Landsat Mission Operations (LMO) Request for Information (RFI) Industry Day

Vickie Floyd, Contracting Officer, USGS

Jim Nelson, Landsat 9 Project Manager, USGS

February 2, 2016

USGS science for a changing world

NASA

LANDSAT NINE
NASA GSFC USGS EROS

Agenda

- **Introduction**
  - Vickie Floyd, USGS Contracting Officer
- **Welcome and EROS Overview**
  - Dr. Frank Kelly, USGS EROS Director
- **Landsat Program and Landsat 9 Mission Overview**
  - Jim Nelson, USGS Landsat 9 Project Manager
- **Landsat 8 Overview**
  - Doug Daniels, Landsat Mission Management Officer, The Aerospace Corporation
- **Landsat Mission Operations (LMO) Contract and RFI Overview**
  - Jim Nelson, USGS Landsat 9 Project Manager
- **Questions and Answers**
  - Vickie Floyd, USGS Contracting Officer

Introduction

Vickie Floyd

Contracting Officer

USGS

USGS science for a changing world

NASA

LANDSAT NINE

NASA GSFC USGS EROS

Introduction

- **Purpose of the Industry Day**
  - Provide Information to Improve Industry's Understanding of the Government Requirements
  - Enhance Government Efficiency in Acquisition Approach and Execution
  - Obtain Market Information to Determine if a Set Aside is Possible
  - Obtain Capabilities for Planning Purposes

- **One on One Sessions**
  - March/April Timeframe
  - Provide your intent for a one-on-one session to vfloyd@usgs.gov

- **Tentative Procurement Timeline**
  - RFI responses due on 2/29/2016
  - Draft RFP – 3rd Quarter 2016
  - Final RFP – 4th Quarter 2016
  - Award – 2nd Quarter 2017

Introduction, Cont.

- **Reading Room**
  - A reading room will be established where all documents pertaining to this anticipated requirement will be posted. The link will be posted in a forthcoming amendment.

- **Questions**
  - Please hold all questions until the end of the presentation
  - Additional questions will be accepted through Wednesday, February 8, 2016, 11 AM ET.
  - All questions and answers will be posted to an amendment to the RFI on or about February 10, 2016.
  - The Government also reserves the right to change any answer, should it be necessary later on.
  - E-mail questions to vfloyd@usgs.gov
  - Subject Line: REF G16PS00176 L9 Mission Operations

Welcome and EROS Overview

Dr. Frank Kelly

Director, USGS EROS

USGS science for a changing world

NASA

LANDSAT NINE

NASA GSFC USGS EROS

Earth Resources Observation and Science (EROS)

Mission:

… contributing to the understanding of a changing Earth

Vision:

- The world's primary source of remotely sensed images of the Earth;
- Authoritative providers of land change science information and knowledge;
- Leaders in understanding how changes in land use, cover, and condition affect people and nature.

Landsat Program and Landsat 9 Overview

Jim Nelson

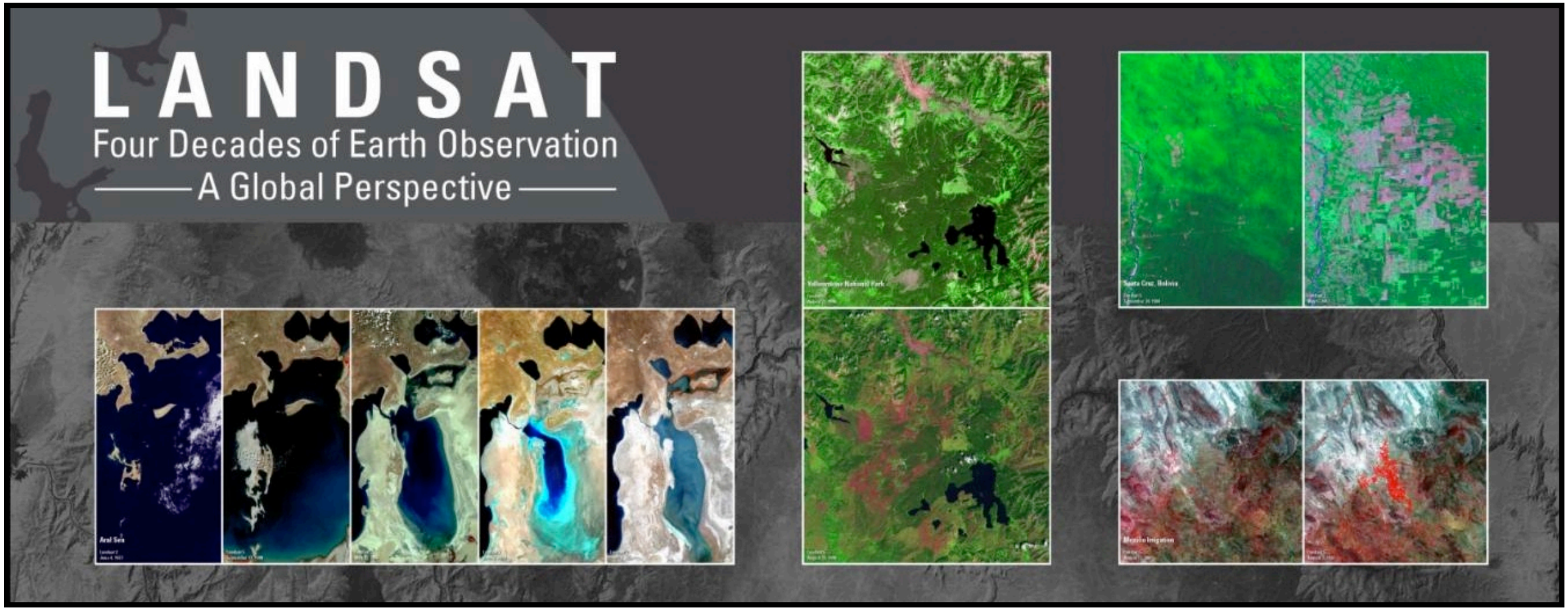
Landsat 9 Project Manager

USGS EROS

USGS science for a changing world

NASA

LANDSAT NINE
NASA GSFC USGS EROS



- The EROS Landsat archive: more than **5 million images (171 billion sq. km) from 1972 to the present** – and spanning the globe.
- All Landsat images are **available to anyone at no cost.**
- **Each year nearly 5 million images are distributed** to users in over 180 nations and territories.

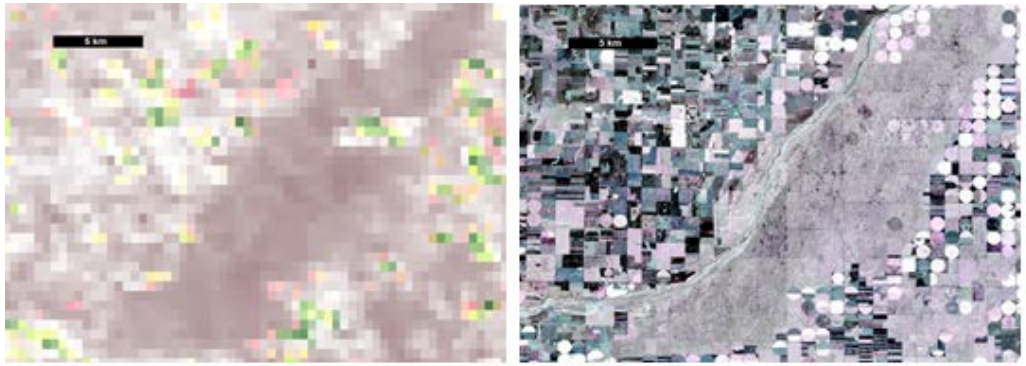
The Role of Landsat

- **By monitoring changes in the land environment, we can advance our understanding of how human activities, climate change, and natural variability combine to affect global land condition and habitability**

- **Key Applications:**
  - Mapping Land Use & Change (deforestation, urbanization, etc)
  - Forest Dynamics and Carbon (harvest, clearing, disturbance, fire)
  - Agriculture (crop type, health, area, timing)
  - Ecosystem Science
  - Water Quality and Use (evapotranspiration)
  - Glacier & Ice Sheet dynamics
  - Essential Climate Variables (Leaf-area, Albedo, Temperature…)
  - Geology and Natural Resources

What Makes It “Landsat”?

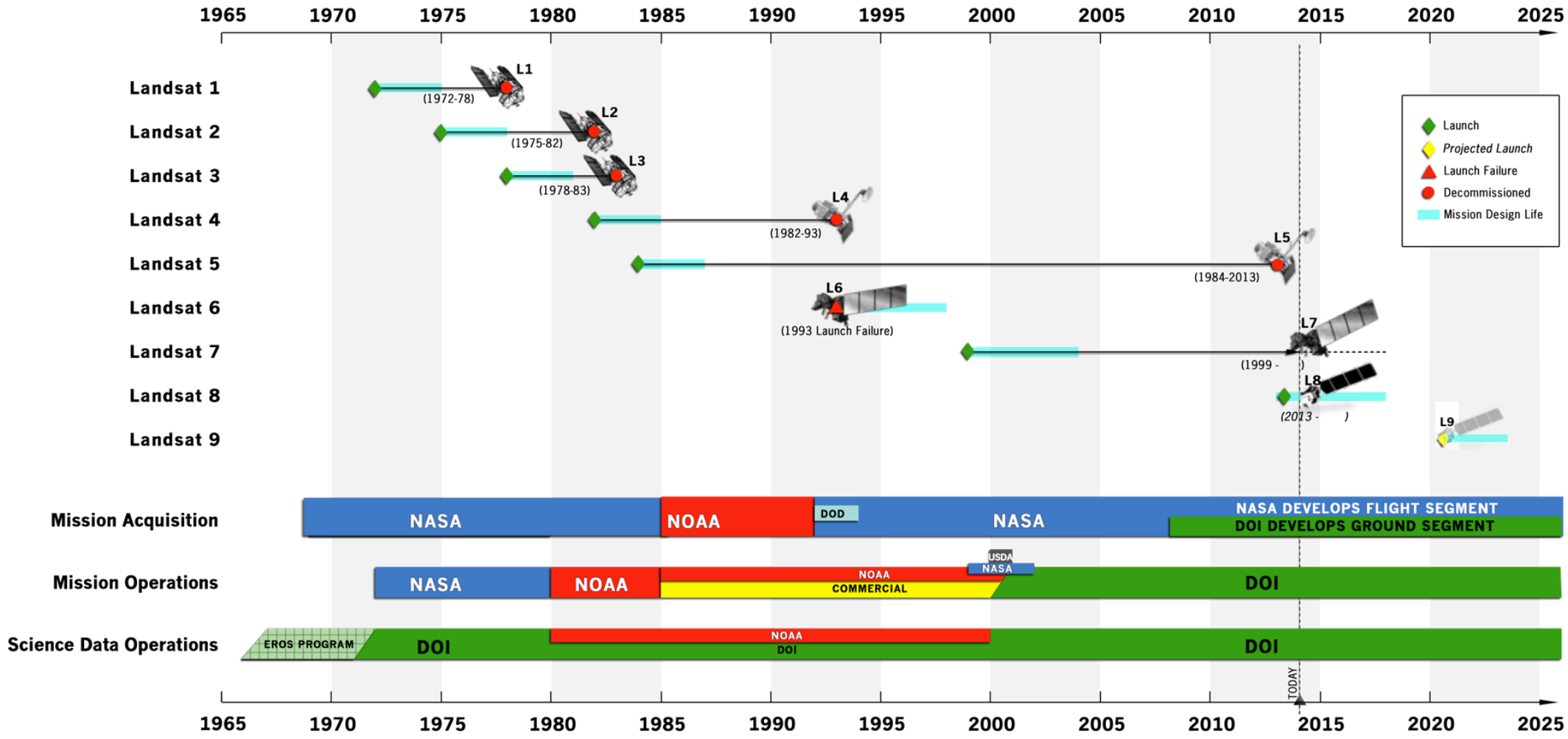
- **Landsat provides multispectral images of the Earth’s land surface on a 16-day repeat cycle. Key attributes include:**
  - Imaging Spatial Resolution (~30m) is sufficiently fine to monitor “patch” landscape dynamics, and sufficiently coarse to allow seasonal global acquisitions
  - Multispectral coverage in broad spectral range
    - Visible and Near Infrared (VNIR)
    - Shortwave Infrared (SWIR)
    - Thermal Infrared (TIR)
  - Calibrated, “science-quality” data – not just pictures
  - Global acquisition strategy augments 43-year archive
  - Free and open distribution



MODIS Data
250m spatial resolution
Near-daily global coverage

Landsat 7 ETM+ Data
30m spatial resolution
Seasonal global coverage

Landsat Missions Timeline



NASA/USGS Landsat Mission Roles

- **USGS**
  - Documents user needs and develops user requirements
  - Leads, funds, and manages the Landsat Science Team
  - Develops Ground System
  - Landsat operations following the completion of on-orbit checkout
    - Satellite operations
    - Science acquisition planning
    - Ground station management and operations
    - Science data archive, calibration/validation, product generation, and distribution

- **NASA**
  - Co-chairs the USGS-funded Landsat Science Team
  - Develops the Space Segment and Launch Segment
  - Leads mission development as system integrator and leads mission systems engineering
  - Leads mission operations through completion of on-orbit checkout period
  - Accountable for mission success through on-orbit check-out and acceptance across all mission segments

Landsat 9 Mission Objectives and Goals

- **The scientific objective of the Landsat Program is to provide the baseline data required to map global land cover, land use, and change on an annual basis over multi-decadal periods of time.**
- **Landsat 9 Mission Objectives:**
  - Collect and archive moderate-resolution, reflective and emissive multispectral image data affording seasonal coverage of the global land mass for a period of no less than five years;
  - Ensure that Landsat 9 data are sufficiently consistent with data from the earlier Landsat missions, in terms of acquisition geometry, acquisition rates, calibration, coverage characteristics, spectral and spatial characteristics, output product quality, and data availability to permit studies of land cover and land use change over multi-decadal period;
  - Distribute standard Landsat 9 data products to users on a nondiscriminatory basis and at no cost to the users.
- **Societal Benefit Areas include agriculture & forestry, biodiversity, climate impacts, disasters, energy resources, human health, and water resources (OSTP 2012 National Plan for Civil Earth Observations)**

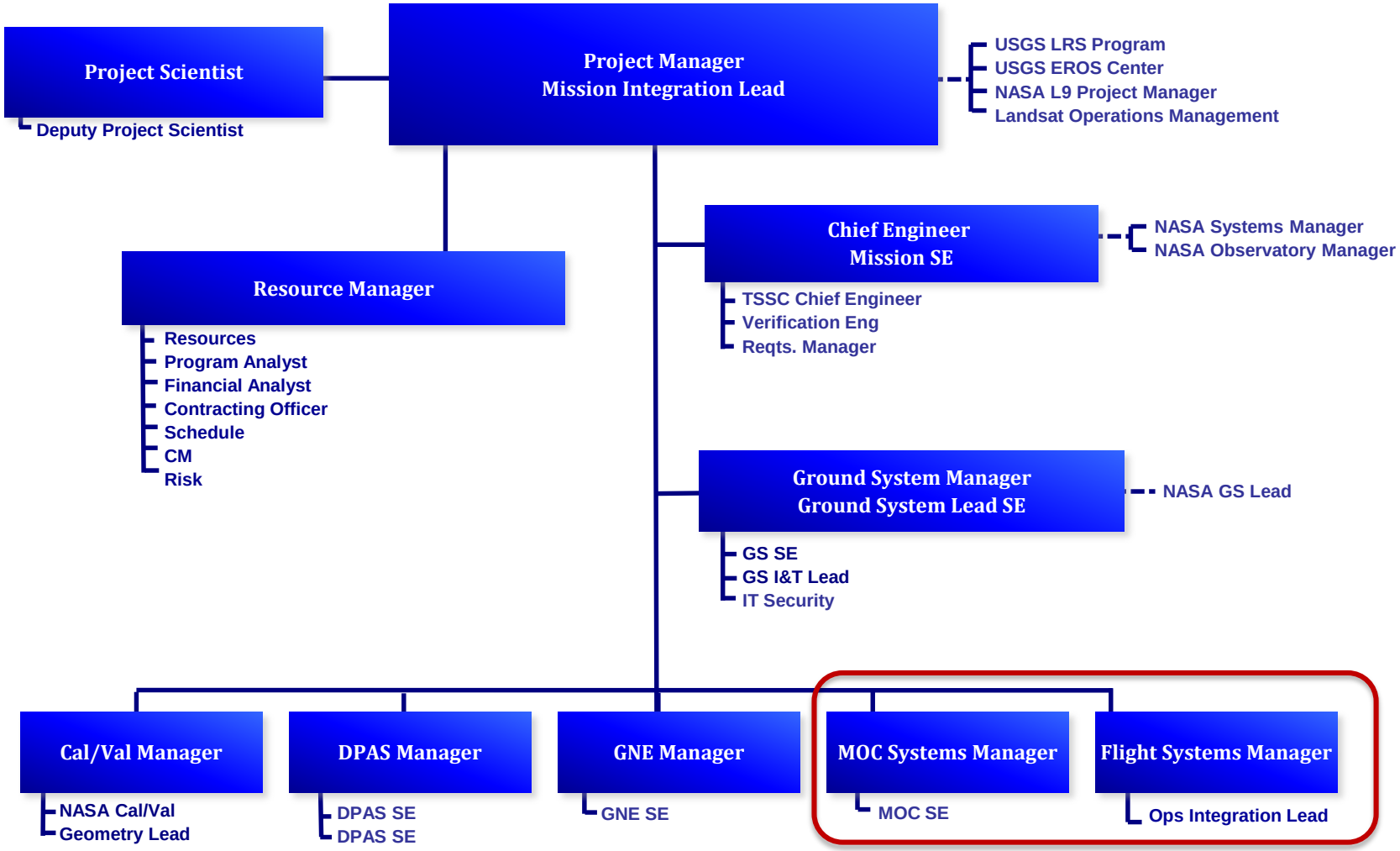
Landsat 9 Development Approach

- **Space Segment (NASA)**
  - Spacecraft
    - Open competition through NASA GSFC Rapid Spacecraft Development Office (RSDO) Rapid III catalog (delivery order)
  - Operational Land Imager-2 (OLI-2)
    - Ball Aerospace rebuild of Landsat 8 Operational Land Imager (OLI)
  - Thermal Infrared Sensor-2 (TIRS-2)
    - NASA Goddard Space Flight Center (GSFC) in-house rebuild/upgrade of Landsat 8 Thermal Infrared Sensor (TIRS)

- **Launch Segment (NASA)**
  - Open competition through NASA Kennedy Space Center (KSC) Launch Services Program (LSP)

- **Ground Segment and Operations (USGS)**
  - Mission Operations Center (MOC) at GSFC
    - Competition for MOC and operations readiness to maximize cost efficiencies
  - Ground Network Element (GNE)
    - Reuse, modify, upgrade, and expand Landsat 8 ground station network as appropriate
  - Data Processing and Archive System (DPAS) at USGS EROS
    - Reuse, modify, upgrade, and expand Landsat 8 data processing and archive capabilities as appropriate

USGS Landsat 9 Project Organization



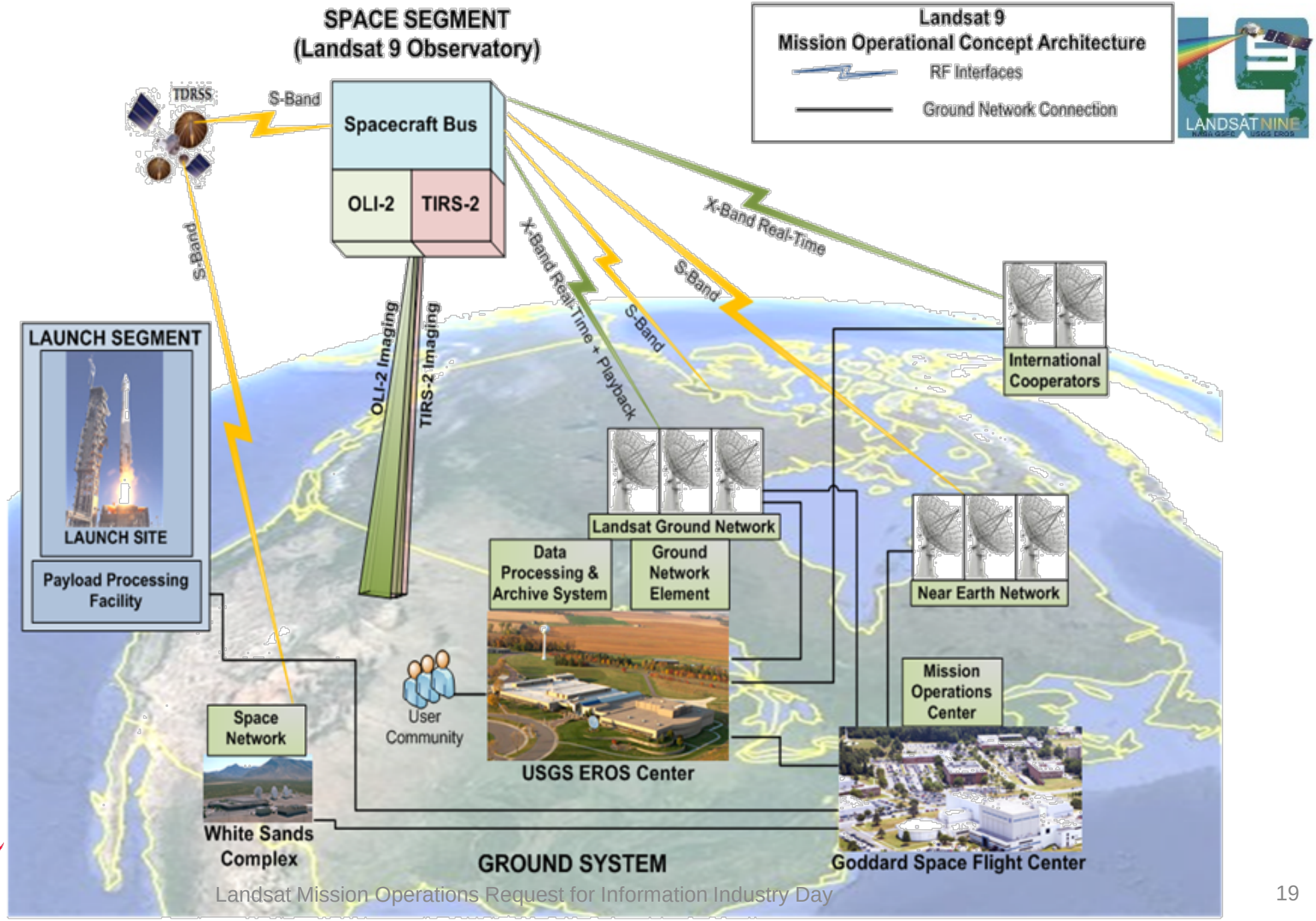
Landsat 9 Project Status

- **Project Management**
  - Planning for System Requirements Review / Mission Definition Review (SRR/MDR) in May 2016 to be followed by Key Decision Point B
- **Spacecraft**
  - Awarded spacecraft studies to five companies on December 18, 2015
    - Ball Aerospace, Lockheed Martin, Northrop Grumman, Orbital/ATK, Thales Alenia
  - Preparing competitive spacecraft acquisition to enable pursuit of earliest possible launch date
- **Operational Land Imager 2 (OLI-2)**
  - Ball Aerospace under contract as of December 30, 2015
  - Planning Heritage Review in April 2016 and Critical Design Review in summer 2016
- **Thermal Infrared Sensor 2 (TIRS-2)**
  - Heritage Review successfully completed on November 19, 2015
  - Planning Preliminary Design Review in summer 2016
- **Ground System**
  - Landsat Mission Operations (LMO) Request for Information (RFI) released on January 26, 2016
    - LMO procurement schedule aligned with spacecraft development schedule
  - Planning Heritage Review in November 2016

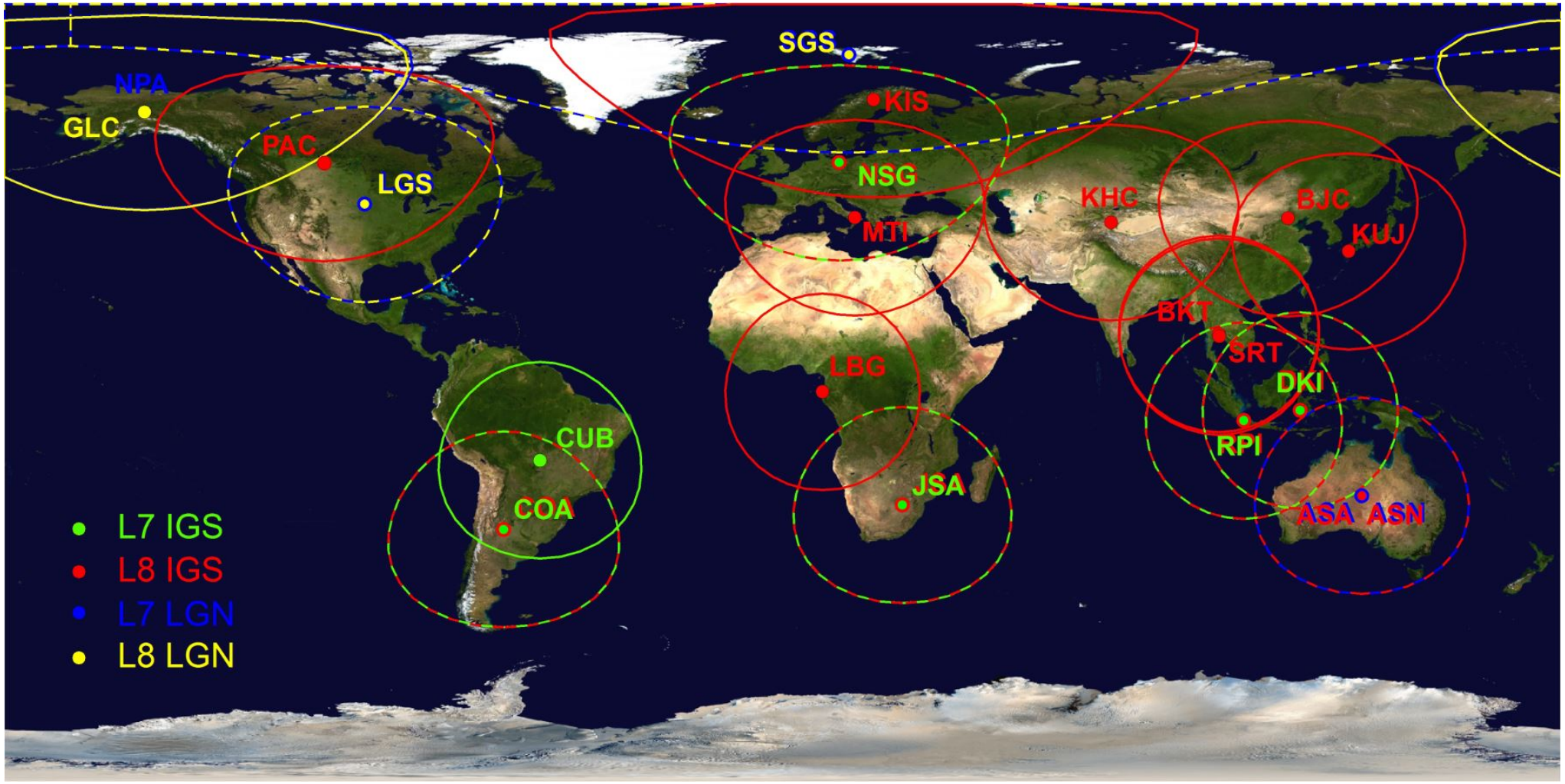
Landsat 9 Project Notional Schedule Milestones

Milestone	Date*
Ground System Heritage Review	Q4 CY16
S/C System Requirements Review (SRR)	Q1 CY17
LMO Contract Award	Q2 CY17
S/C Preliminary Design Review (PDR)	Q3 CY17
Mission Preliminary Design Review (MPDR)	Q3 CY17
Ground System Preliminary Design Review (GS PDR)	Q4 CY17
S/C Critical Design Review (CDR)	Q1 CY18
Ground System Critical Design Review (GS CDR)	Q1 CY18
Mission Critical Design Review (MCDR)	Q1 CY18
System Integration Review (SIR)	Q3 CY19
Mission Operations Review (MOR)	L-12 months
Flight Operations Review (FOR)	L-6 months
Operations Readiness Review (ORR)	L-4 months
Ship Observatory to Launch Site	L-3 months
Ready to Launch (LRD)	Q3 – Q4 CY20
On-Orbit Acceptance Review (OAR)	L+3 months
Post Launch Assessment Review (PLAR)	L+3 months

* All dates listed are notional and subject to change


SPACE SEGMENT
(Landsat 9 Observatory)
Landsat 9
Mission Operational Concept Architecture
RF Interfaces
Ground Network Connection
TDRSS
S-Band
Spacecraft Bus
OLI-2
TIRS-2
S-Band
X-Band Real-Time
X-Band Real-Time + Playback
S-Band
S-Band
OLI-2 Imaging
TIRS-2 Imaging
LAUNCH SEGMENT
LAUNCH SITE
Payload Processing Facility
International Cooperators
Landsat Ground Network
Data Processing & Archive System
Ground Network Element
Near Earth Network
Space Network
User Community
USGS EROS Center
Mission Operations Center
White Sands Complex
GROUND SYSTEM
Goddard Space Flight Center

Landsat Reception Network



Landsat 8 MOC and Operations

Doug Daniels

Landsat Mission Management Officer

The Aerospace Corporation

USGS science for a changing world

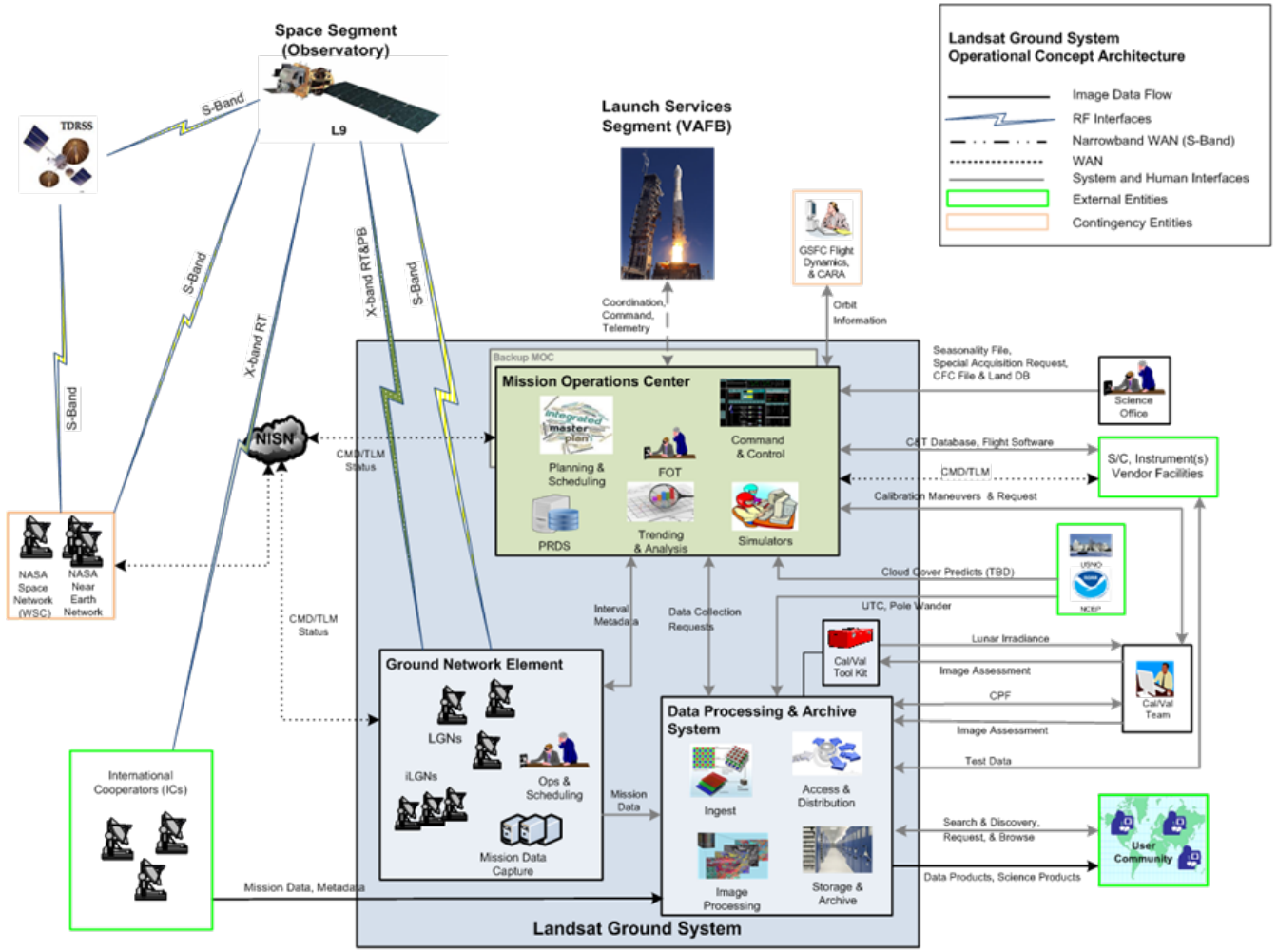
NASA

LANDSAT NINE

NASA GSFC USGS EROS

Landsat 8 Mission Operations Center (MOC)

- **Primary MOC at GSFC Building 14**
  - bMOC at GSFC Building 32 (co-located with Landsat 7 MOC)
- **FOT is responsible for mission operations, operating the MOC/bMOC systems, and interfacing with the space and ground network**
- **The MOC is managed by the Flight Operations Team (FOT) and includes the following primary functions:**
  - CAPE builds and manages collection activity requests from the user community and the Long-Term Acquisition Plan (LTAP)
  - Telemetry, Command & Control; Planning and Scheduling; Flight Dynamics; and Mission Monitor & Analysis
  - Flight software and on-board mass storage management are also performed by the FOT
  - The MOC infrastructure contains networking and system administration, IT security, hardware, and logistics
- **All operational systems within the MOC run within a virtual environment**
- **Limited number of MOC functions are available through remote access**
  - Primarily trending data and telemetry



MOC Functions (1 of 2)

- **Telemetry, Command and Control (TT&C): command loads for transmission to the observatory and monitoring the L8 observatory via real-time (RT) and stored housekeeping telemetry**
  - Accomplished through the Integrated Test and Operations System (ITOS), a MYK-15a, Data Management System (DMS), and a collection of FOT generated scripts
- **Planning & Scheduling: plan and schedule observatory activities, perform constraint checking and schedule de-confliction, and generate observatory activity schedule**
  - Accomplished through flexplan, CAPE, DMS and a collection of FOT generated scripts
- **Flight Dynamics: orbit analysis, maneuver planning (including calibration), ephemeris, attitude performance**
  - Accomplished by the Flight Dynamics System (FDS), which combines FreeFlyer (FF) and Multi-mission Three-Axis Stabilized Attitude Support System (MTASS)
- **Mission Monitor & Analysis: long-term trending, analysis, & anomaly investigation**
  - Accomplished through use of archiva and DMS

MOC Functions (2 of 2)

- **Flight Software: Modifications or updates to observatory flight software are performed by the development contractors/organizations for the spacecraft and imaging sensors**
  - Flight software update command loads are tested first on the observatory simulator in the MOC
- **On-board Mass Storage Management: monitoring of mass storage utilization, scheduling mass storage data downlink and by monitoring the downlink of imaging sensor data through data receipt status messages received from the LGN stations**
  - Accomplished by ITOS, an L8-specific File Accounting Tool (LFAT), and DMS
- **Autonomy: MOC operates in a 10 hours by 7 days mode for nominal operations**
  - Unattended operations include autonomous contacts with ground stations, downlink of housekeeping and mission data, real-time monitoring of the housekeeping telemetry data, monitoring of imaging sensor data receipt acknowledgements, and commanding to unprotect received mission data
  - Monitoring and reporting MOC systems status
    - Attention! Alarm Manager (AM) for notification of on-call staff

Landsat 8 Mission Highlights

- **Currently images an average of 740 WRS-2 scenes per day**
  - Amounts to “all land surfaces” every 16 days
- **Exiting early mission phase and focusing on optimizing operational performance and effectiveness**
- **Requires a robust Landsat Ground Network to help ensure mission success**
- **Performs frequent Calibration activities and maneuvers to ensure acquired data meets image production specifications**

LMO Overview and RFI Questions

Jim Nelson

Landsat 9 Project Manager

USGS EROS

USGS science for a changing world

NASA

LANDSAT NINE
NASA GSFC USGS EROS

USGS Landsat Priorities and RFI Purpose

- **USGS Landsat Long-term Objectives**
  - Science mission is top priority (maximize data collection at highest quality for longest period)
  - Obtain cost efficiency across Landsat program (development and operations, optimize across missions)
  - Involve operations team from early development through on-orbit operations

- **RFI Purpose**
  - Familiarize potential LMO providers with Landsat requirements and concepts of operations
    - Large set of draft procurement and technical reference documents provided
  - Gain feedback from potential providers to factor into LMO procurement
    - Solicit innovative ideas for technical approach and contract structure
    - Gather feedback regarding clarity and driving requirements particularly in the Statement of Work, MOC Requirements Document, and Contract Deliverables Requirements List
    - Obtain ROM cost estimate
    - Explore innovative approaches regarding potential efficiencies across Landsat missions

LMO Scope

- **Management**
  - Project and resource management
  - MOC and Operations Reviews
- **Systems Engineering**
- **Mission and Software Assurance**
- **Mission Operations Center (MOC) Development**
  - Development of MOC systems (hardware and software)
  - Integration, testing, and delivery of systems to the Government at the government-provided facility at GSFC
- **Integration, Testing, and Operations Readiness**
  - Development of operations products, scripts, etc. required for testing and operations
  - Participation in mission integration and operational readiness testing led by the Government
- **Early Orbit Operations and Acceptance**
  - MOC staffing in support of launch and early orbit operations led by the Government
- **Operations and Sustainment**
  - 18 months of on-orbit operations and sustainment of MOC systems after acceptance

Information Released with LMO RFI

- **LMO Applicable Documents**
  - Draft LMO Statement of Work
  - Draft LMO Contract Data Requirements List
  - Draft Landsat 9 Mission Operations Center Requirements Document

- **Reference Materials**
  - Draft Landsat 9 Mission Operations Concept Document
  - Draft Landsat 9 schedule milestones
  - Landsat 9 Ground System technical reference material
  - Landsat 8 MOC technical reference material
  - Draft Landsat 8 Mission Operations Statement of Work
  - LMO applicable document comment spreadsheet

Information Requested (1 of 4)

1. **Organization information:**
   - Organization name and address, point of contact, email address, phone number.
2. **Capabilities:**
   - Provide a brief description of your capabilities and prior experience relevant to this RFI.
3. **Reference Architecture and Concept of Operations:**
   - Provide a reference architecture for a Landsat 9 MOC and approach for flight operations.
   - Include discussion on software applications, hardware, and network optimization concepts.
   - Discuss prior experience with suggested architecture.
   - Discuss approaches for efficiently implementing applicable National Institute of Standards and Technology (NIST) 800-53 Information Technology Security requirements.

Information Requested (2 of 4)

4. System Development Approach:

- Describe full development lifecycle through deployment to operations.
- Include approach to design, implementation, integration and test, operations readiness, and deployment.
- Discuss role of any vendor facility (lab) available versus an onsite MOC development and delivery.
- Discuss MOC software development and operations product development approaches that reduce technical/schedule risks associated with the dependency on Landsat 9 Spacecraft design information.

5. Feedback on Applicable Documents:

- Provide feedback on the LMO applicable documents for completeness and clarity and identify requirements that are the most challenging to comply with or which are unnecessarily driving the MOC design or cost.
- Submit feedback in the provided comment spreadsheet form.

Information Requested (3 of 4)

6. Contract Type and Incentives:

- The LMO is intended to be a cost reimbursable with award fee contract for the development work through on-orbit commissioning and firm fixed price for normal on-orbit mission operations.
- Provide feedback on this contract approach and provide recommendations regarding other LMO contract approaches to provide best value to the government.

7. Rough Order of Magnitude (ROM) Cost Estimate:

- Provide a ROM cost estimate for development through on-orbit commissioning and a separate cost estimate for 18 months of on-orbit operations and sustaining engineering of the Landsat 9 MOC.
- The estimate should include any assumptions and should highlight major cost drivers and opportunities for cost savings such as trade-offs between development costs for automation and operations costs/staffing.

8. Risks:

- Identify risks associated with proposed MOC development approach, and recommend approaches to reduce/mitigate risks.

Information Requested (4 of 4)

Request innovative ideas to reduce the total cost to the Government in two distinct areas:

9. **Contractor-provided Backup MOC (bMOC) Facility:**
   - The baseline approach for Landsat 9 is for a government-provided bMOC facility (building and network connectivity) to host the bMOC systems.
   - Recommend alternative innovative approaches for a Landsat 9 bMOC facility provided by the LMO Contractor.
   - Provide examples of past experience hosting or providing a bMOC, highlighting advantages and disadvantages.
   - Provide a ROM cost estimate for providing a bMOC facility.
10. **Landsat 8 Operations and Sustaining:**
   - Discuss potential optimizations for and cost effectiveness of performing flight operations and sustainment of Landsat 8 concurrently with the development of Landsat 9.
   - Identify approaches to provide cost efficiency in operations as well as long-term maintenance and sustainment of MOC system capabilities.
   - Provide examples where efficiencies can be realized and past experience managing a development concurrently with operating an on-orbit satellite.
   - Provide a delta ROM cost to incorporate Landsat 8 operations and sustainment with Landsat 9 development.
   - Identify associated opportunities and risks and document assumptions.

Questions and Answers

Vickie Floyd

Contracting Officer

USGS

USGS science for a changing world

NASA

LANDSAT NINE

NASA GSFC USGS EROS