

# The National Land Imaging Program

Ensuring Landsat Operational Data Continuity in the 21<sup>st</sup> Century

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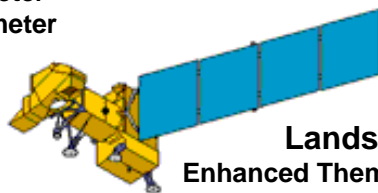
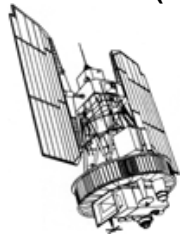
# What is Landsat?

The World's Most Sophisticated Optical Observatories of the Earth

The World's Model for International Collaboration in Earth Observation

## Landsat 1 - 3

Multi-Spectral Scanner (MSS) 79 meter  
Return Beam Vidicon (RBV) 80/40 meter

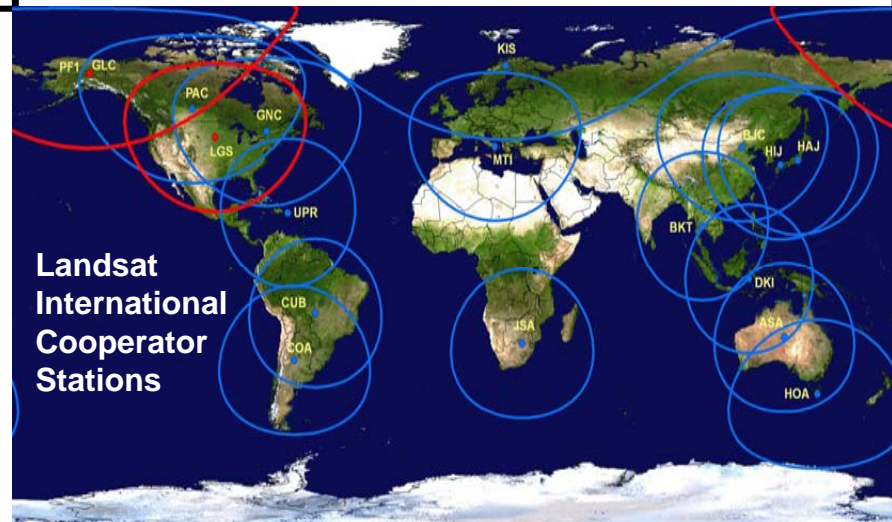


Landsat 7  
Enhanced Thematic Mapper  
Plus (ETM+) 30/15 meter



## Landsat 4 - 5

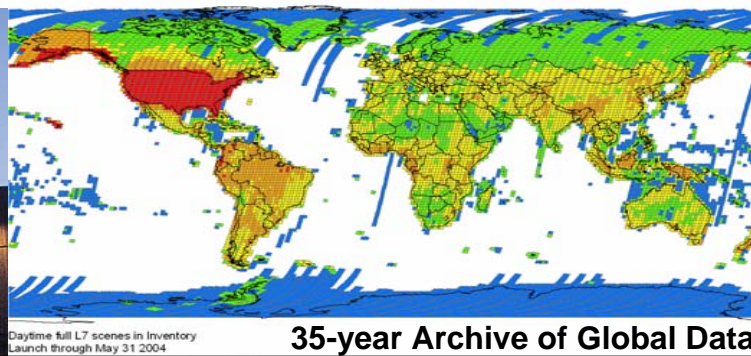
Multi-Spectral Scanner (MSS) 79 meter  
Thematic Mapper (TM) 30 meter



Landsat  
International  
Cooperator  
Stations

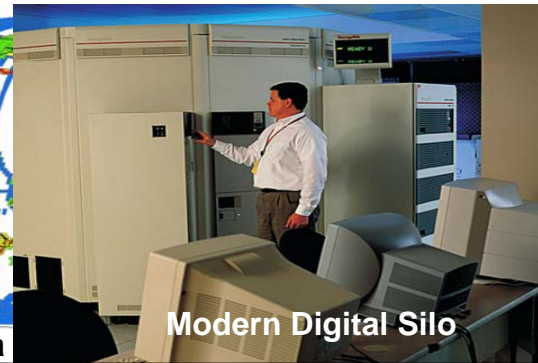


EROS Center  
Sioux Falls, SD



Daytime full L7 scenes in Inventory  
Launch through May 31 2004

35-year Archive of Global Data




Modern Digital Silo

The World's Center of Expertise in Optical Imaging and Land Science

# What is Landsat?

- A record of the changes on the Earth's surface from man-made and natural processes covering over 3 decades.
- Only mission that routinely collects moderate-resolution satellite images of the global land surface:
  - at a scale where human vs. natural causes of change can be differentiated, and
  - on a seasonal basis.
- A program consisting of satellites, computers, networks and data that supports a U.S. and international science and operational user community.
- There is no other satellite program capable/committed to providing global land surface coverage at this scale; not even on an annual basis.

# What is the Status of Landsats 5 and 7



## ■ Landsat 5

- Launched in 1984; now over 23 years old (3-year design life)
- Providing ground station reception-area coverage for U.S. and its International Cooperators
- Operating on several backup subsystem components
- Items of concern: Transmitters, Solar Arrays, Batteries...
- End-of-Life: Projected to be 2012 when fuel is depleted

## ■ Landsat 7

- Launched in 1999; suffered key sensor degradation in 2003
- Providing routine global coverage for U.S. archive
- Each scene retains 75% of high-quality data
- Scenes are still good for some uses “as is” with 25% missing along edges
- Scenes filled in by ground system processing can also be useful
- Items of concern: Gyroscopes
- End-of-Life: Projected to be 2012 when fuel is depleted



# What's the Status of Landsat Continuity?

- **What's next?** Landsat Data Continuity Mission (LDCM or Landsat 8) is being developed with a launch projected for 2011. No backup is available if there is a launch or on-orbit failure.
- **What comes after Landsat 8?** Nothing is being planned.
- **Who's responsible?** No Federal agency has responsibility for land remote sensing.
- **What must be done?** Establish a National Land Imaging Program, led by the DOI, responsible for civilian land remote sensing.

# Policy History of Landsat



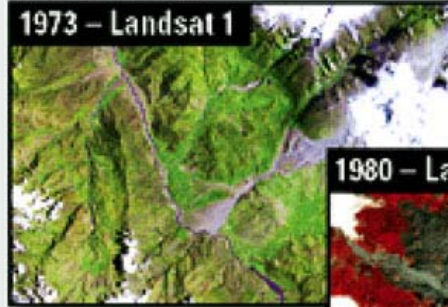
- 1966** DOI proposes a mapping satellite for the United States
- 1972** NASA launches and USGS manages data operations for Landsat 1
- 1979** The U.S. decides to commercialize Landsat
- 1992** After several years of failed business operations, Congress enacts the Land Remote Sensing Policy Act
  - Ends Landsat commercialization
  - Authorizes NASA development of Landsat 7
- 1993** Landsat 6 fails on launch – 9 years after Landsat 5 launch
- 2003** NASA withdraws Landsat Public-Private Partnership
- 2004** The U.S. declares Landsat to be a National Asset worthy of being a sustained operational capability of the U.S.
- 2005** The U.S. decides to build Landsat 8 -- 12 years after Landsat 7 launch

Operational systems provide continuous capability for providing data -- by being highly reliable, maintainable, and readily available soon after failures.

# A History of Uncertainty

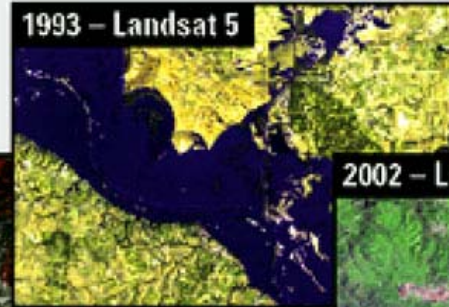
## Continuing Three Decades of Earth Imaging

Avalanche (Peru)

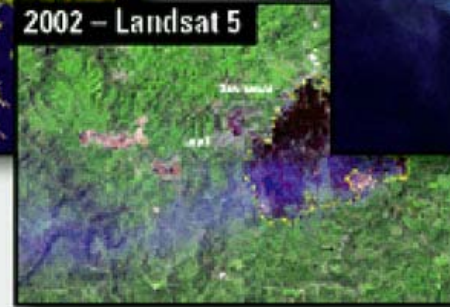


Landsat 1: 1972-1978  
 Landsat 2: 1975-1982  
 Landsat 3: 1978-1983  
 Landsat 4: 1982-1993

St. Louis Flood (Missouri)



Mount St. Helens (Washington)

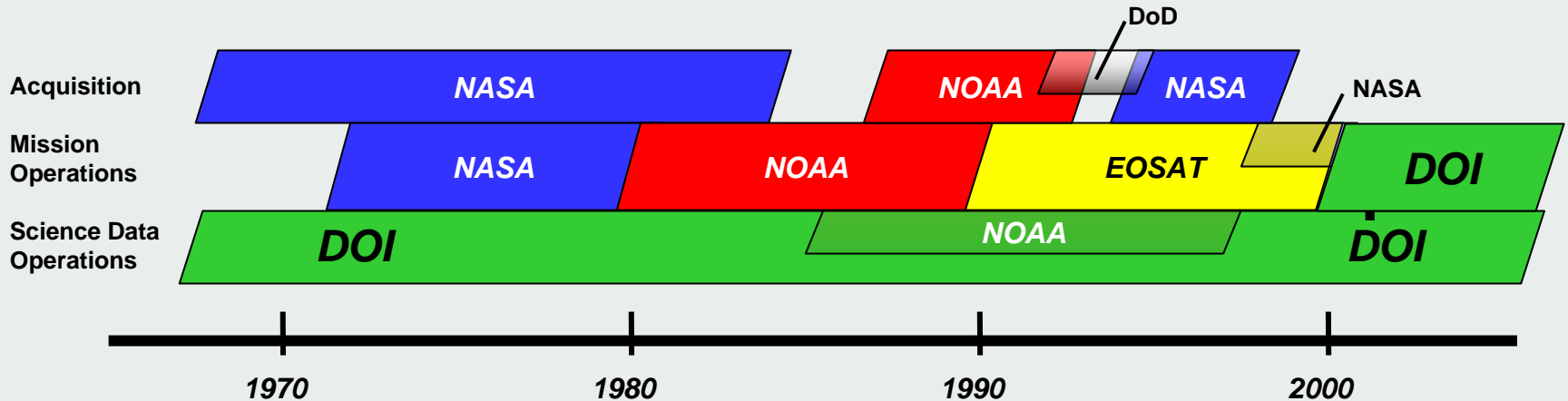


Grizzly Gulch Wild Fires (South Dakota)

Tsunami aftermath (Indonesia)



Landsat 5: 1984-  
 Landsat 6: 1993 - Launch failure  
 Landsat 7: 1999-



# What is the Problem?



- **No long-term U.S. commitment for providing Landsat-like data.**
  - Landsat has been a series of independent missions, funded in an ad hoc manner.
  - No U.S. agency has responsibility to meet U.S. operational requirements.
  - Advancement of land imaging technology and applications has been delayed or disrupted.
- **No U.S. commercial alternative.**
  - Landsat commercialization has failed twice.
- **No resources to sustain an operational land imaging program for the U.S.**
  - No funding for the program after Landsat 8.



# Why Make Landsat Operational?



- **Raise land imaging to status of other U.S. Government civil-operational satellite missions -- communications, weather forecasting, navigation and tracking (GPS).**
- **Ensure continuous, reliable flow of Landsat-like data; no data gaps.**
- **Enable efficiencies across Federal agencies (eliminates duplication of effort).**
- **Secure industry commitment to long-term investments in key technologies and advanced data applications.**
- **Maintain U.S. technological and scientific leadership in this key area of economic, security, environmental, and foreign policy.**
- **Demonstrate U.S. commitment to geopolitical stability, globalization, and sustainable development.**
- **Promote global democracy based on peaceful coexistence and scientific and technological advancement of all the world's nations.**

# OSTP Memoranda



- **In August 2004, OSTP modified Landsat Strategy**
  - Validated the importance of Landsat-type Imagery to U.S. economic, environmental, and national security interests
  - Directed Landsat to be a sustained operational program
  - Placed a Landsat-type instrument on the National Polar Operational Environmental Satellite System (NPOESS)
- **In December 2005, OSTP revised the Strategy**
  - Removed Landsat from NPOESS due to design complexities
  - Authorized procurement Landsat “free-flyer” satellite (LDCM)
  - Initiated a study to identify Future Needs and Options for U.S. Land Imaging through the Future of Land Imaging Interagency Working Group (FLI IWG)

# Call for a National Land Imaging Program (NLIP)



- **OSTP led study to identify future needs and options for U.S. Land Imaging through the Future of Land Imaging Interagency Working Group (FLI IWG).**
  - NASA, DOI/USGS, USDA, DOD, NGA, DOC, DOE, NOAA, DOS, DOT
- **The FLI IWG made the following recommendations:**
  - **Recommendation #1: The U.S. must commit to continue the collection of moderate-resolution land imagery.**
  - **Recommendation #2: The United States should establish and maintain a core operational capability to collect moderate-resolution land imagery through the procurement and launch of a series of U.S.-owned satellites.**
  - **Recommendation #3: The United States should establish the National Land Imaging Program, hosted and managed by the Department of the Interior, to meet U.S. civil land imaging needs.**
- **The Department of the Interior will require new resources to establish and maintain the U.S. civil land imaging program.**

# Are there Alternatives?

- Landsat is the only satellite capable of acquiring seasonal, cloud-free moderate-resolution global land data.
- Partial global coverage, less than seasonal, with fewer spectral bands, and without thermal data is obtained by French, Indian, and Brazilian/Chinese satellites.
- High-resolution U.S. commercial satellites do not meet Landsat Program requirements, primarily the inability to acquire even annual global coverage.



France operates 3 moderate-resolution satellites today, but none to follow. A moderate-resolution European satellite may be developed in the near term, but no plans are in place for post-2015 satellites.



India now operates a lower-resolution system without blue, mid- or thermal-infrared data or full global coverage.



China and Brazil fly a joint moderate-resolution satellite, with numerous shortcomings, that is currently not operating. New satellites are in development, but no plans are in place for post-2015 “Landsat” capability.

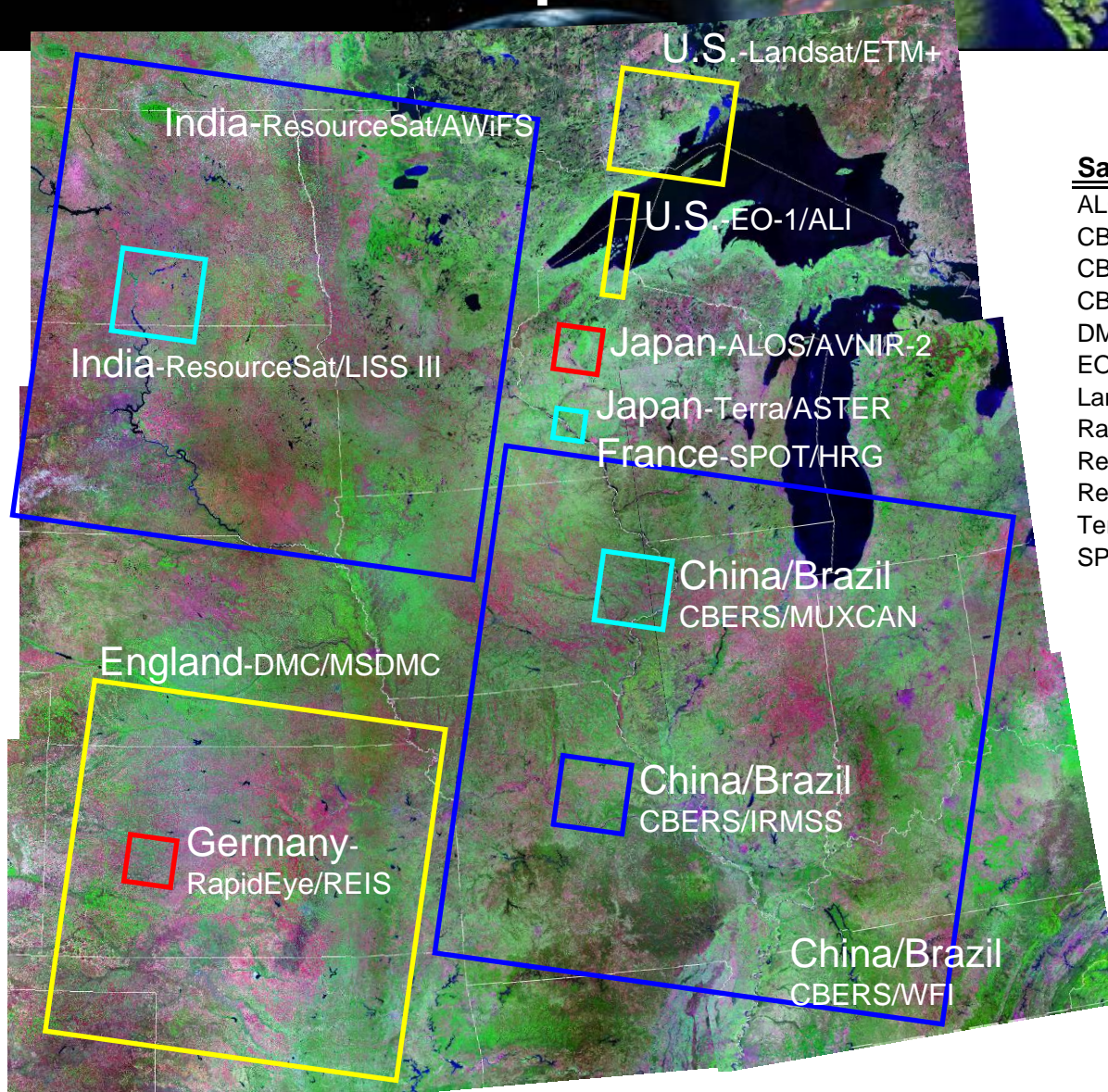


Many new U.S. commercial high-resolution satellites would be needed to provide routine global Landsat-like coverage.





# Alternative Comparisons



Satellite	Sensor	Ground sampling distance (m)	Swath width (km)
ALOS	AVNIR-2	10	70
CBERS-3,4	IRMSS	40/80	120
CBERS-3,4	MUXCAN	20	120
CBERS-3,4	WFI	73	866
DMC	MSDMC	32	600
EO-1	ALI	30	37
Landsat	ETM+	30	185
Rapideye	REIS	6.5	78
ResourceSat	LISS-III	23.5	141
ResourceSat	AWiFS	56	740
Terra	ASTER	15/30/90	60
SPOT	HRG	10/20	60

**Note: Scene size comparison only; not actual orbital paths or operational acquisitions. High-resolution scenes too small to illustrate here.**

# National Land Imaging Program

## Suppliers

Foreign Governments and Commercial Firms

U.S. Aerospace Manufacturers

U.S. Satellite & Aerial Operators



## U.S. National Land Imaging Program

## Users

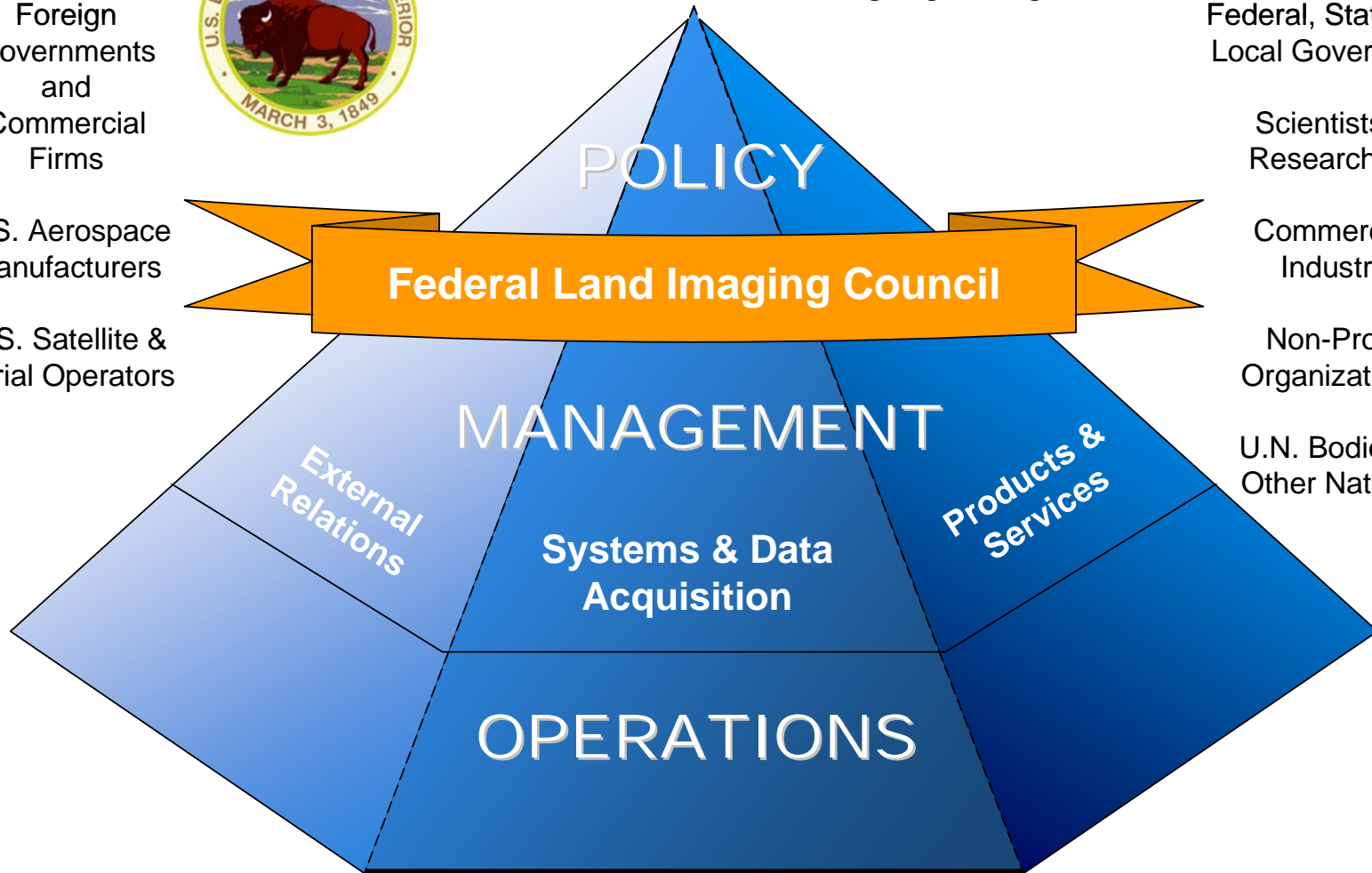
Federal, State, and Local Government

Scientists & Researchers

Commercial Industry

Non-Profit Organizations

U.N. Bodies & Other Nations



The Federal Land Imaging Council will provide guidance and recommendations.  
A Committee of non-Federal land imagery users and suppliers will advise the National Program.



# Summary



## **A National Land Imaging Program will:**

- **Benefit U.S. national security, economy, and environment.**
- **Be supported by Federal agencies, State, and local governments, academia, and U.S. industry.**
- **Provide economic benefits of over \$1 billion/year.**
- **Achieve land imaging program, technical, and financial stability at equal or less cost than the previous ad hoc approach.**
- **Meet the needs for moderate-resolution data that cannot be met by any other U.S. or foreign source.**