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Spatial standards as basis for a sustainable geospatial data infrastructure

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** Prepared by Olaf Ostensen, Chairman of Technical Committee 211 of the International Organization for Standardization, Chairman, Joint Steering Group on Spatial Standardization and Related Interoperability.

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Spatial standards as basis for a sustainable geospatial data infrastructure

Olaf Østensen,
Chairman of ISO/TC 211 Geographic information/Geomatics
Chairman Joint Steering Group on Spatial Standardization and Related Interoperability
e-mail : olaf.ostensen@statkart.no

Introduction

At the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, a major resolution was passed to focus on reversing the impacts caused by environmental deterioration. The Agenda 21 resolution establishes measures to address deforestation, pollution, depletion of fish stocks, and management of toxic wastes to name a few. The importance of geographic information to support decision-making and management of these growing national, regional, and global issues was cited as critical at the 1992 Rio Summit, and by a special session of the United Nations General Assembly assembled in 1997 to appraise the implementation of the Agenda 21.

Geographic information is vital to make sound decisions at the local, regional, and global levels. Crime management, business development, flood mitigation, environmental restoration, community land use assessments and disaster recovery are just a few examples of areas in which decision-makers are benefiting from geographic information, together with the associated infrastructures (i.e. Spatial Data Infrastructure or SDI) that support information discovery, access, and use of this information in the decision-making process.

The disciplines of cartography and geography, in response to technological innovations, have individually and collectively undergone significant changes during the past half-century. The 1950's witnessed the quantification of geography followed by the introduction of computers and modeling during the 1960's. The application of computer technology to cartography during the 1970's gave rise to automated/computer-assisted cartography, along with the adaptation of the mathematics of topology to computer cartography / geography around 1975 that lead to the emergence of geographic information systems (GIS). From 1985 to1995 saw the widespread development, use,

and acceptance of GIS technology. During the period from 1995 to 2000, spatially enabled enterprise databases and the deployment of geographic information on the Internet rapidly positioned a new location-based technology as part of generic information technology. Leveraging wireless and mobile applications, location-based products, services, and solutions are now initiating the new millennium with the promise of an increasing need for locational functionality and geographic information via the Internet by not just the geographic community, but the world at large.

The era of modern of geographic standardization spanned the decade from the early 1980's to the early 1990's. Internationally, initial standardization efforts within cartography and geography were slow and arduous. National and international organizations were busy developing standards for the transfer / exchange of geographic data between computers systems. The technical development of such standards were limited to few national and regional user communities. There were no standards that had broad international support. By 1995, ISO/TC 211 and the Open GIS Consortium (OGC) emerged with GIS standards becoming a highly visible and prominent part of the international geographic agenda. The value of these initial international standardization efforts was to gain the international recognition and acceptance by the cartographic and geographic communities of the need and value of geographic standardization.

Spatial Data Infrastructure

Different countries and regions have dissimilar definitions of the notion spatial data infrastructure. This reflects differences in tradition, technology, maturity and ambitions. Even highly industrialized countries may fail to recognize the needs for an ambitious spatial data infrastructure to support the development of the information society and enterprise activities associated with it. There is a clear need for stakeholders to take leadership in this development – no infrastructure is built by accident.

Fortunately, important stakeholders are taking the responsibility. The Global Spatial Data Infrastructure is exactly an initiative that identifies many of the requirements of a SDI, and has the ambition to aid countries and regions in concrete actions to achieve the SDI. This is for instance done through the development of "The SDI Cookbook".

In this Cookbook we find the following definition:

> The term "Spatial Data Infrastructure" (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.
>
> .....
>
> An SDI must be more than a single data set or database; *an SDI includes geographic data and attributes, sufficient documentation (metadata), a means to discover, visualize, and evaluate the data (catalogues and Web mapping), and some method to provide access to the geographic data. Beyond this are additional services or software to support applications of the data. To make an SDI functional, it must also include the organizational agreements needed to coordinate and administer it on a local, regional, national, and or trans-national scale.*

Thus we see that several requirements must be fulfilled before we can talk about an SDI. E.g. data is not enough – neither as a single dataset or a database, nor as a set of datasets or databases. Without the possibility to discover data and evaluate data through some mechanism like a metadata catalogue, and ways of accessing data through Internet (e.g. web), it is no *spatial data infrastructure.* It is in these respects that so many still fails to fulfill the requirements. Data may exist – even high quality and large scale data – but it is very difficult for the public to obtain access. Both technology, authorization and pricing may constitute – together, or each – insurmountable obstacles. Concerning technology, the notion of interoperability is a key concern.

Interoperability is the ability of a system or system component to provide information sharing and inter-application co-operative process control. Standardization of geographic information can best be served by a set of standards that integrates a detailed description of geographic information concepts with the concepts of information technology. A goal of the ISO 19100 series standardization effort is to facilitate interoperability of geographic information systems, including interoperability in distributed computing

environments. Interoperability provides the freedom to mix and match information system components without compromising overall success. Interoperability refers to the ability to:

a) Find information and processing tools, when they are needed, independent of physical location.
b) Understand and employ the discovered information and tools, no matter what platform supports them, whether local or remote.
c) Evolve a processing environment for commercial use without being constrained to a single vendor's offerings.
d) Build upon the information and processing infrastructures of others in order to serve niche markets, without fear of being stranded when the supporting infrastructure matures and evolves.
e) Participate in a healthy marketplace, where goods and services are responsive to the needs of consumers and where commodity channels are opened as the market expands sufficiently to support them.

Although not explicitly stated, it is clear that *standards* is a fundamental requirement in both obtaining interoperability and, more general, to build the SDI. A previous definition by Prof. David Rhind is making this explicit:

> "A Global Geospatial Data Infrastructure encompasses the politics, organizational remits, data, technologies, standards, delivery mechanisms and financial and human resources necessary to ensure that those working at the global or regional scale are not impeded in meeting their objectives"

Standardization

Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose. The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies from some 130 countries, one from each country.

The existence of non-harmonized standards for similar technologies in different countries or regions can contribute to so-called "technical barriers to trade". Export-minded industries have long sensed the need to agree on world standards to help

rationalize the international trading process. This was the origin of the establishment of ISO.

Work in the fields of environmental management and geographic information are among the newer activities, taken up in the mid 1990's.

International standardization is well-established for many technologies in such diverse fields as information processing and communications, textiles, packaging, distribution of goods, energy production and utilization, shipbuilding, banking and financial services. It will continue to grow in importance for all sectors of industrial activity for the foreseeable future.

Development agencies are increasingly recognizing that a standardization infrastructure is a basic condition for the success of economic policies aimed at achieving sustainable development. Creating such an infrastructure in developing countries is essential for improving productivity, market competitiveness, and export capability.

ISO and the market

The World Trade Organization (WTO) is the international organization dealing with the global rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably and freely as possible.

ISO – together with IEC (International Electrotechnical Commission) and ITU (International Telecommunication Union) has built a strategic partnership with WTO. The political agreements reached within the framework of WTO require underpinning by technical agreements. ISO, IEC and ITU, as the three principal organizations in international standardization, have the complementary scopes, the framework, the expertise and the experience to provide this technical support for the growth of the global market.

The agreement with WTO recognizes the important contribution that international standards and conformity assessment systems can make to improving efficiency of production and facilitating international trade. Where international standards exist or their completion is imminent, therefore, the code of Good Practice says that

standardizing bodies should use them, or the relevant parts of hem, as a basis for standards they develop. It also aims at the harmonization of standards on as wide a basis as possible, encouraging all standardizing bodies to play as full a part as resources allow in the preparation of international standards by the relevant international body, including the ISO and IEC.

Geographic information market and standards

All businesses that produce, distribute, or utilize spatial information alone or in conjunction with non-spatial information will benefit from spatial standards. Environments supported include geographic information, decision support, data mining, data warehousing and modeling and simulation. Application areas include but are not limited to automated mapping, geo-engineering, computer aided drafting and design, entertainment, modeling, and simulation. These span the planning, design, construction, operation, and maintenance of facilities and their supporting infrastructure such as communications, transportation, and utilities.

A common way to describe the market is by dividing it into three segments: the traditional geographic information systems (GIS) market, business support systems (BSS), and personal productivity (PP). A description can be given as:

- GIS:
  – Spatial information contributes the most value
  – Traditional market for spatial technology
- BSS:
  – Spatial information does not contribute the most value
  – Spatial technology embedded in business applications
- PP:
  – Users want to communicate with maps/ geographic information
  – Follows Office Suite marketA new emerging market is location-based mobile services (LBMS).

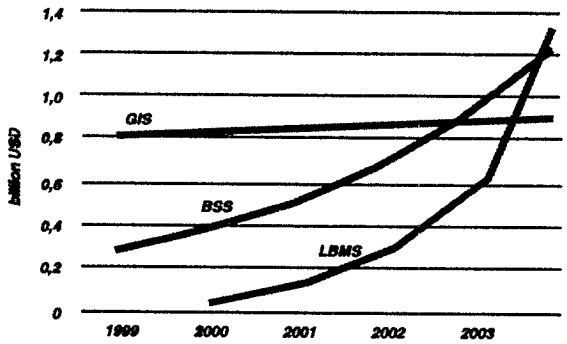

Fig. Revenues in the traditional GIS market (GIS), for business support systems (BSS) and the emerging technology, location based mobile services (LBMS) according to IDC.

There are many places in the marketplace that will benefit significantly from interoperable access to spatial information and services. Industry sectors include such areas as the travel and tourism industries, the mapping and routing industries, communications, utilities, transportation, national defense, agriculture, disaster management and public safety, location/mobile services, inventory management, real and synthetic environmental modeling and gaming, and the emerging needs of electronic commerce for spatial information.

Achieving more interoperability requires proactive coordination of spatial standards at both the abstract and implementation levels of detail. Proactive cooperation between spatial standards activities should also help to utilize, more efficiently, available resources by minimizing technical overlap, where appropriate. Such coordination and cooperation should lead to more market relevant spatial standards and could serve as a useful roadmap for all interested parties.

The increasing recognition for the value of spatial data and geographic information has spawned the entry of new players into the spatial standardization arena, both from within ISO and externally. This has resulted in the formation of a Joint Steering Group on Spatial Standardization and Related Interoperability, chaired by the ISO/TC 211 Chairman. Consequently, a new agenda is emerging for international spatial standardization that includes traditional and new innovative applications across a spectrum of disciplines. For ISO/TC 211, these developments are resulting in new strategic directions.

Current members :

ISO Central Secretariat

ISO/TC 211

OGC

SEDRIS

The following organizations have also been invited and/or participated in the process :

DGIWG

IETF

ISO/TC 184 /SC 4

ISO/TC 204

ISO/IEC JTC 1

ISO/IEC JTC 1/SC 24

ISO/IEC JTC 1/SC 31

ISO/IEC JTC 1/SC 32

OMG

POSC

SAE International

SISO

W3C

WAP forum

Scope of the ISO/TC 211

The formal scope of ISO/TC 211 Geographic information/Geomatics is as follows:

> Standardization in the field of digital geographic information. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data.

Beyond the needs within traditional applications of digital geographic information, there is a growing recognition among users of information technology that indexing by location is a fundamental way to organize and to use digital data. Increasingly, digital data from a wide variety of sources is being referenced to locations for use in a diversity of applications. Consequently, there is an increasing need for standardization of geographic information and services for processing this information. To meet this need, the ISO 19100 series (i.e. the standards developed by ISO/TC 211) standardizes relevant aspects of the description and management of geographic information and geographic information services. This standardization will:

a) increase the understanding and usage of geographic information;

b) increase the availability, access, integration, and sharing of geographic information;

c) promote the efficient, effective, and economic use of digital geographic information and associated hardware and software systems;

d) contribute to a unified approach to addressing global ecological and humanitarian problems.

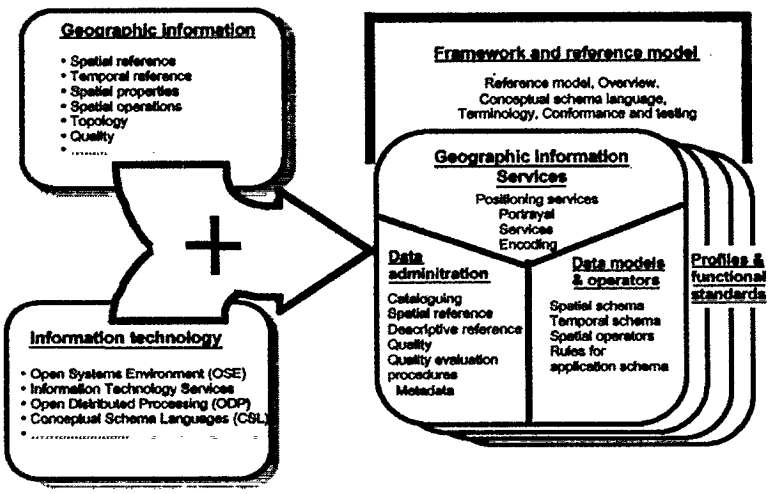

Fig. "Map" of the ISO/TC 211 approach to standardization

The ultimate benefits of standardization are based on the use of widely recognized and accepted international voluntary standards developed to the highest technical level by an open consensus process that includes all those affected. Beyond standardization of traditional geographic functionality: innovative, new, and unknown technology and application domains present challenges transcending the established process of geographic standardization. Previously, standardization was a process for recognizing and

codifying the status quo of technology. Standardization is now beginning to define the requirements and implementation of new technology.

The implied mandate for ISO/TC 211 is to develop an integrated set of standards for geographic information. Equally important, if not more so, is the unstated strategic direction for the international deployment of such standards. Accordingly, the strategic directions for ISO/TC 211 can be viewed in terms of development, deployment, and the underlying coordination/consensus process that integrates both these phases for successful standardization.

For development, the major issues include: standards technical development, organizations developing geographic or related standards, priorities of standards, standards and interoperability testing, and speed of developing technical specifications. For deployment, the key issues are: implementation of standards, standards education / training, and user communities supporting ISO/TC 211 standards.

Inherent and pervasive through standards development, deployment, and their coordination/consensus process are considerations for the implementors and users of geographic standards. Such as data transfer standards that are implemented by vendors or data cataloguing standards implemented by data producers, or metadata standards implemented by vendors, data producers, and general users of geographic information. Implementors and user requirements need to be considered in conjunction with the standards development, deployment, the process of integrating such requirements.

Traditionally, geographic information was produced and used by the geographic community. Increasingly, geographic information is being created and used by everyone else, especially, in the business community. Hence, the once all important technical issues for experts are now being subordinated to the business issues confronting government and commercial organizations. Previously, the cost of standardization was minimal because of the number of users and requirements. Because geographic information has transitioned, in many countries, from being the essence of national mapping organizations to being the common commodity of consumers in the electronic/Internet/wireless communities – the diverse requirements, costs, and complexity for geographic standardization has increased dramatically.

- ISO 19101 - Reference model
- ISO 19102 - Overview
- ISO 19103 - Conceptual schema language
- ISO 19104 - Terminology
- ISO 19105 - Conformance and testing
- ISO 19106 - Profiles
- ISO 19107 - Spatial schema
- ISO 19108 - Temporal schema
- ISO 19109 - Rules for application schema
- ISO 19110 - Feature cataloguing methodology
- ISO 19111 - Spatial referencing by coordinates
- ISO 19112 - Spatial referencing by geographic identifiers
- ISO 19113 - Quality principles
- ISO 19114 - Quality evaluation procedures
- ISO 19115 - Metadata
- ISO 19116 - Positioning services
- ISO 19117 - Portrayal
- ISO 19118 - Encoding
- ISO 19119 - Services
- ISO/TR 19120 - Functional standards + new revision started
- ISO/TR 19121 Imagery and gridded data
- ISO/TR 19122 - Qualifications and certification of personnel
- ISO 19123 - Schema for coverage geometry and functions
- ISO 19124 - Imagery and gridded data components
- ISO 19125-1 - Simple feature access – Common architecture
- ISO 19125-2 - SFA - SQL option
- ISO 19125-3 - SFA – COM/OLE
- ISO 19126 - Profile - FACC Data Dictionary
- ISO 19127 - Geodetic codes and parameters
- ISO 19128 – Web map server interface

Table. The current ISO/TC 211 work programme

ISO/TC 211 is currently accomplishing a very challenging task in developing – mostly in parallel – the set of standards as illustrated in the table above. The first standard is approved for publication and several more will be available during 2001.

Concluding remarks

The goal of international standardization in the field of geographic information is to develop a family of standards that will:

- support the understanding and usage of geographic information
- increase the availability, access, integration, and sharing of geographic information, enable inter-operability of geospatially enabled computer systems
- and ease the establishment of geospatial infrastructures on local, regional and global level.

and thus contribute to a unified approach to addressing global ecological and humanitarian problems and a sustainable geospatial data infrastructure!

A large set of organizations will cooperate in achieving this.

References

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Joint Steering Group on Spatial Standardization and Related Interoperability, www.statkart.no/jsgspatial/