingest** (also considered part of the "Data Push Side") is represented by the Ingest Subsystem (INS). The subsystem provides the interfaces with external applications, data staging capabilities, and storage for an approximately one-year buffer of Level 0 data (so that reprocessing can be serviced from local storage).

Communications and System Management Segment (CSMS)

The Communications and System Management Segment consists of the following subsystems as shown in Figure 8:

- Communications Subsystem (CSS)
- Systems Management Subsystem (MSS)
- Internetworking Subsystem (ISS)

Communications and System Management Segment (CSMS)

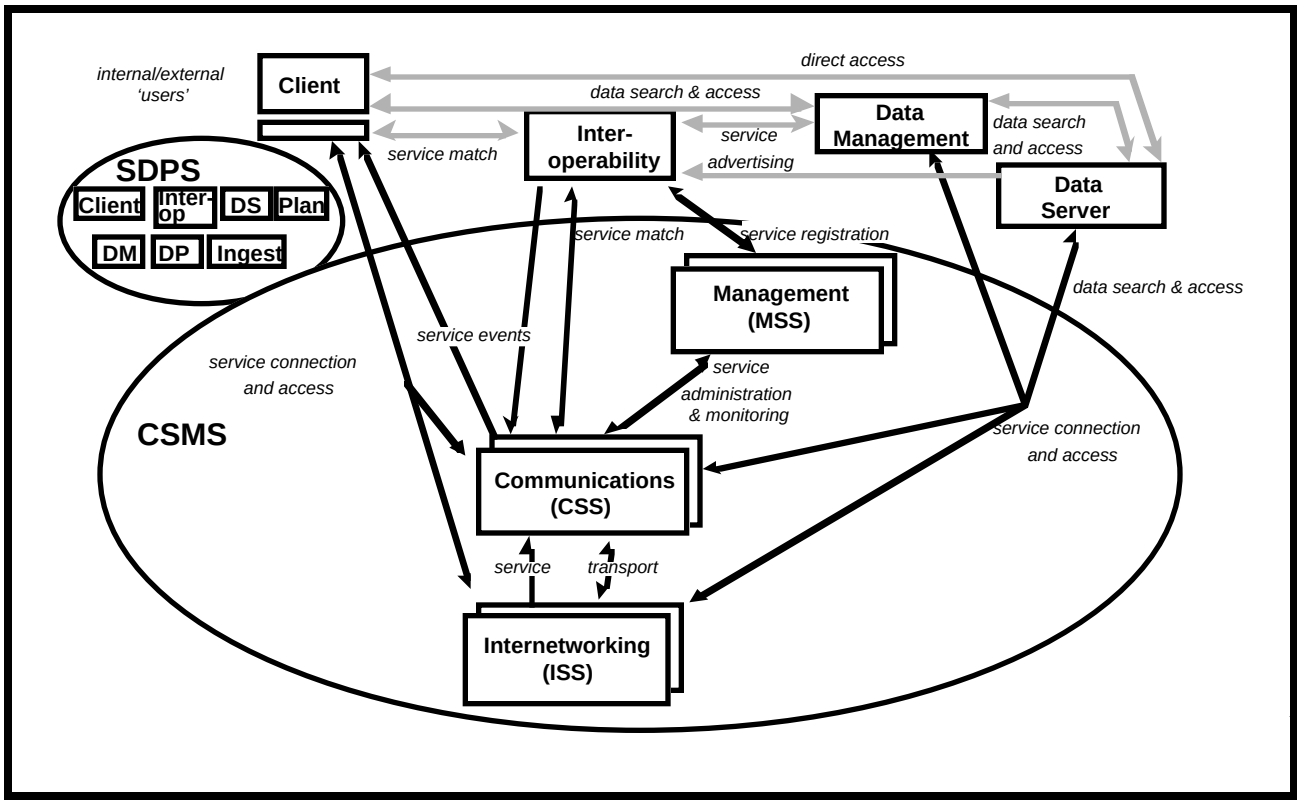

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Figure 8. Communications and System Management Segment (CSMS)

The **Communications Subsystem (CSS)** plays a key role in the interoperation of the SDPS subsystems. Important features of the CSS include:

- SDPS applications follow an object-oriented design. That is, their lowest level software components are "software objects."
  - SDPS also implements a distributed design, that is, its components - the software objects - are distributed across many platforms at a given site, and across several sites.
  - For the software objects to communicate with each other requires a "distributed object" communications environment, which is provided by CSS, using off-the-shelf technology with some custom software.
- The environment allows software objects to communicate with each other reliably, synchronously as well as asynchronously, via interfaces which make the location of a software object and the specifics of the communications mechanisms transparent to the application.
- CSS provides the infrastructural services for the distributed object environment.
  - Services are based on the Distributed Computing Environment (DCE) from the Open Software Foundation (OSF).
  - DCE includes a number of basic services needed to develop distributed applications, such as remote procedure calls (RPC), distributed file services (DFS), directory and naming services, security services, and time services.
- CSS provides a set of common facilities, which include legacy communications services required within the ECS infrastructure and at the external interfaces for file transfer, electronic mail, bulletin board and remote terminal support.
  - The Object Services support all ECS applications with interprocess communication and specialized infrastructural services such as security, directory, time, asynchronous message passing and event logging.
  - The Distributed Object Framework is a collection of a set of core object services, collectively providing object-oriented client server development and interaction amongst applications.

The **Systems Management Subsystem (MSS)** provides enterprise management (network and system management) for all ECS resources: commercial hardware (including computers, peripherals, and network routing devices), commercial software, and custom applications. MSS is characterized by the following features:

- With few exceptions, the management services are fully decentralized, so no single point of failure exists which would preclude the system from continuing to operate or would cause system operations and management to come to a halt.

- However, MSS does provide two levels of an ECS management view.
  - The local (site/DAAC specific) view is provided by Local System Management (LSM).
  - The enterprise view is provided by Enterprise Monitoring and Coordination (EMC) at the SMC, located at Goddard Space Flight Center (GSFC).
  - Enterprise management relies on the collection of information about the managed resources, and the ability to send notifications and commands to those resources. For network devices, computing platforms, and some commercial off-the-shelf software, MSS relies on software called "agents" which is usually located on the same device/platform and interacts with the device's or platform's control software, or the commercial software product.
  - However, a large portion of the ECS applications software is custom-developed, and some of the software, (i.e., the science software) is externally supplied. For these components, MSS provides a set of interfaces via which the components can provide information to MSS (e.g., about events which are of interest to system management, such as the receipt of a user request or the detection of a software failure) or can take commands from MSS as provided to MSS from M&O consoles (e.g., an instruction to shut down a particular component).
  - Applications which do not interact with MSS directly are monitored by software which acts as their "proxies". For example, the Data Processing Subsystem (DPS) acts as the proxy for the science software it executes. It notifies MSS of events such as the dispatching or completion of a Product Generation Executive[4] (PGE), or its abnormal termination.
  - ECS selected HP OpenView software as the centerpiece of its system management solution, and is augmenting it with other commercially available "agents", as well as custom-developed software (e.g., the previously mentioned applications interfaces). The information collected via the MSS interfaces from the various ECS resources is consolidated into an event history database on a regular basis (every 15 to 30 minutes) as well as on demand, when necessitated by an operator inquiry. The database is managed by Sybase, and Sybase query and report writing capabilities are used to extract regular and ad-hoc reports from it. Extracts and summaries of the information

[4] Product Generation Executive (PGE) is Data Provider science software code (e.g., executable programs or shell scripts) that contains the instructions for processing data to create the desired products. A PGE populates metadata on a granule by granule basis. (A granule is the smallest aggregation of data that is independently managed (i.e., described, inventoried, retrievable). Granules may be managed as logical granules and/or physical granules.)

are further consolidated on a system-wide basis by forwarding the information to the SMC (also on a regular basis).

- MSS also provides other general system management functions, such as security management (providing administration of identifications, passwords, and profiles), and configuration management for ECS software, hardware, and documents.

The **Internetworking Subsystem (ISS)** provides local area networking (LAN) services at ECS installations to interconnect and transport data among ECS resources. The ISS includes all components associated with LAN services, including routing, switching, and cabling as well as network interface units and communications protocols within ECS resources.

The ISS also provides access services to link the ECS LAN services to Government-furnished wide-area networks (WANs), point-to-point links and institutional network services. Examples include the NSI and various campus networks "adjoining" ECS installations.

Operation Hardware Configuration Overview

The operation hardware description in this section is generalized from available information. There are variations from the generalization at different sites.

ECS Equipment

The operation hardware for the Testbed consists of the following six general types of equipment:

- Server hosts.
- Science processors.
- Operator interfaces (workstations or X-terminals).
- Temporary data storage units.
- Printers.
- Network equipment, including fiber distributed data interface (FDDI) network equipment.

ECS computers are COTS hardware manufactured either by Hewlett-Packard (HP), Silicon Graphics, Incorporated (SGI), or Sun MicroSystems (SUN). The following models of computers, some with single, others with multiple central processing units (CPUs), host servers at the DAACs:

- HP J210
- SGI Challenge L
- SGI Challenge XL
- SGI Indigo
- SUN Sparc 20/50
- SUN Sparc 20/71
- SUN Sparc 20/712

The following computers serve as science processors at the DAACs:

- SGI PC (Power Challenge)
- SGI Indigo Impact (at NSIDC only)

DAAC personnel use the following model of computer as a workstation:

- SUN Sparc 20/50

The following model of X-Terminal manufactured by Network Computing Devices, Inc. (NCD) is used at the DAACs:

- NCD HMX-Pro

The following items of equipment are available at the DAACs for use as temporary storage, working storage, keeping database management system (DBMS) data files, or handling portable storage media (tapes or disks):

- HP redundant arrays of inexpensive disks (RAIDs)
- SUN RAIDs
- SGI RAIDs
- 8mm stackers
- 4mm stackers
- 6250 tape drives

The following model of laser printer is available at the DAACs and SMC:

- HP LaserJet 4M+

Fiber distributed data interface (FDDI) network equipment is available for internetworking.

Types of Equipment Involved in ECS Functions

Table 4 provides an overall summary of the ECS hardware at each of the four Testbed sites. Table 5 lists Testbed hardware at each site by subsystem.

Table 4. Testbed Hardware Summary

Hardware Equipment	GSFC	LaRC	EDC	NSIDC
Sun WS and servers	14	12	12	5
Sun RAID and disk array	3	3	3	1
HP WS and servers	2	2	2	2
HP RAID	1	1	1	1
SGI servers	6	7	5	3
SGI RAID	6	8	From RAID Tower	2
8 mm stacker	3	3	1	1
4 mm	1	1	1	1
X Terminal	2	5	1	1
Printer	4	4	2	1

Table 5. Proposed Testbed Hardware by Subsystem

Subsystem	Function	Type	Make/Model	Quantity			
				GSFC	LaRC	EDC	NSIDC
Data Processing	Science Processor	Computer	SGI Power Challenge	1	2	1	
	Science Processor	Computer	SGI Indigo Impact				1
	Science Processing disk	RAID	SGI C L Vault	—	—	—	—
	Science Processor File Server	Computer	SGI Challenge S				1
	Science Processor File Server Terminal	Terminal	WYSE				1
	Tape stacker	8mm	SGI	2	2	—	
	X terminal	Terminal	NCD HMX-PRO	2		1	
	Queuing Server	Computer	SUN Sparc 20/71		1		
	SSI&T WS	Computer	SUN Sparc 20/50	1	1	1	1
	SSI&T DBMS Server [and SSI&T WS at EDC]	Computer	SUN Sparc 20/50	1		1	1
	SSI&T Disk Array	Disk	SUN			—	—
	SSI&T Printer	Printer	HP Laser Jet 4M+	1		1	
Planning	Planning Server	Computer	SUN Sparc 20/71	1	1		
	Planning WS	Computer	SUN Sparc 20/50	1	1	1	
	Planning Disk	RAID	SUN	1	—	—	
	Planning and Queuing Server	Computer	SUN Sparc 20/712			1	
Ingest	Ingest Server	Computer	SGI Indigo	1			
	Ingest Server	Computer	SGI Challenge L		1		
	Ingest Server	Computer	SGI Indigo				
	Ingest front-end	Computer	SUN Sparc 20/50	1	1		
	Ingest front-end	Computer	SUN Sparc 20/712				
	Tape stacker	8 mm		1			
	Ingest Disk	RAID	SUN		—		

Table 5. Proposed Testbed Hardware by Subsystem

Subsystem	Function	Type	Make/Model	Quantity			
				GSFC	LaRC	EDC	NSIDC
Ingest	Disk Array	Disk	SUN		—		
Data Server	Ops WS	Computer	SUN Sparc 20/50	1	1	1	
	Ops WS	Computer	SUN Sparc 20/50	1	1		
	SDSRV Front-end	Computer	SUN Sparc 20/50	1	1		1
	Science Data Server	Computer	SUN Sparc 20/712			1	
	APC Server	Computer	SGI Challenge L	1	1		
	APC Server	Computer	SGI Challenge XL			1	
	NFS Server	Computer	SGI Challenge L	1	1		
	NFS Server	Computer	SGI Challenge XL			1	
	SDSRV Disk	RAID	SGI	—	—	—	
	Distribution Server	Computer	SUN Sparc 20/71	1	1	1	
	Printer	Printer	HP Laser Jet 4M+	1	2		
	Tape stacker	4 mm		1	1		
	Tape Stacker	8 mm		1	1		1
	Tape drive	6250		1	1		
	Working Storage RAID	RAID	SGI	—			
	Working Storage RAID	RAID (Dual)	SGI		—		
	FSMS Server	Computer	SGI Challenge XL	1	1	1	
	Archive Robotics with Archive 3590 Drive (available in the Testbed configuration but not used by Testbed)		EMASS AML MOD2				
	DRP DBMS Server	Computer	SGI Challenge XL	1	1	1	

Table 5. Proposed Testbed Hardware by Subsystem

Subsystem	Function	Type	Make/Model	Quantity			
				GSFC	LaRC	EDC	NSIDC
	DSS and Ingest DBMS Server	Computer	SGI Challenge L				1
Data Server	DSS Disk Array	Disk	SGI C L Vault				—
	DRP RAID	RAID	SGI	—	—		
	FSMS RAID	RAID	SGI			—	
	DBMS RAID	RAID	SGI			—	
	DRP Front-end	Computer	SUN Sparc 20/71	1	1		
	Netscape Server	Computer	SUN Sparc 20/71	1	1	1	
MSS	MSS Server	Computer	HP J210	1	1	1	1
	CM Server	Computer	SUN Sparc 20/71	1			
	CM Server	Computer	SUN Sparc 20/50		1	1	1
	MSS Printer	Printer	HP Laser Jet 4M+		1	1	
	Shared RAID	RAID	HP	—			
CSS	CSS Server	Computer	HP J210	1	1	1	1
	CSS RAID	RAID	HP			—	
Infrastruc-ture	Staging disk	Disk	SUN	—			
	Staging disk	RAID	SUN		—	—	
	NFS Storage	RAID	SGI		—	—	

The operation hardware for the Testbed has been configured to include the following subsystems as described in subsequent subsections of this lesson:

- Planning Subsystem (PLS)
  - — Planning Hardware
- Data Processing Subsystem (DPS)
  - — Science Processing Hardware
  - — SSI&T Hardware
- Ingest Subsystem (INS)
  - — Ingest Client Hardware

- Data Server Subsystem (DSS)
  - — Access Control and Management Hardware
  - — Working Storage Hardware
  - — Data Repository Hardware
  - — Distribution and Ingest Peripherals Hardware
- Systems Management Subsystem (MSS)
  - — Management Hardware
- Communications Subsystem (CSS)
  - — Distributed Computing Hardware
- Internetworking Subsystem (ISS)
  - — Internetworking Hardware

The Testbed has been configured from the hardware and software assets of the canceled ECS Release A. Not all subsystems of Release A have been included in the Testbed. (For example, the Client Subsystem and Data Management Subsystem hardware items were not included.) Some of the subsystems that are present in the Testbed have been restructured. Some subsystems (e.g., the Data Server Subsystem) are present but are not expected to be used for Testbed operations because the mission of the Testbed is to support Science Software Integration and Test (SSI&T) rather than the whole range of operations planned for Release A.

Planning Subsystem

The Planning Subsystem hardware includes workstations and servers that are needed to support such activities as production planning, the maintenance of planning data, and interaction with the processing environment during the execution of science software.

The following equipment items support planning operations:

- Planning server (SUN Sparc 20/71)
- Planning workstation (SUN Sparc 20/50)
- RAIDs

Data Processing Subsystem

The Data Processing Subsystem hardware includes the necessary equipment to conduct science processing and Science Software Integration and Test (SSI&T).

Science Processing

The science processing hardware provides the capability to perform the following types of processing: standard, reprocessing, and testing. The equipment includes workstations for

managing the production queues and dispatching processing requests in addition to the processors and working storage required during processing.

The following equipment items are provided to support science processing:

- Science processors (SGI PC XL)
- Queuing server (SUN Sparc 20/71)
- X-Terminals (NCD HMX-Pro)
- 8mm tape stacker
- RAIDs

SSI&T

The SSI&T hardware includes the workstations and other devices needed by the SSI&T staff. The hardware needed to run tests in simulated production mode is part of the science processing hardware. The equipment must be able to execute the software development tools and the test and integration tools.

The following equipment items support SSI&T operations:

- SSI&T workstations/DBMS servers (SUN Sparc 20/50)
- SSI&T workstations (SUN Sparc 20/50)
- Printers (HP LaserJet 4M+)

Ingest Subsystem

Although the Testbed does not require the type of ingest function designed for ECS Release A, some of the hardware will be present at some sites. In an operational system the Ingest Subsystem would depend upon Data Server Subsystem hardware for archiving and staging Level 0 Data. In addition, the Ingest Subsystem would share Data Server Subsystem input/output peripherals (see *Distribution and Ingest Peripherals Hardware*).

The Ingest Client Hardware covers the servers and/or workstations required for Ingest management, control, monitoring and/or processing. It includes the workstations needed by the ingest/distribution technicians.

The following items of Ingest Client Hardware are available in the Testbed:

- Ingest servers (SGI Indy or SGI Challenge L)
- 8mm tape stackers
- RAIDs (shared by ingest servers)
- Front-End SUN (SUN Sparc 20/50, SUN Sparc 20/712)

Data Server Subsystem

Like the Testbed Ingest Subsystem the Data Server Subsystem will not function as designed for ECS Release A. However, at least some of the hardware will be present at all DAACs.

The Data Server Subsystem was designed to incorporate the following five hardware groupings:

- Access Control and Management Hardware
- Working Storage Hardware
- Document Data Server Hardware
- Data Repository Hardware
- Distribution and Ingest Peripherals Hardware

The Document Data Server is the only Data Server grouping **not** represented in the Testbed hardware configuration.

Access Control & Management

Although not applicable to the Testbed, the Access hardware was designed to allow for client access (via both the Client Subsystem and direct "push/pull" user access) to the Data Server Subsystem. Accordingly, it was to provide tools and capabilities for system administration, and support many of the infrastructure requirements of the Data Server. The hardware was expected to control logical data server access, maintain client sessions, and direct service requests to other appropriate Data Server Subsystem equipment. The Access Control and Management hardware is broken down into two components; Administration Stations (AS) and Access/Process Coordinators (APCs). The number, type, and configuration of the APCs and Administration stations vary according to site needs and number of data servers supported.

The following items of access control and management hardware are included in the Testbed:

- Access/process coordinator (APC) servers (SGI Challenge L)
- RAIDs (shared by servers)
- Operations workstations (SUN Sparc 20/50)
- Front-end SUN (SUN Sparc 20/50)

Working Storage

The Working Storage (WS) hardware of the Data Server was to supply a pool of storage used for temporary file and buffer storage within the Data Server architecture. In Release B and later releases WS may be used to support the higher levels of a hierarchical storage scheme that utilizes other data repositories as lower levels in the storage schema. Any data residing in WS not designated as temporary data would be copied to a permanent data repository (see *Data Repository*).

WS was to provide the disk staging capacity for data “acquires” (from the archive) and “inserts” (to the archive). Because of its role at the higher levels of the archiving hierarchy, WS might

have held production-related data that was to be accessed in the near future, which would increase Data Server performance. WS would also improve performance by retaining copies of frequently accessed data that had been copied to the deeper archives and servicing data requests for that data in a faster, more efficient manner. Consequently, WS would behave like a cache for frequently accessed portions of the deep archives.

The following items of working storage are present in the Testbed:

- RAIDs (shared by FSMS servers)

Data Repository

The Data Repository hardware was designed to include the permanent storage devices associated with the Data Server Subsystem as well as some forms of Ingest Data Servers like the L0 Ingest Client. The Data Repository hardware includes archive robotics, drives, database repositories (with embedded database software), and file servers. Disk resources used for staging data after retrieval until they are processed or distributed, or after ingest until they are archived, were to be provided by Working Storage.

The following items of data repository hardware are included in the Testbed:

- File Storage Management System (FSMS) servers (SGI Challenge XL)
- Database Management System (DBMS) servers (SGI Challenge XL)
- Archive robot (EMASS AML/Mod 2)
- Linear magnetic drives (3590)
- RAIDs (supporting DBMS servers)

Distribution and Ingest Peripherals

This Distribution and Ingest Peripherals were intended to provide the pool of devices needed for hard media data distribution and data ingest (the equipment is shared by the Data Server and Ingest Subsystems). Consequently, it would be possible to share peripherals capable of both input and output across the two subsystems, increasing cost-effectiveness. The equipment includes disk, tape and other media ingest and/or preparation devices (e.g., 8mm tape and 4mm tape) as needed to fulfill the requirements of the site. The equipment also covers the workstations needed by ingest/distribution technicians.

The following items of Distribution and Ingest Peripherals Hardware are included in the Testbed:

- Distribution servers (SUN Sparc 20/712)
- RAIDs (shared by distribution servers)
- 8mm tape stacker
- 4mm tape stacker
- Tape drive (6250)
- Printers (HP LaserJet 4M+)

Systems Management Subsystem

The management hardware includes the servers and workstations needed to host the enterprise monitoring, local system management and configuration management (CM) software, CM data, and backup copies of all ECS "infrastructure" software.

The following equipment items support the MSS:

- Management Subsystem (MSS) servers (HP J210/1)
- Configuration management (CM) servers (SUN Sparc 2/50 or SUN Sparc 20/71)
- MSS Netscape server (SUN Sparc 20/50)
- MSS workstations (SUN Sparc 20/50)
- RAIDs (shared with the Communications Subsystem)
- Printers (HP LaserJet 4M+)

Communications Subsystem

The Distributed Computing Hardware includes an enterprise communications server and a local communications server. To provide for warm standby, the CSS servers and MSS servers at all DAAC sites are cross-strapped and are configured to include the CSS Distributed Computing Software (including both OODCE client and server); the MSS Management Software; and the MSS Agent Software.

The following equipment items are available to support the communications subsystem:

- Communications Subsystem (CSS) server (HP J210/1)
- RAID (shared with the MSS)

Internetworking Subsystem

The Internetworking Hardware provides the networking hardware for the intra-DAAC, DAAC to V0, and DAAC to EBnet connectivity.

The following equipment items are available to support internetworking:

- FDDI switch
- Alantec Power Hub 7000 with FDDI cards and power supplies
- FDDI concentrators
- Bay networks
- FDDI cables
- Ethernet hub
- Cabletron Micro MAC-22E w/BRIM F6
- Ethernet cables

- Local area network (LAN) analyzer
- Communications cabinets

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Commercial Off-the-Shelf (COTS) Software Overview

Commercial Off-the-Shelf (COTS) Software

Table 6 lists COTS software acquired for ECS Release A. Much of the software included in the table is not expected to be used during the operational period of the Pre-Release B Testbed because it is not essential for SSI&T support. However, much of the software is actually installed on the Testbed hardware even though it may not be used.

Table 6. Operator COTS Tools

Tool	Function	Tool Purpose	Subsystem	Associated Services
AMASS	Computer Systems Administration	File Storage Management System (FSMS)	DSS	• Ingres • Volserv
AutoSys/ AutoXpert	Production Processing	scheduling/ops automation and monitoring tool	DPS	Sybase
Bulletin Board Service	Common Services	• bulletin boards • news groups	CSS	• nnpost (public domain ware that allows posting of messages to a bulletin board) • INN (BBS server) • Netscape Navigator
ClearCase	Configuration Management and Defect Tracking	software change management	MSS	NFS, NIS
DDTS	Configuration Management and Defect Tracking	change request management	MSS	n/a
ESSM	Computer Systems Administration	Sybase administration and monitoring	MSS	• Sybase • Tivoli
Expert Sniffer Analyzer	System Monitoring	monitors network traffic for collisions and troubleshooting	ISS	DCE
HAL (DCE cell manager)	Security and Accountability	security management (distributed communications)	MSS	DCE
HP OpenView	Computer Systems Administration	startup/shutdown	MSS	SNMP
HP OpenView	System Monitoring	system monitoring	MSS	SNMP

Table 6. Operator COTS Tools

Tool	Function	Tool Purpose	Subsystem	Associated Services
Intelligent Query (IQ)	Computer Systems Administration	report generation	MSS	Sybase
isql	Computer Systems Administration	• Monitor, control, and manage database and user activity • Backup and restore databases • Diagnose system problems	MSS	Sybase
Legato Networker	Computer Systems Administration	backup/restore of system software	MSS	n/a
MS Office • Excel • Word • PowerPoint	Common Services	office automation	MSS	Wabi
msql	Computer Systems Administration	command line used for database administration	DSS	Illustra
Netscape Commerce Server	Common Services	access server	DSS	• Illustra • Sybase
Netscape Navigator	Common Services	web browser	CLS	Netscape Commerce Server
Physical Network Manager (PNM)	System Monitoring	tracks, manages, and controls all physical elements in the network	MSS	• HP OpenView • Sybase
Remedy	System Monitoring	problem management/ Trouble Ticketing	MSS	• Sybase • HTML
Remedy Action Request System (user contact log)	User Services	user services records and tracks the progress of any interaction with the user community	MSS	Sybase
SQR Report Writer	Computer Systems Administration	report generation	DPS	Sybase
Sybase Replication Server	Computer Systems Administration	• maintains warm standby copies of application data • replicates changes among databases at different sites	• MSS • CSS • DPS • IOS	Sybase

Table 6. Operator COTS Tools

Tool	Function	Tool Purpose	Subsystem	Associated Services
Tivoli	System Monitoring	• Enterprise Console - monitoring of HPOV, Logfile and SNMP adapters • Sentry - performance, fault, and security management • ADMIN - creation of operator accounts	MSS	Sybase and Tivoli databases
TOPIC (Verity)	Science Data Archive and Distribution	free text index/search engine	DSS	Illustra
XRP II Baseline Manager	Configuration Management and Defect Tracking	baseline management	MSS	UNIFY relational database
Z-mail (client)	Common Services	E-mail	CSS	• Mail User Agent (MUA) • sendmail

The following COTS software packages are essential to the Pre-Release B Testbed and are described in the section that follows:

- HP OpenView
- Sybase
- Distributed Defect Tracking System (DDTS)
- AutoSys/AutoXpert
- ClearCase

HP OpenView

HP OpenView (HPOV) is a software tool that the Management Subsystem (MSS) uses in real time to monitor and report on the performance of ECS hardware components. Its features and capabilities include:

- display of the current status of ECS hardware resources.
- access and display of performance data that has been logged by the database management program (Sybase).
  - — For example, an operator can request HP OpenView to display a graph of interface traffic, a graph of central processing unit (CPU) load, or an event history log.

- system monitoring, with pop-up window and audible alarm to alert the resource manager.
    - HP OpenView also sends a message to the production monitor and user services informing them of the fact that there is a hardware failure that will affect production.

HP OpenView is used most frequently by those ECS personnel who are involved in resource management and fault management at the DAACs and the SEO, for example, the DAAC Resource Manager, the DAAC System Test Engineer, the DAAC Computer Operators and the SEO System Test Engineer.

Sybase

The SDPS uses an off-the-shelf relational database management system (DBMS) called Sybase located on the Data Servers to manage its Earth Science data and implement spatial searching, as well as for the more traditional types of data (e.g., system administrative and operational data). Other Sybase capabilities include:

- management of other databases (e.g., site event history database collected via the MSS interfaces from the various ECS resources at each ECS site). The site event history database is used for both ad-hoc and regular site-level management reporting.
- Sybase query and report writing capabilities are used to extract regular and ad-hoc reports from the site event history database. Extracts and summaries of this information are further consolidated on a system-wide basis.
- physical storage access and management functions on the Data Server Subsystem for the ECS Earth Science data repositories.
    - Other subsystems can access it directly or via the data management subsystem (if they need assistance with searches across several of these repositories).
    - The subsystem also includes the capabilities needed to distribute bulk data via electronic file transfer or physical media.
    - Components of the Data Server include the Working Storage HWCI, the Network Pull Volume, Science Data Server, MD CSC (Sybase), Storage Management, FMS CSC (AMASS), the Data Repository HWCI, Distribution Management, the external network, and MSS Logging & Report Services.

The DAAC Database Administrators use Sybase database administration and reporting writing tools to perform the database administration utilities, such as database backup, Database Transaction Logs maintenance and database recovery due to Database access error, Sybase read/write errors. The DAAC Database Administrators create standard and ad hoc security management reports of stored security management data utilizing the Sybase report generator.

Distributed Defect Tracking System (DDTS)

The Distributed Defect Tracking System (DDTS) is a software tool that is available through the MSS. It is used for the following functions:

- support configuration management by acting as the ECS Change Request Manager.
- track Configuration Change Requests (CCRs), whether in response to recommendations resulting from the investigation of problem reports or any normal evolution of the ECS system hardware or software (such as an updated version of a software package to be installed on the system).
    - DDTS tracks CCRS from their initiation to their final disposition.

The CM Administrators at the DAACs and SEO act as database administrators for DDTS at the appropriate levels. For example, the DAAC CM Administrators are responsible for tracking CCRs at their site. The DAAC Maintenance Coordinators record configuration changes (e.g., completed installation of approved software upgrade) using DDTS. The ILS Logistics Engineer uses DDTS for monitoring and reporting logistics activities.

AutoSys/AutoXpert

The AutoSys/AutoXpert software is a production scheduling tool intended to support the operational activities surrounding production processing in the SDPS. The following features and capabilities are included in AutoSys/AutoXpert:

- job monitoring, scheduling, fault notification and restart capabilities.
- assisting the Production Monitor in determining the effects of failure of a Data Processing Request (DPR) and in determining the cause and actions to be taken due to the failure (although it does not perform any planning activities).
    - AutoSys scheduling software is part of the Data Processing Subsystem (DPS).
- displays the DPRs as job boxes.
    - Each DPR represents the execution of a single science software Product Generation Executive (PGE).
    - Any DPRs that have dependencies on data which are not yet available, are kept in a "held" state by AutoSys until the data become available.

The DAAC Production Monitor uses AutoSys/AutoXpert for modifying DPR priorities and inputs as required, transferring/deleting/suspending/resuming DPRs as required (e.g., requests, resource problems, input data schedule problems, special events, schedule replans, etc.). In addition, the Production Monitor uses AutoSys/AutoXpert to monitor/provide processing status upon request, monitor/review input and output data, and implement production system reconfiguration in response to operations anomalies.

ClearCase

ClearCase is the ECS software baseline and change manager in the MSS. The following capabilities and features are included in ClearCase:

- providing version control of software objects.
- supporting installation of approved new versions of software.
  - — New versions are first entered into ClearCase, which is then used for installing the new software code.
- checking software to confirm suspected software problems.
  - — As with new software, revised software is installed through ClearCase.

The CM Administrators at the DAACs, and SEO act as the database administrators for several tools including the Software Change Manager (ClearCase). As such they record, report, manage and distribute changes to custom ECS software, science software and database control files in the ClearCase tool.

The DAAC and SEO Software Maintenance Engineers use ClearCase to make changes to custom ECS software and database control files.

Operational Processes

System Operations Management and Science Operations

Operational processes are the general functions of the ECS and the general duties of the M&O personnel who operate the system. In this section the operational processes are presented from the perspective of what M&O personnel do rather than what the system does.

Operational processes can be classified into two categories; i.e., (a) System Operations Management and (b) Science Operations. Very brief descriptions of the processes in the two categories are provided in Table 7.

Table 7. Operational Processes

General Category	Operational Process	Description
System Operations Management	System Administration	Controlling and maintaining the applicable system hardware and files. System administration includes such activities as starting up and shutting down the system, backing up and restoring the system, maintaining the system log, controlling access to the system, and monitoring system security.
	Network Administration	Monitoring network performance, troubleshooting network problems, and reporting on network operations. Network administration involves (among other things) maintaining LAN and local DCE configuration, monitoring the performance of networks (e.g., EBnet and NSI); analyzing, isolating, and resolving network faults; coordinating with external network operations organizations; monitoring network security; and responding to security alarms and events.
	Problem Management	Process of identifying, documenting, investigating, and resolving problems with ECS hardware, software, documentation, or procedures. Problem management includes the process of initiating problem reports and continues through the steps involved in resolving problems and properly documenting the problem resolution.
	System Troubleshooting	Process of identifying, locating, analyzing, and determining the cause of system faults. It involves system monitoring to check system status and performance.
	Configuration Management	Process for ensuring that hardware, software, and procedural changes to system hardware and software are properly documented and coordinated. Configuration management includes maintaining accurate baseline lists of hardware and software and managing the change process to ensure that changes to the baseline are properly approved and documented.

Table 7. Operational Processes

General Category	Operational Process	Description
Science Operations	Ingest	Receiving science data (Level 0 data, Level 1-4 products) or ancillary data at an EOSDIS facility for subsequent processing and/or storage in the archives. Data may be delivered electronically via communications networks, or on tapes or disks. The data received are staged (transferred) to the appropriate working storage area where they are available to either the Data Server Subsystem (for archiving) or the Data Processing Subsystem (for processing).
	Archive	Preserving data and products for users by providing secure long-term data storage. Archive functions include putting data/products into the archive and retrieving them from the archive. Fundamental operations include monitoring the performance of archive operations; maintaining the site data catalogue and data directory; managing the archive processing queue; and managing archive content and capacity.
	Data Distribution	Providing archived data or products to users as requested. Data/products are distributed in several forms, e.g., electronically (over a communications network such as NSI) or on “hard media” (e.g., compact disk, 4mm tape or 8mm tape).
	Production Planning and Processing	Preparing plans/schedules for the production processing of ECS science data and monitoring the execution of science software. Production planning includes approving, developing, adding, deleting, modifying, reviewing and validating processing requests; and developing/maintaining primary and alternate plans and schedules in response to loading/resource changes. Production processing includes monitoring/managing processing queues to make optimum use of production resources; modifying data processing request (DPR) priorities; and transferring/deleting/ suspending/resuming DPRs as required.
	Resource Planning	Scheduling events on DAAC production processing hardware resources. In addition to production, events that can be scheduled include such activities as maintenance, testing and training. Resource planning resolves potential conflicts between events that would occur simultaneously on the limited production resources.
	Database Administration	Maintenance of databases involving such operations as installing SQL server products, managing disk storage space, managing ECS personnel accounts and privileges, and performing database backup and recovery operations.

Table 7. Operational Processes

General Category	Operational Process	Description
	Library Administration	Managing documents related to the operational baseline including processing change packages for distribution and maintaining and updating the controlled master copy of all documents. The documents include system requirements, design documents, and baselined operations plans.
Science Operations	User Services	Assisting users in locating and gaining access to EOSDIS-related data. Assistance includes helping users with catalog, search and order systems, bulletin boards, tools kits, services, etc.; helping users who are experiencing difficulties with EOSDIS on-line systems, tool kits, and/or center-specific data sets, software, on-line systems or tools; providing users with information on the status of their order; and maintaining contact with the user community to assess user satisfaction and requirements.
	Software Maintenance	Installing COTS and custom software and troubleshooting and correcting software problems. Software Maintenance includes the analysis of software requirements, problems and anomalies; the formulation of recommended solutions; the production, delivery and documentation of corrections, modifications and enhancements to ECS software and/or the adaptation or incorporation of COTS software for ECS use.
	Science Software Integration and Test (SSI&T)	Ensuring that science production software packages are properly integrated into the production environment at the applicable DAAC. SSI&T activities include checking delivered software to ensure that it meets the applicable standards and testing the science data production software to determine its ability to run to normal completion repeatedly over the normal range of data inputs and run-time conditions. In addition, SSI&T ensures that the execution of new software will not interfere with DAAC operations or with other software executing at the DAAC.
	Administering the On-Line Advertising Service	Developing advertisements for new data sets and services, reviewing product/collection advertisements for completeness and compliance with requirements and publishing the advertisements.

The Pre-Release B Testbed does not require all of the operational processes listed in Table 7 because it is not a full-fledged operational system. Consequently, the sections that follow contain descriptions of the following operational processes that are included in the Testbed:

- System Administration.
- Network Administration.
- Problem Management.

- System Troubleshooting.
- Configuration Management.
- Production Planning and Processing.
- Database Administration.
- Software Maintenance.
- Science Software Integration and Test.

System Operations Management Activities

System Administration

System administration involves performing such functions as installing workstations, starting up and shutting down the system, backing up and restoring the system, maintaining the system log, controlling access to the system, and monitoring system security. The DAAC and SEO System Administrators perform most of the system administration functions. Among the tasks they perform are the following items:

- Create, modify, delete and maintain accounts for ECS personnel.
- Initialize hosts and workstations.
- Perform preventive maintenance for all office staff and operations support hosts and workstations.
- Diagnose and correct system problems on demand.
- Document, investigate and resolve errors, faults and observations for site hosts, peripherals and workstations.
- Coordinate system maintenance scheduling with other ECS centers.
- Monitor workstation performance - tuning when applicable.
- Maintain the local-area network (LAN) and local distributed computing environment (DCE) configuration.
- Provide system-level management of directory services.
- Perform backups and recoveries.
- Install the latest version of ECS custom and COTS software on hosts and workstations.

Among the important software tools used in system administration are HP OpenView, and the Management Subsystem (MSS) software with its graphical user interfaces (GUIs).

Network Administration

Network administration includes network performance monitoring, troubleshooting network problems and reporting on network operations. The system-level Network Analyst, the SEO and

DAAC System Administrators and DAAC Resource Managers perform network administration functions.

As previously mentioned, the SEO and DAAC System Administrators are responsible for maintaining LAN and local DCE configuration.

The Network Analyst is responsible for performing the following tasks (among others):

- Provides performance monitoring of networks (e.g., EBnet and NSI).
- Provides a focal point (in cooperation with affected sites) for inter-ECS network problems.
- Coordinates with external network operations organizations (e.g., EBnet and NSI) on the following types of issues:
  - configuration scheduling/compatibility.
  - fault isolation and resolution.
  - change planning.
  - performance reporting.
- Interacts with external systems on inter-system problems.
- Analyzes soft and hard copy reports on network effectiveness, productivity, capacity and performance (e.g., LAN errors and faults).
- Analyzes network faults.
- Supports fault diagnosis testing for hardware, software and resource-to-resource connectivity.
- Monitors network security and responds to security alarms and events.

The DAAC Resource Managers coordinate with system-level support for network problems and DAAC reconfigurations in response to ECS system anomalies. They are responsible for site hardware, software, LAN and local DCE cell configuration, allocation and utilization performance. They coordinate local network activities with other network management centers (e.g., NSI and other DAACs).

Software resources that are frequently used in network administration include ClearCase and HP OpenView.

Problem Management

Problem management is a process of identifying, documenting, investigating, and resolving problems with ECS hardware, software, documentation, and procedures. It involves all M&O operations and support personnel because all have at least the responsibility to report problems that they encounter. Specific functions involved in problem management in support of the Testbed include writing Non-Conformance Reports (NCRs) and managing NCRs through the problem resolution process.

The Testbed uses DDTS as its problem management software package.

System Troubleshooting

System troubleshooting is a process of identifying, locating, analyzing, and determining the cause of system faults. It involves system monitoring to check system status and performance.

All ECS operators participate in troubleshooting of the systems they operate. The DAAC and SEO System Administrators perform troubleshooting of their systems as part of their maintenance responsibilities. The ECS Fault Manager provides a focal point for inter-ECS site problems and provides support for other centers' troubleshooting activities. The ECS Fault Manager's support for fault isolation, diagnosis, and analysis includes the following tasks:

- Evaluates fault data from multiple sources.
- Runs network analysis tools as required.
- Provides a common point of contact to external systems.
- Evaluates cross-site incident reports.
- Resolves problem reports escalated from ECS centers.
- Coordinates and distributes problem resolutions common to all sites.
- Performs system-wide fault data collection, trending, long-term fault analysis, planning and information distribution across multiple local system managements (LSMs) and networks.

Software resources that are frequently used during system troubleshooting include HP OpenView, Sybase, and the MSS GUIs.

Configuration Management

Configuration management is a process for ensuring that hardware, software, and procedure changes to the baseline are properly documented and coordinated. The DAAC and SEO CM Administrators provide configuration management and monitoring at their respective levels. They act as database managers for such tools as the Change Request Manager, SW Change Manager, and Baseline Manager. They provide support to their respective Configuration Control Boards. They perform the following tasks in these roles:

- Change Request Manager.
  - Record and manage proposed and approved Configuration Change Requests (CCRs) in the Change Request Manager (DDTS).
  - Act as the Change Request Manager database administrator.
  - Coordinate all center CCRs with external interfaces.
  - Coordinate impact assessments and propagate system CCR resolutions to the site-level.
  - Provide support for the deliberations of the Configuration Control Board.

- SW CM Manager.
  - Record, report, manage and distribute changes to custom ECS SW, science SW and database control files.
  - Maintain privileged access to the ECS SW library for SEO, Maintenance Engineers and off-site facilities (ECS Development Facility, DAACs and EOC).
- Baseline Manager.
  - Record, report and maintain system-level changes to the as-built operational baseline of ECS products in the Baseline Manager.
  - Generate the Configuration Status Accounting Records (CSAR).
  - Maintain inventory of control items and version control of ECS Configuration Items.

Software resources that are essential to configuration management include ClearCase, XRP-II, and DDTS.

Science Operations Activities

Production Planning and Processing

The goal of production planning is to make optimum use of computing resources when generating science data products (during production processing). As a result science data products are generated according to plans/schedules for the production processing/reprocessing of ECS products. Production planning also assesses the impact of algorithm changes or reallocations on data transfer requirements and on the processing schedule of other products.

The DAAC Production Planners develop daily, weekly and monthly DAAC science production schedules. They maintain the production database, specifying science software characteristics and production priorities.

The DAAC Production Monitors manage processing schedules and monitor science software execution.

The following tasks describe some of the functions performed by Production Planners:

- In coordination with data providers, develop, and maintain Data Availability Schedules.
- Approve, develop, add, delete, modify, review and validate processing requests.
- Develop daily, weekly and monthly production resource requirements and provide schedules to the Resource Planners.
- Develop and maintain primary and alternate plans and schedules and their associated Data Processing Requests in response to loading/resource changes.

- Manage the Production Planning Database based on Science Software Integration and Test (SSI&T) inputs, instrument team inputs and DAAC policies.
- Develop production operations plans/schedules.
- Develop production plans/schedules to support SSI&T and site system testing and training.
- Coordinate production schedule interdependencies/problems with other producer-receiver sites.

The following tasks describe some of the functions performed by Production Monitors:

- Monitor Data Processing Request (DPR) validation.
- Monitor/manage processing queues to make optimum use of production resources.
  - — Modify DPR priorities and inputs as required.
  - — Transfer/delete/suspend/resume DPRs as required (e.g., in response to requests, resource problems, input data schedule problems, special events, and replans).
- Monitor processing status.
- Monitor input and output data.
- Provide real-time science product QA support.
- Implement production system reconfiguration in response to anomalies in production operations.
- Monitor and analyze resource configurations and utilization.
  - — Provide feedback to Resource Planners and Production Planners to aid in making optimum use of the system.
- Perform on-line authorized production replans as required in response to processing anomalies.
- Provide support for SSI&T.

The DAAC Production Planners use a workstation console that provides access to the Production Request Editor GUI and the Planning Workbench GUI. Among the principal tools used by DAAC Production Monitors are AutoSys and the Planning Workbench GUI.

Database Administration

Database administration involves the maintenance of databases including the installation of SQL server products, managing disk storage space, managing ECS personnel accounts and privileges, and performing database backup and recovery operations.

The DAAC Database Administrators maintain the databases and perform structure management for the integrated SDPS. They initiate database administration utilities, such as database backup and recovery, performance monitoring and tuning.

The following tasks are among the functions performed by Database Administrators:

- Run the database administration utilities, such as the utilities for database backup, database recovery, and the maintenance of database transaction logs.
- Monitor and tune the physical allocation of database resources.
- Maintain user accounts for external users of the system.
- Create user registration and account access control permissions in the security databases.
- Work with Data Specialists in information management tasks involving databases, data sets and metadata management.
- Perform daily database synchronization.

The DAAC Database Administrators use Sybase database administration and reporting writing tools.

Software Maintenance

Software maintenance involves installing (including configuring) software, troubleshooting software problems, and correcting the problems. Both COTS and custom software require maintenance.

Many ECS jobs involve software maintenance. The SEO and DAAC System Administrators install the latest version of ECS and COTS software on host computers and workstations at their centers. The system-level and DAAC Maintenance Coordinators coordinate the actions of COTS vendors concerning the resolution of SW problems and upgrades and coordinate with the center's Software Maintenance Engineer to ensure that adequate and timely assistance is provided. The SEO System Engineer responds to system-wide software problems and works with DAAC personnel in the analysis of software requirements, problems, anomalies and the formulation of recommended solutions. The SEO and DAAC Software Maintenance Engineers produce, deliver and document corrections, modifications and enhancements to ECS software (including COTS) and/or adapt or incorporate COTS software for ECS use.

ClearCase is the software tool used when making changes to custom ECS software, science software or database control files.

Science Software Integration and Test

Science data production software is developed independently of ECS at SCFs, which may employ different computing hardware and different operating systems. Consequently, Science Software Integration and Test (SSI&T) functions must be performed to ensure that science production software packages are properly integrated into the production environment at the

applicable DAAC(s). During SSI&T the science data production software is tested to determine its ability to run to normal completion repeatedly over the normal range of data inputs and run-time conditions. Furthermore, the SSI&T process seeks to ensure that the software executes without interfering with DAAC operations or with other software executing at the DAAC. SSI&T is performed at each DAAC responsible for generating the respective product(s).

The DAAC SSI&T Support Engineers provide DAAC SSI&T execution support, ECS tool and system expertise and science software processing problem support. They provide support to scientists in the development and integration of science software for both updates and new science software into the DAAC ECS system. The following tasks are among the functions that DAAC SSI&T Support Engineers perform:

- Provide support to Instrument Teams for the development and integration of science software into the DAAC ECS system.
- Perform standards checking on all delivered software, including source code, scripts, process control files and related documentation.
- Provide support for metadata updates and additions for science data products.
- Support science processing problem investigation and resolution.
- Recommend, assess, develop, and implement changes to science toolkit software.
- Provide support for the integration and testing of new and modified toolkit functions into the science software.

The DAAC Science Data Specialists serve as the DAAC interface to the Instrument Teams for SSI&T. The following tasks are among the functions that DAAC Science Data Specialists perform in support of SSI&T:

- Interface with the ECS Science office, DAAC and IT and lead ECS-related long-range planning and preparations for data set SSI&T.
- Sponsor IT requests for DAAC testing resources; receive IT delivery; lead DAAC review and feedback of IT software packages; lead the DAAC SSI&T team, including problem resolution management; and provide progress reports to DAAC management.

ClearCase is one of the principal software tools used during SSI&T.

Practical Exercise

Introduction

This exercise is intended to give the students an orientation to the facility, perform login to the system and to familiarize them with a few of the features of the system.

Equipment and Materials

ECS Facility.

One ECS workstation per student.

Tour of the Facility

The exercise involves taking a tour of the facility. The purpose is to become familiar with the layout of the facility and the locations of ECS components within the facility.

Perform the following steps:

1. Follow a tour guide on a tour of the facility and observe the positions of ECS components in the facility.
2. Ask the tour guide relevant questions.

Performing an Operator Login and Logout

The exercise involves logging in to and out from the ECS. The exercise begins with the instructor demonstrating an operator login.

Perform the following steps:

1. Observe the instructor's login to ECS.
2. Log in to ECS.
3. Observe the features of ECS as the instructor describes them.
4. Observe the instructor's logout from ECS.
5. Log out from ECS.

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Slide PresentationÄ

Slide Presentation Description

The following slide presentation represents the slides used by the instructor during the conduct of this lesson.

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