On the Use of ISO Standards in Cadastral Information Systems in Germany

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Key words: ALKIS, AdV, ISO, OGC, Feature Catalogue, Data Encoding, Unified Modeling Language, Application Schema.

ABSTRACT

Germany is a classic example of a country that takes great pride in it's highly accurate maps and cadastral data. In the last three decades several independent geoinformation systems has been developed in the field of cadastre and topographical mapping. Right now a redesign of the German digital cadastral information system ALK (Automated Real Estate Map) is under development. The new approach - called ALKIS (Official Cadastral Information System) - was launched in order to harmonize the structures of ALK and the topographic database ATKIS on the one hand and to integrate the cadastral map and the land titles into one single model which was usually separated for historical and technical reasons.

For that reason the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV) has started developing a new conceptual data model based on international GIS standards which help to fulfill this task. This paper identifies the key items of a cadastral information system which have to be considered in the context of applying GIS standards and reports on the first results.

ZUSAMMENFASSUNG

Deutschland ist ein klassisches Beispiel für ein Land, das schon immer Wert auf genaue Landkarten und Katasterinformationen gelegt hat. In den letzten drei Jahrzehnten wurden mehrere unabhängige Geoinformations-Systeme im Bereich des Katasters und der topographischen Karten entwickelt. Derzeit wird die automatisierte Liegenschaftskarte ALK grundlegend überarbeitet. Der neue Ansatz - genannt ALKIS (Amtliches Liegenschaftskatatser-Informationssystem) – wurde notwendig, um zum einen die Datenstrukturen (Semantik) der ALK und die des topographisch-kartographischen Informationssystems ATKIS aufeinander abzustimmen und zum anderen die Informationen der Liegenschaftskarte und der Liegenschaftsbeschreibung in einem einzigen System zu integrieren. Aus historischen und technischen Gründen mussten diese Systeme bislang getrennt voneinander entwickelt und gepflegt werden.

Aus diesem Grund hat die Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland (AdV) die Entwicklung eines neuen konzeptuellen Datenmodells auf der Grundlage internationaler GIS-Standards begonnen, um diese Integration zu erreichen. Dieser Bericht beschreibt einige wesentliche Kernpunkte, die im

Zusammenhang mit der Anwendung internationaler GIS-Standards beachtet werden müssen und gibt einen kurzen Überblick über die hierbei gewonnenen Erfahrungen.

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1. INTRODUCTION

In many countries a major field for applications is cadastre. This field has a long tradition also in Germany. Right now a redesign of the German digital cadastral information system ALK (Automated Cadastral Map) - which has been in use for approximately one decade – is under development. Besides the ALK, which mainly represents geometric features like parcels, buildings and so on, a separate database (ALB – 'automated land register') with all the titles of the land records exists.

The new model called ALKIS (Official Cadastral Information System) was launched in order to harmonize the structures of ALK and the topographic database ATKIS (Official Topographic-Cartographic Information System) on the one hand and to integrate the cadastral map and the land titles into one single model which was usually separated for historical reasons.

The former ALK system was originally used mainly within the surveying organizations, performing as a central information system to fulfill all tasks that have to be carried out relating to cadastral issues. Besides that from the very beginning the aim of the ALK has been also to provide basic geographic data for many GIS applications in various fields in local governments, utilities and so on. Right now there is also a great demand on having access to these valuable data from others like banks, lawyers, notaries .... All of them in general need for up-to-date data for their applications. So a fast data transfer or even an online access to these data could be very helpful in future. Currently, a lot of projects are established in order to build up a national geographical data infrastructure. That will help to ease the access to the public geodata and reach interoperality between different geoinformation systems within various state administrations.

Therefore the approaches aiming at GIS interoperability like the ones which are coming up from the concepts of the international standardization organization ISO (International Organization for Standardization) and from the OGC (Open GIS Consortium) are very interesting in this field and have to be taken into account by modeling the new application schema ALKIS.

The concept of the Cadastral Information System ALKIS was developed by the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV) called **AdV**. This conceptual data model is completely object based and describes geographic and non-geographic features as well as their relations (associations). In order to describe this model in a standardized way it has been based on the ISO draft standards in the field of geographic information.

2. THE BENEFITS OF USING GIS STANDARDS

ISO 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 [ISO, 2001].

ISO has formulated some objectives that are also valid for ALKIS:

- Increase the understanding and usage of geographic information
- Increase the availability, access, integration, and sharing of geographic information
- Promote the efficient, effective, and economic use of digital geographic information and associated hardware and software systems
- Contribute to a unified approach to addressing global ecological and humanitarian problems.

The AdV has adopted these aims and decided to take into account the ISO standards within the new application schema ALKIS as far as possible.

3. APPLICATION OF THE ISO/TC 211 FAMILY OF GIS STANDARDS IN ALKIS

ALKIS applies a lot of ISO standards which are generally issued as draft international standards (DIS). In detail the conceptual application schema ALKIS is based on the following specifications:

- ISO 19101 Geographic information - Reference model
- ISO 19103 Geographic information - Conceptual schema language
- ISO 19105 Geographic information - Conformance and testing
- ISO 19107 Geographic information - Spatial schema
- ISO 19108 Geographic information - Temporal schema
- ISO 19109 Geographic information - Rules for application schema
- ISO 19110 Geographic information - Feature cataloguing methodology
- ISO 19113 Geographic information - Quality principles
- ISO 19115 Geographic information - Metadata
- ISO 19118 Geographic information - Encoding.

The following report will highlight three main issues in detail. Figure 1 shows an overview about the ALKIS application schema as a package combined with some packages from ISO containing the specification for feature cataloguing, spatial schema and encoding rules.

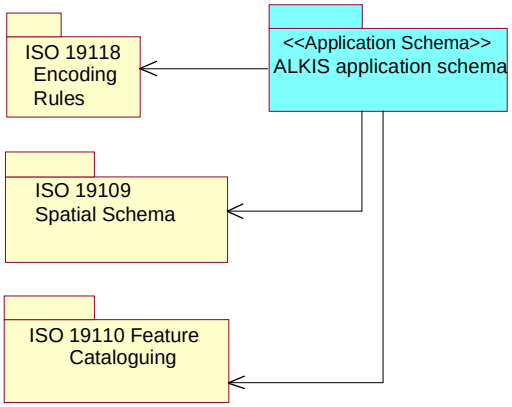

Fig. 1: ALKIS application schema in the ISO model

3.1. Feature Catalogue

As mentioned in the previous sections the ALKIS application scheme is based on real world phenomena which are called features in this paper.
The main characteristics of features defined in ALKIS are:

- They have a unique identifier
- They belong to a class of features
- They have - semantic and other - properties (attributes), especially quality information has to be mentioned here. These properties also have codes and definitions.
- They are spatially referenced or not (geographic or non-geographic features)
  - Spatial objects have a spatial reference (2D or 3D-coordinates)
  - are based optionally on a geometrical sub scheme or a topological sub scheme
- Features are simple (atomic) or compound
- Relations / associations between features have to be maintained
- Features have a life cycle (they appear and disappear), for some features or even the relations the history has to be documented.

These properties characterize ALKIS features which have to be described in a formal structure. ISO offers an appropriate standard to do this (ISO DIS 19110 “Feature cataloguing methodology”).

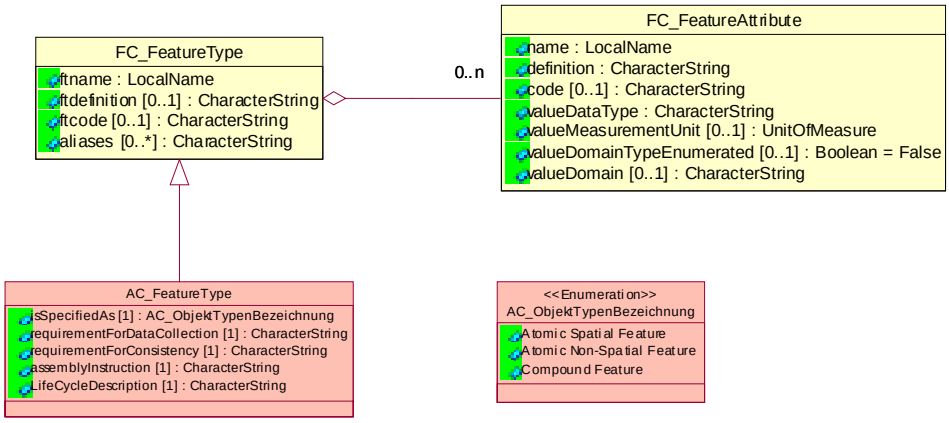

Fig 2: ALKIS feature catalogue structure

Figure 2 shows an extract of the feature catalogue structure derived from ISO. The classes at the top were defined by ISO. But not all requirements needed in ALKIS are provided by this standard (e.g. requirements for data consistency). In figure 2 the highlighted classes below contain additional feature specifications that are needed in ALKIS. These specifications were defined as an extension within the application schema ALKIS.
The ALKIS application schema is completely described by using the conceptual schema language UML (Unified Modeling Language). In addition the feature catalogue can be converted from the UML data model into RTF or HTML data formats automatically. So users are able to read the specification without buying an expensive UML tool.

3.2. Spatial Schema

From a cadastral point of view there are a lot of geographical features (like parcels, buildings ...) but also non-geographical features (like persons, land titles ...) which have also to be considered. Spatial aspects are specified in ISO 19107 “Spatial schema”. Figure 3 shows an abstract of spatial attributes which has been adopted in ALKIS.

The spatial view of the data can either be described by using geometric primitives or topological primitives. Some parts of the ALKIS scheme are described by geometric primitives but in many cases full topology based on an orientated graph structure is required.

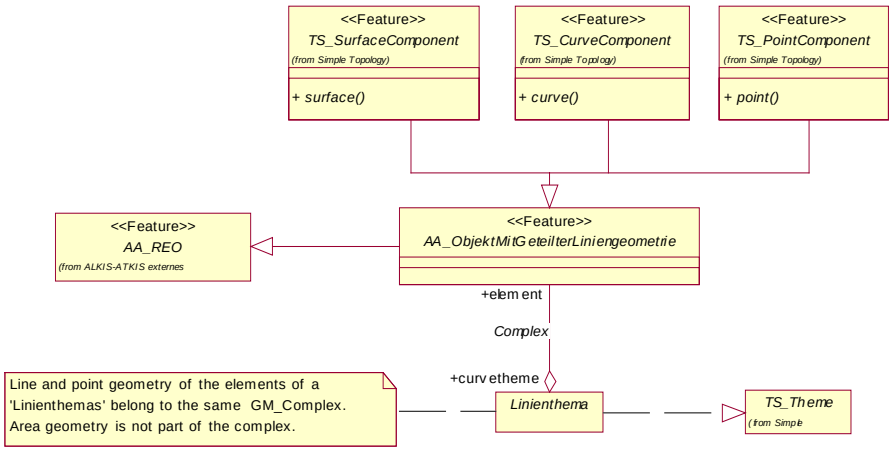

Fig. 3: Extract of the ALKIS spatial schema

The classes at the top partly represents the ISO standard on spatial schema, the other classes specifies the additional requirements of ALKIS. Actually, no serious problems were identified by using this draft international standard. The only difficulties lay in the selection of the necessary spatial elements from the huge list of various possibilities.

3.3. Application of ISO Encoding Rules in ALKIS

At present the technical contents of the data interchange interface of the AdV (Uniform Data Base Interface – EDBS) is very variously due to heterogeneous country realizations in the federal states of Germany. Primarily nationwide data users strongly demand a standardized data interface, because the data interchange is considerably aggravated. Due to the federal structure in Germany only the AdV is able to develop obligatory solutions within the field of official geospatial data. However, the AdV doesn't have any authority order at this and can only express recommendations. By corresponding decisions the AdV member countries commit themselves to these concepts. The AdV has decided to achieve this standardization finally with ALKIS to fulfill today's and tomorrow's needs.

Besides the standardization of the data interchange the definition of the data interface itself (encoding rules) is of great importance. Concrete samples for the data encoding have to be defined. The users must be able to interpret the data without extensive conversions and it must not be developed an "exotic". Therfore a data interface has to apply the concepts of standardization bodies in the field of geographis information. Only this way a vendor independent readability can be guaranteed. The AdV exactly goes this way and bases the interface definition for the data interchange (XML interface) on the appropriate concepts of ISO 19118 "Encoding Rules". Therefore the AdV data interface is called NAS (**N**ormbasierte **A**ustausch**s**chnittstelle - Standard Based Data Interface).

This chapter describes the situation and the difficulties by defining a data interface based on the ISO 19118 encoding standard. The following requirements for the data interface has been identified and determined:

- Avoid consequences on the technical UML application schema
- The structure of the data interface should be as simple as possible to enhance the acceptance of ALKIS by potential users
- The data interface should avoid unnecessary complexity not to build up an unnecessary barrier for the use of geographic data in Germany
- The data interface should be based on international accepted basic standards as far as possible
- Examine and test the encoding rules at concrete instances starting a prototyping before establishing the data interface
- Requests for an update mechanism have to be taken into account.

But also some problems were identified by using the ISO 19118 XML encoding rules within the specification of NAS. This document is still a draft standard and there are parallel developments at OGC (Open GIS Consortium) on the standardization of a data interchange. The OGC interface specification bases on GML (Geographic Markup Language) that is currently available in version 2.0. Actually, both developments aren't coordinated in detail. First attempts for harmonization are recognized, but probably a complete harmonization can't be expected at present. Saying it shortly: GML 2.0 and ISO 19118 encoding rules aren't as compatible as needed for the NAS.
Missing standardized XML-schemas for all ISO 191xx basic standards published in UML is a further problem. So you don't know how to encode the UML specifications correctly using the XML schema definition language for a concrete data transfer specification. If these schemas aren't specified and public available, the users of the ISO standard family will have to define specific encoding rules themselves which certainly causes the loss of interoperability.
Regarding the current situation at OGC's GML specification, there are also problems coming up by using GML 2.0 instead of ISO encoding rules. No exactly defined references to the ISO standards are given. Furthermore it doesn' t exist an update mechanism and either topology nor splines and arcs are supported.

Well, what is the right strategy to define data encoding rules? The AdV will use the ISO 19118 Level 1 in ALKIS, what means that an ISO compliant documentation of "NAS encoding rules" will be produced. This documentation maps the conceptual ALKIS data model to a GML 2.0 encoding schema (see figure 4). However, the NAS encoding rules will be defined as simple as possible and largely compliant to ISO 19118 XML encoding rules. The main objective is ISO and OGC conformance of the NAS encoding rules.

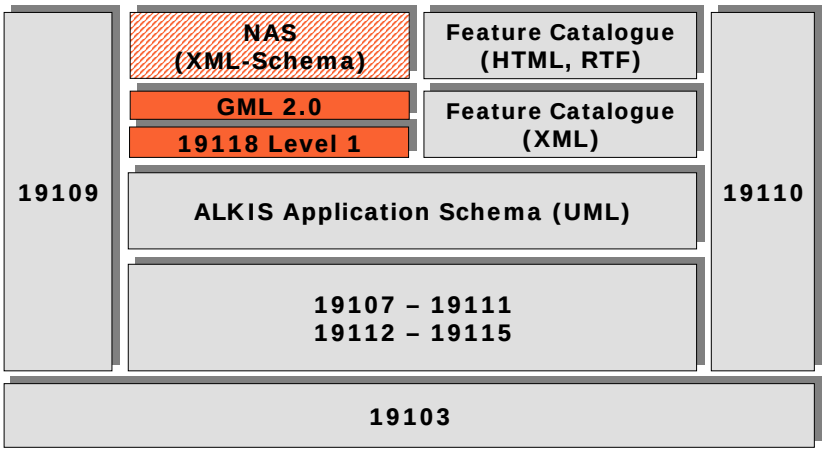

Fig. 4: Derivation of the NAS encoding rules

The NAS encoding rules can be derived from the UML application schema automatically as well as the feature catalogue mentioned above. Geometric elements not spezified in GML 2.0 so far has been defined in consideration of the GML 2.0 compliant extension mechanism (e.g. arcs). The challenge is to consider the upcoming GML daft standard as far as possible and use the existing ISO geometrical elements (surface, spline, ...), if these items aren't provided by GML 2.0 or 3.0. Missing elements needed for cadastral applications should be added at the GML 3.0 specification if possible. If necssary, the NAS encoding rules will be adapted to the final GML specification.

ISO and OGC have recognized the differences between both data interchange specifications and recommended a new work item proposal for harmonization, which will be strongly supported by the AdV.

4. CONCLUSION

The public geospatial data in in the field of cadastre is already used variously. By integration of various datasets in ALKIS, still managed with several systems at present as mentioned before, the use and further processing of the public geospatial data will be simplified substantially. The main reason is the consistent application of the ISO standards in the field of geographic information. So some essential advantages will arise for the users by the new conception:

- The implementation of the concept under consideration of international standards will ensure investment safeguarding, vendor independence and standardization of public geoapatial data.
- Definition of a universal, browser readable interface (XML encoding) for all public geospatial data.
- ALKIS becomes a core dataset that can easily be combined with other data from various administration in order to build up a spatial data infrastructure in Germany.

Therefore ALKIS will standardize the cadastral datasets in various ways in Germany. For the actual realization of ALKIS some further efforts are still necessary. Besides the implementation especially the migration of the datasets requires considerable efforts.
The application schema ALKIS has proved that ISO geographic information standards can largely be used without problems. If the GIS vendors will finally implement these standards as well, the objectives formulated by ISO, which were mentioned above, will soon become reality.

REFERENCES

WWW-Links:

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International Organization for Standardization, Technical Committee 211, **ISO/TC 211**: http://www.statkart.no/isotc211/
Open GIS Consortium, **OGC**: http://www.opengis.org

BIOGRAPHICAL NOTES

Markus Seifert is head of the working group that is modeling the conceptual schema ALKIS. Furthermore he represents the Bavarian Organization for surveying and cadastre in serveral national working groups concernig the standardization of public geospatial data. On behalf of the Working Committee of the Surveying Authorities of the States of the Fedaral Republic of Germany (AdV) he is member of national and international standardization bodies.