National Science and Technology Council
Office of Science and Technology Policy

PUBLIC WORKSHOP
ON
FUTURE LAND IMAGING FOR THE UNITED STATES

July 26, 2006
U.S. Department of the Interior
Main Auditorium
1849 C Street, NW
Washington, D.C.

MEETING SUMMARY

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Meeting Summary Prepared By:
Robert J. Katt, Consultant
INFONETIC

Executive Summary

A public workshop on the future of moderate resolution land imaging for the United States was held on the afternoon of July 26, 2006, in the main auditorium of the Department of the Interior headquarters in Washington, D.C. The workshop included two panel discussions—one of representatives from the Landsat user community, the other of representatives from the aerospace industry—and a comment session open to all who attended.

The Future of Land Imaging Interagency Working Group (FLI-IWG) sponsored the workshop as part of its fact-finding and needs assessment work in preparing a long-term plan for future moderate resolution, satellite-based land imaging capability after the Landsat Data Continuity Mission (LDCM), which is now in procurement. A December 2005 memorandum from the Director of the Office of Science and Technology Policy called for a study to identify future needs and options for U.S. land imaging and named the FLI-IWG, which reports to the National Science and Technology Council, to conduct the study. The workshop opened with a report on the Working Group's preliminary findings and its plans for preparing the long-term plan by February 2007.

The panel presenting views from the user community on Landsat data included two members representing private-sector end users of information derived from Landsat data, two commercial value-added resellers, two users from the nonprofit sector, and one representative of State and local public-sector entities. Kass Green, Vice President of the American Society for Photogrammetry and Remote Sensing (ASPRS) moderated the panel and presented preliminary findings from an ASPRS survey of users' views on future land imaging capabilities. The private sector end users described their reliance on Landsat data for legal expert witness testimony in Federal and State courts and for risk management in the insurance, finance, and health industries. Wildlife conservation and resource management is the focus of one of the nonprofit users; the second relies on Landsat data to determine the extent and consequences of deforestation in the Andes-Amazon basin. One of the value-added resellers primarily serves the Federal defense/intelligence and civil agency markets; the other uses Landsat data for commercial land cover mapping and analysis required by State and local entities and by commercial companies. Among State agencies with responsibilities for resource use or management, Landsat data consistently rank in their top five data needs. Preliminary ASPRS results show that 69 percent of the responders use Landsat data as their primary source of moderate resolution data.

The representatives of the U.S. aerospace industry on the second panel described their corporate capabilities in Earth-observing spacecraft and sensing instruments and their views on trends in future instrument capability and applications development for land imagery. The trades necessary between increasing capability and cost were discussed, as were issues in program continuity, program governance and management, lessons learned from the Landsat experience, and the current global environment for satellite-based sensing and imaging beyond current Landsat or anticipated LDCM capabilities.

During the public comment session, a recurring theme was impatience with the delays and erratic progress toward creating an operational moderate resolution land imaging program, even though such a program has been stated as a National policy since at least 2004. All open-session comments, as well as all views on the subject expressed by panelists, favored a single Agency lead for the future land imaging program.

The public comments ranged between advocates of a no-cost data policy for moderate resolution land imaging supported by public funds, similar to the data provided by the NOAA National Weather Service, and those who argued for a privatized capability on a cost-recovery fee basis, albeit with U.S. Government backing of unspecified degree and form. The affordability of Landsat data was frequently cited by the user panelists as an essential factor in the mushrooming expansion and diversification of applications in all sectors. The moderator of the second panel, reflecting on the extent and characteristics of the applications described during the first panel, estimated the total economic value of just the current applications as being at least in the billion-dollar range, if not worth tens of billions to the U.S. economy.

Acronyms

AIAA	American Institute of Aeronautics and Astrophysics
ASPRS	American Society for Photogrammetry and Remote Sensing
AVHRR	Advanced Very High Resolution Radiometer
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EPA	U.S Environmental Protection Agency
ERTS-A	Earth Resources Technology Satellite A
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FLI-IWG	Future of Land Imaging Interagency Working Group
GEOSS	Global Earth Observing System of Systems
GIS	geographic information system
GPS	Global Positioning System
IEOS	U.S. Integrated Earth Observation System
LIDAR	Light Detection and Ranging
LDCM	Landsat Data Continuity Mission
MAPPS	Management Association for Private Photogrammetric Surveyors
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Adminsitration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NSGIC	National States Geographic Information Council
NSTC	National Science and Technology Council
OSTP	Office of Science and Technology Policy
USDA	U.S. Department of Agriculture
URISA	Urban and Regional Information Systems Association
USGEO	U.S. Group on Earth Observations
USGS	U.S. Geological Survey
VAR	value-added reseller
VIIRS	Visible/Infrared Imager/Radiometer Suite

Public Workshop on Future Land Imaging in the United States

U.S. Department of the Interior
Washington, D.C.
July 26, 2006

Introductory Remarks

Gene Whitney of the Office of Science and Technology Policy (OSTP) opened the workshop. Dr. Whitney is the National Science and Technology Council (NSTC) liaison to the Future of Land Imaging Interagency Working Group (FLI-IWG), which is the sponsor for this public workshop. He introduced the chair of the workshop, Timothy R. Petty, Deputy Assistant Secretary for Water and Science in the Department of the Interior (DOI).

After introducing the two panel moderators, Mr. Petty described the membership and work of the FLI-IWG. Future capabilities in land imaging are important to the Nation, Mr. Petty said, because the scientific determinations from imaging data support better policy decisions with respect to land use and land management, agriculture, and a myriad other aspects of the missions of participating Federal agencies. He reviewed the history of DOI's involvement in land imaging, noting that the Landsat system is now operated under the U.S. Geological Survey (USGS). The general topic for discussion today is how to build upon and continue to grow this national asset in land imaging.

Future of Land Imaging Interagency Working Group

OSTP
- Gene Whitney

Department of Agriculture
- Brad Doorn
- Glenn R. Bethel
- Richard W. Mueller
- James D. Hipple

Department of Defense
- Craig Baker
- Jack Clarke
- Riley D. Jay
- Douglas McGovern
- Patrick Rayermann

U.S. Geological Survey
- Barron Bradford
- Ray Byrnes
- John Cullen
- Jay Feuquay
- Bruce Quirk
- Martin Eckes

NASA
- Bryant Cramer
- Edward Grigsby
- Theodore Hammer

NOAA
- Michael Hales
- D. Brent Smith
- Charles Wooldridge
- Eve Douglas

DOE
- Jeffery S. Amthor

State
- Fernando R. Echavarria

DOT
- Kuppusamy Thirumalai

The Future of Land Imaging Interagency Working Group

Dr. Whitney asked the members of the FLI-IWG to introduce themselves. He gave a brief overview of the process that the FLI-IWG has used and the directions in which it is heading. The objective of this meeting is for the Working Group members to listen to comments from the stakeholders and communities of interest represented on the two panels and in the audience. He emphasized that this meeting is not about the Landsat Data Continuity Mission (LDCM), which is currently in procurement. That procurement activity is a separate process from planning for the future of land imaging beyond LDCM, which is the topic of this workshop. The

purpose of the FLI-IWG is to develop a stable, long-term management and funding situation for U.S. land imaging.

Dr. Whitney described the swath width and resolution characteristics typical of moderate-resolution satellite-based land imaging, in the context of the full panoply of tools and techniques for land observations, including in situ and airborne sensing as well as satellite-based sensing from the lower resolution instruments of VIIRS (Visible/Infrared Imager/Radiometer Suite) and AVHRR/MODIS (Advanced Very High Resolution Radiometer/ Moderate Resolution Imaging Spectroradiometer) to the higher resolution of commercial systems. The FLI-IWG working concept for moderate resolution land imaging has used a range in spatial resolution of roughly 10 m to 120 m. Dr. Whitney presented illustrative lists of uses for land imaging in this range and the societal benefits from them. However, he emphasized that these lists were partial, and hearing about current and potential uses of moderate resolution land imaging from users was a principal workshop objective.

Next, Dr. Whitney reviewed the policy history of U.S. satellite-based land imaging, beginning with the launch of the first Landsat—Earth Resources Technology Satellite A (ERTS-A)—in July 1972 and continuing through the Land Remote Sensing Policy Act of 1992 and the subsequent unsuccessful attempt to establish a public-private partnership to provide Landsat data continuity. He summarized the major implications for Landsat policy of the OSTP memoranda on Landsat strategy of August 2004 and December 2005. In particular, the December 2005 memorandum revised the earlier strategy of including a Landsat instrument in the instrument suite for the National Polar-orbiting Operational Environmental Satellite System (NPOESS), in light of the design complexities that had emerged. Both memoranda set a goal of transitioning Landsat from a series of independently planned missions to a sustained operational program funded and managed by the U.S. Government. The December 2005 memorandum also called for a study to identify future needs and options for U.S. land imaging, to be prepared by the FLI-IWG. The FLI-IWG takes the section of this memorandum on "Ensuring long-term continuity" as the charter for its work. (Full text of the OSTP memorandum is available at http://www.landimaging.gov/12-23-2005.pdf.)

For the past two months, and continuing with this workshop, the FLI-IWG has been conducting fact-finding, analysis, and needs assessment. The Working Group anticipates release in February 2007 of a long-term plan for a moderate resolution land imaging capability, in accord with the goals and objectives of the U.S. Integrated Earth Observation System (IEOS). In addition to this workshop, interested parties can provide input to the process by email (mailto:survey@landimaging.gov) or by responding to a survey on the future of land imaging, sponsored by the American Society for Photogrammetry and Remote Sensing (ASPRS) and available on the ASPRS website (http://www.asprs.org/).

Dr. Whitney presented the FLI-IWG's findings to date on characteristics required for moderate resolution land imaging, calibration of data over time to a national standard to maintain continuity in the land data record, and the necessity of frequent synoptic coverage of the entire Earth. Backward compatibility with the U.S. land data record is a

requirement, but future land imaging capabilities need not be limited to Landsat capabilities. A major Working Group task is to tie required technical capabilities back to the societal benefits of land imaging and how they can best be achieved. Among these benefits are the societal benefits defined for IEOS and the international effort know as the Global Earth Observing System of Systems (GEOSS):

- Weather
- Natural disasters
- Ocean resources
- Climate variability and change
- Human health
- Ecological forecasts
- Agriculture and forestry.

A further set of societal benefits go beyond the GEOSS and IEOS goals, but are important to meet U.S. economic and national security interests. Among these are:

- Land use planning and management
- Public lands conservation and management
- National security operations
- Transportation planning and management.

The best long-term solutions for operational land imaging capabilities to meet national needs traceable to these benefits may vary over time, so proposed solutions should be flexible. The Working Group anticipates that Government-owned satellites will be the near-term data acquisition solution, combined with a complementary international partnership. Other options being considered for the future include public-private partnerships, international partnerships, a commercial program, and combinations of these approaches. With respect to the management and governance structure overseeing the satellite operations, options under consideration include a single Federal agency responsible for all aspects of land imaging, a multiple-agency structure in which responsibilities are shared, an integrated program office reporting to multiple Federal agencies, a national commission to manage the land imaging program, or a purely commercial or international manager with no Federal agency having responsibility for management or oversight.

Multiple Federal agencies have shared responsibilities for operating Landsat satellites. The process for developing each new satellite has been ad hoc. Each agency also interacts independently with potential partners in the academic community and the private sector (e.g., value-added resellers). The FLI-IWG believes that focused Federal leadership of the land imaging community is essential. Although the land imaging enterprise is too large and complex to be conducted entirely by a single agency, a lead agency is necessary. A designated Federal lead agency can provide unified planning and responsibility for operations. It should have responsibility for coordination among agencies on land imaging needs; data acquisition, quality control, and distribution; and

acquisition of technology and systems. The lead agency would serve as a single point of contact for non-governmental users and contractors, as well as for international partners and international negotiations. The management/governance structure must also provide a point of accountability for performance, while allowing for flexibility in leadership as technical, fiscal, and political factors change. The Working Group thus envisions a National Land Imaging Program with a designated lead agency and a coordinating board with members from each of the agencies participating in the program. An option under consideration is to designate DOI as the lead agency, perhaps with management of the program at the assistant secretary level. DOI has sent a letter to OSTP expressing its interest in such an arrangement. The national program would be a coordinating program and would not subsume the existing land imaging programs of the partnering agencies. Dr. Whitney described how this coordinating role might work with respect to other major Federal initiatives including the U.S. Group on Earth Observations (USGEO) and GEOSS, the programs and projects of individual Federal agencies, and land imaging activities in the private sector.

In closing Dr. Whitney encouraged responses to the ideas and options he had presented. Further information on the FLI-IWG is available on its website (www.landimaging.gov), and views can be emailed to survey@landimaging.gov. He also asked participants to send anecdotes showing the value of land imaging, any qualitative information or quantitative metrics about the value of land imaging in particular sectors, and thoughts on trends in land imaging that may be emerging on the horizon.

Panel 1: Views of the User Community on Future of Land Imaging

Kass Green, moderator for the first panel, thanked the DOI for offering a home for a land imaging coordination program. She thanked the panelists for taking time to participate and the FLI-IWG for their efforts to date, then introduced the panelists and their current affiliations (see box). This panel includes two members from the value-added reseller (VAR) community, two members representing end users of information from the imagery, two users from the nonprofit sector, and one representative of State and local public-sector entities.

Panel 1: Views of the User Community

Kass Green, *Moderator*, President of Alta Vista Company and Vice President, ASPRS
Susan Carson Lambert, past President, National States Geographic Information Council
Jim Schriever, Senior Vice President, Sanborn Solutions
John Brown, President, Aircorp
Doug Hall, President and CEO, MDA Federal
Jennifer Swenson, Andes-Amazon Project Manager, NatureServe
Dan Ferhringer, GIS/Remote Sensing Manager, Ducks Unlimited
William Raichle, Vice President for Risk Decision Information, ISO, Inc.

Preliminary Results from the ASPRS Survey

Ms. Green began with a summary of the goals, background, and preliminary results to date from the ASPRS survey on the future of moderate resolution land imaging. The goals are to: (1) estimate the societal benefits of U.S. moderate resolution data, (2) better understand current operational and research uses of moderate resolution data, and (3) identify user requirements in moderate resolution technology and data policy. The survey questions were created and reviewed by a team of professionals with input from

the FLI-IWG. An email blast requesting responses from their members was sent out by the ASPRS, the Management Association for Private Photogrammetric Surveyors (MAPPS), the Urban and Regional Information Systems Association (URISA), the National States Geographic Information Council (NSGIC), and other entities that maintain email pointcasting lists. As of July 25, the survey, which was first posted on July 5, had 914 respondents from around the globe. The respondents are about equally divided among academic, commercial, and governmental affiliations. The majority of respondents (69 percent) use Landsat data as their primary source of moderate resolution data, 46 percent work in an operational program, and 73 percent stated that Landsat is a primary, critical dataset for their applications. Many of the respondents' programs that use Landsat data were established decades before the first Landsat launch; these programs have incorporated Landsat-derived information as it became available. The varied nature of these operational programs is illustrated by the list in table 1, drawn from the survey responses received to date.

Table 1. Operational Programs Currently Using Moderate Resolution Land Imaging Data

Carbon cycle monitoring	Mineral exploration
Coastal change analysis	Monitoring grant performance
Crop estimates	Range management
Deforestation monitoring	Recreation planning
Design of defense systems	Snow and ice monitoring
Detecting and monitoring volcanic activity	Soil analysis
Ecosystem mapping	Space cartography
Emergency response	Support of DOD operations
Forest management	Water resource planning and administration
Invasive species monitoring	Water rights monitoring
Inventorying toxic releases	Weather prediction
Irrigation management	Wetlands rehabilitation
Land use and land cover change	Wildland fire risk assessment
Mapping groundwater discharge zones	Wildlife reintroduction

Ms. Green characterized the preliminary data as confirming that a Landsat data gap is already being felt by users. Of the respondents who expressed an opinion about Landsat, 81 percent stated that current Landsat 5 and 7 data do not meet all of their needs, given the current scan line corrector problems of Landsat 7 and the coverage limitations of Landsat 5. Approximately 78 percent of the same respondents stated that, if the scan line corrector failure on Landsat 7 had not occurred, Landsat 7 data would have met their current needs. In order of importance, the top five reasons cited by respondents for using Landsat data rather than other remote-sensing data were that: (1) Landsat data are more accessible; (2) a large Landsat archive exists, containing over 30 years of consistent data; (3) Landsat data are relatively less expensive; (4) Landsat data provide more repetitive coverage; and (5) the extent of Landsat scenes is most appropriate for the respondent's project. Ms. Green highlighted survey results that indicate the quantitative impacts to users if Landsat service were lost. With respect to increasing the utility of moderate resolution imagery, the top five factors for these respondents were (in order of importance) greater spatial resolution, lower-cost data, more frequent temporal coverage, more spectral resolution, and easier access to data.

The survey analysis will include quantitative data on the spatial resolution (in meters) and temporal resolution (in days between re-imaging) desired by respondents, as well as the strength of respondent opinions (from full agreement to strong disagreement) on a set of survey questions regarding management and ownership of land imaging services, the role of the Government, and directions for expanding imaging capability. These quantitative results will be complemented with quotes extracted from individual responses to illustrate the range of applications, societal benefits, and criticality of moderate resolution imagery like that provided by Landsat. Ms. Green's presentation slides included preliminary quantitative analyses from the responses received through July 21, plus a selection of quotes.

Mapping Ecosystems and Deforestation Impacts in Developing Countries

Jennifer Swenson of NatureServe described the range of services performed by this nonprofit network and then focused on how her Andes-Amazon Project is using Landsat vegetation data to map ecosystems and deforestation in South America. Of the 80 Landsat scenes available for Peru, her project is using about 40. About 105 ecological communities will be mapped. Landsat provides a combination of regional coverage with the details needed to perform this ecological mapping and determine the extent and consequences of deforestation. Landsat's repeat coverage is valuable because of the frequent cloud cover in this region, and the data are affordable enough to allow continuous updating. The historical coverage is essential to showing land use changes over time. Any application involving vegetation mapping or ecosystem monitoring in developing countries, such as Peru, is highly dependent on Landsat to provide the base layer mapping, because of the dearth of ancillary data to map the ecosystems.

Wildlife Habitat Conservation Management

Dan Ferhringer described how Ducks Unlimited uses moderate resolution imagery to manage individual wildlife habitats all along the major continental flyways for migratory waterfowl. The combination of full Western Hemisphere coverage and adequate spatial resolution is essential for these applications, which have included mapping of boreal forests in Canada; the prairies, Great Lakes, and Missouri-Mississippi Valley in the United States, and habitats in Mexico, Central America, and South America. The interpreted imagery products that Ducks Unlimited and its affiliated organizations produce allow them to set priorities and make the best use of their limited resources. The products are also used in their work with Federal, State, and foreign governments on conservation and wildland management priorities, with agricultural and forestry companies on land resource management, and with nongovernmental organizations. Mr. Ferhringer gave examples of activities and programs that have been supported with his habitat analysis products, together with the societal benefits from these activities.

Value Added Products Supporting Defense and Civil Agency Missions

Doug Hall of MDA Federal (formerly Earth Satellite Corp.) said that his company has been processing Landsat data since the early 1970s. The company's clients include 13 agencies and organizations in the Department of Defense (DOD) and the intelligence

community; multiple entities within the DOI, Department of Commerce, and Department of Agriculture; the U.S. Environmental Protection Agency (EPA); the Federal Emergency Management Agency (FEMA) in the Department of Homeland Security, the National Aeronautics and Space Administration (NASA), and entities in State government and the private sector. The combination of comprehensive coverage at regional to national scales and moderate resolution is essential to many of the applications MDA Federal supports, including those shown in table 2. Although MDA Federal also works with high-resolution data from both defense/intelligence sources and the private sector, Mr. Hall emphasized that those datasets complement, rather than replace, the role of moderate resolution imagery such as Landsat provides. Recent projects illustrated in the presentation slides included land use change detection on the Gaza-Egypt border and illicit crop inventory (opium poppy cultivation) in one province of Afghanistan. Another recent project compared the areas of the Indian Ocean affected by the December 2004 tsunami with pre-tsunami scenes, to highlight alterations of coastline and underwater hazards. In closing, Mr. Hall stressed the need for an operational moderate resolution land imaging capability to support Federal agency activities.

Table 2. Value-Added Applications of Moderate Resolution Imagery to Support Federal Missions

Civil Agencies	DOD/Intelligence Community
Land cover mapping	Change detection
Change detection/monitoring	▪ Intelligence tip-offs
Disaster response	▪ Monitoring
Humanitarian relief	▪ Map updating
Geologic mapping	Illicit crop assessment
Forestry assessment	Food security
Agricultural assessment	Land cover mapping
Wetlands mapping	Shoreline/hazards mapping
Fire risk assessment	Infrastructure mapping
Impervious surface mapping	
Environmental monitoring	

Source: MDA Federal

Applications Used by State and Local Governments

After an overview of her career as a land surveyor, cartographer, and geographer with the USGS and as a principal investigator for state projects in Kentucky, Susan Carson Lambert said that the States are major users of Landsat data. She urged the FLI-IWG to ensure that the views of State agencies and offices are surveyed. From a much larger set of applications that her contacts in State and local government had sent her, she presented the representative, but partial list of applications shown in table 3. After describing details for several of the listed applications as they are used by State and local entities, Ms. Lambert stressed that all of these applications represent mandated activities required of State and local governments.

In a study Ms. Lambert conducted of non-Federal public sector needs for data, Landsat data and moderate resolution imagery were in the bottom quartile (lowest 25 percent) for the entire range of public sector entities. However, for State agencies with

responsibilities for resource use or management, Landsat data were always in the top five data needs. Another difference is that entities in states east of the Mississippi often wanted imagery with higher resolution than Landsat, whereas states west of the Mississippi, where the land areas to be monitored or managed are much larger, are typically content with the current Landsat resolution and use the products routinely. She has also observed that the extent to which State entities make use of imagery data and products often depends on their interactions with Federal counterparts, who show them how the data and products can be used.

Table 3. State and Local Applications of Moderate Resolution Imagery Data

Agricultural field crop health	Modeling of rock formation
Comprehensive plan efficacy monitoring	Preliminary analysis for logging species
Crop insurance verification	Rangeland health and change
Forest canopy mapping	Riparian zone mapping
Forest fire scar mapping	Risk management for post-forest fire stream silting, mud slides & erosion and mud-slides
Forest fire susceptibility mapping	Sensing of lava flows
Forestry composition and forest composition change	Water quality analysis
Imperviousness mapping	Watershed analysis for modeling
Insect damage mapping i.e. pine beetles	▪ Modeling watershed capacities
Invasive species mapping	▪ % development before ecosystem damage
Land cover change analysis	Wetland mapping
▪ Comprehensive plans	Wetness/drought analysis
▪ Logging effects	Wildlife management
▪ Mining effects	Wildlife habitat analysis
▪ Efficacy of mine reclamation	
Land management decisions	
Mineral exploration (State geologic surveys)	

For non-Federal public sector entities, Ms. Lambert said in closing, the benefits of Landsat products are that they are affordable and shareable (e.g., among State agencies and from them down to local entities); the bands are usable by many applications these entities have, there is a great deal of supporting science behind the data (algorithms, classification, indices, etc., that can be applied); there is a long period of record for applications such as land use change over time; and Federal agencies support the State and local entities with best practices for using and interpreting Landsat data. The principal downside she hears from colleagues in these entities is that they want higher resolution.

Applications of Landsat Imagery in Legal Proceedings

John Brown is President of Aircorp, which stands for Agricultural Investigation Research Corporation. He described applications of Landsat data in his work as a legal expert witness in Federal and State courts. One example is agricultural fraud detection related to loss claims made under the crop insurance program of the U.S. Department of Agriculture (USDA). He also uses Landsat data as evidence of the impact of human activities on property and land resources, in investigations of water sources and water rights, and for detection of water leaks from pipelines. Clients include the Risk Management Agency in USDA, the U.S. Department of Justice, insurance companies, and local governments.

Among the societal benefits that Mr. Brown sees from his company's uses for Landsat data are fraud detection, finding and ensuring appropriate use of water resources, reducing exposures to chemicals and pesticides, and crop development (precision farming). Another set of benefits relate to detection of the impact of disasters such as Hurricane Katrina, including facilitation of rescue (for example, farm animals) and recovery and for quantifying damages for purposes of compensating for losses.

Important characteristics of Landsat data for legal proceedings are its reasonable cost, ease of access, the extensive historical archive (going back to 1972), and its established record and wide acceptance in the scientific community (proven technology). Ease of access is important because court deadlines are demanding; there are no excuses for failing to meet a Federal court deadline. Although Aircorp's range of applications could use higher resolution, Mr. Brown finds that 30 m resolution is workable. The multi-band algorithms are very important for his work. In addition to the data's established scientific basis, acceptance in court proceedings is aided by the documented chain of custody of the data and the reliability of the data protocols. Mr. Brown also finds that basic analysis techniques for Landsat data are easily taught to clients.

Commercial Land Cover Mapping

Jim Schriever began with a brief history of Sanborn, where he is Senior Vice President of the Sanborn Solutions division. The company was started in 1866 by a Civil War cartographer and initially produced detailed city maps for fire insurance companies. Sanborn still provides subscription mapping services. In addition to its applications of satellite imagery, the company owns a fleet of aircraft with digital and analog airborne sensors and LIDAR for high-resolution mapping products and services. In the moderate resolution area, Landsat is their "workhorse" observing system, although they also use commercial satellite imagery. Mr. Schriever views Sanborn's regional presence, with offices located in a number of states, as an important asset when working closely with clients on applications that are pushing the limits of imagery interpretation. Sanborn's land cover mapping philosophy emphasizes the capability needed not just for imaging, but to put the image data to use. Consistent core funding for some of the baseline applications of Landsat data, he said, is critical for putting that data to work. Coordination of collaborations among State and local public sector entities, Federal agencies, and commercial partners is central to this philosophy. Sanborn has been able to leverage the investment of Federal resources with State resources to the extent that State partners have provided up to $10 in funding for every $1 of Federal funding. Across the board, Sanborn has been able to coordinate partnerships to at least match the Federal contribution, dollar for dollar, with State money.

Other tenets of Sanborn's philosophy are attention to data quality and consistency and the capacity to deliver cost-effective, timely solutions to customers. To illustrate how quality and consistency apply to Landsat data, Mr. Schriever described the successful application of 30 m resolution data to mapping of wildfire fuels in Florida, where better than 90 percent accuracy was achieved. Moderate resolution imagery is often key to providing a timely and cost-effective solution, compared with the prohibitive cost and schedule time required for regional-scale mapping with high resolution datasets. Examples Mr. Schriever cited were species-specific habitat maps of the entire West

Coast, produced within 9-12 months to meet requirements of the Endangered Species Act. Land cover mapping applications for which moderate resolution imagery provides cost-effective, timely solutions of high quality include the following:

- ∞ Fire risk management (e.g., fuels and canopy closure analyses)
  - Fire susceptibility indices are being used in 15 states.
  - Datasets for the National Landfire Program will be based on 2001 imagery.
  - Community Wildfire Protection Plans (CWPP's) for communities at high risk of wildfire losses will probably need higher-resolution data added to a state-level synoptic view.
- ∞ Consistent national datasets (time series) are essential to establish historical baselines needed for:
  - Trend analysis
  - Change detection.
- ∞ Global crop analyses
- ∞ Cumulative effects analyses
  - First approximation reports
  - Response to requirements under the Endangered Species Act
- ∞ Monitoring outbreaks of insects and diseases

In his closing slide, Mr. Schriever presented and discussed an analysis developed for the American Forest Organization. Time series images from the USGS National Land Cover Dataset are used to analyze land cover changes, which in turn can be linked to quantitative changes in tons of air pollutants removed by forested areas, tons of carbon sequestered in biomass, amounts of water retained in soils rather than lost to runoff, and other ecosystem factors. Without the Landsat sensors and the data they provide, such analyses would not be possible.

Risk Management Applications for the Insurance, Finance, and Health Industries

William Raichle described the work of his company, ISO, as helping customers measure, manage, and reduce risk. Its products help customers identify, mitigate, and price for risk by providing them with data, analytics, and decision-support services. The information Mr. Raichle presented about ISO's business is also available on its website at http://www.iso.com/about_iso/. Part of ISO's business is to collect premium and loss data for commercial insurance transactions and to help insurance companies determine loss cost for their business lines. For example, ISO promulgates the fire suppression schedules for firefighting entities across the Nation. These schedules are used in setting property insurance rates. ISO also maintains databases on commercial properties for purposes of insurance underwriting. Its insurance claimant database is used by the insurance industry and the Federal Bureau of Investigation (FBI) to detect insurance fraud.

ISO maintains the largest geographic information system (GIS) in the insurance industry, containing 25 database products. One of the databases that depends on satellite imagery is FireLine, which contains information on the wildfire hazard for purposes of property insurance. Although not a major fire loss risk, wildfire losses are significant for the industry and they are increasing. From 1985 to 1994, wildfires destroyed more than

9,000 properties nationwide, including the 2,449 dwellings destroyed in the Oakland/ Berkeley Hills fire of October 1991, causing an estimated $1.5 billion in damage. A decade later, the southern California firestorms in October 2003 destroyed 3,400 structures and caused more than $2 billion in insured property losses. The FireLine database, which uses Landsat data for its "Fuel" layer, grew out of the inadequacy of more traditional hazard mapping methods to cover large regions. Once interpreters with sufficient expertise with the Landsat data were found, ISO was able to identify and assess the urban-wildland interface consistently and reliably with a cost-effective program. For example, 97.5 percent of the burned area from the 2003 southern California fires had been identified in the FireLine database as exposed to a wildfire hazard, and 95.7 percent of the homes affected by those fires had been identified as exposed. Insurers prefer to base ratings on data from a shared, accurate, and consistent source, such as Landsat data, rather than on proprietary data or conflicting interpretations.

Panelist Responses to Questions on Future Land Imagery Planning

After Mr. Raichle's presentation, Ms. Green asked the panelists what they thought was the most important thing the FLI-IWG needs to know about user needs for future moderate resolution land imagery.

Doug Hall said that imagery and data from sources representing a range of resolutions will be necessary. Although a commercial industry supplying high-resolution land imagery and data is emerging, that alone will not meet all users' needs. He also said there are frequent misperceptions about the source of value-added imagery products offered by VARs, when their data originate from Landsat data.

Jennifer Swenson stressed the importance of international applications for moderate resolution imagery. The low expense, comprehensive coverage, and other attributes of the Landsat data are even more critical in other countries that lack access to any alternatives for many of the applications enabled by moderate resolution satellite imagery.

John Brown said the most important thing for him were the benefits to the American farmer. Modern farming requires this kind of moderate resolution, inexpensive, and dependable data. Increasingly, farmers use such data to conserve energy, lessen environmental damage, and protect their crops. A weekly interval for re-imaging would be important to farmers, but the most important qualities are dependability and reliability.

Jim Schriever agreed with points the previous speakers had made and added that continuity of land data over time, building on the Landsat heritage, was important for many applications. In addition to Federal support for imaging and image archiving, Federal support for a land mapping capability through an operational, continuously funded program is important to realize the potential benefits of the multitude of applications.

Susan Carson Lambert also agreed with the points the other panelists had stressed. She emphasized that U.S. cities and its 3,300 counties and parishes need the data provided by moderate resolution land imaging. The program must maintain accessibility

of the data and its backward compatibility with the historical data. In addition, some basic products for change analysis would be useful to those public sector entities that cannot afford to undertake the required analysis themselves.

William Raichle's suggestion for the FLI-IWG was to get to know the end users, even beyond this workshop. The better that those involved in changing the land imagery program know users and their needs, the better received the inevitable changes will be in the user communities. Another reason to get to know the user communities is to avoid duplication by the Government of services that VARs are providing.

Dan Ferhringer said that, for the nonprofit organizations, the cost of the basic data is always an important consideration. As others had emphasized, continuity of the data is essential because of the importance of change analysis for land stewardship and responsible resource management.

Panel 2: Views of the U.S. Aerospace Industry on Future of Land Imaging

Major General Bob Dickman (U.S. Air Force, retired), the moderator for the panel representing the U.S. aerospace industry, is currently the Executive Director of the American Institute of Aeronautics and Astrophysics (AIAA) and formerly the Deputy for Space in the Office of the Undersecretary of the Air Force. In introducing the panel topic, Gen. Dickman said that the OSTP memorandum of December 2005 made clear the Administration's commitment to the transition of U.S. land imagery capability to an operational program. The path forward and the mechanism to accomplish this transition is less clear, he said. He urged all stakeholders with an interest in such a program to remain engaged in working toward a program that is implemented and consistently funded. In his view, the annual economic value of all the downstream applications described by the previous panel, including both direct benefits and indirect ramifications, is probably at least in billions of dollars and perhaps in the tens of billions.

Panel 2: Views of the Aerospace Industry

Maj. Gen. Bob Dickman (USAF, retired), *Moderator*, Executive Director, AIAA
James Good, Director of OS Program Development, Ball Aerospace
Robert LeRoy, Director of East Coast Operations, Civil Space Systems, Lockheed Martin Space Systems Company
Ron Birk, Director of Mission Integration, Northrop Grumman Space Technology
Satya Kalluri, Senior Engineer, Raytheon Corporation

Lockheed Martin

Robert LeRoy of Lockheed Martin was previously Chief Engineer and then Program Manager for Landsat 7 and has 15 years of involvement in Landsat programs. His talk covered current capabilities in remote sensing, the meaning of the land imaging mission today and in the future, and some lessons learned from the company's past experience with Landsat. The U.S. aerospace industry has demonstrated the capability to deploy a diverse set of land remote sensing missions, covering high-resolution, broad area coverage, multispectral, hyperspectral, and other sensing modalities for military, civil, commercial, scientific, and national security applications. As the supporting technologies in solid state electronics, communications, and spacecraft navigation have

improved, the range of potential mission types and characteristics has multiplied. The industry knows that a wide range of potential customers and application needs to be served and has made substantial investments in remote sensing technologies, as illustrated by Mr. LeRoy's chart of sensor wavelengths covered by remote sensing missions.

Because the Landsats have had overlapping operating lives, the community has been able to provide cross-calibration across the succession of satellite and observing instrument generations. However, to ensure reliability of coverage and historical continuity across satellite generations in the future, a program is needed that plans for and maintains more than one satellite in orbit at a time. For example, the LDCM will introduce new technology with improved performance, which will require cross-calibration and validation with previous data.

Mr. LeRoy offered the following set of lessons learned from Lockheed Martin's work with past Landsats:

- There is no substitute for close cooperation between data users and system builders. Ongoing dialogue is needed on what can be provided within specified cost and other constraints, weighed against the needs to be met.
- Early agreement and a freeze on requirements are essential to control cost and schedule.
- Program schedule and cost depend on the execution of all program elements; including satellite, instrument, ground segment, and launch vehicle.
  - Systems engineering needs to be an integrated effort across the entire system.
- Risk must be carefully assessed for all program elements when defining the system.
  - Low-risk development requires much more than the use of flight heritage hardware and software.
- For operational deployments, instrument development cannot proceed independent of spacecraft development.
- Complete transparency within the government-industry team spells success.

In closing, Mr. LeRoy said that a future land imaging program will have to define and balance the needs of spatial and temporal resolution with spectral and radiometric characteristics. The U.S. and foreign governments will remain the primary customers, and the aerospace industry can help customers define what is technically possible. Finally, the lack of program continuity does impair the industry's ability to provide cost-effective solutions.

Ball Aerospace and Technology Corporation

James Good began by noting that Ball Aerospace and Technology Corporation has participated in all of NASA's Great Observatory missions and became involved with Landsat through its role in commercial land imaging satellites in the 1990s. Ball was a member of both the first Resource 21 team venture for agricultural imaging, which failed

for lack of investor interest, and the Resource 21 team in the unsuccessful commercialization approach to LDCM. Mr. Good emphasized that starts and stops in such programs are difficult for all players. The engineering and requirements analysis required to pursue a bid are a major investment for the offerors, and customer commitment to an operational system is necessary to avoid squandering both industry and Government funds.

Ball believes that U.S. industry is fully capable of implementing a base mission using affordable, low-risk technology and providing capabilities well beyond what is currently being requested for Landsat. Most of the capabilities mentioned during the user panel are certainly available and affordable, such as 5-10 m resolution. By the time a procurement is released for whatever the future land imager will be, the industry and the enabling technologies will be another 4-7 years further developed. With respect to keeping land imaging technology moving forward, Mr. Good stressed the importance of flight demonstrations for each new generation of instruments. To provide continuity as capabilities grow, he suggested that new technology be flown on missions every 5 years or so.

Raytheon Company

Satya Kalluri began with a review of remote sensing instruments built by Raytheon for NASA Earth Observing System (EOS) missions, its work on the EOS Data and Information System (EOSDIS), and the Synergy program to develop EOS applications for Federal, State, and local agencies. The Synergy program, which NASA initiated in 2000, has six major themes: precision agriculture, natural resource management, disaster management, water resource management, urban planning, and disease mitigation. Dr. Kalluri listed some of the Federal, State, and local entities that have been Synergy partners and described in detail several applications of EOS data developed for them. Among these applications are water use monitoring for the Idaho Department of Water Resources and precision agriculture for a group of wheat farmers in North Dakota. Dr. Kalluri suggested the following requirements for moderate resolution land data:

- Frequent coverage
  - Weekly—natural resource management (e.g., agriculture, water resources) and disaster mitigation
  - Every two weeks—land cover monitoring
- Low cost
- Ability to share data without copyright restrictions
- Data continuity, longevity, and reliability
- Standardized data formats and content
- Operational acquisition strategy.

Users have a wide choice of moderate resolution satellite data for land applications, but reliable alternate sources of data to Landsat have not been demonstrated for sustained, operational use in applications within the United States. Wider application from the full

range of sensor types and data suppliers (including foreign-owned satellites) has been hampered by the following barriers:

- ∞ Data incompatibility from different sensors makes analysis of long-term trends difficult.
- ∞ Restrictions in data sharing and copyrights on non-U.S. government data impede their widespread adoption and use.
- ∞ Users are unwilling to adopt "experimental" data in their operational business practices.

Therefore, Dr. Kalluri concluded, we must establish a long term data continuity plan for operational acquisition and use of moderate resolution land imaging data.

Northrop Grumman Space Technology

Ron Birk of Northrop Grumman Space Technology began his career building Landsat simulators. He noted NASA missions to which Northrop Grumman has contributed, including the Aqua and Aura spacecraft, NPOESS, and the telescope for the Space Interferometry Mission (SIM). He emphasized the importance of space-based capability and assets in enabling many aspects of an information society's infrastructure. Economics is now the major driver for maintaining and enhancing space-based assets for communications, navigation, and observing. Continuing technological advances in space-based sensing is increasingly important to U.S. competitiveness. A consistently resourced program to sustain and improve U.S. capabilities in areas such as satellite-based land imaging is more efficient and cost-effective than stop-and-go approaches.

While continuity with the heritage of Landsat data must be optimized, a program is needed to introduce better technology and advanced capabilities. Examples are elevation and other data from radar and enhanced discrimination of land features from hyperspectral sensing and other technologies. The aerospace industry can provide enhanced capabilities for Earth observing with sensor webs and adaptive sensing strategies.

An application area for land imaging that has not yet been mentioned, Mr. Birk said, is climate monitoring. The Global Climate Observing System Group has defined 26 atmospheric, oceanic, and terrestrial variables that are central to climate monitoring. The U.S. has committed to providing a monitoring capability for these terrestrial variables, and a consistent, long-term operational program is needed to fulfill that commitment.

Panel Responses to Questions

At the close of the panel presentations, Gen. Dickman asked the panelists to comment on how they would make the design trades implied by the diversity of potential users and user interests in an environment of constrained resources. Mr. Good suggested that decisions be made on the basis of services or capability that industry is willing to provide at a fixed cost. Higher resolution imagery and new sensing modalities such as hyperspectral sensing can now be priced for operational systems.

Gen. Dickman rephrased his question in terms of how competing capabilities, such as resolution and swath width, should be weighed. Mr. LeRoy said that such decisions will have to trade combinations of competing capabilities against cost. For example, additional instruments on one spacecraft could provide both higher resolution and broad swath coverage. Ron Birk described how multivariate analyses might be applied to assess trades among community needs. Tools such as operational system simulator experiments can be used to vary system parameters and evaluate the resulting performance. Simulations of this kind might be employed as part of a user community meeting to show the impact of different design parameters on system capability. Mr. LeRoy added that iteration of design options with the user community will be needed to arrive at an optimal solution, and sufficient time has to be provided to conduct that iterative process. Dr. Kalluri agreed that the issue will come down to trading cost against capability.

As a final question to the panel, Gen. Dickman asked how important a single lead point of contact in the Federal government would be to the industry. The panelists agreed that the program becomes much more workable when their industry can work with a single Federal point of contact. Gen. Dickman added that a single lead agency will need to work closely with an industry partner that has experience with building and managing spacecraft systems, particularly if the lead agency is not primarily in the business of developing and operating space-based systems.

Open Discussion and Response to the Working Group's Preliminary Findings

Dr. Whitney moderated the open discussion and response session that concluded the workshop. He reminded the audience of Gen. Dickman's point that the hard work of implementing a long-term, operational program for land imaging will just be starting when the FLI-IWG strategy is released in February 2007. If LDCM is launched on its current schedule in 2010 or 2011, then a successor mission will be needed in the 2015–2016 time frame. Even for the near term, naming a new agency home for Landsat, if that happens, will not mean that the program has a budget; it will only provide a mechanism for the program to get into the Federal budgetary process. He asked for the community's support in building a compelling case for future moderate resolution land imaging capability. In opening the floor to comment, he asked the participants to focus on the following questions:

- What are the future societal benefits of moderate resolution imagery?
- What is your vision of the future of moderate resolution imagery?
  - Who provides it?
  - What are the data policies?
  - What are the technologies?
- If you could implement your vision for the future of moderate resolution land imagery, what would be the best combination of governance, technology, and policy for that vision?

- What should be different in the future, and what would be the benefits of the change?

Comment 1: A member of the academic community involved with training the next generation of Landsat users commented that part of managing for land imagery of the future is educating the user community. She had not heard much about education at the workshop and wanted to encourage the FLI-IWG to include the academic teaching community in the future.

Comment 2: Professor Joanne Gabrynowicz, cochair of the USGS's Archive Advisory Committee and Director of the National Remote Sensing and Space Law Center at the University of Mississippi, read a statement from the Archive Advisory Committee, a number of whose other members were also present for the workshop. The statement reiterates recommendations that the committee has made previously to the Secretary of the Department of the Interior. (*Statement below was transcribed from recording and may contain errors due to audibility.*)

> **Recommendation:** That the Department of the Interior should be the single governing FLI [Future Land Imaging] body. DOI should also establish an independent external entity reporting to the Secretary to represent the interests of the user community. Regarding the operational scope of FLI, the FLI program must go beyond supplying data to providing relevant information to address economic, environmental, and other societal needs, irrespective of system architecture or ownership of assets. The program must track performance metrics to report value to society.

In her individual capacity as a long-time observer of the remote sensing community, Prof. Gabrynowicz said it is imperative that the data be available at no cost. If the data are not available at no cost, then the program will be attempting to recover cost of satellites and operation, which is something neither the public nor private sector has been able to do successfully. For remote sensing to achieve its potential, the same approach must be taken to land remote sensing satellites as has been taken with weather satellites and the Global Positioning System (GPS) by providing the data at no cost.

Comment 3: An audience member from SAIC commented that he thought the societal benefits of Landsat-type moderate resolution land imaging were already defined in the *Strategic Plan for the U.S. Integrated Earth Observation System.*[1] He also understood that the necessity of continuing Landsat had been established at a September 2004 White House conference in which multiple agencies made their arguments for that necessity, and a decision was made then to continue it, albeit on a platform that turned out to not be viable. He also understood that the December 2005 memorandum from the Director of OSTP had charged the FLI-IWG with developing a plan, not a strategy. A plan, he said, should contain much more specifics than a strategy and is the goal that needs to be reached. Any plan without funding is unexecutable, so a viable plan would scope out the

[1] This strategic plan was released in April 2005 by the Interagency Working Group on Earth Observations, which works under the NSTC Committee on Environment and Natural Resources.

costs and the partnership funding shares. The capabilities of the system will fundamentally determine what other organizations, whether they be other nations or other industry partners, seek to emerge as willing partners in this effort. If the data quality or revisit frequency fail to satisfy the requirements and needs, and costs are not recoverable, then there will be no industrial partners.

It appears, this commenter continued, that in this day and age it is possible for a commercial company, albeit government-backed, to recover its costs on a moderate resolution, broad area coverage system. He said that, based on the latest annual revenues of SPOT, a satellite designed with a 7-year operational life can make $70-80 million per year and is therefore on a cost recovery path—something deemed unachievable before. A plan to achieve all the requirements and needs of the operational agencies must assess what their requirements and needs are. This commenter does not see that the FLI-IWG has, up to this point, culled the agencies for their yearly requirements with respect to resolution, revisit frequency, and area coverage. If that were done, the commenter believes the resulting picture would distill a center of gravity for the type of system that would be most useful and satisfy the greatest quantify of needs per taxpayer dollar. A higher resolution system, he said, is inherently capable of meeting lower-resolution requirements. Yet a 30 m system cannot satisfy any requirements for spatial resolutions below 30 m. So a higher-resolution system is inherently capable of meeting more agency needs.

Comment 4: This participant from the Department of Geography, University of Maryland, said that what he had heard so far at the workshop has been a reflection of the past. Although there was some innovative thinking from the applications panel about the future, he did not hear any innovative, forward thinking from the aerospace industry panel. If the future land imaging program being discussed is at least 10 years away, there will be huge leaps in technology in that time. The discussion is missing forward-looking thinking about what might be possible.

In response to several of the comments, Dr. Whitney asked any participants who had access to analyses or vision documents that the FLI-IWG may not have seen to send them to the Working Group. Analyses of projected needs would be particularly valuable.

Comment 5: A workshop participant from NASA Goddard Space Flight Center advocated consideration of a schedule for launching a FLI asset before 2015. Reasons given were the need for higher resolution imagery before 2015 and the possibility that the LDCM launch might not be successful.

Comment 6: The FLI-IWG should be looking at moderate resolution imaging more broadly than just land imaging—for example, moderate resolution sea surface temperature monitoring, coastal process monitoring, sea ice monitoring, and atmospheric processes, including cloud imaging. From a Landsat perspective, scenes are always ordered as cloud-free land images. A second comment was to encourage the FLI-IWG to keep the public informed about what it is doing.

Comment 7: Kass Green asked what the user community needs to do to show support for implementation and not just planning, given that several years have passed while LDCM implementation has been stalled. Even the current procurement is still encountering controversy. What more could be done to get things unstuck and finally moving?

Dr. Whitney replied that the whole process being undertaken by the FLI-IWG is an attempt to answer that difficult question. A difficulty for Landsat has been that the user community is very dispersed and disparate; it is difficult to identify "heavy hitter" constituents that can take the case to Congress and the Office of Management and Budget. Something that could help would be a way to communicate the cumulative value of land imaging with something more than a long list of application anecdotes. Some way is needed to sum up, objectively and analytically, both the aggregate societal benefits from moderate resolution imagery and the opportunity costs of the currently unmet needs.

Comment 8: Susan Carson Lambert read some of the comments she received from users in State and local government that distilled a vision of what is needed in 10 years. For example, "satellite imagery should be as ubiquitous as NOAA weather data on the weather.com website" and "you should [be able to] just ask a question and get an answer with the processing happening [in the background]." Other comments addressed future availability of land change analyses, desired resolution in land imagery, and the necessity for political support at the State and Federal levels to ensure program continuity.

Comment 9: It is not a disadvantage that there are 200 uses for moderate resolution land imagery, this commenter said. A variety of uses in a diverse society should be a strength in making the case for the program to budget decision makers. The first and most important step is that a single agency needs to be in charge of the program. That entity needs to be the salesperson for the program.

Comment 10: As a reply to some of the preceding comments about the lack of innovative thinking from industry, Mr. LeRoy said that industry's job is to respond to what customers want. If that dialogue with customers happens, industry can come up with a system to do it. But time to implement it will be necessary.

Comment 11: The background message that this commenter seemed to hear was that a single satellite would be in the $300–$600 million range. He said that the era for that kind of thinking is past. If some time were spent talking about what was needed, it would roll out quickly, and the solution would not require a satellite costing $300-$600 million. The dialogue has been started, he concluded, and now we need to keep up the momentum.

Comment 12: Foreign and civil competitors will spur us to action, this commenter said. When [a new alternative system] is on orbit next June, with 4.5 times better resolution in the visible and infrared bands, with twice the swath width of Landsat at one-fifth the cost of building and launching Landsat 7, we will be forced to deal with a world in which lower cost, broad area imagery will be available. Other emerging developments include the Chinese space agency brief at the National Space Symposium at the Center for Strategic and International Studies on a four optical, four SAR system that will be launched imminently. The small satellite approach is affordable and does not require

charging high costs for products. The future of spectral-mode sensing, he continued, is hyperspectral, not multispectral. Other countries are looking for teaming partners to put up a hyperspectral system with better resolution than Landsat before LDCM is launched. So the question, the commenter continued, is whether the United States will become an "also ran" in spectral-mode sensing. Hopefully not, if national policy is carried out. We have the technology, the money, the requirements and the needs, we have Joint Staff-endorsed hyperspectral architectures. We have U.S. Government strategic plans. We have everything we need to act, but we don't.

Comment 13: Ron Birk commented that the new technical thing introduced today was [his suggestion for] an interactive dialogue with a system simulator to arrive at a community consensus. He pointed to the divergent opinions expressed in the preceding comments as an indicator of the need for some way to drive to a consensus on what a future system should do.

Comment 14: In this week's *Space News*, the Director of the Brazilian National Institute for Space Research stated in an interview, "Some American officials do not realize how important Landsat has been to the world community and how much good will the U.S. could generate by having a free and open data policy. This is really grossly underestimated in many U.S. circles. The point that I have been making here over and over is that there is so much that the U.S. could gain, both internally and externally, from an open data policy, that it doesn't make any sense to adopt any other policy."

Dr. Whitney reminded participants that the FLI-IWG website, www.landimaging.gov, has the email address for sending additional comments to the Working Group (survey@landimaging.gov) and a link to the ASPRS survey. He thanked the panelists and the audience for participating in the workshop. The workshop was adjourned at 5:03 p.m.

The presentations made by Dr. Whitney and panelists can be found at the FLI-IWG website, www.landimaging.gov.