THE CURRENT STATUS AND FUTURE PLAN OF THE ISO 19130 PROJECT

Liping Di [a*], Wolfgang Kresse [b], Ben Kobler [c]

[a] Laboratory for Advanced Information Technology and Standards (LAITS),George Mason University, 9801 Greenbelt Road, Suite 316-317, Lanham, MD 20706, USA – ldi@gmu.edu
[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 ISO TC 211 approved a project to develop an international standard: ISO 19130- Sensor and Data Models for Imagery and Gridded Data. Since August 2002 when the project status was reported at the ISPRS Commission II Symposium, the project has made significant progress. The standard has been advanced from the working draft (WD) stage to the committee draft (CD) stage. This paper discusses the current status of the ISO 19130 project, the content of ISO 19130 CD version 1, and the future plan for both ISO 19130 and new remote sensing standards.

1. INTRODUCTION

ISO TC 211 is a technical committee under the International Organization for Standardization (ISO). It is responsible for setting international standards on geographic information [1]. In March 2001, ISO TC 211 approved a new standard project for setting an international standard on Sensor and Data Model for Imagery and Gridded Data. The standard is designated as ISO 19130. The scope of the standard includes 1) specifying a sensor model describing the physical and geometrical properties of each kind of photogrammetric, remote sensing and other sensors that produces imagery data; and 2) defining 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. Meanwhile, a project team, consisting of 37 experts nominated by 16 ISO TC 211 national members and liaison organizations, was formed to undertake the task of developing the standard.

So far, the project team has produced five versions of the working draft. The development status was reported at several international conferences [2][3]. Since this standard is a member of the ISO 19100 series of standards, during the development of the standard the project team has worked closely with other ISO TC 211 project teams, especially ISO 19115-2 Metadata - Part 2: Extensions for imagery and gridded data [4] and Harmonized Model Maintenance Group (HMMG)[5] to harmonize this standard with other standard. The project team has also worked with Open GIS Consortium (OGC)'s Sensor Model Language (SensorML) [6] team to ensure the compatibility between ISO 19130 and SensorML and to enable the use of SensorML as one of the implementations of ISO 19130.

The project team submitted the latest version of working draft to ISO TC 211 Secretariat on January 23, 2004 as the CD version 1.0. This paper discusses the contents of ISO 19130 CD-1, and the future plan for both ISO 19130 and new remote sensing standards.

2. THE COMMITTEE DRAFT VERSION 1 OF ISO 19130

Currently, the committee draft version 1 (CD-1) is the latest draft of ISO 19130. It represents significant improvement over Working Draft version 2 (WD-2) reported at [3]. The ISO 19130 CD-1 includes twelve normative clauses, one normative annex, one informative annex, and an informative introduction. For Clauses 1-5, there is no significant change from WD-2 to CD-1. The most significant changes and reorganization of the standard have been taken place in Clauses 6-12. The following subsections discuss those clauses.

2.1 Georeferenceable dataset (Clause 6)

This intention of this clause is to provide the overall view of the standard and a top level UML model (figure 1) to show how each classes defined in the standard can be assembled together.

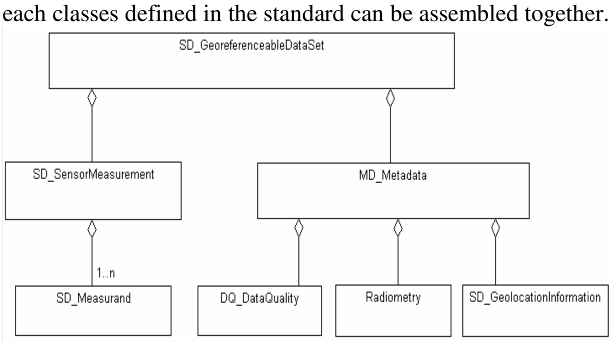

Figure 1. The top-level UML class diagram of ISO 19130.

As shown in Figure 1, ISO 19130 deals with SD_GeoreferenceableDataSet class. All classes defined in ISO 19130 have a prefix SD. A georeferenceable dataset is defined as a geospatial data product that is not georectified but contains sufficient geolocation information so that the georectification process is possible. ISO 19124 review summary discussed the concept of the georeferenceable dataset [7], and the ISO 19101-

---

* Corresponding author

2 Imagery Reference Model will define the relationship between SD_GeoreferenceableDataSet and the overall geographic imagery [8]. A georeferenceable dataset consists of two parts: Data (SD_SensorMeasurement), and metadata (MD_Metadata). MD_Metadata is defined in ISO 19115 and the imagery related metadata are defined in ISO 19115-2 currently in the development [4]. Among all metadata classes relevant to SD_GeoreferenceableDataSet, Figure 1 shows the three ones that are specifically for the imagery and gridded data: DQ_DataQuality, Radiometry, and SD_GeolocationInformation. Among the three classes, ISO 19130 only defines SD_GeolocationInformation class. DQ_DataQuality and Radiometry classes, which are shown in Figure 1 as the placeholders, are not defined yet in ISO 19100 standards.

The class SD_GeolocationInformation is the superclass of all classes existing for georeferencing a dataset (Figure 2). This class has the three aggregated classes: SD_SensorModel, SD_FunctionalFitModel, and SD_GCPCollection. The class SD_GeolocationInformation is aggregated into the class MI_GeoreferencingDescription that is defined in the ISO 19115-2.

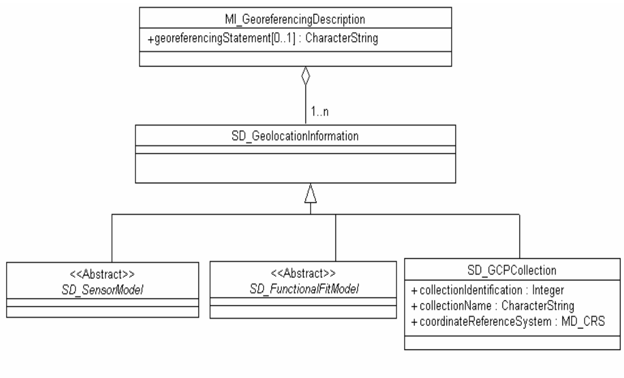

Figure 2 – UML class-diagram of the class SD_GeolocationInformation

2.2 Coordinate Systems (Clause 7)

The CD-1 defines a set of coordinate reference systems that are relevant for the sensors standardized in ISO 19130. These coordinate reference systems express positions in the following coordinate spaces: instrument space including scanner/profiler, area sensor, SAR/InSAR, lidar, and sonar; platform space; orbit space; stereomodel space; Earth centered inertial space; Earth centered rotating space; and projected space. Table 1 summarizes the coordinate reference systems defined in ISO 19130. The structure and the terminology for defining those reference systems are taken from the ISO 19111 (Spatial referencing by coordinates) [9].

Name of coordinate reference system	Short name
Line sensor coordinate reference systems	LIS
Focal plane coordinate reference system	FOP
Aft optical coordinate reference system	AFO
Scan mirror coordinate reference system	SCM
Telescope coordinate reference system	TEL
Area sensor coordinate reference systems	ARS
Stereo model coordinate reference systems	SMO
Platform coordinate reference systems	PLA
Orbital coordinate reference systems	ORB
Paper and film scanners coordinate reference systems	SCA
Earth centered inertial coordinate reference system	ECI
Earth centered rotating coordinate reference system	ECR
Projected coordinate reference system	PRO

Table 1. Coordinate reference systems defined in ISO 19130

2.3 Sensor Types (Clause 8)

Many different sensors are currently used in remote sensing. In order to simplify the standard setting, ISO 19130 classifies sensors into types based primarily on the geometrical properties of the sensor. For each type 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 CD-1: scan linear array, pushbroom array, digital frame camera, frame camera, paper and film scanner, and virtual sensor (Figure 3). The virtual sensor provides general attributes of a sensor in order to enable the use of this standard in the case of a new type of a sensor that will have been developed before a future version of this standard will be published. Other types of sensors, such as Synthetic Aperture Radar (SAR), Interferometric SAR (InSAR), Lidar, and hydrographic sonar, are also important in remote sensing sensors. However, the project team feels that the technology development for such sensors is still ongoing and therefore it is not appropriate to standardize those types of sensor in this standard.

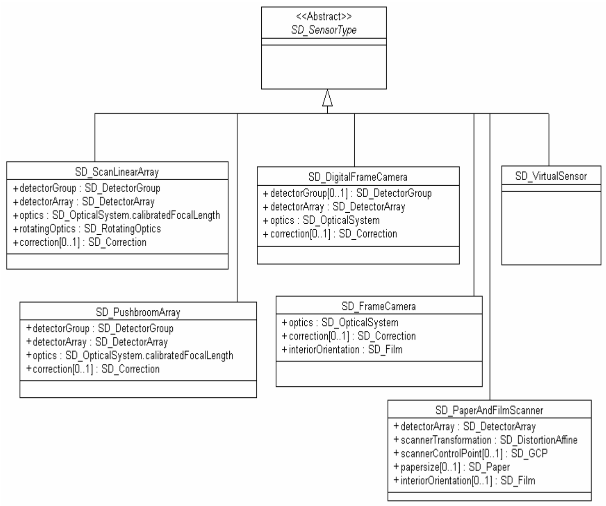

Figure 3. UML class-diagram of SD_SensorType

2.4 Location Model (Clause 9)

The location information described in this clause provides spatial relationships among the components of a sensor, between sensor and platform, between a sensor and the Earth, and between a platform and the Earth. The standard models the location of an object (either moving or stationary) in a coordination reference system by three components: position, attitude, and motion (Figure 4).

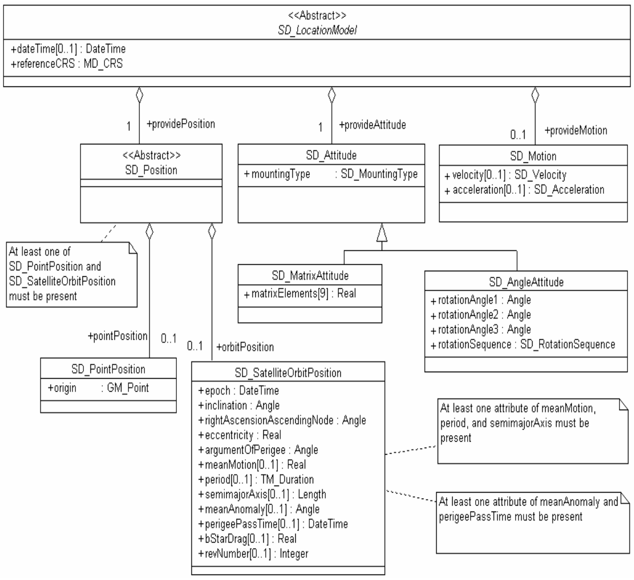

Figure 4. UML class diagram of SD_LocationModel

The standard defines two ways to provide the position of an object. The first way is to provide a position vector (SD_PointPosition). In the case of satellites, an alternative way is to provide the orbital parameters as well as the date/time at which the satellite position is to be determined. In SD_Attitude class, two subclasses are defined for providing the attitude information. The first one is SD_MatrixAttitude that defines the attitude of an object through a 3 by 3 rotation matrix. The second one is SD_AngleAttitude that defines the attitude by the angles of roll, pitch, and yaw and the rotating sequence. The motion of an object (SD_Motion) is defined by the velocity (SD_Velocity) and the acceleration (SD_Acceleration) vectors in the three-dimensional space.

2.5 Sensor Constituents (Clause 10)

This clause was called Sensor Models in WD-2. We have made significant changes in this clause since WD-2. Instead of defining individual sensor model for each senor type independently, we define a sensor model super-class and define individual sensor model as the profile of the super-class (Figure 5). SD_SensorModel consists of five component classes: SD_LocationModel, SD_SensorComponent, SD_SensorType, SD_Platform, and SD_Process.

SD_LocationModel class was defined in Clause 9, which provides the spatial relationship among sensor components and between the sensor and the platform. The common classes used to construct individual sensor types have been grouped under SD_SensorComponent class as the subclasses. This kind of arrangement has two benefits: 1) avoiding the repeating definition of common classes in individual sensor models; and 2) allowing the construction of new sensor models by using the components to cover sensors whose models are not defined in the standard. SD_SensorType defines the individual sensor models for each type of sensors defined in Clause 8 by using the classes defined in SD_SensorComponent and its subclasses. SD_Platform provides information about the platform that carries the sensor. Two types of platforms are defined as the subclasses of SD_Platform: SD_StationaryPlatform and SD_DynamicPlatform. The SD_LocationModel class is used in the SD_Platform class to specify the platform position and attitude. SD_Process provides the parameters required for describing the process by which a sensor provides data. The parameters include the timing for a measurement and the samples of individual scans. SD_Process includes three subclasses, namely SD_LinearScanProcess, SD_PushbroomProcess, and SD_ImageProcess.

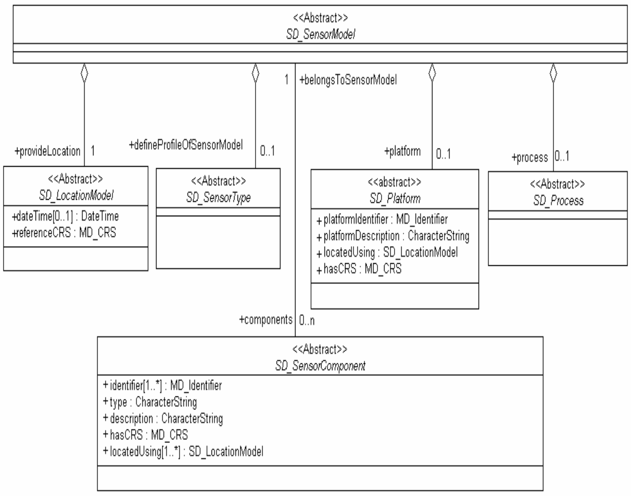

Figure 5. UML class diagram of SD_SensorModel

2.6 Data Model (Clause 11)

The data model specifies semantic definitions of a set of data objects and of the relationships among them [10]. In this ISO standard, the data model defines 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 doesn't define encoding methods for those data.

The required minimum content for georeferenceable datasets defined in this standard includes the instrument readings and the geolocation information. Additional data objects include the radiometric and calibration information (as place holder).

The instrument readings specify the source data that are generated by the sensor. The geolocation information contains necessary metadata for geolocating the instrument readings. The detailed requirement on geolocation information is defined in Clause 12. The radiometric and calibration information provides functions and parameters necessary for converting instrument readings to energy units or geographical/geophysical quantities.

The standard also defines ways for describing the relationship between geolocation (and optional radiometric and calibration) information and the instrument readings. The description tells 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. In addition, the standard also specifies the common data structure and organization used to host the imagery and gridded data.

2.7 Geolocation Information (Clause 12)

This clause defines the methods to provide geolocation information in georeferenceable datasets. The UML class diagram of SD_GeolocationInformation is shown in Figure 2. For any georeferenceable dataset, it must contain at least one of the three types of geolocation information, namely sensor model, functional fitting, and ground control points (GCPs).

The sensor model provides the sensor parameters defined in Clause 10 so that the rigorous geo-locating method can be performed.

Provision of a functional fit between image and geographic coordinates is an alternative to supplying the sensor model information. The functional fit may be derived from a sensor model and supplied to the user instead. Four types of functional fit models have been defined in the standard for geolocation: the polynomial model, the ratios of polynomial model, the universal real-time model, and grid interpolation model (Figure 6).

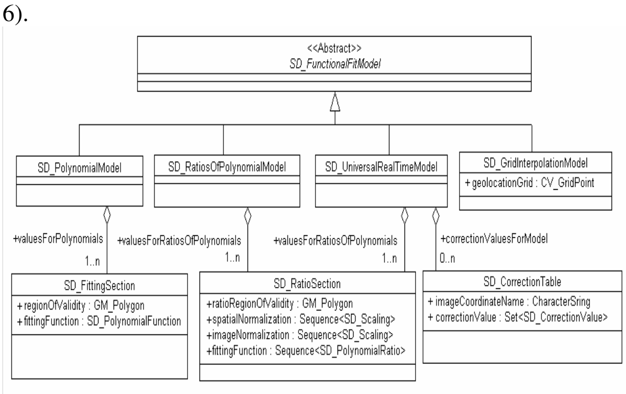

Figure 6. The UML class diagram of SD_FunctionalFitModel

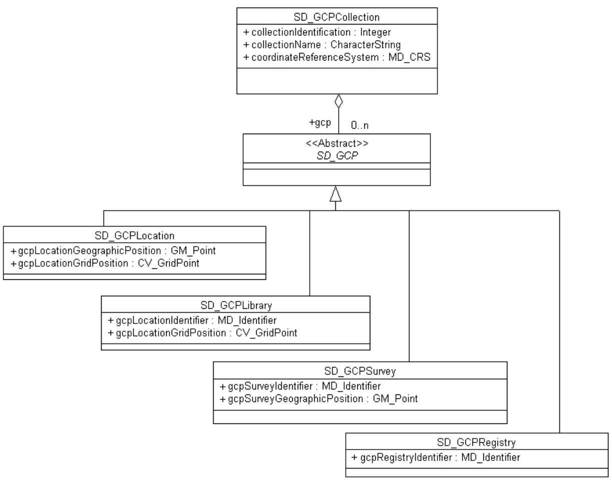

Figure 7. The UML class diagram of SD_GCPCollection

Ground control points (GCPs) provide the geographic location of specific cells/pixels in the imagery and gridded data. Four permissible ways of providing GCPs are defined in the standard. In the first method, a pixel/cell's sensor data coordinate (i.e., line, column), and the Earth location of the pixel in a Coordinate Reference System (i.e., x, y and the optional z) are provided. In the second, a ground control point identifier and a pixel/cell's sensor data coordinate (i.e., line, column) can be obtained. In the third, geographic location is obtained from the location on the map relative to a set of GCPs whose geographic location is known. In this case, a designation for the point and a geographic location are provided. GCPs may be either regularly or irregularly distributed in sensor coordinates. In the fourth, a ground control point identifier and a reference to an organization or a registry from which the Earth location corresponding to that identifier can be obtained. Such a method is used when the supplier of the geolocation information may wish to restrict access, for example for proprietary or military security reasons (Figure 7).

3. THE FUTURE PLAN

The ISO 19130 CD-1 is being voted by ISO TC 211 P-members. There are two possible outcomes from the vote: advancing the CD into the stage of Draft International Standard (DIS) inquiry or have another version of CD (CD-2). The project team felt although the CD-1 was quite complete it was not ready for DIS. The intention for the project team to release CD-1 is to solicit inputs and comments from international remote sensing and geospatial communities for improving the committee draft.

Based on ISO rules, once a standard reaches the CD stage, the project team will be automatically disbanded and an editing committee (EC) will be formed to edit the standard based on comments submitted by ISO TC 211 members and liaison organizations through the official channels. The EC consists of a chair, an editor, and members nominated by ISO TC 211 members. Traditionally, the convenor of the working group the project belongs to will become the chair of the EC and the chair of the standard development project team the editor. In the case of ISO 19130, the chair of the EC is C. Douglas O'Brien of Canada, and the editor Liping Di of USA.

The EC will hold its first meeting in conjunction with ISO TC 211 Plenary in Kuala Lumpur, Malaysia on May 25 and 26, 2004. During the 19130 CD-1 voting period, ISO TC 211 Secretariat has received about 400 comments. The EC meeting will go through those comments to determine if a comment should be accepted, rejected, or partially accepted. It is expected ISO 19130 CD-2 will be issued around September 2004.

As we discussed in this paper, ISO 19130 only standardizes the description of geometric property of remote sensors. Another important property of remote sensors is their radiometric property, which has not been standardized yet. The ISO 19130 data model has used a radiometry class (see Figure 1) as a placeholder. Consequently, ISO TC 211 Working Group 6 decided to initiate preparatory work for setting an ISO standard on radiometric calibration and validation of remote sensing data under the ISO 19130 project team. The decision was reported to the ISO TC211 Plenary in May 2003 [11]. So far the preparatory work has produced a new work item proposal (NWIP). It is expected that the new ISO project on radiometric calibration and validation of remote sensing data will be started at the end of 2004 or early 2005.

4. CONCLUSIONS

ISO 19130 is one of important international remote sensing standards currently under development. Successful development of the standard will make the interoperability of remote sensing data produced by data producers around the world possible. Because ISO 19130 will cover wide range of sensors used in remote sensing, the project team needs inputs and comments from experts. As the developers of this ISO standard, we invite the international remote sensing community to participate in the development of this standard.

REFERENCES

[1] ISO TC 211, http://www.isotc211.org.

[2]. Di, L., 2003. "The Development of Remote-Sensing Related Standards at FGDC, OGC, and ISO TC 211." *Proceedings of IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2003), July 21-25, Toulouse, France.* 4p.

[3] Di, L., W. Kresse, and B. Kobler, 2002. “The Progress and Current Status of ISO Standard Development Project 19130-Sensor and Data Models for Imagery and Gridded Data.” In Chen and Jiang, eds, *The International Archives of Photogrammetry, Remote Sensing, and Spatial Information Sciences*, Vol. XXXIV, Part 2, Commission II, pp 107-110.

[4] ISO 19115-2. Geographic information - Metadata - Part 2: Extensions for imagery and gridded data http://www.isotc211.org/Outreach/Overview/Factsheet_19115-2.pdf.

[5] ISO 19140. Geographic information - Technical amendment to the ISO 191** Geographic information series of standards for harmonization and enhancements. http://www.isotc211.org/Outreach/Overview/Factsheet_19140.pdf.

[6] Botts M., 2002. Sensor Model Language (SensorML) for In-situ and Remote Sensors. OGC 02-026r4. http://www.opengis.org/docs/02-026r4.pdf.

[7] ISO 19124. Geographic information - Imagery and gridded data components. Review Summary 2001-01: N 1017. http://www.isotc211.org/protdoc/211n1017.

[8] ISO 19101-2. Geographic information - Reference model - Part 2: Imagery. http://www.isotc211.org/Outreach/Overview/Factsheet_19101-2.pdf.

[9] ISO 19111.Geographic information - Spatial referencing by coordinates. http://www.isotc211.org/Outreach/Overview/Factsheet_19111.pdf.

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

[11] Di, L., 2004. “The Planned ISO TC 211 Standard Project on Radiometric Calibration and Validation of Remote Sensing Data.” In Morain S. etc eds, *Post-launch Calibrations of Remote Sensors*. A. A. Balkema Publishers, Netherlands (in press).