Landsat 9 Mission Overview

Mission Objectives

• Provide continuity in the multi-decadal Landsat land surface observations to study, predict, and understand the consequences of land surface dynamics
  • Core Component of Sustainable Land Imaging Program

Mission Parameters

• Single Satellite, Mission Category 1, Risk Class B
  • 5-year design life after on-orbit checkout
  • At least 10 years of consumables
• Sun-synchronous orbit, 705 km at equator, 98° inclination
• 16-day global land revisit
• Partnership: NASA & United States Geological Survey (USGS)
  • NASA: Flight segment & checkout
  • USGS: Ground system and operations
• Launch: FY2021 (Targeting December 15, 2020), Category 3 Vehicle

Mission Team

• NASA Goddard Space Flight Center (GSFC)
• USGS Earth Resources Observation & Science (EROS) Center
• NASA Kennedy Space Center (KSC)

Instruments

• Operational Land Imager 2 (Ball Aerospace)
  • Reflective-band push-broom imager (15-30m res)
  • 9 spectral bands at 15 - 30m resolution
  • Retrieves data on surface properties, land cover, and vegetation condition
• Thermal Infrared Sensor 2 (NASA GSFC)
  • Thermal infrared (TIR) push-broom imager
  • 2 TIR bands at 100m resolution
  • Retrieves surface temperature, supporting agricultural and climate applications, including monitoring evapotranspiration

Spacecraft & Observatory I&T

• Orbital ATK

Launch Services

• United Launch Alliance (ULA) Atlas V 401

MOC and Mission Operations

• General Dynamics Mission Systems (GDMS)

Increase in pivot irrigation in Saudi Arabia from 1987 to 2012 as recorded by Landsat. The increase in irrigated land correlates with declining groundwater levels measured from GRACE (courtesy M. Rodell, GSFC)
NASA-USGS Partnership

• Independently-funded Agency partnership (not reimbursable like NASA/NOAA missions)

• Partnership is codified in a NASA-Department of the Interior (DOI) interagency agreement for Sustainable Land Imaging with a NASA-USGS annex for Landsat 9

• NASA is responsible for the space segment (instruments and spacecraft/observatory), mission integration, launch, and on-orbit checkout
  – Support for anomaly resolution during operations on a reimbursable basis, if necessary

• USGS is responsible for the ground system, flight operations, data processing and distribution
  – Operational control/leadership of mission after on-orbit checkout and handover from NASA
OLI-2 will, to the extent possible, be a copy of OLI for Landsat 9 to maintain data continuity with Landsat 8 and to minimize cost and risk

- Contract with Ball Aerospace in Boulder CO established in December 2015
- OLI-2 successfully completed Critical Design Review in August 2016
- Instrument in fabrication at Ball Aerospace
- On target for mid-2019 delivery to spacecraft
OLI-2 Is Coming Together Quickly!!

Installing the Tertiary Mirror into the OLI-2 Optical Bench at Ball Aerospace

OLI-2 Flight Focal Plane Assembly (FPA) and Ball Aerospace FPA Assembly Team

OLI-2 Optical Bench

OLI-2 Baseplate
Thermal Infrared Sensor 2 (TIRS-2)

TIRS-2 will be a rebuild of Landsat 8 TIRS except TIRS-2 will be upgraded from Risk Class C to Class B for Landsat 9

- NASA GSFC TIRS-2 team formed in 2015
- TIRS-2 successfully completed Critical Design Review in February 2017
- Instrument in fabrication at NASA GSFC
- On target for mid-2019 delivery to spacecraft

TIRS-2 Improvements

- Increased redundancy to satisfy Class B reliability standards
- Improved stray light performance through improved telescope baffling
- Improved position encoder for scene select mirror to address problematic encoder on Landsat 8 TIRS

Landsat Science Team Meeting - February 21, 2018
TIRS-2 Is Moving Just As Quickly!!

- Flight TIRS-2 FPA
- Cryocooler (Ball Aerospace)
- Flight Telescope
- Integrated Main Electronics Box (MEB) Testbed

Fully Assembled TIRS-2 Flight Structure
Spacecraft Bus

• Contract competitively awarded to Orbital ATK in Gilbert, AZ in October 2016
• Spacecraft successfully completed System Requirements Review in February 2017 and Preliminary Design Review in July 2017
• Spacecraft Critical Design Review Planned for Feb 26 – Mar 1, 2018
• Targeting readiness to integrate OLI-2 and TIRS-2 in mid-2019

Landsat 9 spacecraft will be similar to that of Landsat 8, and it will also draw on component heritage from ICESat-2 and JPSS-2 missions

Landsat Science Team Meeting   - February 21, 2018
Launch Services

Landsat 9 launch services awarded to same provider as Landsat 8

- Awarded October 2017 to United Launch Alliance (ULA)
- Vehicle: Atlas V 401
- To be launched from Vandenberg AFB SLC-3
- Landsat 9 performed an early Coupled Loads Analysis with ULA to provide latest load estimates for observatory design
- Routine integration/coordination between Landsat 9 and ULA underway
Mission Operations Center (MOC)
- Flight Operations Team (FOT) performs mission planning and scheduling, command and control, health and status monitoring, orbit and attitude maintenance, mission data management
- LMOC and bLMOC (TBR) facilities at GSFC
- Interfaces with Space Network (SN), Near Earth Network (NEN), Flight Dynamics Facility (FDF) and Conjunction Assessment (CARA)
- Landsat Mission Operations (LMO) contract provides Landsat 8 and Landsat 9 MOC development and FOT services

Ground Network Element (GNE)
- Landsat Ground Network (LGN) stations provide X- and S-band communications with the Observatory
- LGN stations in Sioux Falls, SD; Fairbanks, AK; and Svalbard, Norway
- Neustrelitz, Germany and Alice Springs, Australia for use after commissioning
- Data Collection and Routing Subsystem (DCRS) gathers mission data from LGN stations into complete intervals to transfer to the DPAS

Data Processing and Archive System (DPAS)
- Provides data ingest, storage and archive, image assessment, product generation, and data access and distribution
- DPAS facility at USGS EROS Center

Ground System Status
- GNE PDR completed in December 2017
- DPAS PDR completed in February 2018
- LMO PDR completed in February 2018
- Ground System PDR in March 2018
• Addition of Level-2 Analysis Ready Data (ARD) into the Ground System
  • Two major releases have been outlined for Landsat 9 DPAS
    • Build 1 – Fully functional DPAS less some reporting / metrics and processing / performance enhancements (priority 1 and 2 requirements)
    • Build 2 – Remainder of the priority 2 and 3 requirements
  • Collection 2 ARD subsystem functionality in May 2019
    • Priority 3 requirements
    • Available for Landsat 1-8 Operations for Collection 2
    • Baseline plan is to integrate ARD into Build 2, however, in the event of issues or delays with it, the USGS may delay the ARD functionality until after build 2

• Alice Springs, Australia (ASN) and Neustrelitz, Germany (NSN) ground stations added to the GS / GNE
  • Agreements in place with international cooperators
  • Stations utilized for Landsat 8 today
  • Tested during development but utilized after mission transition
    • Priority 3 (non-launch critical) requirements
# Landsat 9 Ground System & Operations Master Schedule

**Version 1.18**

## Task Name

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Mission and Ground System Reviews</th>
<th>Landsat Multi-Satellite Operations Center</th>
<th>Ground Network Element</th>
<th>Data Processing and Archive System</th>
<th>Ground System Tests</th>
<th>Operations Readiness</th>
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<td>KDP-C 9/17</td>
<td>LMO 6/17</td>
<td>GNE 4/17</td>
<td>DPAS 4/17</td>
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<td>LMO 10/18/11/18</td>
<td>GNE 6/18</td>
<td>DPAS 6/18</td>
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## Milestone and Margin

- **KDP-C**: 9/17
- **KDP-D**: 12/19
- **LRR**: 12/20
- **PLAR/MTHR**: 3/21
- **Launch**: 3/21

## Dates

- **10d Margin**
- **20d Margin**
- **30d Margin**
- **40d Margin**

## Current as of 01/29/2018

- **11/18 CT**
- **11/19 MRT 1**
- **2/20 MRT 5**

## Additional Details

- **Mini-MOC**: LMOC CDR
- **PSR**: DPAS ARD
• Instrument development is proceeding rapidly!!!
  • On-orbit performance should be excellent!!!

• Spacecraft development is on-plan for instrument integration in 2019

• Mission CDR in April 2018

• Ground System is making excellent progress
  • Landsat Mission Operations contract awarded and moving quickly
  • All elements completed successful PDRs
  • Ground System PDR in March 2018

• Strong NASA-USGS relationship is well defined and operating effectively

• Landsat 9 has been making excellent progress against an aggressive plan
  • Mission on target for launch in December 2020