



# Landsat Data Gap Readiness Plan

**Briefing to Landsat Science Team  
Rochester, New York**

**June 22, 2009**

**U.S. Department of the Interior  
U.S. Geological Survey**

# Agenda

- Review of January 2009 discussion
- Where are we at today?
- Group Discussion

# LDGST - Recommendations

- The Landsat Program is unique
  - Single source of systematic, global land observations
- Data quality of potential candidate systems is unverified, however, based on preliminary analysis
  - India's **ResourceSat** and **CBERS** are the leading candidates for reducing the impact of a Landsat data gap
- Develop systematic approach to new mission/data evaluations
  - Assess expected mission capabilities (pre-launch)
  - Validate mission, data and science utility (post launch)
  - Perform initial and ongoing cross-calibration sensor testing
  - **Establish contracts and agreements for data acquisition**
  - **Develop infrastructure to receive, manage and distribute data**

# Baseline Data Specifications

Performance Parameter	Performance Goal: LDCM Specification	Acceptable Specification*
<b>Radiometry</b>	<5% error at-sensor radiance	<15% error at-sensor radiance
<b>Spatial Resolution</b>	30m GSD VNIR-SWIR; 15m	100m GSD
<b>Geographic Registration</b>	<65m circular error	<65m circular error
<b>Band-band registration</b>	uncertainty <4.5m (0.15 pixel)	uncertainty <0.15 pixel
<b>Spectral Bandpass (nm)</b>	Blue 433-453	
	Blue 450-515	
	Green 525-600	
	Red 630-680	✓
	NIR 845-885	✓
	SWIR 1560-1660	✓
	SWIR 2100-2300	
	SWIR 1360-1390	
	Pan 500-680	
<b>Global Coverage</b>	Seasonal (4X annually), substantially cloud-free global acquisition Includes U.S. acquisition every 16 days	Global, substantially cloud-free acquisitions twice per year (2 seasons annually)

# USGS Landsat Data Gap Readiness Plan

## Goal

- Define a set of options and capabilities to acquire Landsat-like data from candidate data sources in order to mitigate a potential gap in global Landsat data collection in the event of the loss of Landsat 5 and/or Landsat 7.
  - Augments the future holdings of the NSLRSDA, in accordance with the Land Remote Sensing (LRS) Policy Act of 1992, Public Law 102-555.

## Objectives

- Identify external cost and data licensing provisions – get specific terms and conditions
- Identify data access and archiving implications (cost/schedule) for integrating new data gap missions into the USGS operational infrastructure

# Potential Data Gap Systems

- While there is no exact substitute for Landsat data, the following systems have been identified as existing viable sources to mitigate a potential data gap.
  - **SPOT 4 and SPOT-5 sensors,**
  - **Resourcesat-1 (IRS-P6) AWIFS sensor**
  - **China-Brazil Earth Resources Satellite-2B (CBERS 2-B)**
  - **RapidEye Imaging sensor (limited information as of May 2009)**
  - **UK-DMC – 2 (more information pending launch summer 2009)**
- AWiFS, CBERS2-B, and SPOT have significant CAL/VAL data
- RapidEye CAL/VAL in-work and UK-DMC-2 pending launch

# Potential Data Gap Systems

- **SPOT-5 and SPOT-4 (includes SWIR)**
  - Launched May 4, 2002 (SPOT 5)
  - Four spectral bands, similar to Landsat bands 2 through 5
  - 10 meter spatial resolution (multispectral)
  - 2 x 60 km ground swath
  - 26 day repeat (at nadir), 3-5 day off-nadir or better
- **Resourcesat-1 AWiFS sensor (includes SWIR)**
  - Launched October 17, 2003
  - Four spectral bands, similar to Landsat bands 2 through 5
  - 56 meter spatial resolution
  - 740 km ground swath
  - 5 day repeat
  - ResourceSat-2 to launch 3<sup>rd</sup> Quarter 2009

# Potential Data Gap Systems (cont.)

- China-Brazil Earth Resources Satellite-2B (CBERS 2-B) CCD sensor (no SWIR)
  - Launched September 19, 2007
  - Four spectral bands, similar to Landsat bands 1 through 4
  - 20 meter spatial resolution
  - 113 km ground swath
  - 26 day repeat
- RapidEye Imaging sensor (no SWIR)
  - Five-satellite constellation launched August, 2008
  - Operational Status – March 2009
  - Five spectral bands, similar to Landsat bands 1 through 4
  - 6.5 meter spatial resolution
  - 77 km ground swath
  - 5.5 day repeat (at nadir)

# Potential Data Gap Systems (cont.)

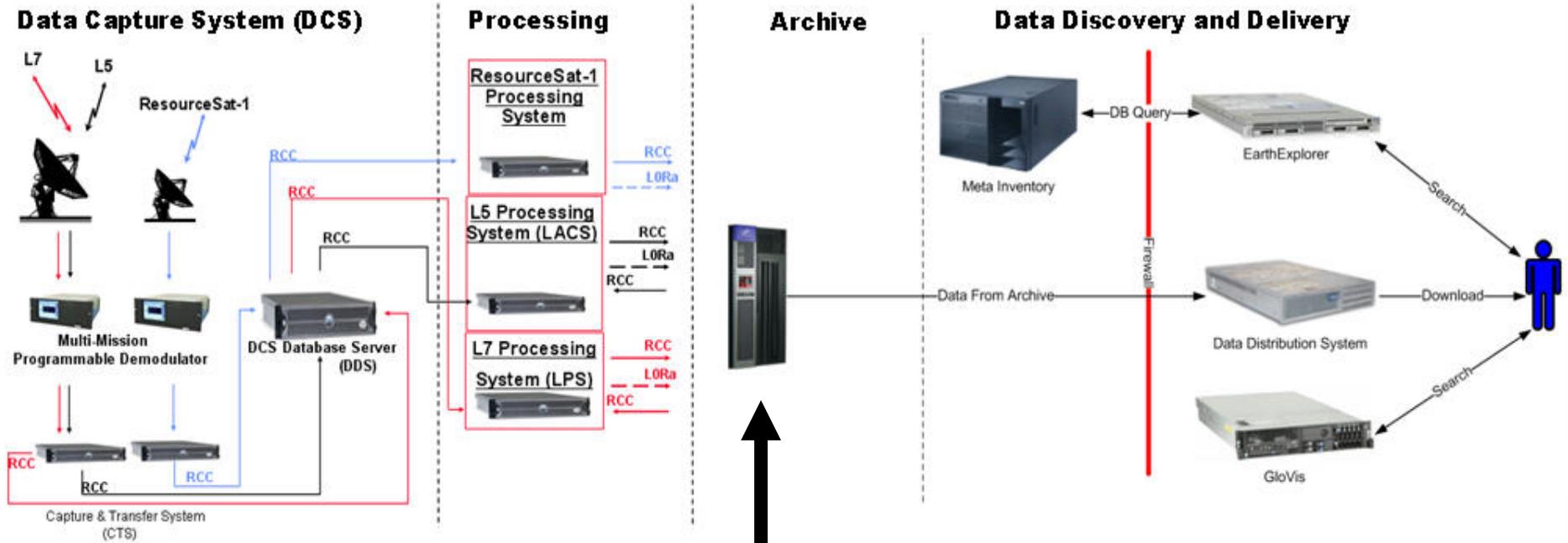
- UK-DMC-2 (no SWIR)
  - Scheduled for launch in summer 2009
  - Three spectral bands, similar to Landsat bands 2 through 4
  - 22 meter spatial resolution
  - X-Band downlink capability
  - 660 km ground swath
  - 3 day revisit

# Discussion with Data Providers - Overview

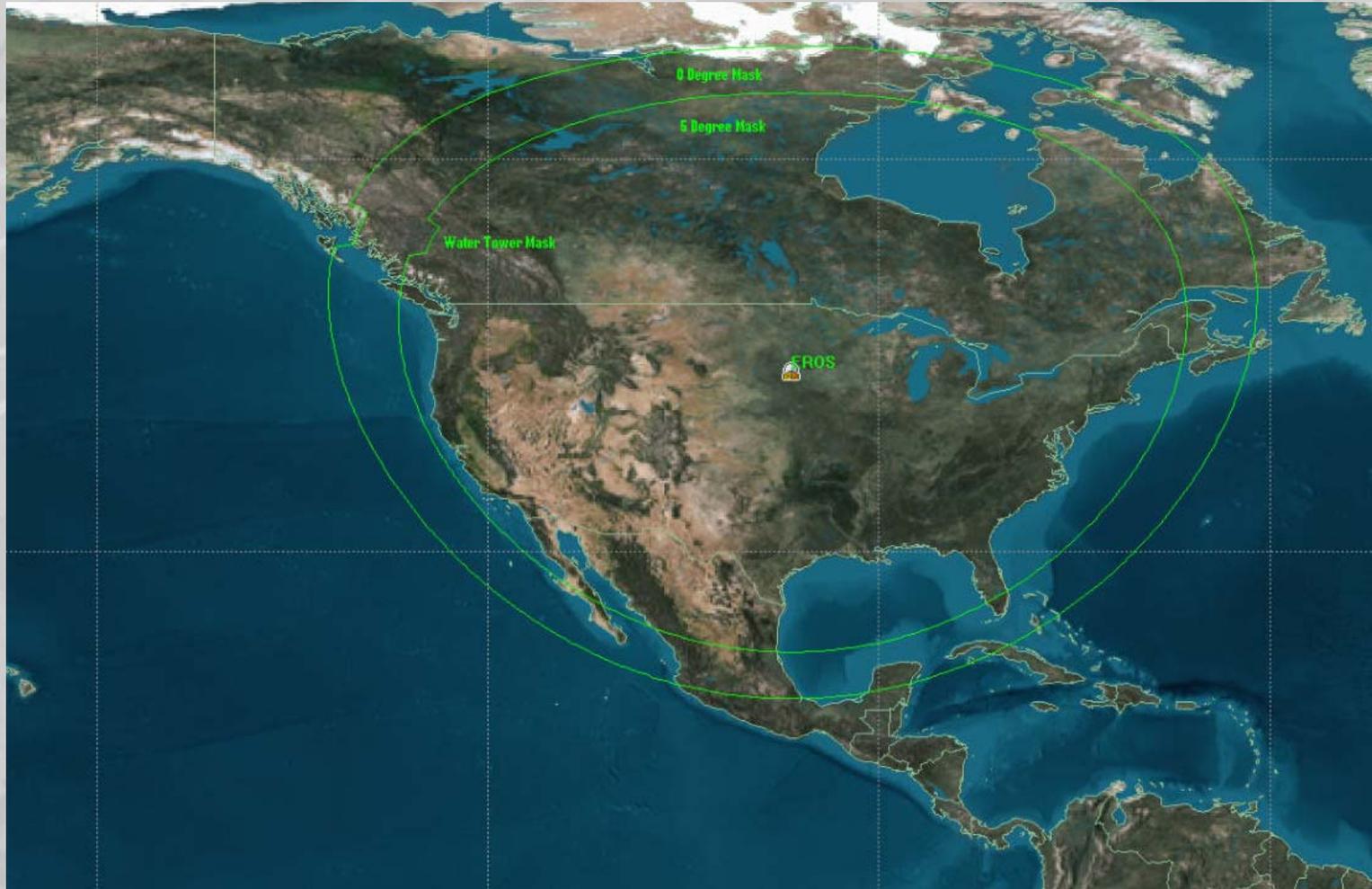
Sensor / Source	SICORP	EROS	Total	Comments
SPOT4/5				<b>Year 1-2:</b> Virtual reception; SPOT does all the work; Fed/Civ, State/Local. All the data we can drink. U.S. only
SPOT4/5				<b>Year 3-5:</b> Direct reception at EROS; EROS does all the work; Fed/Civ, State/Local. All the data we can acq. Includes TS-5 (SPOT-On) U.S. only
Sensor / Source	EOTec	EROS	Total	Comments
AWiFS				<b>Year 1:</b> Direct reception at EROS: EROS does all the work; Fed/Civ, State/Local. AWiFS and LISS-3. U.S. only
AWiFS				<b>Year 2:</b> Global Options to be discussed
Sensor / Source	Brazil	EROS	Total	Comments
CBERS2B/3				<b>Year 1+x:</b> Direct reception at EROS: EROS does all the work; Public Domain. All the data we can acq. U.S. only – Global Options ?
Sensor / Source	RapidEye	EROS	Total	Comments
RapidEye				<b>Year 1+x:</b> Virtual reception at RapidEye; Data transferred to EROS; Fed/Civ, State/Local. Global dataset using 5 satellite constellation (operational?)
Sensor / Source	DMCii	EROS	Total	Comments
DMC-2				<b>Year 1+x:</b> Virtual reception at DMC; Data transferred to EROS; Fed/Civ, State/Local. Global dataset

# Integration into EROS Architecture

- Data Acquired via EROS Antennas, Multi-Mission Programmable Demodulator and EROS Data Capture System (DCS)
- Processor Generates Archive File, L1 Product, Metadata and Browse
- Metadata and Browse Ingested into Inventory Databases
- Access – Earth Explorer and GloVis



# EROS Ground Station Acquisition Circles



# Acquisition Conflicts over 64 days

- 64 days = 4 Landsat cycles
- Assumes 20 minute time to transition antenna between satellites
- Conflict significantly reduced with added 3rd antenna
- Acquisition conflicts for DMC-2 will be analyzed post launch

		Satellite			Potential Data Loss		
Landsat 5	Landsat 7	SPOT-4 SPOT-5	AWiFS	CBERS-2B	With 1 Antenna	With 2 Antennas	With 3 Antennas
✓					0:00:00 0%	0:00:00 0%	0:00:00 0%
✓		✓			67:25:13 52%	6:10:46 5%	0:00:00 0%
✓			✓		66:56:37 52%	11:07:10 9%	0:00:00 0%
✓		✓	✓		107:48:38 65%	30:25:27 18%	2:30:46 2%
		✓			9:19:29 13%	0:00:00 0%	0:00:00 0%
			✓		0:00:00 0%	0:00:00 0%	0:00:00 0%
				✓	0:00:00 0%	0:00:00 0%	0:00:00 0%
✓				✓	29:53:04 32%	0:00:00 0%	0:00:00 0%
✓		✓		✓	105:48:23 65%	29:51:23 18%	1:58:33 1%
✓			✓	✓	66:56:37 52%	11:07:10 9%	0:00:00 0%
✓		✓	✓	✓	146:42:47 74%	63:13:57 32%	11:18:17 6%
		✓	✓		41:40:01 39%	3:47:55 4%	0:00:00 0%
		✓		✓	40:19:27 39%	3:09:18 3%	0:00:00 0%
			✓	✓	17:10:18 25%	0:00:00 0%	0:00:00 0%
		✓	✓	✓	77:15:56 56%	18:19:52 13%	1:11:42 1%
<b>RapidEye, All 5 Satellites</b>					249:17:06 93%	0:00:00 0%	0:00:00 0%



# Data Gap Readiness Plan Recommendations

- Preparations for EROS ground station automation and archive augmentation be undertaken as soon as possible, pending funding.
- Prior to the occurrence of a Data Gap, put Partnership agreements in place with recommended vendors to allow execution of data receipt when needed.
  - Pursue agreements in principle to allow for the rapid initiation of data, whether via direct or virtual reception.
  - SPOT – Investigate the possibility of adding a rider to the existing USGS contract to include virtual data reception capabilities – an option that can be exercised at anytime.

# Data Gap Readiness Plan Recommendations

- Continue to investigate Global coverage options: Pursue global data partnerships, as recommended by the LDGST and the Landsat Science Team.
  - Further investigate a detailed SPOT proposal for global virtual reception.
  - Continue to investigate and document the global capabilities and qualities of RapidEye, UK-DMC-2, AWiFS, and CBERS.
- Landsat Science Team to be asked about potentially reducing the LDGST minimum requirements, i.e., SWIR specification and 2X global. **(completed)**
- Using the cost estimates provided in the Landsat Data Gap Readiness Plan, prepare a draft budget initiative for 2011. **(completed)**

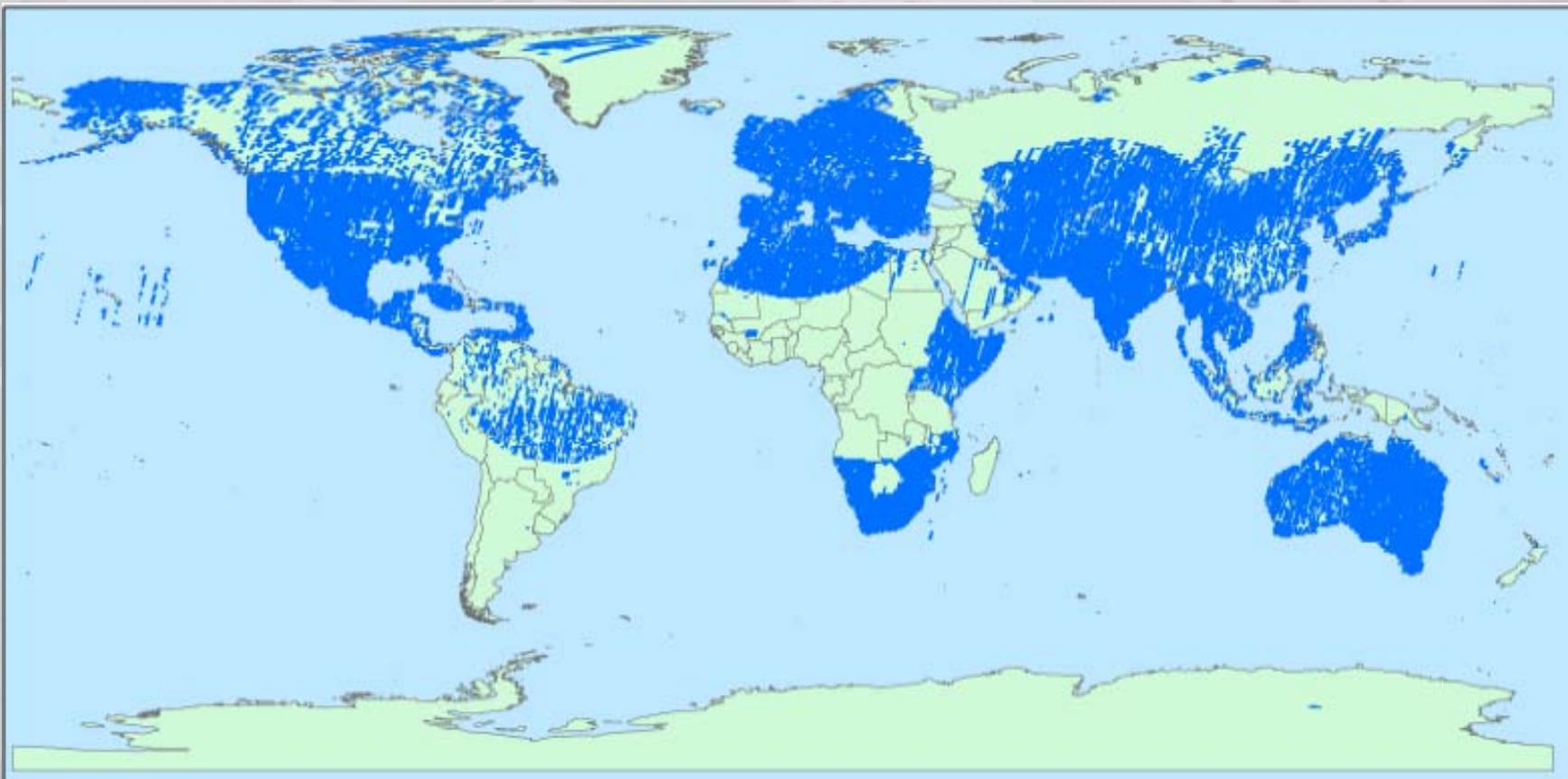
# Data Gap Readiness Plan Discussions with LST Data Gap Sub-group - conclusions

- Consider missions that do not meet the LDGST specifications (e.g., RapidEye, CBERS, etc.), i.e. no SWIR
- **Global coverage the most important issue**, and one clear pixel for the entire global land area is the top priority. After that, options should be prioritized according to how to best meet the LDGST specs (in areas where there are multiple choices), and then go with the best available for everywhere else.

# Discussion



# SPOT-4 2008 Collection: < 10% Clouds



# SPOT-5 2008 Collection: < 10% Clouds

