# THE SWISS CADASTRAL SYSTEM IN THE DIGITAL AGE

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## ABSTRACT

The Swiss cadastral surveying system is operational since 1912 and is the basis for land registration. In 1993, a new legislation was put in force defining the digital format of the cadastral surveying system, which at the same time extended the purpose of the data to be the basis for "any other land information system" as well, thus establishing the foundation of the upcoming spatial data infrastructures. This paper describes the basic conceptual elements of the digital format of cadastral surveying in Switzerland.

**Key words**: Switzerland, Cadastre, Data modelling, Spatial data infrastructure.

## COUNTRY CONTEXT

Switzerland is situated in the centre of Western Europe, bordering with Germany, Austria, Liechtenstein, Italy and France. Its territory covers an area of 41,290 sq km and is dominated by mountain ranges with a central plateau and large lakes. The total population is 8.2 million, of which 68% are living in urban areas.

The federal constitution defines Switzerland as a "league of the peoples of 23 sovereign Cantons" (three Cantons are subdivided into half-cantons) making it a federative country with largely decentralized structures. The Constitution also defines the separation of the three powers – legislative, executive, and judiciary. The Confederation, however, has only limited power. The 26 Cantons and the approx. 2,300 municipalities exercise a large degree of autonomy according to the subsidiarity principle. The Cantons are autonomous and have their own constitutions, parliaments, governments and courts. Also the municipalities enjoy certain autonomy with their own constitutions and communal statutes, although being under the supervision of their respective Cantons.

During the early 19th century under Napoleonic influence, cadastres were established in many of the 26 Cantons; however mainly for fiscal purposes. With the putting in force of the federal constitution in 1847, a modern state with a stable rule of the law developed, and with the industrial developments, the need for a legal cadastre emerged, securing land ownership rights and enabling land transactions. The Civil Law from 1912 constitutes the basis of the cadastral system with the two main elements of land registration and cadastral surveying. Several principles have been defined at that time, which are still valid today:

- the land register has five main parts and is based on a cadastral map;

- the cadastral map has to be based on cadastral surveying;
- according to the political and administrative structure of the country, the operational control of cadastral surveying and land registration is with the Cantons;
- the Confederation is supervising and subsidizing the Cantons;
- cadastral surveying can be contracted to private sector land surveyors;
- surveyors carrying out cadastral surveying need to hold a federal licence.

## INSTITUTIONAL FRAMEWORK

According to the political and administrative structure of Switzerland, the organizations involved in the cadastre are situated on the different administrative levels – federal and cantonal – and have different tasks and functions. For cadastral surveying, the Federal Directorate for Cadastral Surveying (V+D) has mainly the responsibility of supervising the cantonal surveying agencies. Those have the responsibility to implement cadastral surveying within their jurisdiction and territory. There are different, although similar solutions in each Canton, but most of them contract the fieldwork as well as the maintenance of surveying data and cadastral maps to private land surveyor offices, which then are acting as public agents on behalf of the Cantons. On the federal level, there are approx. 15 employees working for cadastral surveying, while there are approx. 300 on the cantonal level, and approx. 3,000 on the municipal level – most of them in the private surveying offices (compare Figure 1).

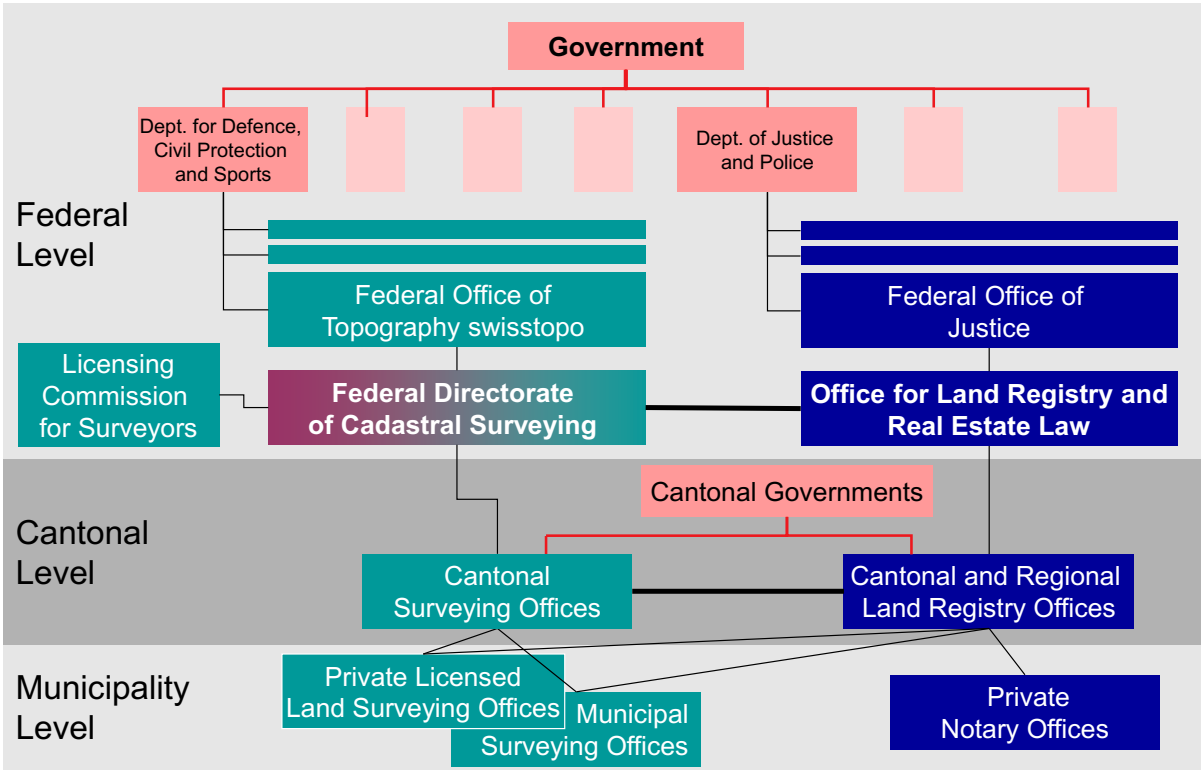


Figure 1: Organizations involved in the Swiss cadastral system.

For land registration, the regulations, set-up of offices and districts, the appointment and the compensation of land registrars lie in the competence of the Cantons. The Confederation supervises the Cantons through the "Federal Office of Land Registration and Land Law" with approx. 5 employees. Some of the smaller Cantons maintain a single cantonal land registry office, while in 18 Cantons, there are offices per one or several districts, or even per municipality resulting in a total of approx. 350 cantonal or regional land registry offices.

The involvement of the private sector in cadastral surveying is a normal practice since the establishment of the cadastral system in the early 1900's; it carries out 80-90% of the total work. The private sector is commissioned with projects – through a tendering process – for data acquisition, upgrading, and updating. There is a long established and accepted system, through which the private sector is mandated with data updating and maintenance procedures. As such, the private surveyors are acting as public agents providing decentralized services close to customers. With the availability of digital data, Cantons and municipalities are introducing their own land information systems and private surveying offices quite often support such projects either by contract or by consulting.

With the introduction of the land registration system in 1910, the Confederation also introduced a regulation for the licensing of cadastral surveyors. Only licensed land surveyors can carry out cadastral surveying. Although they are mostly operating in the private sector, they are public agents, bound by regulations and contracts.

On the university level, there are education programs in surveying on both campuses of the Federal Institute of Technology (ETH), one in Zurich and the other in Lausanne. Both offer programs equivalent to Masters degrees, which focus more on rural and environmental engineering with mostly optional courses in geomatics. The tendency towards environmental engineering over the last few years is actually a big challenge for geomatics. Around 50-60 students graduate from both ETH's combined each year. There are also two technicums that offer bachelor degrees in surveying, which have both combined some 20-30 graduates annually.

## CADASTRAL SYSTEM

From 1912 until 1993, the cadastral system had purely a legal purpose and was mainly geared for securing land ownership rights. The cadastral surveying data have however always widely been used as basis for utility mapping and all sorts of municipal and planning and management purposes. Since 1993, in addition to the legal purpose, cadastral surveying data (in digital form) are also intended to serve as basis for any land information systems. Since 2002, there is a growing need to document public law restrictions and responsibilities; working groups have been established to investigate their integration into the cadastral system.

There is only one comprehensive cadastral system, which by definition of land parcels covers the whole territory in a complete way. Every piece of land is a parcel with an assigned owner. Roads or public areas can for example be in the ownership of municipalities, cantons, or federal organizations. Also private companies or cooperatives can be owners of land parcels.

The cadastral system is based on a folio principle, i.e. each "land parcel" on the ground is related to exactly one land ownership title registered in the land registry. Every land parcel has a

unique parcel identifier number, to which all parcel-relevant information is linked. Buildings are by definition integral parts of "land parcels" and by default cannot cross parcel boundaries. In the case of a building sitting on top of a parcel boundary, the boundary would need to be rectified accordingly or the two parcels would need to be merged. Land parcels can be sold only as complete entities.

## CADASTRAL MAPPING

In 1993, two new ordinances – VAV ("Verordnung für die Amtliche Vermessung" or Ordinance for Cadastral Surveying) and TVAV ("Technische Verordnung für die Amtliche Vermessung" or Technical Ordinance for Cadastral Surveying) – replaced the old instruction for cadastral surveying from 1919. The aim was to renovate the cadastral surveying system and to introduce the digital data format. Due to the versatility of data in digital form, the purpose of the cadastral surveying data has been extended from purely serving the land register to serving land information systems of any kind. The establishment of the system independent data description language INTERLIS was a crucial element in this concept.

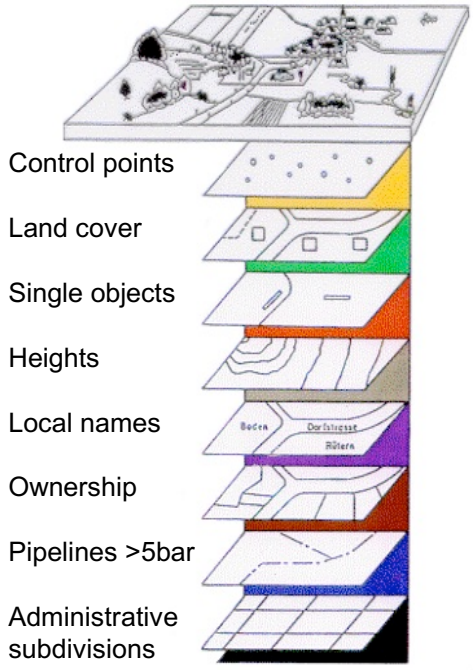


Figure 2: The original eight information layers of Swiss cadastral surveying.

The "digital" cadastral map has originally been defined to consist of eight information layers as illustrated in Figure 2. By definition, the two layers "Land cover" and "Ownership" cover the whole territory in a complete way, i.e. without overlaps and without gaps, while other layers have different structural definitions. Buildings are part of the "land cover" layer. The separation of the data into the eight information layers has the advantage that the layers can be acquired independently from each other. Each of the eight information layers is object-oriented and defined by an entity-relationship diagram, which is the data model and also the basis for the translation of the data into an interoperable INTERLIS data exchange format.

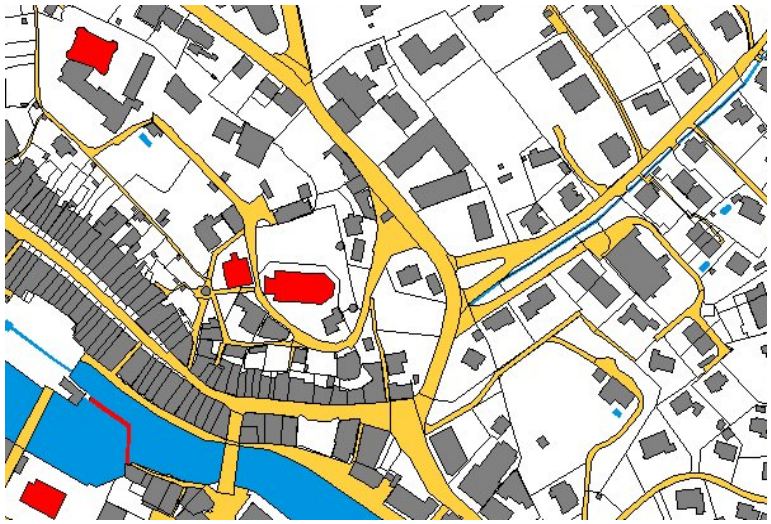

Figure 3: Example of new digital Swiss cadastral map with object-oriented approach.

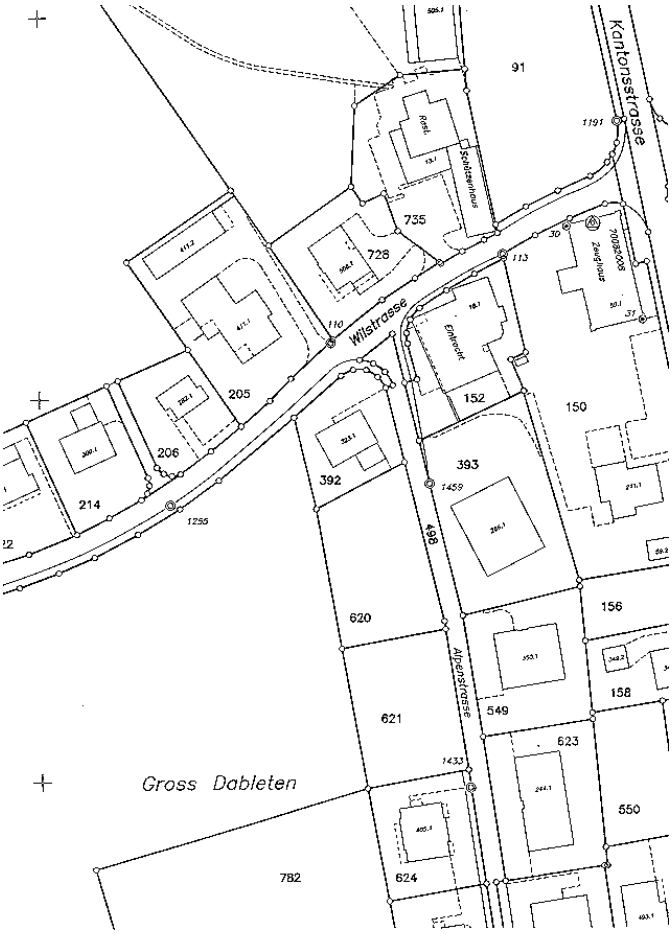


Figure 4: Example of a traditional Swiss cadastral map.

The introduction of the new data-modelling concept for the description of cadastral surveying data in 1993 triggered the development of SDI in Switzerland. The basic building block is the data description language INTERLIS with which spatial data can be defined, modelled, and exchanged without information loss and independent from any system restrictions. The data model for cadastral surveying has been named AV93, which is defined in the federal TVAV ordinance and legally binding for cadastral surveying in all Cantons. The data-modelling concept with INTERLIS has initiated the definition of more than 100 other spatial data domains since 1995, enabling the use of the same data exchange mechanisms like in cadastral surveying. In 1998, a new agency (COSIG) has been established to foster the coordination, acquisition, and use of spatial data within the federal administration. COSIG promotes the INTERLIS concept for the definition and handling of all spatial data. This concept is also at the core of the e-government project (www.e-geo.ch), which attempts to bring digital spatial data closer to the users.

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# FROM A TRADITIONAL TO A COMPREHENSIVE CADASTRE

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## ABSTRACT

The Statement 1 of the FIG Brochure 'Cadastre 2014' states: *Cadastre 2014 will show the complete legal situation of land including public rights and restrictions*. Based on this statement the author outlines the way to go to achieve the 'Comprehensive Cadastre' starting from the traditional property cadastre. The Comprehensive Cadastre will be the future tool for sustainable land management, which is increasingly important to master the future challenges. The author explains the design, the content, and the processes of the Comprehensive Cadastre and he shows the criteria and the preconditions for a successful implementation.

**Key words:** Cadastre, Cadastre 2014, modern cadastral systems

## DEVELOPMENT OF CADASTRES

The first cadasters date back to roman times to recover state owned lands that had been appropriated by private individuals, and thereby recover income from such holdings. With the fall of Rome the use of cadastral maps effectively discontinued. Medieval practice used written descriptions of the extent of land rather than using more precise surveys. In the sixteenth and early seventeenth centuries did the use of cadastral maps resume, beginning in the Netherlands. Napoléon, after taking the power about 1800, commanded to survey the parcels and to install cadastral systems for the land taxation wherever he invaded. Since then the official cadastre systems were spreading over the world and they served for the documentation of land rights and for land taxation.

These purposes remained unchanged for a long time until the issues of overcrowding and environment protection became obvious mainly after World War II. Emission cadasters, pipeline cadasters and multi-purpose cadastre arose, in many cases as parallel facilities to the property cadastre.

In view of the developments taking place in the field of cadastre, FIG Commission 7 launched in 1994 a working group with the following terms of reference:

*'Study cadastral reform procedures as applied in developed countries, take into consideration automation of the cadastre and the role of the cadastre as part of a larger land information system, evaluate trends in this field and produce a vision of where cadastral systems will be in the next 20 years, show the means by which these changes will be achieved and describe the technology to be used in implementing these changes'.*

The result of the work was published 1998 under the title CADASTRE 2014 - A Vision for a Future Cadastre System by the leader Jürg Kaufmann and the secretary Daniel Steudler with the Working Group 1 of FIG Commission 7.
CADASTRE 2014 after the publication was translated in about 30 languages and influenced the thinking about cadastre systems.

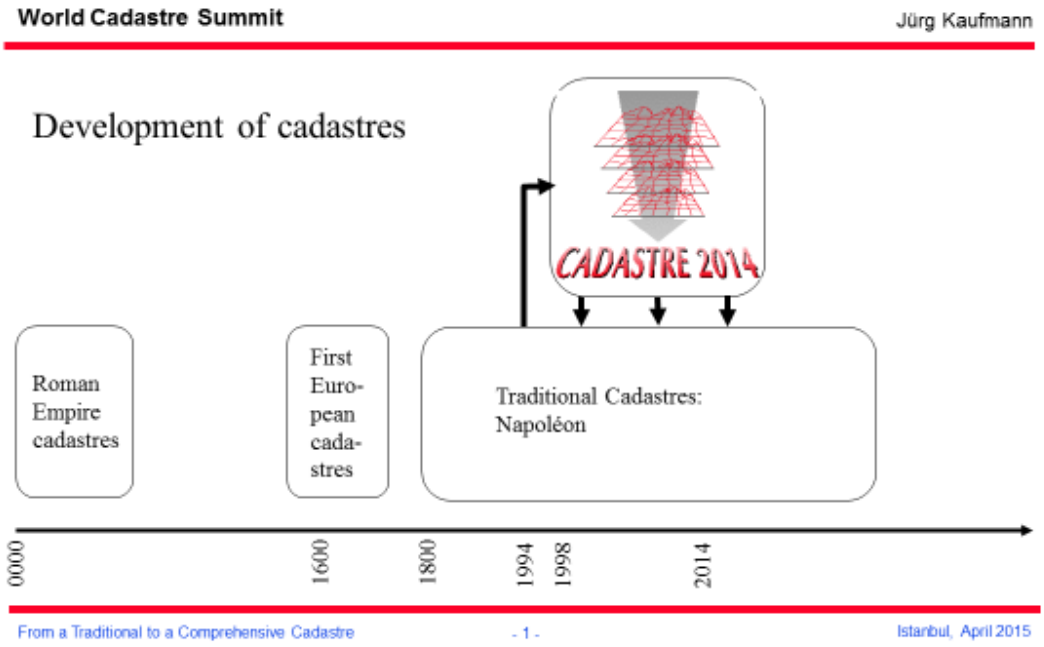


Figure 1 Development of cadasters

The brochure Cadastre 2014 launched six statements showing the developments to be expected in the next 20 years:

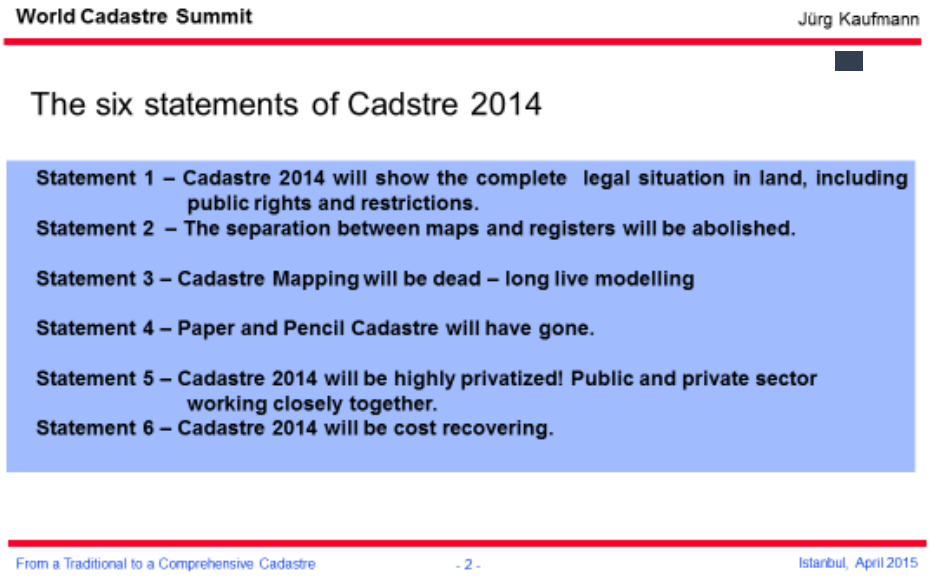


Figure 2 The six statements of CADASTRE 2014

Statement 1 describes the idea of a Comprehensive Cadastre as a further development of the traditional cadastre to an infrastructure documenting not only the land property rights but also all the rights restriction and responsibilities imposed on land by official or traditional whether written or unwritten regulations.

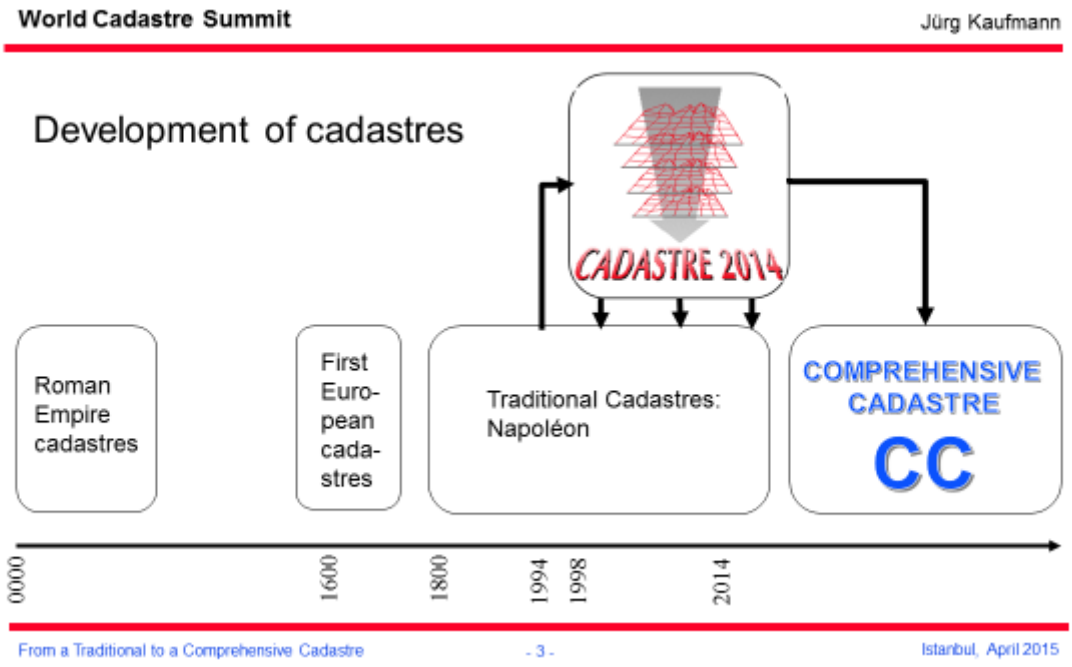


Figure 3 The next development step: The Comprehensive Cadastre

The Comprehensive Cadastre must cover a wider field than the traditional cadastre has since its introduction. The circumstances of the resource land have changed significantly since its inception.

During the development of the legal systems the private laws were dominant. The constitutions of most countries defined the rights of the citizens, one of which is the guarantee to own property. Civil codes have reinforced this guarantee and defined clear procedures and institutions to protect the rights of citizens against alienation.

The growing world population and the development of new technologies lead to an intensified use of natural resources including land. To protect the natural resources from being totally consumed, damaged, or destroyed, restrictions of the absolute right to use the natural resources were defined in the name of the social necessity.

Especially after World War II a growing number of new public laws were created. Land use planning, environment protection, noise protection, construction laws, protection against danger caused by natural phenomena, and so on, were regulated by public laws.

These definitions under public law can have an impact on the property right of the owner, but they are not part of the official register. The boundary definition process of the rights and

restrictions defined under public law follows democratic legal rules. But there is no boundary verification, no title verification, and no registration in an official legal register.

Aside from land objects from private and public law, a third category of legal land objects occurs in several countries where traditional rights exist. In these cases, areas are defined where tribal land use rights exist. They can overlap other legal land objects, such as private property rights and public rights and restrictions, and concessions for the exploitation of natural resources. These traditional, customary rights are often not documented in a manner that creates the necessary legal security.

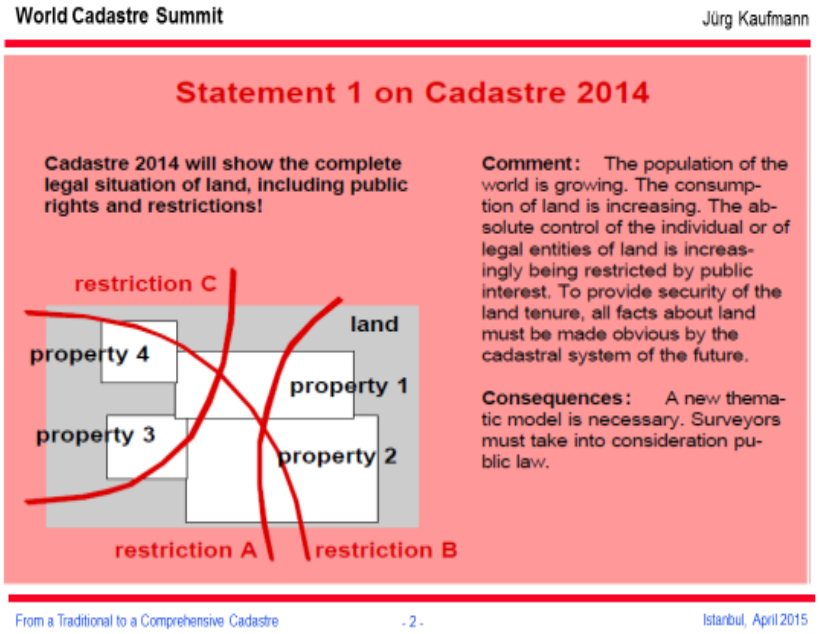


Figure 4 Statement 1 of CADASTRE 2014

The Comprehensive Cadastre must correct this situation, which is becoming more and more precarious. It must document, in a safe manner, all legal aspects of land.

## STRUCTURE OF THE COMPREHENSIVE CADASTRE

CADASTRE 2014 has introduced some principles to be applied for the structure of the Comprehensive Cadastre.

The structure of the Comprehensive Cadastre is to follow the principle of legal independence.


Figure 5 The principle of legal independence

*The principle stipulates that:*

- *legal land objects, being subject to the same law and underlying a unique adjudication procedure, have to be arranged in one individual data layer; and*
- *for every adjudicative process defined by a certain law, a special data layer for the legal land objects underlying this process has to be created.*

*The Comprehensive Cadastre is therefore based on a data model, organized according to the legislation for the different legal land objects in a particular country or district.*

While the traditional cadastre consists in general of one information layer representing the information about boundaries between different properties, in the Comprehensive Cadastre are added information layers representing the boundaries between land objects defined by different legal topics, which exist in a jurisdiction.

Daniel Steudler and Abbas Rajabifard designate this principle in the FIG Publication No 58 Spatially Enabled Society33 as institutional independence. With this term, they indicate that this structure is suitable to assign the responsibility for the data layers to the authority charged with the enforcement of a certain Act.

## PRECONDITION FOR THE COMPREHENSIVE CADASTRE

A further principle stipulated in Cadastre 2014:
*To make sure that legally independent organized land objects can be combined, compared, and brought into relation to each other, it is necessary that they will be localized in a common reference system. The combination and comparison of the thus located land objects can be*

[33] Spatially Enabled Society FIG Publication Nr. 58

*realized by the method of polygon overlaying. This method was published in already in 1973 by Kaufmann and Bigler [1973]*[34].

The Comprehensive Cadastre will only function in an efficient manner when the relations between land objects can be derived from their location. This avoids links between land objects in different information layers. According to experience in many cases, traditional and distorted maps are anyway to be replaced by data sets located in a common reference system in order to enable modern geographic information systems be able to render the expected services.

## STEPS TO IMPLEMENT A COMPREHENSIVE CADASTRE SUCCESSFULLY

### Introduce the possibility for the Comprehensive Cadastre in your legal framework

It is wise to fix the principle of a Comprehensive Cadastre before starting with the setup. Switzerland decided to introduce the cadastre of Public Law restrictions on Landownership, which can be considered as a first step of the Comprehensive Cadastre. A short article was introduced in Switzerland's Federal Act of 5 October 2007 on Geoinformation (Geoinformation Act) http://www.admin.ch/ch/e/rs/c510_62.html:

***Cadastre of Public-law Restrictions on landownership***
*Art. 16 Subject matter and form*
*1 The Cadastre of public-law restrictions shall contain public-law restrictions on landownership rights which, in accordance with the provisions of the Civil Code are not part of the Land Register.*
*2 The Federal Council determines which official geodata under federal legislation are entered in the Cadastre of public-law restrictions.*
*3 The cantons may define additional official geodata of proprietary nature that must be recorded in the Cadastre of public-law restrictions.*
*4 The Cadastre of public-law restrictions shall be made available in electronic form either online or by any other method.*
*5 The Federal Council shall determine the minimum requirements with regard to the organization, management, data harmonization, methods and processes for the Cadastre of public-law restrictions.*
In the Principality of Liechtenstein the legal base was laid in the Law on the official surveying as follows:

***Documentation of the public-law restriction of the landownership***
*Art. 57 Basic principle*
*1) The public-law restrictions with geometric characteristic as, in particular land use and development plans, protection zones or building lines, are represented in specific information layers.*
*2) The government determines the spheres, were information layers are defined.*

[34] Kaufmann & Bigler: New Techniques in Land Consolidation

**Develop a short enactment on the Comprehensive Cadastre**

Because the rules for the Comprehensive Cadastre are the same as those for the traditional cadastre a regulation can be kept short. In Switzerland we developed an Ordinance on the Cadastre of Public-law Restrictions on Landownership (PLR-Cadastre) with 33 articles regulating the details.

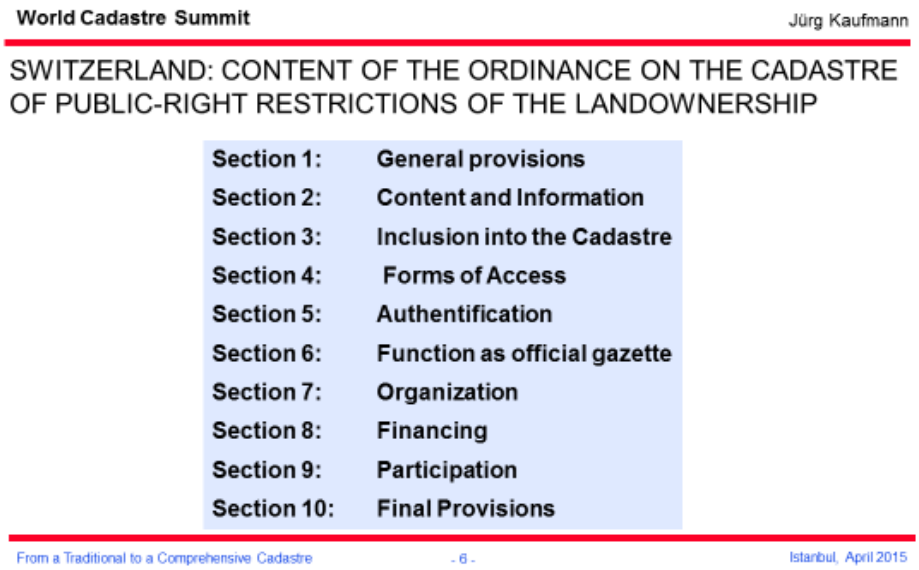


Figure 6 The content of the Swiss Ordinance on the PLR-Cadastre

**Introduce data and representation modeling as mandatory**

One important aspect for the successful implementation is the provision to use data modelling for the description of all data topics of the Comprehensive Cadastre and representation models to define how these data are to be represented on maps or other documents. Switzerland regulated this in the framework of the Federal Act of 5 October 2007 on Geoinformation. As modeling standard we use INTERLIS 2. Details may be found under www.interlis.ch .

**Determine a responsible authority for the Comprehensive Cadastre**

In every country a responsible authority must be designated to organize the Comprehensive Cadastre. To allocate this task to the authority already taking care of the traditional property cadaster seems to be appropriate and advantageous.

**Scan your legal framework including traditional rules authority**

A first task of the responsible is the scanning of the existing legal framework and also all existing unwritten traditional legal arrangements. As soon as a law or a regulation contains arrangements concerning maps, sketches, schemes, boundaries, building lines, etc., it is to be supposed that the respective land objects are candidates for inclusion in the Comprehensive Cadastre.

**Identify the stakeholders**

A further result of this scan shows the institutions responsible for the enforcement of the law. These institutions are the stakeholders to be involved in the implementation of the Comprehensive Cadastre. Together with these stakeholders the further steps are to be executed.

**Create data models for all legal topics included into the Comprehensive Cadastre**

It is absolutely important to describe all data of the Comprehensive Cadastre in a precise and easy to interpret manner in cooperation with the respective stakeholders. The modeling paradigm was launched by statement 3 of Cadastre 2014.

A tool for data modeling is determined in the ISO/TC211 - Geographic information/Geomatics Standards. The ISO 19152 standard deals with the Land Administration Domain Model (LADM) and was published in 2012. The standard describes the data model with Entity-Relationship-Diagrams but does not offer automatic model and data checking possibilities. Switzerland uses since 1993 the standardized data description language INTERLIS 2 which allows computer-assisted model and data checking. Recently the developers of the LADM from The Netherlands and Swiss data modelling specialists undertook an initiative to combine these modeling approaches by description of the LADM in INTERLIS 2 to profit from automatic checking facilities.

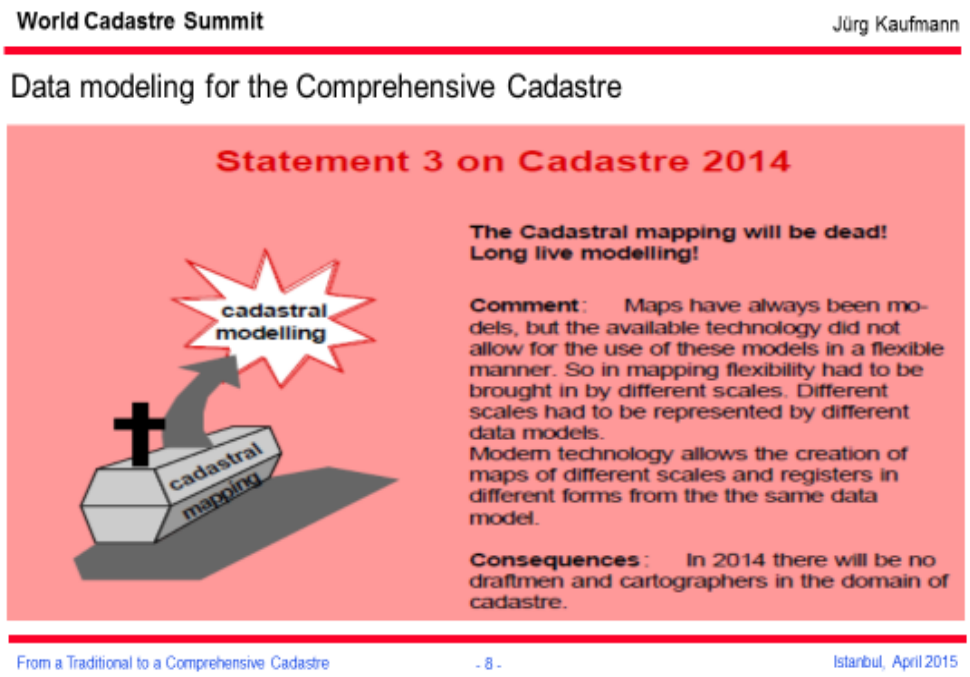


Figure 7 Data modeling

For all data topics to be included in the Swiss PLR-Cadastre data models have been developed. They are public and can be found on http://models.geo.admin.ch/ .

**Identify the procedures for the definition of legal arrangements**

Similar to the traditional cadastre the effective procedures must be known and pursued by the Comprehensive Cadastre System to make sure it works correctly. Sometimes these procedures are complicated and in many cases not handled correctly. It is worthwhile to analyze the procedures carefully and to take the opportunity to simplify them if this is possible.

**Develop a feasible IT-Infrastructure**

A Comprehensive Cadastre can only be realized with the help of IT. In a modern environment it makes sense to base the Comprehensive Cadastre on internet-technology.
In Switzerland's PLR-Cadastre a modern solution GeoApp replacing WebGIS by Web-Application was chosen to realize an integration platform organizing the access to the different information systems of the stakeholders by governing the directories, controlling the access rights, integrate data from different sources, and managing the rules to be applied.

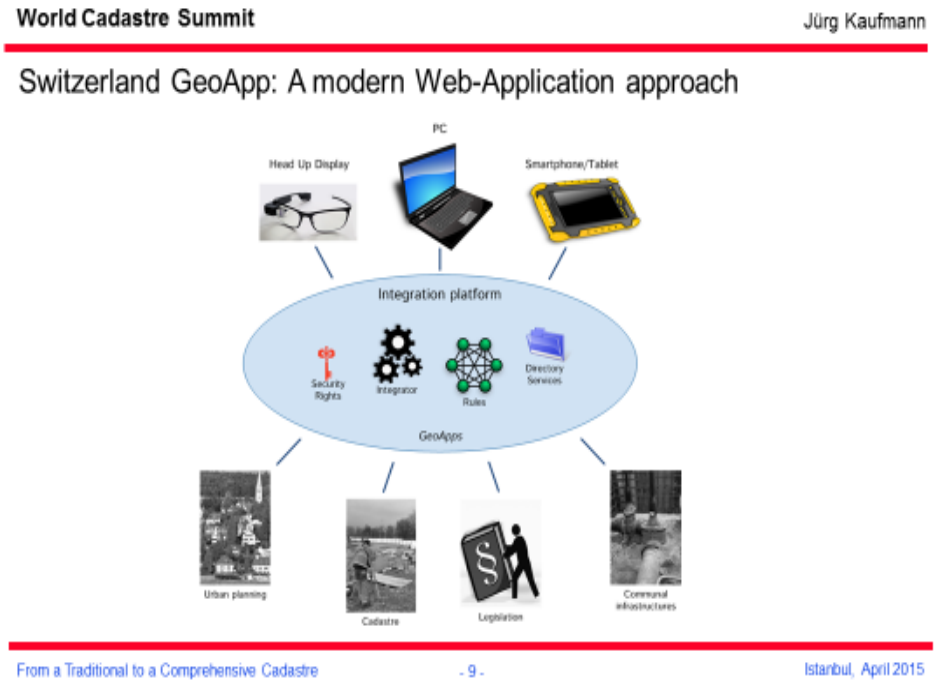


Figure 8 Modern approach in Switzerland

**CONCLUSION**

The Comprehensive Cadastre is the tool to keep the land matters under control and to allow sustainable land management. Only a comprehensive land documentation makes land administration and land management possible.

# CADASTRAL SYSTEMS IN FEDERAL STRUCTURES

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## ABSTRACT

The operation of cadastral systems in federative structures with decentral responsibilities is a special challenge. Successful solutions are possible provided flexibility, creativity, standards and commitment is available. The experience with federal structures can provide worthwhile impulses for the further development from cadaster systems to cadaster information infrastructures.

**Key words**: federalism, cadastre, decentral, spatially enabled society,

## ABSTRACT

Der Betrieb von Katastersystemen in föderalen Strukturen mit dezentralen Verantwortlichkeiten stellt eine besondere Herausforderung dar. Mit Flexibilität, Kreativität, Standards und Commitment können erfolgreiche Lösungen etabliert werden. Die Erfahrungen in föderalen Strukturen können wertvolle Impulse für die Weiterentwicklung von Katastersystemen zu Kataster-Informations-Infrastrukturen liefern.

## INTRODUCTION

In decentralized organizations with distributed responsibilities one of the challenges is to serve the customer needs by having easy access to all cadastral information in a high quality through one user-portal. The heavier challenge is it to change traditionally grown institutional structures.

In the last decades too much energy was wasted in projects to change structures instead of investing in creative solutions to overcome the limits of these structures. In decentralized systems the data maintenance and the data management take place in various areas and different organizational contexts. This flexibility in maintaining data is one of the advantages of federalistic structures. But how can a national user-portal be built without centralized spatial data infrastructure and without central authority?

In reality every federalistic level publishes its own data. In Switzerland this would mean one portal of the federation, 26 portals of each canton and more than 2000 portals of the municipalities. This would not be costumer friendly.

## PRINCIPLES OF SUCCESS

**Flexibility**

Distributed structures offer big chances to satisfy the differing needs and requirements of the society. The principle that data are to be maintained at the place where the change happens is easy to be implemented. Decentralized data maintenance provides normally better data actuality and quality.

The question of private or public cadastral services can be answered in a flexible way. So the tradition of each system can be taken into consideration. In the Trier-Architecture if SDI (data, business logic, user interface) the flexibility diminishes from down to up. The data management shall and should be handled flexibly according to the needs. The user interface in contrary should be as uniform as possible. For future cadastral systems flexibility on every level is a crucial requirement (Lüthy J. and Kaul Ch. 2015).

**Creativity**

For successful solutions in federalistic systems the established concepts and techniques cannot be adopted as is. Creative impulses and approaches are needed. The following example shall illustrate this: In Switzerland the data of the official cadastral surveying are normally administered on municipal level. Only few cantons take care of the data on cantonal level. The Swiss Federation has no own cadastral data. The classical approach where every level sends a copy of the data to the Federation fails due to the autonomy of the cantons and municipalities. The creative approach is to leave the data in the custody of the cantons or municipalities. A cascading business logic ensures that the client can make use of all the data with the help of a central portal.

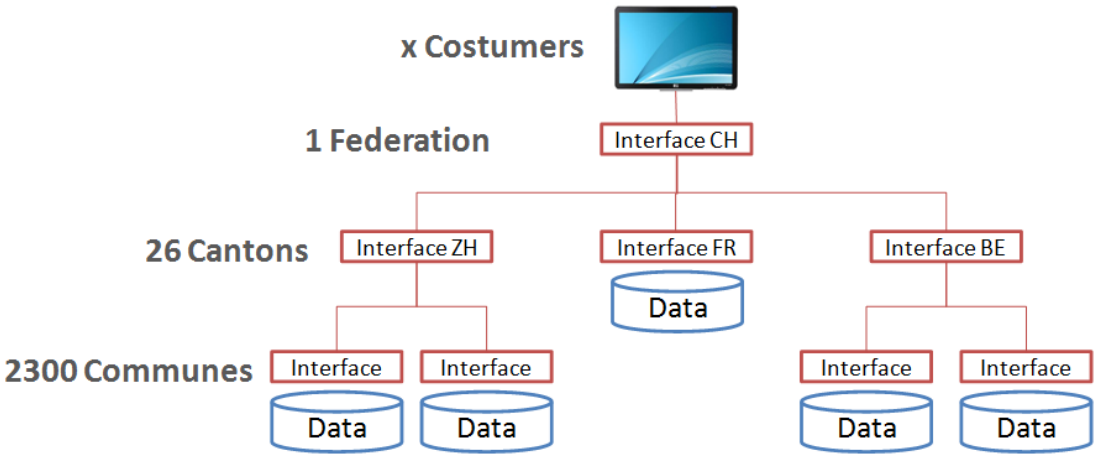


Fig. 2 Central use of decentralized data

**Standards**

Flexible and creative solutions can function optimally only when all involved components cooperate according to approved standards, In addition to common data models rules for services, algorithms and presentations are needed.

## Commitment

All principles mentioned above are useless when the will to find common solutions covering all federal levels is missing. In particular between the Federation and the cantons a strong commitment to find always new possibilities is needed. For this purpose Switzerland has implemented e-geo.ch, a special panel for exchange and common decisions.

## Look into the future

Independent from the question of federal or centralized cadastre organizations the cadastral systems are to become more flexible and dynamic to respond to the increasing future use requirements. The achievement of a Spatially Enabled Society (Steudler D. and Rajabifard A., 2012) is a big challenge. Within the general development from Spatial Data Infrastructures (SDI) to Spatial Information Infrastructures (SII) the cadastre is again the cutting edge (Lüthy J. and Kaul Ch., 2015). Experience in the field of federal systems provides worthwhile impulses.

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# STANDARDIZED DATA MODELING AND ITS BENEFITS

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## ABSTRACT

The Swiss Federal Act on Geoinformation [1] caused an intense activity in the creation of data models in Switzerland. By end of 2016 a total of 160 data models will be created for the Swiss National Spatial Data Infrastructure (NSDI). The data modeling language INTERLIS was chosen to define all data models in a standardized and easy accessible form. Through the model based INTERLIS approach easy sharing of high quality data between all parties (government agencies, private companies) becomes a reality.

**Key words**: Data Modeling, MDA, INTERLIS

## INTRODUCTION

Data modeling in the geo information space has a long tradition in Switzerland. Already in early 1990 the cadastral surveying model was published with the data modeling language INTERLIS in a standardized system neutral form (AV93). AV93 and its successor DM01 allowed public authorities and private companies to exchange standardized land information data in a system neutral format, thereby enabling to all parties the freedom of system choice.

The success of the original AV93/DM01 approach led to a private sector initiated project proposing the integration of the public-law restrictions (PLR) into the cadaster. In 2007, with the Federal Act on Geoinformation, the scope of activities was massively broadened again. The goal is to establish a National Spatial Data Infrastructure (NSDI) giving access for all participants to geo related information at minimal costs. In the NSDI not only the land information (cadastre, registration of right) and PLR layers are published, but also all other geo related information layers of the federal government. In the NSDI context the usage of a common standardized data modeling / integration concept like INTERLIS becomes essential for success.

## INTERLIS LANGUAGE

The first version of the data modelling language INTERLIS was introduced in Switzerland in the late 1980s (Dorfschmid et al [2]) and has become a Swiss standard in 1998 (SN 612030). INTERLIS [3] is an object-oriented conceptual schema language (CSL), which is being used to precisely define (spatial) data models in textual form with a rigid computer processable syntax. INTERLIS has a unique set of features which sets it well apart from other modelling standards (i.e. UML, XML-Schema or EXPRESS):

- INTERLIS can be used to describe relational or object-oriented data models in a system neutral way;
- INTERLIS can be easily understood by application and IT experts, therefore bridging the gap between IT and application domains;
- INTERLIS is precise enough to be directly processed by modern software tools;
- each INTERLIS data model automatically defines a system neutral XML based data exchange format;
- the language has built-in geometric data types (point, poly-line, polygon), making it especially suitable for models in the geoinformation domain;
- it is possible to quality check INTERLIS data against INTERLIS data models, thereby enabling fully automated quality control of spatial data including geometric attributes;
- INTERLIS is compatible with the most relevant international standards (UML, XML Schema, XML, GML).

But INTERLIS has not only an interesting set of features; it is also supported by a wide range of free and commercial tools for many years:

- the INTERLIS compiler checks the syntactical correctness of an INTERLIS data model (free);
- the INTERLIS checker can quality check INTERLIS XML data against INTERLIS data models (free);
- the INTERLIS UML editor is used to create INTERLIS models from UML diagrams or to visualize existing INTERLIS data models as UML diagrams (free);
- data translators can convert data sets from many GIS systems / databases to and from INTERLIS XML (free and commercial);
- schema tools can generate database schemata directly from INTERLIS data models (free and commercial);
- there is even a web based data server / map server based on INTERLIS (commercial).

More information, also in English, about the INTERLIS language and its tools are available at the official INTERLIS web site www.interlis.ch.

## BENEFITS

### Automated Quality Control

As the transfer format is directly derived from data model it becomes possible to check data against the data model. That property can be used to establish automated internet check services. In a typical usage scenario data is exported by the data collector in the system neutral format, sent to the internet check service for quality control and is finally transmitted to a portal server for publishing if the no errors in the dataset are found. The common INTERLIS data model is used to configure both check service and portal server.

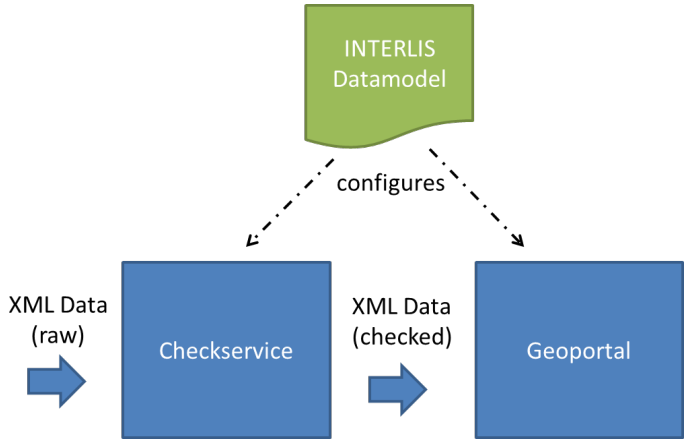


**Figure 1**: Checkservice Dataflow

## Generation of Databases

Several commercial and non-commercial tools have been developed to generate database schema directly from INTERLIS data models. With the help of the tools it becomes possible to create vendor specific database schemes (i.e. Oracle, ESRI) from the same INTERLIS data model.

## Public Model Repositories

In the context of an NSDI it is important to keep the many data models easily accessible and well organized. The Swiss government therefore publishes all INTERLIS data models in a public model repository at models.geo.admin.ch. Model repositories may be linked to other model repositories. Tools like the INTERLIS compiler or INTERLIS checker can automatically find the proper model by searching the repository and linked sub-repositories.

| Name | Last modified | Size | Description |
|---|---|---|---|
| ARE/ | 15-Jan-2015 16:38 | - | |
| ASTRA/ | 15-Jan-2015 16:38 | - | |
| BABS/ | 15-Jan-2015 16:38 | - | |
| BAFU/ | 09-Mar-2015 17:24 | - | |
| BAK/ | 15-Jan-2015 16:39 | - | |
| BAKOM/ | 15-Jan-2015 16:39 | - | |
| BAV/ | 04-Mar-2015 08:25 | - | |
| BAZL/ | 15-Jan-2015 16:39 | - | |
| BFE/ | 06-Mar-2015 14:19 | - | |
| BFS/ | 15-Jan-2015 16:40 | - | |
| BJ/ | 15-Jan-2015 16:40 | - | |
| BLV/ | 02-Dec-2014 09:54 | - | |
| BLW/ | 15-Jan-2015 16:40 | - | |
| CH/ | 20-Feb-2015 12:44 | - | |
| ENSI/ | 15-Jan-2015 16:41 | - | |
| VBS/ | 15-Jan-2015 16:42 | - | |
| V_D/ | 15-Jan-2015 16:42 | - | |
| ilimodels.xml | 12-Mar-2015 13:29 | 251K | |
| ilisite.xml | 12-Nov-2012 09:36 | 1.1K | |
| robots-disallow.txt | 11-Feb-2014 17:02 | 26 | |
| swisstopo/ | 15-Jan-2015 16:42 | - | |

**Figure 2**: Model Repository models.geo.admin.ch

## CONCLUSIONS

INTERLIS allows us to share standardized data models across multiple organizations and to exchange data in multivendor environments. System independent quality control becomes possible as the system neutral transfer format is directly derived from the standardized data model. In complex NSDI environments a common data modelling / data integration concept is the foundation for collaboration and therefore key to success.

## REFERENCES

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