Lunar Reconnaissance Orbiter Project

Data Management and Archive Plan

LRO GSFC CMO
June 26, 2007
RELEASED

Goddard Space Flight Center
Greenbelt, Maryland

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1.0 INTRODUCTION

1.1 PURPOSE

This Data Management and Archive Plan (DM&AP) for the Lunar Reconnaissance Orbiter (LRO) Mission describes the roles and responsibilities of the LRO Mission Operations Center (MOC), LRO Instrument Science Operations Centers (SOCs), and the Planetary Data System (PDS), including the relationships between these entities, with regard to measurement and support data flow.

1.2 SCOPE

This Data Management and Archive Plan describes and dictates the relationship of the SOCs to the PDS and to the MOC. It addresses measurement and support data flow between the MOC, SOCs, and PDS. It does not address the technical means by which the data flows (which are documented in Interface Control Documents), data management within SOCs (which are documented in their individual Data Management and Archive Plans), nor data flow from the flight instruments to the MOC.

1.3 APPLICABLE DOCUMENTS

The following documents apply only to the extent they are cited:

- ESMD-RLEP-0010 Lunar Reconnaissance Orbiter Requirements
- 431-OPS-000042 Lunar Reconnaissance Orbiter Mission Concept of Operations
- 431-PLAN-000079 Lunar Reconnaissance Orbiter Mission Readiness Test Plan
- 431-ICD-000049 External Systems Interface Control Document for the Lunar Reconnaissance Ground System

PDS reference documents:

- Planetary Data System Standards Reference, JPL D-7669, Part 2
- Planetary Science Data Dictionary Document, JPL D-7116
- Planetary Data System (PDS) Proposer's Archiving Guide (PAG), JPL D-26359
- Planetary Data System Archive Preparation Guide (APG), January 20, 2005, Version 0.050120, JPL D-31224

1.4 SCHEDULE FOR DATA DELIVERY TO THE PDS

The phrase “within 6 months of creation” as used herein should be considered shorthand for the following level 1 requirement:
“RLEP-LRO-P110  Measurement Investigation Requirements” The time required to [...] make the initial data products available via the PDS to the Headquarters and the Program office shall be six months or less from delivery to Earth. New or improved data product releases and derived data products shall be delivered to the PDS as soon as they are available.”

The LRO Data Working Group (LDWG) has clarified this as follows:

The six core SOCs will deliver 3-6 month old data every 3 months starting at launch + 8 months (completion of commissioning + 6 months). Subsequent versions and derived products are required to go to PDS “immediately” (at the next scheduled 3 month delivery). Final data versions are required to go to PDS by 6 months after the end of the primary mission, and by 6 months after the end of an extended mission. Any instrument data from the commissioning phase may be archived in PDS at the instrument Principal Investigator’s discretion at launch + 8 months.

The Mini-RF technology demonstration data is delivered to the PDS Geosciences Node every 6 months, where the data are 6-9 months old. This schedule would coincide with every other data delivery for the other LRO instruments, starting with their second deliveries at launch plus 11 months.

The MOC data delivery schedule to the SOCs and PDS NAIF is described in the document entitled: "Lunar Precursor and Robotic Program (LPRP) Lunar Reconnaissance Orbiter Project: External Systems Interface Control Document for the Lunar Reconnaissance Ground System". This document is referenced as the GS ICD in this document.

To ensure successful data delivery, the SOCs will send test data to the PDS Nodes according to a test schedule determined by the LDWG. MOC test data deliveries to the SOCs and SOC deliveries to the MOC where applicable of test versions of Activity Requests, will be performed as part of Mission Readiness Testing (MRT) #5 and #6, where these tests will occur during the period November 2007 through June 2008.
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Schedule Date: 2007-05-14

Author: Stan Scott /LRO Project

Notes:
1. Document versions: 1 = draft, 2 = final
2. Allow 2 months for Data Product SIS Peer Review by PDS and for SIS revision; final version depends on outcome of peer review
3. RDR Pipeline Data Prod SIS & Archive Vol SIS drafts due Nov 15, 2007; cumulative RDR SISs & data delivery due near end of mission
4. Electronic data delivery test between SOC and PDS, if applicable
5. GS&O Testing- actual dates within those specified, test types, test data used, and test goals are as agreed between GS&O & SOC Lead
6. SOC data deliveries to PDS in time for public release at 3 month anniversaries of start of LRO post-commissioning operations
7. Mini-RF (MRF) data deliveries to PDS coincide with every other release from other teams

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2.0 MISSION OVERVIEW

2.1 LRO CONTEXT AND GOALS

LRO is the first mission of the Lunar Precursor and Robotic Program (LPRP). LRO is scheduled for launch in October 2008. The goal for the LPRP is to prepare for future human exploration of the Moon. LRO specific objectives are:

- Characterize the lunar radiation environment, biological impacts, and potential mitigation
- Determine a high resolution global, geodetic grid of the Moon in 3 dimensions
- Assess in detail the resources and environments of the Moon’s polar cap regions
- Perform high spatial resolution of the Moon’s surface

2.2 LRO INSTRUMENTS

The LRO instrument complement includes six core instruments and one demonstration instrument:

- Cosmic Ray Telescope for Effects of Radiation (CRaTER): CRaTER will investigate the effect of solar energetic particles and galactic cosmic rays on tissue-equivalent plastics as a constraint on models of biological response to background space radiation.
- Diviner Lunar Radiometer Experiment (DLRE): Diviner will map the temperature of the entire lunar surface at 500-meter horizontal scales to identify cold-traps and potential ice deposits.
- Lyman-Alpha Mapping Project (LAMP): LAMP will observe virtually the entire lunar surface in the far ultraviolet. LAMP will search for surface ices and frosts in the polar regions and provide frost abundance, landform and surface UV spectral maps of permanently shadowed regions illuminated only by starlight and interplanetary Lyman alpha.
- Lunar Exploration Neutron Detector (LEND): LEND will map the flux of neutrons from the lunar surface to search for evidence of water ice and provide measurements of space radiation environment which can be useful for future human exploration.
- Lunar Orbiter Laser Altimeter (LOLA): LOLA will determine the global topography of the lunar surface at high resolution, measuring landing site slopes and search for polar ice in shadow regions.
- Lunar Reconnaissance Orbiter Camera (LROC): LROC will acquire targeted images of the lunar surface capable of resolving small-scale features that could be landing site hazards. LROC will also produce wide-angle images at multiple wavelengths of the lunar poles to document the changing illumination conditions and potential resources.
- Mini-Radio Frequency technology demonstration (Mini-RF): Mini-RF will fly as a technical demonstration of a unique miniaturized multi-mode dual frequency (X&S band), dual polarization radar observatory. The primary image data products will be multi-mode Stokes parameters (or their primitives), a major pioneering capability in space-based radar astronomy. Additional communications and navigation demonstrations will also be made to validate new instrument technologies.
3.0 **ROLES AND RESPONSIBILITIES**

3.1 **LRO PROJECT OFFICE (LPO)**

The LRO Project Office has overall responsibility for the acquisition, integration, launch, and operation of the LRO Observatory, and ensures compliance by all parties with contractual requirements. With regard to mission measurement and support data, the LPO provides data coordination via chairing the LRO Data Working Group (LDWG). The LDWG coordinates the planning for data product generation, data validation, and release of Planetary Data System (PDS)-compliant archives to the PDS. LDWG membership includes representatives from the LPO, Mission Operations Center (MOC), Science Operations Centers (SOCs), PDS, and other interested parties selected to ensure that measurement data, generated products, engineering data sets, and documentation are archived in PDS. During the active mission the LDWG will provide the coordination needed to ensure that archives are assembled, validated, and delivered to the PDS according to schedule.

Documentation to be provided by the LPO:
- This LRO Data Management and Archive Plan

Documentation to be provided by the LPO to the PDS in compliance with PDS standards:
- High-level mission description (MISSION.CAT)
- High-level spacecraft description (INSTHOST.CAT)
- References (REF.CAT)

3.2 **MISSION OPERATIONS CENTER (MOC)**

The LRO MOC is LRO’s central collection and distribution center for measurement and support data. MOC responsibilities include measurement data Level 0 processing for Science Operations Centers (SOCs) that request it, daily distribution of measurement data (raw data or NASA Level 0 data according to SOC choice) and associated information to the SOCs, and archiving spacecraft housekeeping, and health and safety data, as well as MOC-generated SPICE data in the PDS.

3.3 **SCIENCE OPERATIONS CENTERS (SOCs)**

Instrument Team Science Operations Centers are responsible for all measurement data related activities for their instrument from receipt of data from the MOC to submission of initial data to the PDS within 6 months of creation. This includes designing, implementing, documenting, and peer reviewing as appropriate:
- Data receipt from the MOC
- Data storage, internal transmission, and backup
- Generate Activity Requests containing instrument command sequences
- Algorithm development for product generation
- Product generation processing and reprocessing
- Data validation for both science and engineering aspects

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- Special data delivery to the LPO or other special requesters
- Data submission to the MOC for redistribution as applicable
- Data preparation, validation, and submission to the PDS for archive
- Configuration management processes
- SOC information technology security
- Distribution in fulfilling the obligations of a PDS Data Node for those SOCs serving as a PDS Data Node
- Distribution as part of education and public outreach activities

A SOC may arrange, with project and PDS concurrence, to become a PDS Data Node. The LOLA team and the PDS Geosciences Node have signed the LOLA Data Node Memorandum of Agreement. The LROC proposal was approved with the requirement and funding for the LROC team to host the LROC Data Node. The LOLA and LROC Data Nodes will abide by the guidelines and obligations that go with Data Node status, including archive and distribution requirements. LOLA and LROC are PDS Data Nodes for the duration of the LRO mission. Within six months of the completion of the LRO Mission, and extended mission if applicable, the LOLA and LROC archives will be transferred respectively to the PDS Geosciences and Imaging Nodes.

Documentation to be provided by the SOCs to the LPO (Maintained under SOC configuration management):
- SOC Requirements Document
- SOC Risk Assessment Plan and IT Security/Contingency Plan
- SOC Data Management & Archive Plan (DM&AP)
- SOC Test Plan

Documentation to be provided by the SOCs to the PDS in compliance with PDS standards:
- SOC-PDS Discipline Node Interface Control Document (Jointly developed)
- Software Interface Specifications (SISs) for data products and for archive volumes
- High-level instrument description (INST.CAT)
- High-level data set description (DATASET.CAT)
- Key personnel (PERSON.CAT)
- References (REF.CAT)
- Calibration information and data sufficient to enable a user to understand and reproduce the calibration of higher level products
- Data processing production methodology and algorithms
- References to instrument papers for journals

3.4 MINI-RADIO FREQUENCY (MINI-RF) TECHNOLOGY DEMONSTRATION

The Mini-Radio Frequency Instrument Team has indicated a desire to follow SOC roles and responsibilities. To the extent Mini-RF wishes, the SOC roles and responsibilities apply, but Mini-RF is under no formal obligation to do so.
3.5 PLANETARY DATA SYSTEM (PDS)

The Planetary Data System (PDS) is the designated archive and public distribution center for the LRO Mission. The PDS will work with the LDWG and individual MOC/SOCs to ensure that the LRO archives are compatible with PDS standards and formats. The PDS Geosciences Node will provide overall coordination of PDS activities for LRO. A Data Engineer from the PDS Engineering Node will work with the PDS Discipline Nodes involved with the LRO Mission throughout the archive planning, generation, and validation phases. The PDS provides data archiving specifications, integration and test support, data archive, and distribution. The PDS is funded independent of the LRO budget for generation, distribution, and maintenance of LRO archives for the NASA planetary science community once the LRO data have been delivered.
4.0 DATA FLOWS

4.1 MISSION OPERATIONS CENTER (MOC)

All LRO data will be transmitted from the LRO Orbiter to the MOC. The MOC and Flight Dynamics Facility (FDF) will generate LRO SPICE data files for distribution to the SOCs. These data include lunar ephemeris, leap seconds, planetary constants, etc. The GS&O External ICD includes these data flows. The MOC will receive raw instrument data files and distribute instrument files along with relevant spacecraft files to the appropriate SOC. The MOC will archive all orbiter data along with mission products for the life of the mission. The MOC is responsible for transferring LRO SPICE data files to the PDS within 6 months of creation. The MOC will also distribute to the SOCs and PDS all reprocessed orbital data in SPICE format.

4.2 SCIENCE OPERATIONS CENTERS (SOCs)

The SOCs receive measurement data (raw or NASA Level 0 data according to SOC choice) and support data as well as SPICE data from the MOC, generate higher level products, and deliver all NASA Level 0 and higher data products to the Planetary Data System (PDS) within 6 months of creation per PDS specifications. The SOCs are responsible for all internal data handling and specified product generation. Those SOCs serving as PDS Data Nodes also have PDS responsibilities as noted in 4.3.

4.3 PLANETARY DATA SYSTEM (PDS)

The Planetary Data System archives and distributes all measurement data and support products meeting PDS standards submitted from the MOC and SOCs.
5.0 **LRO MEASUREMENT DATA OBJECTIVES**

The list of measurement data objectives below is similar to a list in the LRO Level 1 requirements. The MOC and SOCs may decide to aggregate them differently and map their data products to them such that there is not a one-to-one mapping between objective and product for delivery to the PDS. The PDS delivery aggregation will be documented by the SOCs in their DM&AP, SOC-PDS Discipline Node ICD, and SISs.

5.1 **LRO MISSION OPERATIONS CENTER (MOC)**

Destination PDS Node: Navigation and Ancillary Information Facility (NAIF) Node, JPL
Data Products: SPICE data generated by the MOC.

5.2 **COSMIC RAY TELESCOPE FOR EFFECTS OF RADIATION (CRATER)**

Principal Investigator: Dr. Harlan Spence, Boston University, Boston, Massachusetts
Destination PDS Node: Planetary Plasma Interactions Node, UCLA
Data Products:
- Measure and characterize that aspect of the deep space radiation environment, Linear Energy Transfer (LET) spectra of galactic and solar cosmic rays (particularly above 10 MeV), most critically important to the engineering and modeling communities to assure safe, long-term, human presence in space.
- Investigate the effects of shielding by measuring LET spectra behind different amounts and types of areal density, including tissue-equivalent plastic.

5.3 **DIVINER LUNAR RADIOMETER EXPERIMENT (DLRE)**

Principal Investigator: Dr. David Paige, UCLA, Los Angeles, California
Destination PDS Node: Geosciences Node, Washington University
Data Products:
- Direct temperature mapping at ~300M spatial resolution with minimum detectable temperature of 24K over an entire diurnal cycle enables the detection and characterization of cold traps in polar shadowed regions.
- Determine rock abundances of up to 50 selected potential landing sites.
- Provide illumination map derived from Illumination and Scattering Model (Includes slopes, raytraced shadows, and full 3-D radiosity solution for scattered solar and infrared radiation), and 1-D lunar thermal model
- Fine-component thermal inertia and lambert albedo from surface temperature, solar reflectance and topography measurements

5.4 **LYMAN-ALPHA MAPPING PROJECT (LAMP)**

Principal Investigator (Acting): Dr. Randy Gladstone, Southwest Research Institute, San Antonio, Texas
Destination PDS Node: Imaging Node, JPL
Data Products:
- Albedo maps of all permanently shadowed regions with resolutions down to 100m.
- Develop exposed water-frost concentration maps of the lunar polar regions. Mapping resolutions as good as 3km for frost abundances down to 1.5%.

5.5 LUNAR EXPLORATION NEUTRON DETECTOR (LEND)

Principal Investigator: Dr. Igor Mitrofanov, Institute for Space Research, and Federal Space Agency, Moscow, Russia
Destination PDS Node: Geosciences Node, Washington University

Data Products:
- Radiation Data Product for global distribution of neutrons at Moon’s orbit with spatial resolution of 50 km at different energy ranges from thermal energy up to >15 MeV separately for periods of quiet Sun and for periods of Solar Particle Events.
- Develop maps of water ice column density on polar regions of the Moon with spatial resolution from 5-20km.
- Determine hydrogen content of subsurface at polar regions with spatial resolution from Half-Width Half-Maximum (HWHM)=5km and with variation sensitivity from 100 parts per million (ppm)

5.6 LUNAR ORBITER LASER ALTIMETER (LOLA)

Principal Investigator: Dr. David E. Smith, NASA Goddard Space Flight Center (GSFC), Greenbelt, Maryland
Destination PDS Node: Geosciences Node, Washington University (LOLA SOC has requested to be a PDS Node for LOLA data during the life of the LRO mission)

Data Products:
- Provide global digital elevation model of the moon with 1 m vertical resolution and 100 m horizontal resolution with 1 km average cross track sampling at the equator.
- Provide global topography with 1 m vertical resolution and 100 m horizontal resolution with 1 km average cross track sampling at the equator.
- Provide digital elevation model of topography in permanently shadowed polar regions with 50m horizontal resolution, 1m vertical resolution.
- Provide reflectance data from the permanently shadowed regions (PSRs) to identify surface ice signatures at a limit of 4% ice surface coverage by area.
- Provide topography, surface slopes, and surface roughness at 25-m spacing over a 70-m wide field of view (FOV) swath at up to 50 selected potential landing sites.
- LOLA will map the polar regions poleward of latitudes 86° with a vertical resolution of 10 centimeters (cm) and a spatial resolution of 25 to 35m after one year, which will identify potential sites of optimal solar power generation.

5.7 LUNAR RECONNAISSANCE ORBITER CAMERA (LROC)

Principal Investigator: Dr. Mark Robinson, Arizona State University, Tempe, Arizona
Destination PDS Node: Imaging Node, USGS, Flagstaff, Arizona (LROC SOC has requested to

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be a PDS Node for LROC data during the life of the LRO mission).

Data Products:
- For areas of high interest (targets), provide 2m scale Digital Elevation Models (DEM) for areas 5km x 5km.
- Acquire 100m/pixel global stereo imaging reducible to 1km/pixel global topography in EDR format (no maps). Back up for LOLA data, if needed WAC.
- 100m/pixel global color mosaic @ nominal 50km orbit.
- Provide up to 50 Mosaics of selected potential landing sites with 1 m/pixel resolution.
- Provide uncontrolled illumination movies, 1 each of North and South Lunar Poles over the course of 1 lunar year at an average time resolution of 5 hours or better. (Wide Angle Camera [WAC])
- Provide 1 m/pixel resolution summer (uncontrolled) mosaics of the lunar poles (+/- 4 degrees). (Narrow Angle Camera [NAC]). There will be some gores in the data due to tolerance (20km) of the nominal 50km orbit altitude.
- Global imaging 400m/pixel in the ultraviolet (UV) bands and 100m/pixel in the visible bands, ten uncontrolled demonstration multi-spectral mosaics for high priority targets.

## 5.8 MINI-RADIO FREQUENCY (MINI-RF) TECHNOLOGY DEMONSTRATION

Principal Investigator: Dr. Stu Nozette, Naval Air Warfare Center (NAWC), China Lake, California
Destination PDS Node: Geosciences Node, Washington University, St. Louis, Missouri

Data Products:
- Products as agreed between LPO and Mini-RF PI

CHECK WITH LRO DATABASE AT: [https://lunarpgin.gsfc.nasa.gov](https://lunarpgin.gsfc.nasa.gov)
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.
6.0 ARCHIVE GENERATION, VALIDATION, TRANSFER, AND DISTRIBUTION

The list of products and other tabular material supporting this section can be found in the Appendix.

6.1 GENERATION

LRO science operations will be geographically distributed, with a Project-controlled central database at the MOC containing telemetry data, SPICE files, and other information needed by the SOCs to generate their products. The MOC will transfer this data to the SOCs.

An Interface Control Document (ICD) will exist for each relationship between a facility that provides data and the PDS node that receives it. This document will describe the management interface between the two entities, roles and responsibilities of each side, and policies and procedures that govern the flow of data from provider to PDS. Each type of data product to be delivered to PDS will be described in a Data Product Software Interface Specification (SIS), which may be included as an Appendix to the ICD. The SIS will include an example of the PDS label for the data product. In addition, an Archive Volume SIS will describe the contents and organization of the complete archive to be delivered to PDS, including data products, indices, documentation, software, and other supporting materials. The Archive Volume SIS may also be appended to the ICD. The data product SIS and volume SIS serve as the definitive documents for defining the contents, structure, and organization of the data deliveries. The data product SIS and archive volume SIS may be combined into a single document, if this is acceptable to both the instrument team and the PDS Node leader.

The archives are intended to preserve observational data that support instrument calibration as well as measurement data. Measurement data acquired during the LRO mission cruise and commissioning phases may also be archived in PDS at the discretion of the instrument Principal Investigator. Calibration data acquired during cruise and in orbit will be archived in the same manner as measurement observations. Calibration data gathered by the instrument team before LRO launch will also be archived in PDS. These pre-flight calibration data, or a suitable roll-up of these data as applicable, will be archived in PDS in "safed mode." Safed mode archive data have no SIS documentation and do not undergo a peer review.

The archives associated with instrument data and measurement data investigations will be assembled at the SOCs, using archive volume SISs that define the elements of archives and the associations among the elements. Archive volume SISs will pertain both to online archives and to the physical volumes that must be made and transferred to the PDS. Archives produced by the MOC, namely telemetry files, SPICE files, engineering data sets, and any other relevant information, will follow the same procedures that are designated for the measurement archives.

6.2 VALIDATION AND PEER REVIEW

The LDWG will provide oversight and coordination of validation of archives. The validation process includes the following components:
1. A quality control activity built into SOC product generation.
2. Analysis of the derived products.
3. SOCs, and the Project, as relevant, will check the products for conformance to SIS documents.
4. SOCs and the relevant PDS node will check the archive volumes for conformance to Archive Volume SIS documents.

PDS requires data sets to be peer reviewed before they can be accepted as PDS archives. A typical PDS peer review includes a committee of a few scientists who are knowledgeable about the type of data under review, along with representatives from the data provider and the PDS. The committee is asked to review the data set for completeness and scientific utility. The result of a peer review is a list of liens against the data set that must be resolved before PDS can accept it. PDS will arrange for these peer reviews.

For data products from ongoing missions that are delivered periodically, the peer review takes place as follows.

1. Before data production begins, the committee reviews a representative sample of data products along with associated documentation, software, and other ancillary files that will make up the archive to be submitted to PDS. This is done early to allow time for the data provider to make any necessary changes to the product design, and to ensure that sufficient ancillary materials are provided so that the typical user can access and interpret the data (e.g., software).
2. The committee also reviews the data "pipeline"; that is, the procedures that the provider will use to generate standard products during the mission. The idea is that with the reviewers' approval of a sample of the product and the method for generating it, the PDS can be reasonably sure that future products generated in the same way will be equally valid.
3. Reviewers have an opportunity to view revised products and supporting materials to ensure that the liens have been resolved. Data Product SIS documents are updated as necessary to describe the revised products.
4. With each delivery of data products, the appropriate PDS node performs a standard set of validation procedures to ensure that products conform to the Data Product and Archive Volume SISs. As long as the product design and processing steps do not change, no further peer review is necessary.

6.3 TRANSFER
Data will be transferred from the SOCs and MOC to the PDS via mechanisms detailed in the relevant SOC-PDS ICD or GS ICD.

6.4 DISTRIBUTION
Once released to the PDS, the LRO archives will be available to the general public.
## Appendix 1. LRO Payload

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Data Source Type</th>
<th>Investigator</th>
<th>Key Parameters</th>
<th>PDS Archive Node</th>
<th>PDS ICD &amp; Reference ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRaTER</td>
<td>Lineal energy transfer spectrometer</td>
<td>Dr. Harlan Spence, Boston University, Boston, Massachusetts</td>
<td>Continuous LET spectra (0.2–7000 KeV/µm in Si) of primary cosmic rays behind varying materials including tissue-equivalent plastic.</td>
<td>PPI</td>
<td>CRaTER-PDS PPI ICD</td>
</tr>
<tr>
<td>DLRE</td>
<td>9-channel high-precision radiometer sensing 0.3 to 200 micrometer wavelength radiation</td>
<td>Dr. David Paige, University of California, Los Angeles (UCLA), Los Angeles, California</td>
<td>At 500 m spatial resolution: Global Surface Temperature, Annual Min, Max and Average Surface Temperature, Lambert Albedo, Fine Component Thermal Inertia, Anisothermality, Rock Abundance</td>
<td>Geosciences</td>
<td>DLRE-PDS GEO ICD</td>
</tr>
<tr>
<td>LAMP</td>
<td>Far-ultraviolet spectrograph</td>
<td>Dr. Randy Gladstone, Southwest Research Institute, San Antonio, Texas (Acting)</td>
<td>Far-UV brightness, landform albedo, H2O absorption feature depth maps; atmospheric and atmospheric brightness spectra</td>
<td>Imaging</td>
<td>LAMP-PDS IMG ICD</td>
</tr>
<tr>
<td>LEND</td>
<td>Collimated sensor and sensors to detect thermal, epithermal, and high-energy neutrons</td>
<td>Dr. Igor Mitrofanov, Institute for Space Research, and Federal Space Agency, Moscow, Russia</td>
<td>Maps of hydrogen in upper 1 m of Moon at 10 km scales; epithermal neutrons and high energy neutrons with high angular resolution</td>
<td>Geosciences</td>
<td>LEND-PDS GEO ICD</td>
</tr>
<tr>
<td>LOLA</td>
<td>5-spot, 28-Hz, 1064-nm laser altimeter</td>
<td>Dr. David E. Smith, NASA Goddard Space Flight Center (GSFC), Greenbelt, Maryland</td>
<td>~25 m scale polar topography at &lt; 10 cm vertical, global topography, surface slopes and roughness</td>
<td>Geosciences</td>
<td>LOLA-PDS GEO ICD</td>
</tr>
<tr>
<td>LROC</td>
<td>Two Narrow Angle Camera (NAC) with 0.5 meter per pixel resolution, and a Wide Angle Camera (WAC) with 100 meter per pixel resolution</td>
<td>Dr. Mark Robinson, Arizona State University, Tempe, Arizona</td>
<td>1000’s of 50cm/pixel images, and entire Moon at 100m in UV, Visible. Illumination conditions of the poles</td>
<td>Imaging</td>
<td>LROC-PDS IMG ICD</td>
</tr>
<tr>
<td>Mini-RF</td>
<td>Miniature Synthetic Aperture Radar system</td>
<td>Dr. Stu Nozette, Naval Air Warfare Center (NAWC), China Lake, California</td>
<td>Targeted X &amp; S band SAR imaging strips with 6 or 4 km swath width at a spatial resolution of 75 m/pixel or 15 m/pixel. Targeted interferometry strips with 6km swath width and 75 m/pixel spatial resolution.</td>
<td>Geosciences</td>
<td>MRF-PDS GEO ICD</td>
</tr>
</tbody>
</table>
Appendix 2. Total Mission LRO Data Volume (in GB) Delivered to PDS by Data Type

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Data Volume</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDR (CODMAC 1)</td>
<td>22</td>
<td>0%</td>
</tr>
<tr>
<td>EDR (CODMAC 2)</td>
<td>20,360</td>
<td>29%</td>
</tr>
<tr>
<td>CDR (CODMAC 3)</td>
<td>45,512</td>
<td>66%</td>
</tr>
<tr>
<td>RDR (CODMAC 4)</td>
<td>340</td>
<td>0%</td>
</tr>
<tr>
<td>RDR (CODMAC 5)</td>
<td>3,155</td>
<td>5%</td>
</tr>
<tr>
<td>Ancillary (CODMAC 6)</td>
<td>7</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>69,374</td>
<td>100%</td>
</tr>
</tbody>
</table>

Appendix 3. Total Mission LRO Data Volume (in GB) Delivered to PDS by Delivery

<table>
<thead>
<tr>
<th>Data Source</th>
<th>IOC + 6 Mo</th>
<th>IOC + 9 Mo</th>
<th>IOC + 12 Mo</th>
<th>IOC + 15 Mo</th>
<th>IOC + 18 Mo</th>
<th>EOM + 6 Mo</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOC</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>CRaTER</td>
<td>113</td>
<td>113</td>
<td>113</td>
<td>113</td>
<td>0</td>
<td>452</td>
<td></td>
</tr>
<tr>
<td>DLRE</td>
<td>30</td>
<td>646</td>
<td>646</td>
<td>646</td>
<td>624</td>
<td>2,592</td>
<td></td>
</tr>
<tr>
<td>LAMP</td>
<td>525</td>
<td>525</td>
<td>525</td>
<td>598</td>
<td>0</td>
<td>2,173</td>
<td></td>
</tr>
<tr>
<td>LEND</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>LOLA</td>
<td>87</td>
<td>142</td>
<td>196</td>
<td>250</td>
<td>223</td>
<td>898</td>
<td></td>
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<tr>
<td>LROC</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
<td>18,071</td>
<td>0</td>
<td>63,071</td>
<td></td>
</tr>
<tr>
<td>Mini-RF</td>
<td>0</td>
<td>83</td>
<td>0</td>
<td>83</td>
<td>0</td>
<td>166</td>
<td></td>
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<tr>
<td>Total</td>
<td>15,765</td>
<td>16,519</td>
<td>16,491</td>
<td>19,771</td>
<td>849</td>
<td>69,396</td>
<td></td>
</tr>
</tbody>
</table>

Note: Initial Operational Capability (IOC) date is the day after the end of the commissioning period.

Appendix 4. Nominal PDS Schedule for Public Release of LRO Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 15, 2008</td>
<td>Launch</td>
</tr>
<tr>
<td>December 15, 2008</td>
<td>Launch + 2 Months, End of commissioning phase, beginning of data capture (IOC)</td>
</tr>
<tr>
<td>June 15, 2009</td>
<td>Launch + 8 Months, IOC + 6 Months, First 3 months of data delivered</td>
</tr>
<tr>
<td>September 15, 2009</td>
<td>Launch + 11 Months, IOC + 9 Months, Second 3 months of data delivered</td>
</tr>
<tr>
<td>December 15, 2009</td>
<td>Launch + 14 Months, IOC + 12 Months, Third 3 months of data delivered</td>
</tr>
<tr>
<td>March 15, 2010</td>
<td>Launch + 17 Months, IOC + 15 Months, Fourth 3 months of data delivered</td>
</tr>
<tr>
<td>June 15, 2010</td>
<td>Launch + 20 Months, IOC + 18 Months, EOM + 6 Months, Final data delivery</td>
</tr>
</tbody>
</table>

CHECK WITH LRO DATABASE AT:  
https://lunargin/gsfc.nasa.gov  
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.
## Appendix 5. LRO Standard Products Archived in PDS

<table>
<thead>
<tr>
<th>Instrument/Product Short Name</th>
<th>Product Long Name/Description</th>
<th>NASA Level</th>
<th>CODMAC Level</th>
<th>Mission Volume (GB)</th>
<th>Mission Volume Includes Reprocessing (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOC</td>
<td>Total MOC Mission Standard Data Volume</td>
<td></td>
<td></td>
<td>6.58</td>
<td></td>
</tr>
<tr>
<td>FDF-29</td>
<td>Definitive SPICE SPK File</td>
<td>6</td>
<td>1.14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>FDF-30</td>
<td>LRO Predictive SPICE SPK File</td>
<td>6</td>
<td>0.43</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>FDF-35</td>
<td>SPICE Definitive CK (Definitive S/C, Orientation)</td>
<td>6</td>
<td>1.14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>FDF-36</td>
<td>Reprocessed SPICE SPK Data</td>
<td>6</td>
<td>1.14</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>MOC-2</td>
<td>SPICE SCK – Clock Correlation File</td>
<td>6</td>
<td>0.01</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>MOC-33</td>
<td>SPICE Event kernel</td>
<td>6</td>
<td>0.00</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>MOC-39</td>
<td>SPICE FK – Frame Kernels</td>
<td>6</td>
<td>0.00</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>MOC-41</td>
<td>SPICE Predicted CK (Predicted S/C Orientation)</td>
<td>6</td>
<td>0.43</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>MOC-xx</td>
<td>SPICE Definitive HGA CK</td>
<td>6</td>
<td>1.14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>MOC-xx</td>
<td>SPICE Definitive SA CK</td>
<td>6</td>
<td>1.14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>CRaTER</td>
<td>Total CRaTER Mission Standard Data Volume</td>
<td></td>
<td></td>
<td>451.92</td>
<td>N</td>
</tr>
<tr>
<td>CR_L0_HK</td>
<td>Unprocessed Housekeeping data</td>
<td>0</td>
<td>2</td>
<td>0.13</td>
<td>N</td>
</tr>
<tr>
<td>CR_L0_PS</td>
<td>Unprocessed Primary Science data</td>
<td>0</td>
<td>2</td>
<td>17.50</td>
<td>N</td>
</tr>
<tr>
<td>CR_L0_SS</td>
<td>Unprocessed Secondary Science data</td>
<td>0</td>
<td>2</td>
<td>1.38</td>
<td>N</td>
</tr>
<tr>
<td>CR_L1_HK</td>
<td>Depacketed housekeeping data</td>
<td>1</td>
<td>3</td>
<td>0.33</td>
<td>N</td>
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<tr>
<td>CR_L1_PS</td>
<td>Depacketed primary science data</td>
<td>1</td>
<td>3</td>
<td>128.67</td>
<td>N</td>
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<tr>
<td>CR_L1_SS</td>
<td>Depacketed secondary science data</td>
<td>1</td>
<td>3</td>
<td>4.32</td>
<td>N</td>
</tr>
<tr>
<td>CR_L2_HK</td>
<td>Time-tagged housekeeping data</td>
<td>2</td>
<td>3</td>
<td>0.39</td>
<td>N</td>
</tr>
<tr>
<td>CR_L2_PS</td>
<td>Lineal energy transfer deposition in Si primary science data</td>
<td>2</td>
<td>4</td>
<td>293.28</td>
<td>N</td>
</tr>
<tr>
<td>CR_L2_SS</td>
<td>Time-tagged secondary science data</td>
<td>2</td>
<td>3</td>
<td>5.71</td>
<td>N</td>
</tr>
<tr>
<td>CR_L3_SCI</td>
<td>Lineal energy transfer spectra sorted by solar particle events and galactic cosmic rays</td>
<td>3</td>
<td>5</td>
<td>0.12</td>
<td>N</td>
</tr>
<tr>
<td>CR_L4_SCI</td>
<td>Lineal energy transfer spectra in tissue</td>
<td>4</td>
<td>5</td>
<td>0.12</td>
<td>N</td>
</tr>
<tr>
<td>DLRE</td>
<td>Total DLRE Mission Standard Data Volume</td>
<td></td>
<td></td>
<td>3,095.00</td>
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</tr>
<tr>
<td>Level 0</td>
<td>Depacketized Time-Sequenced Raw Science and Housekeeping Data</td>
<td>0</td>
<td>2</td>
<td>119.00</td>
<td>N</td>
</tr>
<tr>
<td>Level 1b</td>
<td>Calibrated Radiances and Housekeeping Data merged with project-supplied geometry and timing information</td>
<td>1b</td>
<td>3</td>
<td>2,464.00</td>
<td>N</td>
</tr>
<tr>
<td>Global Temperatures</td>
<td>Gridded (Lat, Lon, Local Time) Global Surface Temperature</td>
<td>2</td>
<td>5</td>
<td>1.00</td>
<td>N</td>
</tr>
<tr>
<td>Global Temperature Database</td>
<td>Gridded (Lat, Lon, Local Time) Global Surface Temperature and Annual Min, Max and Average Surface Temperature In Queryable Online Database</td>
<td>2</td>
<td>5</td>
<td>1.00</td>
<td>N</td>
</tr>
<tr>
<td>Global Fields</td>
<td>Gridded Derived Global Fields: Lambert Albedo, Fine Component Thermal Inertia, Anisothermality, Rock Abundance</td>
<td>3</td>
<td>5</td>
<td>1.00</td>
<td>N</td>
</tr>
<tr>
<td>Global Fields Database</td>
<td>Gridded Derived Global Fields: Lambert Albedo, Fine Component Thermal Inertia, Anisothermality, Rock Abundance In Queryable Online Database</td>
<td>3</td>
<td>5</td>
<td>1.00</td>
<td>N</td>
</tr>
<tr>
<td>Polar Resource Maps</td>
<td>Polar Resource Products: Maps of permanently shadowed regions, Localized maps of derived surface and subsurface temperatures, illumination levels, water ice near infrared reflectance maps for all regions potentially containing cold-trapped volatiles</td>
<td>3</td>
<td>5</td>
<td>4.00</td>
<td>N</td>
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<tr>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>--.00</td>
<td></td>
</tr>
<tr>
<td>LAMP</td>
<td>Total LAMP Mission Standard Data Volume</td>
<td>2,172.50</td>
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<td></td>
</tr>
<tr>
<td>Photon Event Stream</td>
<td>FITS file of the time-tagged photon event stream</td>
<td>0</td>
<td>2</td>
<td>100.00 N</td>
<td></td>
</tr>
<tr>
<td>Transformed Photon Event Stream</td>
<td>Level 0 located and transformed with needed ancillary and auxiliary data</td>
<td>1a</td>
<td>3</td>
<td>2,000.00 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>Far-UV Brightness Maps</td>
<td>Far-UV Brightness Maps</td>
<td>3</td>
<td>5</td>
<td>36.00 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>Far-UV Landform Albedo Maps</td>
<td>Far-UV Landform Albedo Maps</td>
<td>3</td>
<td>5</td>
<td>36.00 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>H2O Absorption Feature Depth Map</td>
<td>H2O Absorption Feature Depth Map</td>
<td>3</td>
<td>5</td>
<td>0.50 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>Atmospheric Spectrum</td>
<td>Atmospheric Spectrum</td>
<td>3</td>
<td>5</td>
<td>&lt; 0.1 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>Atmospheric Brightness Spectrum</td>
<td>Atmospheric Brightness Spectrum</td>
<td>3</td>
<td>5</td>
<td>&lt; 0.1 ( \text{Y} )</td>
<td></td>
</tr>
<tr>
<td>LEND</td>
<td>Total LEND Mission Standard Data Volume</td>
<td>38.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEND_SCI_EDR</td>
<td>Raw Spectra</td>
<td>0</td>
<td>2</td>
<td>11.00 N</td>
<td></td>
</tr>
<tr>
<td>LEND_HK_EDR</td>
<td>Engineering / Housekeeping</td>
<td>0</td>
<td>2</td>
<td>3.00 N</td>
<td></td>
</tr>
<tr>
<td>LEND_IDR</td>
<td>Raw Spectra, Spatial and Temporalianal</td>
<td>1a</td>
<td>3</td>
<td>19.00 N</td>
<td></td>
</tr>
<tr>
<td>LEND_DER_RDR</td>
<td>Derived Spectral Data</td>
<td>1b</td>
<td>4</td>
<td>2.00 N</td>
<td></td>
</tr>
<tr>
<td>LEND_AVG_RDR</td>
<td>Averaged Derived Data</td>
<td>2</td>
<td>5</td>
<td>1.00 N</td>
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<tr>
<td>LEND_SCDP_RDR</td>
<td>Surface Composition Data</td>
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<td>5</td>
<td>1.00 N</td>
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<tr>
<td>LEND_RDP_RDR</td>
<td>Radiation Data</td>
<td>3</td>
<td>5</td>
<td>1.00 N</td>
<td></td>
</tr>
<tr>
<td>LOLA</td>
<td>Total LOLA Mission Standard Data Volume</td>
<td>903.01</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LOLA_EDR</td>
<td>Raw experiment science and status data</td>
<td>2</td>
<td></td>
<td>107.00 N</td>
<td></td>
</tr>
<tr>
<td>LOLA_RDR</td>
<td>Geolocated science and status in SI units</td>
<td>3</td>
<td></td>
<td>746.00 Y</td>
<td></td>
</tr>
<tr>
<td>LOLA_GDR</td>
<td>Gridded experiment data records</td>
<td>4</td>
<td></td>
<td>45.00 Y</td>
<td></td>
</tr>
<tr>
<td>LOLA_SHADR</td>
<td>Selenodetic shape and potential</td>
<td>5</td>
<td></td>
<td>0.01 Y</td>
<td></td>
</tr>
<tr>
<td>LROC</td>
<td>Total LROC Mission Standard Data Volume</td>
<td>63,071.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAC_EDR</td>
<td>NAC EDR</td>
<td>0</td>
<td>2</td>
<td>12,000.00 N</td>
<td></td>
</tr>
<tr>
<td>NAC_CDR</td>
<td>NAC CDR</td>
<td>1a</td>
<td>3</td>
<td>24,000.00 N</td>
<td></td>
</tr>
<tr>
<td>WAC_EDR</td>
<td>WAC EDR</td>
<td>0</td>
<td>2</td>
<td>8,000.00 N</td>
<td></td>
</tr>
<tr>
<td>WAC_CDR</td>
<td>WAC CDR</td>
<td>1a</td>
<td>3</td>
<td>16,000.00 N</td>
<td></td>
</tr>
<tr>
<td>Landing Site Assessment</td>
<td>Up to 50 mosaics of selected potential landing sites with one meter scale resolution</td>
<td>1c</td>
<td>5</td>
<td>500.00 N</td>
<td></td>
</tr>
<tr>
<td>Polar Illumination Characterization</td>
<td>Provide uncontrolled illumination movies, 1 for each pole over the course of 1 lunar year at an average time resolution of 5 hours</td>
<td>1c</td>
<td>5</td>
<td>179.00 N</td>
<td></td>
</tr>
<tr>
<td>Meter-scale Polar Illumination Conditions</td>
<td>Polar uncontrolled mosaics (86º to 90º), composed of summed 2x observations (1 m/p) arranged into 103 tiles (lambert and stereographic projections)</td>
<td>1c</td>
<td>5</td>
<td>293.00 N</td>
<td></td>
</tr>
<tr>
<td>Selected High Resolution Topography</td>
<td>For areas of high interest collect multi-look NAC data reducible to 2 m scale DEM for 25 km sq areas (photometric and stereo), generate a few test DEM models</td>
<td>1c</td>
<td>5</td>
<td>25.00 N</td>
<td></td>
</tr>
</tbody>
</table>

CHECK WITH LRO DATABASE AT: [https://lunargin/gsfc.nasa.gov](https://lunargin/gsfc.nasa.gov)

TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.
Global Multispectral Observations | 7 band global color observations: three campaigns to obtain 10° to 40° incidence equator crossings; 100 m/pixel VIS; 400 m/pixel UV; and ten uncontrolled demonstration multispectral mosaics for high priority targets | 1c | 5 | 639.00 | N

Global BW Basemap | Best effort, uncontrolled global monochrome WAC mosaic at 100m/p resolution | 1c | 5 | 27.00 | N

Regolith Characterization | Target key areas to investigate variations in regolith thickness and structure | 1c | 5 | 128.00 | N

Impact Rate | Determine current small impact hazard by rephotographing areas imaged by Apollo Pan camera (1 m/p) and Lunar Orbiter (1 m/p) | 1c | 5 | 1,280.00 | N

### Appendix 6. LRO Special Products Archived in PDS

<table>
<thead>
<tr>
<th>Instrument/Product Short Name</th>
<th>Product Long Name/Description</th>
<th>NASA Level</th>
<th>CODMAC Level</th>
<th>Mission Volume (GB)</th>
<th>Mission Volume Includes Reprocessing (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRaTER</td>
<td>Total CRaTER Mission Special Data Volume</td>
<td></td>
<td></td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>CR_L3_SCI</td>
<td>Lineal energy transfer spectra sorted by solar particle events and galactic cosmic rays</td>
<td>3</td>
<td>5</td>
<td>0.12</td>
<td>N</td>
</tr>
<tr>
<td>CR_L4_SCI</td>
<td>Lineal energy transfer spectra in tissue</td>
<td>4</td>
<td>5</td>
<td>0.12</td>
<td>N</td>
</tr>
<tr>
<td>Mini-RF</td>
<td>Total Mini-RF Mission Special Data Volume</td>
<td></td>
<td></td>
<td>165.50</td>
<td></td>
</tr>
<tr>
<td>SAR Raw Data</td>
<td>SAR Raw Data</td>
<td>Packet</td>
<td>1</td>
<td>9.30</td>
<td>N</td>
</tr>
<tr>
<td>SAR range-azimuth Strips (V, H, &amp; cross products)</td>
<td>SAR range-azimuth Strips (V, H, &amp; cross products)</td>
<td>1A</td>
<td>3</td>
<td>10.00</td>
<td>N</td>
</tr>
<tr>
<td>SAR range-azimuth Strips (stokes parameters)</td>
<td>SAR range-azimuth Strips (stokes parameters)</td>
<td>1A</td>
<td>3</td>
<td>10.00</td>
<td>N</td>
</tr>
<tr>
<td>SAR range-azimuth Strips (LCP, RCP, albedo and CPR)</td>
<td>SAR range-azimuth Strips (LCP, RCP, albedo and CPR)</td>
<td>1A</td>
<td>3</td>
<td>10.00</td>
<td>N</td>
</tr>
<tr>
<td>SAR projected strips (V, H &amp; Cross products)</td>
<td>SAR projected strips (V, H &amp; Cross products)</td>
<td>1C</td>
<td>3</td>
<td>30.00</td>
<td>N</td>
</tr>
<tr>
<td>SAR projected strips (stokes parameters)</td>
<td>SAR projected strips (stokes parameters)</td>
<td>1C</td>
<td>3</td>
<td>30.00</td>
<td>N</td>
</tr>
<tr>
<td>SAR projected strips (LCP, RCP, albedo and CPR)</td>
<td>SAR projected strips (LCP, RCP, albedo and CPR)</td>
<td>1C</td>
<td>3</td>
<td>30.00</td>
<td>N</td>
</tr>
<tr>
<td>Interferometry raw data</td>
<td>Interferometry raw data</td>
<td>Packet</td>
<td>1</td>
<td>12.20</td>
<td>N</td>
</tr>
<tr>
<td>Interferometry range-azimuth strips</td>
<td>Interferometry range-azimuth strips</td>
<td>1A</td>
<td>3</td>
<td>24.00</td>
<td>N</td>
</tr>
</tbody>
</table>

Note: This data is included in Appendices 2 and 3 summaries.
## Appendix 7. LRO Special Products Archived in CDDIS, FDF, and Laser Ranging

<table>
<thead>
<tr>
<th>Instrument/Product Short Name</th>
<th>Product Long Name/Description</th>
<th>NASA Level</th>
<th>CODMAC Level</th>
<th>Mission Volume (GB)</th>
<th>Mission Volume Includes Reprocessing (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOLA</td>
<td>Total LOLA Mission Special Data Volume</td>
<td></td>
<td></td>
<td>5.001.14</td>
<td></td>
</tr>
<tr>
<td>LOLA_LRFDF-29</td>
<td>ILRS Range Data and Normal Points Definitive SPICE SPK File</td>
<td>3,4</td>
<td></td>
<td>5.001.14</td>
<td>NN</td>
</tr>
</tbody>
</table>

Note: This data is not included in Appendices 2 and 3 summaries.
## Appendix 8. Definitions of Processing Levels for Measurement Data Sets

<table>
<thead>
<tr>
<th>NASA</th>
<th>CODMAC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet data</td>
<td>Raw Level 1</td>
<td>Telemetry data stream as received at the ground station, with science and engineering data embedded.</td>
</tr>
<tr>
<td>Level 0</td>
<td>Edited Level 2</td>
<td>Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.</td>
</tr>
<tr>
<td>Level 1-A</td>
<td>Calibrated Level 3</td>
<td>Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).</td>
</tr>
<tr>
<td>Level 1-B</td>
<td>Resampled Level 4</td>
<td>Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).</td>
</tr>
<tr>
<td>Level 1-C</td>
<td>Derived Level 5</td>
<td>Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).</td>
</tr>
<tr>
<td>Level 2</td>
<td>Derived Level 5</td>
<td>Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.</td>
</tr>
<tr>
<td>Level 3</td>
<td>Derived Level 5</td>
<td>Geophysical parameters mapped onto uniform space-time grids.</td>
</tr>
<tr>
<td>Ancillary data</td>
<td>Level 6</td>
<td>Nonscience data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets, pointing information for scan platforms, etc.</td>
</tr>
</tbody>
</table>
## Appendix 9. Suppliers of LRO Archive Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Contents</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPICE Archives</td>
<td>SPICE Kernels</td>
<td>MOC</td>
</tr>
</tbody>
</table>
| Measurement Data     | High-level mission, spacecraft, instrument, and data set descriptions for the PDS Catalog  
                      | Software Interface Specification (SIS) Documents                         | SOCs     |
|                     | Archive Volume Software Interface Specification Documents               |          |
|                     | Processing Descriptions, Algorithms, and Software (to use in understanding reduced data product generation) |          |
|                     | Instrument Calibration Reports and associated data needed to understand level 1 product generation |          |
|                     | Experiment Data Records and Reduced Data Records, containing standard products, with PDS Labels |          |
| Engineering Data     | Software Interface Specification Documents                               | MOC      |
| Archives             | Uplink sequences and notebook entries                                    |          |
|                      | Telemetry data                                                           |          |
### Appendix 10. Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation/ Acronym</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCB</td>
<td>Configuration Control Board</td>
</tr>
<tr>
<td>CDDIS</td>
<td>Crustal Dynamics Data and Information System</td>
</tr>
<tr>
<td>CDR</td>
<td>Calibrated Data Record</td>
</tr>
<tr>
<td>CM</td>
<td>Configuration Management</td>
</tr>
<tr>
<td>CMO</td>
<td>Configuration Management Office</td>
</tr>
<tr>
<td>CODMAC</td>
<td>Committee on Data Management, Archiving, and Computing</td>
</tr>
<tr>
<td>CRaTER</td>
<td>Cosmic Ray Telescope for Effects of Radiation</td>
</tr>
<tr>
<td>DLRE</td>
<td>Diviner Lunar Radiometer Experiment</td>
</tr>
<tr>
<td>DM&amp;AP</td>
<td>Data Management &amp; Archive Plan</td>
</tr>
<tr>
<td>EDR</td>
<td>Experiment Data Record (also called Engineering Data Record)</td>
</tr>
<tr>
<td>EOM</td>
<td>End of Mission</td>
</tr>
<tr>
<td>FDF</td>
<td>Flight Dynamics Facility</td>
</tr>
<tr>
<td>GS</td>
<td>Ground System</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document</td>
</tr>
<tr>
<td>IOC</td>
<td>Initial Operational Capability</td>
</tr>
<tr>
<td>LAMP</td>
<td>Lyman-Alpha Mapping Project</td>
</tr>
<tr>
<td>LDWG</td>
<td>LRO Data Working Group</td>
</tr>
<tr>
<td>LEND</td>
<td>Lunar Exploration Neutron Detector</td>
</tr>
<tr>
<td>LOLA</td>
<td>Lunar Orbiter Laser Altimeter</td>
</tr>
<tr>
<td>LPO</td>
<td>LRO Project Office</td>
</tr>
<tr>
<td>LPRP</td>
<td>Lunar Precursor and Robotic Program</td>
</tr>
<tr>
<td>LRO</td>
<td>Lunar Reconnaissance Orbiter</td>
</tr>
<tr>
<td>LROC</td>
<td>Lunar Reconnaissance Orbiter Camera</td>
</tr>
<tr>
<td>Mini-RF</td>
<td>Mini-Radio Frequency Technology Demonstration</td>
</tr>
<tr>
<td>MOA</td>
<td>Memorandum of Agreement</td>
</tr>
<tr>
<td>MOC</td>
<td>Mission Operations Center</td>
</tr>
<tr>
<td>NAIF</td>
<td>Navigation and Ancillary Information Facility</td>
</tr>
<tr>
<td>PDS</td>
<td>Planetary Data System</td>
</tr>
<tr>
<td>PI</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>RDR</td>
<td>Reduced Data Record</td>
</tr>
<tr>
<td>SIS</td>
<td>Software Interface Specification</td>
</tr>
<tr>
<td>SOC</td>
<td>Science Operations Center</td>
</tr>
<tr>
<td>SPICE</td>
<td>Spacecraft, Planet, Instrument, C-matrix (pointing), and Events</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>TBR</td>
<td>To Be Resolved</td>
</tr>
</tbody>
</table>