9

A standardized land administration domain model as part of the (spatial) information infrastructure

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Spatial data sets are most useful in the support of decision making, management of space, performance of government and business, etc, when integrated in governmental information infrastructures (architectures). This implies availability of well maintained links between spatial datasets and other ‘basic’ or ‘key’ datasets, e.g. on addresses, persons, companies, buildings, land rights etc. Integrated, and inter-organizational value chains, business process management and reduction in administrative overheads can be introduced based on new business models. In general the resolution of problems in society requires more information than provided from one single data set, and this is equally true for problems with a spatial concept. It is evident that this type of data provision is complex in case data is stored at a variety of locations and in data models specific to its application domain. In this chapter it is argued that an effective infrastructure can be achieved solely by the use of authentic registers (or 'key registers') to store key data that is available for integration and multiple use.

A standardized Land Administration Domain Model (LADM) provides an extensible basis for efficient and effective cadastral system development based on a model driven architecture

(MDA), and enables involved parties to communicate based on the shared ontology implied by the model. As it is already difficult within one domain (such as Land Administration) to agree on the used concepts and their semantics, it will be even more difficult in case of dealing with other domains. However, we can not avoid this if a meaningful interoperable spatial information infrastructure has to be developed and implemented.

In this chapter we will discuss the standardization on domain level with Land Administration as a case (section 9.1). Programmes at European and national government level are signaling opportunities, setting policies and taking measures to capture the benefits of ICT. In tandem with societal demands, this will lead to government services via internet, key registers, web services and more. Developments on (S)II at national (with the Netherlands as a case) and European scale are introduced in key registers in the Netherlands of this chapter (section 9.2). The effects of the (S)II on a registration will then be analyzed in effects of (S)II on a registration (section 9.3). An introduction to the standardization efforts on the cadastral domain is provided in standardisation of the cadastral domain (section 9.4). Impact of further integration of cadastral data onto a spatial information infrastructure is discussed in discussion and conclusion (section 9.5).

9.1 Standardization on domain level

Sensing technologies, Global Navigation Satellite Systems (GNSS), and wireless communication have improved gathering and use of information on the web, resulting in a worldwide increase in use of digital geographic data. This has led in turn to renewed interest in applications employing geographic data, how objects relate spatially and new geo-information dissemination possibilities such as Google Earth, maps.com and Microsoft Virtual Earth. There are fast-growing possibilities for online use of geographic data for all kinds of analysis, and the reliance of society upon such data is growing commensurately. To enable the use of data from multiple national and international data sources a worldwide structure must be developed for describing digital geographic data and services. This is the aim of the International Organization for Standardization (ISO), in close co-operation with other organizations such as the Open Geospatial Consortium (OGC). Using ISO standards, a national standard for the exchange of geo-datasets based on a semantic model is currently being implemented in the Netherlands: using the base model geo-information of the Netherlands. For cross-border access to geo-data, a European metadata profile based on ISO standards is under development using rules of implementation defined by the Infrastructure for Spatial Information in the European Community - INSPIRE. For actual data exchange, the INSPIRE implementing rules will further define harmonized data specifications and network services. This is complemented with data access policies and monitoring and reporting on the use of INSPIRE (see Chapter 1 describing INSPIRE in more detail). From the Kadaster point of view, the main areas for web-services development include business-process management, data acquisition, online use of data from multiple sources, and e-commerce applications (Groothedde 2006).

In this chapter the role of a cadastral registration (or land administration) as an important component of the (Spatial) Information Infrastructure – (S)II – is investigated. In our view the cadastral registration itself contains both spatial information, e.g. on land parcels, and administrative information, e.g. registered real rights. In addition the cadastral registration has important relationships with other registrations in the (spatial) information infrastructure, again both spatial, e.g. topography, buildings, and administrative information: persons, addresses, companies/trade. It is therefore important to have unambiguous definitions of the contents of these registrations in order to avoid overlap and to enable reuse of information in other registrations. Further, due to continuous updating of these independent, but related, registrations care has to be taken to maintain consistency, not only within one registration, but also between registrations in the information infrastructure. By reusing of basic standards (geometry, temporal, meta data, observations and measurement), at least the semantics of these fundamental parts of the model are shared and well defined. What is needed in addition is domain specific standardization to capture the semantics of the cadastral domain on top of this agreed foundation (ISO General Feature Model). The model should specified in a Unified Modeling Language – UML – class diagram and then converted into a eXtended Markup Language – XML – schema, which can then be used for actual data exchange in our networked society (interoperability).

9.2 (S)II developments: key registers in the Netherlands

Information- and communication Technology ICT offers many opportunities for improving the performance of government and business. Areas which may profit include education, safety, health care, international co-operation, economic efficiency (integrated value chains, business-process management, and reduction in administrative overheads), prevention and detection of fraud, and accident and disaster management. ICT trends such as ubiquitous access, smart objects, open source, increased bandwidth; interoperability and data-exchange standards will result in new business models. New perspectives are opened up by options like increased location independence, high-quality online services based on immediate access to all required data, use of identified objects available for process control, integration within business chains and government organizations, and increased e-shopping.

The basic idea behind information infrastructures is that it provides for tools giving easy access to distributed databases to people who need those data for their own decision making processes. Although information infrastructures have a substantial component of information technology, the most fundamental asset is the data itself (commonly agreed representations of real world phenomena or social constructs), because without data there is nothing to have access to, to be shared or to be integrated. Last decade it was understood that the development of information infrastructures not only provided easy access to distributed databases, but also gave good opportunities for re-thinking the role of information supply for the performance of governments. Based on this starting point, the ‘Streamlining Key Data’ Programme of the Netherlands' government (Duivenbode and de Vries 2003) took the lead in the development and implementation of a strategy for restructuring government information. This is done in such a way that an electronic government evolves that:

- inconveniences the public and the business community with request for data only when this is absolutely necessary,
- offers them a rapid and good service,
- can not be misled,
- instills the public and the industrial community with confidence, and
- is provided at a cost that is not higher than strictly necessary

Jointly with a number of other government registers (see Figure 9.1), the property registers & cadastral maps & topographic maps of the Netherlands' Cadastre, Land Registry and Mapping Agency (hereinafter called ‘Kadaster’) have been formally appointed in 2002 as ‘key registers’ of the governmental information infrastructure. The key registers will be the core of a system of so-called authentic registers, which might be any register that is maintained by a single government body and used by many others as the authentic source of certain data. If a register is formally designated as an authentic register, all other government organizations are strictly forbidden to collect the same data by themselves. In their budget allocation they will not find any money for data collection at this point. The impetus that the Programme 'Streamlining Key Data' concentrates on two goals:

- The communal use of data: in principle data would be collected on one occasion, and repeatedly used for the implementation of series of laws and regulations.
- The joint use of data: data from different records required for the performance of a specific government duty would be combined in one database.

An authentic register is defined in the Programme as 'a high quality database accompanied by explicit guarantees ensuring for its quality assurance that, in view of the entirety of statutory duties, contains essential and/or frequently-used data pertaining to persons, institutions, issues, activities or occurrences and which is designated by law as the sole officially recognised register of the relevant data to be used by all government agencies and, if possible, by private organisations throughout the entire country, unless important reasons such as the protection of privacy explicitly preclude the use of the register' (van Duivenbode & de Vries, 2003).

The resolution of problems in society requires mostly more information than provided from one single data set, and this equally true for problems with a spatial concept. It is evident that this type of data provision is complex in case data is stored at a variety of locations and in data models specific to its application. An effective infrastructure can be achieved solely by the use of authentic registers (or 'key registers') to store key data that is available for integration and multiple use. Various countries work on this subject. The Streamlining Key Data Programme offers for the Netherlands the appropriate policy. This is to the benefit of efficient and effective performing authorities, and contributes to the reduction of the administrative overhead in both the public and the business environment. Legislation is currently being prepared – or has been approved – for the confirmation of the designation of the following registers:

- Municipal Personal Records Database - Population Register
- Cadastre (Parcels and Rights)
- Company Key Register ('New Trade Register')
- Addresses
- Buildings
- Topography (TOP10NL)

At 8th February 2007 the Dutch Parliament approved the Act on Basic Registration Cadastre and Topography. Planned implementation date is 1st of january 2008. The Municipal Personal Records Database has also been accepted as authentic register; the acts where Buildings and Addresses and further the New Trade Register will be appointed as key register are under process.

Experience acquired with the Municipal Personal Records Database (the population register, which can not yet be consulted on-line) indicates that the Kadaster could play a role in rendering these addresses and buildings accessible at a national level, even though the municipalities remain the owner of the source. The Kadaster’s justification for this approach is based on one of the agency’s core competences, i.e. its skills in the management and maintenance of national databases whit an extremely high update frequency.

It is Kadaster's strategy to play a leading role in the system of key registers. Figure 9.1 provides an overview of the system of key register.

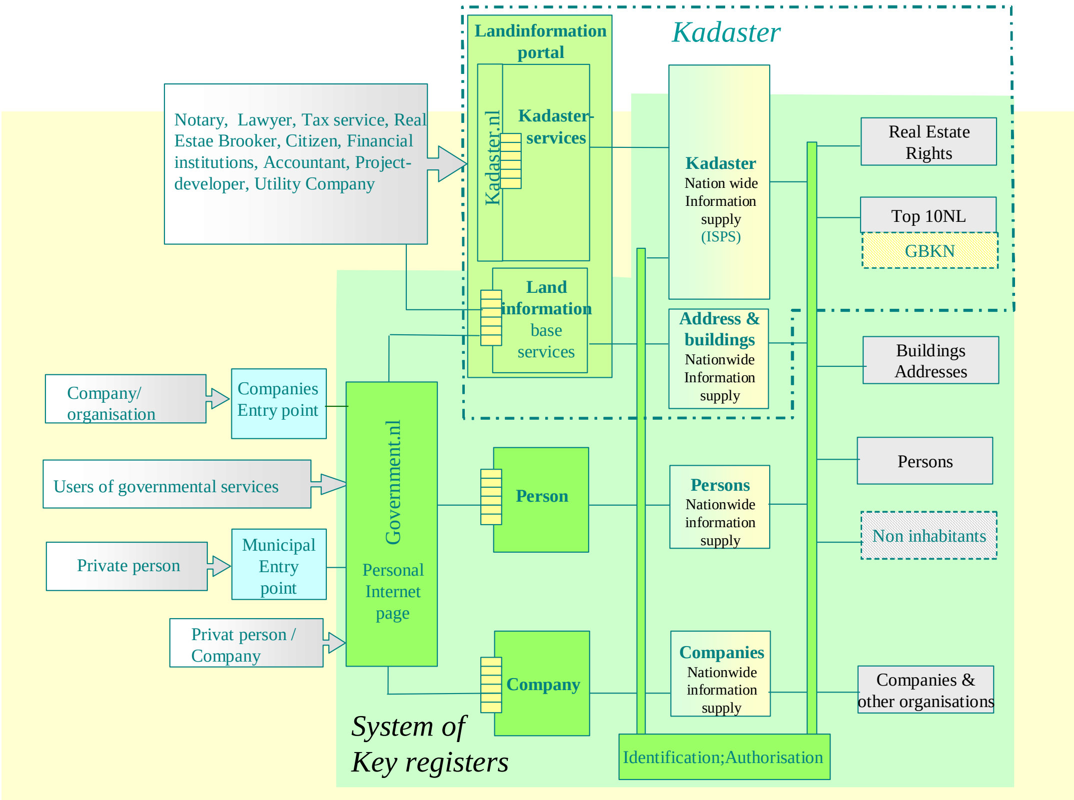

Figure 9.1: A landscape: the system of key registers and the Kadaster landinformation portal (Note that GBKN is the Dutch acronym for 'Grootschalige BasisKaart Nederland', or in English: Netherlands Large Scale Topographic Base Map, 1:1.000)

One can observe that this infrastructure does not only concern spatial data. Kadaster will review the extent to which supplementary relevant data could be included in the land register. The Kadaster can play a leading directive role in the organisation of the provision of this information to the market players, whereby consideration will need to be given to the cooperation with some registers within the context of digital availability and fast accessibility. The Kadaster can acquire a good position by the provision of a series of topographic and geographic products that possess an internal consistency and are indispensable to third parties within the context of spatial planning, land use, management, and maintenance. For this reason the cadastral map, the Large Scale Topographic Base Map 1:1.000 and Topographic Key Register 1:10.000 will need to be object-oriented and maintained mutually consistent by means of dataset integration using ontologies. Advanced detection of changes, for example using satellite images followed by the processing of the changes in all datasets ('change propagation') will then become a feasible proposition. The assumption of the management of, for example, the 'General Elevation Dataset of the Netherlands', and the 'National Road Database', indispensible to dynamic traffic management would be compatible with this. The integration of the National Triangulation (RD[1]: x and y) and Elevation Datum (NAP[2]: z) in a 3D reference frame would result in a pivotal role in the geometric infrastructure, inclusive of elevations.

At European level the priorities include completion of a Single European Information Space promoting an open and competitive internal market for information society and media, strengthening research into Innovation and Investment in ICT and achieving an Inclusive European Information Society. Objectives have been set for improving the security and reliability of broadband services, for creating better and smarter use of ICT within the public domain and for improving interoperability. Another issue at European level is better access to (key) data sets. The Infrastructure for Spatial Information within the European Community

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[1] RD is the Dutch acronym for 'Rijksdriehoeksmeting'

[2] NAP is the Dutch acronym for 'Normaal Amsterdams Peil'

(INSPIRE) aims to create a system for access to and exchange of spatial information for environmental monitoring. Cadastral and topographic data is considered relevant environmental data and will thus be included in discussions on European harmonized (meta)data content, network services, data access policy and monitoring data/services use.

Based on the above, Kadasters' current strategic objectives might be reformulated as aiming for the best possible performance of current public duties and promotion of innovation and knowledge for the adoption of a leading role in their evolution in response to societal developments. Strategic sub-objectives include:

- Investigation of evolution towards a (more) positive land-registration system
- Introduction of a 3D land register
- Ambition to adopt role as centre for a range of key registers
- Provision of more complete in-sight into private and public legal status of registered property
- Achieving a substantial role in organizing information needs of the property market chain
- Provision of appropriately linked set of topographic and geographic datasets, object-oriented and mutually consistent with respect to change
- Fulfillment of pivotal role in geometric infrastructure (x, y and z)
- Acceptance of prominent EU partner role in harmonizing registered-property law, land registration, and cadastres
- Development of flexible land-planning instruments suitable for use in realizing a variety of societal spatial objectives.

9.3 Effects of (S)II on a registration

In this section attention is paid to three of aspects that require specific attention when a certain registration is playing a role in the (S)II. The first observation is that the information content within the (S)II consists of several registrations and that it is therefore important to define what contents belongs to which registration. That is, defining the boundaries of the registrations. In the first part of this section this will be discussed in detail for the cadastral registration (also called land administration). The second observation is that the different registrations are related, i.e. there are references in the content from one registration to another registration. As the registrations are maintained by largely autonomous organizations care has to be taken when information is updated that related registrations are informed (in order to trigger potential related updates elsewhere). This topic will be discussed in the last part of this section. The third and final observation is that an unambiguous data specification is of course needed for the registration itself, but also when addressing the first two issues mentioned above (registration boundary and consistency between registrations after updates). How to achieve harmonized data specification of a registration (both with respect to other domain registrations in the same country and with respect to the same domain in other countries) is also introduced in this section. The next section will focus on the standardization of the cadastral domain.

First, the issue of the content of a specific registration and for this the cadastral registration will be used as an example. The result of comparing current cadastral registrations in different countries depends a lot on the equal scope of the models; e.g. if one cadastral model includes a person registration (with all attributes and related classes to persons) and the other model just refers to a person (in another registration), then the two models may look different, but the intentions are the same. Only the system boundary of the involved models is different. It is therefore proposed to try to get some consensus on the model boundary by considering the current cadastral registration practice in different countries of the world. Next an attempt to list themes that are related to, but outside, the Land Administration Domain Model (see next section for more details):

1. Spatial (coordinate) reference system;
2. Ortho photos, satellite imagery, and Lidar (height model);
3. Topography (planimetry);
4. Geology, geo-technical and soil information;
5. (dangerous) Pipelines and cable registration;
6. Address registration (incl. postal codes);
7. Building registration, both (3D) geometry and attributes (permits);
8. Natural person registration;
9. Non-natural person (company, institution) registration;
10. Polluted area registration;
11. Mining right registration;
12. Cultural history, (religious) monuments registration;
13. Ship- and airplane (and car) registration;
14. …

The first four topics listed above are or can be used in the cadastral system for reference purposes (or for support in data entry). Other topics have a strong relationship in the sense that these (physical) objects may result in legal objects (‘counterparts’) in the cadastral registration. For example, the presence of utility cables or pipelines can also result in a restriction area (2D or

3D) in the cadastral registration. However, it is not the cable or pipeline itself that is represented in the cadastral system; it is the legal aspect of this. Though strongly related, these are different aspects, compare this to a wall, fence or hedge in the field and the ‘virtual’ parcel boundary. The fact that these ‘external’ objects (or packages) are so closely related also implies that it is likely that some form of interoperability is needed. When the cables or pipelines are updated then both the physical and legal representations should be updated consistently (within a given amount of time). This requires some semantic agreement between the ‘shared’ concepts, or at least the interfaces and object identifiers. In other words these different, but related domain models need to be harmonized. As it is already difficult within one domain (such as the cadastral world) to agree on the used concepts and their semantics, it will be even more difficult when we are dealing with other domains. However, we can not avoid this if a meaningful interoperable geo-information infrastructure has to be developed and implemented. It seams appropriate that also a more neural organization plays a coordinating role in this harmonization process: OGC, ISO, INSPIRE, FIG (International Federation of Surveyors), CEN (European Committee for Standardization),….

In several countries of the world we see attempts to harmonize a number of domain models within one country; e.g. Australia, Germany, the Netherlands. But this is not sufficient, as the models should also be harmonized internationally as in the case of INSPIRE. One could raise the question: ‘what is the best order for harmonizing: first within a specific domain (at an international level as for example is the case with the LADM) and then harmonize these different domains, or first within a specific country (including all relevant domains) and then harmonize these different country models?’. Anyhow, it will be an iterative process as our insight and knowledge will keep on refining (and both approaches will probably be applied). An extremely important aspect of the future (Spatial) Information Infrastructure, (S)II, in which (related) objects can be obtained from another source (instead of copied), is that of ‘information assurance’. Though the related objects, e.g. persons in case of a cadastral system, are not the primary purpose of the registration, the whole cadastral ‘production process’ (both update and delivery of cadastral information) does depend on the availability and quality of the data at the remote server. Some kind of ‘information assurance’ is needed to make sure that the primary process of the cadastral organization is not harmed by disturbances elsewhere. In addition, remote (or distribute) systems/users might not only be interested at the current state of the objects, but they may need an historic version of these object; e.g. for legal claims, taxation or valuation purposes. So even if the organization responsible for the maintenance of the objects is not interested in history, the distributed use may require this (as a kind of ‘temporal availability assurance’).

Finally, a fundamental question is: ‘How to maintain consistency between two related distributed systems in case of updates?’. Assume that System A refers to object X in System B (via object id B.X_id), now the data in System B is updated and object ‘X_id’ is removed. As long as System A is not updated the reference to object X should probably be interpreted as the last version of this object available. Note that the temporal aspect is getting again a role in and between the systems! The true solution is of course also updating system A and removing the reference to object X (at least at the ‘current’ time). How this should be operationalised will mainly depend on the actual situation and involved systems. It might help to send ‘warning/update messages’ between systems, based on a subscription model of the distributed users/systems.

9.4 Standardisation of the cadastral domain

In order to obtain a unambiguous definition of the content of a cadastral registration, at the FIG Congress in Washington in 2002, the proposal was launched to develop a (shared) Core Cadastral Domain Model; the FIG CCDM (Lemmen and van Oosterom 2006), which has recently been renamed to Land Administration Domain Model (LADM), as in some contexts the term CCDM caused confusion and misinterpretations. After the launch several specific international workshops have been devoted to the development of this topic, various organizations have been involved (Open Geospatial Consortium - OGC, International Organization for Standardization - ISO/TC211, UN-Habitat, INSPIRE), MSc/PhD students, researchers and international experts have devoted a significant part of their research to cadastral modeling, resulting in a series of versions of the CCDM/LADM published in different magazines, proceedings and journals.

A standardized LADM, covering land registration and cadastre in a broad sense, the ‘multipurpose cadastre’ (Kaufmann and Steudler 1998), serves at least two important goals: (1) avoid reinventing and re-implementing the same functionality over and over again, but provide a extensible basis for efficient and effective cadastral system development based on a model driven architecture (MDA), and (2) enable involved parties, both within one country and between different countries, to communicate based on the shared ontology implied by the model. The second goal is very important for creating standardized information services in an international context, where land administration domain semantics have to be shared between countries (in order to enable needed translations). But the second goal is also important within one country, in order to meaningful combine and exchange information from several different registrations in the information infrastructure.

Important conditions during the design of the model were and still are: should cover the common aspects of cadastral registrations all over the world, should be based on the conceptual framework of Cadastre 2014 (Kaufmann and Steudler 1998), should follow the international ISO and OGC standards, and at the same time the model should be as simple as possible in order to be useful in practice. The LADM itself represents an important new wave in geo-information standardization: after the domain independent basic geo-information standards (current series of ISO and OGC standards), the new standards based on specific domains will now be developed. Due to historical differences between countries (and regions) similar domains, such as the land administration domain, may be modeled differently and therefore non-trivial harmonization has to be done first. The LADM is a result of this harmonization and one of the first presented examples of semantic geo-information domain standards.

A cadastral parcel is single area of land or more particularly a volume of space, under homogeneous real property rights and unique ownership (UNECE 2004 and WG-CPI 2006). Remark: by unique ownership is meant that the ownership is held by one or several owners for the whole parcel. By homogeneous property rights is meant that rights of ownership, leases and mortgages affect the whole parcel. This does not apply to specific rights as servitudes, which may only affect part of the parcel. Irrespective of the legal system adopted by each Member State, the Cadastre is defined as a register under the responsibility of the government. Its use complies with the principles of equality, security and justice to all the citizens of the European Union. Access to cadastral information is ruled by laws and regulations in order to protect the personal information. The classical Cadastre basic unit is the parcel. Parcels can be grouped in immovable register objects. A parcel has a nationwide unique real property identifier. The spatial description of the parcels and other cadastral objects should be provided with an adequate degree of accuracy. Descriptive data may include the nature, size, value and legal rights or restrictions associated with each immovable register object under or over the surface (adapted from PCC 2003). Cadastral parcels cover a territory (regional or nationwide) and there are no overlaps or gaps (in reality). An exception to this rule may be government land (or public domain) not registered within the Cadastre - though this is not recommended practice.

Besides various types of ownership, cadastral parcels, or to be more general immovable register objects, can be associated with other types of real rights (usufruct, superficies, long lease,…), responsibilities or restrictions. The line where a discontinuity in the specific legal situation occurs is the cadastral boundary. Vertices of this boundary can be marked in the field (or not). In many cases field sketches with survey observations are available as a source document. Observations (classical surveying: directions or bearings, angles and distances combined with control points or 'GPS-based surveying': co-ordinates) are used to determine coordinates in a projection system; those coordinates are adjusted to the cadastral map. Current practice is to express the coordinates in the cadastral map in the National Reference System. In the future this might be changed to the European Terrestrial Reference System (ETRS89), because more and more GNSS (GPS, GLONASS and Galileo) surveys will be used to collect data and this will better enable data consistency near the country boundaries within Europe.

A cadastral boundary does have several attributes of its own. Field sketches (or survey plans) can be used for boundary reconstruction in case of disputes. From a technical point of view the set of related boundaries is sometimes stored as a closed polygon, with a risk for gaps and overlaps between parcels (this is a quality problem in the database of course, not in reality). This also implies that every boundary would be stored at least two times (in 'left' and 'right' parcel), which is redundant. Further, boundaries do also have their own attributes, which have to be attached to

a specific instance (which would imply a three representation). In order to avoid these issues, a parcel representation based on a topological structure is often used. Mostly boundaries do not have a meaningful (based on an administrative hierarchy) identifier, but could be associated with field sketches (which do have some kind of meaning full identifier, known in the outside world).
To illustrate the relationships of the cadastral parcel registration with other registrations within an (S)II, a number of examples from INSPIRE will now be described. Specific boundaries of cadastral parcels are also the boundary of an administrative unit (municipality, province, country); this is an important relationship with theme 4 from Annex I of INPIRE directive (DIRECTIVE 2007/2/EC). Parcels and boundaries have associations with Buildings (theme 2 from Annex III of INPIRE directive) - sometimes used as local reference for boundaries, but also used for orientation purposes. Parcels and boundaries have associations with transport networks (theme 7 from Annex I of INPIRE directive) - same orientation purpose, but also roads, railroads, waterways are separate parcels as they are often owned by government. A strong link exists between cadastral parcels and addresses (theme 5 from Annex I of INPIRE directive). Links exist between cadastral parcels, land use (theme 4 from Annex III of INPIRE directive) and land cover (theme 2 from Annex II of INPIRE directive).
Cadastral parcels must have a unique real property identifier to which the legal status is attached. This identifier is often based on a hierarchy of administrative area's (provinces/districts/cantons/..., municipalities/communes/...., sections/polygons/...) and sometimes to the 'mother' parcel (subdivision of parcel ..../..../..../37 means for example ..../..../..../37/1 and ..../..../..../37/2). At a European level, the national identifiers should get a country code prefix to make them unique within Europe. Alternatively there could be explicit associations between predecessors and successors. The cadastral information should be

maintained continuously in order to reflect the actual legal situation. Of course, in reality and in information provision there might be a slight delay. Due to the legal importance, the history is currently maintained in some countries, but this may be needed in many countries.

In the annex of this paper the UML class diagram and the associated feature catalogue for the cadastral parcel data specification example is given (taken from INSPIRE D2.6 2007) and partly described as an example how a feature catalogue could look like. This feature catalogue is under development and will be based on the ISO 19110 (ISO 2005) as can be observed in the model there are both internal references (e.g. between parcels and boundaries based on the ISO19107 topology model) and external references to information in other registrations of the (S)II; e.g. Persons, Buildings, Addresses. The cadastral parcel model as presented in the Annex is based on the last version of the LADM (Lemmen and van Oosterom 2006), but adapted to the INSPIRE Generic Conceptual Model (INSPIRE D2.5 2007) and with application of the INSPIRE methodology to derive and describe harmonized data specifications (INSPIRE D2.6, 2007). It should be noted that stricter use of the ISO TC211 series of standards has been applied in this version, compared to the previous versions of the model.

9.5 Discussion and conclusion

Every country (countries can be in a federation) in Europe has a Cadastral or Land Administration system operational (in some countries not yet for the complete territory), often as the responsibility of a national organization, or as the responsibility of a more local government organization. Due to different legal systems and different national tradition, there is a rich variety of cadastral systems around. As this limits interoperability (e.g. in the context of EULIS) and results in high system development and maintenance costs, non-governmental (international) organizations, such as the FIG, developed the LADM and submitted this to ISO TC211 as a new work item proposal (N2125). Before the standardization procedure will start a complete feature catalogue of the LADM will be developed in addition to the UML class diagram.

Cadastres or Land Information Systems form an important part of the Land Administration Systems of the Member States. Cadastral activity is related to creating and updating the land parcel’s alphanumerical and graphical information and its aggregation. The Cadastral Organizations in each Member State are those public organizations that have specific legal responsibility in creating and updating the land parcel’s alphanumerical and graphical geo-referenced information, or its coordination at national level (PCC 2003).

Looking at it from a little distance one can observe that the systems are in principle mainly the same: they are all based on the relationships between persons and land, via (property) rights and are in most countries influenced by developments in the Information and Communication Technology (ICT). The two main functions of every cadastral system are: (1) keeping the contents of these relationships up-to-date (based on legal transactions) in a cadastral registration system and (2) providing information on this registration. In this chapter is has been explored which important issues related to a registration in an (S)II have to be confronted (registration content boundaries, keeping related registrations consistent after updates, and harmonized data content). Based on the experience of the Netherlands Kadaster solutions are proposed to solve these issues and this has been illustrated with on-going standardization activities within several international bodies (FIG, ISO TC211, INSPIRE,…).

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Annex Cadastral Parcels Data specification

Besides the foundation schemas and the proposed Generic Conceptual Model (see INSPIRE D2.5. 2007) it also contains a draft application schema for a theme, 'cadastral parcels'. The schema has been included to provide an example for an application schema. The current version of the model is shown on the UML class diagrams below.

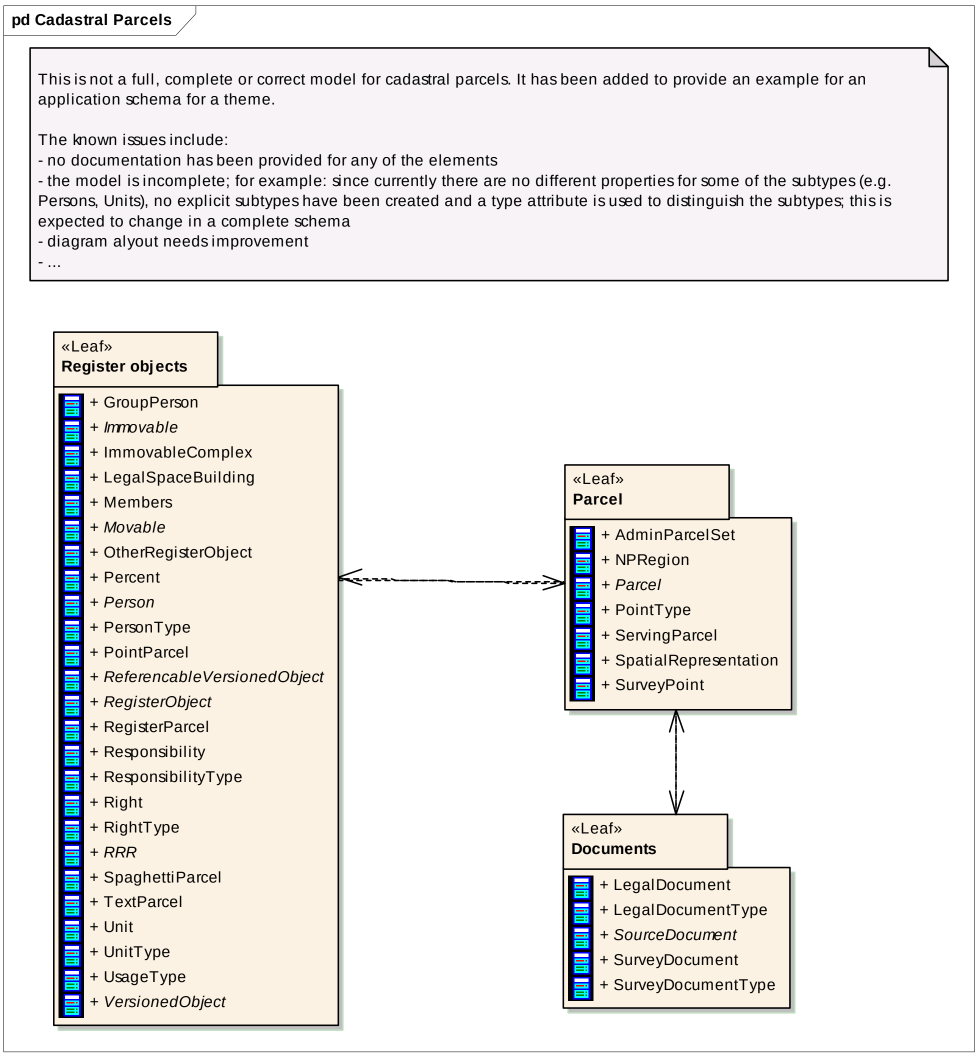

Figure 9.2 – Packages in application schema 'cadastral parcels'

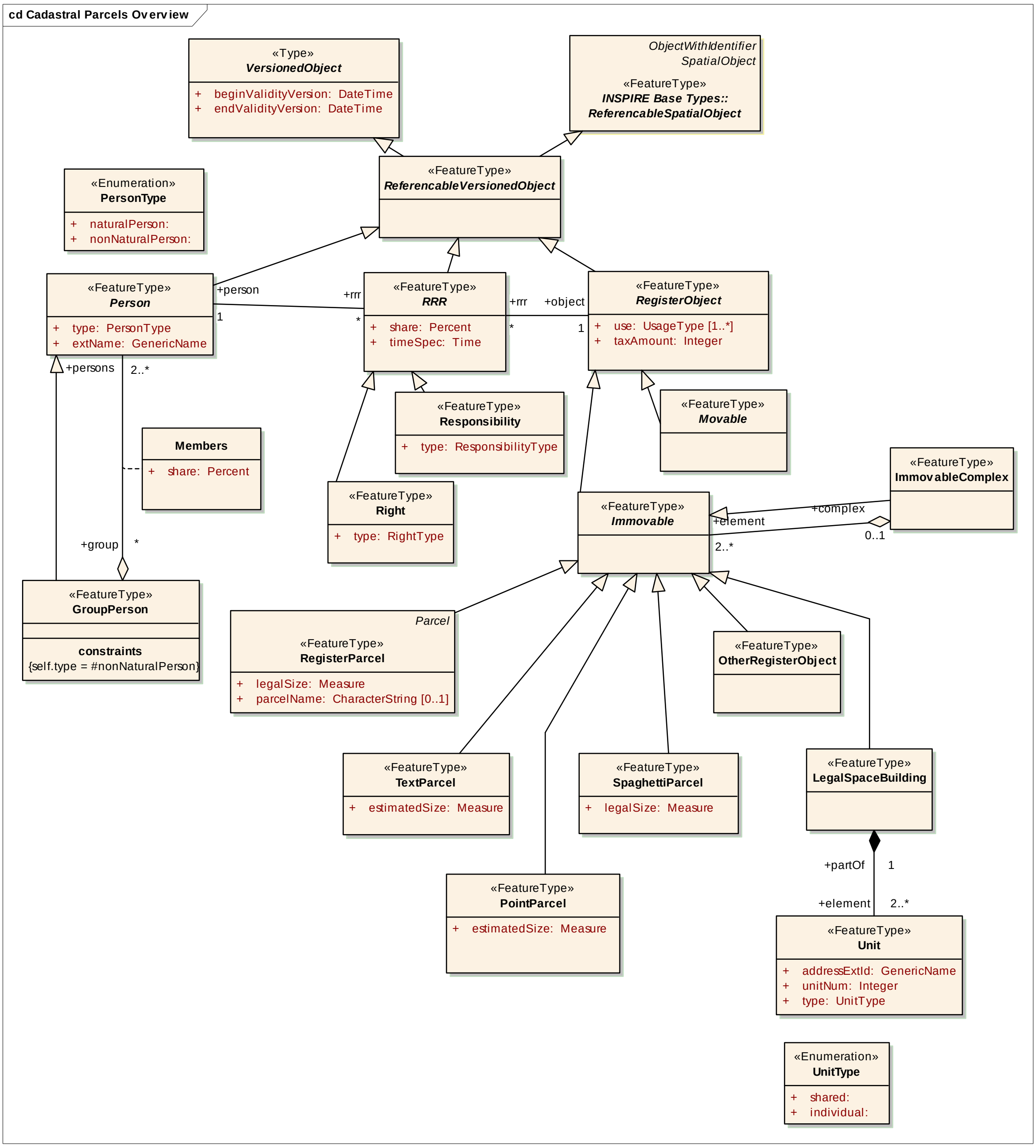

Figure 9.3 – Registered objects

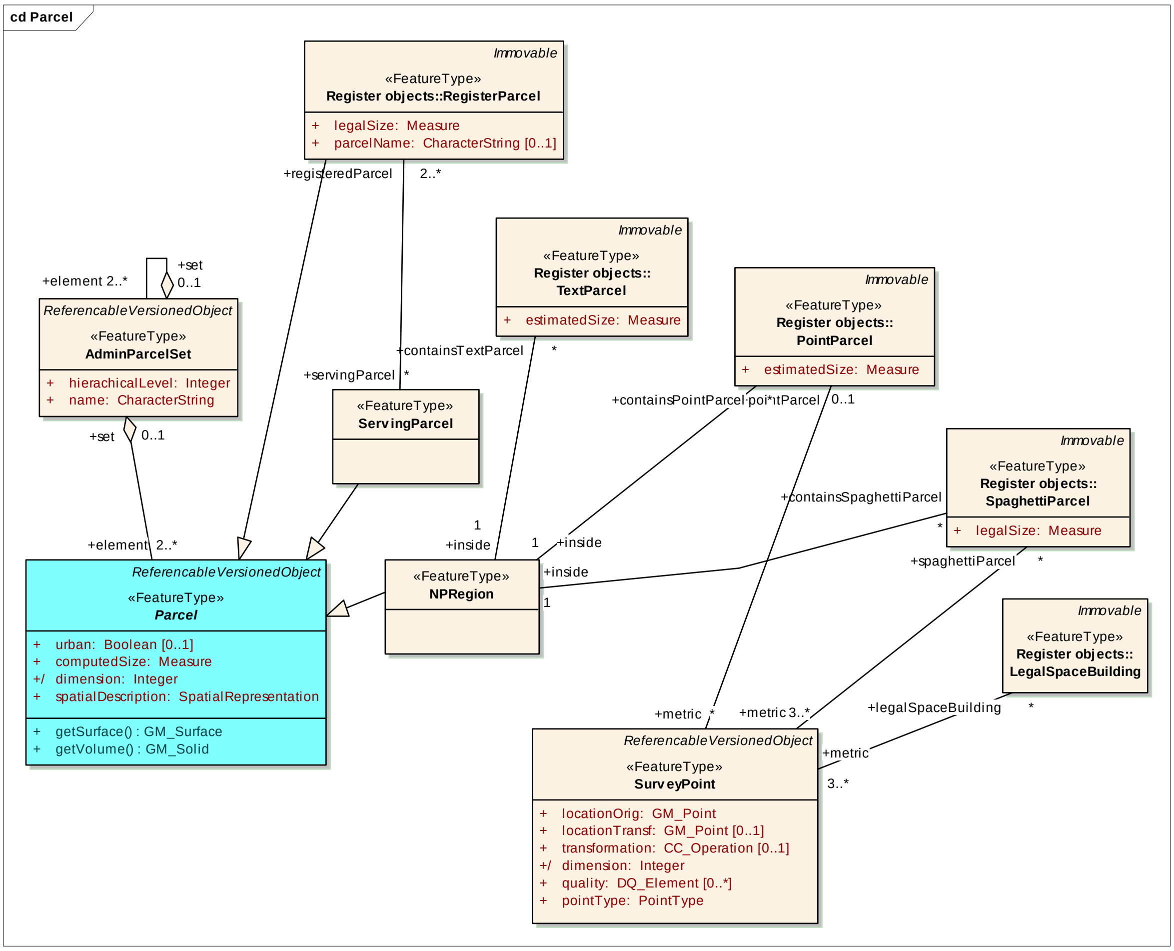

Figure 9.4 – Parcels

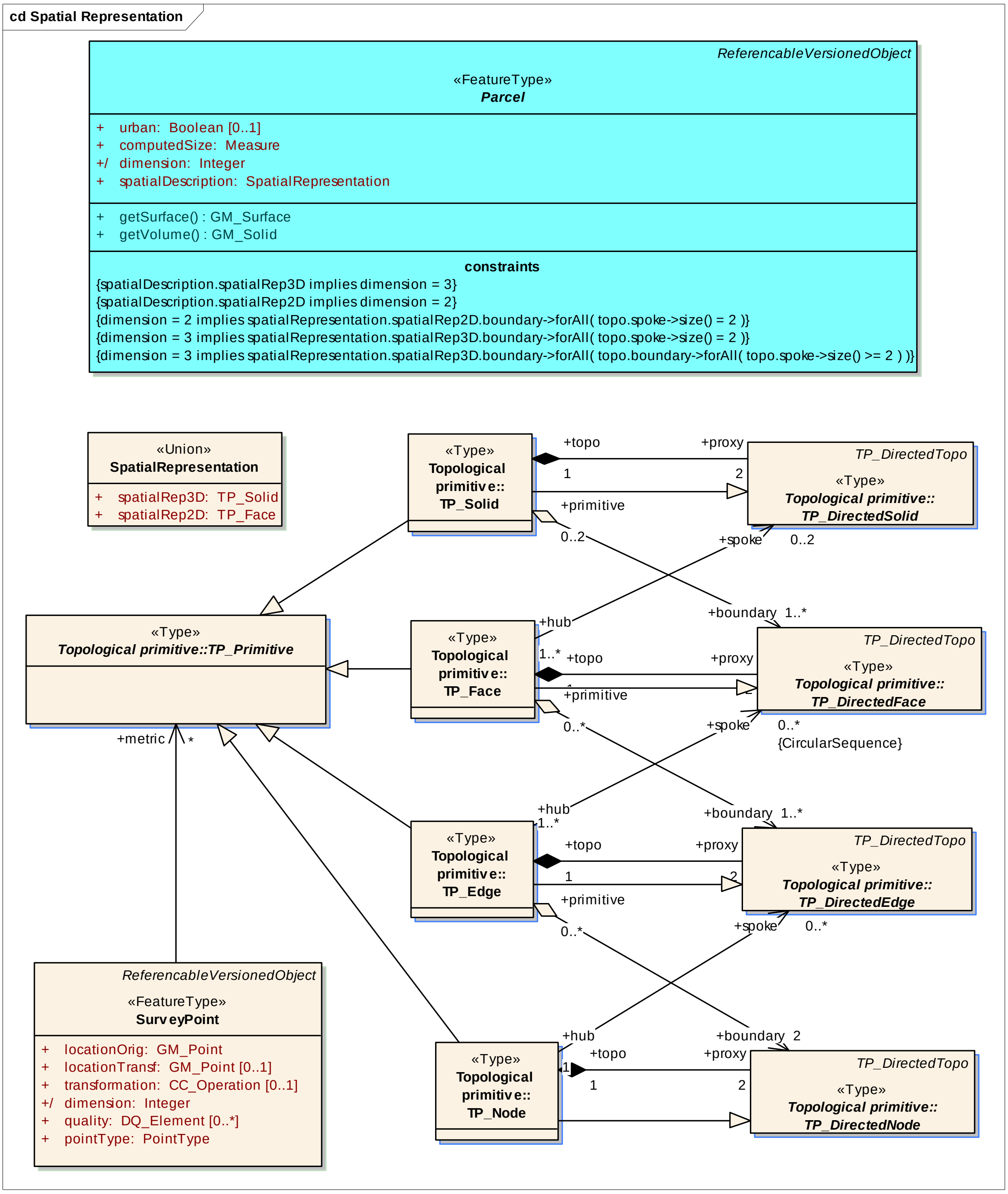

Figure 9.5 – Spatial representation of parcels and survey points

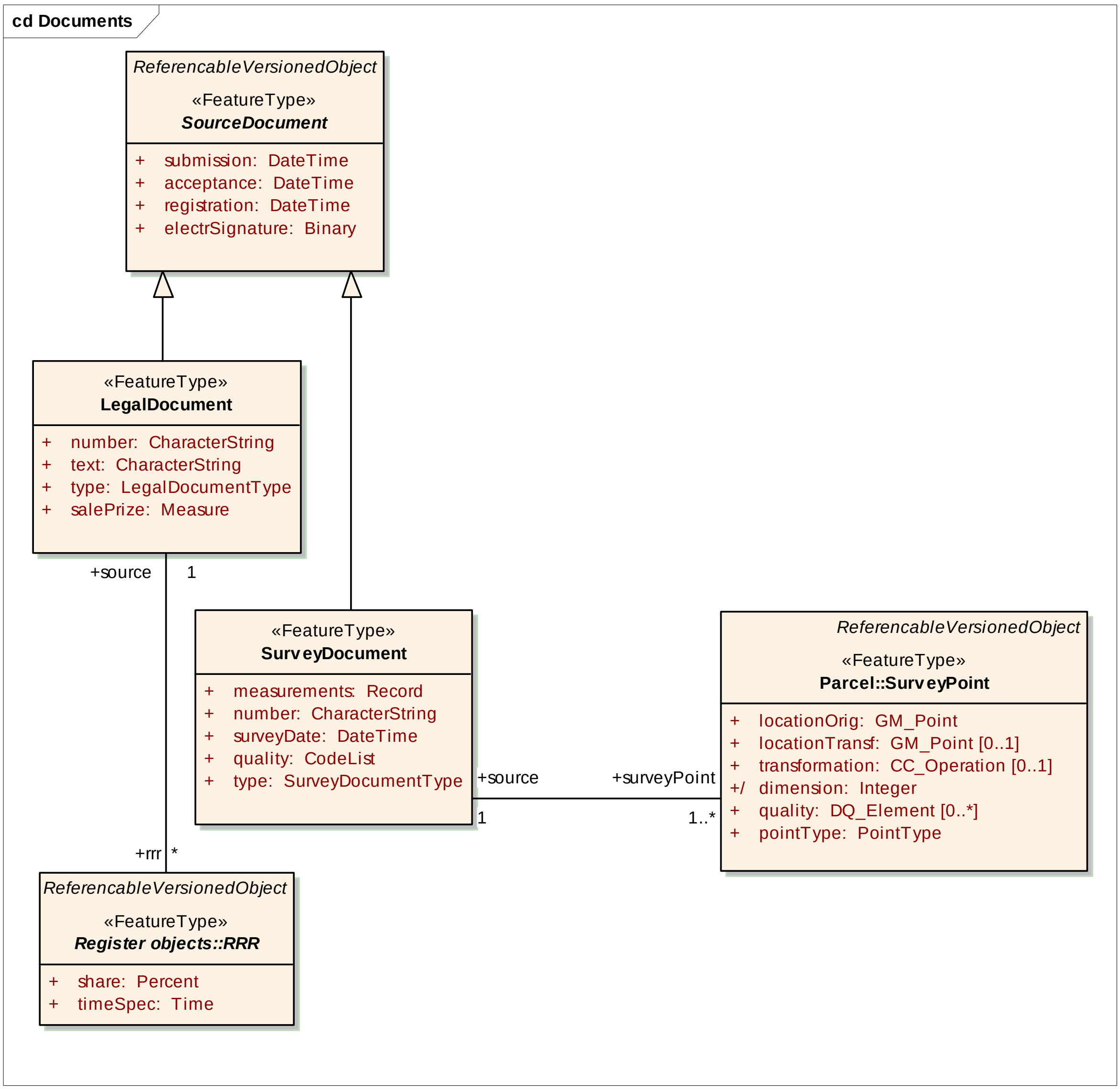

Figure 9.6 – Documents

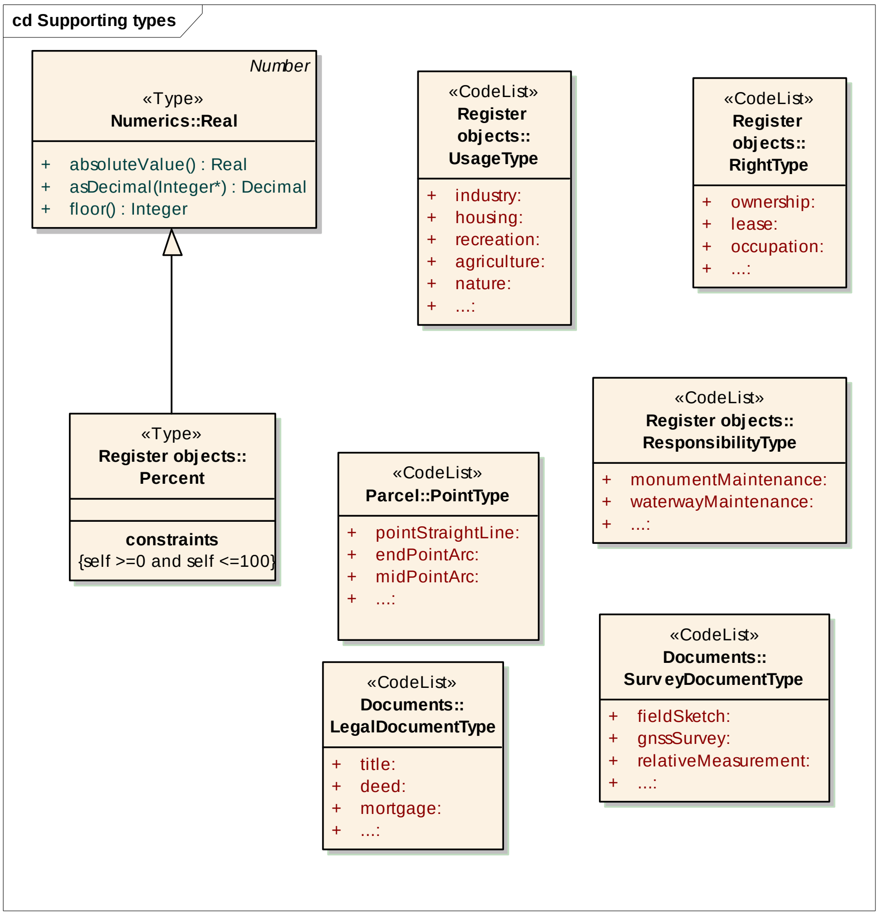

Figure 9.7 – Supporting types (basic types and code lists)

Feature catalogue for feature-based data (vector data).

The feature catalogue as presented below describes, as an partial example, how a feature catalogue for the Land Administration Domain may look like. A selection of the features as presented in the class diagram above is described here: the RegisterObjects which can be Movable or Immovable are introduced. RegisterParcel is one of the specialization classes of Immovable and is presented in this example – as well as ServingParcels and Parcels as specialization classes of RegisterParcel.

Feature catalogue metadata

Feature catalogue name:	*cadastral parcels*
Scope:	*cadastral parcels*
Field of application:	*multipurpose land administration (ownership, taxation, planning,..), including social tenures*
Version number:	*v0.2*
Version date:	*20-July-2007*
Definition source:	*INSPIRE DT (EULIS)*
Definition type:	*full model (feature, attribute, operation, association,...), example*

FEATURE TYPE

Name:	***RegisterObject***
Definition:	*Objects which are subject to registration in a (public) registration by law. Contains movable and immovable objects*
Aliases (optional):	*Dutch: registerobject*
Feature attribute name(s):	*use* *taxAmount*
Feature association name(s):	*to_RRR*
Feature operation names(s) (optional):	*N.A.*
Subtype of;	*ReferencableVersionedObject*

Feature Attribute

Name:	*use*		
Definition:	*main use of RegisterObject*		
Value data type:	*UsageType [1..*]*		
Value measurement:	*from legal document*		
Value domain type:	*enumeration type (CodeList)*		
Value domain:	*Depends on local situation*		
Feature attribute value(s):	Label:	Code:	Definition:
	Industry	*i*	*produce goods*
	Housing	*h*	*where people live*
	Recreation	*r*	*where people play*
	Agriculture	*a*	*produce food*
	Nature	*n*	*unspoiled environment*
	...	…	…

Feature Attribute

Name:	*taxAmount*
Definition:	*amount of real estate tax for the RegisterObject*
Value data type:	*Numeric*
Value measurement:	*local currency (UoM, Euro, Pound, etc.)*
Value domain type:	*integer*
Value domain:	*non-negative*

Feature Association

Name: *RegisterObject-RRR*

Inverse relationship: *RRR-RegisterObject*

Definition: *Rights, Restrictions and Responsibilities associated with RegisterObject*

Feature types included: *RegisterObject, RRR*

Order indicator:

Cardinality: ** at RRR, 1 at RegisterObject*

Constraints:

Role name: *rrr, object*

FEATURE TYPE

Name: ***Movable***

Definition: *A movable object*

Feature attribute name(s):

Feature association name(s):

Feature operation names(s) (optional): *N.A.*

Subtype of; *RegisterObject*

FEATURE TYPE

Name: ***Immovable***

Definition: *An immovable object: land and attached objects. A single* *area of land or more particularly a volume of space, under homogeneous real property rights and unique ownership. Remark: By unique ownership is meant that the ownership is held by one or several owners for the whole Immovable. By homogeneous property rights is meant that rights of ownership, leases and mortgages affect the whole Immovable. This does not apply to specific rights as servitudes which may only affect part of the Immovable.*

Aliases (optional): *Dutch: vastgoedobject*

Feature attribute name(s):

Feature association name(s): *to ImmovableComplex*

Feature operation names(s) (optional): *N.A.*

Subtype of; *RegisterObject*

FEATURE TYPE

Name: **RegisterParcel**

Definition: *Parcel subject to Registration*

Aliases (optional):

Feature attribute name(s): *legalSize;*

parcelName

Feature association name(s): *ServingParcel*

Feature operation names(s) (optional): *N.A.*

Subtype of; *RegisterObject and Parcel*

Feature Attribute

Name:	*legalSize*
Definition:	*The area of the parcel as described in legal (source) documents. This area can have been determined earlier in time and in general this area is not equal to calculated area from the spatial cadastral boundary vertices*
Value data type:	*numeric*
Value measurement:	*square meters (or alternative from legal document)*
Value domain type:	*real; other data types (Area: ha.are.ca or integer: in sqm) as they can be in local use can be derived from this*
Value domain:	***positive real***

Feature Attribute

Name:	*parcelName*
Definition:	*geographic name of the parcel as locally known*
Value data type:	*character*
Value measurement:	*from legal document*
Value domain type:	
Value domain:	

FEATURE TYPE

Name:	***ServingParcel***

Definition: *Serves two or more RegisterParcels and is held in joint ownership by the owners of those RegisterParcels*

Aliases (optional): *Dutch: mandeligheid; French: mitoyenneté*

Feature attribute name(s):

Feature association name(s): *RegisterParcel*

Feature operation names(s) (optional): *N.A.*

Subtype of; *Parcel*

FEATURE TYPE

Name: ***Parcel***

Definition: *A single area of land, or more particularly a volume of space, under homogeneous real property rights (UN/ECE, 2004) or social tenure relationships. The whole domain is subdivided in two types of regions (where it concerns the representation of real objects into the model): regions based on a partition (ServingParcel and RegisterParcel) and regions not based on a partition (NPRegion: non planar region; described within a NPRegion by TextParcel, PointParcel, or SpaghettiParcel's). Regions with a partition are completely covered by non overlapping parcels and can be represented in a topological structure (nodes, edges and faces and, depending on the dimension: solids). A Parcel may change its representation over time* *from TextParcel to PointParcel to SpaghettiParcel to RegisterParcel (fuzzy faces belonging to the same partition of space or surface).*

Aliases (optional): *Dutch: perceel*

Feature attribute name(s): *Urban, computedSize, dimension, spatialDescription*

Feature association name(s): *AdminParcelSet*

Feature operation names(s) (optional): *N.A.*

Subtype of;

Feature Attribute

Name: *Urban*

Definition: *Is Urban or Rural parcel (in case of Urban and Rural Cadastral system)*

Value data type: *boolean*

Value measurement: *from legal competence*

Value domain type:

Value domain:

Feature Attribute

Name: *computedSize*

Definition: *calculated area based on the co-ordinates of the boundary points. This area is most of the time not exactly equal to the legalSize of registerParcel*

Value data type:	*real; other data types (Area: ha.are.ca or integer: in sqm) as they can be in local use can be derived from this*
Value measurement:	*spatial database*
Value domain type:	
Value domain:	

Feature Attribute

Name:	*dimension*
Definition:	*dimension of Parcel: surface or volume*
Value data type:	*integer*
Value measurement:	
Value domain type:	
Value domain:	*2D, 3D*

Feature Attribute

Name:	*spatialDescription*
Definition:	*spatialRepresentation*
Value data type:	
Value measurement:	
Value domain type:	
Value domain:	*ISO 19107*