THE PROGRESS AND CURRENT STATUS OF ISO STANDARD DEVELOPMENT PROJECT 19130-SENSOR AND DATA MODELS FOR IMAGERY AND GRIDDED DATA

Liping DI [a], Wolfgang Kresse [b], Ben Kobler [c]

[a] Laboratory for Advanced Information Technology and Standard (LAITS),George Mason University, 9801 Greenbelt Road, Suite 316-317, Lanham, MD 20706, USA
lpd@rattler.gsfc.nasa.gov
[b] University of Applied Sciences, Neubrandenburg, Germany
kresse@fh-nb.de
[c] NASA Goddard Space Flight Center, Code 423, Greenbelt, MD 20771, USA
kobler@gsfc.nasa.gov

Commission II, WG II/4

KEY WORDS: ISO, Standard, Sensor Model, Data Model, Remote Sensing

ABSTRACT:

In March 2001 the ISO TC 211 approved a project to develop an international standard on sensor and data models for imagery and gridded data. The project and the standard to be developed were designated as ISO 19130. The standard will specify a sensor model describing the physical and geometrical properties of each kind of photogrammetric, remote sensing and other sensors that produces imagery and gridded data. It will also define a conceptual data model that specifies, for each kind of sensors, the minimum content requirement and the relationship among the components of the content for the raw data that was measured by the sensor and provided in an instrument-based coordinate system, to make it possible to geolocate and analyze the data. The standard will be applicable to most low-level remote sensing data. Since the form of project team in March 2001, significant progress has been made for drafting the international standard. The latest version of working draft of the international standard is version 2 released to members of the project team for comments in March 2002. This paper describes the progress and the current status of ISO 19130 project, the content of the standard in the working draft 2, and the future plan. As the leaders of ISO 19130 project, we invite the international remote sensing community to participate in the development of this new ISO standard.

1. INTRODUCTION

Government mapping and remote sensing agencies and commercial data vendors produce, archive, and distribute large amounts of imagery and gridded data collected by photogrammetric, remote sensing and other instruments. For example, NASA EOS program generates more than one terabyte of data per day by various remote sensors [Asrar and Greenstone,1995]. Such data need to be further processed in order to derive useful information from them. To facilitate the further processing of data, useful metadata have to be available with the data.

Current scientific research and applications, such as global environmental monitoring, call for integrated analyses of data from multiple sources [Asrar and Dozier,1994]. This requires the interoperability of data from multiple sensors and data producers. In order to achieve the interoperability, standards for imagery and gridded data have to be developed. In the past several years, data producers, nations, and some international bodies worked on this problem and produced some internal standards in this area [Di, etal 2000; FGDC, 1999; Di and Kobler, 2000; FGDC, 2001;DIN; OGC, 1999]. However, there is no international standard available. In order to fulfill this gap, ISO TC 211 approved a standard development project for developing an international standard on the Sensor and Data Models for Imagery and Gridded Data. The standard, designated as ISO 19130 "Sensor and Data Models for Imagery and Gridded Data", will specify a sensor model describing the physical and geometrical properties of each kind of photogrammetric, remote sensing and other sensors that produces imagery type (two dimensions or higher) of data. It also defines a conceptual data model that specifies, for each kind of sensor, the minimum content requirement and the relationship among the components of the content for the raw data that was measured by the sensor and provided in an instrument-based coordinate system, to make it possible to geolocate and analyze the data. The standard will also address sensor models for scanned synthetic source imagery, such as scanned paper maps, and the registration and correction parameters for such data. This paper gives a brief history and efforts of ISO TC 211 on developing international standards related to geospatial imagery as well as the ISO 19130. Then the paper describes in details the contents of the latest working draft of the standard, version 2. We invite comments and inputs from ISPRS for further improvement of the working draft.

2. ISO TC 211 AND THE HISTORY OF ISO 19130 PROJECT

ISO TC 211 is a technical committee under the International Organization for Standardization (ISO). It is responsible for setting international standards on geographic information [ISO TC 211]. The early stage of the TC 211 efforts was mostly concentrated on developing international standards for feature-based geographic information. In 1997, ISO TC 211 started to work on the imagery and gridded data area through project 19121, Imagery and Grid Data. The purpose of this ISO stage-0 project was to develop a type-3 report, which addresses the manner by which TC 211 should handle imagery and gridded data in the context of the field of geographic information [ISO TC 211]. The project was finished in 1999 and produced an ISO technical report on imagery and gridded data. As a result of ISO 19121 study, a new project, ISO 19124-Imagery and Gridded Data Components, was started in 1999 to identify areas of new standards needed for imagery and gridded data. The work also identified aspects of existing parts of the family of standards that need to be expanded to address imagery and gridded data [ISO TC 211]. The project was finished in 2000 and produced a review summary that summarized the areas for standardization in imagery and gridded data. One of areas identified in the review summary is the need for an international standard in the sensor and data models for imagery and gridded data [ISO TC 211].

Based on the conclusion of project 19124, we proposed in November 2000 a new ISO project, through now disbanded Working Group I (WG-1) of ISO TC 211, to develop an international standard on sensor and data models for imagery and gridded data. The project was approved by TC 211 member countries and assigned to ISO TC 211 WG-1 at 12th ISO TC 211 Plenary in March 2001. The project team was formed at the same time with the leadership of Dr. Liping Di of USA as the project chair and Dr. Wolfgang Kresse of Germany as the editor [ISO TC 211]. At the end of May 2002, the project team consists of 28 experts from eight TC 211 member countries and five Class-A liaison organizations. These countries are Australia, Canada, Germany, Malaysia, Saudi Arabia, South Africa, Thailand, and USA. The five liaison organizations are Open GIS Consortium (OGC), the International Society for Photogrammetry and Remote Sensing (ISPRS), the International Hydrographic Organization (IHO), Committee on Earth Observing Satellites (CEOS), and Digital Geographic Information Working Group (DGWIG).

The project team has held three team meetings and produced two versions of the working draft, the version 1 and version 2 since its formation. The first project team meeting was hold in Berlin, Germany in June 2001 as a joint meeting between ISO 19130 and ISPRS Working Group II/4. The meeting discussed the development plan based on the standard outline attached in the original project proposal. The meeting assigned individual tasks to individual experts for writing sections of the first working draft. The working draft version 1 (WD-1) was developed and distributed to the members of the project team as well as members of TC211 working group 1 for comments in September 2001. The second project team meeting was held, in conjunction with 13th ISO TC 211 Plenary in Adelaide, Australia in October 2001. The main focus of the second project team meeting was to discuss WD-1 and to plan the further development. Large numbers of comments and suggestions were received from the members of the project teams as well as observers from TC 211 member countries. Meanwhile, during the Adelaide Plenary ISO TC 211 was reorganized. Four working groups were disbanded, including WG-1, and four new working groups were created, including WG-6, Imagery. Project 19130 was assigned to WG-6. After the Adelaide meeting, the project team concentrated on the development of the second working draft (WD-2) of the standard. The working draft version 2 was developed and distributed to project team members in March 2002. The third project team meeting was held in Bangkok in conjunction with the 14th ISO TC 211 Plenary in May 2002. The meeting was mainly on discussing WD-2 and the comments. The meeting decided that the project team should concentrate on re-organizing the WD-2 in a formal way to comply with the style of ISO standards since WD-2 contained enough information for the project team to further develop the standard.

3. THE WORKING DRAFT VERSION 2 OF ISO 19130

Currently, the working draft version 2 is the latest draft of ISO 19130. It represents significant improvement over WD-1. WD-2 was not only added more types of sensors into the standard, but also reorganized the structure in the draft and improved the writings in the existing clauses/paragraphs. It consists of ten normative clauses and four informative annexes and one informative introduction. The types of sensors defined in the draft include frame camera, scan linear array sensor, SAR, Lidar, hydrographic sonar, and paper scanner. For each type of sensors, a set of parameters is defined for describing the physical and geometric properties of the type of sensors. A set of coordinate systems necessary for geolocating the sensor data to Earth locations is also defined. The data model specifies the minimum content requirements for the raw imagery and gridded data, which are measured by the sensors defined in this standard and still in the sensor coordinate system. It also defines the methods for describing the relationship between components of the data content. The data model also discusses the treatment of optional auxiliary information or metadata. The following subsections provide the descriptions of each clause in WD-2 of ISO 19130.

3.1 Scope

This clause defines the scope of ISO 19130 standard:

1. It will specify a sensor model describing the physical and geometrical properties of each kind of photogrammetric, remote sensing and other sensors that produces imagery data.
2. It will define a conceptual data model that specifies, for each kind of sensor, the minimum content requirement and the relationship among the components of the content for the raw data that was measured by the sensor and provided in an instrument-based coordinate system, to make it possible to geolocate and analyze the data.

3.2 Conformance

This clause defines the conformance classes for complying with the international standard. Since ISO 19130 defines the standard in two related areas: sensor models and data models, this clause defines separate conformance classes in each area. For sensor models, there is a separate conformance classes for each sensor. For data models, there is a separate conformance class for each type of model. To conform to this International Standard, an implementation shall satisfy the general requirements for sensor and data models and shall also satisfy the specific requirements for the sensor and data model appropriate to the implementation.

3.3 Normative References

This clause defines a suite of ISO standards that are normative to ISO 19130. For those who use ISO 19130, they also need to comply with all other ISO standards listed in this clause. The following is the list of standards currently in the clause.

ISO 19107, *Geographic information — Spatial schema (DIS)*
ISO 19111, *Geographic information — Spatial referencing by coordinates (FDIS)*

ISO 19113, *Geographic information — Quality principles (FDIS)*
ISO 19115, *Geographic information — Metadata (DIS)*
ISO 19116, *Geographic information — Positioning services (2^{nd} CD)*
ISO 19117, *Geographic information — Portrayal (DIS)*
ISO 19118, *Geographic information — Encoding (2^{nd} CD)*
ISO 19123, *Geographic information — Schema for coverage geometry and functions (CD)*
ISO 19129, *Geographic information — Imagery, gridded and coverage data framework (WD)*

Based on ISO rules, if standards listed in this clause are dated, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references of standards, the latest edition of the normative document referred to applies. Currently all standards in this clause are undated references.

3.4 Terms and Definitions

This clause defines all terms used in this ISO standard that are not defined in the ISO 19100 suite of standards.

3.5 Symbols and Abbreviated Terms

This clause defines all symbols and abbreviated terms used in this ISO standard that are defined in other ISO 19100 suite of standards.

3.6 Coordinate Systems

The WD-2 defines a set of coordinate systems necessary for geolocating pixels on Earth. By definition these coordinate systems are bound to a physical unit. The coordinate systems are used as a reference for related metadata and for doubtless transformations. The coordinate systems used for geolocating pixels are grouped into two groups: image and Earth. The following listing contains the names of the coordinate systems currently defined in the WD-2.

Name of coordinate system	*Short name*
Image coordinate systems	**IMA**
• Frame camera	FRA
o Analogue frame camera	AFC
o Digital frame camera	DFC
o Model	MOD
• Scan linear array	SLA
o Viewing plane	VIP
• SAR and InSAR	SAR
o Slant range	SLR
o Ground range	GRR
o Interferogram	INF
• Points	POI
• Scanner	SCA
Earth coordinate systems	**ECS**
• Coordinate reference system	CRS
o Geodetic	GED
o Projected	PRJ
o Cartesian	CAR
• Compound coordinate reference system	CCRS

3.7 Classification of Sensor Types

There are many different sensors currently used in remote sensing. In order to simplify the standard setting, those sensors have to be classified into sensor types. There are many ways for classifying remote sensing sensors into sensor types. They can be classified, for example, based on their mounting platforms such as spaceborne and airborne, on their physical properties such as optical and electro-optical, or on detector types such as visible-near infrared and thermal. ISO 19130 classifies remote sensing sensors based primarily on the geometrical properties of the sensor that are used to derive the geographic or map location of a pixel. Sensors of a given geometry are further classified by their platforms and their physical properties. For each class of sensors, the standard provides a general description of the sensors so that users of this standard can easily find the class their sensor belongs to. The following sensor types are currently described in WD-2: frame camera, scan linear array, SAR, Lidar, hydrographic sonar, and paper and film scanners. Additional sensor types may be added into the future working drafts.

- Frame Camera. The frame camera is the classical photogrammetric camera. The original data are stored on a photographic film together with the image of a frame that represents the camera (sensor-) coordinate system. Latest developments have replaced the film by a CCD-array. In this case the “frame” is obsolete.
- Scan linear array. The sensor detects radiation from objects. The heart of this sensor is a linear array of sensor elements that is moved across to the direction of movement. The image is created by putting the lines together forming a long strip-like image.
- Synthetic Aperture Radar (SAR) / Interferometric SAR. The sensor measures the distance to an object using radio signals. With the known position and attitude of the sensor the position of the object can be derived. The intensity of the reflectance allows distinguishing between different objects. The synthetic aperture and the interferometry allow better angular resolution of the sensor.
- Lidar. The sensor measures the distance to an object using light. With the known position and attitude of the sensor the position of the object can be derived. The term lidar means light detection and ranging.
- Hydrographic Sonar. The sensor detects sound that has been generated by an artificial transmitter and than reflected by the marine bottom. The heart of this sensor is a linear array of sensor elements that is moved across to the direction of movement. The geometry of the sensor model is similar to the swath/pushbroom-case.
- Paper and Film Scanners. Those scanners convert analogue originals into a digital representation. Linear and area CCD-arrays are in use. In most cases paper scanners have larger formats as the film scanners. Otherwise in most cases the film scanners have a higher geometrical and radiometric accuracy.

3.8 Platform Information

This clause standardizes the way of describing the platform that carries remote sensors. The platform information required for determining pixel geolocation includes platform’s position and attitude, and the sensor position and orientation relevant to platform. The position of a remote sensing platform at a given time is defined by a position vector in a three dimensional space. The vector is measured relative to a reference coordinate system such as the Earth Centred Inertial (ECI) System and geodetic system (latitude/longitude). If the platform is a spacecraft, its position can be determined by orbital characteristics. The spacecraft’s orbital tracking data are received by ground stations and are used to determine the platform’s instantaneous position and velocity. If the platform is airborne/landborne/shipborne, its position is determined by platform's internal flight/tracking/cruising control system or global positioning system. The attitude of a remote sensing platform at a given time is defined by its instantaneous orientation in a 3-dimensional space in respect to known reference such as celestial and inertial references. Attitude motion describes the attitude evolution around its centre of mass.

3.9 Sensor Model

For each class of the sensors defined in the clause of classification of sensor type, the sensor model clause standardizes the name, definition, and unit of parameters necessary for geolocating the data, collected by the class of sensors, by rigorous georeferencing methods based on the position and attitude of the measuring instrument. The kind of parameters to be defined is dependent on the sensor type. For example, for frame camera, parameters describing the interior and exterior orientations will be defined. The interior orientation describes the hardware specifications of the camera including the focal length, the principle point, and the distortion. These parameters are required to quantitatively specify those physical properties of the frame camera required for a rigorous georeferencing derived from the conditions of the measurement. The exterior orientation describes the transformation between the sensor coordinate system and an object related coordinate system.

3.10 Data Model

The data model specifies semantic definitions of a set of data objects and of the relationships among them [FGDC,1999]. In this ISO standard, the data model will define the minimum content requirement and the relationship among the components of the content for data products produced by the sensors defined in the sensor model section for making it possible to geolocate the data. Those definitions are at the conceptual level, and the standard will not define encoding methods for those data.

The minimum content (the data objects) for data products produced by a sensor defined in this standard will include the instrument readings and the geolocation information. Additional data objects include the radiometric and calibration information.

The instrument readings specify the source data that are generated by the sensor. The geolocation information contains necessary metadata for geolocating the instrument readings. At least one of the following sets of geolocation information has to be presented with the instrument readings: the parameters defined in the sensor model and platform information sections of this standard for the rigorous methods of geolocating, the ground control points, the polynomial or other fitting functions for converting image coordinate to Earth coordinate, or Earth coordinate for each pixel in an image. The radiometric and calibration information provides necessary functions and parameters necessary for converting instrument readings to energy units or geographical/geophysical quantities.

The standard will also define the ways for describing the relationship between geolocation (and optional radiometric and calibration) information and the instrument readings. The description will tell how to apply geometric and radiometric data to instrument readings. An example is the frequency or the density of the geometric information to the instrument readings.

4. CONCLUSIONS AND FUTURE PLAN

ISO 19130 is one of important international standards in remote sensing currently under development. Successful development of the standard will make the interoperability of remote sensing data produced by data producers around the world possible.

From current WD-2 to an official international standard, ISO 19130 still has a long way to go. We plan to produce WD-3 by September 2002. WD-3 will be discussed and further refined at the 4th project team meeting in South Korean in November 2002, in conjunction with 15th ISO TC 211 plenary. During the meeting we will decide if we should advance WD-3 to Committee Draft version 1 (CD-1) or produce WD-4. The current plan calls for ISO 19130 to become a draft international standard (DIS) in September 2003, a formal draft international standard (FDIS) in April 2004 and an international standard (IS) in July 2004.

Because ISO 19130 will cover wide range of sensors used in remote sensing, the project team needs inputs from experts of those sensors. As the leaders of this new ISO TC 211 standard project, we invite the international remote sensing community to participate in the development of this standard.

REFERENCES

Asrar G. and Dozier J., 1994. *EOS: Science Strategy for the Earth Observing System*, American Institute of Physics Press, Woodbury, New York 11797.

Asrar G. and Greenstone R.,1995. *MTPE EOS Reference Handbook*, NASA Goddard Space Flight Center, Greenbelt, MD 20771.

DI L. and Kobler B., 2000. NASA Standards for Earth Remote Sensing Data, *International Archives of Photogrammetry and Remote Sensing (IAPRS)*, Vol. XXXIII, ISPRS. CD-ROM publication 9.

DI L., Schlesinger B. and Kobler B., 2000. U.S. FGDC Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata, *International Archives of Photogrammetry and Remote Sensing (IAPRS)*, Vol. XXXIII, ISPRS, CD-ROM 4.

DIN, *Photogrammetrie und Fernerkundung*, 18716-1, 18716-2, 18716-3, Deutsches Institut für Normung.

FGDC, 2001.*Content Standard for Digital Geospatial Metadata, Extensions for Remote Sensing Metadata*, draft standard under public review, Reston, Virginia.

FGDC, 1999. The FGDC Content Standard for Remote Sensing Swath Data, *FGDC-STD-009-1999*. Reston, Virginia.

ISO TC 211, http://www.isotc211.org.

OGC, Open GIS Consortium Abstract Specification - 99-AS-RFP009 Topic-7 Earth Imagery, http://www.opengis.org.