LDCM-I&T-002
Version 1.0

Department of the Interior
U.S. Geological Survey
National Aeronautics and Space Administration

LANDSAT DATA CONTINUITY MISSION (LDCM)

Ground Readiness Test Plan

DRAFT

September, 2009

Executive Summary

Document History

Document Number	Document Version	Publication Date	Change Number
LDCM-I&T-002	1.0	September, 2009	Original

Contents

List of Figures

List of Tables

Section 1 Introduction

1.1 Purpose

The purpose of the Landsat Data Continuity Mission (LDCM) Ground Readiness Test Plan is to define a comprehensive plan to test the LDCM ground system and verify the LDCM Ground System Requirements Document (GSRD) Level 3 requirements and ensure that the LDCM Ground System is ready to support the Mission Readiness Tests (MRTs) and the LDCM Mission.

1.2 Scope

The scope of this test plan covers all functions associated with the LDCM Ground System. This document includes the methodology that will be used for testing the LDCM Ground System, problem reporting procedures, roles and responsibilities, and an overview of each planned Ground Readiness Test and other tests that will be used to verify the LDCM Level 3 requirements in the LDCM GSRD.

A series of six Ground Readiness Tests (GRTs) will verify the functional requirements as defined in the GSRD. GRT 4 (USGS DPAS functionality) has been broken into multiple parts. The scope of the GRTs is outlined in this test plan. Details of each test, including the requirements to be verified, are included in the individual GRT Test Procedures. Successful completion of the GRTs is a requirement for conducting the MRTs.

Performance requirements and functional requirements requiring configurations outside the scope of the GRTs will be verified in appropriate network and mission level tests. These requirements are denoted in the GSRD Verification Requirements Matrix (VRM) and detailed in the appropriate network and mission level test plans and procedures.

1.3 Ground System Overview

This section provides a brief overview of the LDCM Ground System, its major components, and the responsibilities of each component. The LDCM Ground System will provide the following functions for the mission:

- Radio Frequency (RF) Communications with the Spacecraft
- Spacecraft Monitoring and Control
- Instrument Monitoring and Control
- Mission Planning
- Science Data Processing
- Science Data Archive and Distribution
- Orbit Management

These functions are performed by existing and new facilities. Figure 1-1 depicts the LDCM Ground System Overview. A description of the segments/systems and their constituent elements is shown in Table 1-1. Specifically, the MOE, CAPE and GNE are responsible for communication and control of the observatory, and collecting and transferring mission data to the Data Processing and Archive System (DPAS) for processing, storage, and distribution. The space segment consists of the spacecraft (S/C) bus and the Operational Land Imager (OLI) and Thermal Infra-Red Sensor (TIRS) instruments (jointly referred to as the observatory). NASA's Space Network (SN) and White Sands Complex (WSC) and Near Earth Network (NEN) provide S-band Narrowband communications between the observatory and MOC during launch and early orbit and during observatory critical events and contingency activities.

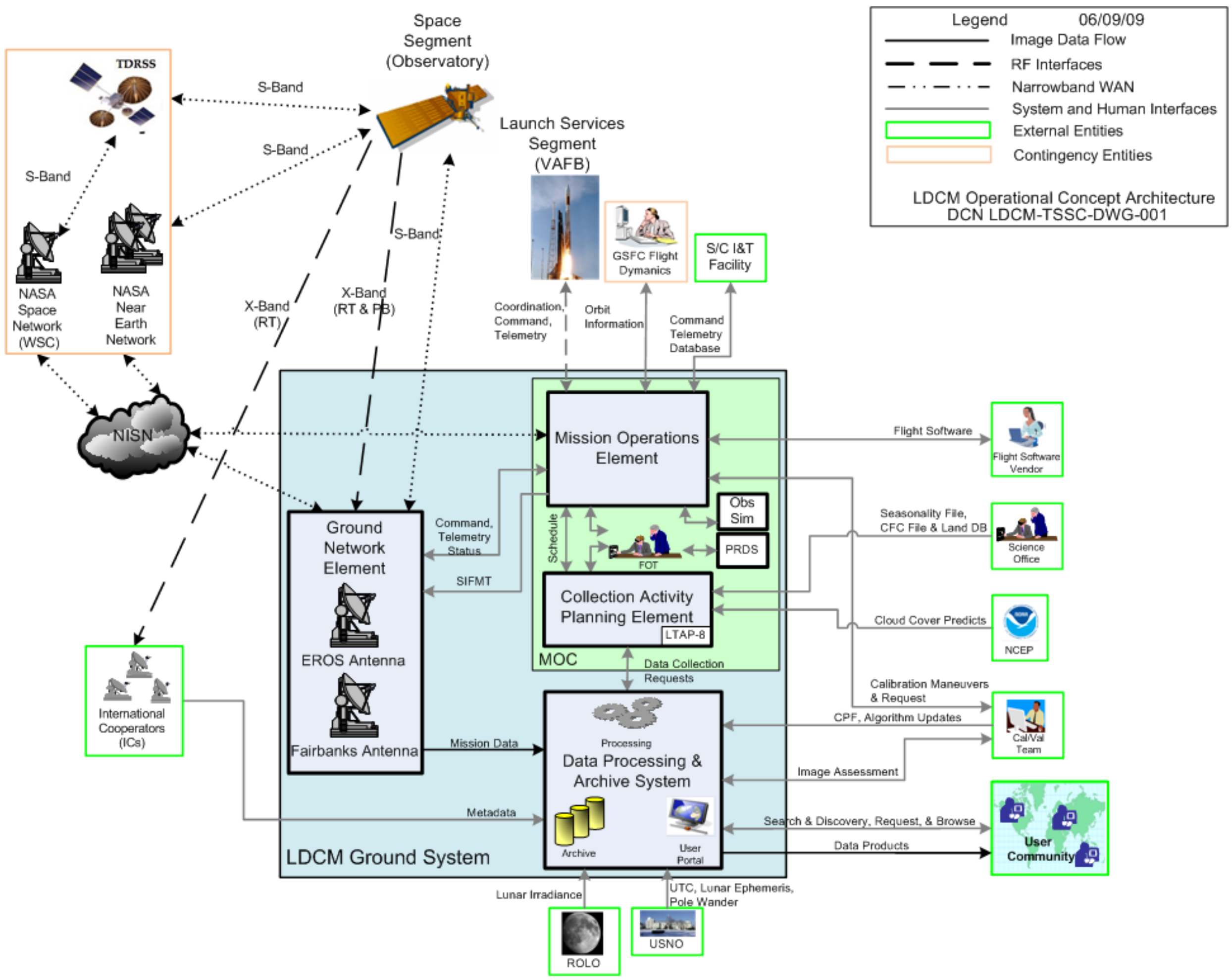


Figure 1-1 Ground System Overview

Segment/System	Element	Description/Function
Space	Bus	Provides power, command and control, and data handling for the OLI
	OLI	Acquires science image data
	TIRS	Acquires thermal infra-red data
Launch Services	Launch Vehicle	Places Observatory in proper orbit
Ground System	Collection Activity Planning (CAPE)	Generates schedules for instrument image acquisition
	Ground Network (GNE) Gilmore Creek LGN station (GLC) USGS/EROS LGN station (LGS)	Provides S-Band and X-Band radio frequency (RF) communication with the Observatory to send commands (CMD), receive housekeeping telemetry (TLM), and receive mission data via LDCM Ground Network (LGN) stations and wide area networks. The GNE also provides a mission data cache at the stations for disaster recovery.
	Mission Operations (MOE)	Provides the primary means to control and monitor the observatory; including mission planning and scheduling, command and control, monitoring and analysis, flight dynamics and onboard memory management. Resides within the Mission Operations Center (MOC), backup MOC (bMOC) and is operated by the Flight Operations Team (FOT)
	Data Processing and Archive System (DPAS)	Performs mission data ingest, data product generation, and image assessment; provides on-line, near-line, and offline storage for LDCM archive and product data; provides user interface for data search/discovery and distribution, and allows for users to submit imaging requests

Table 1-1 LDCM Segment/System Overview and Functions

1.4 LDCM System Interfaces

There are certain external entities that exchange information with the LDCM System. They are described in the sections that follow.

1.4.1 NASA Space Network (SN)

NASA's Space Network (SN) will provide S-band communications capabilities for LDCM. The SN Tracking and Data Relay Satellite System (TDRSS) will provide bi-directional data transmission services between LDCM and ground receiving stations, using satellite-to-satellite communications links to allow communications even when LDCM is not in view of a ground station. LDCM will utilize the SN during launch and early orbit for low-rate S-band uplink and downlink operations. Following commissioning, the SN will only be used to support observatory emergency operations and maneuvers.

1.4.2 Near Earth Network (NEN)

The Near Earth Network (NEN) includes several satellite ground receiving stations throughout the world that are available to support NASA missions. LDCM will interface with a subset of NEN stations for support during launch and early orbit operations. Following commissioning, the NEN will only be used in support of observatory emergencies and maneuvers. The NEN stations will provide S-band services for uplink and downlink only, with no X-band reception.

1.4.3 NASA Integrated Services Network (NISN)

NISN provides Wide Area Network (WAN), data, voice, facsimile, video, and other communications services. LDCM will utilize the Restricted IO Net between the LDCM MOE and GNE and other LDCM System Interfaces, NASCOM voice services, facsimile, video and other services.

1.4.4 NASA Flight Dynamics Analysis

The LDCM will utilize Flight Dynamics Analysis services during pre-launch, early orbit and for anomaly resolution activities. The NASA Goddard Space Flight Center maintains a Flight Dynamics Facility (FDF) that provides orbit determination, prediction, and control services which may be utilized in this support. The FD Analysis group offers interface and coordination support between operational missions and the entities discussed in the following sub-paragraphs. These interface needs may be satisfied directly by the LDCM Mission or through the FD Analysis group.

1.4.5 GSFC Space Asset Protection Mission Support Office

The GSFC Space Asset Protection Mission Support Office performs routine Conjunction Assessment (CA) analysis for LDCM utilizing data provided by the United States Strategic Command (USSTRATCOM) Joint Space Operations Center (JSpOC). The JSpOC generates close approach predictions between LDCM and other objects in USSTRATCOM's Space Object Catalog using an LDCM–provided ephemeris. The GSFC CA Team determines the threat posed to LDCM by each predicted event by computing the collision risk probability and analyzing other relevant factors. If needed, the GSFC CA Team provides consultation support to LDCM in planning any appropriate risk-mitigating action.

1.4.6 Earth Science Mission Operations (ESMO)

The ESMO office at NASA GSFC is responsible for the operation of several NASA Earth science missions. The LDCM orbit will allow LDCM to fly as part of a morning constellation that includes several ESMO missions, if they are still operational. (This constellation presently consists of Landsat 7, Terra, SAC-C, and EO-1.) Any required orbit or maneuver coordination to maintain this constellation is performed through human interaction with the ESMO staff and the potential exchange of state vectors corresponding to observatory orbits.

1.4.7 External Data Sources

LDCM will utilize certain external data as input to the ground system. These data will include auxiliary data such as government-provided ground control data and digital elevation models for terrain correction or lunar irradiance data to support imaging sensor calibration. External data will also include cloud prediction information used in data collection scheduling, or other data that are used to operate the mission or produce LDCM data products.

1.4.7.1 National Centers for Environmental Prediction (NCEP)

LDCM will obtain loud cover predictions from NCEP periodically throughout the day to support CAPE scene selection.

1.4.7.2 US Naval Observatory (USNO)

LDCM will obtain UTC / UTC1 timing and polar wander information from the USNO for use in geometric correction.

1.4.7.3 Robotics Lunar Observatory (ROLO)

The USGS lunar calibration program provides radiometric calibration and sensor stability monitoring for remote sensing satellite imaging instruments using the moon.

1.4.8 Spacecraft Integration and Test Facility (S/C I&T Facility)

LDCM interfaces with the Spacecraft Integration and Test Facility during the pre-launch phase to develop and test interfaces between the LDCM Observatory and Ground System. Database information, housekeeping telemetry and mission data are provided to the Ground System. A command interface is made available during controlled test periods. Testing is supported by a secure network between the MOC and LDCM resources at the I&T facility. An RF link is provided for test while the Compatibility Test Van is resident at the facility.

1.5 Primary Internal & External Users

This section describes the groups and teams that use or interact with the capabilities of the LDCM.

1.5.1 User Community

The User Community encompasses all those members of the general public that use Landsat data for purposes as diverse as scientific research and operational resource management. The User Community interfaces to the Data Processing and Archive System to search for, browse, order, and receive LDCM data products, and to request image collections. For ground system I&T, this role will be performed by a member of the GS test team or their designee.

The USGS convenes a Landsat Science Team (LST) composed of competitively selected investigators. The LST conducts research on issues critical to the success of the LDCM, including data collection, product access and format, practical applications, and science opportunities for new- and past-generation Landsat data. The LST offers research and science support to the USGS on topics that will affect the overall success of the LDCM mission. The USGS and NASA LDCM Project Scientists will co-chair the Science Team.

1.5.2 International Cooperators (ICs)

The USGS maintains agreements with several foreign entities (typically, governmental) referred to as the LDCM International Cooperators (ICs). The ICs are a special subset of the User Community that has the ability to receive LDCM data from the observatory real-time downlink stream. Real-time imaging sensor and ancillary data (including spacecraft, calibration data, etc.) necessary for processing are contained in the real-time stream and are received by IC ground stations. The number of active IC ground stations is not constant. IC ground stations may move to/from an active condition based upon the state/terms of their respective Landsat agreement, funding conditions, or the technical capabilities of the IC ground station. For ground system I&T, this role will be performed by a member of the GS test team or their designee.

1.5.3 Flight Operations Team (FOT)

The LDCM Flight Operations Team (FOT) is the team of mission operations personnel managed by the USGS. The LDCM FOT will use the MOE to operate the observatory from launch vehicle separation through the life of the mission. The FOT operates the MOE and CAPE at the MOC and interfaces with the GNE. The FOT will exercise its normal responsibilities during ground system I&T.

1.5.4 Data Acquisition Manager (DAM)

The USGS Data Acquisition Manager (DAM) manages the data collection schedules for LDCM. The DAM adjudicates data collections for input into the CAPE within the MOC. The DAM will exercise its normal responsibilities during ground system I&T.

1.5.5 Cal/Val Team (CVT)

The Calibration/Validation Team (CVT) consists of discipline scientists and engineers who perform calibration of the LDCM imaging sensor and data. The CVT is geographically dispersed and includes members from both NASA and USGS. While the team will advise on and review imaging sensor calibration activities, they will remain independent from the development contractor/organization in their calibration assessments through the life of the mission. NASA leads this team during observatory development through on-orbit acceptance. Following on-orbit acceptance, this team is led by USGS. The CVT works with members of the LST and from academia on various calibration and validation issues and special collections of LDCM data. The FOT and DAM interact with the CVT on a routine basis to schedule Lunar Calibration events, etc. The Cal/Val team will participate as themselves in support of ground system I&T.

1.5.6 DPAS Operators

The DPAS Operators are responsible for all operations related to long term LDCM data archiving, processing, assessment, and data product distribution to the general public. The DPAS will be housed and operated out of the USGS EROS Center. In addition, the USGS provided DPAS will be used during the SS ground testing and end-to-end data flow validation in preparation for mission readiness as well as On-orbit Initialization and Verification (OIV) for support of instrument checkout through Level 0 generation.

1.5.7 GNE Operators

The USGS GNE Operators will operate the LGN stations and the GNE for data capture and routing.

1.6 Document Organization

Section 1 Describes the purpose, scope, Ground System overview, and document contents
Section 2 Presents an overview of the Ground Readiness Test Methodology
Section 3 Presents the Test Management approach that will be used
Sections 4-10 Presents an overview of each planned Ground Readiness Test (GRT)

Section 2 GROUND READINESS TEST METHODOLOGY

The development, integration, and test of the LDCM ground system is a collaborative effort between NASA and USGS. Integration of the MOC is performed by NASA and integration of the DPAS is performed by USGS with oversight provided by NASA. Ground Readiness Testing is managed by NASA and USGS with tests conducted by FOT, GNE, and DPAS operators.

This section defines the process that will be used for testing the LDCM Ground System. The testing will be planned and executed by members of the Ground Readiness Test Team (GRTT) with support from element operators, system administrators, Configuration Management, and Mission Assurance.

2.1 Assumptions and Constraints

- Successful completion of Level 4 formal qualification or acceptance testing
- Successful completion of element integration
- Successful completion of appropriate ICTs
- No significant DRs outstanding

The ground system test objectives and schedules have been coordinated with all element build capabilities to ensure compatibility. Figure 2-1 depicts the ground system build sequence and scope. The figure indicates both the associated element builds and the tests supported by each build.

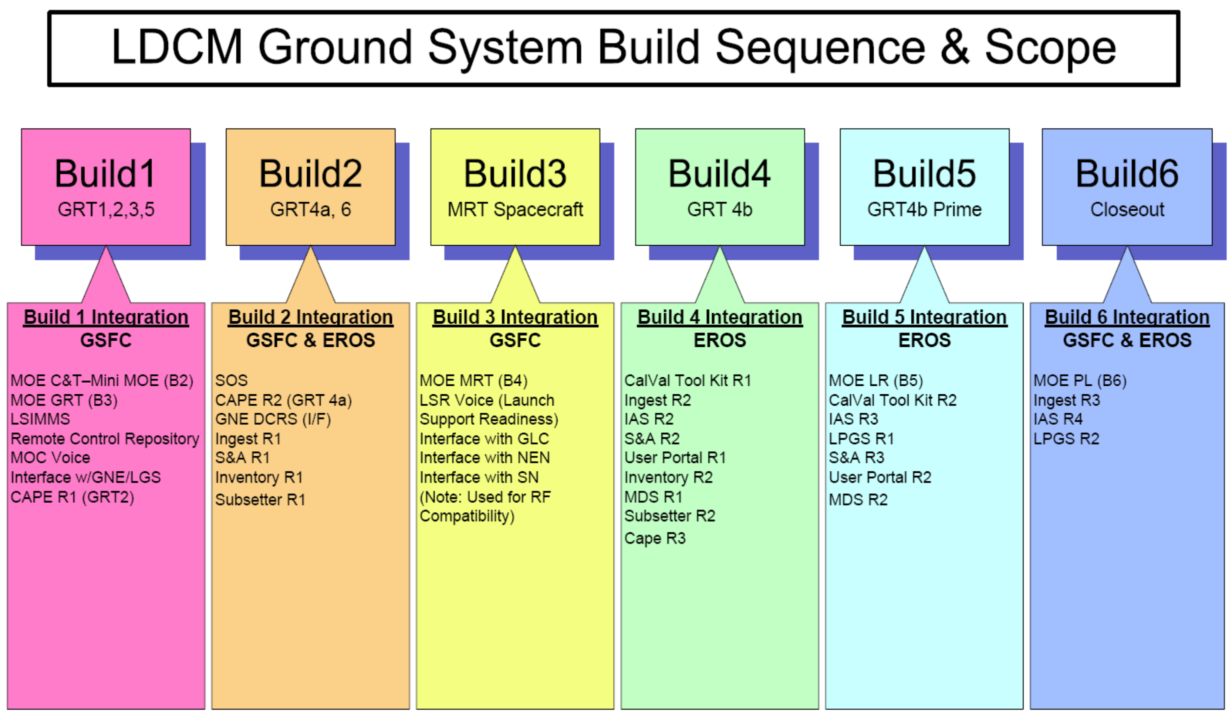


Figure 2-1 LDCM Ground System Build Sequence and Scope

2.2 Test Process

The process for the planning, execution, and evaluation for the GRTs is shown in Figure 2-2. Tests and the supporting documentation are derived from the Ground System Requirements Document (GSRD). The Verification Requirements Matrix (VRM) traces each requirement to the appropriate GRT/Mission Test. The VRM is used both for planning and providing status of requirement verification.

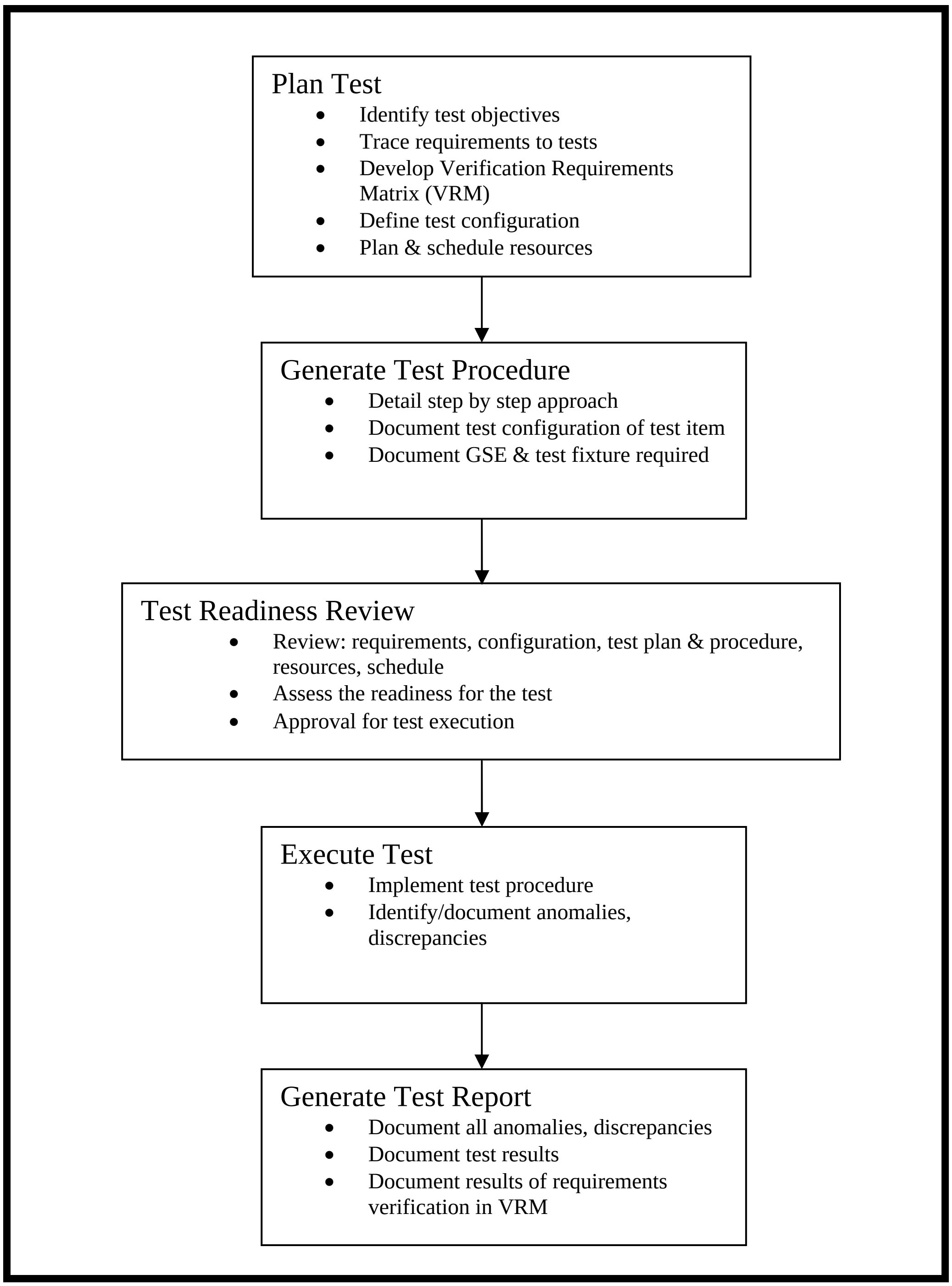


Figure 2-2 Test Process

2.2.1 Plan Test

This test plan outlines the GRTs to be performed, the test methodology and management for those tests. It includes the functionality to be verified in each test, the trace of requirements to be verified in each test, and the expected test configuration and resources required to complete each test. The test plan is written by the Ground Readiness Manager (GRM-NASA).

2.2.2 Generate Test Procedure

The GRM and USGS I&T Manager will develop a GRT test procedure template to be used to generate the GRT Test Procedures. The template will include test objectives, test configuration, functional requirements to be verified, interface requirements to be exercised, and the general test steps based on the GRT story that was developed. The element system engineers and/or operators will provide the details of each test step. Each procedure provides the detailed steps required to complete the proposed test.

2.2.3 Test Readiness Review (TRR)

A Test Readiness Review (TRR) will be conducted 1 week prior to each GRT to ensure that the ground system is ready to support the test. The GRM and USGS I&T Manager will lead the TRR with support from system engineering and operations for each element supporting the test. This review will be informal. If necessary, a delta TRR will be conducted just prior to the start of the GRT. An outline for the material to be addressed in the TRR is provided in Appendix A. The NASA and USGS GS management will give approval to execute the planned test.

2.2.4 Execute Test

The FOT, GNE and/or DPAS operators will execute the test according to the approved test procedure. The GRM and/or the USGS I&T Lead, or their designee will witness each test and/or review test materials. MA may also witness each test and/or review test materials. Anomalies will be identified and tracked via the NASA GSFC Problem Report/Problem Failure Report (PR/PFR) System.

2.2.5 Generate Test Report

The GRM will provide the GRTT and the LDCM Project Team with a Preliminary Test Report immediately following each test. The purpose of this report is to provide a brief summary of the accomplishments and problems of the test. A detailed test report, including test objectives, planned and actual activities, requirement verification, and problems encountered and corresponding PR/PFR will be provided within 45 – 90 days following test completion. The format of the test report is provided in Appendix B.

2.3 Test Simulators

The GRTT has several simulator tools that will be used in the execution of the Ground System Test Plan. Table 2-1 provides an overview of the simulators that may be used by the GRTT to validate the LDCM Ground System.

Simulator/Provider	Deliver to	Purpose	Need By
LDCM Scalable Integrated Multi-mission Support System (L-SIMSS)/GSFC Code 450	MOC	Provides a capability to test low-rate forward- and return-link interfaces between the LDCM Ground Network (LGN), Near Earth Network (NEN), Space Network (SN) and the LDCM Mission Operations Center (MOC)	First customized release of the MOE
Spacecraft/Observatory Simulator (SOS)/Bus Vendor	MOC	Provides high-fidelity representation of Observatory (both spacecraft and instruments) to support GS certification during GRTs, FOT training, proc development, and Mission sims	Must be integrated into MOC in time to support GRTs
RF Suitcase/ Bus Vendor	LGN Stations	Emulates X-band and S-band (TBR) downlink for compatibility tests with LGN stations	MRT #1

Table 2-1 LDCM Simulators used for Ground System Verification

2.4 Testing Approach

2.4.1 Functional Testing

The purpose of ground readiness testing is to validate the ground system interfaces, data flows, and major functionality of the LDCM ground system. This will be accomplished through a series of six ground-system oriented tests. The purpose of each GRT is provided in Table 2-2. More details of each GRT are found in Sections 4-10.

GRT #	GRT Focus
GRT 1	TLM/CMD (S-band/X-band)
GRT 2	Planning and Scheduling
GRT 3	Maneuvers and Special Event
GRT 4a	DPAS connectivity to MOC
GRT 4b	DPAS
GRT 5	Contingency Operations
GRT 6	Capstone/Clean-up

Table 2-2 Ground Readiness Tests

2.4.2 Interface Testing

The planned operational interface will be used for the exchange of data products whenever possible during GRTs. Data products will be utilized by the receiving element as part of the functional testing. Use of interfaces and data products will be recorded in the Interface Verification Matrix (IVM).

2.4.3 DR Fix Testing

DR fixes provided in element releases will be verified during the next appropriate GRT. The element impacted by the original problem must confirm that the provided fix satisfactorily corrects the problem and recommends to the GS DRB that the DR be closed as fixed and verified.

2.5 Verification Approach

The ground system management will define verification so as to be consistent with the Science and Mission Requirements Document (SMRD). The SMRD's definition of verification is "The process of proving that the implementation satisfies the requirement." The central question is whether the system has been built correctly.

To show requirement compliance, the SMRD uses the methods and definitions in Table 2-3.

Test Method	Definition
Analysis	A process used in lieu of, or in addition to testing to verify compliance with specifications. The techniques typically include an interpretation or interpolation/extrapolation of analytical or empirical data under defined conditions or reasoning to show theoretical compliance with stated requirements. Analysis may be accomplished via models or simulations (e.g. mathematical, narrative, graphical, physical). For software, analysis involves the technical evaluation of equations, charts, graphs, models, diagrams and data.
Inspection	An observation, or examination of hardware against the applicable documentation to confirm compliance with requirements. Inspections include simple measurements, such as length and weight. Inspection includes visual checks of a physical item, detailed design documentation, or vendor documentation for commercial off-the-shelf (COTS) units. Inspections typically verify configuration, rather than performance, of an item. For software, inspection involves the physical examination of documentation and/or code.

Demonstration	An exhibition of the operability or supportability of an item under intended service/use conditions. These verifications are usually non-repetitive and are oriented almost exclusively toward acquisition of qualitative data. Demonstrations may be accomplished by computer simulation. The main objective of a demonstration is to show product/item capability. A demonstration has a predicted result, even though it does not necessarily produce analytical data. For software, demonstration involves the operation and performance monitoring of software through a normal operational scenario with display of results.
Test	An action by which the operability, supportability, performance capability or other specified qualities of an item are verified when subjected to controlled conditions that are real, or simulated. These verifications may require use of special test equipment and instrumentation to obtain quantitative data for analysis, as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control. For software, test involves the operation of software with actual, or synthesized stimuli, and with provisions for recording, analyzing and evaluating quantitative data.

Table 2-3 Verification Approach Test Method and Definition

2.5.1 Verification Requirements Matrix (VRM)

The GRM, with assistance from the USGS I&T Lead, the Ground Systems Engineers and the GRTT, is responsible for developing and maintaining the GSRD Verification Requirements Matrix (VRM) for tracking verification of all ground system requirements. The matrix contains all ground system requirements included in the GSRD, the verification method for each requirement, as well as test trace and verification status. The VRM is maintained in DOORS and can be exported to an Excel spreadsheet. The VRM can be sorted by test to readily identify which requirements are to be verified in a given test. The requirements to be verified within a given test can easily be sequenced to align with the test objectives. This sequence of requirements is referred to as the “test story”.

The VRM will be updated as necessary to reflect the current test plans based on the results of the ground system build tests. The VRM will be updated following facility certifications, GRTs, network tests, MRTs, etc to reflect the results of the requirements verification. VRM updates will be done by CCR and approved by the GS CCB. The updated VRM will be included in each GRT Test Report.

2.5.2 Interface Verification Matrix (IVM)

The Interface Verification Matrix (IVM) developed by USGS is used for tracking verification of ground system interfaces and data product format. Verification will be done during element development and Interface Connectivity Tests (ICTs). Interfaces exercised and data products exchanged and utilized by the receiving element during GRTs, network tests, MRTs, etc will be tracked in the IVM.

2.6 Discrepancy Reporting

This section briefly describes the discrepancy management approach for use by the LDCM Ground System. Discrepancy management refers to the processes used to document, prioritize, track, and close out anomalies that are detected during the ground system integration, ground system testing and mission readiness testing supported by the ground system. Discrepancies found will be recorded and managed through the NASA GSFC Problem Report/Problem Failure Report (PR/PFR) System. The PR/PFR System requires problem information regarding the observation, investigation, resolution and assessment of the problem.

The Ground System Discrepancy Review Board (DRB) will disposition all DR's, allocating the proper criticality based on the criticality of the associated functionality. The GS DRB is responsible for the evaluation and tracking of the individual system anomalies and associated repairs. Problems that are considered essential to supporting launch and early orbit activation will be categorized as "launch critical," and will thus receive the appropriate level of priority by the development team. The GS DRB will be chaired by the NASA and USGS GS Management and will be made up of the GRM, the USGS I&T Manager, and MA as well as representatives from each of the Ground System elements and appropriate operations personnel. The GRTT and GS DRB will work closely together, but essentially will serve two different purposes: the GRTT will primarily plan and analyze tests, while the GS DRB will evaluate and track individual system anomalies and associated repairs.

The LDCM Discrepancy Review Board (DRB) will manage all DRs discovered during Mission Level Activities including Network tests, MRTs, and Mission Simulations. The LDCM System Engineer will chair the LDCM DRB. The LDCM Systems (GS) Engineer will work with the Ground System Engineer to ensure that appropriate lower level DRs are resolved prior to all mission level testing.

Section 3 GROUND READINESS TEST MANAGEMENT

3.1 Roles and Responsibilities

NASA Ground System Mgr. (GSM) – The Ground System Mgr (GSM) is responsible for the overall ground system development, integration, and testing. The GSM leads the development of the Ground System Integration and Test Plan, oversees MOC integration and is responsible for the MOC Integration Plan and procedures.

NASA and USGS Infrastructure Managers - The NASA and USGS Infrastructure Managers are responsible for the MOC and DPAS facility design, implementation and maintenance, including networks, respectively.

NASA and USGS Integration Managers– The NASA and USGS Integration Managers are responsible for the overall ground system integration and test coordination of the MOC and DPAS elements, respectively. They are responsible for the development of the MOC and DPAS Integration Plan and procedures.

NASA Ground Readiness Manager (GRM) – The Ground Readiness Manager (GRM) is responsible for the verification of the ground system functional requirements. This does NOT include ground system performance requirements, FOT product performance, or FOT readiness. The GRM develops the Ground System Integration and Test Plan, the Ground Readiness Test Plan and the Ground System Verification Requirements Matrix.

Together the NASA GRM and the USGS I&T Manager lead the Ground Readiness Test Team (GRTT) to develop and execute the Ground Readiness Tests (GRTs). Their joint responsibilities include:

- Co-chair the regular GRTT meetings
- Produce the GRT Procedure Outline
- Approve the GRT Procedures
- Oversee the preliminary interface and engineering tests
- Ensure element readiness for GRTs
- Conduct GRT TRRs
- Witness/verify GRTs
- Ensure PR/PFRs are captured and worked
- Support GS Discrepancy Review Board
- Produce test reports
- Develop management-level reporting material

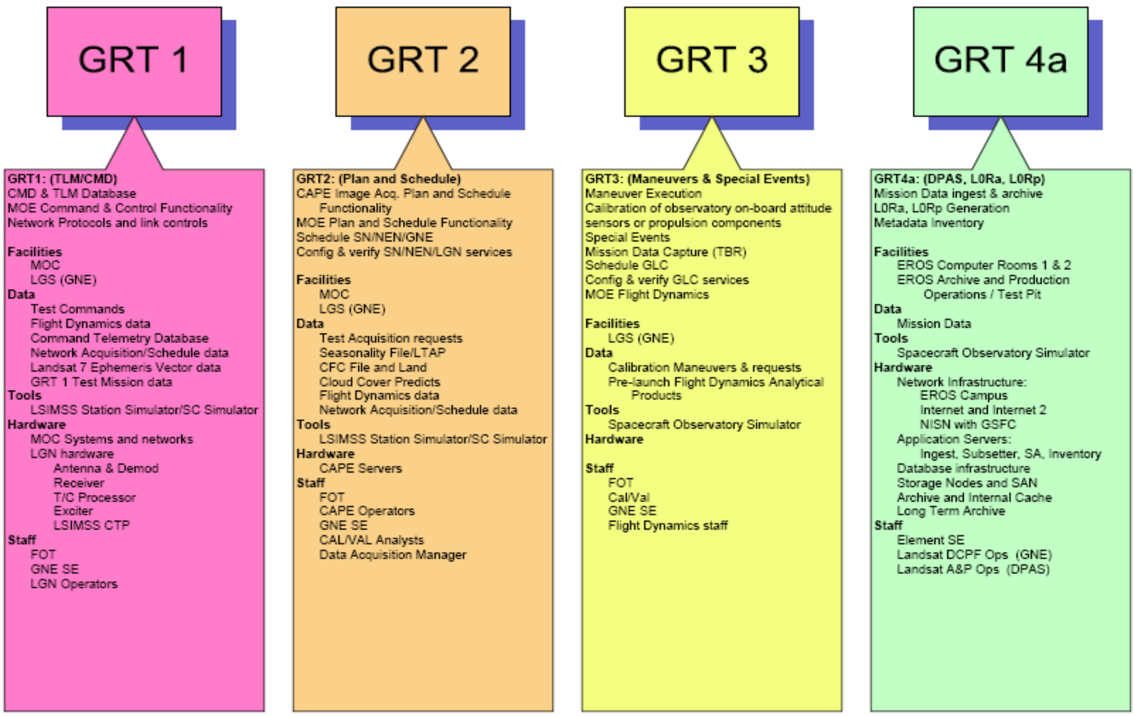
Element Operators (FOT, GNE, DPAS Operators) – The element operators together with the element system engineers are responsible for developing the details of the GRT and Mission Readiness Tests (MRT) procedures and scripts, act as test conductors for the GRTs and MRTs and work off assigned PR/PFRs. These responsibilities are assumed beginning with GRTs.

Mission Assurance (MA-NASA) – Mission Assurance will be a member of the GRTT. MA may review test plans and procedures, witness/verify GRTs, monitor requirements verification and discrepancy reporting/tracking, and support the Discrepancy Review Board.

3.2 Test Support

This test plan identifies the support required for each GRT. During the detailed test planning and procedure generation, the support required will be finalized.

Figure 3-1 briefly summarizes the overall test objectives for each GRT and the resources required to support that GRT.



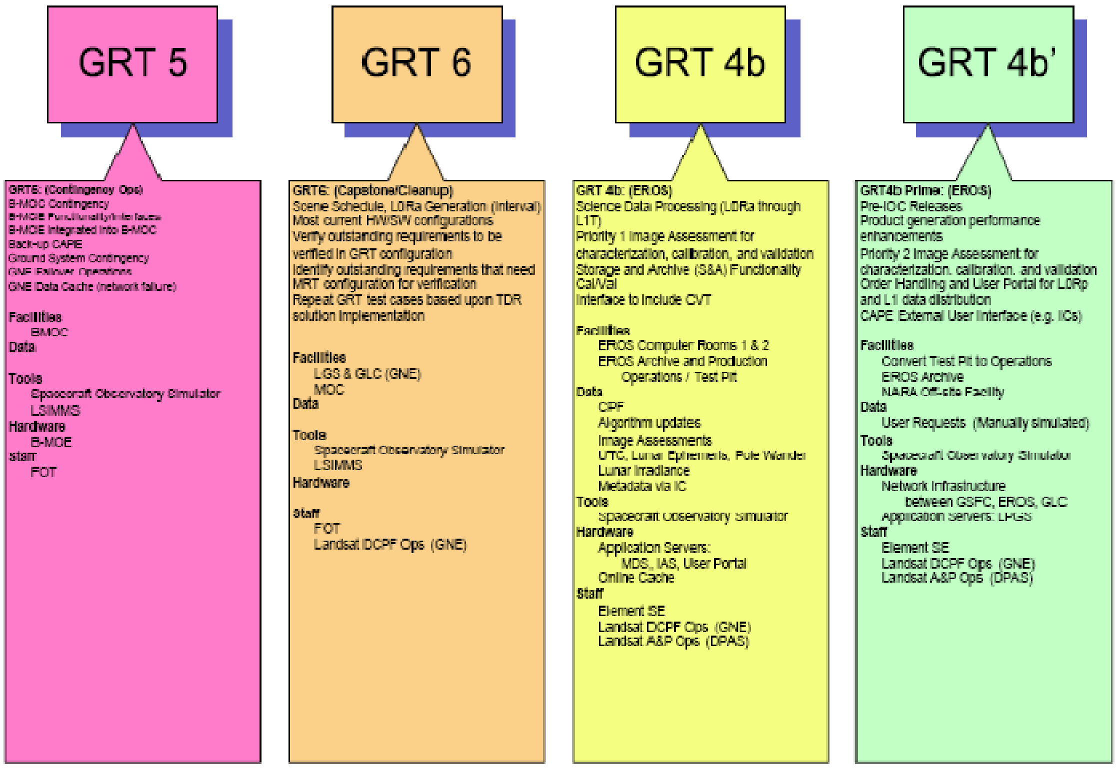


Figure 3-1 GRT Required Resources

3.3 Test Evaluation, Requirements Verification, and Problem Reporting

Following test execution, the FOT, GNE and DPAS operators will review and evaluate all test products, results, and reports and provide an assessment as necessary with oversight by the GRM and the USGS I&T Manager. GSRD requirements to be partially or fully verified in a given GRT are noted in the most current version of the Verification Requirements Matrix (filename = LDCM-VRM-001_GS Verification Requirements Matrix.xls), which can be found in the Bidder's Library:

The requirements verification status will be updated in the VRM to reflect the test results. Verification status will show that the requirement is fully verified, partially verified, failed, deferred or untested. Requirements that are failed, deferred, or untested at the end of a given test will need to be assigned to a future test for verification.

Links to test evidence will be included in the VRM.

IRD requirements to be exercised in a given GRT are noted in the most current version of the Interface Verification Matrix (filename = LDCM-VRM-002 LDCM Interface Verification Matrix (IVM) Draft v1.xls), which can be found in the Bidder's Library.
Any discrepancies noted during the evaluation will be written as PR/PFRs.

Section 4 GRT 1 Telemetry and Command

4.1 Test Overview and Objectives

The primary purpose of GRT 1 is to validate TLM and CMD (S-band T&C) capability through the LGN. This test will consist of scheduling and simulating S-Band T&C contacts with the primary LGN station, the SN, and the NEN from the MOE. A S/C simulator will be used to turnaround CMDs and generate simulated TLM at the primary GNE (LGN) station.

4.2 Required Functionality

4.2.1 MOE

The MOE shall provide the following functionality for this test:

- Scheduling:
    - Generate and de-conflict schedules for GNE (LGN) stations, NEN stations, and SN assets
- CMD Generation:
    - Generate CMDs to be sent and analyze CMD messages recorded by stations to verify correct receipt
- TLM Processing:
    - Receive, display, and analyze real-time (RT) and stored playback (PB) TLM
    - Verify the CCSDS File Delivery Protocol (CFDP) feedback loop for simulated received data files
- Flight Dynamics:
    - Update orbit models and generate ephemeris based on positioning information in simulated TLM, and distribute ephemeris to stations as required
    - Generate definitive ephemeris data products and definitive attitude products
- Communication:
    - Voice (SCAMA) communications to GNE (LGN) as required

4.2.2 GNE and Network

The GNE shall provide the following functionality for this test via the primary LGN station in Gilmore Creek, AK (GLC):

- Scheduling:
    - Accept and de-conflict a schedule from the MOE; Schedule station assets for a simulated contact event per a received contact schedule from the MOE
- S-Band Services:
    - Receive CMDs from the MOE for uplink, and receive simulated RT and PB TLM from the S/C simulator for transmission to the MOE; Retransmit (play back) recorded TLM on request from the MOE

- T&C Turnaround:

    - Provide a receiver and processor to receive simulated CMDs that are passed to the S/C simulator, and provide an exciter that generates simulated TLM from the S/C simulator
- Communication:
    - Voice (SCAMA) communications to the MOE as required

4.3 Test Configuration

4.3.1 GNE Contacts

A notional test configuration is shown in Figure 4-1. The MOE generates a forecast schedule, which is sent to the station for de-confliction. The station then sends its availability back to the MOE, and the MOE sends out a contact schedule. The station schedules the requested contacts. CMDs are received over the network, processed, and sent to the exciter for uplink. A receiver is connected to the U/L test port, which passes the CMDs to the S/C simulator for processing. The S/C simulator then generates appropriate TLM in response to the CMDs, which are fed to an exciter. The output of the exciter is injected into the downlink path and on to the receivers and TLM processor. Processed TLM is sent in real-time to the MOE, and is also recorded (archived) for later playback as requested by the MOE. A simulated CFDP file listing is sent to the MOE at the end of the contact to simulate the CFDP feedback loop.

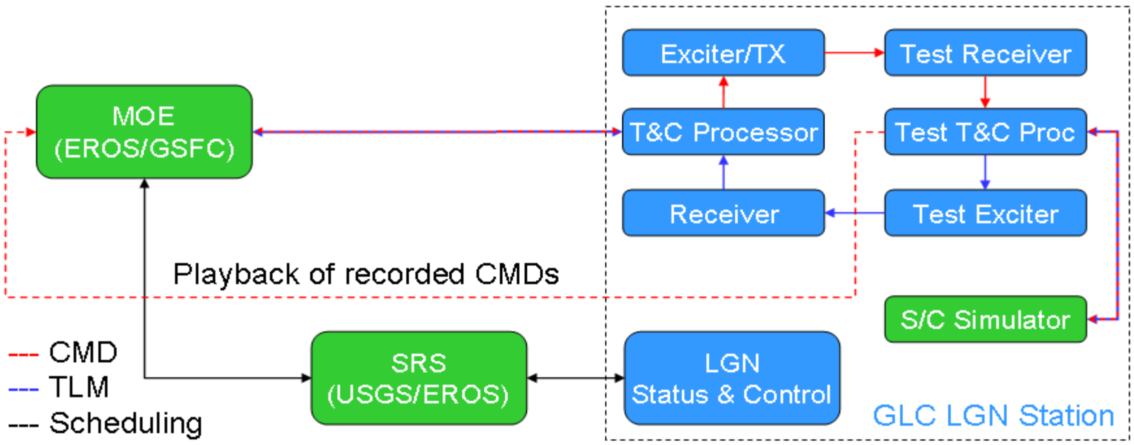


Figure 4-1 Notional GRT 1 GNE Test Configuration

Section 5 GRT 2 Planning and Scheduling

5.1 Test Overview and Objectives

This test consists of generation of an image acquisition schedule that is based upon execution of the Long-Term Acquisition Plan 8 (LTAP-8) requirements, calibration requirements, cloud cover predictions from the National Center for Environmental Prediction (NCEP), and off-nadir imaging requests. The CFDP feedback loop will be exercised for solid-state recorder (SSR) management/modeling by the MOE and CAPE. The imaging acquisition schedule from the CAPE will be used by the MOE to generate its master schedule for the observatory as well as forecast and contact schedules for the GNE (LGN). The MOE will interface to the Infrastructure Element (IE) to load acquisition information into the appropriate databases.

5.2 Required Functionality

5.2.1 CAPE

The CAPE shall provide the following functionality for this test:

- Scheduling/Planning
    - Access NCEP for predicted cloud cover
    - Utilize the LTAP-8 and standing acquisition policies
    - Schedule calibration events
    - Generate a coordinated/de-conflicted schedule that incorporates the above inputs
- Communication:
    - Provide acquisition schedules to the MOE and receive SSR management and model updates
    - Receive GNE availability information from the MOE and factor this into planned acquisition schedules as appropriate
- SSR Management:
    - Accept inputs from the MOE to update the SSR management and model, and use the model to adjust the planned acquisition schedule as appropriate

5.2.2 MOE

The MOE shall provide the following functionality for this test:

- Scheduling/Planning:
    - Generate and de-conflict schedules for GNE (LGN) stations, NEN stations, and SN assets
    - Convert CAPE schedules to observatory and instrument schedules, and verify CMD loads
    - Analyze and convert calibration events scheduled by the CAPE into maneuvers as required
    - Analyze and convert off-nadir imaging scheduled by the CAPE into maneuvers as required
- Flight Dynamics:
    - Analyze and convert calibration events scheduled by the CAPE into maneuvers as required
    - Produce predicted ephemeris that support planning and scheduling events
    - Generate and de-conflict GNE (LGN) contact schedules

5.2.3 GNE and Network

The GNE shall provide the following functionality for this test at the primary LGN station in Gilmore Creek, AK (GLC):

- Scheduling:
    - Accept and de-conflict a schedule from the MOE
- X-Band Services:
    - Generate a simulated CFDP file listing for transmission to the MOE

5.2.4 Infrastructure Element

The IE shall accept acquisition information from the MOE and load it to the correct databases. The interface between the IE, CAPE, and MOE will be exercised and receipt of data shall be acknowledged, as required. The received data can be stored in a developmental (or integration) version of the operational database TBR.

5.2.4.1 NCEP

NCEP will access to acquire predicted cloud cover information for the upcoming planning period. No specific action is required by NCEP other than providing normal access to their capabilities.

5.3 Test Configuration

A notional test configuration is shown in Figure 5-1. The CAPE institutes the LTAP-8 and incorporates inputs from NCEP on predicted cloud cover, and standing acquisition policies (i.e. – all continental United States imagery is collected regardless of predicted cloud cover, etc.). Calibration requests are also factored in, and a coordinated schedule is generated. A series of schedules will be generated to test various combinations of request types, LTAP-8 acquisitions, and calibration events. Simulated CFDP feedback from the GNE is used for SSR management to update the model, and is also factored in as appropriate. It is anticipated that this test will simulate operations for a number of days to accommodate the scenarios to be tested.

The CAPE schedules are sent to the MOE where they are de-conflicted and converted into observatory and OLI schedules, and then into verified CMD loads. Calibration events and off-nadir image requests are analyzed and converted into maneuver CMDs as required. This information is also used to generate and de-conflict GNE (LGN) scheduling.

TBS

Figure 5-1 GRT 2 Test Configuration

Section 6 GRT 3 Maneuvers and Special Events

6.1 Test Overview and Objectives

This test verifies the ability of the MOE to plan and execute S/C maneuvers not associated with calibration or off-nadir imaging (i.e. – annual inclination adjustments, re-orientation to mitigate the effects to meteor showers, etc.). Other MOE functions not tested in earlier GRTs will also be demonstrated here, such as flight software management, remote access to MOE resources, and autonomous operations.

6.2 Required Functionality

6.2.1 CAPE

The CAPE shall provide the following functionality for this test:

- Scheduling/Planning:
    - Accept planning constraints from the MOE (i.e. – periods when no imaging is allowed)
    - Only the interface to accept them will be demonstrated, no CAPE scheduling is planned for this test

6.2.2 MOE

The MOE shall provide the following functionality for this test:

- Scheduling/Planning:
    - Generate and de-conflict schedules for GNE (LGN) stations, NASA GN stations, and SN assets
    - Convert CAPE schedules to observatory and instrument schedules, and then to verified CMD loads
    - Analyze and convert calibration events scheduled by the CAPE into maneuvers as required
    - Analyze and convert off-nadir imaging scheduled by the CAPE into maneuvers as required
- Flight Dynamics:
    - Analyze and convert calibration events scheduled by the CAPE into maneuvers as required
    - Generate and de-conflict GNE (LGN) contact schedules
    - Update orbit models and generate ephemeris based on positioning information in TLM, and distribute ephemeris to stations as required
    - Generate definitive ephemeris data products and definitive attitude products

6.2.3 GNE and Network

The GNE shall provide the following functionality for this test at the primary LGN station at EROS:

- Scheduling:
  - o Accept and de-conflict a schedule from the MOE; Schedule station assets for a simulated contact event per a received contact schedule from the MOE
- S-Band Services:
  - o Receive CMDs from the MOE for uplink; Retransmit (play back) recorded TLM on request from the MOE

6.2.4 OLI Instrument Simulator

The OLI simulator shall be used for flight software management activities, in the verification of flight software updates before they are uploaded to the instrument.

6.3 Test Configuration

6.3.1 Maneuvers

Simulated GPS measurements from TLM will be used to update the orbit model. The MOE will plan an inclination adjustment maneuver with the updated orbit model as the baseline. The MOE will calculate the required thruster burns to adjust the modeled orbit to the desired orbit, using appropriate constraints. The required thruster burns will be converted to a CMD load, factoring in instrument actions required (i.e. – safe the instrument during maneuvers, etc.). An updated event list will be sent to the CAPE to factor into scheduling (i.e. – no acquisitions available during maneuver and settling period). The CAPE will generate a de-conflicted schedule that covers the maneuver period. The MOE will also send a schedule to the GNE for station coverage during the maneuver for LGN, NEN, and SN assets required. Updated ephemeris will also be sent out following the simulated maneuver.

6.3.2 Flight Software Management

A candidate flight software upload will be developed and validated by the MOE. The software load will be tested using the S/C simulator to verify that it performs as expected. Revisions will be made as required. The validated software load will be encapsulated in the format for transmission to the GNE.

6.3.3 Remote Access

A remote workstation will be set up outside the MOE network and be used to verify that remote access and analysis functions are available as required.

6.3.4 Autonomous MOC Operations

A nominal weekend (unattended period) schedule will be generated and sent the GNE to schedule contacts. During each simulated contact, the GNE will record the CMD messages from the MOE for later analysis/comparison, and play back simulated TLM from a test file. A series of out-of-limits conditions will be built into the simulated TLM file, which will trigger the appropriate levels of automated notification by the MOE (paging staff, etc.). Automated safing will also be verified, using the appropriate simulated TLM values to trigger the CMD strings to be sent.

Section 7 GRT 4a DPAS/FOS Connectivity

7.1 Test Overview and Objectives

This test verifies the ability of the DPAS to ingest mission data from the GNE, store that data in the archive, and create a Level 0Rp product.

7.2 Required Functionality

7.2.1 CAPE

The CAPE shall provide the following functionality for this test:

- Communication:
  - Provide simulated repository and inventory information to the DPAS
  - Provide full functionality in support of IC and authorized user acquisition requests through its interfaces to DPAS
  - Accept off-nadir and priority imaging requests

7.2.2 MOE

The MOE shall provide the following functionality for this test:

- TLM Processing:
  - Generate simulated TLM products for calibration and validation activities
- Flight Dynamics:
  - Update orbit models and generate ephemeris based on positioning information in simulated TLM
  - Generate definitive ephemeris data products and definitive attitude products
- Communication:
  - Provide simulated auxiliary data to the DPAS

7.2.3 GNE and Network

The GNE shall provide the following functionality for this test at the primary LGN station at EROS:

- X-Band Services:
  - Generate simulated interval data for transmission to the DPAS
  - Generate simulated CFDP acquisition for transmission to the DPAS
  - Generate simulated status and metrics information for transmission to the DPAS
  - Fully implement Data Capture and Routing functionality

7.2.4 DPAS

The DPAS shall provide the following functionality for this test:

- Ingest Subsystem Release 1:
  - Implements the functionality to receive Mission data and create L0Ra
- Storage and Archive Release 1:
  - Provide the capability to store Mission data, L0Ra and L0Rp
- Inventory Release 1:

- Catalogs the data in storage
- Subsetter Release 1:
  - Converts Interval based L0Ra data into scene based L0Rp

7.3 Test Configuration

The notional test configuration for GRT is 4a is a portion of the total DPAS configuration as illustrated in figure 7.1. Specifically the Storage and Archive, Ingest, Subsetter and Inventory Subsystems are needed.

7.3.1 Storage and Archive

The Storage and Archive (SA) subsystem provides both online disk caches and the tape-based archive . There are caches for internal use as well as a cache space for holding L1 and L0Rp products, browse images, and other data which users access through the UP.

7.3.2 Ingest

New data for ingest are placed on the cache by GNE. The Ingest subsystem pulls mission data from the cache, and places completed L0Ra data back onto the cache. Ingest processing functions include quality assessment, decompression, conversion to L0Ra format and extraction/generation of metadata. The ingest subsystem also applies algorithms to OLI and TIRS calibration intervals to extract bias parameters.
Storage and Archive

7.3.3 Inventory

The Inventory subsystem houses a complete LDCM Mission Database (LMD), containing metadata for all LDCM data, plus a searchable inventory to facilitate customer searches. The Inventory subsystem provides data management capabilities for operations such as changing the mode flag, making data searchable or hidden, and so on.

7.3.4 Subsetter

The Subsetter retrieves L0Ra data from the cache, extracts the data requested, and writes L0Rp format to the cache.

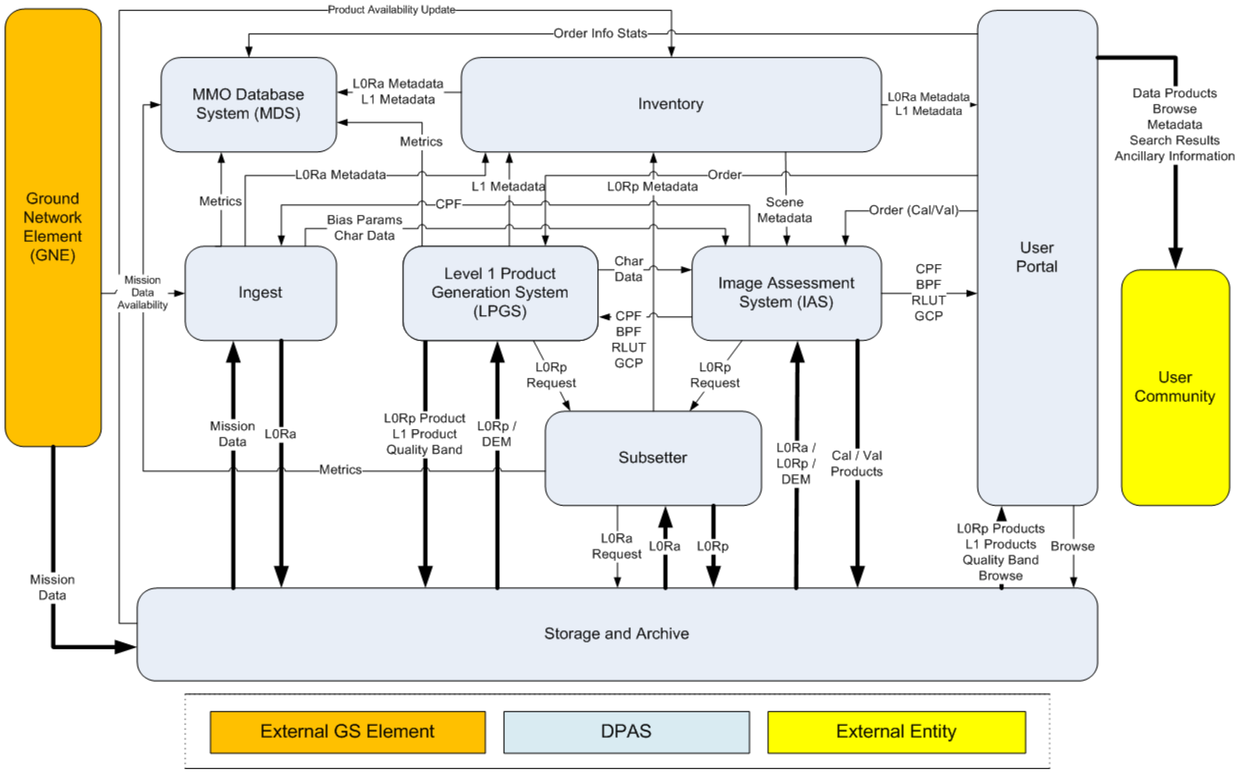


Figure 7-1 GRT 4 Test Configuration

Section 8 GRT 4b and 4b Prime DPAS Functionality

8.1 Test Overview and Objectives

GRT 4 will be conducted at the USGS EROS Center and will emphasize DPAS. This test demonstrates DPAS capabilities to ingest data from the GNE, generate and archive data and products, allow users to search/discover data, distribute data to users, assess and characterize imagery using priority 1 algorithms and test the cal/val toolkit.

8.2 Required Functionality

8.2.1 CAPE

The CAPE shall provide the following functionality for this test:

- Communication:
    - Provide simulated repository and inventory information to the DPAS
    - Provide full functionality in support of IC and authorized user acquisition requests through its interfaces to DPAS
    - Accept off-nadir and priority imaging requests

8.2.2 MOE

The MOE shall provide the following functionality for this test:

- TLM Processing:
    - Generate simulated TLM products for calibration and validation activities
- Flight Dynamics:
    - Update orbit models and generate ephemeris based on positioning information in simulated TLM
    - Generate definitive ephemeris data products and definitive attitude products
- Communication:
    - Provide simulated auxiliary data to the DPAS

8.2.3 GNE and Network

The GNE shall provide the following functionality for this test at the primary LGN station in Gilmore Creek, AK (GLC):

- X-Band Services:
    - Generate simulated interval data for transmission to the DPAS
    - Generate simulated CFDP acquisition for transmission to the DPAS
    - Generate simulated status and metrics information for transmission to the DPAS
    - Fully implement Data Capture and Routing functionality

8.2.4 DPAS

The DPAS shall provide the following functionality for GRT 4B.

- Ingest Release 2
    - Characterizations necessary for OLI and TIRS image processing.
    - Cal / Val Trending as defined in ATBD
- Image Assessment Subsystem Release 1 & 2
    - Includes all priority 1 algorithm functions
    - Create Level 1 products
    - The ability to integrate algorithm from the Cal Val tool kit.
- Storage and Archive Release 2
    - Capability to store level 1 products, Quality Bands, Browse Data, Cal Val Data
- User Portal Release 1 & 2
    - TRAM system to support LDCM Reporting
    - Provide end user data access functions such as search and order, registration, authentication, submit collection requests,
    - Generate Full Res Browse, sub-sampled Browse, and Quality Band.
- Inventory Release 2
    - Catalog the Level 1, browse, metadata and other supporting data.
- Mission Management Office database service release 1
    - Show the capability to provide management reports
- Cal Val Tool Kit Release 1
    - The functions needed for Instrument Check out

GRT 4b' is a regression test of 4b, but also include the late deliveries of algorithms, and product performance improvements. The DPAS shall provide the following functionality for GRT 4b'.

- Closeout releases for DPAS subsystems
    - Includes late algorithms
    - Priority 3 requirements not tested in prior GRTs.
- LPGS Release 1
    - Includes all priority 1 and 2 product algorithms.

Includes the hardware upgrades to meet performance requirements

8.3 Test Configuration

The GNE sends simulated data files to the DPAS, along with acquisition information on intervals received. Simulated metrics are also sent to the DPAS.

The CAPE generates simulated repository and inventory information, which is sent to the DPAS. The MOE generates simulated definitive ephemeris data products and definitive attitude products, which are sent to the DPAS for calibration and validation.

8.4 Test Configuration

The notional test configuration is the remainder of the DPAS element. Additionally this includes the Product Generation Subsystem. Image Assessment subsystem, User Portal, Mission Database Subsystem.

8.4.1 LPGS

Product generation is performed by the Landsat Product Generation System (LPGS). The LPGS requests data from the Subsetter. The Subsetter retrieves L0Ra data from the cache, extracts the data requested, and writes L0Rp format to the cache. The LPGS reads the L0Rp data from the cache and applies calibration and product generation algorithms in order to generate the L1 product.

8.4.2 Image Assessment

Cal/Val functions within DPAS take place primarily within the Image Assessment System (IAS). The IAS functions in a manner similar to LPGS in requesting data through the Subsetter. The IAS has the capability to perform L1 processing for Cal/Val purposes. A suite of other processing capabilities are housed within the IAS.

8.4.3 User Portal

The User Portal (UP) provides the capability to search for LDCM data, and to order or download LDCM data. The UP uses a project web site (shared with the Landsat project) for exchange of mission notices, submission of acquisition requests, and other special functions.

8.4.4 Mission Database

The Mission Database System (MDS) provides an offline database with relevant metrics and database information pulled from all the operational LDCM systems. Data in the MDS comes from DPAS, GNE and MOE. Operational users (primarily the MMO Information Officer) interested in performing data mining can use a few basic canned queries or write their own queries to mine all these databases for operational and MMO reporting purposes.

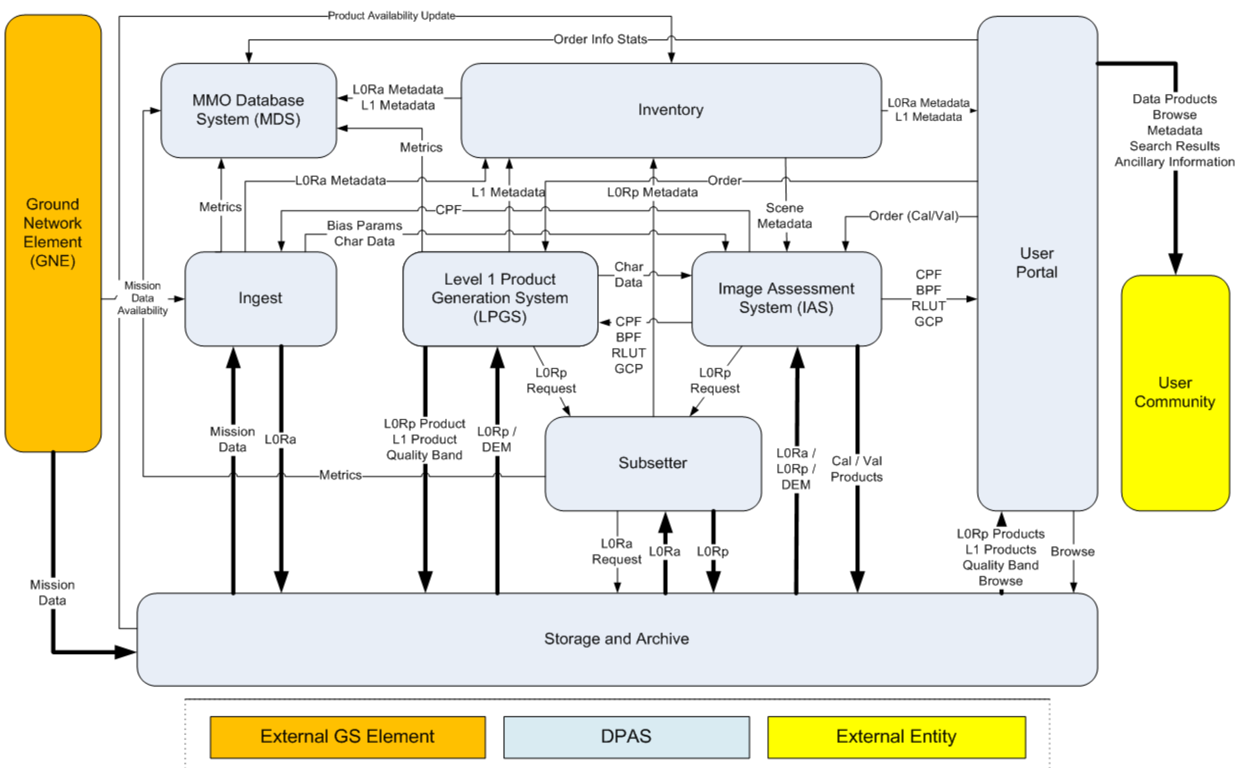


Figure 8-1 GRT 4 Test Configuration

Section 9 GRT 5 Contingency Operations

9.1 Test Overview and Objectives

GRT 5 will be primarily conducted out of the b-MOC with support from the GSFC MOC. This test verifies the functionality of various contingency capabilities of the ground system, including the b-MOC, backup CAPE and MOE, secondary LGN stations, loss and recovery of network connections between the LGN and GNE at USGS/EROS, the backup archive, and the backup UPE capabilities.

9.2 Required Functionality

9.2.1 CAPE

The CAPE shall provide the following functionality for this test:

- Scheduling/Planning:
    - Accept IC and user imaging request
    - Accept off-nadir and priority imaging requests
    - Access NCEP for predicted cloud cover
    - Utilize the LTAP-8 and standing acquisition polices
    - Schedule calibration events
    - Generate a coordinated/de-conflicted schedule that incorporates the above inputs
- Communication:
    - Provide acquisition schedules to the MOE and receive SSR management and model updates
    - Receive GNE availability information from the MOE and factor this into planned acquisition schedules as appropriate
- SSR Management:
    - Accept inputs from the MOE to update the SSR management and model, and use the model to adjust the planned acquisition schedule as appropriate

Both primary and redundant/backup equipment strings will be operational and available for test support.

9.2.2 MOE

The MOE shall provide the following functionality for this test at the MOC:

- Scheduling:
    - Generate and de-conflict schedules for GNE (LGN) stations, NASA GN stations, and SN assets
- CMD Generation:
    - Generate CMDs to be sent and analyze CMD messages recorded by stations to verify correct receipt
- TLM Processing:
    - Receive, display, and analyze realtime (RT) and stored playback (PB) TLM

    - Verify the CCSDS File Delivery Protocol (CFDP) feedback loop for simulated received data files
- Communication:
    - Voice (SCAMA) communications to GNE (LGN), SN, and NEN as required

9.2.3 GNE and Network

The GNE shall provide the following functionality for this test at the primary LGN station in Gilmore Creek, AK (GLC):

- Scheduling:
    - Accept and de-conflict a schedule from the MOE; Schedule station assets for a simulated contact event per a received contact schedule from the MOE
- S-Band Services:
    - Receive CMDs from the MOE for uplink, and receive simulated RT and PB TLM from the S/C simulator for transmission to the MOE; Retransmit (play back) recorded TLM on request from the MOE
- T&C Turnaround:
    - Provide a receiver and processor to receive simulated CMDs that are passed to the S/C simulator, and provide an exciter that generates simulated TLM from the S/C simulator
- X-Band Services:
    - Generate a simulated CFDP file listing for transmission to the MOE
- Communication:
    - Voice (SCAMA) communications to the MOE as required

Both primary and redundant/backup equipment strings will be operational and available for test support.

9.2.4 Other Resources Required

9.2.4.1 b-MOC

The MOE shall provide the following functionality for this test at the b-MOC:

- Scheduling:
    - Generate and de-conflict schedules for GNE (LGN) stations, NASA GN stations, and SN assets
- CMD Generation:
    - Generate CMDs to be sent and analyze CMD messages recorded by stations to verify correct receipt
- TLM Processing:
    - Receive, display, and analyze realtime (RT) and stored playback (PB) TLM
    - Verify the CCSDS File Delivery Protocol (CFDP) feedback loop for simulated received data files
- Flight Dynamics:
    - Update orbit models and generate ephemeris based on positioning information in simulated TLM, and distribute ephemeris to stations as required
    - Generate definitive ephemeris data products and definitive attitude products

- Communication:
    - Voice (SCAMA) communications to GNE (LGN), SN, and NEN as required

9.2.4.2 Secondary LGN Station(s)

The GNE shall provide the following functionality for this test at each of the secondary LGN stations:

- Scheduling:
    - Accept and de-conflict a schedule from the MOE; Schedule station assets for a simulated contact event per a received contact schedule from the MOE
- S-Band Services:
    - Receive CMDs from the MOE for uplink, and receive simulated RT and PB TLM from the S/C simulator for transmission to the MOE; Retransmit (play back) recorded TLM on request from the MOE
- T&C Turnaround:
    - Provide a receiver and processor to receive simulated CMDs that are passed to the S/C simulator, and provide an exciter that generates simulated TLM from the S/C simulator
- X-Band Services:
    - Generate a simulated CFDP file listing for transmission to the MOE
- Communication:
    - Voice (SCAMA) communications to the MOE as required

9.3 Test Configuration

9.3.1 GSFC MOC

TBD

9.3.2 Backup CAPE TBR

Constraints and requests are sent to both the backup and primary CAPE, which are synchronized. The scheduling run is done on the primary string (as a baseline), and also the backup string to simulate the failover. The schedule is then sent to the MOE to verify interfaces. Failover procedures are also tested before the backup string sends the schedule to the MOE.

9.3.3 Secondary LGN

This test is where S- and X-Band compatibility and functionality of the secondary LGN station is tested along with the networks and data transfer functionality. A notional diagram of the test configuration at each secondary LGN is shown in Figure 9-1.

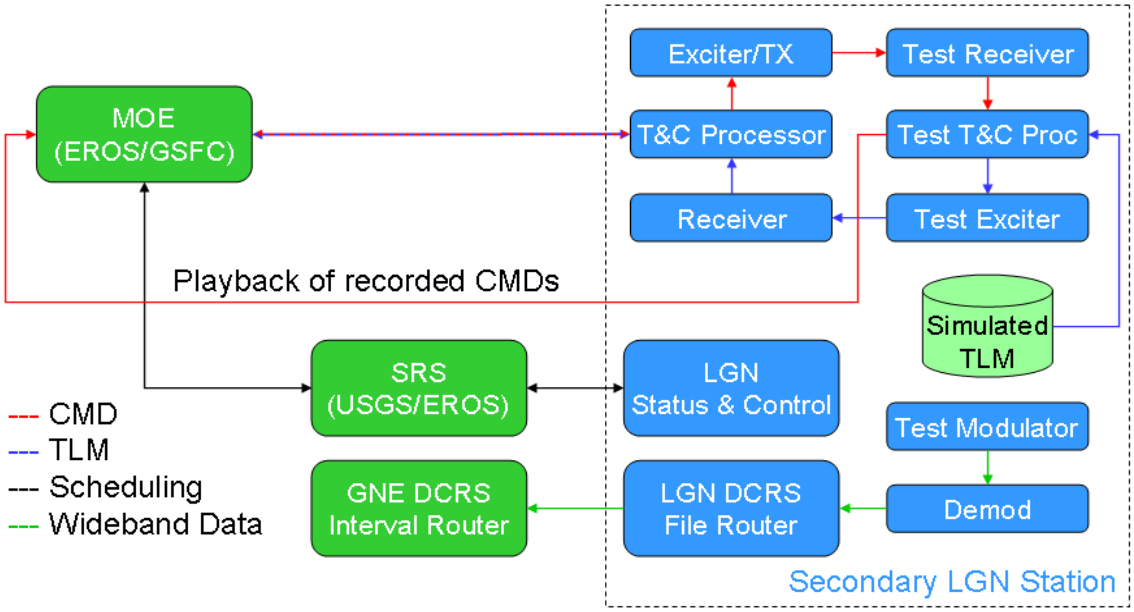


Figure 9-1 Notional GRT 5 Test Configuration for Secondary LGN Stations

The primary GLC LGN station declares an emergency and is unable to take passes. This is communicated to the GNE (Scheduling and Reporting System, SRS), which passes the unavailability message to the MOE (and CAPE). The MOE adjusts schedules and the CAPE adjusts downlink opportunities and SSR management accordingly. A secondary LGN station is scheduled to make up for the outage. The CAPE and MOE build an emergency CMD load to de-allocate downlinks to the GLC LGN and establish downlinks to the secondary LGN. A simulated SN contact is used to uplink the new CMD upload before the first contact at the secondary LGN.

The MOE sends out an emergency schedule to the secondary LGN, which schedules the requested contact. Emergency scheduling procedures are used to coordinate scheduling of the contact (i.e. – voice communication and availability confirmation). The LGN simulates the contact event and flows TLM from a pre-recorded file on the test T&C processor and records CMDs sent from the MOE for later analysis/comparison. A test modulator (D/L simulator) is used to inject modulated X-Band data into the antenna, which is demodulated, CCSDS-processed, and sent to the local Data Collection and Routing System (DCRS) file router at the LGN. The DCRS sends the file data to the GNE DCRS interval router (at USGS/EROS) via the wideband network (or LAN) connection. The DCRS closes the CCSDS File Delivery Protocol (CFDP) loop with the MOE using the simulated data from the secondary LGN.

Following the contact, the MOE request a play back of TLM recorded during the pass to test the TLM re-transmission function. The recorded CMD messages are also sent to the MOE for analysis/comparison at this time.

9.3.4 Wideband Network Loss and Recovery

The LGN will simulate data transfer to the GNE at USGS/EROS DCRS by playing back a test data file. Approximately halfway through the contact network connectivity between the LGN and GNE (DCRS) will be disconnected (shut down). Voice communication (SCAMA) will be used to troubleshoot the problem and execute the contingency procedures. A simulated contact will be scheduled for X-Band services (the wideband network is still “down”). A test data file will be transferred to the local LGN DCRS simulating reception and capture of X-Band data. This data will be processed and buffered on the local LGN DCRS cache until network connectivity is available. Following the simulated contact, network connectivity will be restored (turned back on). Appropriate recovery procedures will be exercised to verify the connection. Once the connection has been validated, the GNE at USGS/EROS will request transmission of data from the missed passes. The USGS/EROS GNE DCRS will continue processing and complete creation of the simulated intervals for transfer to the DPAS.

The test data file will be constructed to contain multiple intervals, so the transfer will pass a number of files from complete intervals before connectivity is lost (having only some of the files from an interval transferred). The USGS/EROS GNE DCRS will process and make ready for transfer the completed intervals and buffer the partial interval until connectivity is restored.

9.3.5 Narrowband T&C Network Loss and Recovery

A simulated contact will be scheduled for use of S-Band services. Approximately halfway through the contact network connectivity between the LGN and MOE will be disconnected (shut down). Voice communication (SCAMA) will be used to troubleshoot the problem and execute the contingency procedures. The S/C simulator will continue to provide simulated TLM through the duration of the contact (which is being recorded on the T&C processor). Following the end of the simulated contact, network connectivity will be restored (turned back on). Appropriate recovery procedures will be exercised to verify the connection. Once the connection has been validated, the MOE will request a playback of TLM from the pass. The LGN will play back the recorded TLM files to the MOE, as well as the recorded CMD messages to determine which CMDs were received by the S/C (simulator).

Section 10 GRT 6 Capstone

10.1 Test Overview and Objectives

GRT 6 will be conducted out of the GSFC MOC with support from USGS EROS DPAS facility. This test consists of a demonstration of the end-to-end flow and operations of the Ground System through a series of capstone scenarios that exercise all parts of the Ground System over a simulated 16-day cycle. All operational S/C and instrument modes and events (i.e. – calibration, maneuvers, flight S/W updates, etc.) will be exercised during the simulated cycle. Full functionality will be required for this test, including injection of simulated data from the Observatory and RF into antenna apertures.

10.2 Required Functionality

10.2.1 CAPE

The CAPE will provide full functionality for this test.

10.2.2 MOE

The MOE will provide full functionality for this test, via the GSFC MOC facility. Failover to the b-MOC will not be retested unless there are issues remaining from GRT 5 (TBR).

10.2.3 GNE and Network

The GNE will provide full functionality at the GLC primary LGN site. Full S-Band services and scheduling functionality will be provided at other LGN sites, along with simulated X-Band services via transmission of simulated data and CFDP file information to other elements/segments. Primary and redundant equipment will be exercised.

10.2.4 DPAS

10.2.5 RF Suitcase TBR

The RF suitcase downlink simulator provided by the S/C vendor will be used to inject simulated data into the antenna aperture at X-Band for this test at the GLC primary LGN station. Simulated data will be used at other LGN stations for this test. The RF suitcase will be used to verify RF compatibility with all the LGN stations prior to or after this test, as schedules permit TBR.

10.3 Test Configuration

A detailed series of capstone scenarios will be developed that exercise the routine end-to-end dataflow and process flow for the ground system for a predetermined (nominally 16 day) cycle. Time flow may likely be accelerated (i.e. – 3-4 cycle days per calendar day of testing) to allow the test to be completed in a manageable time (i.e. – five working days). Off-nadir imaging and calibration events will be inserted to simulate expected operational levels of these events. At various points in the timeline, equipment/system failures will be simulated, and redundant strings will be brought online as a replacement.

Appendix A TRR Agenda

TRR for GRT # will be
Date/Time/Location

Telecon info is:

Expected Participants:

Agenda:

1. GRT #x Logistics

Dates/Times:
Voice check: xxxxz

Procedure:
from CM library:
user account required

Test Participants:

Voice:

Data Source:

2. Test Objectives: Section x.x of test procedure

3. Test Configurations: Section x.x of test procedure

4. Requirements to be verified: Appendix x in test procedure

	Verify
Element #1	x
Element #2	x
Element #x	x
Total	xx

All elements need to confirm that they are able to verify requirements assigned to them via the test steps in Section x of test procedure.

5. Data Products to be verified: Appendix x in test procedure

All elements need to confirm that they are able to verify transfer/receipt/data format of data products

6. Discrepancy Reports:

7. Pre-GRT #x Tests completed:

8. Pre-GRT #x tests/activities still to be completed:

9. Open Issues from pre-GRT #x tests:

10. Test Procedure Overview

11. Element readiness to support GRT #x

12. Action Items to be completed before GRT

Supply signatures and ok to sign to
Complete tests in #8
Procedure update and post

Appendix B GRT Test Report

B.1 LDCM Ground Readiness Test Report

Date:	
Test:	
Test Participants:	

Primary test Objectives:

Activities:

Planned	Completed (Y/N)	Time (UTC)

Problems:

Anomaly Reports:

Table 10-1 Ground Readiness Test Report

Attach the following to this report:

- Element Report Summary
- Updated GSRD Matrix
- Updated Data Products Table
- Anomaly Reports
- Element Test Evidence Sites

GRM Signature: ____

Appendix C Glossary

<u>Glossary Item</u>: Definition

Appendix D Acronyms

For information regarding the acronyms contained within this document please refer to LDCM-REF-006 Acronym List

Acronym	Description
bMOC	Back-up MOC
CAPE	Collection Activity Planning Element
CCB	Configuration Control Board
CCS	Constellation Coordination System
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CM	Configuration Management
CMD	Commands
CTE	Compatibility Test Equipment
CTV	Compatibility Test Van
CVT	Cal/Val Team
DAM	Data Acquisition Manager
DiTL	Day in The Life
DOORS	Dynamic Object Oriented Requirement System
DPAS	Data Processing and Archive System
DR	Discrepancy Report
DRB	Discrepancy Review Board
DTS	Development and Training Simulations
EROS	Earth Resources Observation and Science
ESMO	Earth Science Mission Operations
ETE	End to End
FDD	Facility Definition Document
FDF	Flight Dynamics Facility
FIA	Final Implementation Agreement
FOR	Flight Operations Review
FOT	Flight Operations Team
FQT	Formal Qualification Testing
GNE	Ground Network Element
GRM	Ground Readiness Manager
GRT	Ground Readiness Test
GRTT	Ground Readiness Test Team
GS	Ground System
GSFC	Goddard Space Flight Center
GSM	Ground System Manager
GSIRD	Ground System Interface Requirements Document
GSRD	Ground System Requirements Document
HW	Hardware
I&T	Integration and Test
IC	International Cooperator
ICD	Interface Control Document

ICT	Interface Connectivity Test
IO	Input Output
IP	Installation Plan
IVM	Interface Verification Matrix
LDCM	Landsat Data Continuity Mission
LGN	LDCM Ground Network
LGS	Landsat Ground Station
LSIMSS	LDCM Scalable Integrated Multi-mission Support System
LSS	Launch Services Segment
LST	Landsat Science Team
LTA	Long Term Archive
MA	Mission Assurance
MOC	Mission Operations Control Center
MOE	Mission Operations Element
MOM	Mission Operations Manager
MOS	Mission Operations Simulation
MOR	Mission Operations Review
MRT	Mission Readiness Test
MSM	Mission Simulations Manager
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NCEP	National Centers for Environmental Prediction
NEN	Near Earth Network
NISN	NASA Integrated Services Network
NOAA	National Oceanic and Atmospheric Administration
NOM	Network Operations Manager
OIV	On-orbit Initialization and Verification
OLI	Operational Land Imager
OSS	Operations Support Simulations
PDR	Preliminary Design Review
PIA	Project Implementation Agreement
PFR	Problem Failure Report
PR	Problem Report
PSLA	Project Service Level Agreement
PSR	Pre Ship Review
QA	Quality Assurance
RF	Radio Frequency
SC	Spacecraft
SMRD	Science and Mission Requirements Document
SN	Space Network
SNAS	Space Network Access System
SOA	Service Oriented Architecture
SOS	Spacecraft/Observatory Simulator
SPITL	Scheduling Period In The Life
SRR	System Requirements Review
SS	Space Segment

STOL	
SW	Software
TDRSS	Tracking and Data Relay Satellite System
TLM	Telemetry
TRR	Test Readiness Review
TWITL	Total WRS-2 in the Life
UP	User Portal
USGS	United States Geological Survey
USNO	US Naval Observatory
USSTRATCOM	U.S. Strategic Command
UTC	Universal Time Code
VDD	Version Description Document
VRM	Verification Requirements Matrix
WAN	Wide Area Network
WSC	White Sands Complex
WSGT	White Sands Ground Terminal

References

LDCM Science and Mission Requirements Document (SMRD), GSFC 427-02-01, Revision B April 25, 2008

LDCM Operations Concept, GSFC 427-02-02, December 5, 2006

LDCM Ground System Requirements Document (GSRD), LDCM-REQ-001, Version 1.18, April 5, 2009

LDCM Ground System (GS) Verification Requirements Matrix (VRM)

LDCM GS Interface Requirements Document (GSIRD), LDCM-REQ-011, Version 1.1,March 4, 2009

LDCM GS Interface Verification Matrix (IVM)

LDCM Ground System Operations Concept, LDCM-OCD-002, Version 1.0, December 15, 2007

LDCM Ground System (GS) Integration and Test (I&T) Program, LDCM-TEST-001, May 2009

MOC Integration Plan, LDCM-ITP-002, Draft

DPAS Integration Plan, LDCM-ITP-001, Draft

RF Compatibility Test Plan

Mission Readiness Test (MRT) Plan

Mission Operations Simulation Test Plan

LDCM Ground Readiness Test Procedures GRT 1-6

LDCM Project Service Level Agreement (PSLA), 451-PSLA-LDCM, Draft March 2009

NASA Gold Rules, NASA-GSFC-1000