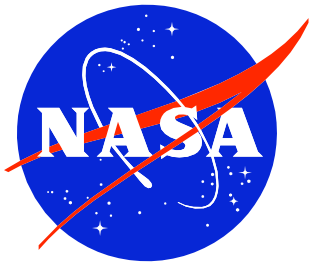
DRAFT

LDCM Project

Mission Operations Element Requirements Document

June 20, 2006

Revision – 0.0



Signature Page

Prepared by: Vicki Zanoni LDCM Data Systems & Ops Manager NASA GSFC Code 581	Date	Prepared by: Paul Cruz Operations System Engineer SAIC, Contractor to the USGS EROS	Date
Reviewed by: Ted Grems LDCM Mission Systems Engineer AI Solutions GSFC Code 427	Date	Reviewed by: Jim Nelson LDCM Lead Systems Engineer SAIC, Contractor to the USGS EROS	Date
Reviewed by: Del Jenstrom LDCM Deputy Project Manager NASA GSFC Code 427	Date	Reviewed by: USGS	Date
Approved by: William Ochs LDCM Project Manager NASA GSFC Code 427	Date	Approved by: Tom Kalvelage LDCM Project Manager USGS	Date

Document Revision History

This document is controlled by the LDCM Project Management. Changes require prior approval of the LDCM Project Manager, LDCM observatory Manager, and the LDCM Mission Assurance Manager. Proposed changes shall be submitted to LDCM Mission Systems Engineer.

RELEASE	DATE	BY	DESCRIPTION
–			Initial Version

List of TBD's/TBC's/TBR's

This document contains information that is complete as possible. Items that are not yet defined are annotated with TBD (To Be Determined). Where final numerical values or data are not available, best estimates are given and annotated TBC (To Be Confirmed). If there is an inconsistency between two requirements then the best estimate is given and annotated with a TBR (To Be Resolved). The following table summarizes the TBD/TBC/TBR items in the document and supplements the revision history.

ITEM	REFERENCE	DESCRIPTION

Table of Contents

1 Introduction

1.1 Scope

The Mission Operations Element Requirements Document (MOERD) establishes the procurement requirements for the LDCM Mission Operations Element. It is a Level 3 document that contains the functional and performance requirements for the software and hardware systems comprising the Mission Operations Element.

1.2 Mission Operations Element (MOE) Overview

The LDCM Mission Operations Element (MOE) is that part of the LDCM Flight Operations Segment that provides the primary means to communicate with the observatory and conduct the LDCM mission as described in the LDCM Operations Concept (Ref Doc. XXXX).

The MOE software and hardware systems will reside at the LDCM Mission Operations Center (MOC), a government facility located at TBD1. For operations contingency purposes a backup MOE (bMOE) will reside at a backup MOC (bMOC) facility, located at a geographically separate location from the MOC. The primary MOE and the bMOE interface for data transfer and operational transfer of observatory command and control.

MOE external interfaces are described and defined in the LDCM Space to Ground Segments Interface Requirements Document (IRD).

The MOE consists of four primary functions

- Command and Control
- Planning and Scheduling
- Trending & Analysis
- Flight Dynamics

The MOE functions are not intended to imply a particular MOE architecture or system design. Rather, the functions and corresponding document organization serve as a functional grouping of requirements.

Command & Control: The Command and Control function generates, verifies, and sends observatory command loads for transmission to the observatory. Command loads are built to implement observatory activity schedules and flight software updates. The Command and Control function monitors the LDCM observatory through the receipt, processing, and monitoring of observatory telemetry.

Planning & Scheduling: The Planning and Scheduling function builds and manages an activity schedule for the LDCM observatory. The schedule incorporates requests for image collections and non-routine instrument calibration requests that are generated externally to the MOE. The observatory activity schedule also includes orbit adjustments, maneuvers, ground station contacts and other events that occur on board the observatory.

Trending & Analysis: The Trending & Analysis functions process near- and long-term observatory telemetry data. This function is used to trend and analyze the performance of the observatory for state of health monitoring (e.g., potential problems with the observatory attitude, power, temperature, or other subsystems).

Flight Dynamics: The Flight Dynamics functions provide orbit prediction, maneuver planning, definitive ephemeris generation, and ground station in-view data.

Updates to the LDCM observatory flight software will be provided to the MOE by the LDCM Mission Contractor. The MOE will build and send the flight software command loads to implement flight software updates on the observatory.

2 Reference Documents

2.1 LDCM Project Level Documents

The MOERD is consistent with, and responsive to, the following documents of the exact issue and revision shown.

GSFC Document Number	Revision/ Release Date	Document Title
427-xx-xx		Level 1 Requirements for the LDCM Mission
427-xx-xx		Science and Mission Requirements Document
427-xx-xx		LDCM Acronym List and Lexicon
427-xx-xx		LDCM Operations Concept Document
427-xx-xx		LDCM Space to Ground Segments IRD
427-xx-xx		Statement of Work
427-xx-xx		Mission Assurance Requirements
		Special Calibration Test Requirements (SCTR)
White paper		LDCM World Reference System -2

2.2 Government Documents

Document Number	Revision/ Release Date	Document Title
GSFC STD-1000	Rev. A, May 30, 2005	Rules for the Design, Development, Verification and Operation of Flight Systems
NPD 8010.2D		NASA Policy Directive, Use of the SI (Metric) System of Measurement in NASA Programs
NPR 2810.1A	May 16, 2006	NASA Policy Guideline, Security of Information Technology
STDN 101.2	Rev. 7 /Nov. 1995	GSFC Space Network (SN) Users' Guide
452-ICD-SN/CSM	May 2004	Interface Control Document Between the Space Network and Customers for Service Management

2.3 Reference Documents

Document Number	Revision/ Release Date	Document Title

CCSDS 231.0–B–1	September 2003	Recommendation for Space Data Systems Standards. TC Synchronization and Channel Coding. Blue Book. Issue 1.
CCSDS 231.0–B–1 Cor.1	June 2006	Recommended Standard Technical Corrigendum 1 to CCSDS 231.0-B-1, Issued September 2003. Blue Book. Issue 1.
CCSDS 232.0–B–1	September 2003	Recommendation for Space Data Systems TC Space Data Link Protocol. Blue Book. Issue 1.
CCSDS 232.1–B–1	September 2003	Recommendation for Space Data Systems Standards. Communications Operations Procedure-1. Blue Book. Issue 1.
CCSDS 133.0-B-1	September 2003	Recommendation for Space Data Systems Standards TM Space Packet Protocol. Blue Book. Issue 1.

3 Command and Control

3.1 Commanding

The MOE shall be synchronized to a GFE-provided external master time signal reference.

The MOE shall provide the capability to correlate the observatory reference time to UTC reference time to within 100 microseconds.

The MOE shall archive all narrowband data, command operations and command history for the life of the mission.

The MOE shall provide the capability to generate commands to perform Flight Software (FSW) modifications and updates.

The MOE shall provide the capability to perform real time commanding to the observatory.

The MOE shall provide the capability to generate discreet observatory commands.

The MOE shall provide the capability to command the observatory into any operational mode.

The MOE shall provide the capability to generate command loads from de-conflicted observatory activity schedules.

The MOE shall provide the capability to generate command procedures.
Rationale: This is current COTS capability for a real time system, is standard practice, and: allows operator to see the real time command sequence; automate the execution of command sequences that vary based upon observatory state or operator input. See the definition of "procedure" in the glossary.

The MOE shall support the referencing of commands and command sequences based on mnemonic specification.

The MOE shall provide the capability to allow authorized operators to edit command loads.

The MOE shall provide the capability to allow users to display command loads.

The MOE shall provide the capability to report command load status.

The MOE shall provide a capability to generate time-tagged commands and on-board triggers using absolute time.

The MOE shall provide a capability to generate time-tagged commands and on-board triggers using relative times.

The MOE shall perform real-time command constraint checking and validation.

The MOE shall verify all command loads against predefined rules and constraints prior to transmission.

The MOE shall provide the capability to modify or edit command rules and constraints.

The MOE shall preclude the transmission of commands or command sequences that have not been constraint or rule checked.

The MOE shall provide notification to the operator of any invalid commands.

The MOE shall provide the capability to identify and designate critical commands.

The MOE shall provide the capability to identify and designate hazardous commands.

The MOE shall employ a two-step process where the second step is accepted or rejected for critical commands.

The MOE shall employ a two-step process where the second step is accepted or rejected for hazardous commands.

The MOE shall be capable of notifying the operator that the commands sent to the observatory were correctly received.

The MOE shall alert the operator of upcoming execution of scheduled command loads.

The MOE shall provide telemetry verification of commands executed on the observatory.

The MOE shall provide the capability to manually and autonomously retransmit commands or command loads that did not execute successfully.

The MOE shall prevent concurrent commanding by multiple operators.

The MOE shall have the capability to perform commercially available command encryption compliant with NPR 2810.1A Section 11.3.

The MOE shall provide the capability to enable and disable the command encryption function.

The MOE shall have the capability to internally store commands and command loads.

The MOE shall provide the capability to generate LDCM Ground Network (LGN) forward and return link service requests.
Rationale: MOE must acquire link through LGN before commanding

The MOE shall provide the capability to generate NASA Space Network (SN) forward and return link service Ground Control Message Requests (GCMRs) consistent with the Interface Control Document between the Space Network and Customers for Service Management.
Rational: GCMRs are sent to SN to acquire the SN link

The MOE shall automatically determine if a valid command link exists prior to transmission.

The MOE shall provide the capability for autonomous retransmission of valid commands that fail command verification, consistent with CCSDS 232.1-B-1, Communications Operations Procedure -1.

The MOE shall provide the capability to enable and disable the autonomous command retransmission capability.

The MOE shall be capable of establishing a command/telemetry interface with up to 3 ground stations and SN stations concurrently.
Rationale: allows handoff from one station to another

The MOE shall transmit commands to the observatory through a single LGN, NASA Ground Network (NGN), or SN link at a time.
Rationale: ensure only one station sends command to the observatory at a time

The MOE shall identify the LGN station, NGN station, or SN resource that is communicating with the observatory.
Rationale: To provide the MOE operators positive identification of the "in-use" resource

The MOE shall be capable of concurrent commanding and telemetry ingest.

The MOE shall be capable of verifying the execution of commands using the observatory simulator.

3.2 Telemetry Processing and Reporting

The MOE shall be capable of processing and reporting all housekeeping telemetry.

The MOE shall provide the capability to convert telemetry counts into Engineering Units (EUs).

The MOE shall provide the capability to display telemetry data in real time.

The MOE shall provide the capability to filter telemetry parameters in real time.

The MOE shall provide the capability to display discrete telemetry parameters with user-defined text or numeric values in real time.

The MOE shall provide the capability to decommutate all housekeeping telemetry.

The MOE shall provide a capability to verify in real-time that telemetry parameters are within prescribed operating limits.

The MOE shall provide the capability to replay housekeeping telemetry based on a user-specified start and stop time and replay rate.

The MOE shall provide a capability for users to define and modify telemetry parameter limit conditions.

The MOE shall provide a color coding scheme to display telemetry relative to limit ranges.

The MOE shall provide the capability for notification of limit violations only after a user-specified number of consecutive limit failures.

Rationale: Addresses limit persistence - the ability to set how many consecutive points which exceed the limit values must be received before a limit failure is reported (and the telemetry point's state changed).

The MOE shall provide the capability to generate event messages when limit state transitions occur.

The MOE shall provide a capability to turn ON and OFF selected or all limit checks.

The MOE shall verify receipt of housekeeping telemetry.

The MOE shall perform session monitoring and sequence error checking on active links between ground stations and the MOE.

Rationale: quality checking on link and data transfer during communications

The MOE shall provide the capability to create observatory contact summary reports.

The MOE shall provide the capability to ingest and process real-time status/control messages from the LGN.
Rationale: Allows telemetry and command functions to process key status information about the quality of data received in an LGN contact.

The MOE shall provide the capability to ingest and process real-time status/control messages consistent with the Interface Control Document between the Space Network and Customers for Service Management.
Rationale: Allows telemetry and command functions to process key status information about the quality of data received in an SN contact.

3.3 Event and Logging Operations

The MOE shall provide the capability to allow users to create, modify, and manage event definitions.

The MOE shall provide the capability to generate user-defined event message reports.

The MOE shall allow the user to enable, disable, filter, and display event messages.

The MOE shall provide a user-configurable control to filter repeated event messages.
Rationale: Allows user to prevent the same event message from occurring over and over in the event log. You may not want the same limit violation repeated over and over again, but rather on every nth occurrence

The MOE shall provide the capability to store and log all event messages for the life of the mission.

The MOE shall provide the capability to display all event messages and logs.

The MOE shall provide a capability to generate and save operator logs.
Rationale: keep a record of FOT activities

The MOE shall provide the capability to store and log all transmitted observatory commands.

4 Planning and Scheduling

The MOE shall provide the capability to plan and execute all observatory housekeeping activities for the life of the mission.

The MOE shall be capable of saving, storing, printing all mission planning and scheduling data for the life of the mission.

The MOE shall provide the capability to create and modify activity priorities, constraints, and rules.

The MOE shall produce time-ordered activity plans listing all planned activities for the observatory planning window.

The MOE shall provide the capability to identify, status, and de-conflict unavailable observatory resources.

The MOE shall provide the capability to store availability for the resources in the LDCM Ground Network.

The MOE shall provide the capability to store availability for the ICs.

The MOE shall provide the capability for planning and scheduling observatory image collections.
Rationale: allows MOE to task the instrument(s) without going through CAPE

The MOE shall provide the capability to incorporate activity requests into an activity plan.

The MOE shall provide the capability to plan all observatory maintenance and housekeeping activities.

The MOE shall provide the capability to automatically update activity plans as activity requests are received.

The MOE shall provide a capability to notify operators of constraint, conflicts, and rule violations during planning and scheduling.

The MOE shall provide the capability to schedule a contact within 15 minutes (TBC1) of an in-view observatory contact.
Rationale: For emergencies

The MOE shall provide the capability to schedule all observatory and ground station activities within operational resource constraints.

The MOE shall provide the capability to produce a Coordinated Universal Time (UTC) time-based activity schedule in terms of specific start/stop times.

The MOE shall be capable of converting to and from UTC reference time to the observatory reference time.

The MOE shall provide the capability to generate a 72-hour (TBC2), conflict-free schedule every 12 (TBC3) hours.
Rationale: allows FOT to generate new schedules every 12 hours, consistent with cloud-cover prediction inputs

The MOE shall provide the capability to generate a 72-hour (TBC2), conflict-free schedule within 4 (TBC4) hours.
Rationale: allows FOT to generate new schedules within 4 hours for priority activities

The MOE shall incorporate all resource down times or reserved times into schedule generation.

The MOE shall evaluate all activity requests for current scheduling window during schedule generation.

The MOE shall incorporate constraints and rules into schedule generation.

The MOE shall schedule observatory activities based on prioritization criteria.

The MOE shall provide the capability to report schedule generation status.

The MOE shall provide the capability to-generate a de-conflicted activity schedule.

The MOE shall provide the capability to manually modify an activity schedule.

The MOE shall provide the capability to generate a graphical timeline of activity plans and schedules.

The MOE shall provide the capability to generate user-defined planning and scheduling reports.

The MOE shall be capable of designating WRS-2 scenes as priority.
Rationale: Ensures that observatory is able to correctly handle priority scenes

5 Trending and Analysis

The MOE shall provide the capability to ingest and store real time raw telemetry for the life of the mission.

The MOE shall provide the capability to display stored telemetry data for any user-specified time interval.

The MOE shall provide the capability to define pseudo-telemetry via user-defined equations.

The MOE shall provide the capability to filter telemetry parameters based on user-defined criteria.

The MOE shall provide the capability to display discrete telemetry parameters with user-defined text or numeric values.

The MOE shall provide the capability to export user-specified telemetry data to current PC-based media, standard desktop software applications, and via the internet.

The MOE shall be capable of displaying multiple sets of stored telemetry data concurrently for multiple users.

The MOE shall be capable of generating trending products from real-time telemetry.

The MOE shall be capable of generating trending products from stored telemetry.

The MOE shall be capable of generating statistical products from real-time telemetry.

The MOE shall be capable of generating statistical products from stored telemetry.

The MOE shall provide the capability to generate trending and statistical products for any user-specified time interval.

The MOE shall be capable of generation of trending and statistical products by multiple concurrent users.

The MOE shall provide the capability to indicate limit values on trending and statistical displays and reports.

The MOE shall provide the capability to generate trending products and statistical products for a user-defined time period.

The MOE shall provide the capability to both manually and automatically generate trending products and statistical products.

The MOE shall be capable of generating a trending and statistical product from the complete telemetry data set within 30 minutes (TBC5).
Rationale: assumes all telemetry is stored on-line

The MOE shall display a single requested telemetry value from the complete telemetry data set within 1 (TBC6) second.
Rationale: response time on telemetry retrieval during the full life of the mission; assumes all telemetry is stored on-line

The MOE shall provide the capability to display telemetry parameters in either raw or EU-converted format.

6 Flight Dynamics

The MOE shall provide the capability to perform observatory maneuver planning for the life of the mission.

The MOE shall be capable of generating maneuver plans in support of all observatory orbit maintenance, calibration, and imaging activities.
Rationale: Key function and SMRD traceability.

The MOE shall provide the capability to identify and report maneuver constraint violations during maneuver planning.

The MOE shall provide the capability to automatically detect and notify MOE operators when the observatory orbital parameters deviate from established limits.

The MOE shall maintain an observatory ground track to WRS-2 grid within +/- 5 Km at the equator.
Rationale: key function; SMRD traceability

The MOE shall provide the capability to propagate the observatory orbit to the following accuracies (TBC7):

Accuracy of 3-day predicted orbit state vectors data for the first forty (40) hours, given a solar flux value of less than 215 and no maneuver activity during the 3 days, shall be at least:

7 meters (3s) radial
375 meters (3s) along-track
10 meters (3s) cross-track
375 meters (3s) RSS

Accuracy of the 3-day predicted orbit state vectors data shall degrade to no worse than the following after 72 hours:

12 meters (3s) radial
1200 meters (3s) along-track
12 meters (3s) cross-track
1200 meters (3s) RSS

The MOE shall provide the capability to propagate the observatory orbit for user-defined durations.
Rationale: need for orbit prediction / maneuver planning; parent requirement to predicted ephemeris generation

The MOE shall provide the capability to generate the actual (definitive) ephemeris of the observatory at an accuracy of 30m in each axis, 3 sigma.
Rationale: processing of on-board GPS ephemeris

The MOE shall maintain the mean local time of the observatory descending node within 10:00 a.m. +/- 15 minutes for the life of the mission

The MOE shall provide the capability to calibrate the on-board attitude sensors.

The MOE shall provide the capability to calibrate the observatory thrusters
Rationale: to perform thruster cal using maneuver reconstruction after each burn.

The MOE shall provide the capability to monitor and predict observatory consumable usage throughout the life of the mission.
Rationale: propellant (maneuver planning), battery state of charge, storage capacity, etc.

The MOE shall provide a capability to display the observatory orbit and ground tracks based on user-defined durations.

The MOE shall be capable of ingesting externally-generated observatory ephemeris data.
Rationale: in the event of a GPS failure, allows MOE to use ephemeris from external source e.g. FDF

The MOE shall be capable of exporting ephemeris and attitude data for a user-selectable time interval to current PC-based media, standard desktop software applications, and via internet.

The MOE shall provide the capability to generate predicted ground station view periods for the observatory.
Rationale: accuracy for in-view is derived from orbit propagation accuracy

The MOE shall incorporate ground station antenna masks in computing predicted station in-view periods.

The MOE shall provide a capability to generate predicted SN contact/view periods for the observatory.

The MOE shall provide the capability to model sun-line RF interference.

The MOE shall provide the capability to generate operator-specified flight dynamics reports.

The MOE shall report and plot attitude with respect to user specified reference frames.

7 Flight Software Management

The MOE shall provide version control for Ground Reference Image (GRI) of observatory memory.
Rationale: Required to provide health/status of on-board computers; required to enable reload of flight software executable from ground segment in case of single event upsets or other anomalies.

The MOE shall provide the capability to modify writeable memory locations on the observatory.

The MOE shall provide the capability to create a voted memory dump from multiple copies of the same memory dump.
Rationale: bit error checking to verify that the dump was transmitted correctly

The MOE shall be capable of exporting observatory memory dump data to current PC-based media, standard desktop software applications, and via internet.
Standard requirement to allow effective data management of memory dump data.

The MOE shall provide the capability to compare multiple stored memory dumps and report the specific differences.
Required for OBC memory management.

The MOE shall provide the capability to compare memory dumps with the GRI and report the specific differences.

The MOE shall provide the ability to view the Ground Reference Image.

The MOE shall provide the ability to view observatory memory dumps.

8 General / Administrative

The MOE shall conform to NPD 8010.2D, NASA Policy Directive, Use of the SI (Metric) System of Measurement in NASA Programs.

The MOE shall provide the capability to maintain version control for all MOE data.

The MOE shall provide the capability to produce and store data and products in a tabular, plot, and graphics form

The MOE shall provide the capability to generate textual and graphical reports.

The MOE shall provide the capability to save and retrieve any report.

The MOE shall provide the capability to generate user-defined reports and plots based on user-provided scripts.

The MOE shall provide the capability to generate one-time and regularly recurring reports and plots at times indicated by user-provided scripts.

The MOE shall provide the capability to print all data displayable on a workstation.

The MOE shall provide an anomaly reporting and status tracking capability.

All MOE capabilities shall comply with NPR 2810.1A, NASA Procedural Requirement, Security of Information Technology.

The MOE shall log all security events for the life of the mission, including successful and unsuccessful system access attempts, and file creations, deletions, and modifications.

The MOE shall provide individual user account and password controls for access to the system and use of the software.

The MOE remote access interface shall be password protected.
Rationale: Satisfies basic security requirements levied/described in NPR 2810.1A. Reduces probability of telemetry pages being accessed by unauthorized personnel.

The MOE shall have the capability to restrict user access.

The MOE shall be accessible by concurrent multiple authorized users.

9 User Interface

The MOE shall have the capability to provide video output of a workstation display to multiple workstations and/or video projection devices.

The MOE shall provide the capability for the user to define and display customizable views of data and graphics.

The MOE shall utilize a Graphical User Interface (GUI) for system operation.

The MOE shall provide the capability for a secure remote web interface for real-time telemetry, trending and analysis, and event/messaging MOE capabilities.

10 Automation

The MOE pre-staged commanding, telemetry ingest, and telemetry monitoring functions shall be capable of operating autonomously during unattended periods for at least 72 hours (TBC8).

The MOE shall provide interoperability across MOE functions.
Rationale: plug and play subsystems to support service oriented architecture (SOA)

The MOE shall provide the capability to monitor and report message traffic and system health status among and between MOE functions.
Rationale: monitor communications between MOE functions in service oriented architecture (SOA) environment and provide status of MOE equipment and software

The MOE shall be capable of generating alert notifications remotely to a communications/pager service.

11 Availability and Redundancy

The MOE shall provide system monitoring tools to track MOE system performance.

The MOE shall have a system up time availability of at least 99.95% (TBC9) averaged over 30 days.
Rationale: MOE must be available to support around the clock observatory operations

The MOE shall have a mean time to restore operations of 1 minute (TBC10) or less.
Rationale: hot backup redundancy

The MOE shall provide an off-line redundant functionality
Rationale: to facilitate training, maintenance, and testing concurrent with operations, with no interruption to operations.

The MOE shall provide the capability to log, track, and report system faults and failures.

The MOE shall provide the capability to report system faults and failures remotely to a communications/pager service

12 Backup MOE (bMOE)

The bMOE shall provide all the capabilities of the MOE as described in sections 3-11 of this document.

The primary MOE shall communicate bi-directionally with the bMOE for data transfer, synchronization, and check-pointing.

The MOE and bMOE system shall be capable of bi-directional transfer of system operations within one hour.

Appendix A: Requirements Traceability (TBR)

Appendix B: Glossary

anomaly -- any unplanned or unexpected event which may result in a loss of operation data or a sharp departure of certain telemetry parameters from their nominal values – a deviation from normal operation that affects the performance of an observatory system or subsystem.

Activity – a user-defined combination of ground directives and/or observatory commands which can be planned and scheduled. An action (or set of actions) which can occur on the ground or observatory that requires resources and is associated with a definitive start and stop time.

Activity Request – a request for operators to schedule activities.

Activity Schedule – a time-based or time-tagged set of activities for a given time period.

Command Loads – a set or packaging of commands related by execution time and/or function, converted to binary streams to be up-linked. (Packaging of both telemetry and commands can be performed in a number of ways, such as the CCSDS Telemetry and Commanding Packaging format.)

Command Sequence – a set of commands related by time. A list of stored command mnemonics identified by a unique name known to the operators that can be re-used.

Commanding -- the coding and packaging of the command information, command validation and verification, as well as authorization to perform the commands. Telemetry and Commanding are necessarily related to one another because Telemetry and Commanding form a feedback loop; the values of down-linked telemetry may play a role in deciding what command or what command parameters to send next.

Commands – Messages that instruct an action on the observatory to execute.

Critical Command (or Critical Operations) – an observatory command which, when executed under certain conditions, could jeopardize the health and safety of the spacecraft or its subsystems. It requires the intervention/authorization of an operator before transmission.

Decommutated Telemetry – the extracted telemetry parameters from their assigned positions (such as the Major/Minor Frame Number in TDM telemetry systems or the Byte Position in a Packet within the Transfer Frame in CCSDS telemetry systems) within the telemetry stream.

Directive -- a command to the ground software system. Examples of directives are: bring up a display page, turn limit checking on/off, acquire telemetry, etc.
Engineering Unit (EU) – computed human and machine readable values for telemetry analysis Examples of Engineering Units include values for voltage, temperature (degrees K or C), kilometers, etc.

Event – an occurrence detectable within mission operations systems that is used to monitor and track or otherwise audit ground and space operations.

Event Message – the resulting message from a detected event

Ground Reference Image (GRI) – the ground-based, controlled flight software version that is currently resident on the observatory (i.e. the image/memory currently used by the On-Board Computer containing data, commands, subroutines, etc).

Hazardous Command – a command which when executed may endanger the safety of human beings working on the spacecraft during I&T, launch preparation or launch. It also requires the intervention of an operator before transmission.

Health & Safety – the discipline of monitoring observatory telemetry to check the well-being of the observatory.

Hot backup – an idle, but equivalent system or subsystem ready to take-over instantly when the primary system or subsystem fails.

Housekeeping Telemetry – All other data from the Observatory other than image data.

Housekeeping Telemetry– observatory telemetry used in Health and Safety determination. Observatory housekeeping telemetry also includes instrument/payload telemetry, also known as science telemetry and payload data.

Limit violation – an event when a telemetry parameter exceeds its expected range of values.

Log – A time-tagged list of actions or events

Memory Load —generally a combination of flight software updates, table loads, and command loads that affect the on-board observatory memory.

Mission Operations Element (MOE) data – all data that is received externally to the MOE, sent out from the MOE, or created for internal MOE use. Examples include: all forms of Telemetry (e.g. Raw, Calibrated, etc), all forms of Commands and mnemonics, Pass Summaries, operator-saved analysis, event messages, plans/schedules, logs, etc.

Mnemonic – an alphanumeric shorthand representation of a telemetry point or a command assigned by convention and operators, and stored in a database to reference.

Observatory – The entire LDCM spacecraft including the bus, instrument(s) and any associated components.

Pass Summary – MOE data related to an observatory pass

Planning – the discipline of predetermining and coordinating the mission activities for any period of time.

Proc(edure) – A stored sequence of commands or directives written in a high-level language with built-in flow controls (such as if-then-else, do while, case, etc.) to automate observatory operations.

Pseudo Telemetry – telemetry values derived by calculation often involving multiple telemetry points.

Raw Telemetry – telemetry that has not been converted into Engineering Units

Reports – user-filtered MOE data output to a file, screen, plotter or printer

Scheduling – the process of assigning and coordination of resources associated with planned activities, and the assignment of each planned activity to a specific time.

Scripts – a capability involving editable and stored sets of directives (see Directive) whereby mission operations ground systems administration can be accomplished automatically.

State transition – an event when the observatory, one of its subsystems or telemetry parameters enters or exits an operator-defined, detectable condition

Stored Command – a command awaiting execution onboard the observatory.

Table Load -- An uplink of observatory parameters that typically reside in specific on-board memory locations

Telemetry – Includes housekeeping telemetry and pseudo telemetry.

Telemetry Counts – discrete values for raw specific telemetry points

Telemetry parameters – values used in the determination of observatory health and safety.

Trending – the discipline of tracking telemetry values for any number of recent or historical telemetry downlinks.

Voted memory dump - an observatory memory dump which is the outcome of comparing multiple copies of the same dump from the observatory and determining the bits based on a majority vote from the copies.