STANDARDIZATION IN PHOTOGRAMMETRY AND REMOTE SENSING

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Ad-hoc Group on Standards

ABSTRACT:

The range of photogrammetric and remote sensing technology has considerably widened during the past years. In particular, many new sensors have been put into operation, which ended the dominance of a few leading systems and their de-facto standards. The great variety of sensor types created a strong demand for worldwide sensor standards. Standards for imagery metadata, geopositioning, sensor networking, calibration, and certification are completed, in preparation, or planned.Another push for standardization came from GEOSS, the government supported world system for the integration of geo-technologies and -sciences. This effort requires new umbrella standards that better link neighbouring fields such as meteorology, agriculture, and computer science. GEOSS has founded a subgroup that is responsible for standardization, the "Standards and Interoperability Forum" (SIF).From the viewpoints of ISO and OGC photogrammetry and remote sensing are subclasses of geographic information. The new ISO-standards as well as the Sensor Web Enablement and other initiatives of the OGC will be portrayed. Other organizations in this field like GEOSS or the European expert group EuroSDR, European Spatial Data Research, will be addressed.

1. INTRODUCTION

After almost a century of de-facto standards in photogrammetry defined by the few leading companies the diversification of technology has strengthened the demand for widely accepted and officially branded standards. Many details are well known. With their enhanced spectral capabilities photogrammetric cameras may be applied for remote sensing tasks. The remarkable improvements in sensor technology allow the use of space borne sensors for photogrammetric applications. The public gained access to formerly classified defense technology. The series of classical photogrammetric film cameras was replaced by a great variety of digital systems and virtually new sensors like Lidar. The Internet fosters a formerly unknown quality of data integration that lead to popular systems like Google Earth and a strong public recognition of photogrammetry and remote sensing. Last but not least the mentioned sciences play an important role in meeting the present challenges of mankind like climate change and degradation of biodiversity.

The great complexity of the integration task may be the reason for a much longer standards development period than originally expected. While standardization of geographic information started in 1994 and first documents were published in 2001 the work on standards for photogrammetry and remote sensing took at least half a decade longer.

The out coming documents may be a lot different to what many experts thought of a decade ago. The demand for a standardized exterior orientation was one of the first steps. The final document in its present state contains a great variety of georeferencing approaches. OGC's SensorML was planned to become the implementation level of the ISO standard for the georeference of imagery. However, SensorML now covers any sensor that can be monitored via the Internet from space borne to water borne, from imagery to scalars like temperature and pressure.

The present suite of standards developed by ISO, OGC, and others represent a well defined base for photogrammetry and remote sensing. Because the practical experience is still very limited shortcomings of the documents combined with additional demands from the users are probable. Future updating processes will allow improving the alignment between the individual standards in particular across the borders between different organizations like ISO/TC 211 and the OGC.

The existing variety of standards makes it difficult to decide which standards applies for a given task and which processes need to be considered because they soon will relevant for standardization.

The International Organization for Standardization (ISO) is the official standardization body. The Technical Committee 211 (ISO/TC 211) is responsible for all standards in the field of geographic information / geomatics. All other standardization organizations are unofficial, but may have a strong influence on the market. Primarily the industry consortia like the Open Geospatial Consortium and the World Wide Web Consortium have done many important developments of de-facto standards. This causes sometimes a competitive situation which in the case of ISO/TC 211 and the OGC has been wisely solved with a cooperation agreement.

Other standardization groups like EuroSDR (European spatial data research) perform a lot of applied research and function as preparatory stage of the later standards developed by one of the worldwide organizations.

Since the formation of GEOSS (Global Earth Observation System of Systems) another type of standardization organizations has shown up. Formed by the Unites Nations the primary task of GEOSS is an integrated view on the world's ecological system in order to understand and eventually influence hazardous processes for mankind like the Earth's warming. Though

standardization is not GEOSS's primary focus the practical work soon leads to standards. This work tends to duplicate the activities of ISO/TC 211 because ISO formally connects the important players in a field as liaison-members. Therefore the participants in the GEOSS-process are liaison-members of ISO/TC 211 as well.

2. ISO/TC 211

The ISO/TC 211 "Geographic information / Geomatics" has widened its suite of standards from ISO 19101 "Reference model" to almost ISO 19150 including some numbers that stand for two standards like ISO 19115 "Metadata" and ISO 19115-2 "Metadata – Part 2: Extensions for imagery and gridded data". The first generation standards which are approximately those between ISO 19101 and ISO 19120 have passed their first five-year period and are in a review process accordingly. Newer developments deal with mobile systems.

The imagery standards have the following status:

Number	Name	Status by April 2008	Planned publication
ISO/TS 19101-2	Reference model – Part 2: Imagery	FDIS	2008
ISO 19115-2	Metadata – Part 2: Extensions for imagery and gridded data	DIS	2009
ISO/TS 19129	Imagery, gridded and coverage data framework	PDTS	2008
ISO/TS 19130	Geographic information – Imagery sensor models for geopositioning	PDTS	2009

TS = Technical Specification
FDIS = Final Draft International Standard
DIS = Draft International Standard
PDTS = Preliminary Draft Technical Specification

Table 1: Status of the imagery standards of ISO/TC 211

2.1 ISO/TS 19101-2 "Reference model – Part 2: Imagery"

This Technical Specification provides a reference model for processing of geographic imagery which is frequently done in open distributed manners. In terms of volume, imagery is the dominant form of geographic information. Large volumes of geographic imagery will not be portrayed directly by humans. Human attention is the scarce resource, and is insufficient to view petabytes of data. Semantic processing will be required: for example, automatic detection of features; data mining based on geographic concepts.

Information technology allows the sharing of geographic information products through processing of geographic imagery. Standards are needed to increase creation of products. A number of existing standards are used for the exchange of geographic imagery.

Currently a large number of standards exist that describe imagery data. The processing of imagery across multiple organizations and information technologies (IT) is hampered by a lack of a common abstract architecture. The establishment of a common framework will foster convergence at the framework level.

This Technical Specification provides a reference model for processing of geographic imagery which is frequently done in open distributed manners. The basis for defining an information system in this specification ISO/TS 19101-2 is the Reference Model for Open Distributed Processing (RM-ODP) (ISO/IEC 10746-1:1998). The RM-ODP viewpoints are used in the following fashion:

- Typical users and their business activities, and policies to carry out those activities, are addressed in the Enterprise Viewpoint

- Data structures and the progressive addition of value to the resulting products are found in the schemas of the Information Viewpoint,
- Individual processing services and the chaining of services are addressed in the Computational Viewpoint,
- Approaches to deploy the components of the Information and Computational viewpoints to distributed physical locations are addressed in the Engineering Viewpoint.

(ISO/TS 19101-2:2008)

2.2 ISO/CD 19115-2 "Metadata – Part 2: Extensions for imagery and gridded data"

Within the suite of ISO geographic information standards, ISO 19115 defines the guidelines for describing geographic information and services. While the ISO 19115 Metadata model does provide some provisions for imagery and gridded data, the requirements were not fully developed at the time ISO 19115:2003 was drafted. To permit the development of ISO 19115 to proceed, inclusion of metadata definitions for imagery and gridded data was deferred until the framework for these data was more fully specified within the suite of ISO geographic information standards. Additionally, other standards that implement metadata for imagery and gridded data have been surveyed and are described in ISO/TR 19121.

The object of this part of ISO 19115 is to provide the additional structure to more extensively describe the derivation of geographic imagery and gridded data. This structure is intended to augment ISO 19115 (ISO 19115-2, 2008).

2.3 ISO/TS 19129 "Imagery, gridded and coverage data framework"

Over the past two decades many, largely incompatible, standards have been developed that are widely used for the interchange of geographic imagery and gridded data. These standards exist both within and external to ISO. With so many different imagery and gridded data standards, each standard aimed for different but overlapping information communities, there is a tremendous legacy problem. This Technical Specification endeavours to address the harmonization of the broad legacy of existing imagery and gridded data. The approach specified is NOT to build a very flexible standard that encompasses everything with a broad array of options, because that does not create compatibility. This Technical Specification combines a number of well-defined content structures in accordance with the ISO 19123 "Coverage geometry and functions" together with metadata, spatial referencing and other aspects of imagery, gridded and coverage data into a framework. This will foster a convergence at the content model level for existed imagery, gridded and coverage data while allowing for backward compatibility with the identified suite of existing standards (ISO/TS 19129, 2008).

2.4 ISO/TS 19130 "Imagery sensor models for geopositioning"

The purpose of this Technical Specification is to specify the geolocation information that an imagery data provider shall supply in order for the user to be able to find the geographic location of the data using a generic sensor model, a true replacement model, or functional fitting. Detailed sensor models are defined for passive electro-optical / infrared (IR) sensors - frame, pushbroom and whiskbroom - and for an active microwave sensing system: Synthetic Aperture Radar. A set of components from which models for other sensors can be constructed is also provided. Metadata required for geopositioning using the true replacement model, functional fitting, and ground control points are also specified. The intent is to standardize sensor descriptions and specify the minimum

geolocation metadata requirements for data providers and geopositioning imagery systems.

Vast amounts of data from imaging systems are collected, processed and distributed by government mapping and remote sensing agencies and commercial data vendors. In order for this data to be useful in extraction of geographic information, further processing of the data is needed. Geopositioning, which determines the ground coordinates of an object from image coordinates, is a fundamental processing step. Because of the diversity of sensor types and the lack of a common sensor model standard, data from different producers may contain different parametric information, lack parameters required to describe the sensor that produces the data, or lack ancillary information necessary for geopositioning and analyzing the data. Consequently, a separate software package often has to be developed to deal with data from each individual sensor or data producer. Standard sensor models and geolocation metadata allow agencies or vendors to develop generalized software products that are applicable to data from multiple data producers or from multiple sensors. With such a standard, different producers can describe the geolocation information of their data in the same way, thus promoting interoperability of data between application systems and facilitating data exchange (ISO/TS 19130, 2008).

3. OGC

The Open Geospatial Consortium has turned its interest towards Earth Observation (EO) with the subtopics Sensor Web and Earth Observation products. GML (Geography Markup Language) und Web Mapping standards have been practically completed. One of the remainders is CityGML.

The following table gives an overview over the present OGC's standardization projects, valid for April 27, 2008.

Title	Version	Document type
KML Encoding Standard (OGC KML)	2.2	IS
Sensor Model Language (SensorML)	1.0.0	IS
Observations & Measurements (O&M) Encoding Standard	1.0	IS
OASIS ebRIM application profile of the Catalogue Service	2.0.2	IS
Geospatial Digital Rights Management Reference Model (GeoDRM RM)	1.0.0	AS
City Geography Markup Language	0.4.0	BPP
Sensor Alert Service	0.9	BPP
Sensor Planning Service Application Profile for Earth Observation Sensors	0.9.5	BPP
GML Application Schema for Earth Observation Products	0.9.0	BPP
Ordering Services for Earth Observation Products	0.9.0	BPP
Web Map Services - Application Profile for Earth Observation Products	0.2.0	BPP

IS = Implementation Specification
AS = Abstract Specification
BPP = Best Practice Paper

Table 2: Status of the Remote Sensing related standards of the Open Geospatial Consortium

The OGC's Sensor Web Enablement (SWE) initiative is focused on developing standards to enable the discovery, exchange, and processing of sensor observations, as well as the tasking of sensor systems. The functionality that OCG has targeted within a sensor web includes:

- Discovery of sensor systems, observations, and observation processes that meet an application's or user's immediate needs;

- Determination of a sensor's capabilities and quality of measurements;
- Access to sensor parameters that automatically allow software to process and geo-locate observations;
- Retrieval of real-time or time-series observations and coverages in standard encodings
- Tasking of sensors to acquire observations of interest;

- Subscription to and publishing of alerts to be issued by sensors or sensor services based upon certain criteria.

(Botts M et al., 2007)

Sensor Web Enablement standards that have been built and prototyped by members of the OGC include the following pending OpenGIS Specifications:

- **Observations & Measurements Schema (O&M)** – Standard models and XML Schema for encoding observations and measurements from a sensor, both archived and real-time.
- **Sensor Model Language (SensorML)** – Standard models and XML Schema for describing sensors systems and processes; provides information needed for discovery of sensors, location of sensor observations, processing of low-level sensor observations, and listing of taskable properties.
- **Transducer Markup Language (TransducerML or TML)** – The conceptual model and XML Schema for describing transducers and supporting real-time streaming of data to and from sensor systems.
- **Sensor Observations Service (SOS)** - Standard web service interface for requesting, filtering, and retrieving observations and sensor system information. This is the intermediary between a client and an observation repository or near real-time sensor channel.
- **Sensor Planning Service (SPS)** – Standard web service interface for requesting user-driven acquisitions and observations. This is the intermediary between a client and a sensor collection management environment.
- **Sensor Alert Service (SAS)** – Standard web service interface for publishing and subscribing to alerts from sensors.
- **Web Notification Services (WNS)** – Standard web service interface for asynchronous delivery of messages or alerts from SAS and SPS web services and other elements of service workflows.

(Botts M et al., 2007)

The full list of OGC's specifications and further details can be retrieved from the homepage of the Open Geospatial Consortium (Homepage of the OGC, 2008).

Additional information about the OGC will be given by others authors who are member of this consortium, e.g. Thomas Kolbe.

4. EuroSDR

EuroSDR (formerly OEEPE) is a European spatial data research organization that undertakes collaborative applied research projects, hosts focused workshops, publishes an official series of reports, delivers an annual series of short distance learning courses, contributes to the development of specifications and standards by OGC, ISO and CEN and participates in the drafting of the INSPIRE implementing rules (Homepage of EuroSDR, 2008).

Currently EuroSDR works on the following projects.
- **EuroDAC² - Camera Certification** – In 2007 EuroSDR has commenced an initiative in digital airborne camera certification, where a clear need has been identified for an agreed European Digital Airborne Camera Certification (EuroDAC²) process.
- **Airborne Laser Scanning (ALS) Intensity** – The objective of the project is to develop feasible, cost-effective techniques for National Mapping and Cadastral Agencies (NMCAs) and value-adding companies to carry out intensity or backscatter cross-section calibration and to evaluate together with NMCA and companies the proposed approach.
- **Digital Camera Calibration** – The goal of this project is the collection of publicly available material on and the development of commonly accepted procedure(s) for camera calibration.
- **Medium Format Digital Cameras** – This project is going to evaluate the application of medium format cameras in aerial photogrammetry.
- **Unconventional Platforms** – This project deals with the application of Unmanned Aerial Vehicles (UAVs)
- **CityGML** – This project integrates the requirements of the NMCAs into CityGML.
- **Generalization** – This project reviews the state-of-the-art of generalization.
- **Detection of Buildings** and **Tree Extraction** – Both projects evaluated existing software solutions for object recognition (buildings and trees) in aerial photography.

(Homepage of EuroSDR, 2008)

Additional information about EuroSDR will be given by others authors of this conference, e.g. Michael Cramer.

EuroSDR, together with EuroGeographics and supported by the International Hydrographic Organization, hosted the International Workshop on "Production Partnership Management" at the Ordnance Survey Great Britain in Southampton, UK, in November 2007. The aim of this workshop was to consider the application of production partnership management and agree best practice through the acceptance of a guideline document (Homepage of EuroSDR, 2008).

5. GEOSS

The Group on Earth Observations (or GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). This emerging public infrastructure is interconnecting a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. This "system of systems" supports policymakers, resource managers, science researchers and many other experts and decision-makers (Homepage of GEOSS, 2008).

To support the critical need for interoperability among systems within GEOSS, the Standards and Interoperability Forum (SIF) was created under the leadership of the IEEE. The SIF provides advice, expertise and impartial guidance on issues relating to standards and interoperability for GEOSS. Its membership is composed of experts nominated by GEO Members and Participating Organization (Achache, 2007).

An interoperability interface and the register for storing GEOSS standards and other interoperability arrangements have been developed and are being operated as a GEOSS resource. In addition, the associated registry serves as an educational resource and forum for discussion on matters related to interoperability for GEOSS (Achache, 2007).

The author of this paper is an ISPRS-nominated member of the SIF and has taken part in several of its conferences.

Additional information about GEOSS and SIF will be given by other authors of this congress, e.g. Jiashen Zhang.

6. CONCLUSIONS

This paper summarizes the standardization activities in photogrammetry and remote sensing.

ISO/TC 211 is working on or has almost completed the Reference model for imagery (ISO 19101-2), the Metadata for imagery (ISO 19115-2), a framework standard (ISO 19129), and the standards for georeferencing imagery (ISO 19130).

The Open Geospatial Consortium is about to complete the Sensor Web Enablement and has launched a number of activities on Earth Observation systems.

EuroSDR currently works on projects mainly dealing with the application of new digital sensors, and their calibration and certification.

With its recently created Standards and Interoperability Forum (SIF) GEOSS has started to explore the relevant standards for the planned global monitoring system.

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