Opportunities for Applying Standards for Geodata Management in the Realm of City Administration

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Conteúdo

Resumo: *A modernização do setor público é um tema atual no mundo todo, especialmente no contexto de países em desenvolvimento. Existe uma grande pressão sobre a Administração Municipal para que haja uma melhor administração de seus recursos e uma melhora no seu papel de prestador de serviços à comunidade. nest contexto, um dos desafios é que se desenvolva um sistema que envolva toda a organização e que permita solucionar a demanda por alternativas que permitam um gerenciamento efetivo de informações. Atualmente, o meio técnico para interoperabilidade e comunicação entre sistemas está presente, entretanto, ainda há uma grande necessidade de se definir como esta comunicação se processa, em um nível de abstração mais elevado. O presente artigo aborda padrões aplicados ao processamento e gerenciamento de geo-dados, o importante papel que desempenham na viabilização da comunicação entre sistema, e até que ponto estes padrões existem e em que sentido ainda devem ser desenvolvidos. Uma classificação dos padrões aplicados ao geoprocessamento também é apresentada. Questões relativas à padronização e formalização de processos e produtes raramente foram tratadas no âmbito do COBRAC. Este artigo apresenta um panorama sobre este tema, abordando principalmente:*

- *Por que padrões em tecnologia de informação são importantes para o Poder Municipal?*
- *Que tipo de padrões existem e como podem ser classificados?*
- *Como pode/se analizar o ciclo de vida de um padrão em relação à evolução da tecnologia e aceitação do usuário?*
- *Quais as oportunidades para padronização no âmbito do Poder Municipal?*

Palavras chave*: Sistems Informaçoes geograficos, standards*

Abstract: *The modernisation of the public sector is a very current issue world-wide, particularly if developing countries are regarded. There is a big pressure on city administrations for better efficiency regarding the management of their resources and for an improved performance in their role as a service provider for the community. In this context, one of the challenges is to develop an enterprise-wide application system that can meet the demand for alternatives that permit a responsive management of information assets. Nowadays, the technical medium for interoperability and communication is present, but to enable interoperability in addition there have to be standardized ways of information interchange which are located at a higher level of abstraction. The following article shows the need for and the role played by standards which are applicable to geodata processing and geodata management, in which amount they are present already and where they have to be improved. Further on a differentiation between several types of standards is given and the different reliability and acceptance of standards are mentioned. Issues regarding standardisation and formalisation of processes and products had been rarely treated in the realm of COBRAC. This article shall draw a panorama of this theme, focusing on the following issues:*

- *Why do IT standards play a key role for city administration?*
- *What kind of standards are available and how can they be classified?*
- *How can the life cycle of a standard be analyzed regarding user acceptance and technological evolution?*
- *What are the opportunities for standardisation in the realm of city administration?*

Keywords*: Geoinformation systems, standards*

1 Motivation

The modernisation of the public sector is a very current issue world-wide, particularly if developing countries are regarded. There is a big pressure on city administrations for better efficiency regarding the management of their resources and for an improved performance in their role as service providers for the community.

The Internet and World Wide Web represent a foundation on which enterprises are working to build their organisational strategies. They represent a very expressive paradigm shift in the way knowledge is exchanged and has provided new means for remote, on-line and 24h access to information.

In this context, one of the challenges is to develop an enterprise-wide application system that can meet the demand for alternatives that permit a responsive management of information assets. Nowadays, the technical medium for interoperability and communication is present, but to enable interoperability on the application level there have to be additional, standardized ways of information interchange, which are located at a higher level of abstraction.

Spatial data processing plays a major role in planning and management tasks in the context of a city administration. In the last decades a lot of effort and money were invested in data collection and management for Geographic Information Systems (GIS).

Information systems are developing away from centralized systems towards distributed systems, where GIS is just one component within a broader IT network, which encompasses also non spatial data, like financial workflow, personal management etc. Geodata is a fundamental and important part of the data warehouses of administrative and commercial organisations [Hofmann et al, 2000].

The 70's and 80's were characterized by the disjoint evolution of techniques that nowadays have a major effect on geodata management:

- Database management systems (DBMS)
- Object-oriented paradigm for modeling of business processes
- Computer aided design and drafting algorithms.

All these techniques were invented independently from geodata management and processing, but they (will) have a great influence on that discipline. During the 90's, these efforts started to converge with GIS products and concepts. This ongoing process demands that interfaces, protocols and standards have to be defined.

The following sections show the need for general standards which are applicable to geodata processing and geodata management, in which amount they are present already and where they have to be improved. Further on a differentiation between several types of standards is given and the different reliablility and acceptance of standards are mentioned.

2 Definition of a Standard

According to the ISO/IEC Guide 2 (1996) a standard is a *document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context*. In the scope of this paper, however, we will expand this definition to also encompass Open Technologies defined by process and license (General Public Licence), by process but not license (Java, ODBC, DCOM), and the so-called "*de facto*" standards (e.g. DXF, ESRI Shapefiles etc.) [ALLAIRE, 2000].

A set of common characteristics of these standards is listed below. They play a key role for defining standards important for the current economic players and, as a consequence, are directly connected to intensive user demand and acceptance [WSSN, 2000]:

- Standards cover and integrate several disciplines;
- Standards are developed by specialized bodies, with a lot of experience in the subject;
- A standard is never neutral, it results from the participation and common sense of interests of public and private sectors of the economy;
- Standards reflect a stable level of a state-of-the-art technology. They represent the maturity of a certain technology in a certain moment;
- Standards are available to all;
- A global standard network warrants a hierarchy between international and national committees. That improves the acceptance of standards and the interoperability between agents which act in different domains.

3 The Role of Standards

Since the industrialisation in the last century, standards have been established in many different fields. The following list tries to point out some major roles of standards in general:

Customer side

- Incitation, protection and assurance of long-term investments.
- Contribution to client acceptance of a given technology;
- Communication, interoperability and exchangeability: As far as different systems comply to the same standard, they may be compatible.

Industry and trade side

- Standards promote and accelerate technological development. They intensify knowledge transfer between economic players;
- Standards facilitate and clarify the contractual relations between economic partners, they serve as a reference for trading transactions and are helpful for specifications of products;

- Standards serve as a reference for quality control. The definition of parameters for quality assessment of products and workflows is a major goal of standards;
- Standards enable competition between several vendors or service providers which leads to cheaper products and distributed production chains.

Yet remarkable is the increasing participation of other economic players, which are not official agencies, in the definition of new specifications. The active participation of the industry is a consequence of a competitive market and the increasing effects of the organisation over the whole enterprise (see, for instance, ISO 9000 and ISO 14000). Economic players may intensify their participation, as an strategic choice (competitiveness) and to support their specific interests in the final standard texts.

Another factor that decisively contributes to the standardisation and pulls it all over the world is the need for regional economic integration. International trading and service providing obligates an additional effort to define para-national standards, otherwise commercial transactions are not possible or even constricted. Noticeable examples are the European Committee for Standardisation (CEN) and the Standardisation Committee of the MERCOSUL (CNM) in South America.

This leads to an hierarchy of standardisation bodies. Though standards are most of the time not mandative and the transposal from a higher instance to a lower one is voluntary, there has to exist an informal, well-defined order of precedence from the international to national standardisation bodies. Figure 1 presents, as an example, the CNM criteria for choosing a base-text for a new norm.

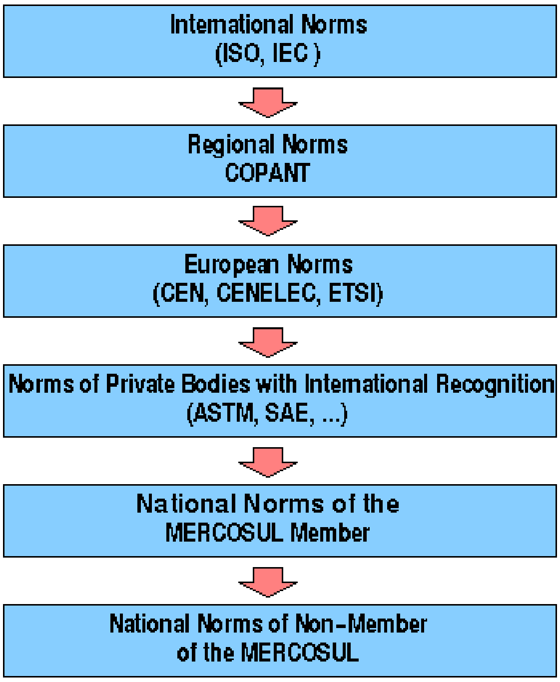

Figure 1 : The selection of a new base-text at CNM

4 Classification of Standards

The World Standard Services Network (WSSN) [WSSN, 2000] classifies the standards according to their content:

- Fundamental standards
- Test methods and analysis standards
- Product and service activities standards
- Organisation standards

In the scope of this paper an additional type has to be included. *De-Facto* standards encompass those standards that were defined by the commercial success of a specific proprietary technology (e.g. DXF, ASP, ESRI Shapefiles etc).

5 The Evolution Curve

Figure 2 represents the relation between the evolution and the approval of different standards' releases with user acceptance and technology evolution. A first release may have a very short life, it just a necessity to wake up user interest. Lauching a new release (A) is necessary to catch a larger user acceptance, better adapting the specifications to user/market demands. Remarkable is the fact that the user acceptance may increase in higher rates after a second release is lauched. This acceptance, however, may grow till a maximum peak (C), after which it decays due to technological changes (D). These changes can be the result of a paradigm shift, for instance.

A second aspect that may be observed is that there is always a gap between technology status and the release specifications. Standards are not static. As technology evolves, so does a standard, but in a slower pace: only after some new knowledge was corroborated by the practice of its use, it is candidate to be added to an existing standard, to form a new release.

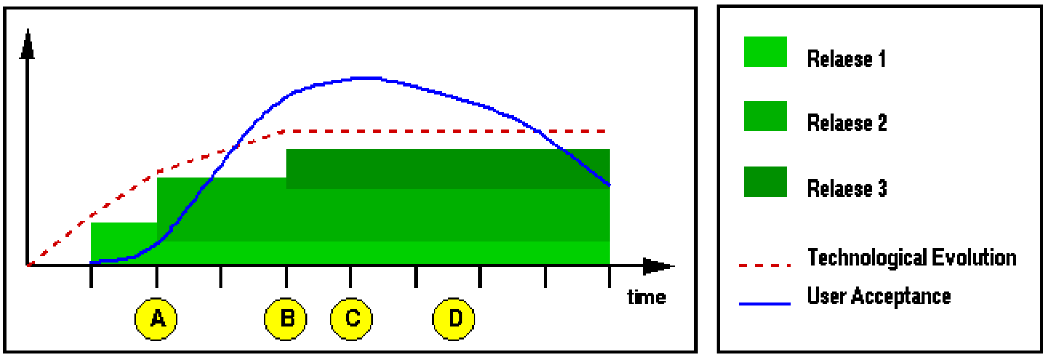

Figure 2 : The releases of a standard vs user acceptance and technologyevolution.

6 The need for geoinformation

In Western Europe the analog carthographic products have reached a very sophisticated and complex standard. They are nationally standardized in scale and content and are used in a widespread field of applications as a base for deriving thematic maps or as background for application specific maps. But in the future the need for geoinformation which is processable in a digital, automated and computer-based way is demanded. This means that the sophisticated signature based modelling of maps has to be transformed to an object based geodata model which represents the data in an objective, application independent way. The maps have to be made integratable into upcoming geoinformation systems, where the map layout and the style of presentation will be done on the end-users desktop in an application specific way.

Three basic kinds of geodata are proposed:

- digital geocoded aerial orthoimages
- object based digital landscape models (DLM)
- digital cartographic representations of the DLM

An increased demand for geoinformaton can be stated for the following domains:

Navigation systems: This kind of information system has shown a very rapid development in Germany. Its application these days is to find mainly in car navigation systems, but it is expected that similar systems will reach the market for portable, palmtop- or mobile-phone-based navigation systems for pedestrians.

Communal Rescue Management Systems: These kinds of systems are benefitting from the recent developments in geoinformation processing and try to include these information sources into their systems. The special needs of these disciplines are in street data for routing and navigation and in building data for rescue mission planning. In the context of research projects related to hazard risk mitigation 3D city models are proposed for risk and impact simulation and for the support of rescue tasks [Weindorf et al., 1999].

7 Relevant International Committees and Organisations for Geoinformation and their standards

7.1 Organisations

The following table presents some of the important organisations and their technical committees, which are responsible for defining standards in the field of geoprocessing.

Tab. 1: Organisations providing relevant standards

Organisation / Commitee	Working Group
ISO/TC211 - Geographic Information / Geomatics The Technical Commitee 211 aims at the establishment of a "structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the earth" [ISO 211]	• Framework and reference model • Geospatial data models and operators • Geospatial data administration • Geospatial services • Profiles and functional standards

Open GIS Consortium Inc. (OGC) The OGC is a non-profit organisation founded in 1994 to support the development of interoperable systems in the context of geodata processing. The interoperability of geoinformation systems as well as the communication with standard IT systems is addressed by the OGC. A good introduction to the OGC can be found in the OpenGIS guide published via the WWW [OpenGIS, 1998]. Meanwhile nearly all international IT vendors are members of the OGC and therefore they are prompted to develop products which are conform to the specifications worked out by the OGC.	• Feature Geometry • Spatial Reference Systems • Locational Geometry • Stored Functions and Interpolation • The OpenGIS Feature • The Coverage Type • Earth Imagery • Relations Between Features • Accuracy • Feature Collections • Metadata • The OpenGIS Service Architecture • Catalog Services • Semantics and Information Communities • Image Exploitation Services • Image Coordinate Transformation Services
Federal Geographic Data Commitee (FGDC) This institution coordinates the development of the National Spatial Data Infrastructure (NSDI) in the United States of America. NDSI "encompasses standards, policies and procedures to cooperatively produce and share geographic data" [http://www.fgdc.gov].	• Base cartographic subcommitee • Bathymetric subcommitee • Cadastral subcommitee • Cultural and demographic subcommitee • Geodetic subcommitee • Geologic subcommitee • Ground transportation subcommitee • International boundaries subcommitee • Soils subcommitee • Spatial water data • Vegetation subcommitee

7.2 Known Standards

Tab. 2: Selected standards, relevant to geodata processing

Standard / Target	Origin
Spatial Data Transfer Standard (SDTS): used by the US Geological Survey	FGDC / USGS
Cadastral Data Content Standard: intended to support the automation and integration of publicly available land records information	FGDC
Common Object Request Broker Architecture (CORBA): Middleware technology to support the wrapping of distributed objects in a network (Platform independent)	OMG
Object Linking and Embedding (OLE), Component Object Model (COM), Distributed Component Object Model (DCOM): Technique for application intercommunication (Platform dependent, MS-Windows only)	Microsoft Corp.
Structured Query Language (SQL): Database Query and Management Language	ISO
Extensible Markup Language (XML)	W3C
Virtual Reality Modelling Language (VRML)	
Simple Features Specification (SFS)	OGC
GeoTIFF	
Java Database Connectivity (JDBC), Database access for Java	Sun Microsystems Inc.
Open Database Connectivity (ODBC), Database access	Microsoft Corp.
Unified Modelling Language (UML): Standard for modelling processes and software components	OMG
Petrochemical Open Source Consortium (POSC): Standards in projections and coordinate systems	
Metadata Catalog Services	OGC
ESRI Shapefile, Interchange format of ESRI ArcView	ESRI
AutoCAD DXF, CAD data interchange format, focused on geometry	Autodesk Inc.
ARC/INFO E00, ASCII interchange format of the ARC/INFO system	ESRI

8 Problems and Challenges

During the last decades a huge amount of spatial and descriptive data has been collected in the municipality sphere to form special purpose databases. Geometric and non-geometric descriptions of urban objects (streets, infrastructure, buildings etc.) have been simultaneously recorded by several companies and departments, addressing different objectives: management, control, planning, tourism, documentation, water and energy supply etc. These datasets represent the reality under distinct, application dependent levels of abstraction and are usually stored and managed with standard office software, simple database tools, CAD files or even under the control of a Database Management System (DBMS).

Data aquisition and the updating of this data is the most expensive part in creating and maintaining geoinformation systems, this task may consume up to 90% of the overall budget for a GIS project [Buhmann and Wiesel, 1999]. Therefore a multiple and interdiciplinary usage of this datasets is more and more a strategic business factor and one of the most challenging tasks in the GIS community. One special kind of information system concept in that context is represented by the multipurpose cadasters which provide information relevant to many applications and services [Loch, 1998]. Another concept is the use of multi-tier architectures which take advantage of so called application-servers or middleware layers which take care of the interoperability of several a-priori independent data sources or information systems [Weindorf & Hofmann, 1999], [Hofmann et al, 1999], [OpenGIS, 1998]:

The main advantages which are to be expected while combining different data- or information sources are:

- Costs of data acquisition are reduced: Using existing data from other departments reduces the investment in acquiring, storing and managing data;
- Actuality and consistency of the data can be maintained more easily: Databases are updated within the competence of dedicated authorities (cartographical service, financial service etc.), redundancy and thus a source of inconsistency is reduced;
- Synergy effects are gained: Sharing data means sharing common concepts. This is the foundation for a cooperative work between private and public agencies.

To achieve the goals listed above, industries and customers came together in the form of non-profit consortia (e.g, W3C, OGC etc.) that aim at the development of standards to make interoperability of different information systems possible. This interaction or interoperability between special purpose databases takes place on different levels:

- System level (hardware, network protocols etc.);
- Syntactical level (file formats);
- Semantic level (object catalogs, metadata descriptions etc.).

The essential problem in interoperable systems today is not the pure data exchange on the low level, but the transfer of information without loss is still a challenging task for system integrators and researchers. To support this information interchange between several disciplines and systems, on one hand standards are up to be defined on an international and national level (cf. section 2 and 3), on the other hand the users (e.g. city administrations) have to define their own specific standards in the following fields:

- **Products**, to promote them to public and other departments;
- **Data exchange**, to support synergy effects and to reduce the costs of data aquisition and maintenance;
- **Processes and workflows**, to optimize internal work, to be more cost efficient, to enable quality control.

8.1 Definition of standard products

The definition of standard information products is a basic step and a precondition for the definition of standard workflows. If a city administration, as well as every other private company, defines standard information products to be used in its workflows like maps of a specified scale and content, these products may also be provided to private or industrial customers and other administrative services to be used in their workflows as well. As an example in Germany the *german base map of scale 1:5000 (DGK5)* is the official base for the strategic land management of a region. Another example are the cadastral maps which are the official base for urban planning tasks. This status is given to these information products by federal laws, and therefore these information products have reached a very good acceptance. A selection of standard products provided by lots of Europe's mapping agencies is listed in Tab. 3.

The base data products may be used in proprietary applications which may rely on a stable and long-term data model of this base data. For instance there are traffic guide systems, specific cadastres for documentaion of telecommunication facilities or energy suppliers facilities. Usually disciplines asking more and more for geographic base data are insurances, banks, logistic service providers etc. [Bischoff, 2000].

Tab. 3: Standard products

Product	Comments	Standardizable in ...
Orthoimage	• Relatively easy to aquire • covering large areas in short times • most objective representation, ungeneralized, uninterpreted	• Scale • Panchromatic / Color / Infrared • Reference System
Orthomap	• Orthoimage with additional descriptive information	• Dto. • Additional descriptions like streetnames, rivernames, parcel boundaries etc.
Vector Data	• Basic geodata, without presentation attributes (digital landscape model) • Enriched by object attributes (streetnames, parcelnumbers, owner data etc.)	• Object types • Format of distribution • Thematic scope • Way of representation (Shape, middle axis etc.) • precision of objectaquisition

Rastermap	• Rasterized vector map with specific thematic content	• Scale • Color, B/W • Format of distribution • Reference system • Thematic scope

8.2 Development of standard data schemes

Another important kind of standard is the coordinate system to be used for specific applications. Within a geoinformation system the coordinates in terms of the geometry of the stored objects play the role of the primary key known from traditional database systems. The so called georeference is used to combine data originated in different systems for different basic purposes. Along the common georeference they may be combined into a new information product.

A lot of effort was taken to define standards for data excange, but it is still a very challenging task to define standards for information interchange. That means that the process of transferring information (data + semantics) is still at the beginning. Object catalogs and catalog services to describe the format of data sets as well as a description regarding the fitness for specified purposes have to be established in the future. Especially the internet techniques (first of all the WWW) demand to do that in an automatic way to improve the quality of the results of search engines or to improve the cooperation of different data sources and systems. This is an elementary task which has to be supported by a broad community of institutions potentially using and aquiring data. Moreover this process should take international and national standards, like the ones proposed by the OGC, the FDGC etc., into account. It is to state that nearly every city administration has a lot of tasks which are more or less identical or comparable. Therefore a data model created for one city should be applicable, with minor modifications, to another one. But this is only true for national comparison because due to different cultural and economical development every country has its own specific priorities which are described in political directives or are manifested in corresponding laws.

By the definition of a standard data model which is up to be used in the context of city administration the following benefits are to be expected:

- Better and cheaper tools to support administrative tasks;
- Return on investment for basic data aquisition, through off-the-shelf products.

The industry may develop tools to maintain and support these schemes. An example in Germany is the ALK (automated cadastral map) or the ATKIS® (Authorative Topographic Cartographic Information System) which have well defined data schemes and corresponding object descriptions. There are standard software products which are designed especially to deal with that standard data models [Smallworld, 1998], further on most of the software packages support the import and export of data in the appropriate formats. This enables consulting and service providing by private companies which supports the administration and saves costs.

To promote the existence of spatial information in Europe, there is an information network called MEGRIN (Multipurpose European Ground Related Information Network), which was founded in 1993 on the initiative of CERCO (Comité Européen des Responsables de la cartographie Officielle), a group of european national mapping agencies represented by their heads. This network aims at the support and the stimulation of creating pan-european datasets in a homogeneous way. The main tasks are the support of cost-effective datasets and to provide information about these datasets. Several projects or products may be found on the WWW at http://www.megrin.org. Especially interesting is the refence implementation of the European Metadata Standard CEN ENV 12657 of CEN/TC287, the GDDD (Geographical Data Description Directory), which provides a retrieval system for European cartographic standard products.

9 Conclusions and Perspectives

The World Wide Web is a very useful and widely accepted medium for fast and dynamical communication. But, to warrant a specific quality of information transfer, protocols and principles need to be developed which will operate not only on the technical level of communication (like the lower parts of the OSI/ISO model) but also on the semantic level. This will assure that the right message will be delivered at the right time to the right recipients, and that they will understand it the way the sender would like them to understand.

- It was shown that this task is partially adressed by several standardisation organisations, but it is not reached yet and there's a lot of research and work left to do.
- Even if standards help to improve technology and fortune there some aspects to mention.
- Standards have to be backward-compatible. This may slow down the development of technicasl improvements.
- De Facto standards are not always fully supported (DXF 12, 13, 14).
- Standards may attend and observe existing laws.
- Nowadays semantics are not yet exchanged automatically. They are implicit in the form of catalogs or tables (paper). In the future, the semantics have to be made explicit.

In the field of Geographic Information Systems - GIS there have been long-term efforts to develop a "*common data model for the transfer of geographic information and the definition of the behavior of operation on that data"* [OGC Technical Committee, 1998]. Well known entities are the Comité Européen de Normalisation - CEN/TC 287, Open GIS Consortium - OGC and the International Standards Organisation - ISO/TC 211 and some well known standards are the Open GIS' Simple Features Specification and the Structured Query Language - SQL, for instance.

The Institute for Photogrammetry and Remote Sensing - IPF (Karlsruhe) has been working on a Web-based GIS for environmental monitoring, which complies to some of the standards mentioned above [Hofmann, 1999]. In the field of Land Information Systems - LIS (Cadaster-based GIS), data models that regard these standards have been developed, e.g. in Switzerland (INTERLIS) and Germany (ALKIS).

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