INTERNATIONAL STANDARDIZATION AND MANAGEMENT OF GIS-ACTIVITIES

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ABSTRACT

All countries have a strong need to develop and use GIS as a basic tool for their decision processes in a variety fields such as administration, economy and research.
Yet among the many aspects of GIS, the uniformity, standardization and data exchange, methods and systems are essential economic criteria for producers and users of geoinformation. In line with the worldwide development of GIS, the importance of standardization has led to the establishment of corresponding technical committees within ISO and CEN in 1992 and 1994 respectively. It is also evident that a coordination of the activities of the users on the national level as well as quality management is extremely necessary.
Some countries like Germany have advantages regarding the above-mentioned points throughout a highly qualified, traditional and experienced system of land registration, cadastral and state survey tasks and GIS. The base and contents of the German-GIS is funding on an qualified data-collection with completeness, accuracy and up-to-dateness.
Starting from the national standardization the author will report on the situation and results of the international standardization as well as the requirements and activities concerning coordination and management as basis for the further development of GIS concerning quality and economic management effectivness.

1. INTRODUCTION

The development of national and international Geographic Information Systems is proceeding rapidly since many years. In the meantime in some countries, like in Germany since 1970, experiences in establishing, maintaining and especially using them, are available. Additionally other problems must be solved e. g. coordination, quality management and nowadays economic management instruments become more and more important. Many activities are focussed on these tasks worldwide.

2. STANDARDIZATION

2.1 General Aspects and Definition

Standardization is one of the tools we use to organize our technical world. It has become an integral part of our economic, social and legal systems.
International and European standards can remove trade barriers and promote business across national frontiers. They are thus especially important for a country like Germany.
The national standards of highly developed industrial countries are a readily accessible source of information on the current state of the art. They represent an important vehicle for the global transfer of technology and hence also foster economic cooperation with the Third World.
Standards play an essential part in the solution of many technical and economic problems; they serve all involved in trade and industry as an explicit and accurate medium of communication.

The work of standardization as undertaken is a service in the field of science and technology that ist provided for the entire community. The whole of the national economy benefits from the results of standardization.

In every country there is ohne authorized national standardization body, f. e. DIN in Germany, and may be mentioned by way of example on national level. In its work DIN ist guided by ten principles: voluntary basis, public, participation of all interested parties, uniformity and consistency, relevance, consensus, alignment with the state of the arts, alignment with economic factors, alignment with the public benefit, and global approach.

Standardization is the systematic process by which tangible or intangible subjects are reduced to a desired degree of order by the joint efforts of the interested parties for the benefit of the entire community (DIN 820 Part 1).

DIN Standards are technical rules. They promote rationalization, quality management, safety, environmental protection, and communication in industry, technology, science, government and the public domain.

On the European level it is CEN (Comité Européen de Normalisation) and on the worldwide level ISO (International Organization for Standardization) which are the authorized standardization bodies to develop ‘standards’; all other organizations on national and international level produce „de facto-standards“.
International standards are important for use and exchange of spatial data, terminology and quality management are criteria to increase the economic effects.

2.2 National Standardization

The actual work of standardization by DIN ist carried out by about 34 000 external experts organized in 4 000 technical committees.
The national professional work of „surveying, geoinformation“ is done by 4 committees: 'geodesy', 'photogrammetry and remote sensing', 'cartography and geoinformation', 'surveying instruments and apparatus'.

2.3 European Standardization

The aim of European standardization is to create a uniform body of standards meeting modern needs and applying throughout the unique European market. This task is the responsibility of CEN/CENELEC and ETSI. European Standards are generally based on ISO-Standards, if available.

The focus of DIN’s activities has shifted increasingly towards European standardization in the past few years. The proportion of purely national standardization work has fallen continuuously since 1984 and now stands at a mere 15 %.

Concerning ‘Geographic Information’ the Technical Committee CEN/TC 287 has developed standards since 1992 (Secretariat AFNOR, France), mandated by CEN. This basic work is done by 4 working groups and 5 project teams. All standards are nearly finalized. These are Geographic Information -reference model, -referencing position, -referencing-geoidentification, -processing-query and update, -data description - geometry, -quality, -metadata, -data transfer. By decision of the plenary all standards have been finalized on ENV-status. They will serve as well as a basis for ISO.

Results of CEN/TC 287 ‘Geographic Information’

- ENV 12009: 1997-10 Geographic Information - Reference Model
- ENV 12160: 1998-02 Geographic Information - Data description - Geometry
- ENV 12656:1998-10 Geographic Information - Data description - Quality
- ENV 12658: 1998-10 Geographic Information - Data description - Metadata
- ENV 12658:1998-10 Geographic Information - Data description - Datatransfer
- ENV 12661: 1998-10 Geographic Information - Referencing - Geoidentification
- ENV 12762: 1998-11 Geographic Information - Referencing - Direct Position
- ENV 13376: 1998-11 Geographic Information - Data description - Rules for application schemas
- CR 13425: 1998-11 Geographic Information - Overview
- CR 12660: 1998-11 Geographic Information - Processing - Query and update, spatial aspects
- CR 13436: 1998-11 Geographic Information - Vocabulary

CEN/TC 278 „Road Transport Telematics“ developed the GDF-Standard (Georgraphic Data File), which is also used by ISO.

2.4 Worldwide Standardization

2.4.1 Involved Institutions

Standardization at the international level ist the responsibility of the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telegraph and Telephone Consultative Committee (CCITT), all located in Geneva.
In ISO, the national standards bodies of some 120 countries cooperate in activities that aim to facilitate the international exchange of goods and services by creating uniform standards with global validity and to stimulate cooperation in the scientific, technical and economic fields across national frontiers.

ISO/TC 211 ´Geographic Information/Geomatics' had been established in 1994 (Secretariat NTS, Norway). In the meantime this committee has steadily increased, there are 33 full-members, 17 observer-members, 1 correspondent member. Further the internal liaisons: besides 9 "internal" liaisons with other ISO-committees there are 12 "external" (A-)liaisons including the important Open GIS Consortium (OGC), which has a special cooperation with ISO/TC 211 for promoting the results and mutual benefits.

- Centre for Earth Observation (CEO)
- Digital Geographic Information Working Group (DGIWG)
- European Petroleum Survey Group (EPSG)
- International Association of Geodesy (IAG)
- International Cartographic Association (ICA)
- International Federation of Surveyors (FIG)
- International Hydrographic Bureau (IHB)
- International Society for Photogrammetry and Remote Sensing (ISPRS)
- International Steering Committee for Global Mapping (ISCGM)
- OpenGIS Consortium, Incorporated (OGC)
- The Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)
- United Nations Economic Commission for Europe (UN/ECE) and
- CEN/TC 287 'Geographic Information'

The 25 projects are handled by 5 working groups ´Framework and reference model', ´Geospatial data models and operators', ´Geospatial data administration', ´Geospatial services' and ´Profiles and functional standards' and numerous project teams. Every country should join this ISO/TC 211 as participant-member.

OpenGIS-Consortium

One of the A-Liaison-Members is the OpenGIS Consortium (OGC) with the following definitions:

OpenGIS - Open and interoperable geoprocessing, or the ability to share heterogeneous geodata and geoprocessing resources transparently in a networked environment. „The highest level of the interoperability specification." OpenGIS Specification (OGIS). A software specification that enables geodata sharing and geoprocessing interoperability. An interface standard for interoperable geoprocessing. OpenGIS Consortium, Inc. A member-based consensus forum dedicated to the development of OpenGIS technologies and the integration of geoprocessing into enterprise computing.

By OGC there is a challenge to interoperability:

Internet e-services are evolving rapidly around an open environment. Data traditionally separated from each other are now available in a homogeneous way via easy-to-use access methods. Considering the fact that a vast majority of data have a geospatial reference, web-based geo-services are a logical consequence.

In this challenging environment, the Geographic Information Systems (GIS) industry is facing a paradigm shift. Moving away from its traditional role of primarily being a data producer, the new focus is now on supplying services towards a virtual geodata market place. From the multiple utilization of geospatial data captured with automated data acquisition methods new application segments will emerge.

Geospatial data are national infrastructure data. Their availability and utilization is an economic success factor. The vision is that geodata as national infrastructure data are generally available in the web. Authorization and

licensing procedures for using these data are transparent and market oriented. This „globalization“ of geodata implies standards in access and semantics, the keyword ist ‘interoperability’.

The vision of the OpenGIS Consortium Inc. (OGC) is interoperability between GIS systems and the complete integration of geospatial data and geoprocessing resources into mainstream computing. Users will be enabled to exchange geodata without the necessity of translating these data. OGC’s standardization process is conducted in a close and efficient consensus-based cooperation between the OGC members: GIS vandors, IT industry, systems integrators, academia and especially large users like government organizations. However, the activities are not restricted to theory: testbeds and prototypes are an important supplement to the Technology Development Program. The Web Mapping Testbed for example has the goal to evaluate and develop next-generation interoperable web-based mapping technology solutions by integrating geospatial information from multiple sources simultaneously.

ISO/TC 211 and OGC established in 1999 a special cooperation for promoting the results and mutual benefits (see some mainpoint of the agreement):

Co-operative agreement between ISO/TC 211 Geographic Information/Geomatics and the OpenGIS Consortium, Inc. (OGC)

- **Purpose and Background**
- **General principles**
  - OGC wishes to obtain ISO International Standard status for its Industry Implementation Specifications.
  - ISO/TC 211 wishes to adopt appropriate Industry Implementation Specifications as ISO International Standards or other ISO deliverables.
  - OGC wishes, while retaining its market responsiveness, to align with ISO/TC 211 on working practices.
  - ISO/TC 211 wishes, within the constraints of the ISO Directives, to co-operate with OGC in assisting the alignment of life cycle working practices.
  - OGC and ISO/TC 211 wish to harmonize and agree their respective work programmes and to set up a group to handle issues under this agreement.
  - OGC and ISO/TC 211 wish to achieve mutual benefit from sharing the expertise of domain experts of the two organisations and they welcome cross-project participation.
- **Alignment of procedures**
  - Liaison
  - Early collaboration
  - Co-ordination group
    OGC and ISO/TC 211 have established a joint co-ordination group. This group will meet as necessary and will be the forum for discussing and resolving issues that may arise from time to time. The group will support the individual liaisons between ISO/TC 211 working groups/project teams and OGC working groups, and shall not in any way usurp the responsibilities of existing organizational structures in OGC or ISO/TC 211.

    The terms of reference for the co-ordination group are developed and accepted by OGC and ISO/TC 211.
- **Maintenance of standards**

2.4.2 ISO/TC 211 Working Groups and Work Items

The 25 projects are handled by 5 working-groups:
‘Framework and reference model’, ‘Geospatial data models and operators’, ‘Geospatial data administration’, ‘Geospatial services’ and ‘Profiles and functional standards’ and numerous project teams.

WG 1 - Framework and reference model

19101	Reference model	IS 2001-03
19102	Overview	IS 2002-07
19103	Conceptual schema language	TS 2000-11
19104	Terminology	IS 2001-08

19105	Conformance and testing	IS 2000-05
19121	Imagery and gridded data	TR 2000-03
19124	Imagery and gridded data components	Stage 0 ER 2001-01

WG 2 - Geospatial models and operators

19107	Spatial schema	IS 2001-05
19108	Temporal schema	IS 2001-02
19109	Rules for application schema	IS 2001-08
19123	Schema for coverage geometry and functions	IS 2002-01

WG 3 - Geospatial data administration

19110	Feature cataloguing, methodology	IS 2000-11
19111	Spatial referencing by coordinates	IS 2000-12
19112	Spatial referencing by geographic identifiers	IS 2000-12
19113	Quality principles	IS 2000-10
19114	Quality evaluation procedures	IS 2001-06
19115	Metadata	IS 2001-07

WG 4 - Geospatial services

19116	Positioning services	IS 2001-04
19117	Portrayal	IS 2000-11
19118	Encoding	IS 2001-02
19119	Services	IS 2001-08
19125	Simple Feature Access-SQL-Option	IS 2000-12

WG 5 - Profiles and functional standards

19106	Profiles	IS 2001-11
19120	Functional standards	TR 2000-03
19122	Qualifications and Certification of personnel	TR 2001-09

2.4.3 Current Activities of ISO/TC 211

Because the number of involved institutions and the number of projects are increasing, consequently the need of harmonization and work at all as well, so the newly established 'Chairman's Advisory Group' discussed at the meeting in March 2000 how to speed up the standardization work.

The project 19122 'Qualifications and Certification of personel' has been started also in March 2000. Because of the different approches to this subject on national level, the project team developped a questionnaire to analyse worldwide the respective situation for presentation and discussion of the results at the next meeting in July in Amsterdam. The aim is to develop an ISO-Technical Report.

The big number of comments to the draft standards shows the global interest as well as the different professional preconditions on national level. Therefore the Model Harmonization Team decided to involve some national solutions from praxis as testbeds for the ISO-standards.

2.5 Remarks

Due to the fact that the work in CEN/TC 287 and as well in ISO/TC 211 make good progress there are already decisions concerning standardization available for the progress of development on the national level. Many efforts are needed; specialists and budget from the involved organizations accompanying the international work, which are often not available. The standardization work for ISO is continuously increasing from 5 % of the DIN-work to 32 % in 1996 during the last 8 years.

3. MANAGEMENT OF GEOGRAPHIC INFORMATION

3.1 Requirements for an interdisciplinary GIS-Management

Planning and development of successful GIS-applications require a tight GIS-management. Data-capture and data-safety must be conceded the highest priority because of extremely high investment costs and the negative consequences arising out of the smallest misplanning.

Even though the existing departmental competencies should be preserved and each department should remain responsible for maintenance of it´s own data, areas of responsibility must be overcome to stop a proliferation of GIS-datasets, that cannot be combined because of severe inconsistencies, in the beginning. The success of GIS-technology can be regarded in reverse proportion to the welldeveloped departmental egoism. This applies for the different administrations on local, regional and national level and for cooperation and interaction between administration, business and research.

Starting-points for GIS-management can be found on very different technical and organizational levels. Each organizational level is confronted with partly similar, partly different problem areas if the use of GIS is concerned, that primarily need to be solved within each own organization. Important is, that the contact to neighboured, superior or subordinate organizations/companies/administrations can never be neglected. The optimum would be a top-down approach, e.g. the compliance with German nation-wide regulations, if the cooperation of the 16 different German states is concerned. This approach normally will not be successful because various actions cannot be synchronized (different subject-specific pressure on different organizations).

In detail, the main tasks of GIS-management for almost all organizational levels are:

- *Assessment of the coordination needed (of the weak points)*

  For this task it is of utmost importance, to reveal and to avoid confusion with regard to competencies and uneconomical double work. Competencies and areas of responsibility must clearly be defined from the beginning of work with GIS-technology.

- *Definition of general GIS-specifications and standards*

  Uniform spatial reference systems (geodetic reference system, geometric basic data), widely used data exchange formats and co-ordinated data models, database models and contents definitely simplify integration and combination of different subject-specific datasets.

- *Establishment of a meta-information system*

  In large organizations (e.g. state administrations) there often is a constant lack of information about existing digital datasets and those administrative bodies responsible for them. Additional information about datasets closing that gap should be captured and updated in meta-information systems, which at the same time are the first source of information for customers of one´s own data.

- *Definition and control of data quality*

  One part of the information to be found in a meta-information system is the description of data quality, which includes the following details: topicality of data, sources for data capture, geometric and semantic accuraca and completeness of data. The tasks of GIS-management will be quality planning, -control, -assurance and -documentation.

- *Establishment and management of a sales- and pricing-policy*

  Access to GIS-data must be ensured for all customers if the conditions imposed by data protection laws are obeyed (e.g. with regard to the background of the European guideline about free access to environmental data). The interaction between data producers, service providers and data users must be sorted out for both technical and logistical aspects. This includes the development and fixing of unified fee scales and the orientation of the data distribution towards customers´ needs. There should even be a contact person for different subject-specific datasets. The determination of fees certainly requires a clear political framework, especially

for officially (with the money of the tax payer) capured datasets and their distribution either at cost covering charges, at only dissemination costs or even free of charge.

- *Influencing of the development of GIS-technology*

  It is a permanent task of GIS-management, to have a close look at the GIS-market and to influence it. Only with corresponding cooperations between GIS-customers, research and data-producers the weak points of systems and software can be determined, marked and erased (e.g. in the fields of database modelling, data integration, generalization, networks etc.).

- *Guarantee of data-security*

  Looking at it from this point of view it is important, to guarantee the external security of any information-technology system. Assistance is granted by guidelines edited by the Federal Office for Security of Information Technology (BSI) and by recommendations of the Advice Centre for Information Technology of the Federal Government of Germany (KBSt). A multi-tiered concept first of all recommends

  - the ascertainment of the need of protection for GIS-data and information-technology systems,
  - to establish a realistic analysis of the threat ("What could happen?"),
  - to analyze the acceptable risks (loss of data or information technology-systems) and
  - to draw up a security concept (firewall-systems, data-backups) for the own instituion.

- *Establishment of an organizationl structure suitable for GIS*

  The introduction of GIS-technology and -methods mean an important corollary to each employee. System architecture of computer systems may lead to the compulsion of cooperation with divisions/administrations independently working up to now. The dealing with problems or files in small project teams may cause new organizational structures, a flattening out of hierarchies, the eventual composition of new teams and the delegation of responsibilities. The impact on motivation and behaviour of staff must be considered in all relevant plannings at a very early stage.

- *Introduction of a suitable personnel management for GIS*

  A suitable personnel management covers the planning and introduction of training and examination regulations brought into line with the new GIS-environment and a constant further vocational training for all staff. A progressive and modern forecasting of manpower requirements will always have to take into account an inter-disciplinary line-up of personnel. At last there must be mentioned, that a standardized GIS-workflow an impose some disadvantageous restrictions on previously very flexible operational sequences.

3.2 GIS-Coordination in Germany by example of the State of Lower Saxony (Land Niedersachsen)

In Germany, the Surveying and Mapping Agencies of the Länder (States) are building up two basic data sets - the Automated Cadastral MAP (ALK) in the scale region of 1:1000 and the Authoritative Topographic-Cartographic Information System (ATKIS) for medium and small scales. Many other departments are engaged in creating their own data bases containing digital data of special fields (e.g. Environment Information Systems, Land-Planing-IS, Forest-IS, Soil-IS, Road-IS, Municipal-IS,...). The success of all theseGIS-activities depends on the coordinated cooperation of these activities regarding data contents, data standards and data transfer.

In Lower Saxony, the foundation of a successful coordination of GIS-activities has been arranged by a resolution of the central government in 1990. This resolution prescribes that ALK/ATKIS-data of the Cadastral Offices and of the Surveying and Mapping Agency have basic functions within the authorities of the State. Only the respective offices are allowed to digitize cadastral and topographic maps. ALK/ATKIS-data have to be basis of all other digital data bases. Municipalities are recommended to proceed in the same way.

In order to accomplish the demands of this resolution a governmental Working Group on "Geographic Information Systems (WG GIS)" has been installed in 1992. All related departments of the Land are members of the WG as well as some representatives of the municipalities. Important aims of the WG GIS are:

- to avoid double work (e.g. in data capturing),

- to make public and to use well-tested GIS-methods all over the state,
- to support the exchange of experiences with GIS and
- to consider comprehensive interfaces for data exchange and data integration between the related authorities at an early stage.

In 1993 a GIS inventory has been performed. All State authorities and a representative selection of municipal offices have been requested to answer a detailed questionnaire.

Related to the integration of different data sets GIS-software should not only provide facilities for data analysis and data modification (statistics, geometric conversions, raster-to-vector-conversion and vise versa, data merging, area intersection ...) but GIS-software should especially provide the following facilities:

- The integration of data sets which are different in providing an accuracy must be possible at different levels.
- Concerning the level of data integration different functions for the combined cartographic presentation have to be offered.
- The computer-assisted updating of graphical and non-graphical GIS- and basic data must be possible.
- In special cases old data have to be stored in the database (historical data management). These developments in special fields and conditions of the past may be reconstructed.

Some of the most important forthcoming tasks are:

- Steering of data delivery:
  The steering of data delivery means to establish a meta-information-system where all necessary information about other GIS data banks are stored. This steering institution (Geo-Server) may help the user to find his relevant data supplier. Further more the steering institution should be authorized to define uniform data prices and terms of delivery.

- Integration of new research developments:
  Especially the development of tools for automated model generalization and automated cartographic generalization will be of great importance to the GIS world. These tools would make possible the multiple use of one source data base for various purposes and scales; they would multiply the benefit of GIS-techniques.

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