



**21st CEOS Plenary
Big Island, Hawaii
Document Summary**

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Date Submitted: November 5, 2007 Item on Agenda: 9.3

TITLE OF YOUR DOCUMENT: Land Surface Imaging Constellation Study Team Report

SUMMARY AND PURPOSE: This document describes the objectives of the CEOS LSI Constellation, current status of activities, next steps, and future support needed to help ensure successful completion of the defined objectives. The purpose of the document is informational.

ACTION PROPOSED, *IF ANY*

21st CEOS Plenary participants are invited to:

Note the information contained in the following documents: This Report, including Annexes



The following is the Report to the 21st CEOS Plenary Meeting from the CEOS Land Surface Imaging Constellation Study Team. The report follows the format provided by CEOS SIT.

I. LSI Constellation Objectives

The primary objective of the Land Surface Imaging (LSI) Constellation is to define a broad range of rather detailed characteristics (or *standards*) that describe optimal, end-to-end capabilities (and policies) to acquire, receive, process, archive, and distribute space-acquired land surface image data to the global user community. Ideally, users will find such data optimally applicable to the broadest possible range of scientific and practical endeavors important in meeting the needs of mankind. The beneficial outcomes from defining such standards will be the guidance they provide for the coordinated development of future systems, as well as the foundation they provide for establishing criteria against which future proposed Earth observing systems can be assessed. **This objective mirrors the principal thrust of the original CEOS Constellations Concept Paper.**

It also is an objective of LSI Constellation studies and activities to address current and shorter-term problems and issues facing the land remote sensing community today, such as seeking ways to work more cooperatively in the operation of existing land surface imaging systems and helping to accomplish tangible benefits to society through application of land surface image data. The important outcomes from accomplishing this objective lie in the early benefits that will be derived by segments of the land remote sensing user community, as well as in the opportunity to demonstrate the value that CEOS Constellations can contribute to Global Earth Observation System of Systems (GEOSS) and its member organizations. **This objective reflects early guidance provided by CEOS SIT to the four initial prototype CEOS Constellation study teams.**

To address these important objectives, the LSI Constellation Study Team defined three primary goals in its 2007 Work Plan:

- 1) establish agreement(s), among space agencies currently operating mid-resolution land surfacing imaging satellite systems, to cooperate more closely together to operate those systems as a real prototype Land Surface Imaging Constellation;
- 2) develop preliminary standards for a mid-resolution Land Surface Imaging Constellation; and
- 3) meaningfully contribute to the production of a fundamental climate data record (FCDR) by providing mid-resolution LSI data to the FAO Forest Resource Assessment 2010 (FRA2010).

Collectively, these goals and objectives serve to promote the fundamental mission of the CEOS LSI Constellation, which is to promote the efficient, effective, and comprehensive collection, distribution, and application of space-acquired image data of the global land surface, especially to meet societal needs of the global population, such as those addressed by the Group on Earth Observations (GEO) societal benefit areas (SBAs).

II. LSI Constellation Status

A. **Accomplishments.** Work conducted by the LSI Constellation Study Team in 2007 focused on accomplishing the three major goals identified in our 2007 Work Plan. None of the three goals were fully accomplished, but important progress was made toward achieving all three.

1. Seven of the eight CEOS space agencies that currently operate mid-resolution (10m – 100m) LSI satellite systems signed a ***Declaration of Intent for Cooperation on Mid-Resolution Satellite Systems***, wherein they “resolve to realize the benefits of a Land Surface Imaging Constellation by actively seeking ways to cooperate more fully in the operation of their existing mid-resolution land surface imaging satellite programs.” That Declaration is included as Annex 1 of this Report.

To facilitate movement beyond this general declaration of intentions to cooperate more in the future, the LSI Constellation Study Team engaged a small but representative cross-section of the land remote sensing user community to help us formulate recommendations as to specific areas where such increased cooperation would most directly benefit users of mid-resolutions LSI satellite data and through them, society in general. The Recommendations developed by the LSI Constellation Study Team are included as Annex 2 of this Report.

Significantly, those recommendations provided the primary basis upon which the CEOS LSI Constellation Study Team developed three initial ***draft*** agreements that detail specific areas of potential cooperation among CEOS agencies that operate mid-resolution LSI satellite systems. CEOS agencies that signed the ***Declaration of Intent*** will be invited to review those draft agreements and offer suggestions for revision that hopefully will result in actual agreements that two or more of the agencies will sign and implement. The three draft Agreements are included as Annexes 3, 4, and 5 of this Report. They address three important areas of mid-resolution LSI satellite system operations.

- a. Enhanced User Access to Data
 - b. Data Acquisition
 - c. Ground Systems Operation
2. Important progress was made toward the development of preliminary standards for future mid-resolution optical LSI satellite systems that could form a true LSI Constellation, perhaps a decade from now. The LSI Constellation Study Team was aided in our efforts to develop such preliminary standards, based on real user requirements, by a contract let by the USGS to Noblis, a non-profit science, technology, and strategy organization.

Noblis assisted the LSI Constellation Study Team in compiling a cross-section of representative user information requirements to form the basis upon which standards for a mid-resolution LSI Constellation could be derived, and they assisted in the development of a preliminary list of such standards. A summary of the principal sources from which user requirements were compiled is included as Annex 6 of this Report. Annex 7 illustrates the process used to convert user information requirements to system requirements, and Annex 8 is a table showing a high-level summary of possible LSI Constellation standards (guidelines) for mid-resolution LSI satellite systems based on requirements so far compiled. Contents of this table are preliminary and have not been approved by the LSI Constellation Study Team. Work on requirements compilation and standards definition continues.

3. Ideally, the LSI Constellation Study Team had hoped to start providing the FRA2010 Project with actual mid-resolution LSI satellite data contributed by CEOS member agencies by the end of 2007 to fill the gaps in the primary LSI satellite data set being used in the sample-based assessment. However, that was not possible, largely because the FRA2010 Project has not yet been able to identify precisely how much data is needed, or exactly where the data samples are needed, to fill the gaps in their primary data coverage.

It was possible, however, to estimate the maximum number of 20km-by-20km image cells the FRA2010 Project would need from CEOS agencies with mid-resolution LSI satellite systems to complete their global forest resource assessment. Based on those estimates, the Study Team drafted an agreement, for signature by CEOS agencies with mid-resolution LSI satellite systems, that describes the conditions and limitations under which the signing agencies would agree to contribute the needed data to the FRA2010. That draft agreement, which currently is being reviewed by the applicable CEOS member agencies, is included as Annex 9 of this Report.

4. In addition to accomplishments made toward achieving 2007 LSI Constellation Goals, Study Team members contributed presentations about the LSI Constellation at several professional conferences and working group meetings, including the SPIE Europe Remote Sensing Conference and the CCRS/ASPRS Specialty Conference.

B. Agency Contributions. CNES, CONAE, CSA, ESA, INPE, ISRO, JAXA, NASA, NOAA, NRSCC, and the USGS have members on the LSI Constellation Study Team. Some members understandably are more active in their participation and contribution to the activities of the Study Team than are others, yet most attended the Study Team meeting held in Frascati in June. The USGS and ISRO Co-Chair the LSI Constellation Study Team, and their contributions to the work that has been accomplished by the Study Team this year have been notable. Also, notable is the contribution made by INPE in their development of preliminary data and operations policy guidelines for LSI Constellation data.

III. LSI Constellation Next Steps

A. **Key Planned Activities.** The LSI Constellation Study Team will plan, conduct, and otherwise participate in a variety of work and other activities that will advance the mission of the LSI Constellation in the year ahead. Not all are scheduled or fully defined yet, but they include the following.

1. Participate in the Inaugural Meeting of the International Space-based Imaging Spectroscopy Working Group meeting to be held in Hilo, November 15 & 16.
2. Present an overview of the CEOS Constellation Concept and LSI Constellation Study Team activities and plans at the January meeting of the Landsat Data Continuity Mission (LDCM) Science Team Meeting.
3. Schedule and hold a meeting of the LSI Constellation Study Team early in 2008 to reflect on 2007 successes and failures, engage in longer-term strategic planning, and develop the 2008 Work Plan.
4. Continue to work on unfinished tasks defined in the 2007 Work Plan, including broader engagement of the land remote sensing user community and select GEO SBA task teams.

B. **Key Challenges.** Developing and successfully implementing a new group of international cooperative activities presents a number interesting challenges, as the LSI Constellation Study Team became rather aware during its first year. Some of the key ones include:

1. Mustering and applying sufficient personnel resources to successfully accomplish the work defined to be accomplished.
2. Securing agency concurrence on documents reviewed and approved by the Study Team.
3. Fully engaging broad elements of the diverse land remote sensing user community in LSI Constellation activities, particularly user requirements definition.
4. Managing expectations, particularly in terms of what we reasonably can expect to accomplish and in what timeframe.
5. Balancing agency agendas with common goals, because both are important.
6. Gaining greater appreciation for the fact that, for most LSI satellite data, *the value of the data does not lie in the price that can be charged for their purchase, but rather the value lies in the good that can be accomplished through their application.*

IV. Requested Support

Mostly, we need people experienced and knowledgeable in the science, technology, and applications of land remote sensing to devote meaningful time, energy, and expertise to formulating and conducting LSI Constellation plans and activities. We need the space agencies, particularly, to view LSI Constellation activities not only as important to the land remote sensing user community and through them to society, in general, but also as being important to their future as providers of satellite data. We need them to do this so that they are motivated to make the Constellations a priority and commit appropriate resources to ensure their success. If each agency would commit two-tenths, or even one-tenth, of their LSI Constellation Study Team member's time to work on LSI Constellation activities, and support them with travel funds to participate in two Study Team meetings per year, the LSI Constellation would make significant progress toward accomplishing its goals and objectives. To the extent that the CEOS Chair or CEOS SIT can help secure such support from the member agencies, we would ask you to do so.

V. LSI Constellation Connections to GEO Work Plan and Targets

The LSI Constellation is strongly connected to the Group on Earth Observation (GEO) through the relevance, current and in the future, of LSI Constellation objectives, goals, and activities to many tasks described under the GEO SBAs and to many of the 2-, 6-, and 10-year targets identified by GEO. For detailed information about these connections, please see the back-up charts included with the presentation version of this LSI Constellation Study Team Report, which also was submitted and posted as a Plenary Document.

**Declaration of Intent by Member Agencies
of the Committee on Earth Observation Satellites
for Cooperation on
Mid-Resolution Land Surface Imaging Satellite Systems
in Support of the CEOS Implementation Plan**

WHEREAS: Several member space agencies of the Committee on Earth Observation Satellites (CEOS) currently operate mid-resolution visible to thermal infrared land surface imaging satellite systems, with a ground sample distance resolution of 10 to 100 meters;

WHEREAS: Data collected from these systems are extremely valuable sources of information used to study and monitor Earth conditions and processes and to solve problems to the benefit of society;

WHEREAS: The CEOS Constellations Concept has emerged as the innovative planning process intended to augment national government planning and support international coordination of space-based Earth observations;

WHEREAS: Routine, well-calibrated, and frequent imaging of the Earth's land surfaces and coastal areas at synoptic to global scales has proven to be of great benefit to society and holds even greater promise for the future;

WHEREAS: Important opportunities exist to provide users with better and more consistent data more frequently and more easily through enhanced collaboration and coordination among agencies in their planning, development, launch, and operation of future mid-resolution land surface imaging satellite systems;

WHEREAS: A constellation of mid-resolution land surface imaging satellites would enhance the benefit of Earth observation to society in many ways, including improved monitoring of the effects of climate change; planning and monitoring of the Earth's resources; discovery of critical energy and mineral resources; enabling societies to better prepare for and respond to natural disasters; studying and maintaining Earth's fragile ecosystems and its biodiversity; addressing human health issues; and helping to undertake many other scientific and practical endeavors beyond the scale of scientific and observational capabilities available today;

WHEREAS: A land surface imaging satellite constellation could improve the quality of life for citizens of all nations, aid in preserving the natural state of the Earth for all future generations, and foster the prospect for peaceful coexistence for all nations and peoples;

The undersigned CEOS space agencies resolve to realize the benefits of a Land Surface Imaging Constellation by actively seeking ways to cooperate more fully in the operation of their existing mid-resolution land surface imaging satellite programs. These agencies will seek to develop the appropriate measures and agreements to manage current and future satellite systems according to a common set of criteria and objectives. These agencies also will consult closely with one another in future development of national satellite systems so as to develop a more robust, coordinated, and comprehensive global approach to global land surface imaging.

The undersigned agencies resolve to work through the CEOS Land Surface Imaging Constellation Study Team to define specific cooperative measures to achieve these objectives.

SIGNED:

Signed

Centre National d'Etudes Spatiales

Chinese Academy of Space Technology

Signed

Comisión Nacional de Actividades Espaciales

Signed

Instituto Nacional de Pesquisas Espaciais

Signed

Indian Space Research Organization

Signed

Japan Aerospace Exploration Agency

Signed

U.S. National Aeronautics and Space Administration

Signed

U.S. Geological Survey, U.S. Department of Interior

**Recommendations
by the
CEOS LSI Constellation Study Team
for
Increased Cooperation in the Operation
of
Existing Mid-Resolution Land Surface Imaging Satellite Systems**

Background

In its 2007 Work Plan, the CEOS Land Surface Imaging (LSI) Constellation Study Team identified as one of its primary goals **increased cooperation in the operation of mid-resolution LSI satellite systems** among CEOS space agencies that currently operate such systems. In response to Study Team efforts, seven of the eight space agencies that currently have mid-resolution LSI systems in space have signed a ***Declaration of Intent*** stating their intentions to actively seek ways to cooperate more fully in operating their mid-resolution LSI satellite systems.

The next challenge the Study Team addressed was to recommend specific areas where such increased cooperation would most directly benefit users of mid-resolution LSI data and through them, society in general. To assist in formulating its recommendations, the LSI Constellation Study Team surveyed a small, but representative, cross-section of the land remote sensing user community and asked them to provide their opinions about what specific types of cooperation among operators of LSI systems would most benefit them. The recommendations provided herein were developed in consideration of the input received in response to the user survey.

Recommendations for Increased Cooperation

Recommendations presented here are grouped by logical categories, though certain overlap between categories does exist. The recommendations are prioritized based on a combination of factors, including importance to users and likely opportunity for early implementation.

Enhanced User Access to Data

1. Cooperate to create and maintain a common website where users can go to acquire information about currently operating mid-resolution LSI satellite systems, as well as the characteristics of the data they collect, and where users are provided with active links to the data search and order tools for all mid-resolution LSI systems that offer open user access.



2. Establish a clearinghouse for free data offered by operators of mid-resolution LSI satellite systems, and work to increase the amount of data available in the free data pools offered by contributing agencies. If practical, develop the clearinghouse as part of the website described in Recommendation #1.
3. Develop, and provide free access to, “bundles” of mid-resolution LSI data collected over common sites by the mid-resolution LSI satellite systems operated by CEOS agencies.
4. Enhance the functionality of the website described in Recommendation #1 to provide “one-stop shopping” for mid-resolution LSI satellite data, by developing an integrated user interface system where users can determine all mid-resolution LSI data over geographic locations worldwide from one search tool.
5. Develop and implement a common data access policy, endorsed by all CEOS space agencies that operate mid-resolution LSI satellite systems, which will provide ready access to all mid-resolution LSI satellite data by all segments of the international land remote sensing user community at the lowest practical cost to the user. A two-tiered data (cost) policy may be a practical starting basis for such a policy.

Data Acquisition

1. Establish coordinated and complementary data acquisition strategies, including optimizing regional coverage by national systems, designed to maximize global coverage, shorten repeat cycles, and increase cloud-free data over cloudy regions. This recommendation implies concurrent efforts to develop equitable plans for sharing data acquired based on the new, coordinated acquisition strategies.
2. Develop a joint “data gap” acquisition strategy to mitigate effects on global data coverage from the loss of one or more of the current or planned mid-resolution LSI satellite systems.
3. Jointly define a suite of environmentally sensitive sites, geohazard sites, calibration sites, and other key sites, and then develop cooperative strategies to ensure regular collection of data over the specified sites by all available mid-resolution LSI satellite systems.
4. Jointly develop and implement a shared real-time information system to provide acquisition schedulers with current, accurate weather information, cloud predict information, volcanic activity information, wild fire occurrence information, etc.

Ground Segment Operations

1. Cooperate in the definition of common processing parameters to provide users with data in standard formats and projections, as well as standard metadata content. Consider development



of a common orthorectified image product available for all CEOS mid-resolution LSI satellite systems.

2. Explore possible sharing of ground system resources, including reception and processing of each others LSI satellite data.
3. Develop common long-term archiving strategies to ensure preservation of important mid-resolution LSI satellite data records for scientific and historical purposes.

Significance of the Recommendations for Increased Cooperation

These recommendations represent an important resource for CEOS space agencies that currently operate mid-resolution LSI satellite systems as they look to cooperate more with each other in the future operation of those systems. These recommendations provided the primary basis upon which the CEOS LSI Constellation Study Team developed three initial draft agreements that detail specific areas of potential cooperation among CEOS agencies that operate mid-resolution LSI satellite systems. CEOS agencies that signed the *Declaration of Intent for Cooperation on Mid-Resolution Land Surface Imaging Satellite Systems in Support of the CEOS Implementation Plan* will be invited to review those draft agreements and offer suggestions for modifications that hopefully will result in actual agreements that two or more of the agencies will sign and implement.

DRAFT
CEOS Member Agency Agreement
to
Enhance User Access to Mid-Resolution LSI Satellite Data

Background

The Committee on Earth Observation Satellites (CEOS) Land Surface Imaging (LSI) Constellation seeks to promote the efficient, effective, and comprehensive collection, distribution, and application of space-acquired image data of the global land surface, especially to meet societal needs of the global population. A major goal of the LSI Constellation Study Team in 2007 was to promote **increased cooperation in the operation of mid-resolution LSI satellite systems** among CEOS space agencies that currently operate such systems. In response to Study Team efforts, seven of the eight space agencies that currently have mid-resolution LSI systems in space have signed a ***Declaration of Intent*** stating their intentions to actively seek ways to cooperate more fully in operating their mid-resolution LSI satellite systems.

The LSI Constellation Study Team has developed a list of recommendations for specific cooperative activities among CEOS agencies that operate mid-resolution LSI satellite systems. The recommended activities would directly benefit users of mid-resolution LSI data and through them, society in general. The recommendations reflect input provided from a survey of a representative cross-section of the land remote sensing user community, and they address the following three areas: 1) enhanced user access to data, 2) data acquisition, and 3) ground segment operations. This agreement is for **cooperative activities that will enhance user access to mid-resolution LSI satellite data.**

Proposal

Based on input from the land remote sensing user community, users first and foremost would like to see space agencies that operate mid-resolution LSI satellite systems cooperate together to **enhance user access** to the data and products provided by those agencies. Consequently, proposed herein is an agreement under which two or more CEOS space agencies with mid-resolution LSI systems and data will cooperate to establish and maintain a common website that will provide detailed information about LSI satellite systems and data and will provide active links to the user interface tools by which users can search and order LSI satellite data and products. The participating space agencies also should work to increase the volume and expedite the access to free LSI data available to users, including offering “bundles” of mid-resolution LSI satellite data collected by different sensor systems over the same site.



Agreement

The undersigned CEOS space agencies agree to cooperate together to design, develop, implement, and maintain a common website for the purpose of enhancing user knowledge about and access to mid-resolution LSI data and products distributed by the international space agencies that operate mid-resolution LSI satellite systems. The undersigned CEOS space agencies further agree to attempt to incorporate into this cooperative website tools by which users may expediently discover and access free (sample) data sets available from operators of mid-resolution LSI satellite systems, and they agree to explore the feasibility of “bundling” and providing user access to data collected over common sites by multiple mid-resolution LSI satellite systems.

SIGNED:

CEOS Member Agency

CEOS Member Agency

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DRAFT
CEOS Member Agency Agreement
on
Acquisition of Mid-Resolution LSI Satellite Data

Background

The Committee on Earth Observation Satellites (CEOS) Land Surface Imaging (LSI) Constellation seeks to promote the efficient, effective, and comprehensive collection, distribution, and application of space-acquired image data of the global land surface, especially to meet societal needs of the global population. A major goal of the LSI Constellation Study Team in 2007 was to promote **increased cooperation in the operation of mid-resolution LSI satellite systems** among CEOS space agencies that currently operate such systems. In response to Study Team efforts, seven of the eight space agencies that currently have mid-resolution LSI systems in space have signed a ***Declaration of Intent*** stating their intentions to actively seek ways to cooperate more fully in operating their mid-resolution LSI satellite systems.

The LSI Constellation Study Team has developed a list of recommendations for specific cooperative activities among CEOS agencies that operate mid-resolution LSI satellite systems. The recommended activities would directly benefit users of mid-resolution LSI data and through them, society in general. The recommendations reflect input provided from a survey of a representative cross-section of the land remote sensing user community, and they address the following three areas: 1) enhanced user access to data, 2) data acquisition, and 3) ground segment operations. **This agreement is for cooperative activities in the acquisition of mid-resolution LSI satellite data.**

Proposal

In the area of **data acquisition**, feedback from the land remote sensing user community indicates that users would like space agencies that operate mid-resolution LSI satellite systems to cooperate in establishing coordinated and complementary data acquisition strategies that would help maximize global coverage, shorten revisit cycles, increase cloud-free data over cloudy regions, and help mitigate negative impacts resulting from failure of one or more mid-resolution satellite systems. Consequently, proposed herein is an agreement under which two or more CEOS space agencies that operate mid-resolution LSI systems will attempt jointly to establish common data acquisition strategies that will provide users with increased volumes of more relevant data and that will include an action plan in the event of failure of one or more mid-resolution LSI satellite systems.



Agreement

The undersigned CEOS space agencies agree to cooperate to attempt to establish and implement coordinated and complementary data acquisitions strategies for the mid-resolution LSI satellite systems they individually operate, keeping in mind the need to maximize global coverage, shorten revisit cycles, increase cloud-free data over cloudy regions, mitigate negative impacts resulting from failure of one or more mid-resolution satellite systems, and other important factors. The undersigned CEOS space agencies further agree to define jointly a suite of environmentally sensitive sites, geohazard sites, calibration sites, or other key sites and jointly to attempt to develop a cooperative strategy for regular collection of mid-resolution LSI data over those sites using satellite systems operated by the signatory agencies.

SIGNED:

CEOS Member Agency

CEOS Member Agency

CEOS Member Agency

CEOS Member Agency

CEOS Member Agency

CEOS Member Agency

DRAFT
CEOS Member Agency Agreement
on
Ground Segment Operations for Mid-Resolution LSI Satellite Systems

Background

The Committee on Earth Observation Satellites (CEOS) Land Surface Imaging (LSI) Constellation seeks to promote the efficient, effective, and comprehensive collection, distribution, and application of space-acquired image data of the global land surface, especially to meet societal needs of the global population. A major goal of the LSI Constellation Study Team in 2007 was to promote **increased cooperation in the operation of mid-resolution LSI satellite systems** among CEOS space agencies that currently operate such systems. In response to Study Team efforts, seven of the eight space agencies that currently have mid-resolution LSI systems in space have signed a ***Declaration of Intent*** stating their intentions to actively seek ways to cooperate more fully in operating their mid-resolution LSI satellite systems.

The LSI Constellation Study Team has developed a list of recommendations for specific cooperative activities among CEOS agencies that operate mid-resolution LSI satellite systems. The recommended activities would directly benefit users of mid-resolution LSI data and through them, society in general. The recommendations reflect input provided from a survey of a representative cross-section of the land remote sensing user community, and they address the following three areas: 1) enhanced user access to data, 2) data acquisition, and 3) ground segment operations. This agreement is for **cooperative activities related to ground segment operations for mid-resolution LSI satellite systems.**

Proposal

In the area of **ground segment operations**, feedback from the land remote sensing user community suggests that users would like space agencies that operate mid-resolution LSI satellite systems to provide data and products in common data formats and map projections, and with standardized metadata content. Many users also strongly desire routine access to an orthorectified (at least georectified) image product generated from three visible and near-infrared (VNIR) bands, available from various mid-resolution LSI satellite systems. Consequently, proposed herein is an agreement under which two or more CEOS space agencies that operate mid-resolution LSI systems will attempt jointly to define and implement common processing parameters such that they can offer users data and products that have common metadata and are delivered in standard data formats and map projections.



Agreement

The undersigned CEOS space agencies agree to cooperate in an effort to define and implement common data processing parameters that would allow them to provide users with mid-resolution LSI satellite data and products that are delivered with standardized metadata and in like data formats and map projections. The undersigned CEOS space agencies further agree to consult with segments of the land remote sensing user community in such definition, and to explore the possibility of defining and offering users an orthorectified image product as a common standard data product produced from the VNIR bands of their various mid-resolution LSI satellite systems.

SIGNED:

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Principal Sources for Compilation of User Information Requirements

Title (Date – Source)	Content
A Plan for a U.S. National Land Imaging Program (Aug 07 – FLI IWG)	The final statement of the Interagency Working Group for the National Science and Technology Council Executive Office of the President on the long-term continuity of U.S. land imaging based on a collection of user requirements.
Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond (2007 – NRC/NAS)	Results of an intensive 2 year study by the National Academy of Sciences for NOAA, NASA, and the USGS.
GMES Sentinel-2 Mission Requirements Document (Mar 07 – ESA)	Very recent and focused statement of mid-resolution data requirements translated into detailed band-by-band sensor specs.
IGOL – An IGOS-P Theme 2007 Final (IGOS)	End product of user requirements studies by an extensive international committee.
GEOSS 10-Year Plan Reference Document (Feb 05 – GEO)	Original GEOSS “big picture” of user data requirements.
IGOL – An IGOS-P Theme Special Meeting on Conservation and Biodiversity (Nov 05 – IGOS)	A focused set of user requirements.
IGOL – Agricultural Monitoring Meeting (Mar 06 – IGOS)	A focused set of user requirements.
Space Mission Requirements for Agriculture and Land Ecosystems Monitoring (Mar 06 - CNES/CESBIO)	A focused study for agriculture and ecosystems with detailed spacecraft and sensor specs.
GEOSS and the U.S. EPA (May 06 – EPA)	A focused set of user requirements
The Geohazards IGOS Theme Space Component Requirements (Jan 04 – CEOS)	A focused set of user requirements.
Landsat Data Gap Studies: Potential Data Gap Sources (Jan 07 – USGS/EROS)	USGS study of minimum requirements for the continuation of the mid-resolution global land cover data archive.
Landsat User Survey Data Only Report (Sep 01 – Noblis)	A detailed survey of Landsat data buyers’ use of and requirements for the bands, resolution, and repeat cycle for a Landsat like mid-resolution system.
A Constellation of Mixed Orbit Micro-Satellites Report to the Decadal Study (Jun 05 – USGS/EROS)	A USGS study focused on the requirement for 10 meter rapid repeat rates to document land change and ecosystem dynamics.



From User Information Requirements to System Requirements

	Vegetation (Cultivated) Crops, Trees, Shrubs, Aquatic- Regularly Flooded	Vegetation (Natural) Forests, Shrubs, Grassland	Infrastructure (Man-made) Urban Areas, Roads, Other Structures	Solid Earth Rock/Soils Topography	Water Availability Water Bodies, Snow, Ice	Geo-Hazards Forest Fires, Volcanoes, Floods
Spectral Band Coverage	<u>Mapping/ Characterization</u> Visible, NIR, SWIR* (IGOL 4.6.1, par. 1)	<u>Ecosystem Function</u> Hyperspectral (Decadal, pg 7-11)	<u>Urban Mapping / Growth Tracking</u> Landsat, SPOT bands, SAR (IGOL 4.8.2)	<u>Surface Composition</u> Hyperspectral, TIR (Decadal, pg 8-21)	<u>Snow Amount Estimation</u> Optical, thermal, and microwave (IGOL 4.6.1, par. 2)	<u>Rapid Post-Burn and Agricultural Flooding Assessment</u> Visible, Infrared, and Microwave (IGOL 4.4.1.1, par 4 and 4.6.1, par. 2)
Radiometric Accuracy	3% Goal/5% Threshold (Sentinel-2, par 3.11) <5% (NLIP, pg 33) (Landsat User Survey, pg 24)	3% Goal/5% Threshold (Sentinel-2, par 3.11) <5% (NLIP, pg 33) (Landsat User Survey, pg 24)	<5% (NLIP, pg 33) (Landsat User Survey, pg 24)	<5% (NLIP, pg 33) (Landsat User Survey, pg 24)	<5% (NLIP, pg 33) (Landsat User Survey, pg 24)	<5% (NLIP, pg 33) (Landsat User Survey, pg 24)
Spatial Resolution	<u>Mapping/Monitoring</u> Regional scale: 10m - 30m Global scale: 100m - 500m (IGOL 4.6.1, par.2)	<u>GSE Forest Monitoring</u> 10 meter Europe/other continents (Sentinel-2, par. 2.3)	<u>GSE Risk/EOS Assets Mapping</u> 5-10m (Sentinel-2, par 2,3)	<u>Surface Composition</u> 50-75m (Decadal, pg 8-21)	<u>Seasonality and Intensity of Irrigation</u> 10m - 30m (IGOL 4.9.4)	<u>Rapid Post-Burn and Flood Assessment</u> 10m - 30m (IGOL 4.4.1.1, par. 4) <20m (IGOL 4.4.3.5) 5-10m (Sentinel-2, par 2.3)
Geolocation Accuracy	<65m uncertainty (NLIP, page 33)	<65m uncertainty (NLIP, page 33)	<65m uncertainty (NLIP, page 33)	<65m uncertainty (NLIP, page 33)	<65m uncertainty (NLIP, page 33)	<65m uncertainty (NLIP, page 33)
Desired Repeat Frequency	<u>Mapping / Monitoring / Characterization</u> 5-10 day return period, cloud-free coverage (10m - 20m) (IGOL 4.6.6)	<u>Ecosystem Function</u> 30-day, or pointable to daily (Decadal, pg 7-11)	<u>Human Settlement "Footprints"</u> Update at or near annual increment (IGOL 4.8.1, par.1)	<u>Surface Composition</u> 30-day, pointable to daily (Decadal, pg 8-21)	<u>Irrigated Area Observation</u> Biannual ("moderate" res.) - Decadal ("fine" res.) (IGOL 4.9.1.1, par. 2)	<u>Rapid Post-Burn Assessment</u> Within 48 hr. of fire (IGOL 4.4.1.1, par. 4)

(EXAMPLE)
Preliminary Guidelines for Mid-Resolution LSI Satellite Systems

		MINIMUM	RECOMMENDED
Space Segment	Spectral Band Coverage	3 VNIR, 1 SWIR	≥4 VNIR, ≥2 SWIR, ≥2 TIR, 2 Atm correction bands
	Radiometric Accuracy	<15 %	<5%
	Spatial Resolution	30m	10 - 15m
	Geolocation Accuracy	500m	50 m
	Geographic Coverage (swath width)	≥ 60km	100 to 200 km
	Desired Global Repeat Frequency	4 Days (Constellation)	2 days (Constellation)
Ground Segment	Processing Level Provided	L1B	L1B-Orthorectified, L0 with metadata, and other derived information products TBD
	Plans to Archive Data	3 months at local direct downlink station	Permanently by each participating satellite provider
	Search/Order Method	On-Line (Internet)	Through GEO Web Portal
	Metadata/Formatting Standards	KML and JPEG2000	KML, JPEG2000, GEOTIFF, HDF, NetCDF
	Product Delivery Method	3-day turnaround; Internet delivery	24-hour turnaround; Internet delivery, with hard media (DVD) option
Data & Ops Policies	Data Use Restrictions	Minimal, consistent with pricing policy	None, consistent with national law
	Distribution Policies (includes pricing)	Non-discriminatory access; tiered pricing, with some free data for education and research	Non-discriminatory access; free (or nearly so) to virtually all
	Acquisition Strategy	Bilateral agreements between satellite operators and local downlink station holders	Global, based on an international LTAP strategy with some opportunities for user data acquisition requests
	General	Standard product and metadata availability	Standard products, metadata, algorithms

DRAFT
**Agreement by Member Agencies
of the Committee on Earth Observation Satellites
that Currently Operate
Mid-Resolution Land Surface Imaging Satellite Systems
to Provide Limited Amounts of Data
to the Forest Resource Assessment 2010 Project**

Background

The Committee on Earth Observation Satellites (CEOS) Land Surface Imaging (LSI) Constellation seeks to promote the efficient, effective, and comprehensive collection, distribution, and application of space-acquired image data of the global land surface, especially to meet societal needs of the global population. An important 2007 objective of the LSI Constellation Study Team is to facilitate and expedite the completion of the United Nations Food and Agriculture Organization's (UN FAO) Forest Resource Assessment 2010 (FRA2010) Project by providing coordinated and complementary access to the global land surface imaging data needed to complete the assessment.

The primary remotely sensed data set being used by the FRA2010 Project for the global forest assessment is the Tri-Decadal Global Landsat Orthorectified data set that includes global coverage from approximately 1975, 1990, and 2000, as well as the new Mid-Decadal Global Land Survey data set. The FRA2010 is looking to the CEOS LSI Constellation member agencies that possess mid-resolution land surface image data for the period 1972 to present to provide data to cover gaps in the primary data sets. The FRA2010 project currently is identifying the specific gaps in the data sets that must be filled by data provided by LSI Constellation agencies, but that work is not yet complete.

However, it is possible to estimate the total amount of data required from LSI Constellation agencies to fill gaps in the primary FRA2010 data sets. The FRA2010 will employ a 1°-by-1° grid sampling strategy to achieve their global forest assessment. The sample area within each 1°-by-1° cell is 20km-by-20km. Excluding desert regions of the earth, data covering approximately 9000 20km-by-20km cells will be needed for four epochs. For the Mid-Decadal Global Land Survey, it is estimated that data for up to 10% of the 20km-by-20km cells may be needed from LSI Constellation agencies and lesser amounts for other epochs. That is, mid-decadal data covering approximately 900 20km-by-20km cells may be needed from LSI Constellation agencies. Adding potential data needs for the earlier epochs, this agreement seeks to ensure provision of mid-resolution land surface image data for up to 1000 20km-by-20km FRA2010 sample cells.

Proposal

CEOS member agencies that currently operate mid-resolution LSI satellite systems and possess archives of mid-resolution LSI data for the period 1972 to present will cooperate to collectively provide the data needed by the FRA2010 Project to fill gaps in their primary land remotely sensed data set. These agencies will provide up to 1000 mid-resolution image samples with minimum dimensions of 20km-by-20km ground coverage for specific locations designated by the FRA2010 Project. The maximum number of 20km-by-20km image samples that any single CEOS agency will be asked to contribute is 400.

Agreement

The undersigned CEOS space agencies agree to cooperate together to provide to the FRA 2010 Project as many as 1000 20km-by-20km optical image samples collected between 1972 and the present by mid-resolution LSI satellite systems we separately operate. Individually, the undersigned agencies agree to provide up to 400 such images samples with minimum ground coverage dimensions of 20km-by-20km, as needed to fill gaps in the primary FRA2010 sample data set. Data provided to the FRA2010 Project under this agreement will be used for the sole purpose of conducting the global forest assessment studies described in the FRA 2010 Project Plan.

SIGNED:

Centre National d'Etudes Spatiales

Chinese Academy of Space Technology

Comisión Nacional de Actividades Espaciales

Instituto Nacional de Pesquisas Espaciais

Indian Space Research Organization

Japan Aerospace Exploration Agency

U.S. National Aeronautics and Space Administration

U.S. Geological Survey, U.S. Department of Interior