

STANDARDIZATION OF GEOGRAPHIC INFORMATION

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ABSTRACT:

Many organizations and groups are active in the field of standardisation. The “official” standards are published by the International Organization for Standardisation (ISO). Through the work of its Technical Committee 211 (ISO/TC 211) the ISO has taken the leading position in the standardisation of geographic information. The ISO/TC 211 has created a complete suite of standards for vector-based GIS which integrates all major developments in this field.

The ISO-numbers for the geographic information standards are between 19101 and 19199 presently ending with 19140. The reference model, the spatial and temporal schema, the referencing by coordinates, the portrayal, the encoding and the metadata are typical titles of the individual standards. These standards have been completed in Phase 1 since 1994. Phase 2 focuses on imagery, gridded data and coverages. Those standards will be the most important development of the ISO/TC 211 in the coming years.

Typical standardisation projects of Phase 2 are the reference model for imagery, the sensor and data model for imagery and gridded data, the encoding for imagery, and the metadata for imagery. The sensor and data models contain a comprehensive approach towards the classical and the new sensors of photogrammetry and remote sensing such as the photogrammetric camera, line sensors, and film scanners.

Most of the ISO 19100 standards contain abstract solutions. Standards on the implementation level have been defined by other organizations such as the Open GIS Consortium. In many cases the implemented solutions are well established existing formats or environments. However, many recent implementation developments are strongly influenced by the ISO works including the use of the Extensible Markup Language (XML), web-based services, and location-based services.

1. INTRODUCTION

Today the development of standards for geographic information has reached maturity. Though the efforts will never end a comprehensive suite of standards has been completed in the last couple of years. Those standards were primarily developed by the ISO/TC 211 “Geographic information / Geomatics”, the Open GIS Consortium (OGC), and the World Wide Web Consortium (W3C). Within this group of organizations the ISO/TC 211 developed an abstract, but detailed baseline including vector, raster, metadata, and georeference. The OGC focused on the implementation-oriented standards including Web mapping and the Geography Markup Language GML. The W3C provided the information technology baseline. Its standards include general Internet technology and the markup languages such as the Extensible Markup Language XML.

2. ORGANIZATIONS FOR STANDARDISATION

The scope of geographic information is large. Within the GIS-community it is seen in the widest possible sense. The definition given in the standard ISO 19101 “Geographic information – Reference model” says a geographic information system is an “information system dealing with information concerning phenomena associated with locations relative to the Earth” (ISO1, 2002). After the start of detailed exploration of other celestial bodies an extension of this definition has to be taken into account.

The term standard has different meanings depending on its responsible organization. Usually one distinguishes between two types of terms, the “standards” and the “de-facto” or “industry standards”. The “standards”, sometimes called the “official standards”, are developed by one of the so called “Standards Developing Organizations” (SDO). There are three SDOs: the “International Organization for Standardisation” (ISO), the “International Electrotechnical Committee” (IEC), and the “International Telecommunication Union” (ITU). The ISO/TC 211 is one of about 150 technical committees of the ISO.

The standards of those three organizations are developed and approved by the participating nations in a public and democratic process. For instance, the final document, the “International Standard”, must be approved by at least a two thirds majority of the participating nations while only a maximum of 25% of votes against is allowed. During the development process similar voting procedures are compulsory. After five years at the latest an International Standard is checked for relevance with the options to keep, update, or withdraw.

All other organizations such as the OGC and the W3C are consortia of companies and government agencies. Their standards are called industry standards or de facto standards. In many cases they play a prominent role in the technical communities. The less formal process of their development and maintenance sometimes leads to a better adaptation to actual needs. However, users may be confused by the publication of

updated documents at shorter intervals. Within a consortium the big players set the standards. The smaller members do not have the amount of influence they have in the ISO environment.

3. ISO/TC 211 “GEOGRAPHIC INFORMATION / GEOMATICS”

The ISO/TC 211 was founded in 1994. Its predecessor is a European standardization committee with a comparable scope. This is the CEN/TC 287 “Geographic information”. CEN stands for “Comité Européen du Normes”. The titles of the 20 basic standards of the ISO 19100 family had been defined by the CEN/TC 287 already. In 1994 the U.S.A. and Canada with the support of NATO (North Atlantic Treaty Organization) proposed an extension of the standardisation of geographic information on a worldwide platform. This was the beginning of the ISO/TC 211.

Today (2004) the ISO/TC 211 consists of 55 national bodies, 23 of them participating members (P-members) and 22 of them only observing members (O-members). Those national bodies represent practically all nations of the world that are active in the field of geographic information. In addition the ISO/TC 211 has 22 external and 12 internal liaison members. The liaison members represent international technical expert organizations that make considerable contributions to the content of the standards. The internal liaison members are ISO or IEC committees such as the ISO/TC 204 “Intelligent transport systems”. All other organizations are called external liaison members. One of them is the ISPRS. The Committee of Earth Observing Satellites (CEOS), the International Hydrographic Organization (IHO), the Digital Geographic Information Working Group (DGIWG) of NATO, and the OGC are other examples of external liaison members, while the OGC probably is the most important one of all. The P-members of the national bodies have the right to vote. All other members only have the right to comment.

The standards developed by the ISO/TC 211 are often called the ISO 19100 family because their numbers range from ISO 19101 to ISO 19140 with the option of an extension until ISO 19199. The standards may be categorized in six groups:

Groups	Examples
1. Reference model	
2. Infrastructure standards	Terminology, Conformance and testing
3. Basic standards	Georeferencing, Spatial schema, Metadata
4. Imagery standards	Sensor and data models for imagery and gridded data
5. Catalogue standards	Feature cataloguing methodology
6. Implementation standards	GML, Web Map Server, Location Based Services

(Kresse, Fadaie, 2004)

The standardization of the ISO/TC 211 follows a model driven approach. This means that all standards are branches of an overall model for geographic information. This model is written in UML, the Unified Modelling Language.

The existence of an overall model basically says that every individual standard is logically linked and harmonized among the suite of standards. Components such as the point object that is described by the class GM_Point is defined only in one of the standards while the other standards simply reuse this class in their models.

The overall model does not mean that it covers every aspect of geographic information. The practically completed suite of standards covers the vector world, while other topics such as imagery are still under development. Also, different expert groups have been dealing with the standardization projects. As a result, the standards differ in the level of detail and in theoretical background. The ISO 19107 “Spatial schema” and ISO 19123 “Coverage geometry and functions” are two very comprehensive works for GIS geometry. However, the ISO 19107 is derived from the “Set Theory” while the ISO 19123 is an industrial development by the OGC. Figure 1 presents the UML class-diagram of the ISO 19107.

A common feature of all ISO standards is the principle “One term – one meaning”, which is valid throughout the whole world of ISO standards. This has created and will maintain a very stable terminology in the field of geographic information.

The range of definitions in most of the ISO 19100 standards has been set as wide and generic as possible to enable their usage in practically all fields. However, for many applications this range is too large and needs to be narrowed for an efficient use. For this purpose the ISO 19106 “Profiles” sets the rules. A profile of conformance level 1 is a subset of the classes provided by a standard. A profile of conformance level 2 is also a subset but includes additional classes that have not been defined in one of the ISO standards.

The ISO 19115 “Metadata” is probably the best known standard of the ISO 19100 family. It provides a large basket of metadata elements that are needed in applications of geographic information. The ISO 19115 consolidates well known sources such as the metadata listing of the FGDC (Federal Geographic Data Committee of the U.S.) in one standard. The large software providers for GIS have begun to incorporate the ISO 19115 in their system enabling the automated and backgrounded generation of metadata elements while the GIS data are updated.

The metadata-model of the ISO 19115 distinguishes between about 20 core metadata elements and the comprehensive listing with about 400 elements. Figure 2 shows the package diagram of the ISO 19115 that illustrates the areas of metadata support.

Outside the ISO another source of metadata definition is well known. This is the Dublin Core. Its definition is a compact listing of 15 elements originally designed for IT and library purposes. The Dublin Core is not fully compliant with the ISO metadata. However, government organizations such as the European Union have adopted the Dublin Core requiring its application even in the field of geographic information.

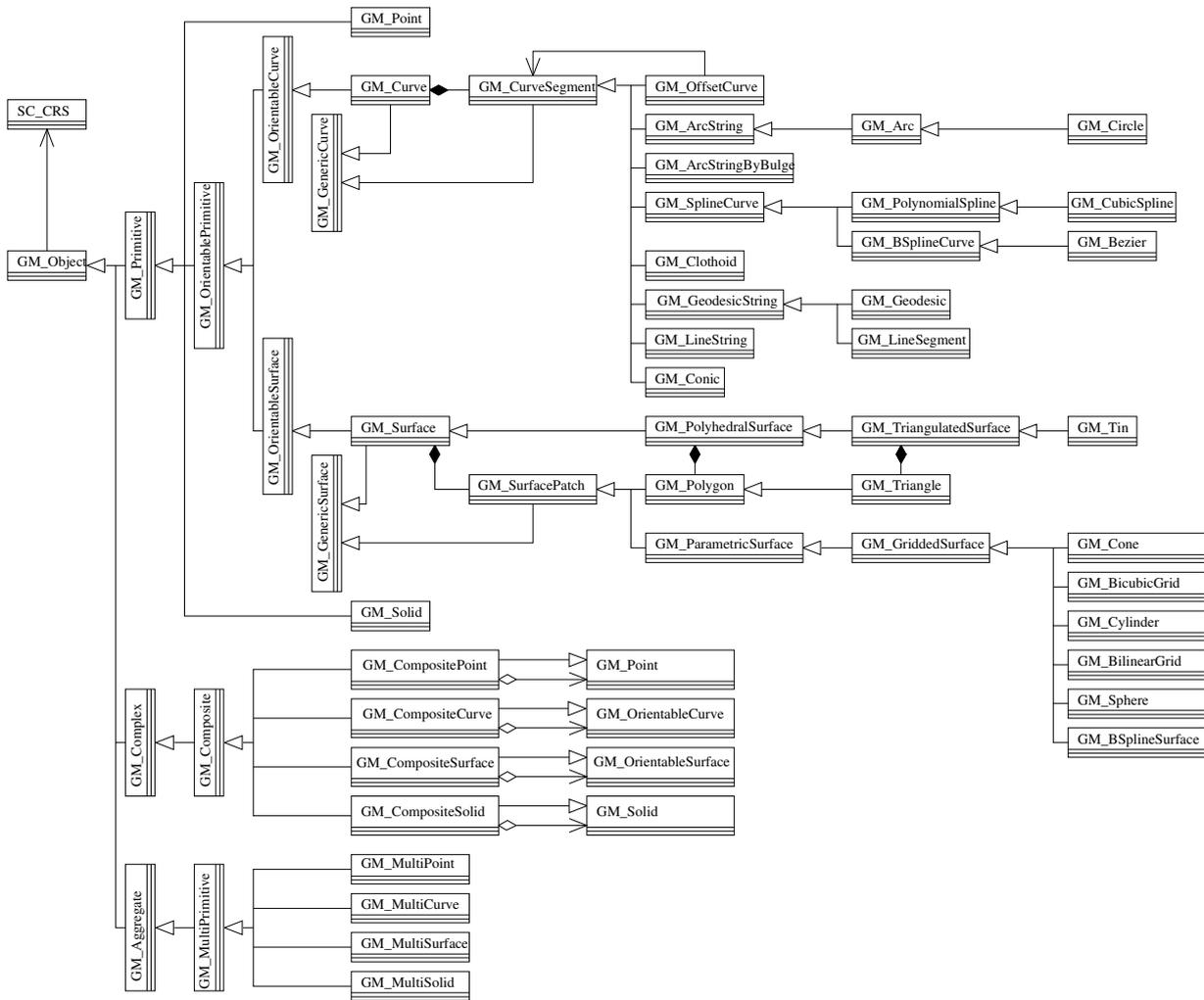


Figure 1. UML class-diagram of ISO 19107 "Spatial schema" (Kresse, Fadaie, 2004)

Photogrammetry and remote sensing have not been issues in the first generation of the ISO 19100 standards. The first standardization project dealing with the georeference of sensors and their imagery is the ISO 19130 "Sensor and data models for imagery and gridded data". It defines the way in which georeferencing information for the orientation of photogrammetric images and remote sensing scenes is described and packaged (Di, Kresse, 2004). Presently the ISO 19130 is in the CD stage. It is planned to complete it as an International Standard at the end of 2005. The ISO 19130 sets an abstract frame for the orientation of data while the SensorML will serve as the related implementation level (Botts, 2002). The data models of both standards, ISO 19130 and SensorML, have been aligned before the ISO 19130 was forwarded to the CD stage. The SensorML still exists as a discussion paper within the OGC committees (see below).

Two additional standards in this field are presently being developed, the ISO 19101-2 "Reference model - imagery" and the ISO 19115-2 "Metadata - Part 2: Metadata for imagery and gridded data". The work on the ISO 19101-2 may be called reversely engineered because its development started after the ISO 19130 had almost been completed. However, the ISO 19101-2 provides a good framework for

the present and future ISO standards in the field of photogrammetry and remote sensing. The ISO 19115-2 extends the existing ISO 19115. It provides information about the measuring equipment and the production process. The georeference standardized in the ISO 19130 is a subtopic of the ISO 19115-2.

The two planned ISO/TC 211 projects for photogrammetry and remote sensing are "Rules for encoding of imagery" and "Calibration and validation of sensors". The first one will set a frame for the formats used for the storage and for the exchange of imagery data. In view of the many existing de-facto standards the ISO does not attempt to replace those standards by an additional new and unknown one. Therefore the title is deliberately called "rules" for encoding, pointing at the fact that the standard only tends to harmonize the manifoldness of formats on a long-term basis. The other project "Calibration and validation of sensors" will standardize the procedures and attributes in this field. It will combine experiences in photogrammetric camera calibration, calibration of remote sensing sensors, and validation of remote sensing scenes. Preliminary work has been made in particular by the Joint Task Force of the ISPRS (Commission I) and the CEOS Working Group on Calibration and Validation (WGCV).

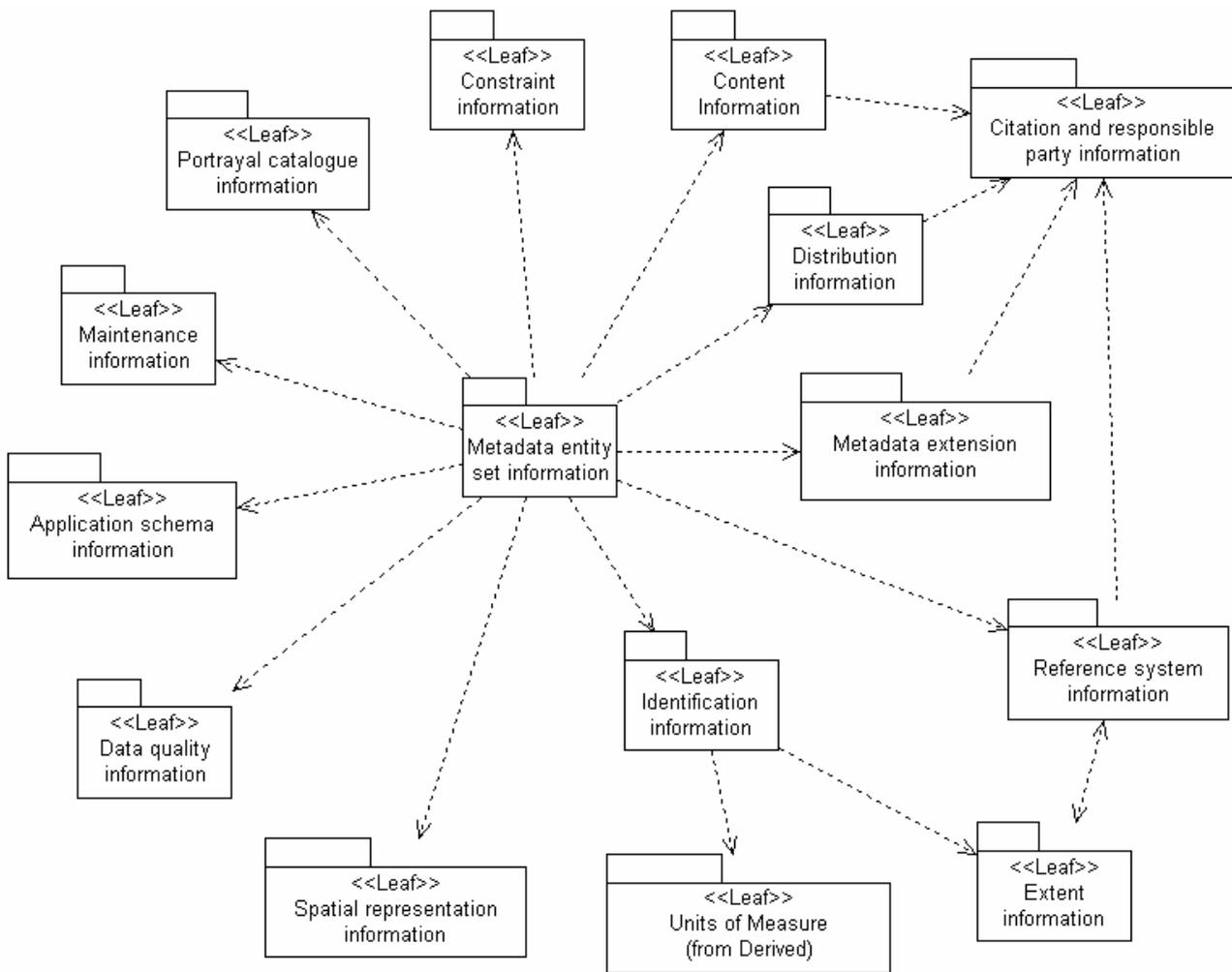


Figure 2. UML package-diagram of ISO 19115 “Metadata” (ISO2, 2003)

4. OPEN GIS CONSORTIUM

The Open GIS Consortium (OGC) is the most important international industry consortium for geographic information. It was founded in 1994 and evolved from the GRASS user groups. GRASS used to be the geographic information system developed by the U.S. military. Today the OGC has more than 250 members categorized into strategic, principle, technical, and associate members. The nine strategic members are large U.S. companies and institutions such as Northrop Grummen, Intergraph, NASA, and NGA (National Geostatial intelligence Agency). They raise about 60% of the overall budget of the OGC.

In 1999 the ISO/TC 211 and the OGC started a close cooperation in which the OGC plays the role of providing the implementation level standards that fit into the abstract frame set by the ISO. The activities of the OGC are split into the Adopted Document Baseline and the initiatives of the Interoperability Program. The Adopted Document Baseline covers all OGC standards. The abstract standards have lost their original relevance as many of their concepts have been integrated into the ISO 19100 standards. Today the strong foundation of the OGC standards are the implementation specifications. The Web Map Server Interface Specification and the Web Feature Service are well known. The

specifications for the Coverage and for the Geography Markup Language are forwarded as ISO 19100 standards (ISO 19123 and ISO 19136).

Before an OGC specification is approved the documents are called discussion papers, requests for proposal, or requests for information. The discussion paper on SensorML has been mentioned.

With the initiatives of the interoperability program the OGC provides guidance during the development of large GIS projects, often as an international cooperation. The North Rhine Westfalia Pilot Project (Germany) is an example of one of the recent successful projects.

5. WORLD WIDE WEB CONSORTIUM (W3C)

The World Wide Web Consortium (W3C) was also founded in 1994. It has about 450 members. They are companies of the computer business that commonly forward the Internet technology and its related standards. The following W3C standards are the most relevant for geographic information:

XML (Extensible Markup Language): As documents in XML can be interpreted by the present version of all common browsers this language has become the most popular way of transferring information via the Internet. XML provides the

way of defining application-specific tags for structuring and storing the information of a document. In recent years a number of “tag sets” have been standardized for various application domains. The SensorML is one example of those “tag sets”. SVG and SMIL are two other examples mentioned below.

DTD (Document Type Definition): This format is used to define the application-specific tags and their relations. While reading an XML document a browser compares its structure with the definitions in the associated DTD. Because the syntax of a DTD has some limitations today an alternative way of defining the structure of an XML document has become more popular. This is the XML schema.

SVG (Scalable Vector Graphics): SVG is an application of XML. SVG provides a great variety of graphic elements that enable the creation of high quality maps. Graphic data are transported in a vector format which leads to a properly resolved display on the screen on any scale. SVG enables every Internet browser to become a cartographic output device.

SMIL (Synchronized Multimedia Integration Language): SMIL is also an application of XML. SMIL is capable of defining animated elements within a document. Sometimes the SMIL is called the “power point of the Internet”.

6. CONCLUSION

This article has discussed the standardisation bodies that are relevant for geographic information. These are primarily the ISO/TC 211 “Geographic information / Geomatics”, the Open GIS Consortium, and the World Wide Web Consortium.

The standards published by the ISO are approved by many nations and therefore enjoy wide international acceptance. The ISO as a maintenance organization guarantees a long-term stability of the standards. The terminology is consistent throughout the whole world of ISO. The ISO 19100 standards are a stable baseline for large projects such as the Geography Markup Language (GML) written in XML or the German AAA project (AFIS, ALKIS, ATKIS).

The OGC focusses on the implementation of GI standards. The standards are approved by the participating industries. Many of their activities are project-driven. The W3C provides the baseline for all Internet applications.

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