Effective Date: August 2018
Expiration Date: August 2023

GSFC ESDIS CMO
August 22, 2018
Released

423-46-01, Revision E
Earth Science Data and Information System (ESDIS) Project, Code 423

Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System Science System

Goddard Space Flight Center
Greenbelt, Maryland

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Functional and Performance Requirements Specification for the EOSDIS Core System Science System Signature/Approval Page

Reviewed by:

Signature obtained on file ***08/22/2018***
Tracy Zeiler — Date
ESDIS Contracting Officer Representative
GSFC – Code 423

Approved by:

Signature obtained on file ***08/22/2018***
Andrew Mitchell — Date
ESDIS Project Manager
GSFC - Code 423

[Electronic] Signatures available in B32 Room E148
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Preface

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Any questions should be addressed to: esdis-esmo-cmo@lists.nasa.gov

ESDIS Configuration Management Office (CMO)
NASA/GSFC
Code 423
Greenbelt, Md. 20771

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Abstract

The portion of EOSDIS specified in this document is called the EOSDIS Core System (ECS). The ECS is based on the functional and performance capabilities required by the baseline EOSDIS design, i.e., the acquisition, processing, storage, and distribution of the data acquired by the EOS spacecraft; the incorporation of selected non-EOS data sets, specifically data sets produced by sources other than EOS instruments that complement data from EOS instruments in supporting NASA's Earth science research program; and the development of a comprehensive data and information management system.

This specification contains the functional and performance requirements of the ECS. The ECS will be an evolutionary development. This specification is the baseline from which the ECS will evolve.

Keywords: F&PR, Specification, ECS, EMD

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Change History Log

Revision	Effective Date	Description of Changes (Reference the CCR & CCB Approval Date)
Original	08/19/2002	CCR 423-46-01-001-R1; Baseline ALL
Rev A	02/06/2004	CCR 423-46-01-002-R1; Mod No. 10 Pages: All
CH01	03/15/2004	CCR 423-41-57-026-R2; Mod No. 10 Pages: iii, v, vi, C-6, C-7, C-8
CH02	06/07/2004	CCR 423-41-56-007; Mod 22 Pages: iii, v, vi, C-11, E-2
CH03	09/22/2004	CCR 423-41-57-035; Mod 22 Pages: iii, v, vi, 6-6, C-5, C-6, C-7
CH04	12/01/2004	CCR 423-46-01-003; Mod 22 Pages: iii, v, vi, C-6, C-7, E-3, E-4, E-5, E-6, E-7, E-8, E-9, E-10, E-11, E-12
CH05	03/08/2005	CCR 423-46-01-004; Mod 25 Pages: iii, v, vi, xi, 3-9, 3-10, 4-9, 4-10, 5-1, 5-2, 5-4, 5-5, 6-2, 6-17, 6-19, 6-23, 6-24, 6-35, 6-43, 6-44, 6-45, 6-49, A-6, A-7, A-9, B-7, B-8, C-1, C-6, C-7, C-8, C-11
CH06	05/17/2006	CCR 423-46-01-005; Mod 42 Pages: iii, v, 6-32, 6-33
Rev B	11/29/2007	CCR 423-46-01-007; Mod 201-13 Pages: All
Revision C	11/17/2008	CCR 423-46-01-008; CCB approved 10/15/2008 Pages: All
Revision D	03/01/2011	CCR 423-0035; CCB approved 02/23/2011 Pages: All
Revision E	08/22/2018	CCR 423-ESDIS-177; CCB approved 08/09/2018 Pages: All Table C-1, Table C-2, Table C-3, Table C-5; see DCN for details

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1. INTRODUCTION

The Earth Observing System Data and Information System (EOSDIS) as the National Aeronautics and Space Administration's (NASA) overall Earth Science discipline data system 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. As a part of the Earth Observing System (EOS) Program, EOSDIS supports: the 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; and the transformation of the observations into physical variables, providing for higher levels of processing and presenting the data to users in forms that facilitate and stimulate interactive scientific research. EOSDIS supports NASA Earth Probe (i.e., non-EOS NASA Earth science flight projects) missions and adds to its database other selected non-EOS data that are required for use in conjunction with EOS data. EOS, Earth Probe, and other selected non-EOS data and products are cataloged, archived, and are retrievable in a manner that supports the scientist in developing a better understanding of the way the earth functions. The portion of EOSDIS specified in this document is called the EOSDIS Core System (ECS) Science System.

The ECS is based on the functional and performance capabilities required by the baseline EOSDIS design, i.e., the acquisition, storage, and distribution of the data acquired by the EOS spacecraft; the incorporation of selected non-EOS data sets, specifically data sets produced by sources other than EOS instruments that complement data from EOS instruments in supporting NASA's Earth science research program; and the development of a comprehensive data and information management system.

1.1 Scope

This specification contains the functional and performance requirements of the ECS Science System. The ECS Science System is comprised of the ECS Science Data Processing Segment (SDPS) and the ECS Communications and System Management Segment (CSMS).

1.2 Document Organization

The document is structured into seven sections plus appendices:

- Section 1, Introduction – Introduces the capabilities of EOSDIS, the purpose, content and structure of the ECS Functional and Performance Requirements Specification (F&PRS). As well as Applicable and Reference Documents that lists the set of Government and non-Government documents which form a part of this specification and which are referenced within.
- Section 2, Overview of EOS and EOSDIS – Presents an overview of the EOS mission, EOS Instruments, EOS and non-EOS data, the Science/User Community and the role of EOSDIS within the mission objectives.
- Section 3, ECS Description – Presents an overview of the ECS architecture which provides a basis for the requirements specification. A description of the internal interfaces and major external interfaces is presented along with a high-level description of the data flows between the ECS elements and the supporting external facilities.

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- Section 4, ECS System-Wide Requirements – Discusses the requirements allocated to the ECS end-to-end system. The system-wide operational, functional and performance requirements are specified. In addition, overall system-wide Security, Reliability, Maintainability, and Availability (RMA), and ECS external interface requirements are included in this section.
- Section 5, SDPS – Presents a description of the SDPS and defines the requirements necessary to establish the ECS science data archiving and distribution capabilities.
- Section 6, CSMS – Presents the concepts, architecture and requirements necessary to define the system management and network functions.

Appendices – Contains appendices to the ECS Functional and Performance Requirements Specification as follows:

- Appendix A: Glossary – Contains the glossary for this document.
- Appendix B: Acronyms – Contains the list of acronyms for this document.
- Appendix C: Data Volumes and Assumptions – Contains tables of ECS data volumes for the Distributed Active Archive Centers (DAAC)s.

1.3 Traceability

This document contains requirements with unique requirement identifiers to aid in the upward and downward tracing of requirements. An attempt was made to ensure that each unique requirement was written as a "shall" statement and was assigned an identifier.

1.4 Expandability

This specification describes the performance requirements with which the ECS shall comply. This specification also describes certain requirements for expandability or future expansion beyond those performance requirements with which the ECS must comply. These requirements may be added to the ECS. The design, implementation, and maintenance and operations of the ECS must permit such expansion. Unless explicitly limited to expandability or future expansion, the terms "shall," "shall provide the capability," "shall have the capability," and "shall be capable" shall be interpreted identically and mean that the function, service, capacity, etc. described is a mandatory and current requirement for the baseline.

1.5 Design Goals

This specification also describes certain design goals that ensure adequate design margins exist for key performance requirements. Adherence to design goals shall be demonstrated by modeling, simulation, and/or analysis as part of the design review process and the as-built configuration audit process. System acceptance shall be based only on specified requirements and not design goals.

1.6. Related Documentation

1.6.1 Applicable Documents

The following documents are referenced within or are directly applicable, or contain policies or other directive matters, used to define the requirements of this specification, that are binding upon the content of this document. In the event of a conflict, this specification takes precedence. Should a conflict occur, the Contractor shall request resolution from the Contracting Officer.

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NPR 2210.1	Release of NASA Software – Revalidated w/change 1
NPR 2810.1	Security of Information Technology
NPR 7150.2	NASA Software Engineering Requirements
NASA-STD-8719.13	NASA Software Safety Standard
NASA-STD-8739.8	Software Assurance Standard
IEEE Standard 730	(Institute of Electrical and Electronics Engineering) Software Quality Assurance Plans

1.6.2 Reference Documents

The following documents are not binding on the content but referenced herein and, amplify or clarify the information presented in this document; they provide insight into the operation, characteristics, and interfaces of the EOSDIS, as well as relevant background information. The Contractor is bound by these documents to the extent specified in this specification or in its applicable documents.

NPR 4200.1	NASA Equipment Management Procedural Requirements
NPR 7120.5	NASA Space Flight Program and Project Management Requirements

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2. OVERVIEW OF EOS AND EOSDIS

This section presents background information on the EOS mission and EOSDIS. It is intended to provide a synoptic look at EOSDIS in the context of the EOS program and to address the assumptions and constraints affecting the ECS architecture and specifications.

2.1 EOS Mission

EOS is a long-term, interdisciplinary, and multidisciplinary research mission to study global-scale processes that shape and influence the Earth as a system. An objective of the EOS mission is to provide the long-term observations and the supporting information necessary to develop a comprehensive understanding of the way the Earth functions as a natural system. This includes the interactions of the atmosphere, oceans, cryosphere, biosphere, and solid Earth, particularly as they are manifested in the flow of energy through the Earth system, the cycling of water and biogeochemicals, and the recycling of the Earth's crust driven by the energy of the interior of the Earth. The comprehensive global approach to the study of these processes has been termed Earth System Science and has a strong focus on the development of the capability for accurate prediction of the future evolution of the Earth system on time scales of decades to a century.

The EOS mission objectives are accomplished through the provision of:

a. An observing system to provide the full set of essential, global Earth science data available from low Earth orbit on a long-term, sustained basis and in a manner which maximizes the scientific utility of the data and simplifies its analysis;
b. A comprehensive data and information system to provide the Earth science research community with easy, affordable, and reliable access to the EOS and other appropriate Earth science data;
c. An integrated scientific research program to investigate processes in the Earth system and improve predictive models.

The EOS program is international and interagency in scope. The acquisition of new global science data has been accomplished by the integration and launch of instruments on the spacecraft developed by NASA, the ESA, the Russian Space Agency, the Netherlands Agency for Aerospace Programmes (NIVR), the Japanese Aerospace Exploration Agency (JAXA), and Argentina's space agency, Comisión Nacional de Actividades Espaciales (CONAE).

2.2 EOS Instruments

Please see the Earth Science Reference Handbook: A Guide to NASA's Earth Science Program and Earth Observing Satellite Missions:
(http://eospso.gsfc.nasa.gov/sites/default/files/publications/2006ReferenceHandbook.pdf).

2.3 ECS Data

In this specification, "ECS data" is defined as all data, from whatever source, that will be ingested, cataloged, archived, and distributed by the ECS, and therefore for which the ECS shall provide information management and archive and distribution functions as described in Section 5 of this specification.

In this specification, all NASA non-EOS Earth science flight missions, or non-NASA missions on which NASA will fly instruments, are referred to as "Earth Probes."

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2.3.1 EOS Spacecraft and Instrument Data and Products

Data product capacities for the EOS series are described in Appendix C.

2.3.2 Other Earth Science Mission Data

Data products and metadata from then ongoing and subsequent new Earth science missions, including those listed in the preceding section that are still active and new Earth science missions may be selected by NASA to be supported by the ECS. The ECS will receive these data, products, and metadata from the mission unique data systems. Data from other Earth Science Mission spacecraft are described in Appendix C.

2.3.3 Data from Non-NASA Earth Science Flight Missions

The ECS will provide information management, archive, and distribution services for the missions identified in Appendix C.

2.3.4 Correlative Data

The ECS shall ingest and provide information management and archive and distribution functions for selected correlative data required to support NASA's Earth science research program, including non-NASA satellite and in situ data required for EOS product generation or quality assessment and validation.

2.4 Science/User Community

The EOSDIS user community includes three major categories of users, (1) EOS investigators, (2) non-EOS-affiliated science users, and (3) other users. The EOS investigators are funded or approved by EOS for instrument development and scientific investigations. The EOS investigators support staff also fall into this category. Non-affiliated science users include Earth science researchers at U.S. and foreign government agencies and universities. ECS user support staff will use the system to assist users in acquiring data sets of interest.

The NASA Earth Science Statement on Data Management, as stated in the Earth Science Reference Handbook, helps transcend the traditional boundaries of access to mission data for these groups. Investigators using data are expected to contribute products back to EOSDIS, so that the data and information base maintained by EOSDIS will grow in size and science value over time.

2.4.1 EOS Investigators

There are three types of EOS-funded science investigators:

a. Instrument Investigators [a single Principal Investigator (PI) plus Co-Investigators (Co-Is)];
b. Facility Instrument Teams [a single Team Leader (TL) plus Team Members (TMs)]; and
c. Interdisciplinary Investigators [a single PI and Co-Is]

Instrument Investigations are performed by a group of scientists interested in investigations which include the design, development, test, calibration, operation, algorithm development, and data analysis for Earth observing instruments. These scientists, under the leadership of the PI, plan and conduct research, reduce, analyze and interpret data, and publish their results. The PI ensures that the experiment definition, instrument design and development, planning and support of mission

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operations, and data validation, quality control, analysis, and publication are successfully carried out. The Co-Is assist the PI in meeting his responsibilities and participate in the group's operation as defined in a Science Management Plan.

A Facility Instrument Team consists of selected scientists who are interested in investigations which make use of one of the Facility Instruments being developed by the EOS Project, and who can contribute substantially to guiding its design, development, test, calibration, operation, data reduction, or algorithm development. The Facility Instrument TMs function in a manner similar to Co-Is on an instrument investigation. Each team is organized under the direction of a TL. The TL has the primary responsibility for the conduct of the Team's Investigation as well as direction of Team activities.

An Interdisciplinary Investigation is conducted by a group of scientists interested in the analysis and interpretations of data from EOS instruments as well as data from other sources. The purpose of this type of participation is to exploit the synergistic nature of the EOS experiments to assure that the multidisciplinary scientific tasks of EOS are adequately addressed, to help guide the development of EOSDIS and to provide a strong theory and data analysis perspective to mission planning. In addition to analyzing data, these investigations may include the development of theoretical models whose capabilities and results would be made available to the EOS investigator community. The interdisciplinary investigators, under the leadership of the PI, plan and conduct the research, analyze and interpret EOS and non-EOS data, and publish their results.

The range of disciplines contained in this portion of the science/user community covers the atmosphere, biosphere, cryosphere, hydrosphere, and solid Earth. Within the user community there are two major orientations, the instrument-oriented user and the discipline-oriented user. The instrument-oriented user is usually a remote sensing scientist concerned with how best to use the data from a given instrument to learn more about the environment. This user will be particularly interested in how best to calibrate the instrument and validate its data products. The user will also be interested in developing new sensing techniques. The discipline-oriented user will usually be a PI or Co-I associated with an interdisciplinary science team. Their interest is more likely to involve use of data from multiple instruments to tackle a science problem.

Within the discipline-oriented users, there is a further important distinction between investigators interested in global data sets and investigators oriented towards regional data. The two geographic interests are important for such data operations as subsetting and data examination. A global investigator is likely to want overviews and latitudinal averages as part of his searches for meaningful data. A regional investigator is likely to want to look at small portions of the Earth with many different kinds of data. The investigator may need subsets of many of the standard data products. Design of the EOSDIS takes into consideration that several of the discipline-oriented investigations involve global modeling. This activity requires a large number of diverse inputs and large volumes of data are generated by running the model.

EOS investigators and their staff have different levels of familiarity with computer investigations of data and data retrieval technology. They also have different preferences for their method of interacting with the EOSDIS in searching for and ordering data. Although a continuum of experience and knowledge is likely to be present, instrument-oriented investigators are likely to be focused on their instrument data and similar kinds of data in EOSDIS, whereas discipline-oriented investigators are likely to be less familiar with the full range of data that might apply to their work. Furthermore, instrument-oriented investigators are likely to be data producers;

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discipline-oriented investigators are likely to be data users. These distinctions have important ramifications for the organization of the data and metadata, and for the work done by the EOSDIS Information Management System (IMS).

2.4.2 Non-EOS Affiliated Science Users

The user community of the EOSDIS extends past the boundary of mission-selected research scientists (the TLs, TMs, PIs, and Co-Is) associated with a particular instrument or research investigation. EOS data and information are used by the broader operational and research communities, including such groups as U.S. and international operational agencies and the international Earth science research community at academic and government institutions. Fittingly for a science program studying global processes, the EOSDIS user base is global in nature, spanning not only U.S. and International Partner (IP) investigator teams, but the general international science community as well.

Researchers at academic and governmental institutions who are not affiliated with the EOS Program need to be able to access the EOSDIS catalogs and order EOS and related data products. In particular, the EOS data system needs to provide access to data for research programs of other U.S. Government agencies (e.g., U.S. Geological Survey, NOAA, and the National Forest Service).

Non-EOS affiliated science users will include on their application for resources an abstract of the work to be done, their university or corporate affiliations, funding agencies, and fields of scientific research. These users will also indicate whether the EOS data and EOSDIS services will support such activities as non-profit scientific research, industrial research, operational forecasting, regulatory or law enforcement, or producing engineering requirements for future observation systems.

During the early years of this effort, these users were likely to be drawn from the pool of existing customers of Earth science data, including the Climate, Land, and Ocean Data Centers, as well as users of the Landsat and SAR databases. As EOSDIS developed, this portion of the user community has expanded.

In contrast with the EOS investigators, many of the non-EOS affiliated science users will have a much greater need for a user-friendly data search capability and extensive help features. These users are expected to become the dominant community when EOS data are being produced on an operational basis, after validation.

2.4.3 Other Users

Other users constitute a population with more diverse characteristics than the two categories listed previously. These users can be further subdivided into the following groups:

a. Policy makers and implementers
b. EOSDIS and EOS managers
c. EOSDIS development and operations personnel
d. External system developers and tool developers
e. Small data set users
f. Commercial/applications users
g. Educational users

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Policy makers and implementers include such groups as Congressional staff, and employees or consultants for state and local planning organizations. These users are expected to want to use EOS data for examining the current situations under their jurisdictions.

EOSDIS and EOS managers interact with EOSDIS for such purposes as obtaining accounting information, analyzing system use and user profiles, and measuring other statistical information that will aid in managing and planning EOS and EOSDIS. These users are often required to generate system wide reports related to system usage and data holding for NASA management and budget authorities.

The EOSDIS development and operations personnel access EOSDIS to test and tune the components of the system and to carry out daily operations and maintenance. In addition, the user support staff access tools that allow them to assist science users in searching metadata and ordering data.

External system developers include consultants and other individuals developing systems outside the EOS data use activity who wish to gain insights from the EOSDIS design. Such users are likely to want to try all elements of the system, but may not have a serious long-term use for the data, since their interests lie in the development of systems involving other kinds of data.

Tool developers and users are individuals who wish to explore ideas for data manipulation and visualization. These individuals are not likely to use large amounts of data. Rather, they work with a small amount of data repeatedly. These individuals are usually quite competent at computer programming.

Small data users are individuals who want only a small amount of data for illustrative purposes in a scientific research paper. Some of them might prefer to have the data in ASCII format.

2.5 Science Computing Facilities

Science Computing Facilities (SCFs), located at science investigator facilities, will be used to develop and maintain algorithms, produce data sets, validate data, and analyze and synthesize EOS and other data to expand knowledge about the Earth System and its components. The ECS provides toolkits for use by scientists at the SCFs. SCFs are outside the scope of the ECS.

2.6 International Partners

EOSDIS also supports interfaces to the IPs who, as major participants in the EOS program, provide spacecraft, instrument payloads, satellite communications relay, and data acquisition, processing, archiving, and distribution capabilities. Considerable coordination is required to make EOSDIS work on an international scale. Memoranda of Understanding have been signed between NASA Headquarters and the ESA, a representative agency in Japan, the NIVR, and the Canadian Space Agency (CSA) which contain details of each agency's participation.

All agencies exchange data and support planning and scheduling, commanding, and operations of instruments on their respective spacecraft. Instruments from several countries are carried by U.S. spacecraft, requiring commanding support as well as data processing and exchange services. U.S. participants require data from international payloads on any of the spacecraft and the international participants require access to U.S. payload data for their processing and/or investigations. EOSDIS also provides for the exchange of data between the U.S. and the many international databases.

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2.7 Operations Concept

The operational EOSDIS can be divided into two major areas of functional responsibility – Mission Operations and Science Operations. Mission Operations is outside the scope of the ECS Science System.

Science Operations include the receipt of instrument science data; the routine processing and reprocessing of the instrument data to standard data products; quality assuring, accounting, cataloging, and archiving of these data products; the management of data, metadata, and information; and the distribution of these data products to the user community. Also included in data operations are access to instrument and spacecraft engineering data, and access to non-EOS data archives. Additionally, the receipt, archiving, and distribution of non-standard EOS data products from the EOS investigators, and of data from Earth Probes and other data sources, is part of data operations.

2.8 EOSDIS Role

A major key to the success of the EOS mission lies in the successful implementation of the EOSDIS. This distributed information system provides access to data from the EOS instruments, Earth Probe instruments, related data, and to the scientific results of the research using these data. The EOSDIS provides the data management infrastructure for space-based Earth science research in this decade and beyond. The EOSDIS role includes:

a. Receive, process, store, and manage all data from the EOS mission and research results
b. Receive, store, and manage data and products from NASA Earth Probe missions as they are identified
c. Provide for the distribution of data to investigators, the exchange among the investigators of research results, and the information system capabilities, including software, required to carry out the research
d. Provide access for the Earth science community to all Earth Probe data and the data products resulting from research using these data
e. Provide the planning and scheduling for, and the command and control of, space elements of the mission

EOSDIS provides the capabilities for spacecraft command and control of the NASA spacecraft with EOS payloads; for instrument command and control for all NASA instruments on any spacecraft; for having the data processed and active, permanent archiving of data from EOS instruments, Earth Probe instruments, and selected other data; and for exchanging commands, data, and algorithms with non-NASA entities involved in the overall EOS mission.

EOSDIS also provides information on the location and content of Earth science data sets, provisions for ordering and acquiring new data sets from the spacecraft, acquisition and processing of standard data sets for use by the user community, obtaining, retaining, and distributing detailed research results (special data sets) which have made use of EOS data, and for supporting selected EOS investigations. The EOSDIS is designed to provide easy access to EOS, Earth Probe, and other archived data from the beginning to at least four years beyond the end of the last EOS observing mission.

EOSDIS is conceived as a complete research information system that incorporates traditional mission data system facilities, but includes additional capabilities such as well-calibrated,

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well-documented long-term data products and direct, on-line electronic data access for EOS researchers.

Key functional objectives for the overall EOSDIS system include:

a. Unified and simplified means for accessing and obtaining Earth science data
b. Prompt access to all levels of data and documentation concerning the processing algorithms and validation of the data, and to data sets and documentation that result from research and analyses conducted using the data provided by EOS and Earth Probes
c. Enabling a distributed community of Earth scientists to interact with data sources and mission operations from their home facilities
d. Responsiveness to user needs
e. Capability for evolution, growth, and adaptation to new sources of data and new data system technologies

ECS provides much of the basic functionality of EOSDIS as described in Section 3.

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3. EOSDIS CORE SYSTEM DESCRIPTION

This section describes the EOSDIS Core System (ECS) in terms of the system architecture, external interfaces, ECS functionality, and a high-level view of operations.

3.1 ECS Architecture

Because of its size and complexity, the ECS is conceived as a hierarchy of segments, elements, subsystems, and components. The ECS segments are defined to support the two major operational areas: science data processing and communications/system management. The segments are divided into ECS functional subsystems to provide the support required by the operational segments.

The ECS segments and their supporting elements are as follows:

a. The SDPS provides a set of archive and distribution elements for science data and a data information system for the EOSDIS. The SDPS components primarily reside at three DAACs. The DAACs provide the facilities along with the management and operations support for the SDPS provided functions. The SDPS consists of:

   1. Data archive and distribution function - provides short and long-term storage for EOS Missions and other related data, software, and results, and distributes the data to EOSDIS users
   2. Information management function – a data and information management function provides user web access and applications programming interfaces for user-service clients.

b. The CSMS provides overall ECS management and operations of the ground system resources, facilities and communications/networking services at each ECS Site facility, and interfaces to other communications networks. The CSMS does not include the inter-DAAC wide area network. The CSMS elements include:

   1. ECS Site-specific networks – an internal ECS site-specific communications network and services providing for the interconnection of ECS subsystems at each ECS site facility to support ECS operations; an interface to the wide area network for transfer of data between ECS DAACs, and between EDOS (EOS Data and Operations System) facilities and ECS elements at each ECS site facility.

3.2 Major Functions

The major ECS system-level functions relate directly to the responsibilities assigned to each of the ECS segments:

a. Science Data Processing Segment
   - Data archive
   - Data distribution
   - Data information management
   - User support for data information
   - User support for data requests
   - Data and results ingest
   - Support of DAAC operation and management

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b. Communications and System Management Segment
   1. Interface with external networks
   2. Site-specific Network/communications management and services
      - System configuration management
      - System performance, fault, and security management
      - Communication of data sets, models, and software
   3. System monitoring services

The functions pertaining to the ECS Science System segments (SDPS and CSMS) and elements are described in detail in Sections 5.0 and 6.0, respectively.

3.3 ECS External Interfaces

ECS utilizes the functionality and facilities of institutions and organizations external to ECS to obtain data products, provide user information search and ordering interfaces and report metrics. Most of these are actually elements within the EOS project. The ECS uses the NASA networks for these external interfaces. Figure 3-1 summarizes the ECS DAAC external interfaces with their data flows.

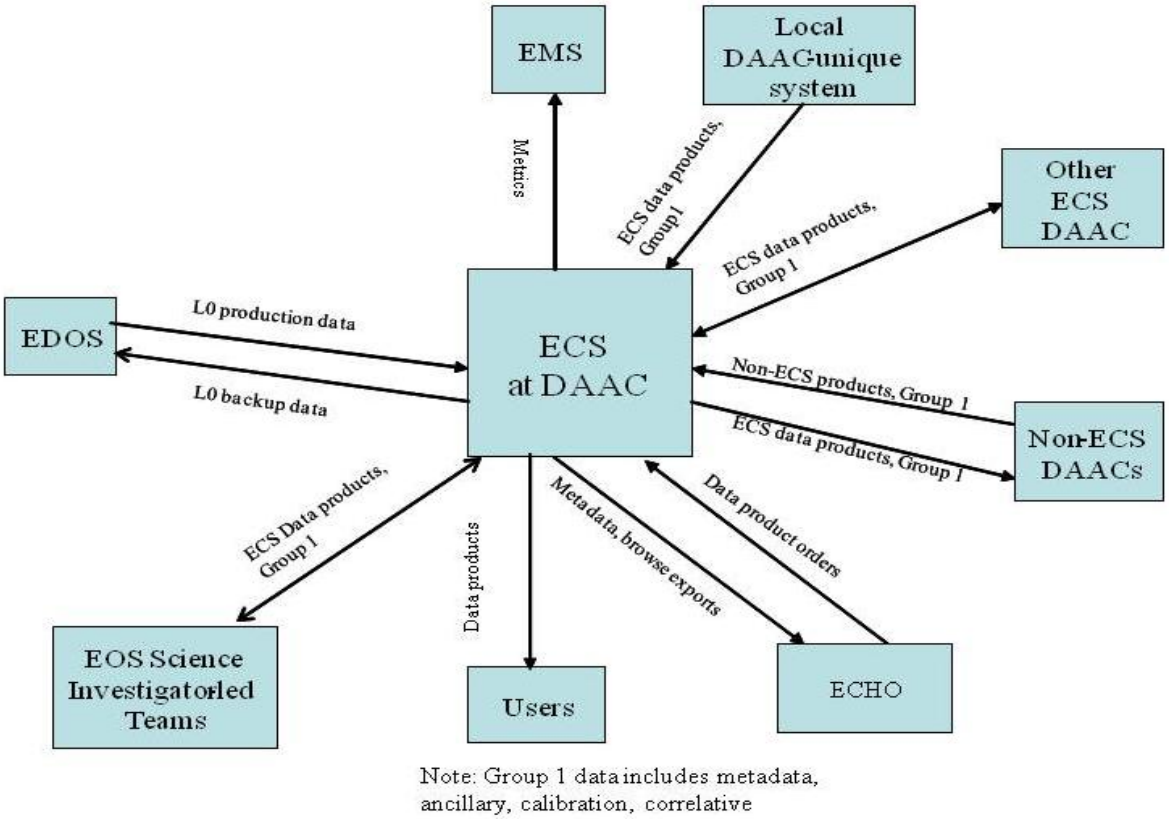

Figure 3-1. Conceptual ECS System Context (ECHO has been replaced by CMR)

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3.3.1 EOS Project

EDOS, a data handling and data distribution capability developed by NASA, provides Level 0 instrument data to ECS. EDOS also maintains a permanent back-up archive of Level 0 data, and provides copies of Level 0 data from the back-up archive to the ECS upon request.

The ECS receives EOS data from Science Investigator-led Processing Systems (SIPS) via a standard interface as documented in the SIPS ICDs (Interface Control Documents)

Some EOS data products are supplied to the DAACs by the data producers and the DAAC then transfers them from co-located DAAC-Unique systems to the ECS. Examples are ASTER Level 1A, AMSR-E Level 1 and AMSR Level 1 data products.

The ECS DAACs may exchange data products with each other and obtain some required ancillary data from a non-ECS DAAC.

The EOSDIS Metrics System (EMS) reports ingest, archival, and distribution metrics supplied from the ECS at the DAACs.

ECHO (Earth Observing System ClearingHouse) brokers orders for ECS data and metadata. ECS exports metadata and browse images to ECHO to populate the ECHO metadata inventory for search by ECHO clients. ECHO has been replaced by the Common Metadata Repository (CMR).

3.3.2 Networks

Networking and communications support for the ECS are provided by NASA networks. Other institutional and commercial networks may be used also as links to the NASA networks for general science community users.

3.3.3 Data Centers

DAACs provide the facilities and the management and operations support for the production, archive and distribution of EOS standard data products. The ECS is installed at three DAACs, where it provides the operational interfaces required for management and control of data archive/distribution and user support services. The SIPS produce science data which is archived at the ECS and other DAACs.

The ECS is installed at the following three DAACs:

a. The Atmospheric Sciences Data Center (ASDC) DAAC at the Langley Research Center, Hampton, Virginia. The ASDC LANCE functionality (Land, Atmosphere Near real-time Capability for EOS) and redundancy is met by the ECS at ASDC, and a smaller, redundant instance, referred to as “little LANCE”.
b. The Land Processes (LP) DAAC at the Earth Resources Observation System (EROS) Data Center (EDC), Sioux Falls, South Dakota
c. The NSIDC (National Snow and Ice Data Center) DAAC at the University of Colorado, Boulder, Colorado

Note that the ECS was formerly installed at another DAAC, namely Goddard Space Flight Center (GSFC) Earth Sciences (GES), Greenbelt, Maryland, which continues to support the same missions that were supported by the ECS.

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3.4 System Data Flow

This section provides an overview of the flow of data in the ECS necessary to satisfy the EOS mission objectives.

Raw science data is provided to the SDPS for archive from EDOS, which processes the telemetry data to Level 0 and delivers the data to the DAACs via NASA networks. Data products are produced at participating science investigator facilities and by non-ECS systems co-located at the DAACs and provided to the SDPS through automated interfaces. The ECS distributes data products to the investigator facilities, the science user community, other ECS data centers, and requesting non-EOS data centers.

Algorithms and processing and calibration software are provided to the SDPS from the investigator facilities. Users provide research results, such as new derived data sets, back to the SDPS.

The CSMS interfaces with the SDPS segment to perform global system management, local system management, ECS site-specific communications/network management, monitoring, and control functions.

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4. ECS SCIENCE SYSTEM WIDE REQUIREMENTS

This section specifies the requirements, which are allocated to the ECS as an end-to-end system. The system-wide operational, functional, and performance requirements are specified. The requirements specifications for overall system-wide security, for RMA, and for SDPS external interface elements are also included in this section.

4.1 Operational Requirements

This section specifies the ECS science system level operational requirements, which describe how the system is to work when built.

EOSD0020 The ECS shall use and support the EDOS/NASA network interface to obtain the data capture, data archival, and data distribution services needed to achieve full end-to-end ECS functionality.

EOSD0030 The ECS shall, during its lifetime, ingest, archive, distribute and provide search and access for EOS and related non-EOS data and products.

4.2 Functional Requirements

ECS science system level functional requirements are provided in this section. These requirements describe functions to be provided by all ECS elements.

EOSD0630 The ECS shall be capable of simultaneously supporting the Independent Verification and Validation (IV&V) activities and ECS development activities, both before and after flight operations begin.

EOSD0740 The ECS shall provide a set of real or simulated functional capabilities for use in the following types of test:

a. Subsystem
b. ECS System (Integration of ECS subsystems)

EOSD0750 The ECS shall provide a set of real or simulated functions which interfaces with both its ECS internal and external entities for use in the following types of test:

a. Subsystem
b. EOSDIS System (Integration of EOSDIS subsystems)

EOSD0760 The ECS shall support end-to-end EOS system testing and fault isolation.

EOSD0780 The ECS shall be capable of being monitored during testing.

4.3 Performance Requirements

Performance requirements are specified in this section. These requirements describe system capacities, capabilities, and throughput.

EOSD1015 Each ECS DAAC that receives instrument Level 0 data from EDOS shall provide the capability to ingest and archive the data at a rate that is equivalent to 1.2 times the DAAC's average Level 0 input rate.

EOSD1019 Each ECS DAAC that receives reprocessed MODIS (Moderate-Resolution Imaging Spectrometer) Level 2 and Level 3 Land and Atmosphere products from the MODIS SIPS shall provide the capability to ingest and archive the data at a

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peak rate that supports the DAAC specified reprocessing plan. (The 2017 ingest rates observed for Release 9.0 are shown in Appendix C Table 1.)

EOSD1030 The ECS shall have the capacity to accept a daily average of two (2) percent of the daily data throughput as expedited data for use in mission functions of calibration and anomalies.

EOSD1082 The ECS shall make available to the users externally generated products immediately (but no longer than 24 hours) after ingest of those products from the external data providers.

EOSD1140 [DELETED]

4.4 External Interfaces

ECS external interfaces refer to the interfaces between the ECS elements and the elements external to ECS including the supporting elements provided by the EOS project, NASA institutional facilities, cooperating institutions, the user community, and the International Partners.

This section specifies the major system-level external interface requirements. ECS external interfaces are discussed in the following subsections:

a. NASA Network and External elements – The external elements included in this category consist of the NASA networks, NASA data systems and the EDOS.

b. Data Centers - The DAACs provide the facilities, management and operations for the SDPS.

c. The ECS user community – Users are the ECS participants, other Government agencies, universities and other institutions, and commercial enterprises. This interface also includes the community which produces science products external to ECS (i.e. SIPS) and provides these science products to ECS for archive and distribution.

4.4.1 Networks and NASA Elements

EOSD1502 The ECS shall use NASA networks for data communications for the following types of data:

a. Production data sets (Level 0 data)
b. Expedited data sets
c. EMOS Activity Schedules
d. Production Data Transfers between DAACs

EOSD1620 The ECS shall provide data to the EMS.

4.4.2 Data Centers

EOSD1703 The ECS shall provide maintenance and operations interfaces to the DAACs to support the functions of:

a. System Management
b. Data Ingest/Archive/Distribution
c. User Support Services
d. System Maintenance

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4.4.3 The ECS User Community

EOSD1750 The ECS shall receive data including the following types of supporting information from the ECS science community (TLs, TMs, PIs, and Co-Is):

a. Science Software
b. Instrument calibration data
c. Data transfer requests (science products, metadata and browse) and associated data transfer requests and confirmations
d. Data Quality/Instrument assessment
e. Instrument operations information
f. Ancillary data

EOSD1760 The ECS shall send the following types of data to the ECS science community (TLs, TMs, PIs, and Co-Is):

a. Metadata
b. Browse data
c. Archived data

4.5 Security

This section contains ECS system-level security requirements applicable to all components of ECS. Additional element-level security requirements may be found in the CSMS section of this specification, Section 6.

EOSD1990 The ECS system shall employ security measures and techniques for all applicable security disciplines which are identified in the following documents:

a. Federal Information Security Act of 2002
b. NPD 1600.2A
c. NPR 2810.1A
d. CD-004-M-GSF-4238, EOS Moderate System

4.5.1 Technical Security

Technical security embodies requirements for security management, administrative controls, and access control to computer systems hardware, software, and data.

EOSD2100 The ECS technical security policy planning shall be comprehensive and in accordance with CD-004-M-GSF-4238, EOS Moderate System.

4.5.2 Security Requirements

This section specifies the overall ECS security requirements applicable to all ECS elements. Each DAAC and the ECS Development Facility (EDF) Performance Verification Center (PVC) will be responsible for its respective security postures. In the following requirements, security-controlled data are those that have limited access and security protection constraints based on the user authorization level.

EOSD2400 The ECS shall provide data protection suitable for moderate data integrity as defined in National Institute of Standards and Technology (NIST) (SP 800-100.

EOSD2430 ECS data base access and manipulation shall accommodate control of user access and update of security-controlled data.

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EOSD2440 ECS data base integrity including prevention of data loss and corruption shall be maintained.

EOSD2510 ECS shall maintain an audit trail of:

a. All accesses to security-controlled data
b. Users/processes requesting access to security-controlled data
c. Data access/manipulation operations performed on security-controlled data
d. Date and time of access to security-controlled data
e. Unsuccessful access attempt to security-controlled data by unauthorized users/processes

EOSD2550 The ECS shall limit use of master passwords or use of a single password for large organizations (i.e., group passwords) requiring access to a mix of security controlled and non-sensitive data.

EOSD2555 The ECS shall maintain confidentiality of user product requests

EOSD2620 ECS shall disconnect an operator after a predetermined number of unsuccessful attempts to access data.

EOSD2650 The ECS shall report detected security violations to the ESDIS Information System Security Officer (ISSO) or designee.

EOSD2660 The ECS shall at all times maintain and comply with the security directives issued by the cognizant ISSO.

EOSD2710 ECS shall report all detected computer viruses and actions taken to the cognizant ISSO.

4.5.3 Contingency Requirements

EOSD2990 The ECS shall support the recovery from a system failure due to a loss in the integrity of the ECS data or a catastrophic violation of the security system.

EOSD3000 The ECS shall provide for security safeguards to cover unscheduled system shutdown (aborts) and subsequent restarts, as well as for scheduled system shutdown and operational startup.

EOSD3200 A minimum of one backup which is maintained in a separate physical location (i.e., different building) shall be maintained for ECS software and key data items (including security audit trails and logs).

EOSD3220 All media shall be handled and stored in protected areas with environmental and accounting procedures applied. (At the time of Release 9.0, this is a DAAC responsibility.)

4.6 Reliability, Maintainability, Availability

4.6.1 Science Data Processing Segment RMA

The ECS requirements for system-level reliability, maintainability, and availability (RMA) are a DAAC operational responsibility, and therefore are beyond the scope of the SDPS.

The RMA requirements in the remainder of this section pertain to equipment required to support the functional capabilities stated in the requirements.

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4.6.2 Communications and System Management Segment RMA

The CSMS RMA requirements have been divided into two categories, critical and non-critical. Critical services are those necessary to ensure the DAAC can operate on a 24-hour per day basis and those necessary for interactions with the ECS elements to maintain the ECS mission. These critical services include the resource management of the configuration management service, the performance management service, the fault management service, the security management service, and directory services. Non-critical services include the scheduling service and all functions of configuration management except the resource management service, accounting/accountability service, and report generation service.

EOSD4035 The ECS network shall have no single point of failure for functions associated with site-specific network databases and configuration data.

EOSD4036 The ECS operational availability of individual network segments shall be consistent with the specified operational availability of the supported ECS functions.

4.6.3 Fault Detection and Isolation Requirements

EOSD4100 The ECS network segments and components shall include the on-line (operational mode) and off-line (test mode) fault detection and isolation capabilities required to achieve the specified operational availability requirements.

4.7 Evolvability Requirements

The requirements of this section are termed “Evolvability Requirements”. Typically, these requirements are changes which ECS “shall enable.” “Shall enable a change," means ECS shall be packaged and documented to allow the change by others, perhaps at a later time, without redesign of the ECS. These requirements will be validated by analysis presented at reviews.

4.7.1 Interoperability Infrastructure

EOSD5030 The ECS shall enable the addition of information search and retrieval services.

4.7.2 Evolution of DAACs

EOSD5200 The ECS shall enable the addition of the following as required for discipline specific user support: unique fields to metadata and products for browse. These activities shall require minimal software change to ECS.

EOSD5230 The ECS shall enable the addition of new data types similar to previous types with minimal changes to the software of the core system.

EOSD5240 The ECS shall enable addition of new data types significantly different from previous types with minimal changes to the core architecture.

EOSD5250 The ECS shall enable access to configuration-controlled interfaces that permit development of DAAC-unique value-added services and products.

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5 SCIENCE DATA PROCESSING SEGMENT

5.1 Overview

The SDPS has the responsibility to meet the objectives of the EOS mission for data product archiving and distribution and order fulfillment. The SDPS archives Standard Products, including browse products such as subsetted, subsampled, and summarized data sets, as well as the associated metadata. The SDPS stores all data sets and supports user access to data and related information. The SDPS also includes software toolkits for the EOSDIS users. A toolkit is an integrated package of routines that provide a wide range of common user services including data visualization tools, data transformation tools, data access services, and algorithm development resources. The toolkit also allows ECS data providers to create science data and metadata in the ECS standard formats.

5.2 SDPS Architecture

The SDPS receives Level 0 data transmitted from the EDOS. It receives and archives EOS data products from external science processing systems, including the S4P (Simple Scalable Script-Based Science Processor) systems at the DAACs. For all products, it either receives or creates metadata files to be stored for the received data. It distributes the EOS data products and associated metadata to the PIs and other science users for reprocessing, quality check, and scientific analysis and applications. It exports metadata and browse metadata to CMR in accordance with DAAC configured settings. It allows users to locate and retrieve desired products, and receives and fills orders.

The SDPS interfaces with the SIPS and with other ECS or non-ECS DAACs for exchanging data products, metadata, correlative data, ancillary data, and algorithm information.

The ECS is located at three data centers: the ASDC DAAC at Langley Research Center (LaRC) in Hampton, Virginia, LP DAAC at the EDC in Sioux Falls, South Dakota, and the NSIDC DAAC at the National Snow and Ice Data Center in Boulder, Colorado.

5.3 General SDPS Requirements

This section contains overall SDPS functional and interface requirements. Succeeding sections provide functional, performance and interface requirements for SDPS elements.

SDPS0091 The ECS shall receive a quality report that is generated and transmitted by the PIs or the other science users, and associated with the data products being archived by the ECS.

SDPS0092 The ECS shall provide an interface as defined in the SIPS ICD for supporting external production and reprocessing of standard ECS products.

SDPS0093 The ECS shall use priorities in support of external production and reprocessing of standard ECS products.

SDPS0130 The ECS shall provide the capability for DAACs to exchange data products, metadata, and data quality information.

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5.4 SDPS Elements

5.4.1 Product Generation System (PGS) Functionality

5.4.1.1 Overview

The ECS does not itself produce data products at the DAACs. However, it does include toolkits to support production by external systems.

5.4.1.2 Algorithm Integration and Test Service

The following requirements apply to the toolkit provided to instrument teams by the ECS for development of algorithms for external processing.

PGS-0970 The ECS shall provide file access subroutines that enforce compliance with the adopted standard ECS formats.

PGS-0975 The ECS shall provide file access subroutines that will, upon execution, allow science processing programs to read files that were written with HDF-EOS libraries based on either or both of HDF Version 4 and HDF Version 5.

PGS-0976 The ECS shall provide file access subroutines that will, upon execution, allow science processing programs to write files with HDF-EOS libraries based on either or both of HDF Version 4 and HDF Version 5.

PGS-0977 The ECS file access subroutines shall support the following features from HDF Version 5:

a. thread-safety
b. compression (including unlimited dimensions)
c. array data types with all dimensions unlimited
d. compound data types for HDF-EOS point structures
e. external files
f. Local data attributes (for both data and geolocation fields)
g. Links (aliases) for data field names

PGS-0980 The ECS shall provide job control routines that provide all required task parameters to the Standard Product software.

PGS-0990 The ECS shall provide error logging subroutines for use by Standard Product software in notifying the system operators of conditions requiring their attention.

PGS-1000 The ECS shall provide error logging subroutines for use by Standard Product software in notifying users of conditions requiring their attention.

PGS-1010 The ECS shall provide mass storage allocation subroutines that provide Science Software with a means for dynamic allocation of storage for temporary files.

PGS-1015 The ECS shall provide ancillary data access subroutines that provide Standard Product software access to ephemeris data (e.g., solar, lunar, and satellite ephemeris), Earth rotation data, and time and position measurement data. These subroutines shall perform operations such as:

a. Interpolation
b. Extrapolation

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c. Coordinate system conversion

PGS-1025 [DELETED]

PGS-1030 The ECS shall provide a toolkit for external data processing containing versions of the routines specified in requirements PGS-0970 to PGS-1015.

5.4.2 Application Programming Interfaces (APIs)

PGS-1410 The ECS shall provide the capability for each DAAC to add to the SDP Toolkit DAAC-developed software required to support discipline specific needs.

5.4.3 Data Archive and Distribution System (DADS) Function

5.4.3.1 Overview

The ECS archives EOS and some non-EOS data and distributes it on request over networks. Science products are provided by ECS through the interfaces shown in Figure 3-1.

The ECS DAACs may receive and store production data from EDOS, data products, special data products and other information produced by designated EOS science processing facilities, and ancillary and other data originating from other systems. ECS checks the data for consistency, updates their metadata with inventory control and consistency check information, and stages them for distribution or archiving as necessary. The storage at each ECS may be composed of devices and technologies of varying capabilities in terms of speed of access, capacity, and footprint.

ECS distributes data electronically over networks in response to user requests received.

5.4.3.2 Ingest

5.4.3.2.1 Receive Metadata Updates

DADS0010 The ECS shall receive updated metadata for products that have been QA'd.

DADS0020 The ECS shall, upon receipt of updated metadata for products which have been QA'd, store the metadata in its inventory.

5.4.3.2.2 Receive Data

DADS0130 The ECS shall receive from the EDOS the following:

a. Production data (L0)
b. Expedited data

DADS0131 The ECS at the ASDC DAAC shall receive SAGE III (Stratospheric Aerosol and Gas Experiment III) L0 data from the SAGE III SCF via the SIPS interface.

DADS0140 The ECS DAACs shall receive from other ECS DAACs the following:

a. L0-L4 data
b. Metadata
c. Ancillary data
d. Calibration data
e. Correlative data

DADS0142 The ECS DAACs shall receive from non-ECS DAACs the following:

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a. L0-L4 data
b. Metadata
c. Ancillary data
d. Calibration data
e. Correlative data

DADS0160 The ECS shall receive from the EOS Operations Center (EOC) the following with associated metadata:

a. Spacecraft history log (or subset of history log)
b. Activity schedules
c. Carry-out files to support attitude generation
d. Carry-out files to support instrument science processing softwares

DADS0190 The ECS shall receive from the external processing systems the following:

a. Special products (L1-L4)
b. Metadata
c. Ancillary data
d. Calibration data
e. Correlative data
f. Science Software
g. Standard Products (L1-L4)

DADS0200 The ECS shall receive from the LP DAAC the following ASTER GDS data:

a. L1A and L1B data products (and L1T in Release 9.0)
b. Metadata associated with data sets

DADS0202 The ECS shall associate ASTER L1B and L1T data products to the browse data that is delivered for ASTER L1A data products.

DADS0205 The ECS shall be capable of receiving data in any and all formats produced by the distribution service specified in section 6.4.3.2.8.1 of this specification.

DADS0208 The ECS shall receive inventory metadata in the Extensible Markup Language (XML).

DADS0250 The ECS shall receive data in the following forms:

a. Electronic network communications

DADS0260 The ECS shall receive non-EOS correlative and ancillary digital data.

5.4.3.2.3 Automated Data Checking

DADS0290 The ECS shall check all metadata it receives against validation rules (e.g., required fields and groups, valid values) and correctness of the data set granule size (if specified in the metadata).

DADS0300 The ECS shall generate status information indicating the success or failure of metadata consistency checks.

DADS0310 The ECS shall verify that data received came from an approved/authorized source.

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DADS0320 The ECS shall verify compliance of scientist provided data with EOSDIS defined standards for metadata.

5.4.3.2.4 Generate Metadata

DADS0350 The ECS shall generate the following metadata items for each data granule:

a. Unique Granule ID
b. Date and time of storage
c. Physical location
d. Data check status

5.4.3.2.5 Archive

DADS0405 The ECS shall provide the capability to archive multiple versions of selected archive data.

DADS0425 Archive and backup media at each ECS DAAC shall have a rated shelf life of at least 10 years as determined by the National Archives and Records Administration (NARA), National Institute for Standards and Technology (NIST), NASA, or a professional or industry organization such as ANSI, the Society of Motion Picture and Television Engineers (SMPTE) or the National Association of Broadcasters (NAB).

DADS0430 The ECS shall provide its operations personnel the capability to manually alter the routing of data sets to physical storage locations.

DADS0435 The ECS shall provide its operations personnel the capability to add new physical volumes and eject physical volumes from the archive for off-line or off-site permanent storage.

DADS0440 The ECS shall provide storage for the following EOS data:

a. Standard Products
b. Associated correlative data sets
c. Associated ancillary data sets
d. Associated calibration data sets
e. Associated metadata
f. Science Software

DADS0460 The ECS shall provide storage for non-EOS data required for Standard Product production.

DADS0472 The ECS shall provide the capability to store and provide access to an average of 4 scenes per day up to a maximum of 10 scenes per day of ASTER Level 1A and 1B expedited data.

DADS0488 The ECS shall archive the EDOS production data sets (Level 0) received from EDOS.

DADS0490 The ECS shall archive Level 1B - Level 4 data products.

DADS0491 The ECS shall provide the capability for an authorized operator to delete data products.

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5.4.3.2.6 Process Orders/Requests

5.4.3.2.6.1 Receive Orders/Requests

DADS0525 The ECS shall accept from operators updates/cancellations of data order requests.

DADS0660 The ECS shall maintain the following information for each order, including standing orders:

a. Priorities
b. Distribution directions
c. State (i.e., active, canceled, suspended)

DADS0690 The ECS shall support the prioritized retrieval and delivery of data based on the priority information specified in the data retrieval request.

5.4.3.2.6.2 Subset

DADS0745 The ECS shall support the integration of external data subsetting and on-demand processing services that can be invoked as part of the end-user data order process.

5.4.3.2.6.3 Reformat

DADS0760 The ECS shall distribute data in native archive format.

DADS0810 The ECS shall provide tools for subsetting, re-projecting and re-formatting HDF data products.

5.4.3.2.6.4 Generate Statistics

DADS0890 The ECS shall generate distribution resource statistics consisting of:

a. Request number and user identification
b. Media type and quantity

5.4.3.2.6.5 Send/Receive Status

DADS1020 The ECS shall generate data retrieval status to acknowledge the acceptance or rejection, including the reason for rejection (e.g., distribution parameters missing, data not present or unreadable), of a product order.

DADS1030 The ECS shall generate data distribution status to monitor the progress of the distribution process.

DADS1070 The ECS shall send data check and storage status to the provider of ingest data.

5.4.3.2.6.6 Data Logs

DADS1080 The ECS shall maintain an external data receipt log.

DADS1085 The ECS shall maintain a data access log.

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DADS1100 The ECS shall maintain a log of all updates to the local inventory. The log shall be used to generate status reports and, in conjunction with the inventory backup, recreate the local inventory in the event of catastrophic failure.

DADS1110 The ECS shall maintain a data distribution log.

DADS1114 The ECS shall maintain a log of staging activity.

5.4.3.2.7 Manage System

5.4.3.2.7.1 System Faults

DADS1300 The ECS shall display all faults to the system operators.

DADS1310 The ECS shall track problems such as missing or corrupted files requiring restoration or regeneration of data.

DADS1320 The ECS shall provide fault isolation information at the system and subsystem levels.

DADS1330 The ECS shall provide information to support fault isolation between ECS-unique components and external interfaces.

5.4.3.2.7.2 Media

DADS1360 The ECS shall monitor the status and performance of all storage systems used.

DADS1370 The ECS shall provide a mechanism for statistically monitoring both the raw and corrected bit error rate (BER) of storage media in the archive.

DADS1375 The ECS shall support management and copying/refresh of archive media.

5.4.3.2.7.3 Data Transfer

DADS1380 The ECS shall monitor data transfer between external (non-ECS) elements and the ECS.

DADS1390 The ECS shall monitor data transfer between components of the ECS.

5.4.3.2.7.4 General

DADS1450 The ECS shall, upon detection that L0 data has been lost, generate a request for a replacement product from EDOS, dispatch the request, and ingest the replacement product.

DADS1470 The ECS shall manage SDPS element resource utilization.

DADS1472 The ECS shall contain the capacity to respond to contingencies and peak loads.

DADS1475 The ECS shall provide tools to the users to perform:

a. Format conversion of HDF-EOS tabular data to ASCII or binary format
b. Subsetting of HDF-EOS grid, swath, and profile data

DADS1510 The ECS shall ensure that metadata is maintained on all products that are stored in the ECS.

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5.4.3.2.7.5 File and Storage Management System (FSMS)

DADS1520 The ECS shall provide a file storage management capability that supports a hierarchy of devices and media, with location-transparent access to the files.

DADS1530 The ECS shall maintain a file directory of all files archived under its control.

DADS1540 The ECS shall provide, in case of corruption or catastrophic failure, capabilities for recovering the archive file directory.

DADS1550 The ECS operations/systems personnel shall be able to access, list, or modify the contents of the archive file directory in a special privileged mode.

DADS1610 The ECS file storage management capability shall provide for continued performance, albeit in a degraded mode, when a device (e.g., disk or cartridge drive, operator's console) fails.

DADS1620 The ECS at each DAAC shall provide tools for operations/systems/maintenance personnel to monitor performance, carry out maintenance, and alter operating parameters.

DADS1630 The ECS at each DAAC shall provide tools for recovery of data from failed media and devices.

DADS1640 The ECS shall support the number of files derivable from Appendix C, with the ability to expand to match growth.

DADS1780 The ECS shall provide the capability to store as a single entity logically grouped sets of data.

DADS1790 The ECS shall periodically verify that all data sets are present and accounted for.

DADS1791 The ECS shall have the capability to mount archival media via automated means.

DADS1795 The ECS shall update internal file directories with the unique Data set ID.

DADS1800 The ECS shall maintain data storage inventories defining the physical location of files.

DADS1805 The ECS shall provide an inventory system capable of the following:

a. Accepting the number of new inventory entries, one per granule, for the number of granules per day as specified in Appendix C
b. Uniquely identifying each data granule
c. Tracking the physical location of each data granule

DADS1806 The ECS shall provide the capability of retrieving any data granule stored in the archives.

5.4.3.2.7.6 Scheduling

DADS2160 The ECS shall maintain a list of standing orders.

DADS2170 The ECS shall maintain a list of one-time orders.

DADS2190 The ECS shall maintain a list of products which could not be delivered electronically (e.g., workstation off-line).

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5.4.3.2.7.7 Backup

DADS2270 The ECS shall have the capability to provide an off-site backup copy of all EOS data which would otherwise be impossible or difficult to recover in case of loss (e.g., ancillary data, metadata, Science Software, calibration data, systems and applications software, selected data products, depending on need).

DADS2276 The ECS shall have the capability to restore its archive from a backup copy of EOS data or backup copy of information required to regenerate the data.

DADS2300 The ECS shall provide a capability for local and offsite backup/restore of system files.

DADS2302 The ECS offsite and local backup media shall be based on published, open, and non-proprietary formats which fully describe the physical organization and structure of files.

DADS2307 The ECS shall fulfill requests for L0 data from EDOS with L0.

5.4.3.2.8 Distribution

5.4.3.2.8.1 Send Data

DADS2340 The ECS shall have the capability to send from one DAAC to another DAAC the following:

a. L0-L4 data
b. Metadata
c. Ancillary data
d. Calibration data
e. Correlative data

DADS2370 The ECS shall have the capability to send to the user the following:

a. L0-L4 data
b. Special products (L1-L4)
c. Metadata
d. Ancillary data
e. Calibration data
f. Correlative data
g. Science Software
h. Browse data

DADS2410 The ECS shall distribute data from the archive in response to receipt of a product order.

DADS2430 The ECS shall be capable of distributing any data granule stored in the archive.

DADS2440 The ECS shall distribute data under a multi-level priority system.

DADS2455 ECS shall be able to process multiple distribution requests concurrently where concurrent distribution peripherals are available.

DADS2460 The ECS shall have a manual override function capable of altering the priority of a distribution request.

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DADS2470 The ECS shall transfer Standard Products and subsetted data to the requester.

DADS2480 The ECS shall support the export of inventory metadata using the Extensible Markup Language (XML) (Note: This requirement has evolved over time to include compliance with the formats used in the external metadata repository (the common metadata repository (CMR)).

5.4.3.2.8.2 Write to Variety of Physical Media

DADS2490 [DELETED]

DADS2492 [DELETED]

DADS2494 [DELETED]

DADS2496 [DELETED]

DADS2498 [DELETED]

DADS2510 [DELETED]

5.4.3.2.8.3 Distribute to Networks

DADS2580 The ECS shall distribute data electronically.

DADS2585 The ECS shall have the capability to distribute electronically via subscription using a secure interface.

DADS2675 The ECS shall maintain a log of all transmission problems and take internal corrective action when network performance interrupts distribution efforts.

DADS2676 The ECS shall be able to use on-line storage as the primary archive for ECS data products such that its public data is accessible by end users via the Web and FTP (File Transfer Protocol).

5.4.3.3 DADS Performance

DADS2770 [DELETED].

DADS2778 The ECS shall be capable of receiving and archiving three days worth of data (see Appendix C) in any given day.

DADS2900 The ECS shall provide archival capacity for current volume requirements plus one year. Volume requirements are specified in Appendix C.

DADS2910 The ECS archival storage at each DAAC shall be field-expandable.

DADS2950 The ECS archive media shall be capable of being manually mounted at each DAAC.

DADS3000 The ECS archive backup media shall support a bit error rate after correction of less than 1 in 10 to the 12th.

DADS3040 The ECS backup media shall be removable from the DAAC (e.g., for safe off-site storage).

DADS3055 At each ECS DAAC all backup media shall be capable of being mounted automatically where appropriate, with the provision for manual failover.

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DADS3090 The ECS shall be capable of 200% expansion in data archive input/output throughput and archive capacity without architecture or design change.

DADS3100 The ECS shall be capable of transmitting data over communications network in support of:

a. External data production at the data rate specified in the SIPS ICD
b. Data distribution requests at a rate equivalent to the daily distribution volume at the DAAC as specified in Appendix C.

DADS3105 The ECS shall be capable of ingesting and archiving data in support of external data production at the data rate specified in the SIPS ICD.

DADS3135 The ECS shall have the capability to support the transaction rate and response times as specified in Table 6-1.

5.4.4 Information Management System Functions

5.4.4.1 Overview

The primary role of the ECS Information Management System (IMS) is to give its clients efficient access to the ECS data products, providing them with all of the information and tools to search, locate, select, and order those products required to perform their science investigations. These products may be stored in the archives or may entail external higher-level processing of an archived product.

Table 5-1. User Load and Concurrent Session Characteristics

Session Category	Number of Operations per Hour	Specific Operation	Response Time Requirement*	Response Time Design Goal*
Status Check (account or request)	60	Status of pending order	13 sec	10 sec
Ordering Services	25	Local DAAC order submission and confirmation	13 sec	12 sec

5.4.4.2 Functional Requirements

5.4.4.2.1 System Access and User Registration

5.4.4.2.1.1 System Access (Deleted)

5.4.4.2.1.2 User Registration (Deleted)

5.4.4.2.1.3 Global User Interface

IMS-0090 The ECS shall be accessible to users via network link.

IMS-0100 Deleted

IMS-0110 The ECS user interface shall support access to ECS services from the personal computers and workstations of the general user community, without requiring them to install ECS client software.

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IMS-0120 The ECS shall ensure standard use of keys across custom ECS GUIs.

IMS-0130 The ECS shall verify that a user is authorized to access a particular ECS service before providing the service to the user.

IMS-0170 The ECS user interface shall be designed so that restructuring of the ECS databases shall not result in the need for changes to the ECS user interface.

5.4.4.2.2 Information Management

IMS-0220 The ECS shall store, maintain and provide data management services for ECS directory and inventory data.

IMS-0240 The ECS shall provide database administration utilities for:

a. Modifying the data base schema
b. Performance monitoring
c. Performance tuning
d. On-line backup
e. On-line recovery
f. Export/import of data

IMS-0250 The ECS shall provide the following maintenance of the ECS databases:

a. Capability to restructure the database
b. Capability to interrupt a maintenance session and restart the session without loss of information

IMS-0290 The ECS internal database management queries shall be expressed in a standard query language.

IMS-0300 The ECS shall maintain a log of all information update activity.

5.4.4.2.2.1 Metadata Data Base Management

IMS-0320 The ECS Standard Product related metadata shall contain:

a. Identifiers for locating products in the ECS archive by granule
b. Key organizations and personnel for all product-related DAACs, ADCs, and ODCs (Other Data Centers)
c. Granule-specific information

IMS-0330 The ECS metadata shall support a cross reference that relates science data to the following:

a. Calibration data, navigation data, and instrument engineering data
b. Processing algorithms used for data generation
c. Software used for data generation
d. Parameters used for data generation
e. Input data used for data generation
f. The DAAC at which the data was processed
g. QA (Quality Assurance) Data

IMS-0350 The ECS shall provide the capability for authorized personnel to add, delete, or modify ECS metadata entries, individually or in groups.

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IMS-0355 The ECS metadata shall be expandable to include additional attributes which are identified during the mission and deemed useful for data search.

5.4.4.2.2.1.1 Guide (Documentation/Reference Material) Metadata

IMS-0400 The ECS shall provide a Web server capability at each DAAC for use by operations to store documents to allow them to be accessed through the Web.

IMS-0410 The ECS shall provide a DAAC-configurable, dataset-specific Guide URL in the metadata.

IMS-0420 The ECS shall provide to the user, the Guide URL along with the data distribution information. This shall be part of the DAAC configurable portion of the data distribution information.

5.4.4.2.2.1.2 Inventory Level Metadata

IMS-0430 The ECS shall maintain an on-line inventory with information that individually describes each granule of EOSDIS data, where granule refers to the minimum traceable logical unit of data stored in the archives, as defined by the instrument science team.

5.4.4.2.2.1.3 Metadata Interface

IMS-0450 The ECS shall accept and validate new and updated metadata for all ECS archive data which has been inserted at a DAAC.

5.4.4.2.3 Information Search

IMS-0550 The ECS shall allow its clients to locate and identify desired data without detailed knowledge of the system:

a. Architecture
b. Data Base management system
c. Data Base structure
d. Query languages
e. Data formats

IMS-0627 The ECS shall support external requests for data product orders.

IMS-0640 The ECS shall provide the capability to query geographic metadata by any of the following criteria at a minimum:

a. Minimum bounding rectangle
b. Polygon

5.4.4.2.4 Archival Product Requests (Deleted)

5.4.4.2.4.1 EOSDIS Data Product Requests

IMS-0740 The ECS shall provide the capability to generate and update requests for standing orders for the ECS to distribute the following archive holdings, Standard Products, and Standard Product software.

IMS-0750 The ECS shall provide the capability to fill orders for Standard Product software in accordance with EOSDIS distribution criteria.

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IMS-0785 The ECS shall accept orders requesting a compression format in which ECS archival data formats are to be distributed.

IMS-0810 The ECS shall support product orders, to retrieve specified data from the archive and distribute it, containing the following information:

a. Requester identification
b. Data type
c. Data set identifier
d. Data set subsetting, reformatting, reprojection, and on-demand processing instructions
e. Data formats
f. Distribution instructions, including media and data compression requirements
g. Request priority

IMS-0820 The ECS shall provide product order information to confirm or reject an order, which contains the following information:

a. Requester identification
b. Request identification
c. If rejection, then the reason for the rejection

IMS-0840 The ECS shall provide the capability to record data order status when the ordered data has been shipped to the user.

5.4.4.2.5 Data Processing Requests

5.4.4.2.6 Toolkit Services

5.4.4.2.6.1 ECS Toolkit User Application Services (Science Data Processing (SDP) Toolkit)

IMS-1500 The ECS shall provide the tools to support user preparation or automated generation of metadata, for example, directory and inventory entries.

IMS-1507 The ECS shall provide a tool for HDF (Hierarchical Data Format) file comparison.

5.4.4.2.6.2 Data Visualization (Deleted)

5.4.4.2.7 Statistics Collection for Local System Management

IMS-1646 The ECS shall provide a record of data orders for the purposes of maintaining a full and complete history of all data orders.

5.4.4.2.7.1 Monitor ECS Usage

IMS-1650 The ECS operations data shall contain information on:

a. System utilization
b. Outstanding data distribution requests

IMS-1665 The ECS shall log services usage by each client (to include user identification where available, service identification, date/time stamp) for later reporting and determination of access patterns.

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5.4.4.2.7.2 Fault Detection

IMS-1760 The ECS shall raise the following detected hardware faults:

a. Processors
b. Network interfaces
c. Storage devices

5.4.4.3 Performance

Projected annual ingest rates, distribution rates, inventory granule counts and archive capacity is provided in Appendix C for each DAAC. Performance testing and analysis should use these numbers for the target year, and the inferred operational activities needed to achieve these rates and volumes. In request status checking, it should be assumed that there are 2000 outstanding requests for data.

In testing performance, level of activity (i.e., number of operations per hour) should be at least that described in Table 6-1. Note that the number of operations in any category will be distributed among the specific operations indicated.

IMS-1780 The ECS shall respond to each user session operation within the time period specified in Table 6-1 with the specified rate of operations.

IMS-1785 The ECS performance specified in Table 6-1 shall be maintained during other ECS operational activities such as database updates.

IMS-1790 The ECS shall provide, based upon the data sizing defined in Appendix C, sufficient storage for:

a. Directory metadata
b. Inventory metadata
c. System space, management data, and data base system overhead
d. Metadata staging area
e. Ancillary data metadata
f. Metadata describing externally provided software

IMS-1800 The ECS design and implementation shall have the flexibility to accommodate the growth indicated in Appendix C without major changes to the hardware and software design.

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6. COMMUNICATIONS AND SYSTEM MANAGEMENT SEGMENT

6.1 Overview

The Communications and System Management Segment performs system-wide services, as well as provides essential services to each element of the ECS. Intra-site communications; intra-site networking; intra-site network management; and system-wide, site, and element resource and operations management are but some of the services performed by this segment and provided to the other segment.

6.2 System Management Function

6.2.1 Overview

The main mission of the System Management function is to provide a system-wide view of the ECS operations. The ECS provides system-wide coordination of activities at individual sites by providing high level resource configuration directions and schedule adjustments.

6.2.2 System Management Center (SMC) Functional Requirements

6.2.2.1 Scheduling Service

6.2.2.1.1 Schedule Generation (Deleted)

6.2.2.2 Configuration Management Service

6.2.2.1.2 Resource Management

SMC-2120 The ECS shall make available for automated distribution to users all non-licensed toolkit software, toolkit software upgrades, and toolkit documentation.

SMC-2130 The ECS shall administer the allocation of the number of licenses to each site for deployed commercial-software funded by the ECS contract, including commercial software as authorized for specific users.

6.2.2.1.3 Maintenance Management

SMC-2210 The ECS shall coordinate with each site in the management of corrective hardware and systems software maintenance.

SMC-2220 The ECS shall support the monitoring of hardware and systems software maintenance status for repair actions.

6.2.2.1.4 Logistics Management

SMC-2300 The ECS shall support the monitoring of the spares inventory.

SMC-2310 The ECS shall support the management of the replenishment of spare parts for all elements.

SMC-2320 The ECS shall support the monitoring of consumable items.

SMC-2330 The ECS shall support the monitoring of the replenishment of consumable items.

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6.2.2.1.5 Training Management

SMC-2400 The ECS shall support the management of training and certification programs for ECS. (DELETED)

SMC-2410 The ECS shall provide support for the development of schedules for training courses. (DELETED)

SMC-2420 The ECS shall support the development of on-the-job training. (DELETED)

SMC-2430 The ECS shall support the development and use of training materials. (DELETED)

SMC-2450 The ECS shall support the evaluation of the effectiveness of the training programs. (DELETED)

6.2.2.2.5 Inventory Management

SMC-2500 The ECS shall establish and maintain a system-wide inventory of all hardware and system software contained within ECS, including:

a. Hardware or software identification numbers
b. Version numbers and dates
c. Manufacturer
d. Part number
e. Serial number
f. Name and locator information for software maintenance
g. Location where hardware or software is used

SMC-2510 The ECS shall provide configuration management tools for the operational hardware, scientific and system software contained within ECS. The configuration management tools shall support the migration of hardware and software upgrades into the operational environment.

6.2.2.2.6 Policies and Procedures Management

SMC-2600 The ECS shall support, control, and maintain ECS policies and procedures covering the following areas:

a. Site responsibility and authority – DAAC operations
b. Resource management – ECS
c. Fault identification, priorities, recovery – ECS
d. Testing – ECS
e. Maintenance – ECS and DAAC operations
f. Logistics – ECS
g. Performance evaluation – ECS
h. [DELETED]
i. Quality and product assurance – ECS
j. Inventory management – ECS
k. System enhancements – ECS

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l. System Administrative actions – ECS and/or DAAC operations (Note: The applicability of this requirement to ECS or DAAC Operations is determined by ESDIS)
m. Security to support the ECS system – ECS and DAAC operations

SMC-2610 [DELETED]

6.2.2.3 Performance Management Service

SMC-3300 The ECS shall monitor site hardware status to determine operational states including:

a. On-line
b. Off-line (e.g., failed, off for maintenance)

SMC-3302 The ECS shall monitor system software status to determine their operational states including:

a. Executing
b. Failed (i.e., abnormally terminated)
c. Not executing (i.e., not started or shut down normally)

SMC-3304 The ECS shall support the operation and management of software in independent modes.

SMC-3370 For each performance parameter, the ECS shall have the capability of establishing and evaluating multiple thresholds to include, as applicable:

a. On/off
b. Pass/fail
c. Various levels of degradation

SMC-3380 The ECS shall provide tools to monitor overall system performance.

SMC-3390 The ECS shall generate alert indicators of fault or degraded conditions.

SMC-3410 The ECS shall provide tools to perform short and long-term trend analysis of system and site performance to include:

a. Operational status
b. Performance of a particular resource
c. Maintenance activities (e.g., number of repairs per item)

SMC-3420 The ECS shall provide tools to perform short and long-term trend analysis of system and site performance to determine the impact on resources of:

a. Modifying system, site, or element activity allocations
b. Potential enhancements to system, site, or element

6.2.2.4 Fault Management Service

SMC-4310 The ECS shall support fault analysis including:

a. Isolation
b. Location
c. Identification

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d. Characterization

SMC-4311 The ECS shall support fault analysis to the level of:

a. Software processes
b. Equipment

SMC-4320 The ECS shall support the following fault diagnosis testing:

a. Software and hardware testing
b. Resource-to-resource connectivity testing

SMC-4330 The ECS shall have the capability to send fault recovery commands, directives, and instructions to ECS components.

6.2.2.5 Security Management Service

SMC-5340 [DELETED] The ECS shall provide tools to perform security including secure interactive access and file transfer, auditing and compromise detection.

SMC-5356 [DELETED] The ECS shall follow NASA best security practices in accordance with CD-004-M-GSF-4238, EOS Moderate System.

6.2.2.6 Accountability Service

SMC-6300 [DELETED] The ECS shall support accountability policies and procedures based on ESDIS Project policies and procedures.

SMC-6310 The ECS shall generate security audit logs.

SMC-6320 The ECS shall perform, as needed, data and user audit trails.

SMC-6340 The ECS shall track system configuration that audits:

a. Hardware resources
b. Software resources

6.2.2.7 Directory Information Service

6.2.2.8 Report Generation Service

SMC-8730 [DELETED]

SMC-8750 [DELETED]

SMC-8770 The ECS shall have the capability to generate detailed and summary reports showing the inventory of:

a. Hardware system and scientific software
b. Spares and consumables
c. COTS (Commercial Off-The-Shelf) Software

SMC-8790 [DELETED]

SMC-8860 [DELETED] The ECS shall have the capability to generate the following fault management reports describing the fault management of ground resources:

a. Fault type and description

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b. Time of occurrence of fault
c. Effect on system
d. Status of fault resolution
e. Fault statistics

SMC-8863 [DELETED] The ECS shall allow operators to forward fault reports for resolution to other DAACs.

6.2.2.9 Local System Management (LSM) Service

The purpose of the LSM is to manage its element(s) within ECS, which may include its managed subsystem components.

6.2.2.9.1 Maintenance Management

SMC-2205 The ECS shall support on-site preventive and corrective hardware and systems software maintenance.

6.2.2.9.1.1 Inventory Management

SMC-2505 [DELETED]

SMC-2535 The ECS shall provide tools to facilitate the implementation of changes within its hardware and software.

6.2.2.9.2 Performance Management Service

SMC-3385 The ECS shall evaluate system performance against the ESDIS project established performance criteria.

6.2.3 SMC Performance (Deleted)

6.3 ECS Site-specific Network (ESN)

6.3.1 Overview

The ECS is responsible for local area network connectivity and exchange of data between the ECS elements located at each ECS site.

Many existing networks already service EOS researchers and will continue to provide the required connectivity.

6.3.2 Functional Requirements

6.3.2.1 General Communications

ESN-0003 The ECS shall interface with collocated DAAC networks to enable researchers on existing networks (TCP/IP) to gain access to data and ECS services in a transparent manner to the underlying differences between the networks.

ESN-0006 The ECS shall interface with NASA networks.

ESN-0080 The ECS shall support data exchange via NASA networks for inter-site data transmission between DAACs.

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ESN-0240 The ECS shall be extensible in its network design to provide capability for growth and enhancement.

6.3.2.2 Data Transfer and Management Service

ESN-0280 The ECS shall provide file transfer service and as a minimum shall include the capability to transfer the following data types:

a. Unstructured Text
b. Binary Unstructured
c. Binary Sequential
d. Sequential Text

ESN-0290 The ECS file transfer service shall be available in interactive and non-interactive services.

6.3.2.3 Electronic Messaging Service

ESN-0340 The ECS shall interoperate and exchange messages and data with external SMTP mail systems.

ESN-0345 The ECS shall be capable of transparently transmitting Multi-purpose Internet Mail Extensions (MIME) messages.

ESN-0350 The ECS Electronic Messaging Service shall be capable of exchanging binary data.

6.3.2.4 Remote Terminal Service

ESN-0370 The ECS shall provide interactive virtual terminal services.

6.3.2.5 Process-To-Process Communication Service

ESN-0450 The ECS shall provide process-to-process communication service.

6.3.2.6 Network Directory and User Access Control Service

ESN-0510 [DELETED]

ESN-0610 [DELETED]

6.3.2.7 Network Management Service

ESN-0620 The ECS shall include a network management function to monitor and control the local ECS networks.

ESN-0640 The ECS shall include management functions at each ECS site, for the management of ECS network equipment or gateways.

ESN-0650 The ECS shall perform the following network management functions for each protocol stack implemented in any ECS element, and each communications facility:

a. Network Configuration Management
b. Network Fault Management
c. Network Performance Management
d. Network Security Management

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ESN-0690 The ECS shall be capable of reconfiguration transparent to network users.

ESN-0700 The ECS management architecture shall be consistent with the standards defined by the IETF (Internet Engineering Task Force) to the extent they apply to the network services provided by ECS.

ESN-0740 The ECS network management service shall retrieve performance/fault data about local ECS network protocol stacks and equipment.

ESN-0750 The ECS network management component at each DAAC shall provide capabilities for the extraction, tabulation, and display to the operator of network performance data.

ESN-0760 The ECS network management function at each DAAC shall provide, on an interactive basis, network configuration, fault and performance information.

ESN-0780 The ECS network elements, shall have the capability to report, periodically and on an interactive basis, network statistics to the ECS network management function, including the following information:

a. Network reset and restart indications
b. Outages and CRC (Cyclic Redundancy Code) errors
c. Performance statistics

6.3.2.7.1 Network Configuration Management

ESN-0790 The ECS shall include the following configuration management functions:

a. Collect information describing the state of the network subsystem and its communications resources
b. Exercise control over the configuration, parameters, and resources of the subsystem, and over the information collected
c. Store the configuration information collected, and
d. Display the configuration information
e. Register all configuration modifications

6.3.2.7.2 Network Fault Management

ESN-0810 The ECS shall provide the following fault management functions:

a. Detect the occurrence of faults, and
b. Control the collection of fault information

ESN-0815 The ECS shall provide a network analyzer capability to troubleshoot network problems and to use in network planning.

ESN-0830 The ECS shall have the capability to detect and report communications related errors and events.

ESN-0840 The ECS shall have communications error reporting, event logging and generation of alerts.

ESN-0900 The ECS shall detect the following errors and events:

a. Communications hardware errors

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b. Protocol errors
c. Performance degradation conditions
d. Telecommunications errors and failures

ESN-0910 The ECS communications fault management shall provide the capability to perform the following functions locally:

a. Set, view, and change alert threshold values
b. Enable and disable alert notifications (alarms) within a system
c. Enable and disable event reports within a system
d. Manage error and event logging files

ESN-0920 The ECS shall provide a set of utilities to perform diagnostic and testing functions for purposes of communications fault isolation.

ESN-1000 The ECS network management function shall have the capability to build histories for different types of errors and events, and the capability to analyze errors and recommend corrective action wherever practical.

ESN-1010 The ECS shall provide, for selective use as a debugging aid, the capability to perform packet tracing of its supported protocols.

ESN-1030 The ECS shall perform periodic testing of alternate communication capabilities to verify that they are operational.

6.3.2.7.3 Network Performance Management

ESN-1060 The ECS network performance management function shall provide the capability to evaluate the performance of ECS networks resources and interconnection activities.

ESN-1065 The ECS network performance management function shall include trend analysis for prediction of loading and bottlenecks/delays.

ESN-1070 The ECS shall provide the capability to perform the following functions:

a. Generate/collect network statistics
b. Control collection/generation of network statistics

ESN-1090 The ECS shall provide the capability to control the communications performance parameters of the network.

6.3.2.7.4 Network Security Management

ESN-1380 The ECS shall provide countermeasures for the following security threats related to data communications:

a. Modification of data (i.e., manipulation) while in transit over the network
b. Disclosure of authentication information
c. Impersonation of authentication credentials or authorization privileges

ESN-1400 The ECS shall provide the following security functions and services:

a. Authentication
b. Access (authorization) control

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c. Data confidentiality

ESN-1430 The ECS shall provide the following security event functions:

a. Event detection
b. Event reporting
c. Event logging

6.3.2.8 Internetwork Interface Service

ESN-1140 [DELETED] The ECS shall provide protocol translation, termination, bridging and routing.

ESN-1170 [DELETED] The ECS shall provide necessary translation within supported file transfer.

ESN-1180 The ECS shall interoperate with NASA networks to provide user access to ECS.

6.3.3 ESN Protocols and Standards

ESN-1340 The ECS shall provide support for TCP/IP communications protocols and services to external interfaces as required by the IRDs (Interface Requirement Documents).

ESN-1350 The ECS LANs (Local Area Networks) shall provide physical devices and the corresponding medium access control (MAC) protocol compatible with ISO (International Standards Organization) and ANSI (American National Standards Institute) standards.

6.3.4 ESN Capacity and Performance

ESN-1206 The ECS network capacity and performance shall be consistent with the specified capacity and performance requirements of the ECS functions.

ESN-1207 The ECS network capacity and performance shall be capable of expansion to be consistent with the specified capacity and performance growth requirements of the ECS functions.

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Appendix A Glossary

Appendix A is a glossary of terms widely used in the EOS Program.

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Affiliated Data Center (ADC)	A facility not funded by NASA that processes, archives, and distributes Earth science data useful for Global Change research, with which a working agreement has been negotiated by the EOS program. The agreement provides for the establishment of the degree of connectivity and interoperability between EOSDIS and the ADC needed to meet the specific data access requirements involved in a manner consistent and compatible with EOSDIS services. Such data-related services to be provided to EOSDIS by the ADC can vary considerably for each specific case.
Algorithm	Software delivered to the SDPS by a science investigator (PI, TL, or II) to be used as the primary tool in the generation of science products. The term includes executable code, source code, job control scripts, as well as documentation.
Ancillary Data	Data other than instrument data required to perform an instrument's data processing. They include orbit data, attitude data, time information, spacecraft engineering data, calibration data, data quality information, and data from other instruments.
Attitude Data	Data that represent spacecraft orientation and onboard pointing information. Attitude data includes: • Attitude sensor data used to determine the pointing of the spacecraft axes, calibration and alignment data, Euler angles or quaternions, rates and biases, and associated parameters. • Attitude generated onboard in quaternion or Euler angle form. • Refined and routine production data related to the accuracy or knowledge of the attitude.
Averaging	Standard data averaging involves extraction from a data granule of aggregate pixels formed by numerically averaging the N adjacent pixels in each of one or more dimensions of the granule. The number of pixels in each dimension to be averaged is characterized by the value of "N."
Baseline Activity Profile	A schedule of activities for an instrument that has activities that are routine and repetitive.
Batch and Incremental Scheduling	Two modes of scheduling. Batch scheduling is the automatic scheduling of a full set of events. Incremental scheduling is interactive scheduling of selected events. For example, the initial generation of a schedule might use batch scheduling, while the addition of a single event with the desire to avoid perturbing previously scheduled events might use incremental scheduling.
Browse Data Product	Subsets of a larger data set, other than the directory and guide, generated for the purpose of allowing rapid interrogation (i.e., browse) 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.
Calibration Data	The collection of data required to perform calibration of the instrument science data, instrument engineering data, and the spacecraft engineering data. It includes pre-flight calibration measurements, in-flight calibrator measurements, calibration equation coefficients derived from calibration software routines, and ground truth data that are to be used in the data calibration processing routine.

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Catalog Interoperability	Refers to the capability of the user interface software of one data set directory or catalog to interact with the user interface at another data set directory or catalog. Three levels of Catalog Interoperability are recognized: • Level 1 Interoperability – simple network interconnectivity among systems. • Level 2 Interoperability – catalog systems can exchange limited search and user information. • Level 3 Interoperability – catalog systems exchange standard search protocols. This provides "virtual" similarity between different systems.
Command and Data Handling (C&DH)	The spacecraft Command and Data Handling subsystem which conveys commands to the spacecraft and research instruments, collects and formats spacecraft and instrument data, generates time and frequency references for subsystems and instruments, and collects and distributes ancillary data.
Command Group	A logical set of one or more commands which are not stored onboard the spacecraft and instruments for delayed execution, but are executed immediately upon reaching their destination on board. From the perspective of the EOC, a preplanned command group is one that has been preprocessed by the Command Management Service and stored on the ground for later uplink, where a real-time command group has not undergone any preprocessing.
Commercial Off-The-Shelf (COTS)	"Commercial off-the-shelf" means a product, such as an item, material, software, component, subsystem, or system, sold or traded to the general public in the course of normal business operations at prices based on established catalog or market prices (see FAR 15.804-3I for explanation of terms).
Correlative Data	Scientific data from other sources used in the interpretation or validation of instrument data products, e.g., ground truth data and/or data products of other instruments. These data are not utilized for processing instrument data.
Data Acquisition Request (DAR)	A request for future data acquisition by an instrument(s) that the user constructs and submits through the IMS.
Data Center	A facility storing, maintaining, and making available data sets for expected use in ongoing and/or future activities. Data centers provide selection and replication of data and needed documentation and, often, the generation of user tailored data products. Also known as archive center.

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Data Product Levels	Data levels 1 through 4 as defined in the EOS Data Panel Report. Consistent with the CODMAC and ESADS definitions: • Raw Data – Data in their original packets, as received from the spacecraft and instruments, unprocessed by EDOS • Level 0 – Raw instrument data at original resolution, time ordered, with duplicate packets removed • Level 1A – Level 0 data, which may have been reformatted or transformed reversibly, located to a coordinate system, and packaged with needed ancillary and engineering data. • Level 1B – Radiometrically corrected and calibrated data in physical units at full instrument resolution as acquired • Level 2 – Retrieved environmental variables (e.g., ocean wave height, soil moisture, ice concentration) at the same location and similar resolution as the Level 1 source data • Level 3 – Data or retrieved environmental variables that have been spatially and/or temporally resampled (i.e., derived from Level 1 or Level 2 data products). Such resampling may include averaging and compositing • Level 4 – Model output and/or variables derived from lower level data which are not directly measured by the instruments. For example, new variables based upon a time series of Level 2 or Level 3 data
Data Rate Profile	Instrument's and subsystem's data rate requirements (e.g., recorder data rate) over a certain period of time.
Data Set	A logically meaningful grouping or collection of similar or related data.
Data Set Documentation	Information describing the characteristics of a data set and its component granules, including format, source instrumentation, calibration, processing, algorithms, etc.
Detailed Activity Schedule	The schedule for a spacecraft and instruments which covers a few days and is generated/updated daily based on the Instrument Activity List for each of the instruments on the respective spacecraft. For a spacecraft and instrument schedule the spacecraft subsystem activity list needed for routine spacecraft maintenance and/or for supporting instruments activities are incorporated in the Detailed Activity Schedule.
Direct Broadcast	Continuous down-link transmission of selected real-time data over a broad area (non-specific users).
Directive	Flowdown of policy.
Directory	A collection of uniform descriptions that summarize the contents of a large number of data sets. It provides information suitable for making an initial determination of the existence and contents of each data set. Each directory entry contains brief data set information (e.g., type of data, data set name, time and location bounds).
Distributed Active Archive Center	An EOSDIS facility which generates, archives, and distributes EOS Standard Products and related information for the duration of the EOS mission. An EOSDIS DAAC is managed by an institution such as a NASA field center or a university, per agreement with NASA. Each DAAC contains functional elements for processing data (the PGS), for archiving and disseminating data (the DADS), and for user services and information management (elements of the IMS).
ECS-Supported	A hardware or software component that conforms to an ESDIS approved set of standards and has been fully tested by the ECS contractor.

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EDOS Production Data Sets	Data sets generated by EDOS using raw instrument or spacecraft packets with space-to-ground transmission artifacts removed, in time order, with duplicate data removed, and with quality/accounting (Q/A) metadata appended. Time span, number of packets, or number of orbits encompassed in a single data set are specified by the recipient of the data. These data sets are equivalent to level zero data formatted with Q/A metadata. For EOS, the data sets are composed of: • Instrument science packets • Instrument engineering packets • Spacecraft housekeeping packets • Or onboard ancillary packets with quality and accounting information from each individual packet and the data set itself and with essential formatting information for unambiguous identification and subsequent processing.
EDOS Expedited Production Data Sets	Data sets generated by EDOS using raw instrument or spacecraft packets from a single TDRSS acquisition session and made available for delivery to a user within 3 hours of receipt of the last packet in the session. Transmission artifacts are removed, but time ordering and duplicate packet removal is limited to packets received during the TDRSS contact period.
Engineering Data	All data available on-board about health, safety, environment, or status of the spacecraft and instruments. • Spacecraft Engineering Data – The subset of engineering data from spacecraft sensor measurements and on-board computations • Instrument Engineering Data – All non-science data provided by the instrument • Housekeeping Data – The subset of engineering data required for mission and science operations. These include health and safety, ephemeris, and other required environmental parameters
Ephemeris Data	(See Orbit Data)
Expedited Data	Data received during one TDRSS contact period which have been processed to Level 0 (to the extent possible for data from a single contact). These are data that have been identified to EDOS as requiring priority processing.
Facility Instrument	An instrument defined by NASA as having broad significance to the EOS Program and provided by a designated NASA center or foreign agency.
Granule	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.
Ground Truth	Geophysical parameter data, measured or collected by other means than by the instrument itself, used as correlative or calibration data for that instrument data. It includes data taken on the ground or in the atmosphere. Ground truth data are another measurement of the phenomenon of interest; they are not necessarily more "true" or more accurate than the instrument data.
Housekeeping Data	(See Engineering Data)
Incremental Scheduling In Situ Data	(See Comprehensive and Incremental Scheduling) (See Ground Truth)

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Institutional Facilities or Elements	Facilities established by an institution that take on some responsibility in support of EOSDIS, or elements of the EOSDIS that function as part of an institution, and represent both EOSDIS and the programs, goals and purpose of the institution.
Instrument Activity Deviation List	An instrument's activity deviations from an existing instrument activity list, used by the EOC for developing the detailed activity schedule.
Instrument Activity List	An instrument's list of activities that nominally covers seven days, used by the EOC for developing the detailed activity schedule.
Instrument Data	Data specifically associated with the instrument, either because they were generated by the instrument or included in data packets identified with that instrument. These data consist of instrument science and engineering data, and possible ancillary data.
Instrument Engineering Data	(See Engineering Data)
Instrument Housekeeping Data	(See Engineering Data)
Instrument Micro-processor Memory Loads	Storage of data into the contents of the memory of an instrument's microprocessor, if applicable. These loads could include microprocessor-stored tables, microprocessor-stored commands, or updates to microprocess or software.
Instrument Resource Deviation List	An instrument's anticipated resource deviations from an existing resource profile, used by the EOC for establishing TDRSS contact times and building the preliminary resource schedule.
Instrument Resource Profile	Anticipated resource needs for an instrument over a target week, used by the EOC for establishing TDRSS contact times and building the preliminary resource schedule.
Instrument Science Data Interdisciplinary Investigator Computing Facilities (IICF)	Data produced by the science sensor(s) of an instrument, usually constituting the mission of that instrument. Project-provided facilities at interdisciplinary investigator locations used to pursue EOS-approved investigations and produce higher-level data sets.
Investigator Working Group (IWG)	A group made up of the Principal Investigators and research instrument Team Leaders associated with the instruments on a single spacecraft. The IWG defines the specific observing programs and data collection priorities for a single spacecraft based on the guidelines from the IIWG.
Long Term Spacecraft Operations Plan	Outlines anticipated spacecraft subsystem operations and maintenance, along with forecasted orbit maneuvers from the FDS, spanning a period of several months.
Long-Term Instrument Plan (LTIP)	The plan generated by the instrument representative to the spacecraft's IWG with instrument-specific information to complement the LTSP. It is generated or updated approximately every six months and covers a period of up to approx. 5 years.
Long-Term Science Plan (LTSP)	The plan generated by the spacecraft's IWG containing guidelines, policy, and priorities for its spacecraft and instruments. The LTSP is generated or updated approximately every six months and covers a period of up to approximately 5 years.

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Metadata	Information about data sets which is provided to the ECS by the data supplier or the generating algorithm and which provides a description of the content, format, and utility of the data set. Metadata may be used to select data for a particular scientific investigation.
Nominal Orbit Spatial Extent (NOSE)	Due to the irregular shape, and large extent, of spatial regions that often define swath-based products, ECS has been designed to capture these definitions. Referred to as NOSE, for nominal orbit spatial extent, this archival feature accommodates the finer spatial extent of data products associated with a fixed, nominal set of orbits. NOSE also exploits the known constraints of the ECS implementation to provide a more efficient means of archiving and spatially searching on ECS products than would otherwise be possible, for products of this type, under the normal ECS archival mechanisms.
Off-Line	Access to information by mail, telephone, facsimile, or other non-direct interface.
On-Line	Access to information by direct interface to an information data base via electronic networking.
Operational Data	Data created by an operational instrument (i.e., NOAA AMRIR).
Orbit Data	Data that represent spacecraft locations. Orbit (or ephemeris) data include: Geodetic latitude, longitude and height above an adopted reference ellipsoid (or distance from the center of mass of the Earth); a corresponding statement about the accuracy of the position and the corresponding time of the position (including the time system); some accuracy requirements may be hundreds of meters while other may be a few centimeters.
Payload	Complement of instruments for a mission on a spacecraft or spacecraft.
Preliminary Resource Schedule	An initial integrated spacecraft schedule, derived from instrument and subsystem resource needs, that includes the NCC TDRSS contact times and nominally spans seven days.
Preplanned Command Group	(See Command Group)
Preplanned (Stored) Command	A command issued to an instrument or subsystem to be executed at some later time. These commands will be collected and forwarded during an available uplink prior to execution.
Principal Investigator (PI)	An individual who is contracted to conduct a specific scientific investigation. (An Instrument PI is the person designated by the EOS Program as ultimately responsible for the delivery and performance of Standard Products derived from an EOS Instrument Investigation.)
Principal Investigator Computing Facility (PICF)	Project-provided facilities at PI locations used to develop and maintain algorithms, produce data sets, and validate data.
Principal Investigator Instrument Prototype Product	An instrument selected pursuant to the EOS Announcement of Opportunity and provided by a PI at his home institution. Data product generated as part of a research investigation, of wide research utility, requiring too much data or computer power for generation at the investigator SCF, and accepted as a candidate Standard Product by the IWG. Prototype Products will be generated at DAACs, but their routine generation is not guaranteed and will not interfere with other Standard Product generation.
Real-Time Command Group	(See Command Group)

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Real-Time Data	Data that are acquired and transmitted immediately to the ground (as opposed to playback data). Delay is limited to the actual time required to transmit the data.
Refined Orbit Data	Orbit data that is computed on the ground, after data capture that is used to fill in gaps caused by data communications or other failures.
SCC-Stored Commands and Tables	Commands and tables which are stored in the memory of the central onboard computer on the spacecraft. The execution of these commands or the result of loading these operational tables occurs sometime following their storage. The term "core-stored" applies only to the location where the items are stored on the spacecraft and instruments; core-stored commands or tables could be associated with the spacecraft or any of the instruments.
Science Processing Library	The Science Processing Library (SPL) is a repository of software, contributed by scientists and other users, to which ECS will provide access in order to facilitate the reuse of software throughout the community. This software is made available as it was contributed with ECS performing only a cataloging function to identify for users what is available. ECS is not responsible for the validity or maintenance of the software contained in the Science Processing Library.
Spacecraft Recorder Data	Data that have been stored on-board the spacecraft for delayed transmission to the ground.
Spacecraft Subsystems Activity List	A spacecraft subsystem's list of activities that nominally covers seven days, used by the EOC for developing the detailed activity schedule.
Spacecraft Subsystems Resource Profile	Anticipated resource needs for a spacecraft subsystem over a target week, used by the EOC for establishing TDRSS contact times and building the preliminary resource schedule.
Special Data Products	Data products which are considered part of a research investigation and are produced for a limited region or time period, or data products which are not accepted as standard products.
Standard Products	(1) Data products generated as part of a research investigation, of wide research utility, accepted by the IWG and the EOS Program Office, routinely produced, and in general spatially and/or temporally extensive. Standard Level 1 products will be generated for all EOS instruments; standard Level 2 products will be generated for most EOS instruments. (2) All data products which have been accepted for production at a PGS, including (1) above as well as prototype products. This may include browse data products that are generated as part of the product production process.
Subsampling	Standard subsampling involves extraction of a multi-dimensional rectangular array of pixels from a single data granule, where regularly-spaced, non-consecutive pixels are extracted from each array dimension. For each dimension, the size of the pixel array is characterized by the starting pixel location, the number of pixels to extract, and the pixel-spacing between extracted pixels.
Subsetting	Standard subsetting involves extraction of a multi-dimensional rectangular array of pixels from a single data granule, where consecutive pixels are extracted from each array dimension. For each dimension, the size of the pixel array is characterized by the starting pixel location and the number of pixels to extract.

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Target of Opportunity (TOO)	A TOO is a science event or phenomenon that cannot be fully predicted in advance, thus requiring timely system response or high-priority processing.
Team Member Computing Facilities (TMCF)	Project-provided facilities at research instrument team member locations used to develop and test algorithms and assess data quality.
Worldwide Reference System (WRS)	A set of predefined grids related to instrument type and orbit. The Landsat WRS for Landsat 4, 5 and 7 is consistent.

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Appendix B Abbreviations and Acronyms

AC	Atmospheric Chemistry
AD	Applicable Document
ADC	Affiliated Data Center
AMSR	Advanced Microwave Scanning Radiometer
AMSR-E	Advanced Microwave Scanning Radiometer - EOS
ANSI	American National Standards Institute
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ASDC	Atmospheric Sciences Data Center
ASTER	Advanced Spaceborne Thermal Emission and Reflection
BER	Bit Error Rate
Co-Is	Co-Investigators
CONAE	Comisión Nacional de Actividades Espaciales
CMR	Common Metadata Repository
COTS	Commercial Off-The-Shelf
CRC	Cyclic Redundancy Code
CSA	Canadian Space Agency
CSMS	Communications and System Management Segment
DAAC	Distributed Active Archive Center
DADS	Data Archive and Distribution System
ECS	EOSDIS Core System
EDC	EROS Data Center
EDF	ECS Development Facility
EDOS	EOS Data and Operations System
EMOS	EOS Mission Operation System
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EROS	Earth Resources Observation System
ESA	European Space Agency
ESDIS	Earth Science Data and Information System
ESN	EOSDIS Science Network
ESN	ECS Site-specific Network
FSMS	File and Storage Management System
FTP	File Transfer Protocol
GES	GSFC Earth Sciences
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
HDF-EOS	Hierarchical Data Format - Earth Observing System
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineering
IETF	Internet Engineering Task Force
IMS	Information Management System

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IP	International Partner
IRD	Interface Requirement Document
ISO	International Standards Organization
ISSO	Information System Security Official
IV&V	Independent Verification and Validation
JAXA	Japanese Aerospace Exploration Agency
LAN	Local Area Network
LANCE	Land, Atmosphere Near real-time Capability for EOS
LaRC	Langley Research Center
LSM	Local System Management
MAC	Medium Access Control
MIME	Multi-purpose Internet Mail Extensions
MODIS	Moderate-Resolution Imaging Spectrometer
NARA	National Archives and Records Administration
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NIVR	Netherlands Agency for Aerospace Programmes (Nederlands Instituut Voor Vliegtuigontwikkeling en Ruimtevaart)
NOAA	National Oceanic and Atmospheric Administration
NPR	NASA Procedural Requirements
NSIDC	National Snow and Ice Data Center
ODC	Other Data Center
PGS	Product Generation System
PI	Principal Investigator
PVC	Performance Verification Center
QA	Quality Assurance
RMA	Reliability, Maintainability, Availability
S4P	Simple Scalable Script-Based Science Processor
SAGE III	Stratospheric Aerosol and Gas Experiment III
SAR	Synthetic Aperture Radar
SCF	Science Computing Facility
SDP	Science Data Processing
SDPS	Science Data Processing Segment
SIPS	Science Investigator-led Processing System
SMC	System Management Center
STD	Standard
TL	Team Leader
TM	Team Member

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Appendix C Capacities

General

The purpose of this Appendix is to specify, at a summary level, many of the cost-driving capacity requirements for the ECS and to describe the assumptions and methodologies used to derive those capacities. Other capacity requirements, such as CPU main storage, RAID buffering and working storage, local (intra-DAAC) and wide area (inter-DAAC and DAAC-SCF) communications traffic, size and structure of higher levels of the "data pyramid," etc. are not directly tabulated in this Appendix. Some of these other requirements may be derived from engineering models using the same, more detailed, information which is summarized in the tables in this Appendix.

In general, data in these tables are derived from actual workloads for each DAAC as captured in the EOSDIS Metrics System (EMS). For FY2018, the ECS shall support capacity increases for the following missions:

- NSIDC: AMSR, AMSR-E, AMSR-U, Aquarius, ASO, Browse, GLAS, IceBridge, IceSAT-II, Measures, MODIS, Nimbus, NISE, SMAP, VIIRS, SnowEx
- LPDAAC: ASTER, ASTER-GDEM, NASADEM, VCF, GFSAD, JPSS-1, JPSS-2, LSTE, ISERV, ECOSTRESS, GLFC, VIP, MEaSUREs/GFCC, GED, MEaSUREs/GDEM, MODIS, NAALSED, VIIRS, GWELD, ISS GEDI, G-LiHT, TOPOFire
- ASDC: MISR

Table C-1. Daily Ingest Rates

Table C-1 provides the daily ingest workload for each DAAC for 2017 as recorded in EMS.

Table C-2. Daily User Distribution Rates via Network

Table C-2 provides the daily distribution granule counts and sizes for 2017 as recorded in EMS.

Table C-3. Archive Capacity and Number of Granules in Inventory

Table C-3 provides the archive inventory granule counts and size for each DAAC as of December 31, 2017.

Table C-4. Number of Granules in Inventory (Deleted)

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