Landsat Data Continuity Mission
Operational Land Imager
Industry Day

December 11, 2006

Bill Ochs

LDCM Project Manager

OLI Industry Day Agenda

• Welcome/Introduction	Bill Ochs	9:00
• Landsat Overview	Jim Irons	9:15
• USGS EROS Overview	Mike Headley	9:30
• LDCM Mission and OLI Overview	Evan Webb	9:45
• Ops Concept Overview	Vicki Zanoni	10:30
• RFP Overview	Del Jenstrom	10:50
• Open Q&A	Bill Ochs	11:35
• Lunch		11:45
• One-On-One Sessions		1:00 – 5:00

Welcome/Introduction

Bill Ochs

LDCM Project Manager

Logistics

- **Food**
  - **Morning - Breakfast Provided**
  - **Lunch – your on your own**
  - **Afternoon – Snacks Provided**

- **Parking is included**
  - **Make sure you get appropriate voucher, sticker, etc.**

- **Copies of presentation not provided**
  - **Presentation will be posted to web site on December 12th**

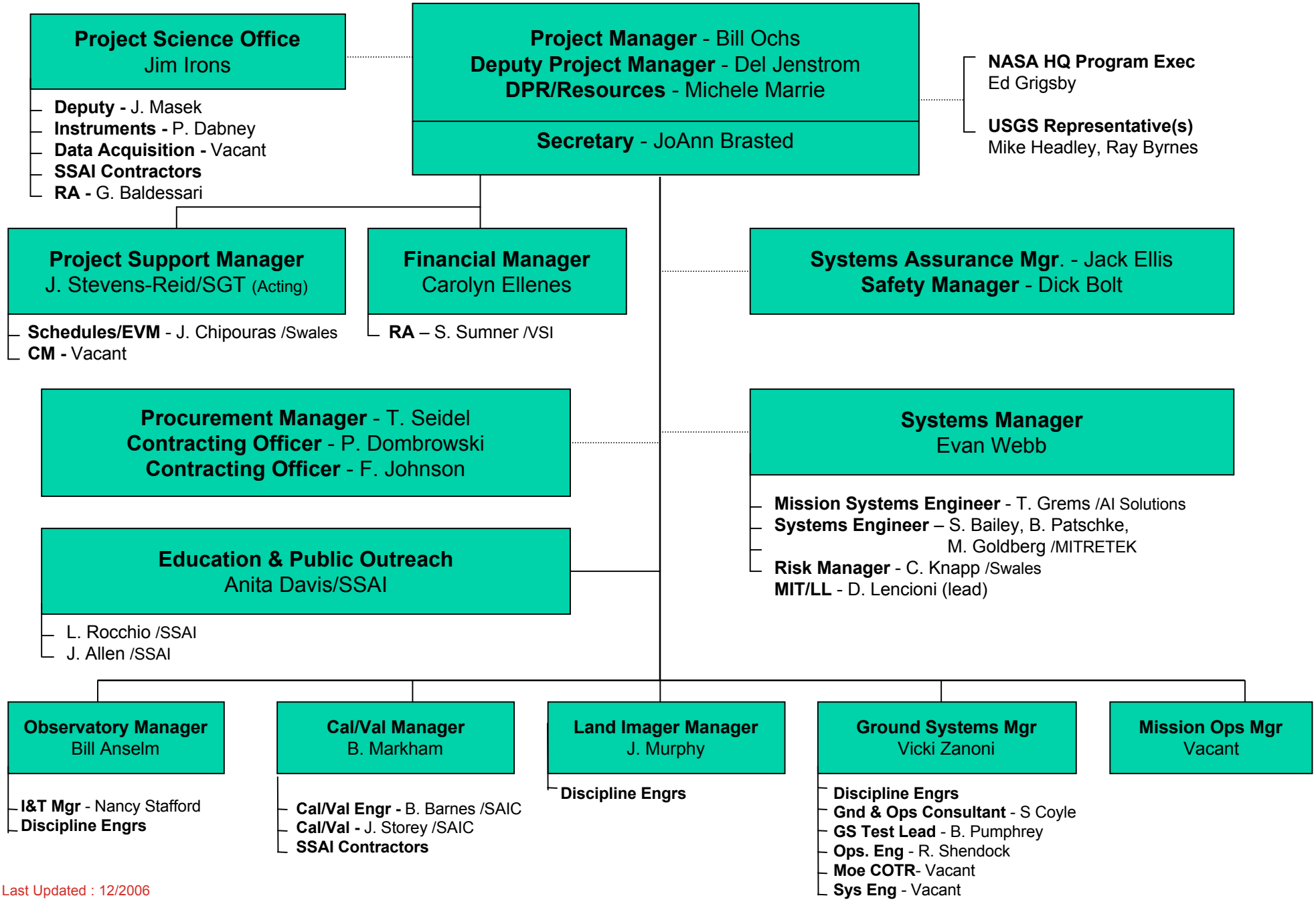
Ground Rules for meeting

- **Information provided today through this meeting or answers provided to questions are not considered official. All information is only considered official when it is contained in the Contracting Officer's release of the Final RFP or releases the Government's official response to questions received.**

- **Responses to questions that affect the RFP package received during Industry Day, will be posted anonymously to the NAIS**

- **Following release of the Final RFP any communication should be directed to the Contracting Officer. Questions about the RFP should be submitted in writing to the Contracting Officer. The questions will be answered and be made available through the NASA Acquisition Internet Service (NAIS) System.**

LANDSAT DATA CONTINUITY MISSION - CODE 427

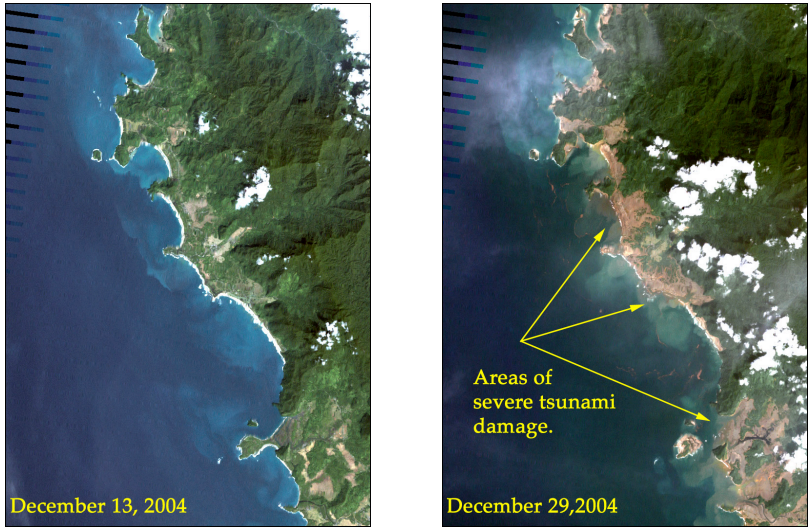


Last Updated : 12/2006

LDCM Overview

Mission Objectives

- **Provide continuity in the multi-decadal Landsat land surface observations to study, predict, and understand the consequences of land surface dynamics**
  - **Land cover/use change**
  - **Human settlement and population**
  - **Ecosystem dynamics**
  - **Landscape scale carbon stocks**
  - **Resource management/societal needs**



Landsat 7 data used to aid Indonesian government with tsunami relief efforts (David Skole, Michigan State University)

LDCM Data Needed to Address NASA Earth Science Focus Areas, Questions, and Applications

Focus Areas	*Science Questions*
• Carbon Cycle, Ecosystems, & Biogeochemistry • Water & Energy Cycle • Earth Surface & Interior	- What are the changes in global land cover and land use, and what are their causes? - How do ecosystems, land cover & biogeochemical cycle respond to and affect environmental change? - What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems ? - What are the consequences of increased human activities on coastal regions?

Instrument

- **Multi-spectral imaging sensor**

Partners

- **NASA Goddard Space Flight Center**
- **Dept. of Interior's United States Geological Survey (USGS)**

NASA/USGS Partnership

- **NASA and DOI USGS are identified as the Landsat Program Management team under authority of U.S. Code Title 15, Chapter 82, "Land Remote Sensing Policy" and Presidential Decision Directive NSTC-3, "Land Remote Sensing Strategy,"**

- **NASA Responsibilities**
  - **Development of**
    - Space Segment, Launch Segment, and the Mission Operations Element (MOE)
  - **Serve as the system integrator for the entire LDCM and lead the missions systems engineering effort**
  - **Lead Mission Operations through the completion of the on-orbit checkout period**

- **USGS Responsibilities**
  - **Development of**
    - Ground System (comprised of the Flight Operations and Data Processing and Archive Segments), excluding procurement of the MOE
  - **LDCM mission operations, after the completion of the on-orbit checkout period**
  - **Accept and execute all responsibilities associated with the transfer of the LDCM Operational Land Imager (OLI) instrument, spacecraft bus and Mission Operations Element contracts from NASA following on-orbit acceptance of the LDCM system including assuming contract management**

Procurement Timeline

Procurement Activity	Completion Date
Industry Day	12/11/06
RFP Release	1/3/07
Proposals Due	2/2/07 (30 days after RFP release)
Initial Evaluation	3/23/07 (7 weeks)
Questions, Discussions, Request for Final Proposals	4/9/07 (2 weeks)
Receive Final Revised Proposals	4/20/07 (2 weeks after request)
Final Evaluation	6/1/07
Award	6/11/07

Launch Readiness Date

- **Targeted Launch Readiness Date**
  - **July 2011**

- **Instrument Delivery**
  - **39 mos. after Contract Award (8/2010)**
    - **Challenge:**
      - Enable an instrument in delivery in 39 months but still meeting all the technical and programmatic requirements defined in the RFP package
        - » Must ensure both Contractor and NASA management are committed to on-time delivery
        - » Schedule is only attainable through a strong partnership between industry and NASA

NASA Future Procurements

- **LDCM Spacecraft**
  - **RSDO S/C**
    - "On-Ramp" to Rapid II Catalog to permit all qualified spacecraft vendors to be added to the current RSDO catalog – On-Ramp Closes Dec. 15th
  - **Contract includes:**
    - Spacecraft
    - Observatory I&T
    - Launch Site Activities
    - On-Orbit Sustaining Engineering
    - 5 1-year options for additional On-Orbit Sustaining Engineering
  - **Request For Offer (RFO) for a s/c study phase**
    - Vendors will be selected for 4 month study
      - Study topics include communications architecture, instrument interface, mission operation element interface, I&T planning, MAR/"Golden Rules"/LDCM Environmental Verification Requirements, etc.
  - **Final RFO release and selection after study phase**

- **Mission Operations Element (MOE)**
  - **Contract includes:**
    - Command & Control, Mission Scheduling, Long-Term Trending and Analysis, and Flight Dynamics capabilities
    - Support for Observatory I&T/Launch Site
    - On-Orbit Sustaining Engineering
    - 5 1-year options for additional On-Orbit Sustaining Engineering
  - **RFI was issued on Nov. 22nd**
    - Requested info included:
      - Reference architecture, use of COTS, approaches to I&T with spacecraft and ops team, etc.
    - Responses due Dec. 14th

All Contracts Will Be In Place By Dec. 07

Landsat Overview

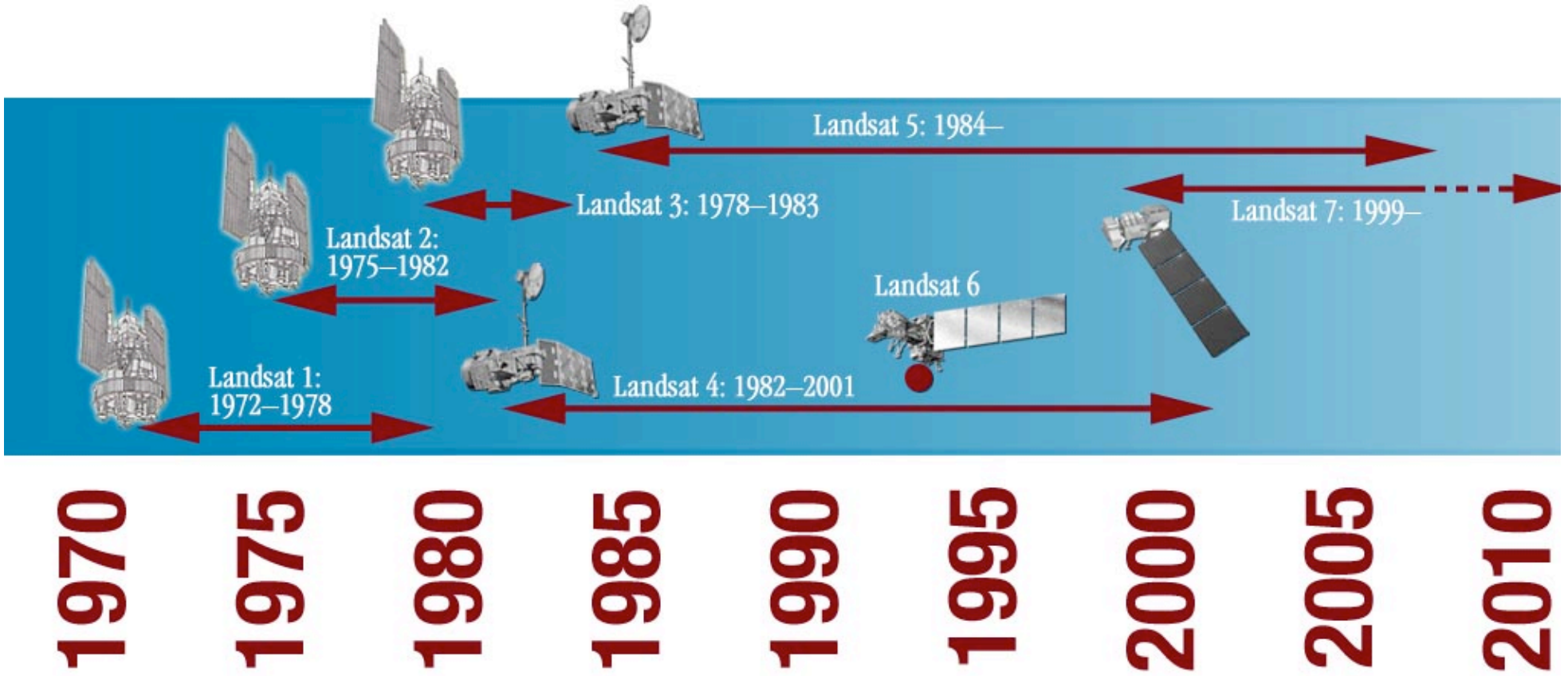
presented by

James R. Irons, Ph.D
LDCM Project Scientist
NASA Goddard Space Flight Center

at the

OLI RFP Industry Day
College Park, Maryland
December 11, 2006

30+ Years of Continuous Land Observations



30+ Years of Programmatic Change

- **Responsibility for Landsat satellite operations has varied over the 33 year program history:**

– **1972-1979:**
NASA managed Landsats 1 to 3 as experimental missions;

– **1979-1984:**
NOAA managed Landsats 2 to 5 as operational missions;

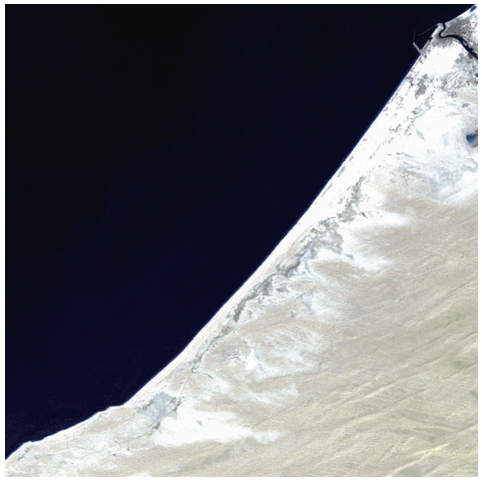
– **1985-2001:**
EOSAT and Space Imaging managed Landsats 4 & 5 as commercial missions per the Land Remote Sensing Commercialization Act of 1984;

– **1999-present:**
USGS is managing Landsat 5 & Landsat 7 as a scientific global survey mission per the Land Remote Sensing Policy Act of 1992 and the October 2000 amendment to Presidential Decision Directive/NSTC-3.

Importance of Landsat Data Continuity

- **Land cover and land use are changing at rates unprecedented in human history with profound societal consequences**
  - **Food and fiber production**
  - **Water consumption and quality**
  - **Weather and climate change**
  - **Human health**

Dubai, United Arab Emirates



Landsat 1 MSS, 1973

Landsat 4 TM, 1990

Landsat 7 ETM+, 2006

Importance of Landsat Data Continuity (cont.)

- **The importance of the Landsat program derives not only from current sensor observations, but also from:**
  - **Rigorous calibration / cross-calibration**
  - **A long-term data archive**
    - The DoI / USGS preserves a 33-yr archive of Landsat data in the National Satellite Land Remote Sensing Data Archive (NSLRSDA) at USGS EROS, Sioux Falls, SD
    - DoI is the only federal agency with a mandate to preserve this archive for public access (the Land Remote Sensing Policy Act of 1992)
    - No other nation is committed to preserving a comparable record of the global land surface
  - **A global data acquisition strategy**
    - No other nation's satellite system is designed or operated to achieve even annual global coverage at the Landsat scale
  - **An open data policy**
    - DoI provides non-discriminatory public access to the Landsat data archive
    - No restrictions are placed on Landsat data sharing

The Land Remote Sensing Policy Act of 1992

- **The Act (P.L. 102-555) direct Landsat Program Management to study options for a successor mission to Landsat 7 that:**
  - **"adequately serve the civilian, national security, commercial, and foreign policy interests of the United States"**
  - **"maintain data continuity with the Landsat system"**
  - **"incorporate system enhancements, including any such enhancements developed under the technology demonstration program under section 303, which may potentially yield a system that is less expensive to build and operate, and more responsive to data users"**
- **The Act defines data continuity as:**
  - **"the continued acquisition and availability of unenhanced data which are, from the point of view of the user --**
    - **(A) sufficiently consistent (in terms of acquisiiton geometry, coverage characteristics, and spectral characteristics) with previous Landsat data to allow comparisons for global and regional change detection and characterization; and**
    - **(B) compatible with such data and with methods used to receive and process such data."**

The Landsat 7 Benchmark

- **Landsat 7 has established a benchmark for its successor mission with respect to:**
  - **Sensor and system performance,characterization, and calibration**
    - On-orbit characterization and calibration over mission life via an Image Assessment System (IAS)
  - **Mission operations and data acquisition**
    - Archive-driven, systematic , substantially cloud-free, global coverage on seasonal basis - The Long Term Acquisition Plan (LTAP)
  - **Data archival and data product distribution**
    - USGS archive provides nondiscriminatory access
    - Data products are available in consistent formats on consistent media
    - Secondary distribution is unrestricted

LDCM Objective

- The LDCM, consistent with U.S. law and government policy, will continue the acquisition, archival, and distribution of multi-spectral imagery affording global, synoptic, and repetitive coverage of the Earth's land surfaces at a scale where natural and human-induced changes can be detected, differentiated, characterized, and monitored over time
- The following are the major mission objectives:
  - Collect and archive medium resolution (circa 30 m spatial resolution) multi-spectral image data affording seasonal coverage of the global land mass for a period of no less than five years.
  - Ensure that LDCM data are sufficiently consistent with data from the earlier Landsat missions, in terms of acquisition geometry, calibration, coverage characteristics, spectral characteristics, output product quality, and data availability to permit studies of land cover and land use change over multi-decadal periods.
  - Distribute LDCM data products to the general public on a nondiscriminatory basis and at a price no greater than the incremental cost of fulfilling a user request.

LDCM Chronology

- **Landsat 7 launch** — **April 15, 1999**
- **Release of LDCM Data Buy RFI** — **June, 1999**
- **Posting of Draft LDCM Data Spec** — **Nov. 06, 2000**
- **Earth Observing-1 satellite launch** — **Nov. 21, 2000**
  - **Advanced Land Imager (ALI) aboard**
- **Public LDCM Workshop** — **Jan. 09 - 10, 2001**
  - **Hosted by USGS, Reston, VA**
- **Release of Formulation Phase RFP** — **Nov. 01, 2001**
- **Formulation Phase Studies** — **March 15, 2002 to Dec. 28, 2002**
  - **Two private firms selected for independent studies leading to system PDR's**

LDCM Chronology

- **Release of Implementation Phase RFP** — **Jan. 06, 2003**
- **Cancellation of Implementation Phase RFP** — **Sept. 23, 2003**
- **EOP convenes interagency LDCM working group** — **Dec., 2003**
- **1st OSTP memorandum signed by Dr. Marburger** — **Aug. 13, 2004**
  - **"Transition Landsat measurements to an operational environment through the incorporation of Landsat-type sensors on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) platform …**
- **2nd OSTP memorandum signed by Dr. Marburger** — **Dec. 23, 2005**
  - **supercedes previous direction to fly Landsat sensors aboard NPOESS satellites**
  - **Directs NASA to acquire free-flyer spacecraft**
  - **Assigns DOI / USGS the responsibility for operating the spacecraft**
- **Industry Day** — **Dec. 11, 2006**

Future Planning

- National Science and Technology Council (NSTC) Future of Land Imaging - Interagency Working Group (FLI-IWG)
  - OSTP Chair
- International Group on Earth Observations (GEO) and the Global Earth Observing System of Systems (GEOSS)
  - Committee on Earth Observation Satellites (CEOS) and the Land Surface Imaging Constellation
- National Research Council Decadal Survey: Earth Science and Applications from Space: A Community Assessment and Strategy for the Future.

The LDCM needs to serve as a foundation upon which future land imaging systems can be built

Landsat 5 & Landsat 7 Status

- **Landsat 7 and its Enhanced Thematic Mapper-Plus (ETM+) sensor reached end of five-year design life on April 15, 2004**
  - **ETM+ scan line corrector (SLC) anomaly occurred on May 31, 2003**
    - Results in missing pixels, or gaps, over 24% of each ETM+ scene
    - Remaining pixels are not effected with respect to radiometric and geolocation accuracies
    - USGS EROS provides composited "gap-filled" ETM+ image products
  - **One of three attitude control gyros was shut down in May 2004 with no adverse impacts on image acquisition or data quality**
  - **Managing fuel to maintain operations through 2012**
- **Landsat 5 and its Thematic Mapper (TM) sensor are 22 YEARS OLD, 19 years past 3-year design life**
  - **Satellite is only capable of the direct transmission of data in real time**
    - EROS Data Center directly receives data only for CONUS
  - **TM data are directly transmitted to International Ground Stations**
    - Only the Australian IGS sends tapes to the EROS Data Center
  - **No redundancy remains for most mission critical subsystems**
    - Redundant Solar Array Drive malfunctioned in Nov. 05; operations continued with fixed solar array
  - **Fuel will impact operations in ~ 2010**

Sources of OLI Specifications

- **OLI specifications derive from:**
  - **The societal benefits of continuing land cover / land use change observations**
  - **The Land Remote Sensing Policy Act of 1992**
  - **Landsat program heritage and the Landsat 7 benchmark**
  - **LDCM mission objectives**
  - **Previous LDCM implementation attempts & the LDCM Data Specification**
  - **The state of current technology (e.g., ALI tech demo)**
  - **Guidance from the Executive Office of the President (OSTP memoranda)**
  - **An eye to the future of land observations from space**

U.S Geological Survey Center for Earth Resources Observation and Science (EROS)

Mike Headley, PMP
USGS LDCM Project Manager

EROS Background

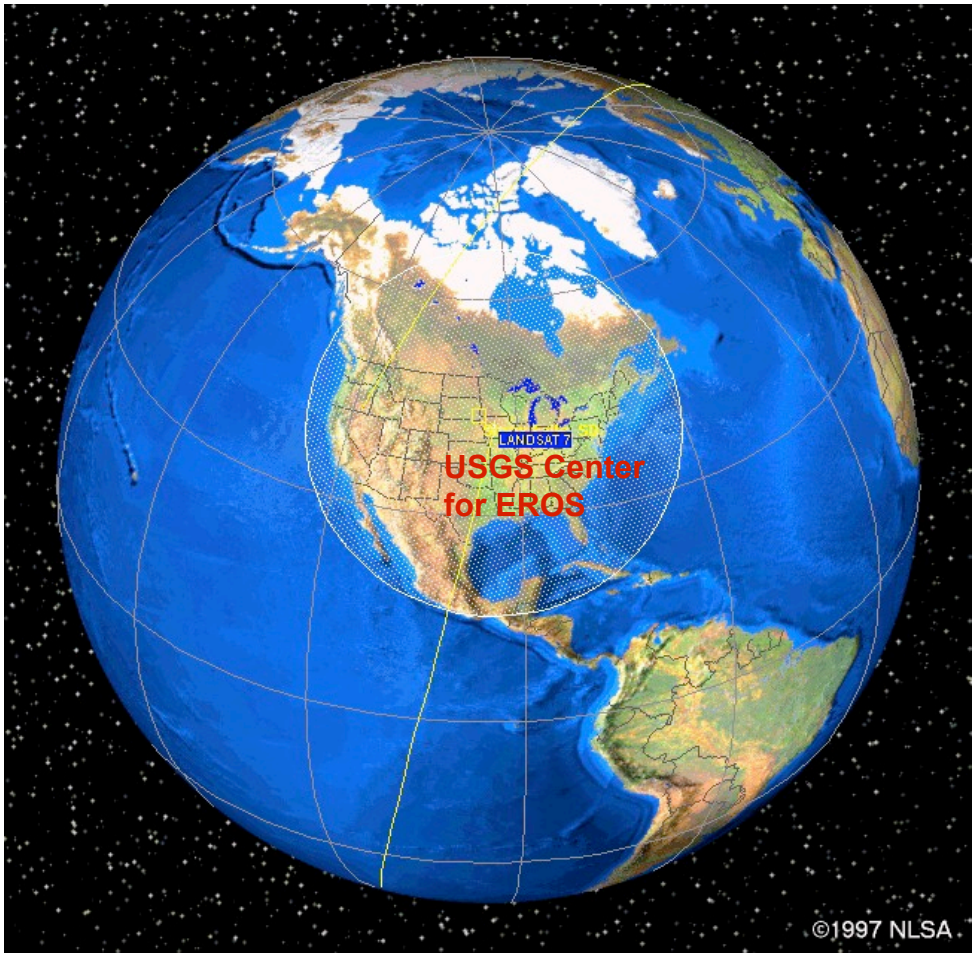
- Established in 1973 to support ERTS/Landsat
- Located 16 miles NE of Sioux Falls, SD on 318 acres; 300,000 sq ft. facility
- Central CONUS location supports earth resources satellite operations
- Staffed by 83 civil servants and 584 contract personnel
- Home to the National Satellite Land Remote Sensing Data Archive (NSLRSDA) and NASA's Land Processes Distributed Active Archive Center (LP DAAC)

EROS Mission

Science: To promote applications, uses, and knowledge of land information to better understand our planet

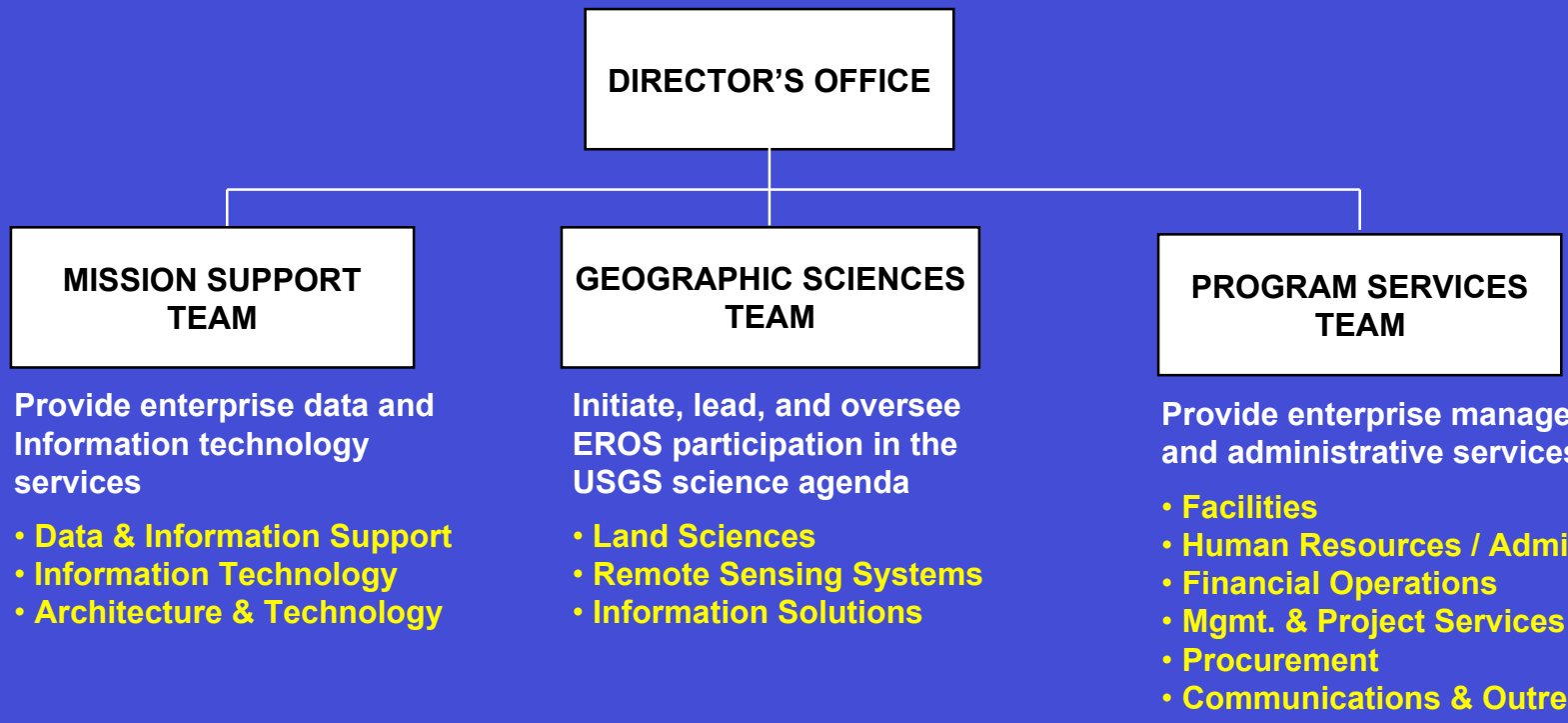
Data Access: To ensure that scientists, researchers, businesses, decision makers, and the public have ready access to land information

Data Archives: To safeguard and expand the national archive of remotely sensed land data



EROS Management Structure

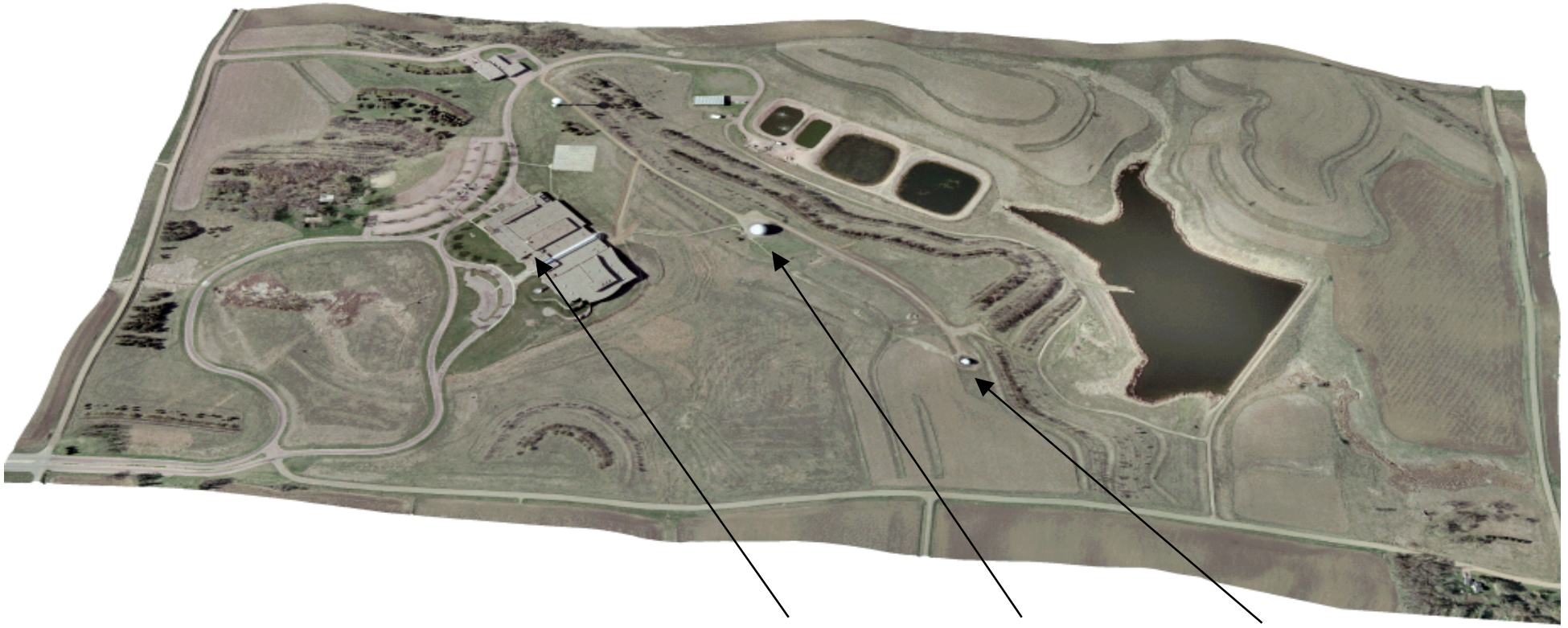
EROS Government Organization



EROS Satellite Operations Activities

- **EROS ground station operations**
  - 19x7 operations schedule; 24x7 capable
  - X-band image data reception
  - S-Band TT&C communications support
- **Active satellite data reception missions**
  - Landsat 5 Thematic Mapper (TM)
  - Landsat 7 Enhanced Thematic Mapper (ETM+)
  - 1 Km AVHRR
  - Earth Observation System (EOS) Terra & Aqua (MODIS) direct broadcast
- **Landsat 5 and 7 satellite operations**
  - Mission Operations Centers (MOCs) located in Maryland

EROS Data Reception Antennas

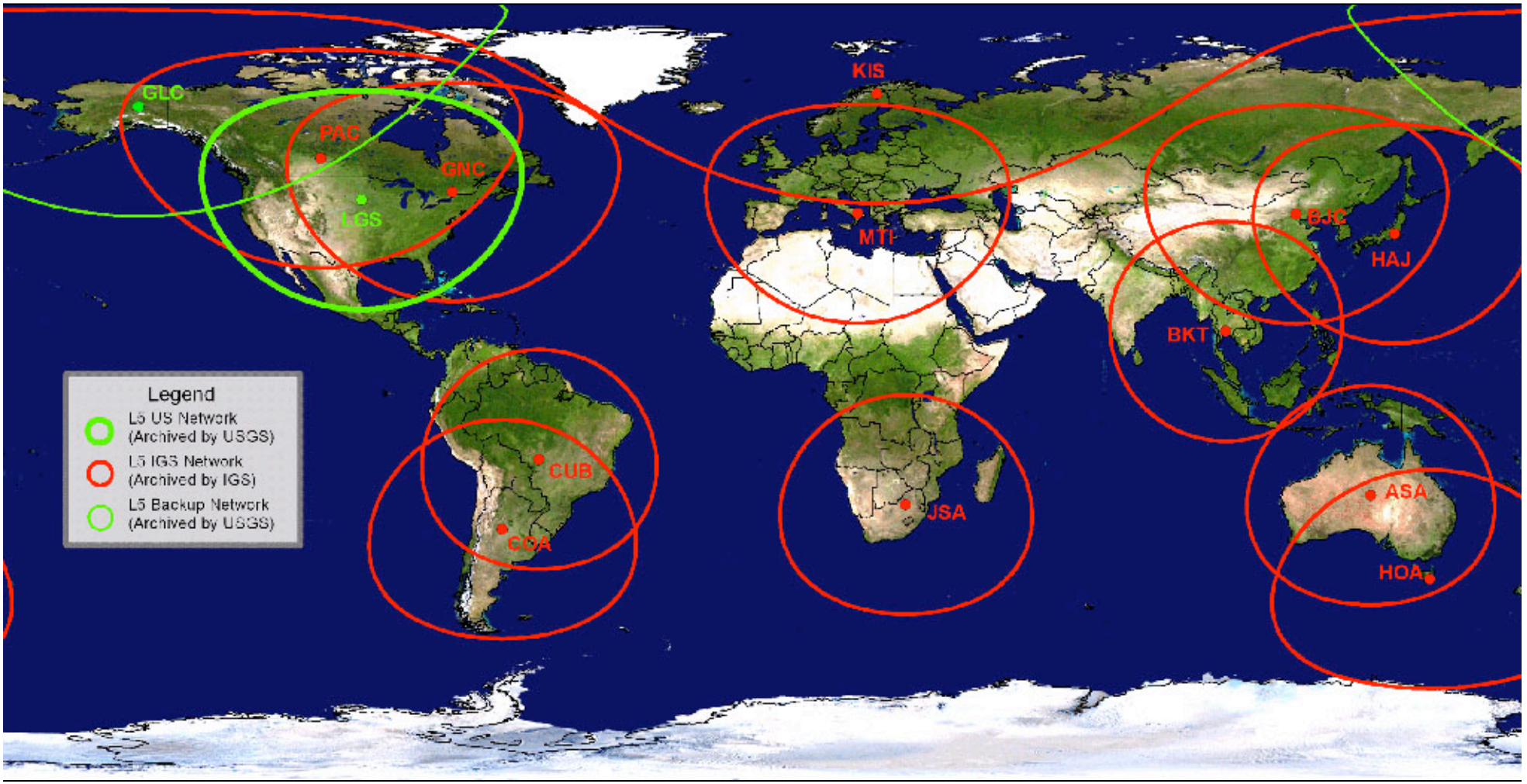


- **Three Full Motion Satellite Antennas (3M ViaSat / 10M Datron / 5.4M ViaSat)**
  - **Initial site preparation work completed for an additional antenna**

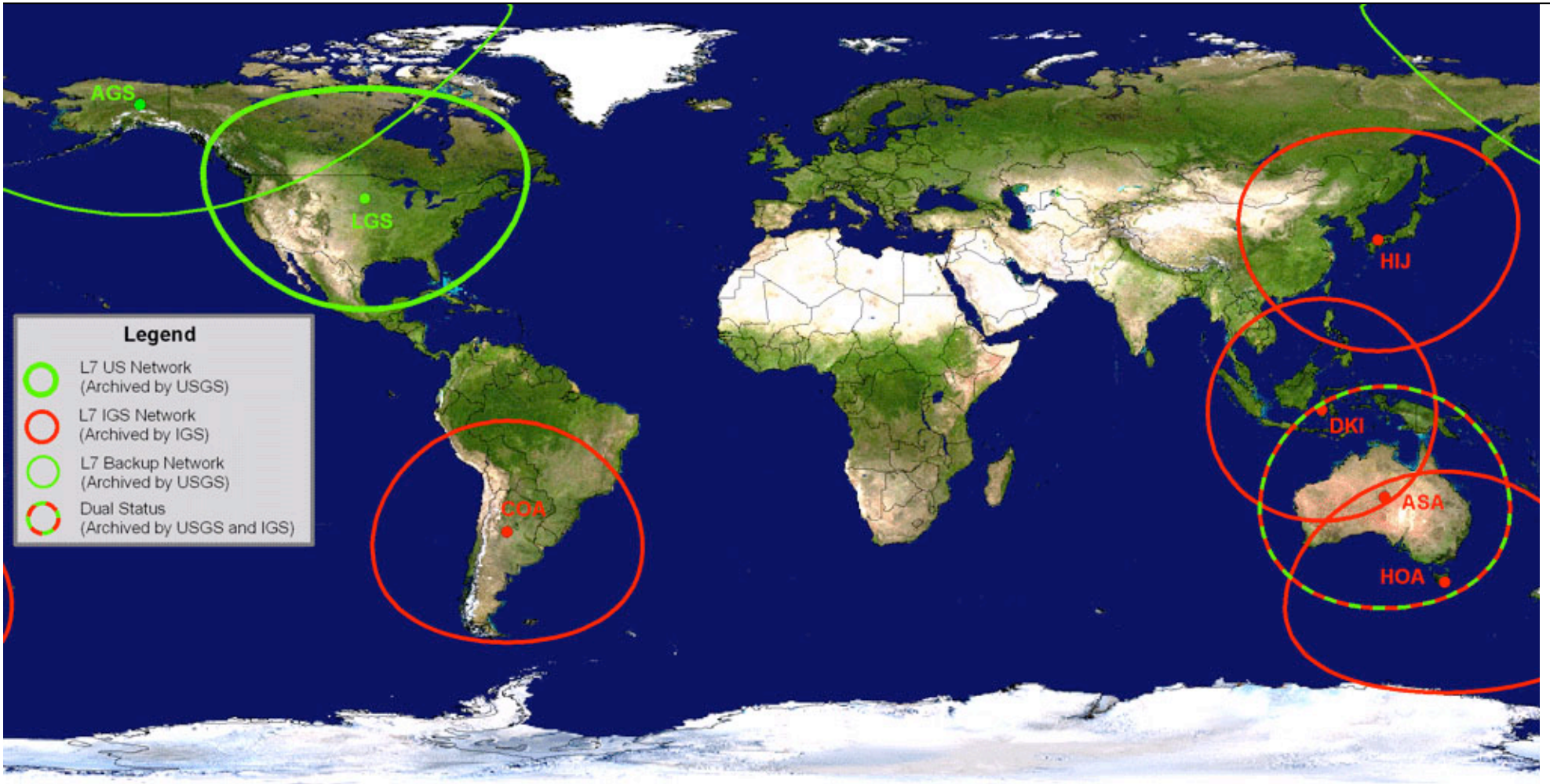
EROS Supports the Landsat Program Objectives

- **Maximize acquisition of global cloud-free Landsat observations**
  - **Populate U.S. archive to support global change science**
- **Distribute products at cost of fulfilling user requests**
- **Promote use of Landsat data for land remote sensing research and applications**
- **Establish and operate a global network of international cooperators**
- **Satisfy national and international Landsat science data requirements**
- **Support the USGS Emergency Response Program within the constraints of the Landsat system**

Landsat 5 International Cooperator Network



Landsat 7 International Cooperator Network



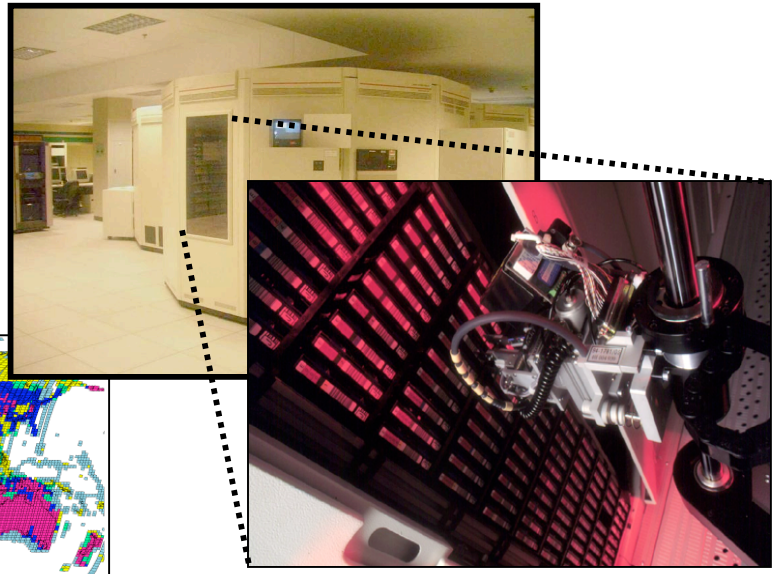
EROS Archive Overview

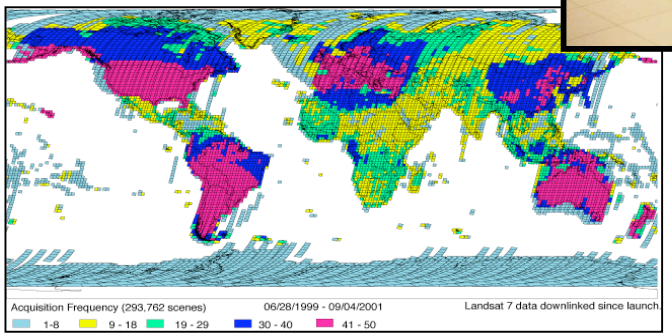
Film Archives

- 1939 to Present
  - 24 Major Collections
  - Multiple film formats/sizes
  - Over 8.6 million frames

Digital Archives

- 1972 to Present
  - 1 to 2 Terabytes / Day
  - 2.8 Petabytes
  - Over 21 million files



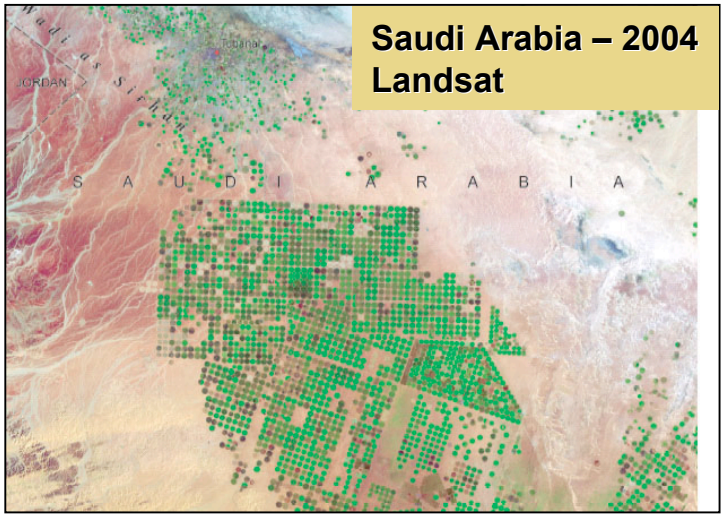


Earth Image Archive Depth

Lake Chad – 1963
Declass-satellite

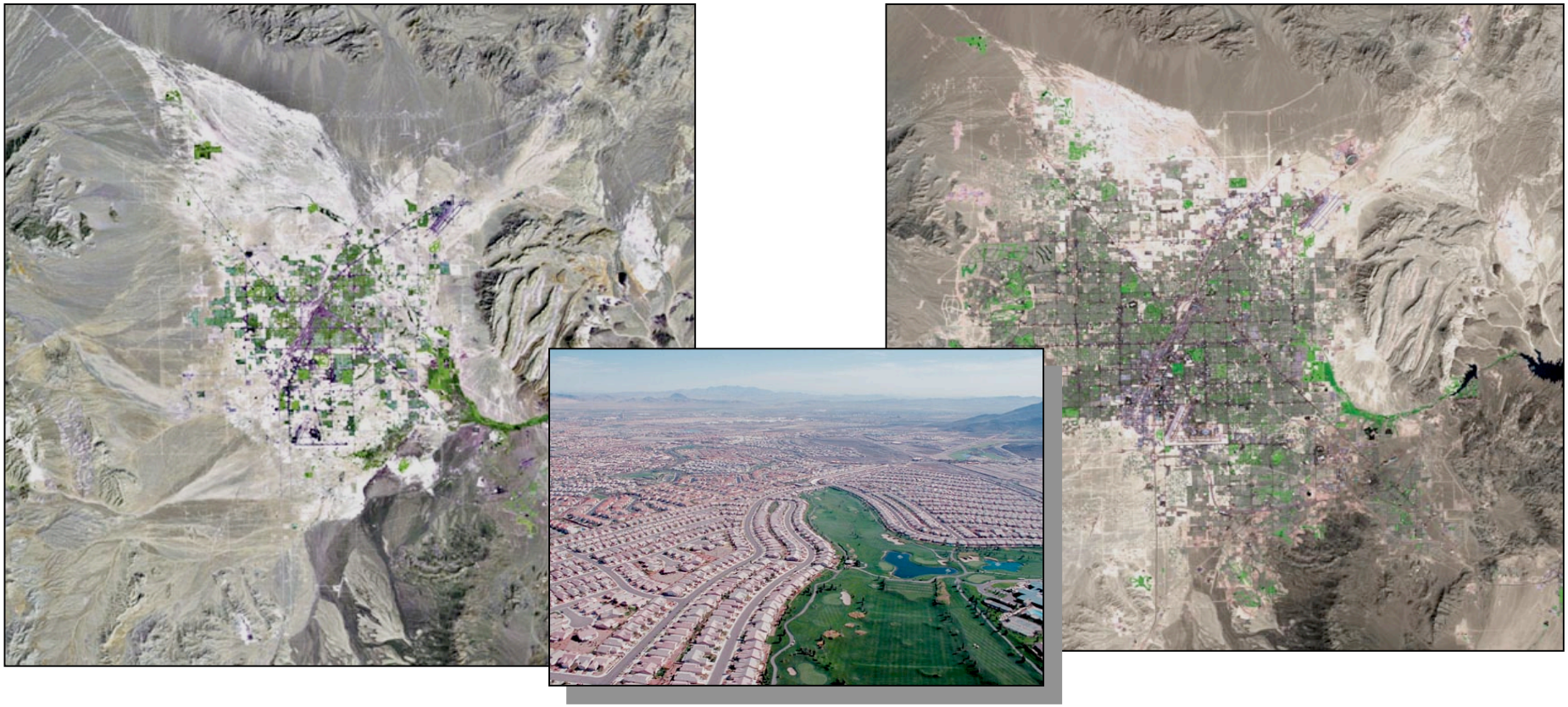
New Orleans – 1980
Aerial

Washington D.C. – 2002
Aerial



Saudi Arabia – 2004
Landsat

EROS Archive Supports Landscape Change Studies



Las Vegas Area
in 1973 (population 358,400)

Las Vegas Area
in 2000 (population 1,563,280)

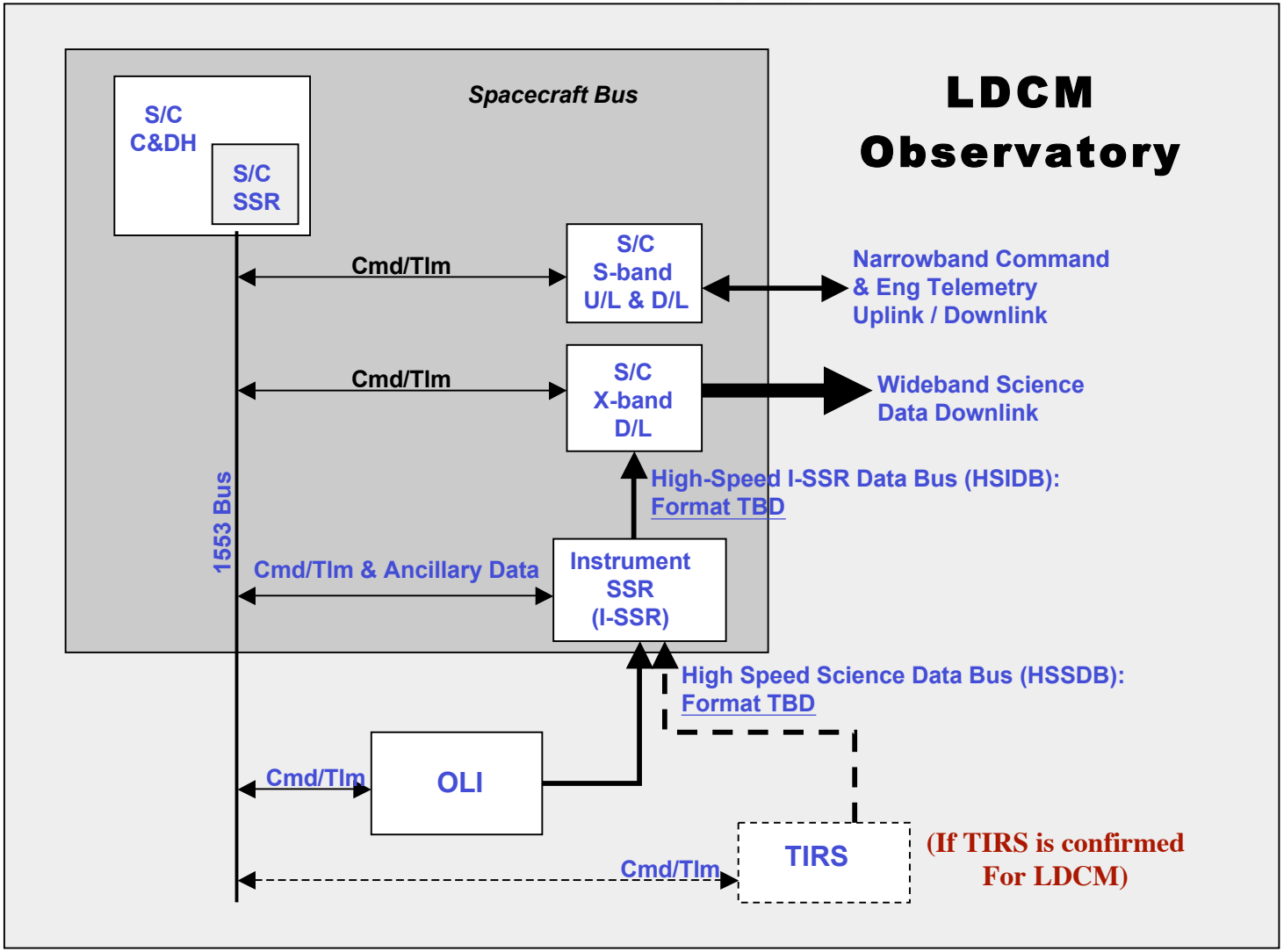
LDCM Mission and OLI Overview

Evan Webb
LDCM Systems Manager

Mission Overview

- **Summary of relevant LDCM Level 1 Requirements:**
  - 5 year mission lifetime/consumables for 10 years
  - Seasonal, global, image data sufficiently consistent with Landsat-7 ETM+
  - WRS-2 path, mid-morning equatorial node, 16 day repeat cycle
  - 30 m GSD for VIS/NIR/SWIR, 15m GSD for PAN
  - 9 spectral bands as specified (exclusive of thermal bands)
  - 400 scenes per day throughout mission
  - Nondiscriminatory public access to all image data
  - Public release of all algorithms used to produce data products
  - International Cooperator (IC) direct broadcast support
  - Support for priority imaging
- **Some Key Level 3 Requirements**
  - OLI reliability of 0.85 at 5 years after commissioning
  - Generally single-fault tolerant design with autonomy
  - High availability
  - Collection of ≥400 scenes per day & transmission to LGN

LDCM Observatory/OLI Context

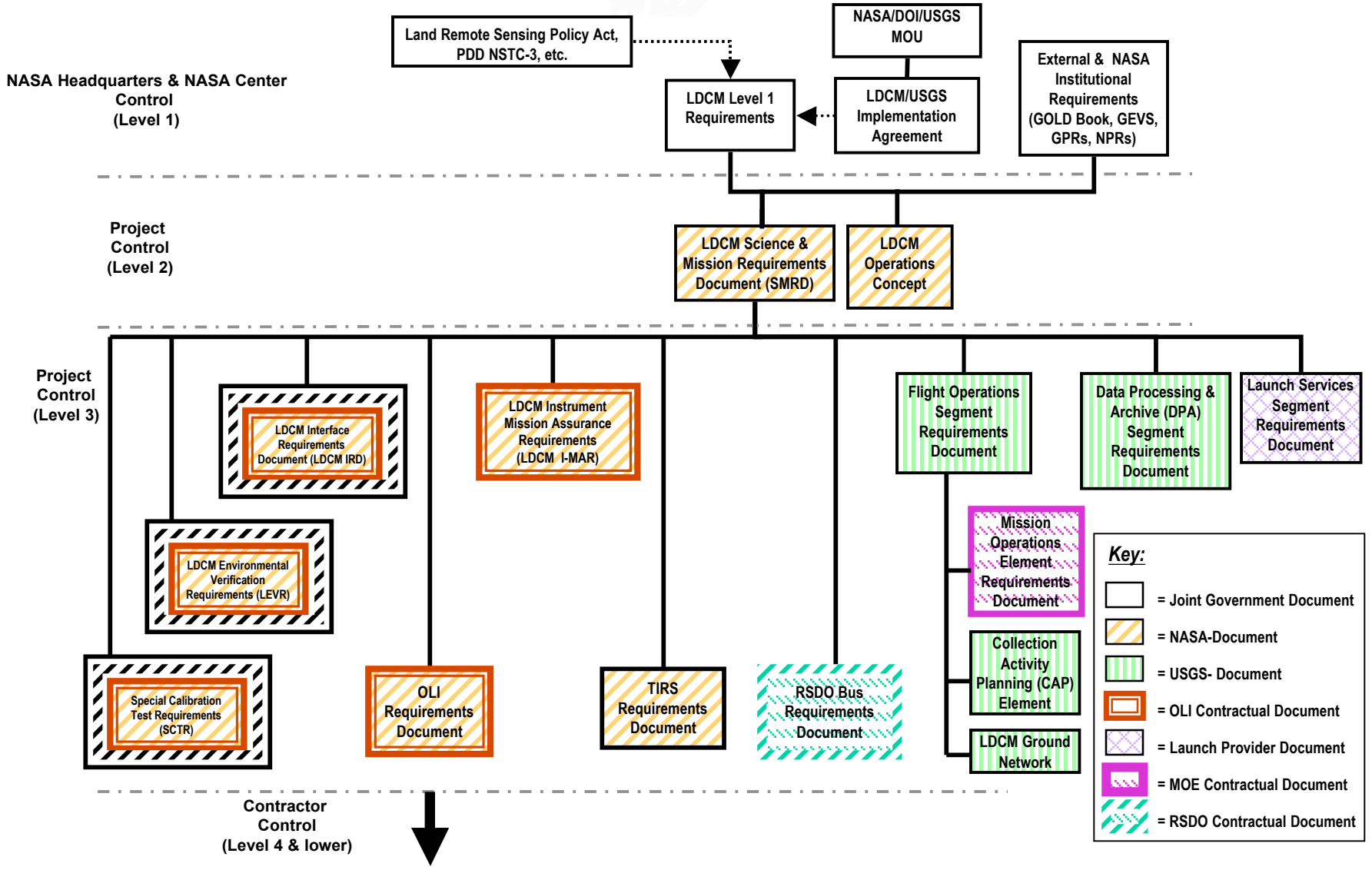


NOTE:
The Instrument SSR (I-SSR) is shown here as separate from the spacecraft SSR for the sake of clarity. However, the I-SSR will be procured as part of the spacecraft bus procurement and it is possible that the spacecraft SSR and I-SSR could be combined into a single component.

Requirements Documents Overview

- **The technical requirements documents for the OLI procurement are:**
  - **OLI Requirements Document (OLI-RD)**
    - Primary requirements document: contains all imaging requirements
  - **OLI Special Calibration Test Requirements (OLI SCTR)**
    - SOW-like requirements to fully characterize the instrument throughout various operating ranges and conditions; applies from component-level to observatory-level and on-orbit.
  - **LDCM Observatory Interface Requirements Document (Obs-IRD)**
    - Requirements related to interfaces within and external to the observatory.
    - Contractual document for both instruments and spacecraft bus.
    - Provides initial requirements (or guidance for analysis) which will be refined in the ICDs.
  - **LDCM Environmental Verification Requirements (LEVR)**
    - Adapted from GEVS; made into specific requirements language for LDCM.
  - **LDCM Instrument Mission Assurance Requirements (I-MAR)**
    - Requires good practices to be followed for the LDCM instrument.

LDCM Requirements Hierarchy



OLI & LDCM Requirements Philosophy

- **We adhered to a few guiding principles when developing the requirements:**
  - **Mostly performance-based requirements**
  - **Put end-to-end imaging performance responsibility on the instrument contractor for the life of the mission**
    - Presumes that the spacecraft bus meets performance requirements
  - **Requirements written to specify performance at end of 5-year design life (EOL)**
    - Contractor must specify the margin that is required at BOL in the design specifications to ensure meeting requirements at EOL
  - **A robust simulation capability is required through I&T and in operations to enable troubleshooting and operational planning & validation**
- **A few basic design concepts are inherent in the requirements, mostly to ensure a reasonable solution with the yet-to-be procured spacecraft bus:**
  - **Isolation of the instrument from the spacecraft via an instrument bench (delivered by spacecraft contractor)**
  - **Management of instrument data rates to enable an X-band downlink**
  - **"Scenes" are not built on-orbit, but produced on the ground from image intervals collected on-orbit**

OLI Key Spectral Performance Requirements

from OLI-RD 5.4.1

#	Band	Minimum Lower Band Edge (nm)	Maximum Upper Band Edge (nm)	Center Wavelength (nm)	GSD (m)
1	Coastal /Aerosol	433	453	443	30
2	Blue	450	515	482	30
3	Green	525	600	562	30
4	Red	630	680	655	30
5	NIR	845	885	865	30
6	SWIR 1	1560	1660	1610	30
7	SWIR 2	2100	2300	2200	30
8	Panchromatic	500	680	590	15
9	Cirrus	1360	1390	1375	30

Key Radiometric Performance Requirements- SNR

from OLI-RD 5.6.2.1

#	Band	SNR @ $L_{Typical}$	SNR @ L_{High}	Radiance Level for SNR, L (W/m^2 sr µm)	
				Typical, $L_{Typical}$	High, L_{High}
1	Coastal Aerosol	130	290	40	190
2	Blue	130	360	40	190
3	Green	100	390	30	194
4	Red	90	340	22	150
5	NIR	90	460	14	150
6	SWIR 1	100	540	4.0	32
7	SWIR 2	100	510	1.7	11
8	Panchromatic	80	230	23	156
9	Cirrus	50	N/A	6.0	N/A

OLI Key Radiometric Performance Requirements

- **Absolute Radiometry (OLIRD 5.6.1)**
  - **Radiance - 5% (1 σ)**
  - **Top-of-Atmosphere Reflectance - 3% (1 σ)**
- **Relative Radiometry**
  - **12 bit quantization (OLIRD 5.6.2.2)**
  - **Pixel-to-Pixel Uniformity (OLIRD 5.6.2.3)**
    - Across Field of View - 0.25% (1 σ) (overall uniformity)
    - In an area covering any 100 contiguous pixel columns
      - <0.5% RMS deviation from FOV average (banding)
      - <0.25% (1 σ) internal variation (step control)
    - Adjacent Pixel Columns (streaking) - < 0.5%
  - **Saturation Radiances (OLIRD 5.6.3)**
    - Top-of-Atmosphere 100% diffuse reflector at 23° Solar Zenith Angle
  - **Radiometric Stability (scene average) (OLIRD 5.6.5)**
    - 0.5% (2 σ) over 60 seconds (after bias and temperature corrections)
    - 1% (2 σ) within 16 day cycle (after bias and temperature corrections)
    - 2% (2 σ) over mission (after radiometric correction)

Key Geometric & Spatial Performance Requirements

- **Geometric**
  - **Band Registration Accuracy – 4.5 meters LE90 (OLIRD 5.7.1)**
    - Near-simultaneous acquisition (within 2-3 seconds)
    - Depends on short-term stability and instrument LOS knowledge
    - Insensitive to absolute pointing and alignment
  - **Image Registration Accuracy – 12 meters LE90 (OLIRD 5.7.2)**
    - Multitemporal image registration without ground control
    - Mean pointing biases can be corrected
    - Depends on within-scene (~30 seconds) pointing knowledge and stability
  - **Geodetic Accuracy – 65 meters CE90 absolute (OLIRD 5.7.3.1)**
    - Without ground control, terrain effects excluded
    - Depends on absolute pointing knowledge and alignment stability over WRS cycle
  - **Geometric Accuracy (terrain corrected) – 12 meters CE90 (OLIRD 5.7.4)**
    - After correction with ground control and terrain data
    - Depends on within-scene pointing knowledge and stability
- **Spatial**
  - **Edge Slope – 0.0270 / meter (30-m bands), 0.0540 / meter (15-m band) (OLIRD 5.5.2.1)**
    - Driven mostly by instrument factors (e.g., detector IFOV, optics, integration time)
    - Also sensitive to jitter and attitude rate errors (if large enough)

Geometric & Spatial Accuracy / Stability versus Time Scale

- The accuracy / stability spatial scale correlates with the time scale over which the geometric/spatial requirements apply

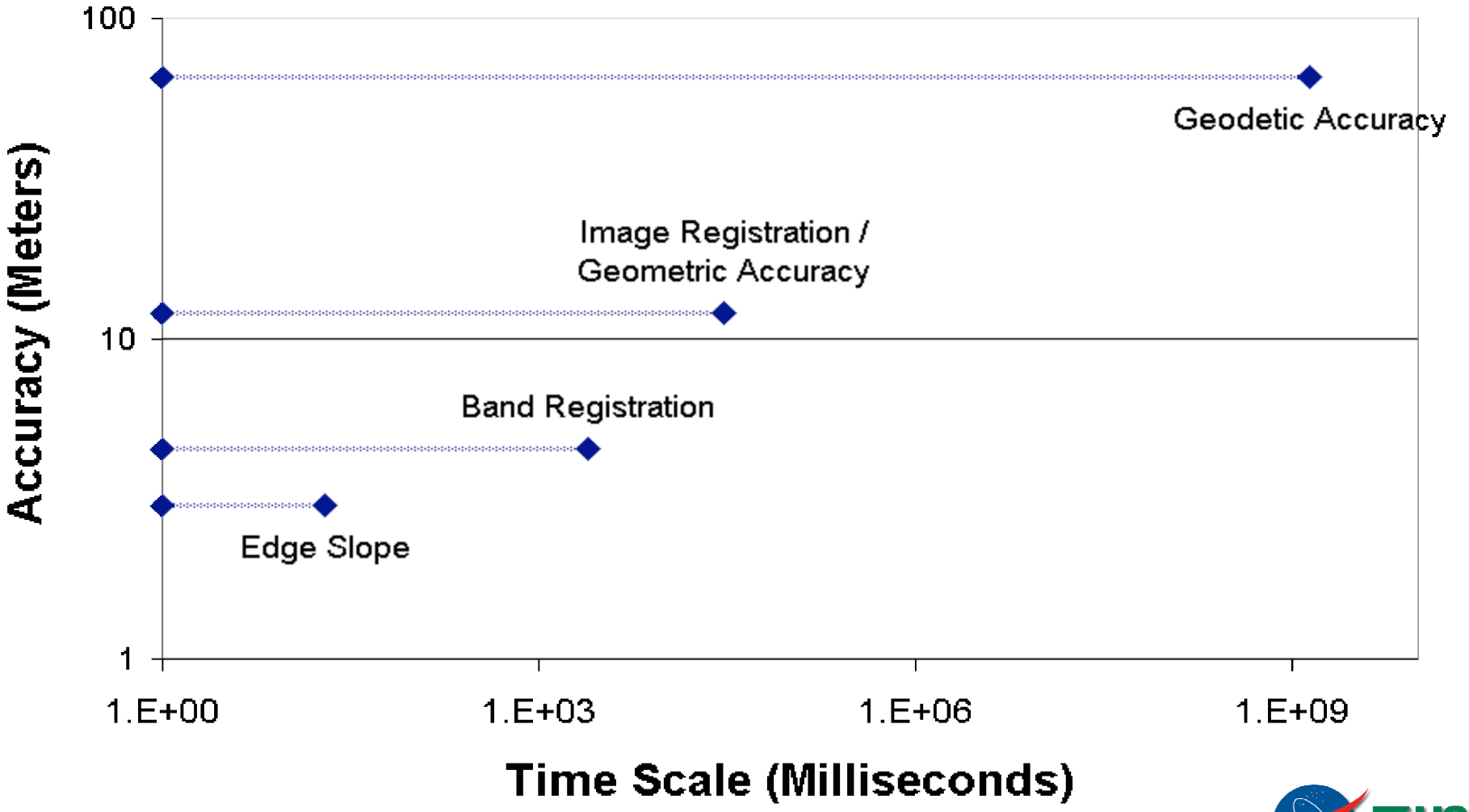


Image Data Handling Overview

- The Instrument Solid State Recorder (I-SSR) will be procured as part of the RSDO spacecraft bus procurement
  - The I-SSR component may ultimately be combined with the spacecraft SSR
- To limit impacts to the I-SSR and X-band downlink subsystems we have constrained the data rate at OLI to I-SSR interface
  - The intent is to specify data rates consistent with 30m GSD data (15m PAN) uncompressed, unpacketized image data
  - The SSR size to be specified is dependent on OLI data volume per scene
  - The spacecraft bus will have to fit service of LGN and up to three simultaneous ICs within a 375 MHz bandwidth (8025 - 8400 MHz)
- Data formats at these interfaces are generally TBD or TBR
- (Lossless) Image data compression is not required, but is permitted, within the OLI instrument; however, the output data rates must fit in the (TBR) constraint in any case
  - (Lossless) data compression may be possible within the I-SSR

Draft Requirements Errata

- **The following errata will be corrected in the final RFP:**
- **OLI-RD**
  - **11.1 Delete last requirement in section [The OLI shall output data that accommodates… (CFDP)]**
  - **11.3 Delete first two requirements that refer to CCSDS packetization**
- **Obs-IRD**
  - **Figure 3.3-1 should be replaced with the OLI context diagram slide 2 of this package**
  - **3.3.1.9.1.1 requirement for TAI time should be replaced with UTC time**

Operations Concept Overview

Vicki Zanoni
NASA Ground Systems Mgr.

LDCM Operations Concept

Launch Segment

Space Segment

Spacecraft — Imaging Sensor(s)

LDCM Observatory

X-Band (real-time and playback)

S-Band

S-Band

S-Band

X-Band (real-time only)

S-Band

LGS Sioux Falls, SD

Fairbanks, AK (TBC)

LDCM Ground Network (LGN)
- X-band data capture
- S-band data capture
- S-band uplink

International Cooperators

WSC/NCC

Flight Operations Segment

Mission Operations Element (MOE)
- Planning and scheduling
- Command and control
- Trending and Analysis
- Flight Dynamics

T&C

mission data

schedules

T&C

T&C

- SGS
- WGS
- MGS
- AGS

NASA Ground Network
- S-band data capture)
- S-Band uplink

Collection activity requests

schedules

acquisition coordination

Collection Activity Planning Element
- Image collection planning

Archive holdings status

Priority requests

Data Processing and Archive Segment

Storage and Archive Element
- Pre-processing
- Data archive

cal requests

Special requests

Image Processing Element
- Metadata and browse generation
- Image Assessment
- Data Product Generation

metadata and browse, Data products

Archived data

Archived data

Cal/Val Team

User Portal Element
- Data distribution
- Billing and accounting
- User services

product

User interact

Operations Flow (1 of 6)

- **Collection Activity Planning Element (CAPE)**
  - **Compiles and de-conflicts requests for image data**
    - Science requests to support the Global Mission Acquisition Plan (GMAP)
    - IC requests
    - Cal/Val requests
    - Special requests
  - **Denotes priority and protected scenes**
  - **Generates a 72-hour path/row-based scene list, optimized for GMAP and cloud cover predications**
  - **Sends scene list every 24 hours to the MOE**

Operations Flow (2 of 6)

- **Mission Operations Element (MOE)**
  - **Converts CAPE scene requests to imaging intervals**
  - **Plans and schedules observatory activities, including**
    - Imaging intervals
    - Maneuvers
    - Non-Earth imaging (lunar, solar) calibration events
    - Observatory maintenance
    - Ground station contacts, including scheduling of priority data downlinks
    - Performs observatory recorder management
  - **Provide schedule feedback CAPE, DPAS, LGN; and observatory constraints to CAPE**
  - **Receives and uploads flight software updates**
  - **Generates and encrypts all commands**
  - **Sends commands to LDCM Ground Network**
    - 72-hour command load sent every 24 hours
    - New command load supersedes and “retires” current command load

- **LDCM Ground Network**
  - **Transmits S-band communications to Observatory**

Operations Flow (3 of 6)

- **Observatory Mission Data Collections**
  - **Nadir image collection (day or night passes)**
    - Collects nadir image data
  - **Off-nadir image collection (day or night passes)**
    - Executes maneuver to off-nadir position
    - Collects off-nadir image data
    - Executes maneuver to nadir-look position
  - **Lunar calibration (~once per 28 days)**
    - Executes maneuver to moon-look position
    - Images moon, re-maneuver
    - Images moon, re-maneuver, etc.
    - Executes maneuver to nadir-look position
  - **Stores all image and calibration data**
  - **Generate and store housekeeping telemetry data**

Operations Flow (4 of 6)

- **Observatory Data Handling and Transmission**
  - **LDCM Ground Network Contact (daytime passes)**
    - Receive S-band communications
    - Transmit real-time housekeeping telemetry
    - Store real-time housekeeping telemetry
    - Transmit (playback) stored housekeeping telemetry

    AND

    - Transmit real-time mission data
    - Store real-time mission data
    - Transmit one unique (playback) stored mission data stream

    OR

    - Store real-time mission data
    - Transmit up to two unique (playback) stored mission data streams

Operations Flow (5 of 6)

- **Observatory Data Handling and Transmission (cont'd.)**
  - **LDCM Ground Network contact (night time passes)**
    - Receive S-band communications
    - Transmit real-time housekeeping telemetry
    - Store real-time housekeeping telemetry
    - Transmit (playback) stored housekeeping telemetry
    - Transmit up to two unique (playback) stored mission data streams
  - **International Cooperator Contacts (daytime passes)**
    - Store real time housekeeping telemetry
    - Transmits real-time mission data
    - Store real-time mission data
  - **Concurrent LGN and IC ground station contacts**
    - Transmit real-time mission data to an IC station
    - Store real-time mission data

    AND
    - Transmit real-time mission data to the LGN station
    - Transmit one unique (playback) stored mission data stream to the LGN station

    OR
    - Transmit up to two unique (playback) stored mission data streams to the LGN station

Operations Flow (6 of 6)

- **LDCM Ground Network**
  - **Monitors X-band (mission data, stored Observatory HK, etc.) file receipt**
  - **Forwards received X-band file status to MOE in near-real time**
  - **Forwards all housekeeping telemetry to MOE**
  - **Forwards all mission data to DPAS**
- **MOE**
  - **Commands un-protection of successfully received data files**
  - **Monitors housekeeping telemetry**
  - **Performs trending**
  - **Sends processed telemetry data sets to DPAS**
- **Data Processing and Archive Segment (DPAS)**
  - **Archives mission data and telemetry files**
  - **Generates browse imagery and metadata**
  - **Characterizes image data and generates/updates calibration parameters**
  - **Performs image processing**
    - Produces standard products as WRS-2 scenes
  - **Interfaces to Users for search, order, and product distribution**

OLI RFP Overview

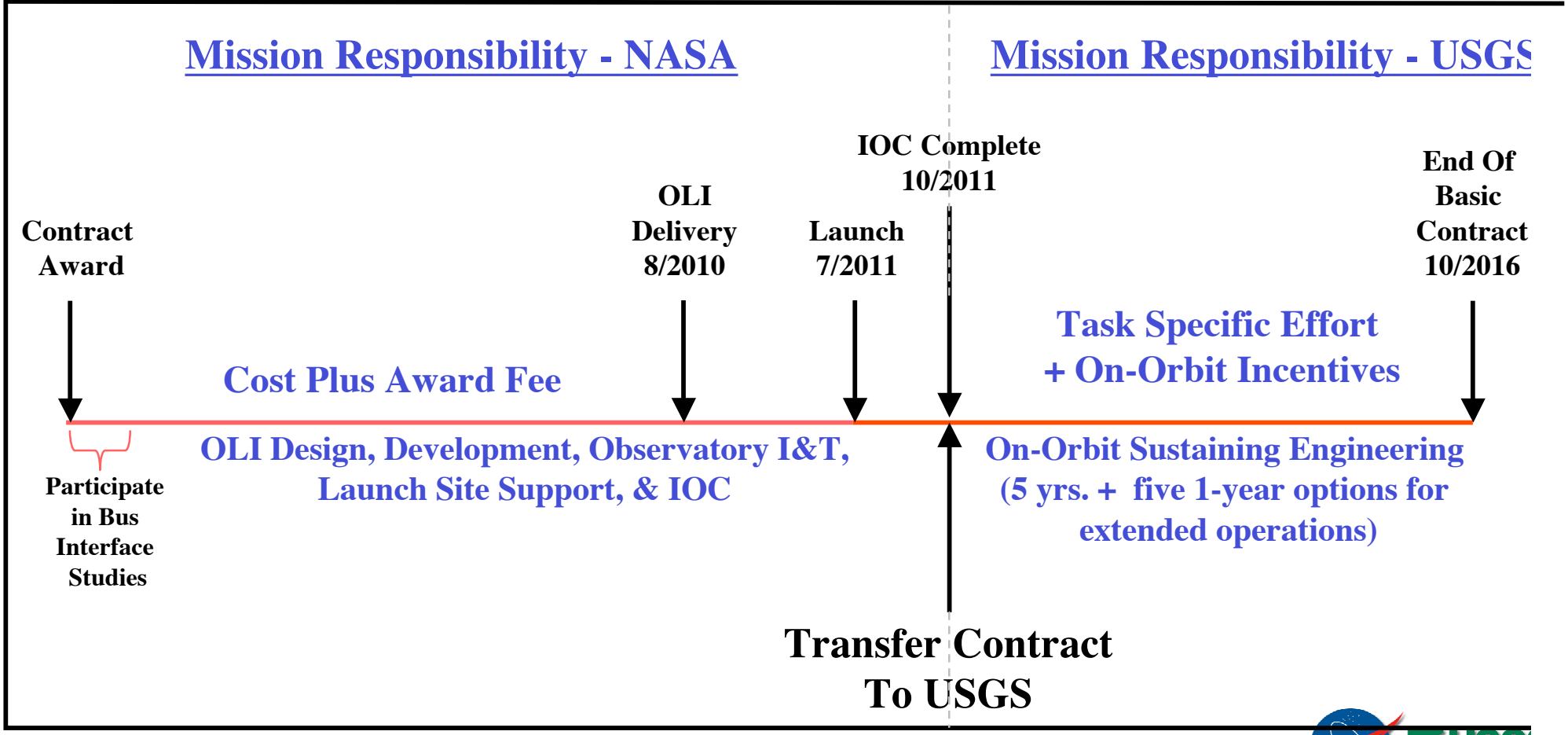
Jeanine Murphy-Morris
OLI Instrument Manager

Del Jenstrom
LDCM Deputy Project Manager

OLI Contract Overview

OLI Contract

Instrument, Observatory I&T/Launch Site Support, & On-Orbit Sustaining Engineering



RFP Documentation

- Contract
  - Sections L & M
  - Attachment O: OLI Key Performance Requirements
- Statement of Work
- Contract Data Requirements List
- Mission Assurance Requirements
- LDCM Surveillance Plan
- OLI Performance Evaluation Plan
- OLI Requirements Document
- Observatory Interface Requirements Document
- LDCM Environmental Verification Requirements
- Special Calibration Test Requirements
- Acronym List & Lexicon

RFP Documentation

Contract

- **Cost Plus Award Fee**
- **Incentive Fee for on-orbit performance**
- **OLI design, build, integrate, test, deliver to spacecraft, support for observatory I&T, launch support, post-launch test and support, and sustaining engineering**
  - 39 month OLI delivery from contract award
  - 11 months Observatory I&T & Launch Site Support
  - Nominal 90-day on-orbit observatory checkout
  - 5 years on-orbit sustaining engineering and performance incentives after checkout
  - Five 1-year options to extend sustaining engineering
- **Deliverables**
  - 1 OLI Instrument
  - 1 OLI Engineering Development Unit (EDU)
  - 1 OLI Simulator
  - 1 OLI interface simulator
  - 1 OLI Software Development and Verification Facility
  - Other stuff (see Model Contract B.1)

Contract Sections L and M

Section L Preparation Instructions

- **30 days preparation time**

Item	Page Limit
Offer Volume	None
Mission Suitability Volume	100
Cost Volume	
Basis of Estimate	2 pages per BOE
Past Performance Volume	30

Contract Sections L and M (cont.)

Mission Suitability subfactors and weighting:

	Points
Subfactor A—Instrument Design Concept	400
Subfactor B—Instrument Testing and Calibration Planning	250
Subfactor C—Management, Systems Engineering, Performance Assurance	250
Subfactor D—Safety and Health Plan	50
Subfactor E---Small Disadvantaged Business (SDB) Participation Program	50
Total	1000

Adjustment for Cost Realism, up to 150 points

Attachment O: OLI Key Performance Requirements

- **Criteria used for evaluating on-orbit performance incentives during the 5-year operational lifetime of OLI**
- **Identifies 15 negative incentive and 6 positive incentive criteria**
  - OLI must meet the Standard Performance Level to be eligible for positive incentives
- **OLI performance will be evaluated against the Contractor's "lifetime-scaled" Instrument Design Specification**
  - Contractor's Instrument Design Specification must provide baseline OLI requirements scaled from BOL through EOL (5 years)

Statement Of Work

1. **Management**
2. **Systems Engineering**
   - Includes Special Studies
3. **Mission Assurance**
   - See the MAR
4. **LDCM Instrument Development**
   - 4.1 Design Engineering
     - 4.1.1 Focal Plane Assembly Design
     - 4.1.2 Telescope and Optics Design
     - 4.1.3 Instrument Electronics Design
     - 4.1.4 Instrument Structure Design
     - 4.1.5 Mechanisms Design
     - 4.1.6 Calibration System Design
     - 4.1.7 Flight Software Design
     - 4.1.8 Harnessing Design
     - 4.1.9 Electrical System Design
     - 4.1.10 Thermal System Design
     - 4.1.11 Contamination Control Design
     - 4.1.12 Instrument Integration and Test Planning
     - 4.1.13 Instrument Simulators Design
     - 4.1.14 Engineering Development Unit Design
     - 4.1.15 Data Processing Algorithms Design
   - 4.2 Fabrication, Assembly, and Test
   - …
   - 4.3 Instrument Operations Support
   - 4.4 Packaging, Handling, Storage, and Transportation
   - 4.5 Delivery, Checkout, and Acceptance
   - 4.6 Ground Support Equipment
   - 4.7 Spares
5. **Post Delivery Support**
   - 5.1 Observatory I&T
   - 5.2 Mission Interface Testing & Rehearsals
   - 5.3 Launch & Early Orbit Support
   - 5.4 Commissioning
6. **Engineering Support**
7. **Optional Extended Support**

Contract Data Requirements List

	Number
• Program Management (PM)	13
• Reviews (RE)	9
• Flight Software (SW)	8
• Integration and Test (IT)	6
• Calibration/Validation (CV)	9
• System Engineering (SE)	33
• Systems Assurance (SA)	26
• On-Orbit Operations (OO)	12
	116

- **Special Calibration Test Requirements**

  - **Details certain requirements for calibration tests and characterizations of instrument spectral, radiometric, and geometric performance which need to be performed in addition to those required to show compliance with the OLI-RD.**

  - **Based on lessons learned and experience from previous Landsat missions and EO-1 Advanced Land Imager (ALI)**

  - **Includes pre-launch and post-launch test and characterization requirements**

RFP Documentation

- **Mission Assurance Requirements**
  - **Overall Mission Assurance Requirements**
  - **Quality Assurance**
  - **Safety**
  - **Reliability**
  - **Software Assurance**
  - **Risk Management Requirements**
  - **Integrated Independent Review Requirements**
  - **Design Verification Requirements**
    - References the LDCM Environmental Verification Requirements (LEVR)
  - **Workmanship Standards**
  - **Materials and Processes Requirements**
  - **Parts Requirements**
  - **Contamination Control Requirements**
  - **Electrostatic Discharge Control**
  - **GIDEP Alerts and Problem Advisories**

All MAR documentation requirements are listed in the CDRL