Earth Observing System Data and Information System (EOSDIS) Test System (ETS) Operations Concept

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Preface

This version of the Earth Observing System Data and Information System (EOSDIS) Test System (ETS) operations concept document is an update to the previous version (Version 3), published in March 1994. Version 3 was signed by cognizant personnel from Codes 505, 515, and 521; however, it was never baselined by a Configuration Control Board.

This new version reflects the ETS understanding of recent changes in the EOSDIS and the role that ETS will play in providing test and simulation tools to support EOSDIS ground system testing. This version has been updated to include comments received after its presentation at the ETS delta system requirements review, held in December 1994, and Earth Science Data and Information System (ESDIS) redirection provided in April 1995.

Abstract

The ETS provides test capabilities for the ground system supporting Earth Observing System (EOS) spacecraft that conform to the Consultative Committee for Space Data Systems (CCSDS) Recommendations. ETS is designed to simulate and test EOS ground data systems and element interfaces. The simulation and testing capabilities cover only Level 0 processing up to data delivery to the Distributed Active Archive Center (DAACs).

This document describes the operations concept for the ETS. It includes a system description, system operations concept for each test configuration grouped by test phase, operations scenarios, an acronym list, and a glossary of terms.

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Section 1. Introduction

1.1 Purpose

This document presents the operations concept envisioned for the Earth Observing System (EOS) Data and Information System (EOSDIS) Test System (ETS) and describes the capabilities and features of ETS that can be used for testing the EOSDIS. The document also discusses aspects of the ETS such as the system overview, operational scenarios, and security.

1.2 Organization

This operations concept document describes ETS as a test tool for the Earth Science Data and Information System (ESDIS) Project and describes the ETS testing capabilities. The document is organized into five sections.

Section 1 is an introductory section. It describes the conventions followed in the document, the mechanism for control of the document, and the scope of the ETS. Section 2 presents the ETS overview. Section 3 describes the ETS operations concept for the five operational configurations of the ETS, and Section 4 describes the operational scenarios for the five configurations. Section 5 discusses security recommendations and issues for the test system itself, the testing environment, and the operations personnel.

This document also contains an acronym list, a glossary, and a list of references.

1.3 Conventions

Throughout this document, the term *element* refers to EOSDIS entities or systems. Examples include but are not limited to the EOS Data and Operations System (EDOS), EOS Communications (Ecom), the EOS Operations Center (EOC), and Distributed Active Archive Centers (DAACs).

The term *user* refers to the various EOSDIS test teams who use ETS resources to support test requirements. These teams include but are not limited to the individual EOSDIS element developer test teams (i.e., EOC, EDOS), the EOSDIS independent verification and validation (IV&V) team, and the EOSDIS integration and test team. The ETS user is responsible for detailing test objectives, defining test data requirements, conducting or monitoring the test, and assessing test results. An ETS operator will set up, control, and monitor system equipment for activities related to pretest, test execution, and posttest operations. The two roles are discussed as though they are separate entities; however, for some tests, the functions may be performed by the same individual or group.

The term *data set* refers collectively to the EDOS data sets, including expedited data sets (EDSs) and production data sets (PDSs), which can be generated by EDOS or simulated or captured by ETS. ETS also handles other types of data, such as channel access data units (CADUs) or rate

buffered data. When referring to any nonspecific type of data, the term *data file* is used in this document.

Some sections of this document differentiate among ETS data generation capabilities. ETS can generate test data by various means, including using a data simulation tool, processing data with ETS hardware, or capturing and transmitting user-provided test data. Because of the complexity involved in the EDOS level-zero processing, the term *simulate* rather than *generate* is used when referring to the ETS capability to provide EDOS data sets. This terminology is meant to emphasize the fact that ETS does not duplicate the EDOS processing but is able to create data sets with the same format and structure as the EDOS data sets.

1.4 Maintenance

This ETS operations concept document (OCD) will conform to ESDIS Project guidelines for configuration control. Required changes in the document thereafter will be made through the issuance of formal Document Change Notice (DCN) pages.

1.5 ETS Scope

The ETS provides testing capabilities for the ground system supporting EOS spacecraft, which are Advanced Orbiting Systems (AOS) spacecraft that conform to recommendations established by the Consultative Committee for Space Data Systems (CCSDS). Although the ETS will be designed to support the AM-1 spacecraft, it is extensible to the PM, AERO, ALT, and CHEM series and other AM spacecraft. In general, ETS

- Generates input and output products that interface with one or more EOSDIS elements
- Provides for appropriate data flow (i.e., ETS transmission and reception) for these products among EOSDIS elements in a given test
- Provides sufficient summary quality and accounting statistics on data transmitted and received for test teams to assess performance of the element under test and to determine correctness and completeness of the element's generated data products

Section 2. System Description

2.1 System Overview

ETS will provide testing capabilities needed to support EOSDIS test activities during the EOS AM-1 mission life cycle. An extensive ground network is being assembled that will support this and subsequent EOS spacecraft. Figure 2-1 shows a high-level data flow of the EOSDIS interfaces that ETS will be able to test or simulate. ETS will provide capabilities to simulate EOSDIS element input, output, and functionality, as shown in the figure.

ETS will provide test capabilities to help verify the data processing of EOSDIS elements under test. ETS will provide capabilities for additional or independent verification of an EOSDIS element processing. ETS will also provide data simulation capabilities associated with interfacing elements to the element under test.

ETS is being developed for the ESDIS Project by Code 515.2, the Simulations Operations Section, in conjunction with Code 521, the Microelectronic Systems Branch, which is providing much of the hardware technology being used in ETS. Functionally, ETS comprises three systems that will provide capabilities to support high-rate simulations, low-rate simulations, and spacecraft simulations. Figure 2-2 shows the high-level functions ETS will perform. Each of these functions is described in the subsections that follow.

High-rate refers to the 150 megabits per second (Mbps) Ku-band science data stream input to EDOS and the resultant EDOS output products. *Low-rate* simulations refer to the generation and processing of the S-band telemetry and spacecraft commands. An ETS high-rate system transmits spacecraft science data and serves as a source and destination for EDOS data sets. Two different ETS systems perform the low-rate functions: one is used primarily for providing EDOS low-rate processing of an external spacecraft data source, and the other is used for providing spacecraft command and telemetry simulations.

2.2 ETS High-Rate Simulation Functions

Specialized ETS equipment and communication interfaces will be required for the high-rate simulation functions that ETS will provide; these functions are assigned to the ETS High-Rate System (ETS-HRS). The ETS-HRS will be used to perform four main functions:

- Simulate science return-link data streams
- Capture EDOS-produced data sets
- Verify EDOS return-link processing
- Simulate EDOS data sets

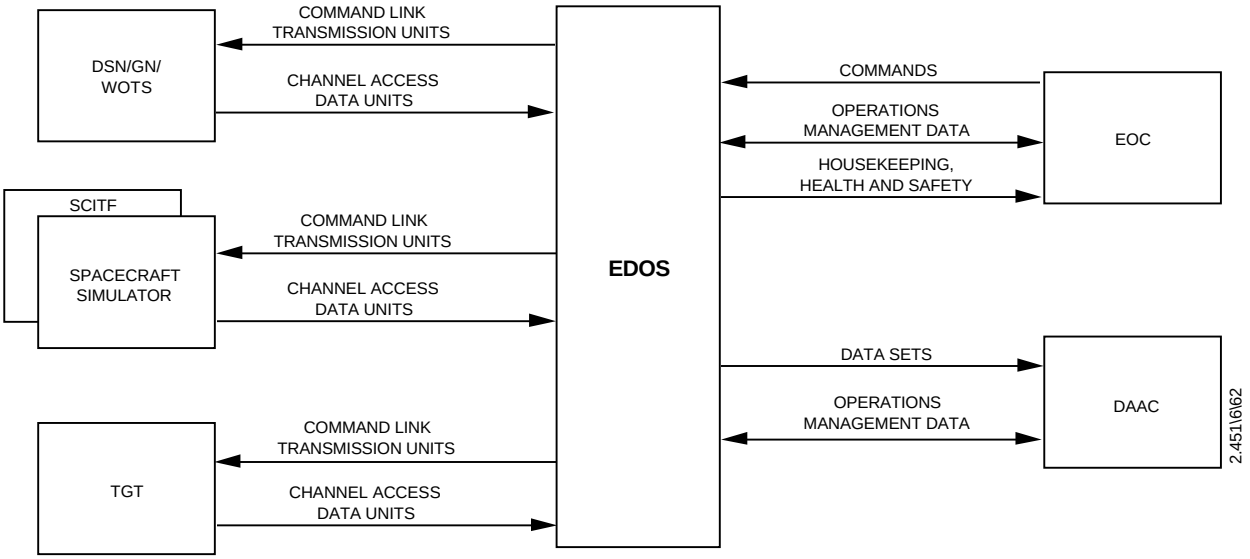


Figure 2-1. EOSDIS Interfaces Simulated by ETS

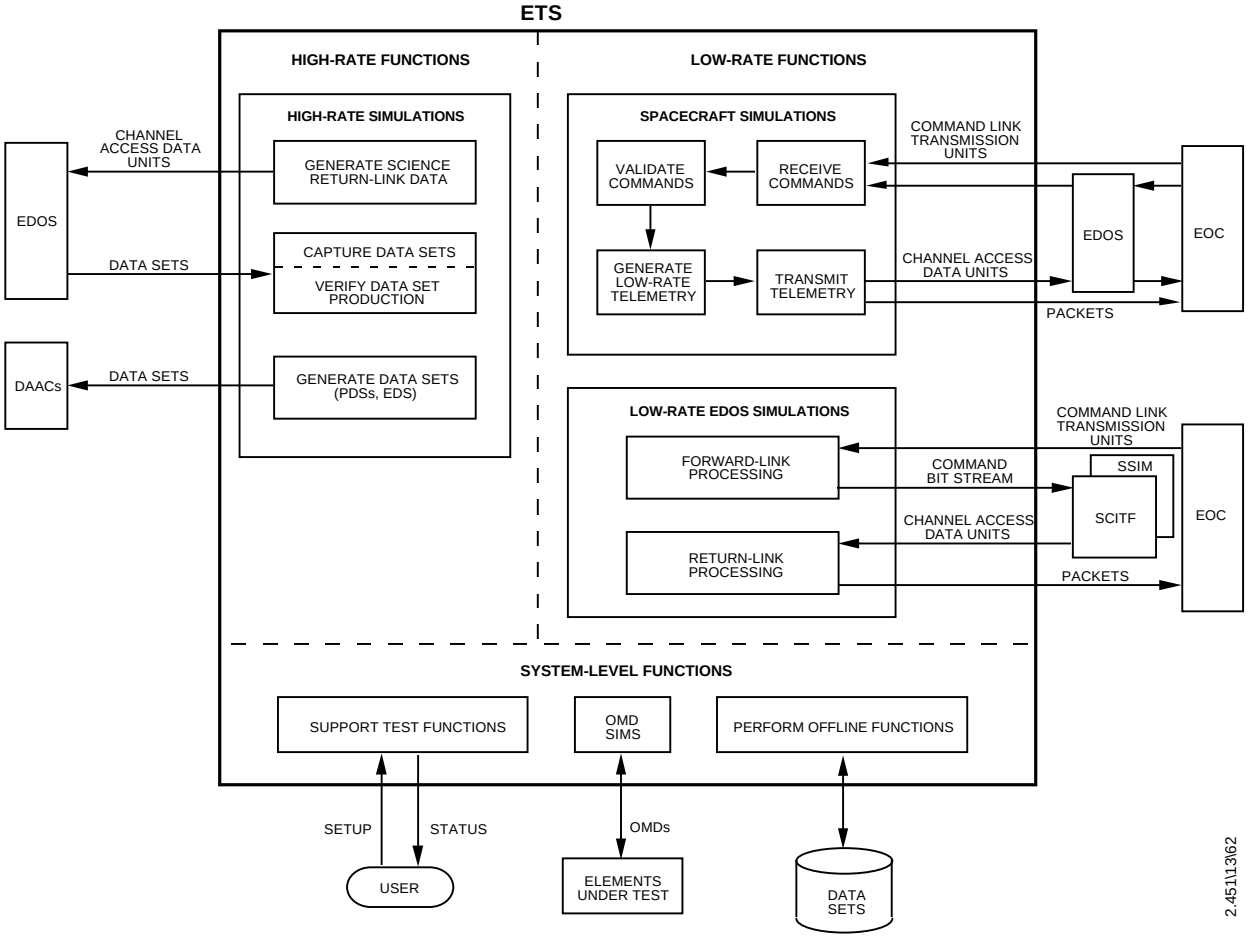


Figure 2-2. ETS Functional Diagram

The ETS-HRS will be used to simulate the solid-state recorder playback of science data. Before an actual test, ETS will be used to generate data sets that contain science and instrument data. The data can be simulated using ETS data-generation utilities or can be created from science or instrument data recorded in tests with the spacecraft or other simulator sources. ETS will transmit the data in the form of CADUs as a serial clock and data stream to the EDOS interface as if the data were being transmitted by the Tracking and Data Relay Satellite System (TDRSS) Ground Terminal (TGT). ETS will be able to provide two streams of science playback data each at a rate of 150 Mbps.

The ETS-HRS will be used to capture the output from EDOS processing. EDOS products will include expedited data sets (EDSs) and production data sets (PDSs). ETS will be able to capture one data set file transfer from EDOS at a rate up to 34 Mbps.

The extent to which ETS will check the data products will depend on the nature of the test. At a minimum, ETS will be able to store and later check the structure and format of the data it receives from EDOS. At the other end of the spectrum, the ETS-HRS can be used to support verification of EDOS return-link processing by verifying the packet-level header quality and accounting information of the actual EDOS product against the corresponding information in the expected product. For this function, before the actual test, ETS will also generate another data set containing the expected output from the EDOS processing. The EDOS processing verification will be performed using ETS utilities that compare the actual EDOS products to the ETS-generated products from the same input data stream.

The fourth major function of the ETS-HRS will be the simulation of EDOS data products for transmission to the DAACs. As noted above, ETS can process a CADU input stream to generate expected EDOS output and create data sets. ETS also has a data-generation utility that will create data sets based on user input. For tests with the DAACs, ETS can be used to transmit prerecorded data sets that a DAAC can process. ETS will be able to transmit up to three data streams with an aggregate rate of 34 Mbps. ETS relies on Ecom for data transport services of all data handled, except the 150-Mbps CADU data stream.

2.3 ETS Low-Rate EDOS Simulation Functions

ETS will be capable of supporting initial tests of the spacecraft with the EOC by performing some EDOS low-rate return- and forward-link processing functions. These capabilities will enable the EOC to interface with the Spacecraft Checkout Station (SCS), located in the Spacecraft Integration and Test Facility (SCITF) in Valley Forge, PA. These same ETS capabilities will also be used for the EOS AM-1 spacecraft simulator (SSIM) being developed by the spacecraft manufacturer as a training simulator for the EOC flight operations team. These low-rate functions are assigned to the ETS Low-Rate System (ETS-LRS) component.

For low-rate return-link data, the ETS-LRS will receive CADUs from the SCITF or SSIM, frame synchronize the data, Reed-Solomon decode and correct the data, extract and annotate the packets, extract the command link control words (CLCWs), and transmit the data packets and CLCWs to the EOC in the format of EDOS data units (EDUs). For forward-link data, ETS will receive the spacecraft commands from the EOC in the form of blocks of command link

transmission units (CLTUs) and will transmit the data as command bit streams to the SCITF or SSIM through Ecom.

2.4 ETS Low-Rate Spacecraft Simulation Functions

Another set of low-rate functions that ETS will perform can be grouped under spacecraft simulations. ETS will generate the basic S-band spacecraft telemetry data formats, including the housekeeping, health and safety, diagnostic, and playback data formats. ETS will receive and verify commands according to Command Operation Procedures (COP-1) protocol. Both ETS low-rate components are capable of providing spacecraft simulation functions. The ETS-LRS transmits a pregenerated data file, whereas the third ETS component—the Multimode Portable Simulator (MPS)—provides greater simulation flexibility and more dynamic interaction. The MPS can respond in telemetry to operator and spacecraft commands. The spacecraft simulator operates in three data format modes: serial spacecraft data for normal Space Network (SN) operations, 4800-bit blocks for contingency network operations [Ground Network (GN), Deep Space Network (DSN), Wallops Orbital Tracking System (WOTS)], and EDOS formats (e.g., EDUs, CLTUs) for direct communication with EOC without requiring EDOS. The MPS is portable and can support ground network testing from various test sites.

2.5 ETS System-Level Functions

The systems described in the preceding sections have several common functions that can be considered system-level functions. They include test support, operations management data (OMD) simulations, and offline utilities.

2.5.1 Test Support Functions

Collectively, the term *test support functions* includes the functions accessible through the system environment and user interface that are active while the user is preparing for a test, executing a test, or performing posttest analysis support activities. The user must provide required system input, and the system will respond with the appropriate operator command responses, such as a stored file, test status, or test results. Test support functions will be provided by but not limited to the following:

- Data-generation tools
- Equipment setup or configuration files
- Automated timelines or scripted operator directives
- System status and test data displays
- Activity logging
- Posttest analysis support tools
- Report-generation tools

2.5.1.1 Data-Generation Tools

Various options will be available for generating test data. If a customized data set is needed and a comparable data set does not exist, one can be created based on the format, content, and error simulation needs for the test. The test data can be simulated by using data-generation utilities or by using spacecraft data provided from external test data sources.

The data-generation utility will be able to create products in the following formats:

- CCSDS version 2 frames [virtual channel data units (VCDUs), coded VCDUs (CVCDUs), CADUs]
- CCSDS version 1 packets
- EDOS-formatted EDSs and PDSs
- EDOS-formatted rate-buffered data files
- National Aeronautics and Space Administration (NASA) Communications (Nascom) blocks (DSN, GN, WOTS format)

For each type of product, the user can specify header fields and data content. In addition, the user can insert errors in the headers or data at specified locations and frequencies.

The user can specify that data be generated from scratch or can provide data in one of the following formats:

- Raw sensor data
- Packets
- Frames
- Data sets

This data can be input to ETS electronically through File Transfer Protocol (FTP) (if the user has connectivity) or by physical media including Sony ID-1 tapes, Ampex DCRSi tapes, or 4-mm tape archival retrieval (TAR)-formatted tapes. The user-provided data can be used as is or be modified by an ETS utility.

To create a set of CADUs to transmit to EDOS, the user will provide a set of parameters defining the desired data stream. Such parameters include, at a minimum: VCDU-IDs, length, and RS interleave depth. If the packet-level data is also needed, the user can specify the application process identifiers (APIDs), length, and packet-level data. Packet-level data can include a fixed byte pattern, incrementing byte pattern, or user-provided packet data. If one of the test objectives is to verify EDOS processing of the ETS-generated CADU data stream, then one or more files of expected results could optionally be produced by the data-generation utility. These files would correspond to expected EDS or PDS packet-level quality and accounting data against which to compare actual data sets received from EDOS during a testing session.

To create an EDOS data set (that is, an EDS or PDS), the user will provide a set of parameters that define characteristics of a data set. Such parameters will include, at a minimum: data set type,

spacecraft ID, VCDU-ID, APID, TDRS service session (TSS) information, number of packets, the time in packets, and error insertion information. Errors to be simulated will include length error, fill, sequence count discontinuity, and gaps. Summary quality and accounting information will also be included as part of the data set. The format of the data set will conform to the interface control document (ICD) between the EDOS and DAACs. The data-generation utility will be able to create PDSs from scratch that simulate up to a 24-hour period.

Interfaces will be provided at each level of data set production; that is, raw sensor data will be formatted into packets and packets will be encapsulated into CADUs for a particular VC-ID. Each of these intermediate data set products will be made available for data analysis. Errors can be simulated at each level of data-set generation; packet, frame, and PDS. For instance, the user can specify packet header errors at a configured frequency or pattern of occurrence.

There is another method of creating data sets that span a 24-hour period. ETS will be able to simulate TGT input to EDOS as multiple TSS events over a 24-hour period by playing back pregenerated test data recorded on high-rate tape drives. Each tape can store up to 96 gigabytes of data, providing a continuous data source for up to 85 minutes at 150 Mbps. The number of TSS events per tape depends on the length of each TSS. Loading a tape takes less than 5 minutes.

After a data file has been created, it will become available for subsequent cataloging, storage, and possible update. Based on test requirements, reuse of a previously created data file as is or with slight modification to selected data fields may be sufficient. Utilities will be available to allow the user to view and edit an existing data file or to modify certain fields throughout the file. For example, a file could be copied, then updated with revised spacecraft time fields in each frame or with changed selected APIDs.

For test cases to verify an EOSDIS element's error-handling process, errors can be intentionally inserted in the ETS data file. The file modification utilities can augment the initial data-generation error-simulation capabilities. Error conditions in the simulated return-link data can include incorrectly formatted data, missing data or gaps (as indicated by breaks in sequence counters or packet fragments), data coding errors, or invalid header fields.

The created data files will be verified internally before they are used in a test. Data files will be checked to ensure that header fields are correct and that proper data format conventions are followed. Data files will be provided to the test teams, at their request, for their independent verification that the data conforms to their specifications.

2.5.1.2 Equipment Configuration Setup

Another test support activity will include defining the configuration of ETS equipment needed to meet the prescribed test requirements. ETS comprises a series of configurable subsystems, each with associated setup parameters that must be specified. The required setup information for the selected equipment configuration can be defined and stored in a setup file before the test. The setup configuration file would include, for example, specific information related to the source of the data (e.g., disk or tape, file identifier), data rate, output channel, logging options, transmission duration, and input channels, if required by the particular test. For input to be received by ETS, the equipment will be initialized to expect and accept data at a scheduled time during the test.

2.5.1.3 Automated Test Scripts

Depending on the nature of the test, the opportunity might arise to automate some user activities. Another test support utility will assist the user in preparing a test script file that could be used during the test to control repetitive or time-critical functions. This feature might be useful for simulations of the solid-state recorder. Different files could be set up corresponding to the various virtual channel buffers. The test script file would specify the sequence of files and duration, for example. Even if no test activities can be automated, a test script must be developed to guide the actions required of the ETS user.

2.5.1.4 System Status and Test Data Displays

During the test, users will be able to monitor ETS displays showing the current status of the test, including the amount of data transmitted and received, data error indicators, test elapsed time, and test configuration information. For the low-rate simulations, users will be able to view portions of the data as they are transmitted or received. For instance, users will be able to view spacecraft commands as received from the EOC.

2.5.1.5 Activity Logging

All user directives or commands from a scripted timeline will be logged to a session journal. System event messages, such as those produced upon receipt of spacecraft commands or upon completion of a tape playback, will also be logged. The user will have an option as to which messages and error conditions are logged to the log file. Timetags are associated with each entry in the log file. The operator can also activate data capture and storage during a test for low-rate spacecraft and operations management data up to specified storage limits.

2.5.1.6 Posttest Analysis Support Tools

Data logged during tests will be available for retrieval and analysis and can be used in fault isolation, data verification, or results determination. Offline utilities will be available to select parameters for either logging or dumping data. For example, a user may only be interested in looking at data from a certain virtual channel or at data received during a specified time interval.

General-purpose utilities will be developed to assist the user in analyzing the data received from the element under test. Data set comparators can be used to identify differences between data files. ETS tools will allow the analyst to search through data sets or log files for selected fields or conditions for displaying, printing, or extracting data to another file. The user will have flexibility in controlling the format of the data being displayed or dumped, such as specifying the number of bytes in each packet to display or specifying a hex or American Standard Code for Information Interchange (ASCII) conversion.

If the test includes a verification of EDOS processing of the ETS transmitted data, ETS tools will assist the user in analyzing the results and determining whether the actual data received is correct and matches the expected data. For example, ETS tools can be used to verify that VCDUs were demultiplexed or that fill frames were discarded from ETS-generated input data, or that the

content of EDOS-generated data sets and the associated quality and accounting information reflect the ETS-provided data.

2.5.1.7 Report-Generation Tools

The user can request various summary reports on the accounting and quality of the transmitted or received data, broken down by data type, or on the results of data analysis utilities. The reports will indicate, for example, counts of data units, errors detected, or time interval encompassed in the produced data set. Again, the user will have some flexibility in generating a report suited to the needs of the particular test. Copies of all reports will be available electronically.

2.5.2 OMD Simulation Functions

An OMD functional subsystem will handle the administrative message simulations required for a given test. This OMD environment will allow the user to create, store, retrieve, modify, delete, and transmit OMD. ETS will provide the capability to generate OMD traffic among the EOSDIS elements within the scope of ETS. When requested, the OMD will be coordinated with and reflect the contents of the ETS-generated data. In addition, ETS will be able to respond to received OMD, such as messages requiring acknowledgments, retransmissions, or responses. For testing purposes, ETS will be able to simulate OMD for up to three sources simultaneously.

2.5.3 Offline Functions

A final set of system-level functions can be included in the general category of offline functions. These capabilities involve managing data required by ETS during operations.

2.5.3.1 Data Updates

It is envisioned that ETS will incorporate data from other sources where possible and will require utilities to accept the data, modify it, access it, and store it for ETS use. The data may consist of user data sets, data tables, or databases. For example, the ETS spacecraft simulation system may require use of a subset of the EOS AM-1 Project’s database (PDB) to build telemetry data formats and to verify received commands. As project updates of the PDB are released, the ETS operations personnel must ensure that ETS is running with the most current version.

2.5.3.2 ETS Library

The collection of user data files will be the basis of an ETS test library, which will be located with the ETS-HRS. The present plan is that the library will consist of tape cassettes containing various test data files already used in testing as samples of each particular type of data. After each user test, or perhaps in the user's original ETS scheduling request, the user test team will indicate whether to keep or delete the test data files. If a user wants to keep a data file beyond a few days, the request must be approved. ETS storage may be provided for up to 6 months for specified test data, subject to physical storage constraints. Users will be given the option of holding their own test data files for safekeeping and as a means of limiting ETS storage and maintenance requirements. The test data library volume will also be controlled with periodic and systematic

review of the data files. Over time, the library holdings would be expected to contain consolidated files that will help improve the thoroughness and efficiency of regression testing or end-to-end IV&V testing.

The ETS operations personnel will catalog the test data files that have been verified and selected by the test team. The test data files will be listed, for example, by data description, including creation source, type, and format of the data, test objective, and date of data origination. Tape cassettes numbered and classified by creation source or testing objective, and accompanied by descriptions and applicable test scripts, will make the test library useful for testing of system upgrades, regression testing, multiple-element testing, and general test repeatability.

The list classifying the test data files will be available for users' reference. Test team coordinators will check on the existence of stored test data files that would meet the needs of planned tests. If the stored data file matches the user's requirements, the need for the ETS data-generation time during the pretest phase would be precluded or reduced simply to customizing existing data for the user's specific requirements. Such customization might include changes to various fields in the header or error insertion.

For data security and physical safety, the test data files on tape cassettes must be kept in a secured cabinet, away from heat, excessive humidity, and magnetic sources. Backup procedures and other configuration management controls will be implemented by the operations personnel to ensure that data integrity is preserved over time.

Section 3. System Operations Concept

This section provides an operational overview of ETS. Section 3.1 presents the ETS operations concept, and Section 3.2 describes five configurations in which ETS will be used to support EOSDIS testing.

3.1 System Operations Concept

ETS is being developed for the ESDIS Project as a key test tool to support EOSDIS testing. It will be available to provide test support for EOSDIS element development, EOSDIS ground system integration, and EOSDIS IV&V test activities. Scheduling and operational support of ETS are controlled by the ESDIS Project. At this time, the staffing profile for ETS operations is not known; for discussion purposes, some functions are ascribed to ETS operations personnel, who will be sitting at ETS consoles and operating ETS equipment, and some functions are assigned to the test team, who will be responsible for detailing the test objectives, describing the needed ETS data, and assessing the test results. The two functional roles are discussed as though they are separate entities; in reality, however, for some tests the roles may be performed by the same group or individual.

ETS will have three phases of operation in a complete test session: the pretest preparation phase, the test execution phase, and the posttest analysis phase. Figure 3-1 shows typical activities performed in these operation phases. In most cases, ETS will be used to generate test data before the test according to the test scripts developed by the EOSDIS test teams. Data will be verified and stored for later use. During the actual test, ETS will transmit the prepared test data at requested data rates to the element(s) under test. Data received by ETS during a test session will be stored and then analyzed. ETS will provide data quality, accounting, and performance monitoring and verification capabilities during the test. Following the test, test data and test summary results of file comparisons and statistical tabulations will be provided to the test team for their analyses and interpretation.

In test scenarios other than those for which ETS provides the simulated spacecraft data as direct bit stream input to EDOS, ETS will be connected to the element under test through Ecom. For contingency-mode operations, Ecom will provide for Nascom circuits and will perform required blocking and deblocking functions. The control of ETS will be accomplished using a workstation incorporated into the ETS architecture. The precise configuration of network communications will depend on the test script, which will be developed prior to the test.

At each test site, ETS will have access to the facility's existing voice communications. Although it is not mandatory for testing operations, ETS access to the facility's e-mail communications is also highly preferred. The voice and e-mail communications will be used during the test execution phase and the posttest phase for informal test reporting.

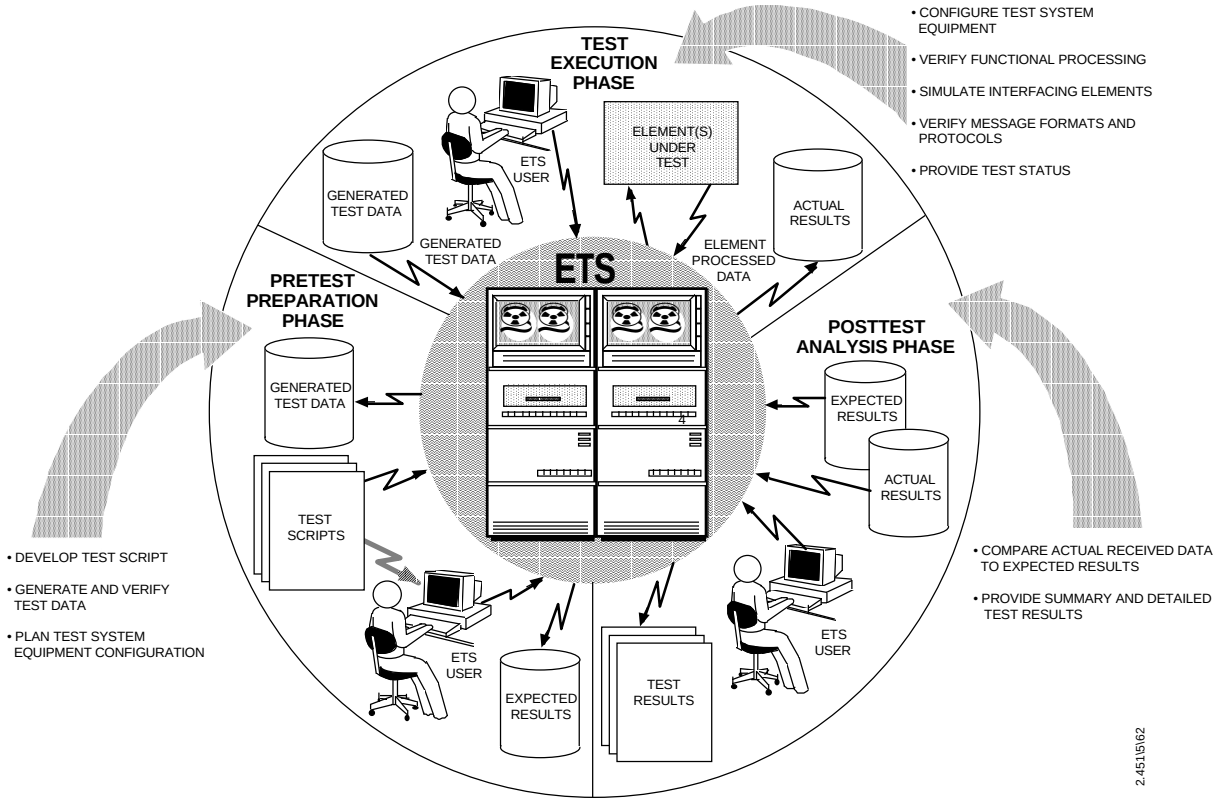


Figure 3-1. ETS Operations Phases

3.1.1 Pretest Preparation Phase

When ETS is scheduled, the test team will develop a detailed description, or test script, of the test objectives; types of test data required; start time; operational sequences and times; and specific, ordered ETS activities to be performed during the test. The test script should also specify the desired systems and communications configuration to be used in the test, as well as the type of results reporting, format, and media required. ETS operations team members will assess the resource requirements associated with the test and will coordinate any special test requirements with the test conductor and test team.

ETS will have capabilities both to generate test data required by the particular test script and to accept user-provided test data. The ETS-generated test data will be sufficient for most element testing, but depending on the testing objective, user-supplied data may be preferred in some cases. Thus, in this pretest phase as well as in the other two operational phases, coordination will be important between the members of the test team, who write the test script, and the members of ETS operations team, who follow the test script and use ETS to generate or ingest the test data. The ETS operations team will be active partners with the test team.

The data-generation activity will be automated to the extent possible. For each data set, a setup or configuration file will be created. Depending on a number of factors, such as the complexity of the data set or test criticality, either the setup catalog file alone or both the file and the resultant generated data will be stored. When the test data has been generated (Reed-Solomon encoded, packets placed into VCDUs, and headers and trailers built), the data will be verified through ETS offline utilities that perform quality and accounting checks on the data. The verified data may then be written to ETS tape cassettes. Data sets stored in this way can be used directly in future tests, thus bypassing the data-generation activity. If the same packet data can be reused with updated time-tags or modified header information, some data-generation time will be required, but it will be less than the time needed for entirely new data generation.

For tests in which ETS will be used to receive and verify the output products of an EOSDIS element under test, the final stage of the ETS pretest phase will include generating expected results files. This activity may involve processing the raw ETS test data using element-established data product specifications and formats, or using knowledge based on the input set characteristics to create the output data set independently. The results files are stored for later reference. In the posttest phase, ETS will use these results files for comparison with the received (element-processed) data.

3.1.2 Test Execution Phase

Just before the start of the test execution phase, the ETS operations team will configure the required ETS resources for the test based on the particulars of the test script. This activity will include loading data-generation catalog files or positioning data files for transmission, checking data lines, and running hardware self-test diagnostics.

During the actual test execution phase, two main types of tests will be executed: tests in which ETS verifies the processing of an element, and tests in which ETS simulates an element in support of testing another element.

In the first case, ETS will transfer test data to the element under test. When that element has completed its required functions on the data, ETS will receive the element-processed test data and store it for access during the posttest analysis phase, when it compares the observed data to the expected data sets.

Examples of the simulation type of tests for which ETS may be used include element interface testing, verification of destination routing, and administrative message handling. Simulation tests may also be performed when an EOSDIS element needs properly formatted data to verify some internal processing, such as would be needed for regression testing after a modification to one of its subsystems. ETS simulations can be useful in element testing when the systems interfacing to the given element are not yet operational or not available for test support.

During the test, ETS operations team members will monitor the ongoing test activities. The ETS control terminal will display system and test status during operations. ETS will have the capability to generate interim or running totals in the test execution phase for the user, on request. The ETS test execution will be automated to the extent possible to conform with the test requirements such as the start and stop times of the test or the delivery of a precise number of data units. A manual override capability will exist to start or stop data transmission at any time, to change data files, or to execute other test-team-directed, nonscripted requests within ETS capabilities. ETS operations team members and the test conductor must maintain close coordination to help ensure that testing proceeds smoothly and that any required manual interventions in the running of ETS are performed accurately and efficiently.

An automated log will be maintained during the test to record test-related activities, such as operator keyboard type-ins or receipt of system inputs such as spacecraft commands. The log will be manually supplemented with details of procedures and activities of the ETS operations team. In the event of anomalous conditions, ETS operations team members will analyze and attempt to correct any test anomalies and will relate their findings to the test conductor.

3.1.3 Posttest Analysis Phase

During the posttest analysis phase, ETS will perform the appropriate calculations, counts, and comparisons needed to generate the particular test's results. For tests that involve EDOS processing verification, an ETS-generated data file of expected results will be compared to the file of data actually received from the element under test. The posttest analysis phase may be able to begin as soon as processed test data is received from the element, based on equipment availability, and it will continue for some time after the test until compilation of the required results is complete. ETS will have the capability to generate test summaries, as well as final analysis results. In some cases, these summary reports in themselves may be sufficient for the test team, and the time and the complexity of the full analysis may not be needed.

The control terminal will display system and test summary information in the posttest analysis phase. Test results can be reported on electronic or physical media or can be disseminated informally through voice or e-mail communications from ETS to the user test team. ETS operations team members will participate in the test debriefing and provide information about the performance of the system.

3.2 ETS Configurations

Through discussions with ESDIS Project representatives, the wide range of possible ETS capabilities was narrowed to those functions needed to support five test configurations. These five test configurations were seen as the most likely ways that ETS would be used to support EOSDIS test and simulation needs:

- Configuration 1—TGT high-rate interface with EDOS
- Configuration 2—EDOS interface with DAACs
- Configuration 3—DAAC interface with EDOS
- Configuration 4—ETS as low-rate spacecraft simulator
- Configuration 5—ETS as EDOS simulator for EOC interface to SCITF and SSIM

In Configuration 1, ETS can be used in a test capacity to verify the EDOS processing of high-rate science data. ETS will transmit a source of science playback data at 150 Mbps to EDOS. EDOS will process the data and transmit the output. The output data from the level-zero processing (LZP) will be captured by ETS for verification of the EDOS data processing. ETS will be active in simulation modes in Configurations 2 and 3, simulating EDOS data set output to DAACs and simulating DAACs input of EDOS data sets, respectively. Configuration 4, which is ETS functioning as a spacecraft simulator, has two variations. Configuration 4A requires EDOS participation for ETS spacecraft simulations with the EOC; whereas in Configuration 4B, ETS simulates the combined spacecraft, ground station, and EDOS interface to the EOC. In Configuration 5, ETS will perform some EDOS low-rate forward- and return-link data processing functions to support early EOC tests with the spacecraft at the developer’s facility and with the EOS AM-1 SSIM. Each of these configurations is discussed in more detail in the subsections that follow.

3.2.1 Simulation of TGT Interface With EDOS

This configuration of ETS can be used to test the TGT high-rate return-link interface with EDOS, verify EDOS processing of EOS AM-1 spacecraft data, and "drive" the EOSDIS for early test and simulation purposes. The primary purpose of this configuration is to test the EDOS ability to capture and process the high-rate return-link data. ETS will provide a source of high-rate science data, receive the EDOS output, and provide tools to assist in the verification of the EDOS processing of the ETS transmitted data. Data format and data rate tests can be performed. Figure 3-2 shows the high-level data flow of this configuration, and Figure 3-3 shows a more detailed decomposition of the ETS functions involved. (See also Section 3.2.3 for ETS in the configuration of capturing EDOS data sets.)

ETS will create a stream of CADUs and transmit it as though the data came from TGT at rates up to 150 Mbps. This data stream will be generated and stored before the data flow; it cannot be modified during a test. The data will be generated according to user selections from formats defined in the applicable spacecraft data format control documents. The items that can be

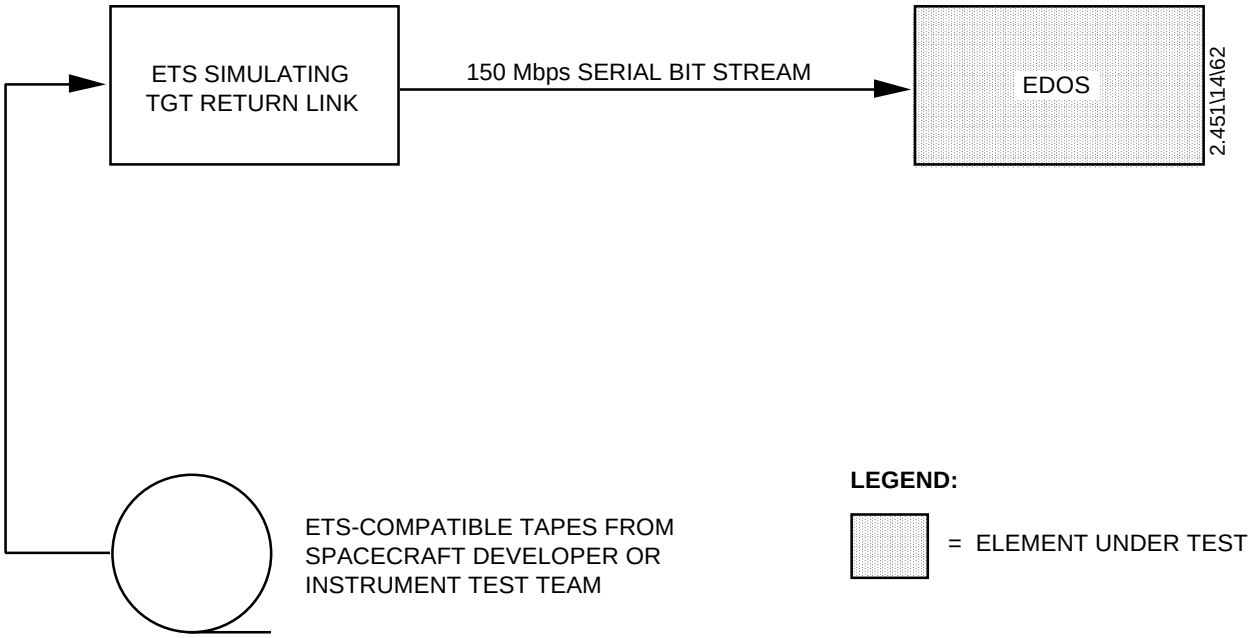


Figure 3-2. High-Rate TGT Return-Link Simulation

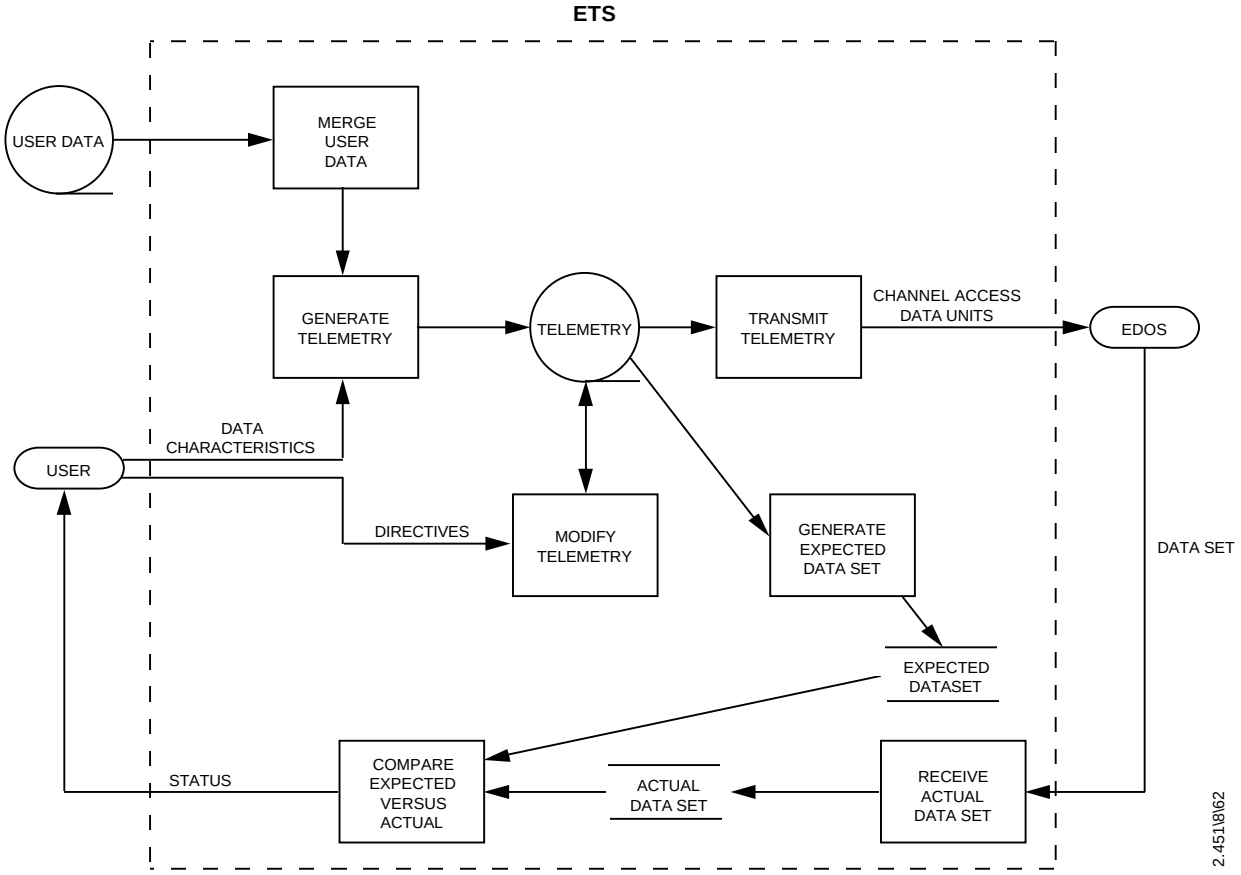


Figure 3-3. Functional Decomposition of Configuration 1

specified will include the number and values of VCIDs, the number and values of APIDs, length of frames, length of packets, Reed-Solomon interleave factor, and characteristics errors. Alternatively, packets or frames from other sources can be used as part of, or instead of, ETS-generated data. Users can provide their own data sets for merging into ETS data streams. Recorded data from actual spacecraft tests or from other data sources, such as spacecraft simulators or instrument subsystems, can be used with ETS when more realistic data is needed for particular tests.

For some test scenarios, errors will be intentionally inserted in the data to test the error handling of the element under test. ETS will simulate various space-to-ground conditions in the data, including errors in the data or loss of data as manifested by data gaps and packet fragments interleaved with complete packets. ETS will be able to generate duplicate data such as would occur during the overlap of two TDRSS sessions. The test team will select the rate, format, duration, and error conditions, if any, for each data transmission during the test to meet their particular test objectives.

If the intent of a test is to verify EDOS processing and its data set production capability, ETS can be used to generate both an input CADU data stream and the expected data set(s) that would result from the EDOS processing of that data. During the test, the input CADU data stream will be transmitted to EDOS. On completion of the EDOS processing, ETS will receive the actual EDOS-produced data sets, which will be compared to the expected data sets. The appropriate interface control documents (ICDs) will be followed to form the data set header, trailer, quality and accounting annotation, and so forth. Data sets will be correlated with the data stream from which they are produced and stored on tape or disk.

Because in most cases ETS will generate test data and store it before the actual test, data sets can be verified internally before they are transmitted to EDOS. Data sets will be checked to ensure that they are what is expected and that proper data format conventions have been followed. ETS will also be used to generate summary quality and accounting statistics on the prepared data. Sufficient lead time for data set creation must be allowed for this configuration. It may take from several hours to a full day to pregenerate a Reed-Solomon encoded CADU data file of 26 gigabytes (GB) that would run for 25 minutes at 150 Mbps. The software encoding, which requires the compute time, is necessary for tests that require data transmission error simulations.

During test execution, the data will be transmitted to a serial interface, appearing as a serial bit stream with clock and data, as input to EDOS. If the test includes a verification of EDOS processing, ETS will be configured to receive the output products from EDOS through Ecom. Following the test, the testers will use analysis tools to verify the content and format of the received data set.

3.2.2 Simulation of EDOS Interface With DAACs

This configuration of ETS will be used to test the output interface of EDOS to the DAACs (or any other element that receives EDOS-produced data sets). Figure 3-4 shows the high-level data flow of this configuration, and Figure 3-5 shows a more detailed decomposition of the ETS functions involved.

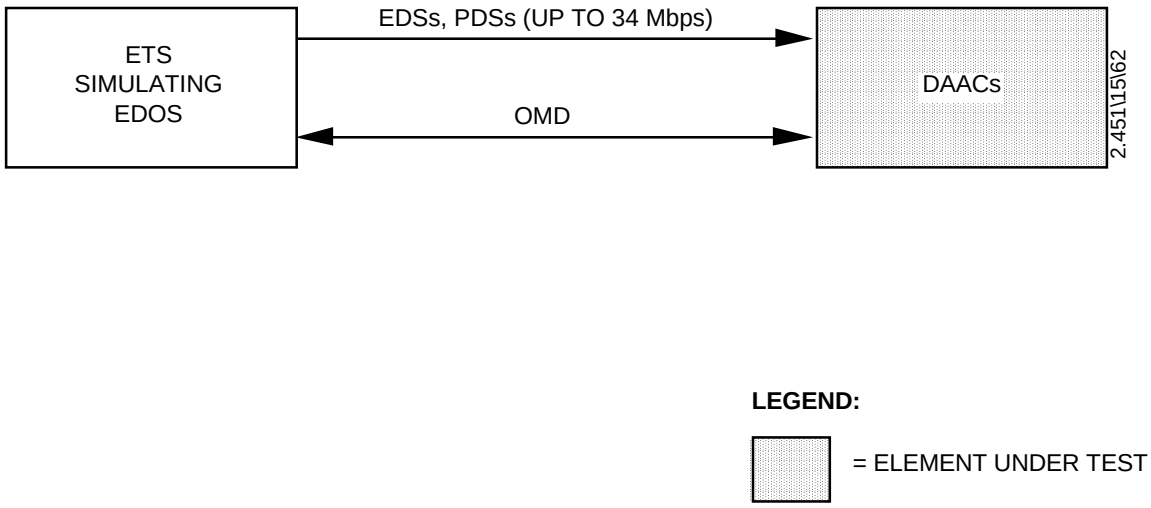


Figure 3-4. EDOS Output Product Simulation

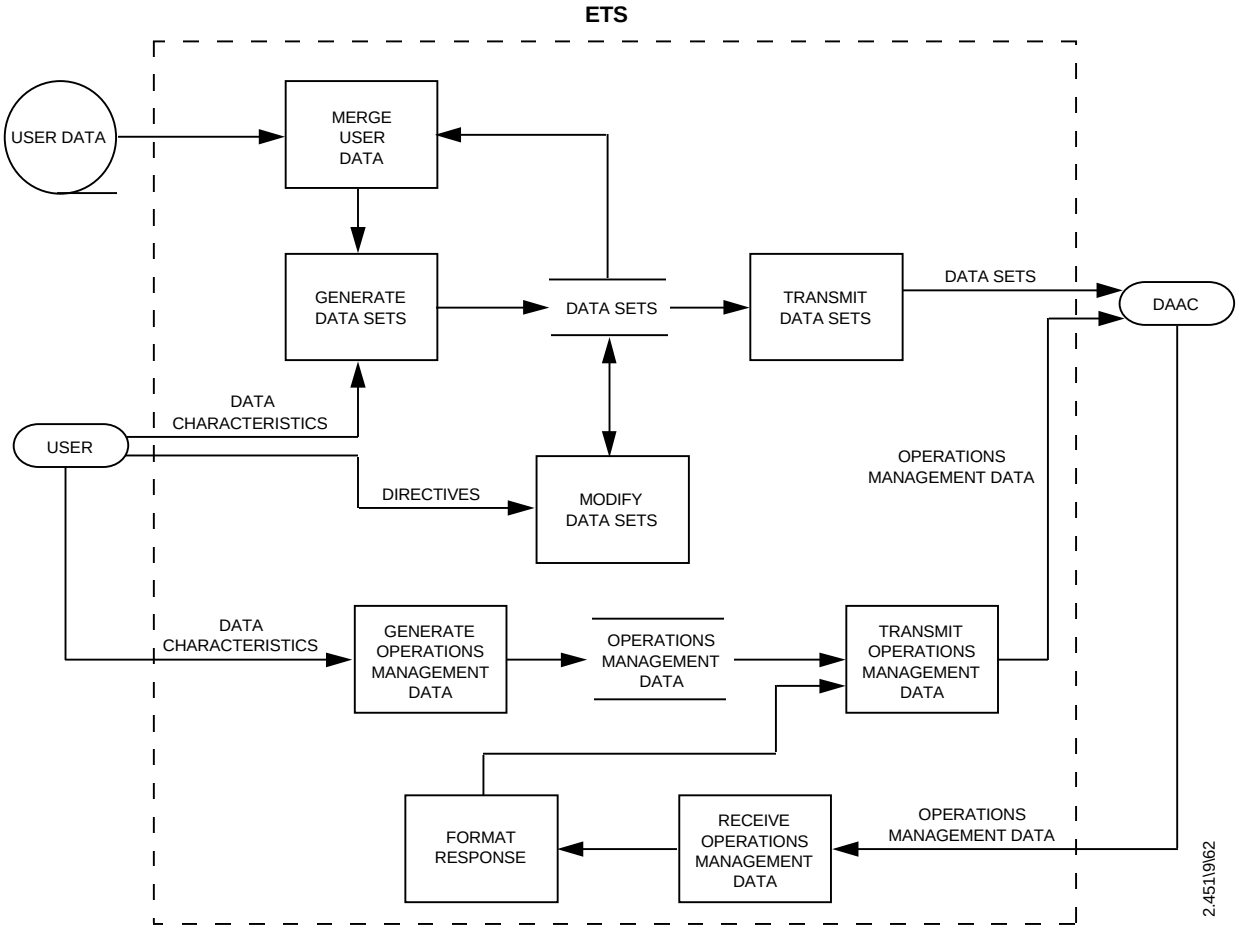


Figure 3-5. Functional Decomposition of Configuration 2

ETS will be used in this configuration to simulate the transmission of EDOS PDSs and EDSs to ECS DAACs. During the test execution phase, ETS will transmit the data sets through Ecom. ETS can simultaneously transmit data sets to three DAAC destinations at a maximum aggregate rate of 34 Mbps.

ETS can simulate the production of an EDOS data set in two ways. A data set generation utility can generate a data set according to EDOS formats and the user specification of packet-level data characteristics. Alternatively, ETS can process a CADU stream to generate a data set. The input stream can be captured from a TGT-test source or can be generated by ETS and then later processed at a lower rate.

To test the interface to the DAACs, ETS will use any data set that the tester selects. Because ETS will generate test data and store it before the actual test, the data sets can be verified internally before they are transmitted to a DAAC. Data sets will be checked to ensure that header fields are correct and that proper data format conventions have been followed. For some test scenarios, errors will be intentionally inserted in the data set header to test the error handling of the DAAC. ETS will also be used to generate summary quality and accounting statistics on the prepared data.

ETS will have limited capability to respond to received OMD. ETS will acknowledge messages when acknowledgment is part of the accepted protocol or will reply to service requests with accept or reject dispositions. In addition, delivery records will be based on the actual data transmitted, and construction records will indicate the quality and accounting information contained in the associated data sets.

3.2.3 Simulation of DAAC Interface With EDOS

This configuration of ETS, shown in Figure 3-6, will be used to test the EDOS output interface to a DAAC for transmission of data sets. ETS will simulate the DAAC by receiving data sets from EDOS through Ecom, storing the received data up to the maximum allotted storage capacity, and providing quality checks and accounting of the data. A single stream of data sets (ETS simulating one DAAC) can be received at an aggregate rate of 34 Mbps. ETS will also simulate the DAAC's exchange of OMD with EDOS, including the receipt of delivery records and the transfer of service requests and status data. Figure 3-7 shows the ETS functions represented in this configuration.

3.2.4 ETS as Spacecraft Simulator

This configuration has two variations, as shown in Figure 3-8, in which ETS will serve as a basic, low-rate spacecraft command and telemetry simulator. Configuration 4A requires EDOS between ETS and EOC; Configuration 4B does not. In Configuration 4A, ETS can be used to test the communication links between the space and ground network interfaces to EDOS and the EOC for normal and contingency modes of operations. Spacecraft data format and data rate tests can be performed. The transportable component of ETS can be used for this configuration; it can be operated at EDOS, the ground stations, or the launch site. ETS transmits low-rate S-band return-link data in the form of CADUs and receives spacecraft commands in the form of CLTUs.

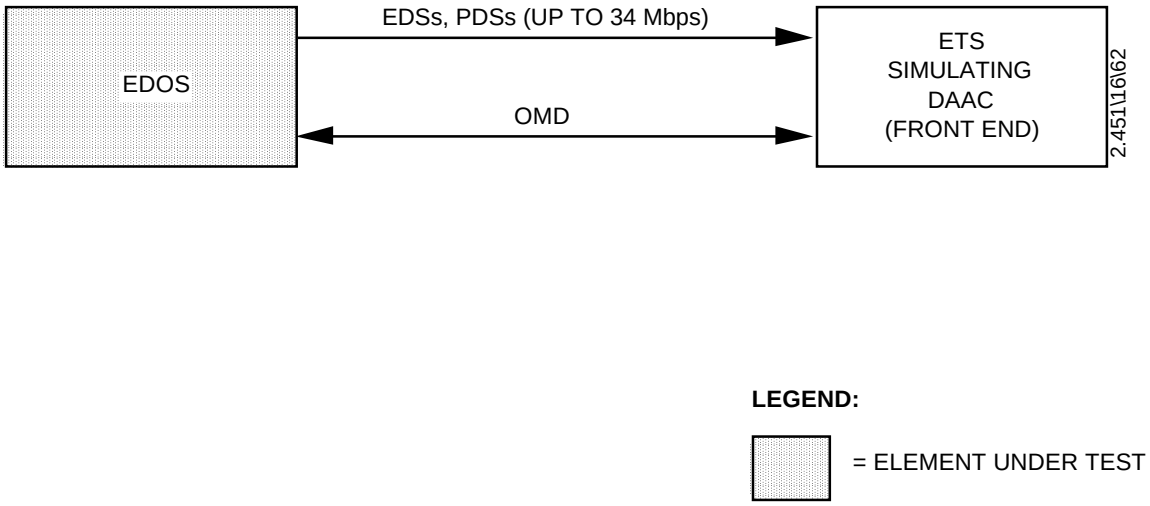


Figure 3-6. DAAC Front-End Simulation

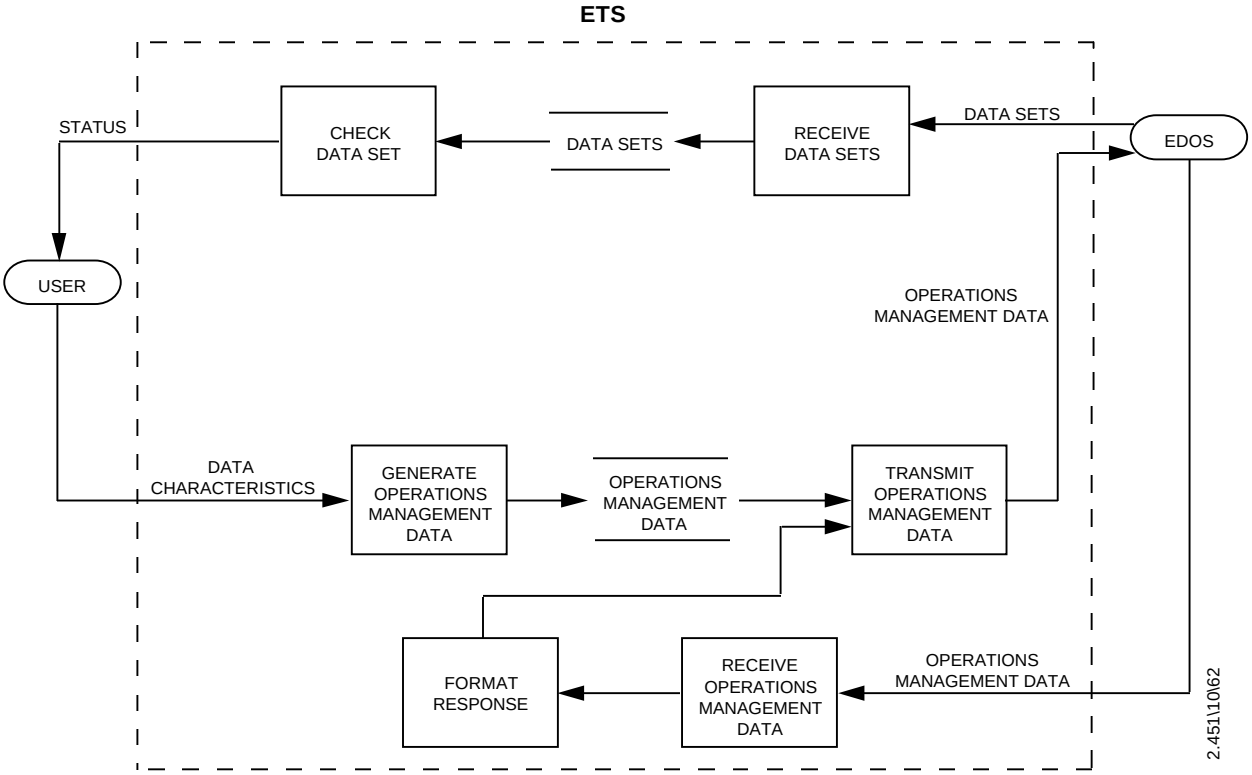


Figure 3-7. Functional Decomposition of Configuration 3

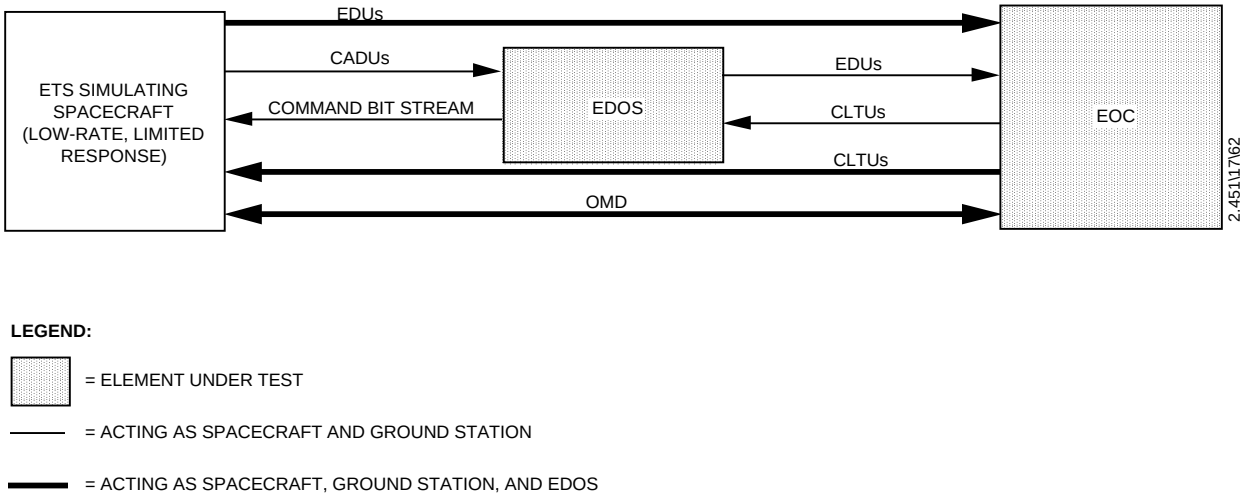


Figure 3-8. Spacecraft and Ground Station Simulation

The return-link data and forward-link commands can be formatted as serial bit streams for normal-mode operations or embedded in Nascom 4800-bit blocks (GN, DSN, or WOTS format) for contingency-mode operations. For Configuration 4B, when ETS is simulating the spacecraft and EDOS simultaneously, ETS will support the data formats established for the EDOS-EOC interface. This data format mode parameter can be set up on a session-by-session basis. Figure 3-9 shows the functional capabilities of ETS as a spacecraft simulator.

If EDOS is available for test support, ETS will operate in the spacecraft-only mode (Configuration 4A). Alternatively, if EDOS is unavailable, ETS will be able to simulate the EDOS interface for direct interaction with the EOC (Configuration 4B).

ETS will receive CLTUs; validate the commands; and for a specified subset of commands, generate telemetry in response to those commands. Command counters and the CLCW will be updated in accordance with the COP-1 protocol. ETS will simulate housekeeping, health and safety, diagnostic dump, and solid-state recorder dumps of the housekeeping data.

ETS will provide the operator with some limited opportunities for interaction with the simulation. The operator will be able to send spacecraft commands, enable or disable any element of the command validation process, and set the CLCW for simulation and test purposes.

The operator will be able to monitor ongoing activities on updating status displays that will provide real-time information such as command status and configuration, telemetry status and configuration, CLCW value, spacecraft time, and values of other telemetry parameters. A history file will log commands received, command errors, and other system events for posttest analysis.

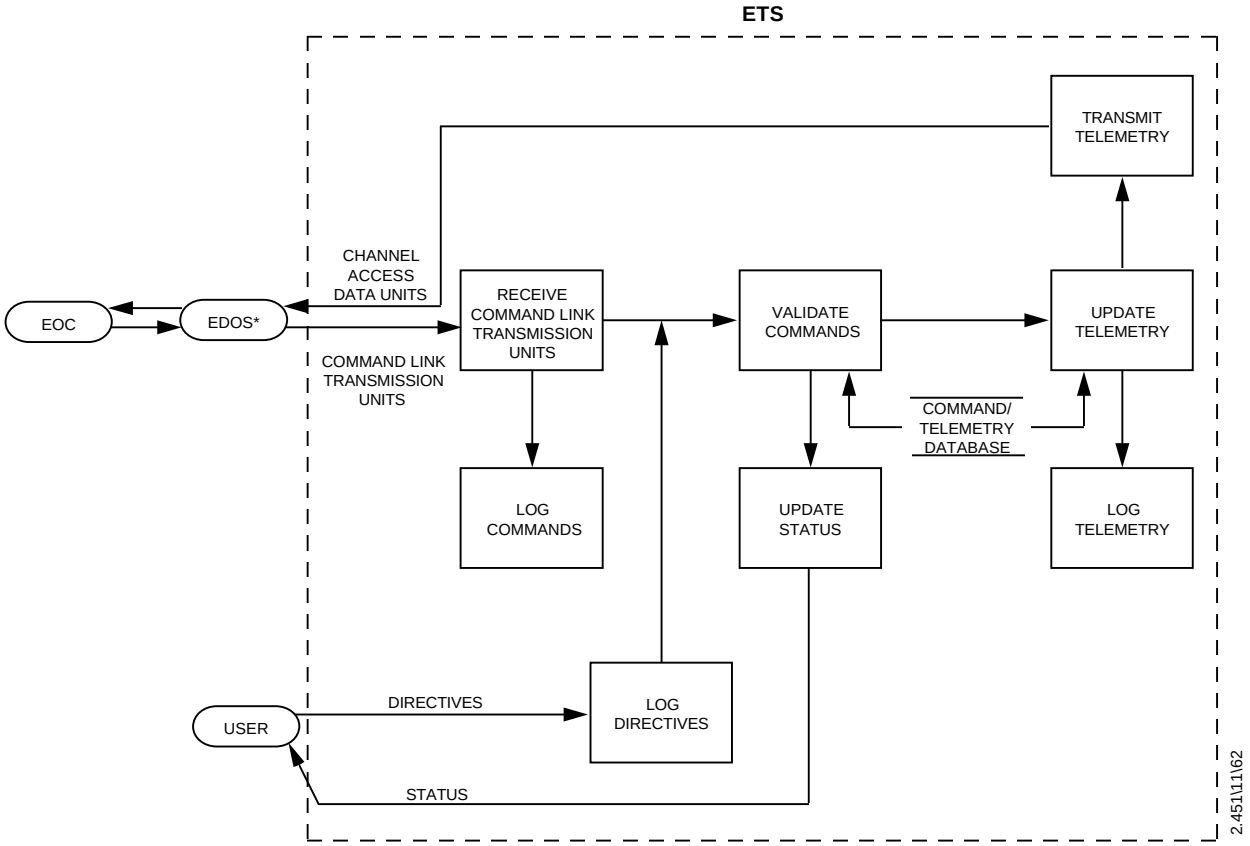
3.2.5 ETS as EDOS Simulator for EOC Interface to SCITF and SSIM

This configuration of ETS will be used to support early interface testing between the EOC and the EOS AM-1 spacecraft before EDOS is available for test support. In this test configuration, the spacecraft will be at the manufacturer's SCITF in Valley Forge, PA. ETS will perform the EDOS low-rate functions on both the received forward-link and return-link data streams. Figure 3-10 is a high-level depiction, and Figure 3-11 shows the functional capabilities of this ETS configuration.

For the return-link data streams of CADUs from the spacecraft, ETS will simulate EDOS by performing frame synchronization, Reed-Solomon decoding and correcting, packet and CLCW extraction, and transmission to the EOC in the form of EDUs. For the forward link, ETS will receive the CLTUs from the EOC and transmit the command bit stream to the spacecraft through the Ecom communication link.

The operator will be able to monitor ongoing activities on updating status displays that will provide real-time information such as the number of commands received from the EOC and the number of frames received from the spacecraft. A history file will log the received commands and received telemetry, subject to storage limitations, for posttest analysis.

This same ETS configuration could also serve as a front end to the EOS AM-1 SSIM, performing the necessary EDOS functions, to enable the EOC FOT to interact with SSIM. This usage of ETS, however, assumes that the SSIM interface to the EOC is identical to the SCITF interface.



*CONFIGURATION 4A: REQUIRES EDOS
CONFIGURATION 4B: ETS SIMULATES EDOS INTERFACE

Figure 3-9. Functional Decomposition of Configuration 4

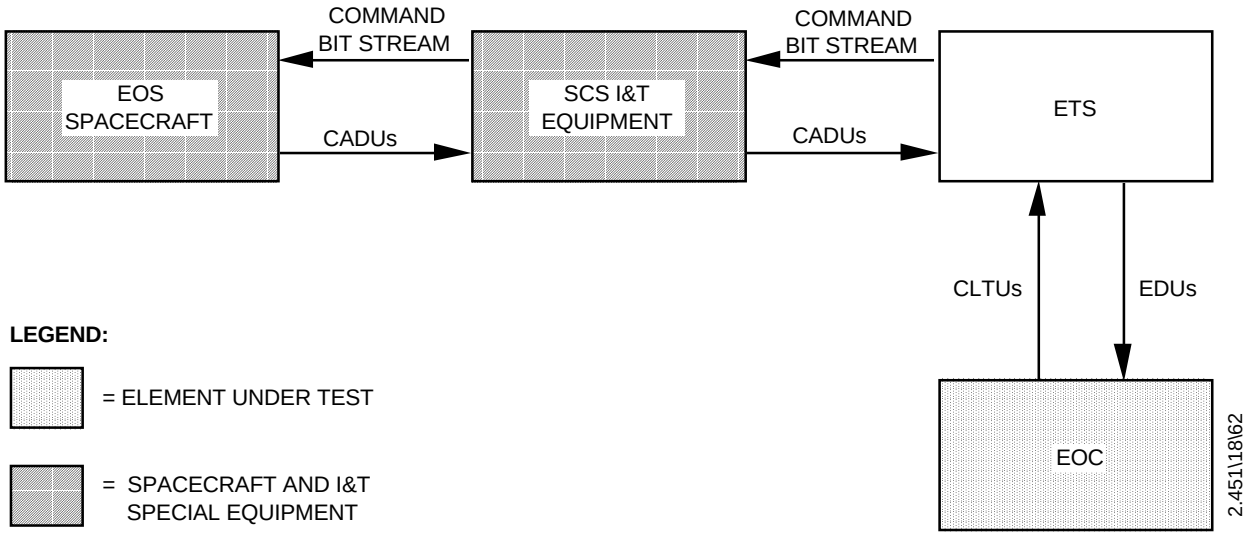


Figure 3-10. EDOS Low-Rate Simulation

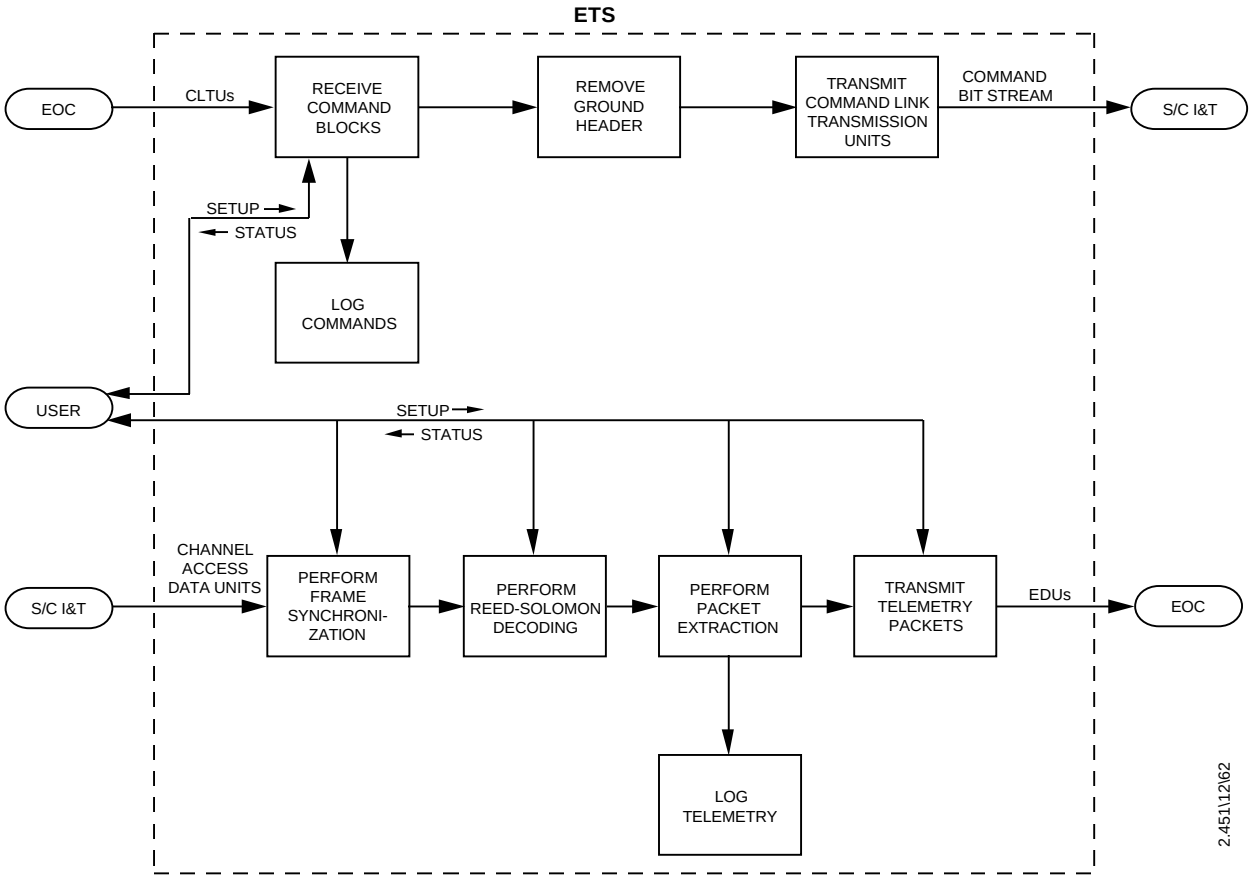


Figure 3-11. Functional Decomposition of Configuration 5

3.2.6 Tests Using Multiple ETS Configurations

Although each of the five configurations is treated separately in this document for discussion purposes, users should note that for a given test, more than one ETS configuration might be involved. For example, if a user wished to have ETS simulate both the high-rate and low-rate interfaces to EDOS with the TGT, ETS Configuration 1 would support the high-rate data requirements and Configuration 4 would support the low-rate data needs for the test. Another common pairing of functional ETS configurations is the test scenario in which ETS transmits the high-rate science data stream into EDOS (Configuration 1), and after EDOS has performed its LZP, ETS captures the data sets and verifies the EDOS processing (Configuration 3).

ETS has three types of simulators: the high-rate simulator (Configurations 1, 2, and 3), the low-rate spacecraft simulator (Configuration 4), and the low-rate EDOS simulator (Configuration 5). The simulators can be run simultaneously in test execution mode as long as all interfacing elements (e.g., EDOS, EOC) are able to support them. A particular simulator can be in test execution mode simultaneously with pretest and posttest activities; however, potential resource conflict may reduce response times below specified levels. The validity of the output products will suffer no negative effect.

Section 4. Operational Scenarios

This section describes a general operational scenario as well as five specific operational scenarios that emphasize the ETS user interaction with the following simulations

- TGT interface with EDOS
- EDOS interface with DAACs
- DAAC interface with EDOS
- ETS as spacecraft simulator
- ETS as EDOS simulator for EOC interface to SCITF and SSIM

Each operational scenario is divided into three ETS phases of operation: pretest preparation, test execution, and posttest analysis. [See Section 4.1 of the ETS system design specification (Reference 1) for more discussion of operational scenarios.]

4.1 General Operational Scenario

Operational scenarios for the ETS system will vary depending on the type of test configuration used; however, all scenarios have a common series of activities. These activities are summarized in Figure 4-1. The steps for the three ETS phases for a general operational scenario are described in the sections that follow.

4.1.1 Pretest Preparation Phase

The ETS user will perform the following steps to complete the pretest preparation phase steps for a general test:

- Define the test-related steps required for the upcoming test. The ETS user will derive the necessary steps from the test's objectives. These steps will be used to guide ETS test data generation, equipment configuration, and test execution activities.
- Use ETS-provided data-generation utilities to create well-defined data sets based on user specifications and/or data obtained externally from other sources if the data is not already in the ETS library.
- Determine the configuration of ETS equipment needed to meet the prescribed test requirements. This information will include, for example, specific information related to the source of the data, data rate, output channel, logging options, transmission duration, and input channels, if required by the particular test.
- For test activities that can be automated, prepare a test script timeline file that is used during the test to control repetitive or time-critical functions, depending on the nature of the test.

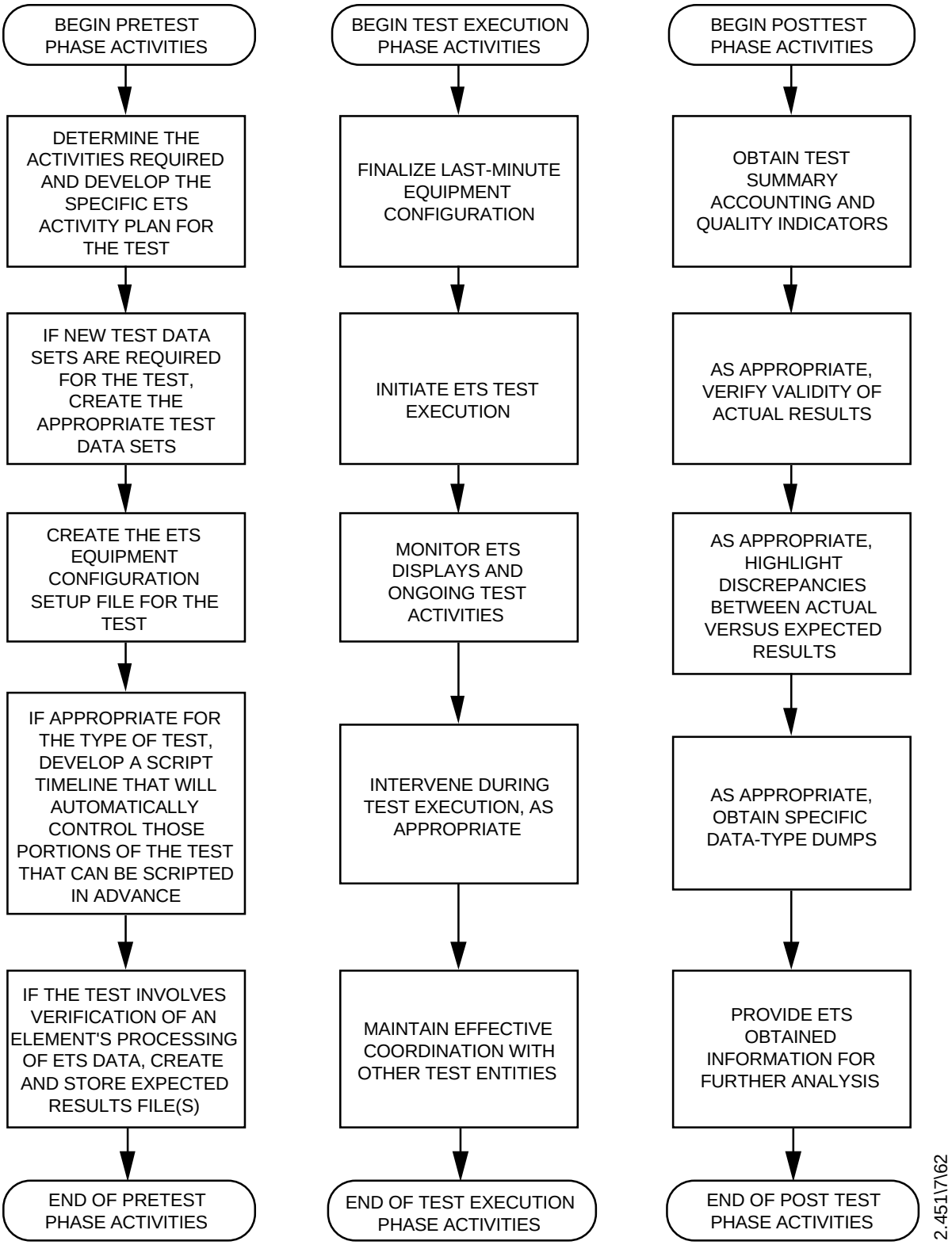


Figure 4-1. ETS General Operational Scenario

- Generate files containing the expected element's output for comparison in the posttest phase if a test includes verifying element (i.e., EDOS) processing of ETS-generated data.

4.1.2 Test Execution Phase

During the test execution phase, the ETS user will complete the following steps:

- Configure the equipment according to the setup parameters and procedures specified in the setup configuration files.
  - If necessary, make immediate adjustments, such as configuring the ports assigned for the specific test.
  - If the tape recorder system is being used as the source of data, the appropriate tape containing the test data set will need to be mounted and positioned.
- Initiate ETS test execution. The transmission of the test data can be initiated manually or be controlled by a test timeline, if one has been developed for the test.
- Monitor ETS displays showing the current status of the test.
- Intervene during test execution as appropriate. The need for direct user involvement during the test will depend on the extent of intervention required for the specific test as well as the extent to which test script timelining was used. The user will select and transmit OMD or respond to any system equipment anomalies as required.
- Maintain effective coordination with other test entities.

4.1.3 Posttest Phase

In the posttest phase, the ETS user will complete the following steps:

- Obtain copies of test summary accounting and quality indicators in printed or electronic format.
- If the test includes verification of element (i.e., EDOS) processing, use ETS general-purpose tools to assist in analyzing the results and determining whether the actual data received is correct and matches the expected data.
- Highlight discrepancies between actual versus expected results. Data set comparators can be used to identify differences between data files. The user will search through data sets or log files for selected fields or conditions for display, print, or extraction to another file.
- Obtain specific data type dumps as appropriate.
- Produce an ETS-generated report suitable for further analysis, and request various summary reports on the input data, the received data, or the results of data analysis utilities. The user can select reports for suitability to the needs of the particular test.

The subsections that follow identify activities characteristic of each test configuration that make it unique from the activities identified in Figure 4-1.

4.2 Simulation of TGT Interface With EDOS

4.2.1 Pretest Preparation Phase

Various options will be available for providing the high-rate Ku-band playback data needed to simulate the TGT interface with EDOS. The scenario for the pretest preparation phase is as follows:

- If new test data sets are required for the test and spacecraft data is not used, the user will
  - Simulate science data sets with a data-generation utility. The data-generation utility can be used to create a data set of CADUs for transmission to EDOS during the test. The user must specify packet APIDs, lengths, and packet-level data, to include a fixed byte pattern, incrementing byte counts, or user-provided packet data. ETS will also allow specification of VCIDs, frame lengths, header fields, and Reed-Solomon interleave depth. The user must specify the header or data fields to modify and the update criteria and cycle associated with each modification.
  - Generate data sets by modifying existing data sets.
  - Introduce error conditions in the simulated return-link data; intentionally inserted errors can include incorrectly formatted data, missing data or gaps (as indicated by breaks in sequence counters or packet fragments), data coding errors, or invalid header fields.
  - Check data sets to ensure that header fields and data formats are consistent with test data specifications.
  - Store data sets on tape.
- If spacecraft data or data from other simulated sources is desired, ETS can use this data. Data recorded during thermal vacuum testing with the spacecraft could be transmitted by ETS directly (assuming media compatibility) or merged into ETS-generated data streams. Presumably, these data sets could be used to supply the more realistic data content needed for certain tests.

4.2.2 Test Execution Phase

The scenario for the test execution phase contains no unique steps.

4.2.3 Posttest Phase

In the posttest preparation phase, the user will complete the following steps:

- Receive actual PDSs or EDSs from EDOS.
- Verify EDOS processing by using ETS general-purpose tools to assist in analyzing the results and determining whether the actual data received is correct and matches the expected data. ETS tools will be used to verify that VCDUs were demultiplexed or that fill frames were discarded from ETS-generated input data, or that the content of EDOS-generated data sets and the associated quality and accounting information reflect the ETS-provided data.

4.3 Simulation of EDOS Interface With DAACs

When ETS is simulating the EDOS, it will transmit simulated PDSs and EDSs. ETS will also generate and transmit OMD to reflect the created data sets. For example, delivery records will be based on the actual data transmitted, and construction records will indicate the quality and accounting information contained in the associated data sets.

4.3.1 Pretest Preparation Phase

In the pretest preparation phase, the user will determine whether an existing data set can be modified or if an entire new data set must be generated. If new test data sets are required for the test, the user will create a test data set using a data set-generation utility. The user will specify the data type, packet-level information (e.g., APID, length, times), data set size, error and quality indicators, and other criteria. Alternatively, ETS can process a previously stored CADU data stream to generate the data sets, if appropriate for the test.

4.3.2 Test Execution Phase

The scenario for the test execution phase contains no unique steps.

4.3.3 Posttest Phase

The scenario for the posttest preparation phase contains no unique steps.

4.4 Simulation of DAAC Interface With EDOS

In this configuration, the ETS user will be required to provide very little information because ETS will be functioning in a primarily passive role of receiving data.

4.4.1 Pretest Preparation Phase

The ETS user will perform the following steps to complete the pretest preparation phase steps for a simulation of ETS DAACs interface with EDOS:

- Create OMD or messages, such as a request for or an acknowledgment of receipt of a data set, if required.
- Establish an equipment configuration that specifies where the received data set should be captured, stored, and checked.

4.4.2 Test Execution Phase

During the test execution phase, the ETS user will transmit OMD and receive a data set. Depending on accepted EDOS procedures for the data transfer, the ETS user will transmit a service request; a message to indicate readiness to accept data; or, on receipt of the data set, an acknowledgment.

4.4.3 Posttest Phase

To complete the posttest for this scenario, the ETS user will use ETS tools to perform checks on the received data sets. Verification of the data will be limited to quality and accounting determinations. The user will check data set structure and format, rather than the actual content. Data search, display, and print utilities will be available to assist the data analysis.

4.5 ETS As Spacecraft Simulator

In both variations of this configuration, ETS will generate EOS spacecraft data formats and will receive and respond in a limited way to spacecraft commands. For this test configuration, ETS will simulate only the low-rate return-link data formats.

4.5.1 Pretest Preparation Phase

The ETS user will perform the following steps to complete the pretest activities for the simulation of the ETS as the spacecraft simulator:

- Use the data generation methods described in the simulation of TGT interface with EDOS. The real-time data formats can be simulated in real time to provide limited responses to a subset of spacecraft commands and to support the COP-1 protocol. Therefore, for this configuration, the entire data set need not be created before the test. An initial data set serves as a basis to which telemetry responses to valid commands are updated.
- Develop a test timeline that automatically controls those portions of the test that can be scripted in advance. The timeline will contain a sequence of operator type-ins accompanied by time-tags that are executed without direct ETS user intervention. This feature is useful in simulating a change in selected telemetry parameters over time; the

method is simpler than using complex modeling algorithms to achieve a predictable change to a data field.

- Interact with the EOC personnel to plan for ETS responses to the proposed commanding sequence for the test. ETS will receive and verify all received commands but will execute and respond only to a subset of EOS commands. The user will verify that ETS is using the same version of the spacecraft command and telemetry database as the EOC is using. The user will also run an offline update utility if needed before the test to ensure compatibility with the project database during the test.

4.5.2 Test Execution Phase

The ETS user will perform the following steps to complete the test execution activities for the simulation of the ETS as the spacecraft simulator:

- At the direction of the ETS user, or on successful execution of a command to initiate the downlink, ETS will begin transmitting the selected return-link data format at the appropriate data rate. ETS will react as planned to received commands.
- Interact with ETS by issuing a command line type-in to perform an ETS function or simulate a spacecraft function. A type-in could modify selected telemetry parameters or activate, pause, resume, or terminate a test script file throughout the test.

4.5.3 Posttest Phase

The posttest phase contains no unique steps.

4.6 ETS As EDOS Simulator for EOC Interface to SCITF and SSIM

ETS will be used in a different way for this configuration; in the other configurations, ETS will either generate or receive data as part of a planned test or simulation. For this case, ETS will simulate the EDOS low data-rate functions to support interface tests between the SCITF in Valley Forge, PA, and the EOC or to enable EOC interaction with SSIM.

4.6.1 Pretest Preparation Phase

The pretest preparation phase contains no unique steps.

4.6.2 Test Execution Phase

To complete the test execution phase when ETS is operating as an EDOS simulator and interface between EOC and either SCITF or SSIM, the ETS user will initialize ETS. During the test, ETS should run without any required intervention. ETS, functioning as a telemetry front-end processor for EOC, will receive CADUs from the spacecraft or simulator, frame synchronize the data, decode the Reed-Solomon error correction scheme, extract the packets, add quality and accounting information, and transmit the data unit to the EOC. CLCWs will also be extracted and

sent as EDUs. For forward link, ETS will accept the forward-link data in the form of CLTUs from the EOC and transmit the command bit stream to the SCITF or SSIM.

4.6.3 Posttest Phase

The posttest phase contains no unique steps.

Section 5. ETS Security

System security is multifaceted. The ETS discussion of security is categorized into five subsections: general security principles, physical protection and access security, system functional security, data security, and network access and interface security.

5.1 General Security Principles

Basic to system security is the principle that disruptive events or actions (either intentional or accidental) that might interfere with the continuity of mission operations should be eliminated or, at least, kept to a minimum. In consideration of ETS security, the following points are raised and recommendations made.

Planning and implementation of security measures for systems developed for the ESDIS Project must begin in the systems' development phases and not wait until their acceptance and operations phases. ETS will be implemented so that its operations meet the security requirements of EOSDIS elements within its testing scope. Because ETS must be a secured system accessing protected data, precautions and procedures that ensure and promote security are required. Procedures for identifying, reporting, and responding to computer security incidents will be established. Awareness of system security will begin early in system development and continue for the duration of the mission.

Another aspect of ETS security and system integrity for the development and operations environments is configuration management. Configuration management will control software versions, hardware upgrades, tracking and implementation of functional change requests, and test data.

5.2 Physical Protection and Access Security

ETS will, to a large extent, depend on the host site facilities and element(s) under test for its physical, power, and environmental security. Although ETS requires no additional protection above that expected to be provided by the test site facilities, it is expected that the test site facilities will support typical operational "good practices." For example, access to facilities and equipment should be limited only to those personnel who have a role in the testing. This restriction will minimize any potential physical damage to the equipment. Damage need not be intentional or purposeful (vandalism or sabotage) but could simply be accidental (coffee spills or smoke/dust pollution).

5.3 System Functional Security

Planning and implementation of security measures for ETS will begin early in its development phase and will continue throughout its operational life. The ETS system administrator's responsibilities will include ETS security and interaction with security personnel at the host facility to ensure ETS compliance with local security measures.

5.3.1 C2 Security Features of ETS

As a system, ETS will be implemented to support and conform to the highest security level of the elements within its testing scope. Degrees of controlled access protection are characterized on a scale from "D" (lowest) to "A1" (highest). Based on the EDOS F&PS 560-EDOS-0207.0004, dated 11/23/92 (Requirement 4.2.1.4.1), ETS is required to meet the "C2" level of trusted computer systems, as described in the *MO&DSD Automated Information System (AIS) Security Policy* (Reference 2). The C2 classification entails monitoring and controlling the following aspects of system operation:

- Discretionary access control—ETS will utilize two-levels of password security for system access. Users will not be able to request system functions for which they have not been given privilege. Access control also includes the capability of the system administrator to monitor and, if necessary, disable a user's privileges, as well as to receive notification of system security incidents, violations, and unauthorized attempts at system access.
- Identification and authentication—To help preclude unauthorized access to the system, each authorized ETS user will be issued a unique password by the system administrator. Users will be required to change their passwords periodically to enhance the level of security.
- Audit trail—ETS will record the login and logoff of system users and will log system input and output data. This will provide a record of system activity that can serve as an audit trail.
- Operational/life-cycle assurance—A combination of the above automated features and documented operations procedures will ensure system security for the system life cycle. These features and procedures will be included in formal training courses at ETS handover.
- Documentation—ETS security plans, automated capabilities, and supporting manual procedures will be documented. The ETS development team will conduct training courses, tailored to the staff's functional positions.

5.3.2 Additional Security Features of ETS

When a user logs into the system, a check is made to validate the access passwords and establish that user's system privileges for that session. All requested activities during the session must be within these privileges.

ETS operations team members running the system will not have access to the ETS executable or source code. That is, there must be a distinction in access privileges at the session level between ETS operations team members and ETS system engineers/maintenance programmers.

Future ETS operations and procedures documentation will describe roles and responsibilities of the system administrator regarding security issues and will recommend schedules, audit, and media maintenance for the backup of system and test data.

5.4 Data Security

The ETS is required to protect its test data and to limit access to this data. ETS must prevent unauthorized access and preclude any unauthorized modification or misuse of the test data content. Appropriate security procedures will be prescribed and installed during ETS development and will be followed by the ETS operations team. These security measures will be mainly procedural and physical rather than automated or implemented as a layer of system software. The design of ETS will permit future upgrade of system and data security to Sensitivity Level 3, if deemed necessary later.

The data security provisions also apply to the ETS library. There are physical requirements for the maintenance of system and test data library files. Removable media (cassettes and/or tapes) will be secured in lockable, nonmagnetic, fireproof, and waterproof containers. Access to these containers will be limited to appropriate personnel. Future ETS operations and procedures documentation will detail the procedures required to ensure physical data security.

5.5 Network Access and Interface Security

Being a test system, ETS has interfaces with external systems and networks. Networks have the specific additional requirement for limited-access communication lines. In general, limited-access line support will be provided to ETS by Ecom and possibly Nascom. ETS will comply with provisions laid out in the *NASA Communications (Nascom) Access Protection Policy and Guidelines* (Reference 3). No requirement currently exists for Ecom or EDOS to provide data encryption.

An issue related to interface security is the recognition and identification by the element(s) under test of test data, in contrast to actual operational data. ETS assumes that there will be an EDOS Service Header test flag that can be used to identify test data.

5.6 Personnel Security

Ultimately, a system's security rests in the quality and understanding of its operations staff. ETS personnel should undergo appropriate training to ensure that they understand the mission in general and their responsibilities, as well as the details of their individual jobs.

ETS personnel will acquire the appropriate security authorization level as determined by the site and the security level needed for the element being tested.

Abbreviations and Acronyms

AERO	aerosols (series of spacecraft)
ALT	altimetry (series of spacecraft)
AM	morning equatorial crossing (series of spacecraft)
AOS	Advanced Orbiting Systems
APID	Application Process Identifier
ASCII	American Standard Code for Information Interchange
CADU	channel access data unit
CCSDS	Consultative Committee for Space Data Systems
CHEM	chemistry (series of spacecraft)
CLCW	command link control word
CLTU	command link transmission unit
COP	Command Operation Procedures
CVCDU	coded virtual channel data unit
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
DSN	Deep Space Network
Ecom	EOS Communications
EDOS	EOS Data and Operations System
EDS	expedited data set
EDU	EDOS data unit
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
ESDIS	Earth Science Data and Information System
ETS	EOSDIS Test System
FTP	File Transfer Protocol
GN	Ground Network

HRS	high-rate system
ICD	interface control document
IV&V	independent verification and validation
LRS	low-rate system
LZP	level-zero processing
Mbps	megabits (millions of bits) per second
MO&DSD	Mission Operations and Data Systems Directorate
MPS	multimode portable simulator
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
OCD	operations concept document
OMD	operations management data
PDB	project database
PDS	production data set
PM	afternoon equatorial crossing (series of spacecraft)
SCITF	Spacecraft Integration and Test Facility
SCS	Spacecraft Checkout Station
SSIM	EOS AM-1 spacecraft simulator
tar	tape archival retrieval
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TGT	TDRSS Ground Terminal
TSS	TDRS service session
VCDU	virtual channel data unit
VCID	virtual channel data unit identifier
WOTS	Wallops Orbital Tracking Station

Glossary

accounting data:	Information that describes in terms of volumes and quality the processing and the input and output of an ETS testing session. Accounting data comprises mission data identifiers, including time references; processing identifiers, and data quality and quantity information obtained and calculated. For examples of accounting data tracked, refer to the EDOS F&PS (Reference 4), Section 5.1.3, RLPF Functional Requirements.
Application Process Identifier (APID):	An 11-bit field within the primary header of a Version-1 CCSDS packet, which identifies a particular user application within a local naming domain. In EDOS, references to APIDs are assumed to be identical with a given spacecraft.
availability:	The probability that a given piece of equipment, function, or system as a whole is ready for operational use at the time it is needed. It is calculated as the ratio of uptime for the element, divided by the sum of its uptime maintenance (i.e., removing and replacing the failed item), preventive and its downtime. Downtime includes time allotted for corrective maintenance (i.e., deferred and scheduled maintenance activities), and administrative and logistic delay time. A = MTTF/(MTTF + MTTR)
bit-error rate (BER):	A ratio of the number of erroneous binary digits (bits) received, divided by the total number of bits received or expected to be received over a specified time period.
CCSDS services:	Data packaging and transmission services described in the CCSDS Recommendations for Space Data Systems Standards, as specified in References 5 through 9.
command link transmission unit (CLTU):	The service data unit used to transmit forward-link data in accordance with the CCSDS Telecommand recommendation, as specified in Reference 9.
construction record:	Data indicating the contents and quality of the associated EDS or PDS.
data set:	A data set created by EDOS, specifically, an EDS or PDS.
Deep Space Network (DSN):	Facilities and equipment, including the 26-meter subnetwork, at the following NASA sites: Goldstone, Madrid, and Canberra.
delivery record:	A record generated by EDOS describing the electronic delivery of an EDS or PDS to the DAAC or a rate-buffered data file to the EOC.
destination:	A ground service access point to which data is delivered.
dynamic data:	Simulated data that has values changing over time in a manner that is not predictable.

electronic media: Data transfer media such as communications networks, e-mail, or data lines, in contrast to physical media (hardcopy computer printout, removable disk, magnetic tape, and so forth).

EOSDIS element: An entity receiving EDOS services. Examples of EOSDIS elements include but are not limited to the EOC and DAACs.

EOSDIS test teams: Test teams including but not limited to the individual EOSDIS element developer test teams (i.e., EOC, EDOS), the EOSDIS IV&V team, and the EOSDIS integration and test team.

ETS Operations Team: Any group or individual who will operate ETS at its test site, including the trained operators, maintenance personnel, and sustaining engineering personnel.

ETS operator: A member of the ETS operations team who sets up, controls, and monitors ETS equipment for activities related to pretest, test execution, and posttest operations.

ETS user: A member of an EOSDIS test team who uses ETS resources to support test requirements and who is responsible for detailing test objectives, defining test data requirements, conducting or monitoring the test, and assessing test results.

expedited data processing: Processing performed on return-link CCSDS packet data from a single TSS. This processing includes the following functions:

- Sorting packets by SCID and APID or by SCID, APID, and secondary header quicklook flag
- Forwarding time order packets
- Identifying data gaps
- Producing summary quality and accounting information
- Creating an EDS from the resulting packets

NOTE: As part of expedited processing, these data do not receive routine production data processing services, such as data merging, and redundant packet deletion. All these packets are retained for production data processing.

expedited data set (EDS): The output of expedited processing. An EDS construction record is associated with the EDS. The EDS is delivered to the DAAC within 1 hour of completion of the TSS.

forward-link data: Data originating on the ground and passing through EDOS for transmission to a spacecraft.

frame synchronization:	A digital data handling procedure performed by a system that recognizes a fixed data pattern to determine the boundaries of a frame of data.
gap:	A condition of the test data in which there is a period of time when it appears that no data is being transferred. Three types of data gap are identified for ETS simulation: a clock signal is present on the transmission line, but no data is being transmitted; neither clock nor data is present on the line; and the clock signal is present, but there are no data transitions.
Ground Network:	Facilities and equipment at the following NASA sites: Mila, Bermuda, and Dakar.
high-rate data:	For ETS purposes, data at rates greater than or equal to 1.1 Mbps.
level-zero data:	Spacecraft or instrument data at full space-time resolution with space-to-ground communications artifacts removed.
log (verb):	To store received or generated data for the purpose of history accounting, fault isolation, or system recovery.
low-rate data:	For ETS purposes, data at rates less than 1.1 Mbps.
mission data:	Spacecraft, instrument, and other data for a specific mission. Mission data includes spacecraft forward- and return-link data in raw and processed forms.
multiple:	More than one simultaneously active data channel.
operations management:	The supervisory, control, and support activities needed to sustain operations at an acceptable level. For EDOS, this includes system processing control, operations planning, and EDOS and Ecom operations coordination for EOSDIS elements.
operations management data (OMD):	A generic term that describes any data used to manage EDOS operations and its interfaces. Examples of OMD include control, reporting, operations planning data, and service requests.
packet fragment:	A portion of a CCSDS packet. Packet fragments result from the loss of a CADU containing packets in the CCSDS Path Service spanning more than one VCDU.
physical channel:	A space/ground transmission medium.
physical media:	Removable disk, magnetic tape, or actual hardcopy (such as a computer printout or a screen dump onto paper), as opposed to electronic media such as communications networks, e-mail, computer memory, or online disk storage.
playback data:	Data that has been recorded onboard a spacecraft for later transmission to the ground.

playback processing:	Playback processing restores "as-recorded order" to spacecraft tape-recorded data received by the frame synchronization function in reverse order. Playback data received in forward order are processed and stored as received. Transfer of playback data commences after the completion of the TSS.
predefined:	Known and planned for. In the case of ETS, the types of errors introduced into the data are known and user chosen; they are not random, unpredictable, or unexpected.
production data processing:	Processing performed on return-link CCSDS packet data, which includes the following functions: a. Sort packets by SCID and APID b. Forward time-order packets c. Identify data gaps d. Identify and delete redundant packets between multiple TSSs e. Produce summary quality and accounting information f. Create a PDS containing merged data from multiple TSSs for up to a 24-hour period
production data set (PDS):	A PDS consists of packets with a single SCID/APID and includes quality and accounting information identifying all packet anomalies and data gaps. A PDS is generated from production data processing and is delivered to the designated DAAC within 8 hours for a covered 24-hour period.
quality and accounting data:	Data that describes the results of EDOS mission data archive and data delivery services. Quality and accounting data includes mission data identifiers such as time references, EDOS processing identifiers, and the mission data quality and quantity information obtained from the EDOS processing.
rate-buffered data:	Mission return-link data that has been received by the EDOS from a single TSS for delivery at a rate different from the rate received.
service access point:	The point at which services are provided by an entity to a user of the entity. Service access points can be internal or external to EDOS.
service reports:	A generic term for reports generated for EOSDIS elements, which may include administrative data, control data, and status data resulting from a request for EDOS services.
service request:	A request from an EOSDIS element for a change in the EDOS services being provided.

SN ports:	Physical connection points to the TGT through which physical channels can be directed.
source:	The ground service access point from which data is received.
Space Network (SN):	The combined space and ground segment elements supporting the TDRSS. The SN includes the TDRSs, the White Sands Complex, and the Network Control Center for TDRS scheduling and control.
static data:	Data that follows a fixed, predictable pattern over time.
status data:	Data that defines the characteristics of current system operations. Status data includes configuration, performance, fault, data accounting, and privacy and security information.
TDRS service session (TSS):	A TDRS service session is the duration of a TDRS service between acquisition of signal and loss of signal, assumed to be nominally 10 minutes in duration for EDOS considerations.
test data:	Data used for testing and/or diagnostics.
test data set:	A data set comprising a test data set identifier, test data used, and accounting data. The expected test results may also be included or logically linked with the original test data.
test data set identifier:	A unique identifier for a given test data set.
test results:	The evaluation of the testing performed. These include detailed specifics of detected errors as well as summary totals and various calculated measurements.
testing session:	ETS testing operations are organized into three phases: pretest preparation, test execution, and posttest analysis. The term *ETS testing session* refers collectively to all three phases, when executed in a contiguous block of time.
user data:	Test data provided to ETS by an ETS-external source.
verification:	The process of confirming by test or comparison to other operating systems that a configuration item or configuration item component can achieve its objectives.
virtual channels:	A CCSDS architectural concept whereby a single physical channel may be shared by different users by creating multiple, apparently parallel, "virtual" paths through the physical channel. This is formally described in Reference 6.

virtual channel data unit (VCDU):	A fixed-length CCSDS AOS data structure used bidirectionally for space/space or space/ground communications. A VCDU that includes forward error correction coding is referred to as a coded VCDU (CVCDU) and is implied by references to VCDUs, as specified in Reference 6.

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